Simplicity SE (Smart Equipment) Controls
Sequence of Operation Overview
Technical Guide

Unit Controls Sequence of Operation Overview

Introduction

This document provides an overview of the 3-40 ton packaged products and 7.5-50 ton split systems products unit controls system components, supported features, and operating modes particular to each type of system.

Overview

Some sequences in this document use operational setpoints and temperatures. Operational setpoints and temperatures are the values that the control is using at a specific moment. For example, on a VAV unit, the operational VAV Cooling setpoint can be either the SAT Upper or SAT Lower setpoint. Furthermore, both of the setpoints can be altered by the Temperature/Humidity Control sequence described in this document.

Another example is the economizer minimum position, which can be altered by sequences like demand ventilation, fixed variable, or low ambient, as described in the economizer section.

A third example is the operational space temperature, which 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. All of the operational setpoints and temperatures can be viewed on the UCB local display.

General 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 they are set appropriately for proper operation.

Heating Parameters

Heating parameters include:

- 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)

Cooling Parameters

Cooling parameters include:

- 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)

Unit Protection

Timers

Timers include:

- 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 the <Heading Reference>Unit Protection section 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 (OprST)

Related Data and Inputs

Related data and inputs include:

- Operational Space Temperature (OprST)
- Space Temperature Source (STSrc)
- Network Override Space Temperature (NetST) communicated input on FC Bus
- NetSensor 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:

- Network Override Space Temperature
- NetSensor Space Temperature Value (NetST)

- Space Temperature Input (ST)
- Return Air Temperature Input (RAT)

If the input in use becomes invalid, Operational Space Temperature (OprST) reverts to the next highest priority input.

The Space Temperature Source (StSrc) describes the input in use for the Operational Space Temperature (OprST), and the indications include:

- *BAS Override*: indicates Network Override Space Temperature (NetST)
- *Network Sensor:* indicates a NetSensor
- *Local Input*: indicates a Space Temperature Input (ST)
- *Return Air Temp*: indicates Return Air Temperature (RAT)
- *Unreliable*: indicates no valid input is available for 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 passes without a communicated value, then the UI displays Value Timed Out and the next highest priority input is used.

NetSensor Space Temperature Value is used after approximately 30 seconds from the time a NetSensor 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 (OprSSO)

Setpoints and Related Data

Setpoints and related data includes:

- Operational Space Temperature Setpoint Offset (OprSSO)
- Space Temperature Setpoint Offset Source (SSOSrc)
- Space Temperature Setpoint Offset Range (SSORange)

Inputs

Inputs include:

- Network Override Space Setpoint Offset (NetSSO) communicated on the FC Bus
- NetSensor 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 NetSensor 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: Network Override Space Setpoint Offset is not bound by the Space Temperature Setpoint Offset Range (SSORange).

The highest valid priority input is used for 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)
- NetSensor Space Setpoint Offset
- Space Temperature Setpoint Offset Input (SSO)

If the input in use becomes invalid, 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:

- *BAS Override*: indicates Network Override Space Setpoint Offset
- *Network Sensor:* indicates a NetSensor
- *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 passes without a communicated value, then the UI displays Value Timed Out and the next highest priority input is used.

NetSensor Space Setpoint Offset is used after approximately 30 seconds from the time a NetSensor with space temperature setpoint offset capability is connected to the SA Bus.

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, CV Occupied Cooling Setpoint (ClgOcc-Sp) and 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 the <Heading Reference>Setpoint Determination section for additional information.

Operational Outdoor Air Temperature

Setpoints and Related Data

Related data includes:

- Operational Outdoor Air Temperature (OprOAT)
- Outdoor Air Temperature Source (OATSrc)

Inputs

Inputs include:

- 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, Operational Outdoor Air Temperature (OprOAT) reverts to the next highest priority input.

The Outdoor Air Temperature Source describes the input in use for Operational Outdoor Air Temperature, and the indications include:

- *BAS Override*: indicates 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 passes without a communicated value, then the UI displays Value Timed Out and the next highest priority input is used.

Outdoor Air Temperature Input (OAT) is used if the temperature sensor is connected to the OAT pins.

Operational Space Humidity

Setpoints and Related Data

- Operational Space Humidity (OprSH)
- Space Humidity Source (SHSrc)

Inputs

Inputs include:

- Network Override Space Humidity (NetSH) communicated value on FC Bus
- NetSensor Space Humidity Value to the SA Bus
- Return Air Humidity (RAH) to RAH pins

Operation

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 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)
- NetSensor Space Humidity Value
- Space Humidity RAH Input (RAH)

If the input in use becomes invalid, Operational Space Humidity reverts to the next highest priority input.

The Space Humidity Source describes the input in use for Operational Space Temperature, and the indications include:

- *BAS Override*: indicates Network Override Zone Humidity
- *Network Sensor*: indicates a NetSensor
- *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

Network Override Zone Humidity is used if a value is set or communicated within the past 15 minutes. If 15 minutes passes without a communicated value, the UI displays Value Timed Out and the next highest priority input is used.

NetSensor Space Humidity Value is used after approximately 30 seconds from the time a NetSensor with space humidity capability is connected to the SA BUS.

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 Operational Space Humidity, control functions that use Operational Space Humidity (OprSH) are not permitted.

Operational Outdoor Air Humidity

Setpoints and Related Data

Related data includes:

- Operational Outdoor Air Humidity (OprOAH)
- Outdoor Air Humidity Source (OAHSrc)

Inputs

- 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. 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 passes 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 (OprIAQ)

Setpoints and Related Data

Setpoints and related data includes:

- Operational Indoor Air Quality (OprIAQ)
- Indoor Air Quality Source (IAQSrc)
- Indoor Air Quality Sensor Range (IAQRange)

Inputs

Inputs include:

- 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) par 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.

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 elapses 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

Setpoints and related data includes:

- Operational Outdoor Air Quality (OprOAQ)
- Outdoor Air Quality Source (OAQSrc)
- Outdoor Air Quality Sensor Range (OAQRange)

Inputs

Inputs include:

- 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 0-10 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 elapses 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

Setpoints and related data includes:

- Operating Purge Command (OprPurgeCmd)

- Purge Command Source (PurgeCmdSrc)
- Exhaust Type (ExFType)

Inputs

- 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:

- *BAS Override:* indicates Network Override Purge Command
- *Local Input:* indicates Local Purge Command Input

Operating Purge Command indicates **True** if either:

- Network Override Purge Command is set to **True** and has not reached or exceeded the 15 minute timeout for communicated values
- Local Purge Command Input indicates **True** - 24 VAC input is applied to Economizer board PURGE terminal

When 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 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 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 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 VFD 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.

Constant Volume (CV) Sequences

Thermostat Inputs

Setpoints and Related Data

Setpoints and related data includes:

- Thermostat Only Control Enable (Tstat-Only) ON

Inputs

Inputs include:

- 24 VAC to limit switch safety terminal LIMIT, LIM2, LIM3
- 24 VAC to gas valve verification terminal MV, GV2, GV3,4
- 24 VAC to HPS1 thru HPS4 and LPS1 thru LPS4
- evaporator coil temperature sensor EC1, EC2, EC3, and EC4
- 24 VAC to terminals Y1 through Y4
- 24 VAC to terminals W1 through W4
- operational outdoor air temperature (OprOAT) from the senor to the OAT terminal or a communicated value

Outputs

Outputs include:

- 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. Thermostat Inputs into Y2 through Y4 energize the C2 through C4 outputs respectively.

Note: If Lead/Lag function is turned ON, refer to the <Heading Reference>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. Y3 input without Y1 or Y2, turns on C1 first, then C2 and C3 in 30 second intervals. Similarly, Y4 input without Y1, Y2, or Y3 stages 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

Setpoints and related data includes:

- 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

Inputs include:

- 24 VAC to limit switch safety terminal LIMIT, LIM2, LIM3
- 24 VAC to gas valve verification terminal MV, GV2, GV3,4
- 24 VAC to HPS1 thru HPS4 and LPS1 thru LPS4
- evaporator coil temperature sensors EC1, EC2, EC3, and EC4
- operational space temperature (OprST)
- operational outdoor air temperature (OprOAT)

Outputs

Outputs include:

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

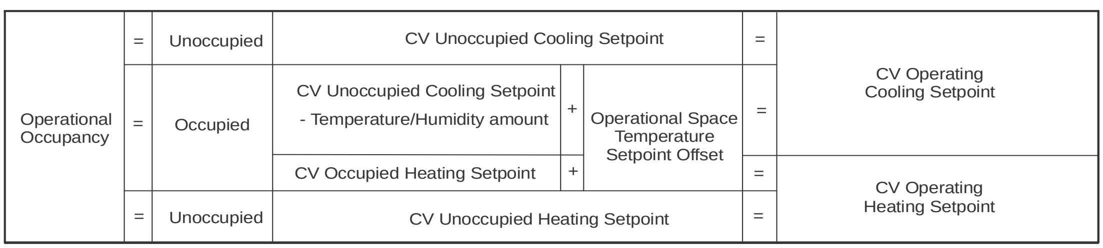

Figure 1: Temperature Setpoint Determination

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 setpoint and length of time away from setpoint.

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. PID Percent commands are +/- 2% in the values.
2. 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 the PID Percent Command table.

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 the PID Percent Command table.

Compressors stage off in 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 the PID Percent Command table.

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 the PID Percent Command table.

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. In unoccupied mode, if the operational space temperature is greater than the CV Unoccupied Cooling Setpoint, stage all compressors on for cooling with a 15 minute interstage delay.

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 30 second 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 30 second 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.

Fixed Variable Fan Control (Intellispeed)

Setpoints and Related Data

Setpoints and related data includes:

- 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 the Economizer section for details.

Inputs

No inputs are related to Fixed Variable Fan Control (Intellispeed).

Outputs

Outputs include:

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

Operation

Operation details include:

- Fan speed is determined by 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

Setpoints and Related Data includes:

- 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

Inputs include:

- Operating Space Humidity (OprSH)

Outputs

No outputs exist for Temperature and Humidity control.

Operation

Operation details include:

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

In an occupied mode, for example, with an Occupied Cooling Setpoint of 72°F, a Temperature/ Humidity Setpoint of 50%, and the Temp/Hum Value That =
1° Offset at 5%:

- 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 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 (SAT) Control

Setpoints and Related Data

Setpoints and Related data includes:

- 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.

With a Operational VAV Cooling Setpoint of 55°F, for example, a Temperature/Humidity Setpoint of 50% and the Temp/Hum Value per 1°F Offset at 5%:

- 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

Without 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. Stage percent command increases or decreases based on relationship of the Operational VAV Cooling Setpoint and supply air temperature.

The rate of change is determined by the deviation from setpoint and length of time away from setpoint. View the Staged Cooling Command (StgClgCmd) using 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 (Table 1).

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 (Table 1).

Table 1: Cooling Staging Switch Points

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 only.

With Thermostat Input

For this sequence the Thermostat Only Control Enable (Tstat-Only) must be ON.

Operation

Operation details include:

Y1, Y2, Y3, and Y4 provides independent compressor control. See the Constant Volume operation section 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

Setpoints and related data includes:

- VAV Unoccupied Cooling Setpoint (VAVClgUnocc-Sp)
- Operational Space Temperature (OprST)

Outputs

Outputs include:

- 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 (SZ VAV)

Setpoints and Related Data

Setpoints and related data includes:

- SZ VAV Enabled (SZVAVEn)   Yes
- Fan Control Type (FanCtl-Type) Enabled   Variable Speed
- SZ VAV Minimum Fan Speed (SZVAVMinFanSpd)
- Operational Occupancy (OprOcc)   Occupied
- Operational Space Temperature (OprST)
- SZ VAV Occupied Cooling Setpoint (SZVAVClgOcc-Sp)
- SZ VAV Unoccupied Cooling Setpoint (SZVAVClgUnocc-Sp)
- SZ VAV Occupied Heating Setpoint (SZVAVHtgOcc-SP)
- SZ VAV Unoccupied Heating Setpoint (SZVAVHtgUnocc-Sp)
- DAT Max Heating SP (DATMAXHtgSP)
- DAT Satisfied SP (DATSatSP)
- DAT Cooling Min SP (SATClgMinSP)
- VAV Operating Cooling Supply Air Temp Setpoint (OprVAVClg-Sp)
- SZ VAV Operating Cooling Setpoint (OprSZVAVClg-Sp)

Inputs

Inputs include:

- Supply Air Temperature (SAT)
- Operational Space Temperature (OprST)

Outputs

Outputs include:

- 2 to 10 VDC from Fan%Command (FanVFD)
- 2 to 10 VDC for Economizer % Command (Econ)

- 24 VAC for C1, C2, C3, and C4 Compressor Commands (C1, C2, C3, C4)
- 24 VAC for Condenser Fan Commands (CN-Fan, CF2)

Operation

If the Operational Occupancy is Unoccupied, the unit does not operate in SZ VAV mode.

If the unit is configured for unoccupied operation, the UCB controls to the SZ VAV Unoccupied Cooling Setpoint or VAV Unoccupied Heating Setpoint. If cooling is needed, the supply fan starts and begins to ramp up to the SZ VAV Minimum Fan Speed. The cooling stages energize in 15 minute intervals until the SZ VAV Unoccupied Cooling Setpoint is reached. If heating is needed, the heating stages begin to energize in 30 second intervals and the supply fan begins to ramp to 100% and all heating/cooling stages energize until the VAV Unoccupied Heating Setpoint

If the Operational Space Temperature and Supply Air Temperature sensors are unreliable, the heating and cooling outputs shut off and the outdoor air damper modulates to minimum position. The supply fan runs at the SZ VAV Minimum Fan Speed.

Discharge Air Temperature Reset

The discharge air setpoint resets based on the zone cooling or heating demand. The controller reads the Operational Space Temperature and SZ VAV Occupied Cooling Setpoint/VAV Occupied Heating Setpoint. The controller calculates a reset output based on the difference of the temperature and appropriate setpoint.

If the zone has a heating demand, the discharge temperature setpoint resets based on the following:

- If 0 < Calculated Heating Load < 40%, then OprSZVAVClgSP = VAVHtgOcc-SP +2°F
- If 40 < Calculated Heating Load < 75%, then OprSZVAVClgSP = VAVHtgOcc-SP + 10°F
- If 75 < Calculated Heating Load, then OprSZVAVClgSP = DATMaxHtgSP

If the zone has a cooling demand, the discharge temperature setpoint resets based on the **following:** and spans the discharge air temperature setpoint based on the DAT Heat Max Setpoint (105°F), DA-T Satisfied Setpoint (70°F), and DAT Cool Min Setpoint (54°F).

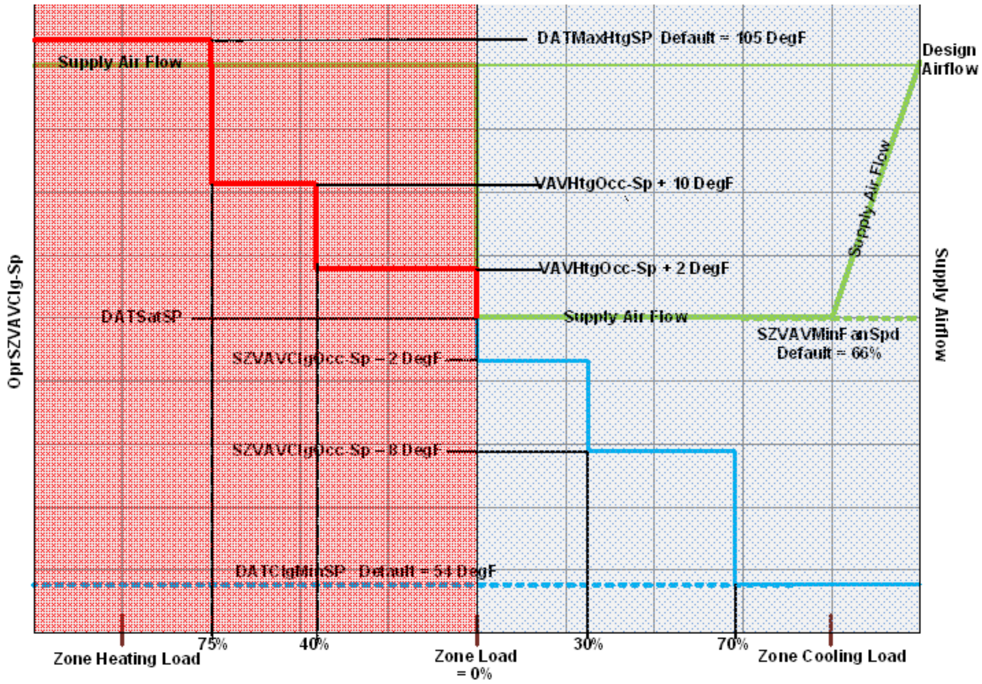

Figure 2: Single Zone VAV Calculation

Free Cooling

When free cooling is available the outdoor air damper modulates to maintain VAV Operating cooling Supply Air Temp Setpoint. When in free cooling mode the supply fan does not modulate.

During the free cooling mode, if the outdoor air damper modulates to 100% open and cannot maintain the VAV Operating Cooling Supply Air Temp Setpoint, the compressors energize in order to maintain the VAV Operating Cooling Supply Air Temp Setpoint.

If the zone temperature exceeds the zone temperature setpoint, the outdoor air damper is 100% open, and the cooling stages are staged on (or locked out due to Compressor_Lockout), the supply fan modulates to maintain zone temperature setpoint.

Normal Operation (No Free Cooling)

The supply air temperature resets based on the zone cooling demand. The unit controls the supply air temperature by staging the compressors. The supply fan runs at the SZ VAV Minimum Fan Speed.

As the zone demand increases and the supply air temperature is controlling to the VAV Operating Cooling Supply Air Temp Setpoint, the supply fan modulates to maintain the zone temperature setpoint.

If Operational Occupancy is Occupied without a heat or cool demand, the supply fan runs at SZ VAV Minimum Fan Speed.

Morning Cool-down

Setpoints and Related Data

Setpoints and related data includes:

- Morning Cool-down Enable ON (MornC-En)
- Morning Cool-down/Return Air Temp Setpoint (MornCRAT-Sp)
- Early Start Period (EarlyStrtPeriod)
- Optionally, Occupancy BI Enabled, Optimal Start Enabled, Schedule
- Optionally, Operational VAV Cooling Setpoint (for Optimal Start)

Inputs

Inputs include:

- Operating Space Temperature
- Operating Occupancy

Outputs

No outputs are required for morning cool-down.

Operation

Operation details include:

BI Input

With a BI occupied command the supply fan turns on for a five minute stabilization period and then operating space temperature is compared to morning cooldown return air temp setpoint.

If the value is equal to or above the morning cooldown return air temp setpoint, all compressors operate for at least 5 minutes. If the value is below the morning cooldown return air temp setpoint, the control goes into Occupied mode.

The compressors energize until 5 minutes passes **and** the operating space temperature is below the morning cooldown setpoint **or** the early start period expires. The control goes into Occupied mode thereafter.

Optimal Start

Historical data determines when 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. The control goes into Occupied mode thereafter.

Schedule

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

If the value is equal to or above the morning cooldown return air temp setpoint, all compressors operate for at least 5 minutes. If the value is below the morning cooldown return air temp setpoint, the control goes into Occupied mode.

The compressors energize until 5 minutes passes **and** the operating space temperature is below the morning cooldown setpoint **or** the early start period expires. The control goes into Occupied mode thereafter.

VAV Heating

Morning Warm-Up

This section describes the Morning Warm-Up setpoints and related data, inputs, outputs, and operation.

Setpoints and Related Data

Setpoints and related data includes:

- Morning Warm-Up Enable   (MornW-En) ON
- Morning Warm-Up RAT Setpoint (MornWRAT-Sp)
- Operational Space Temp (OprST)
- Early Start Period (EarlyStrtPeriod)
- Optionally: Occupancy BI Enabled, Optimal Start Enabled, Schedule
- Optionally: Operational VAV Heating Setpoint

Inputs

Inputs include:

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

Outputs

Outputs include a 24 VAC for heat stages from terminals H1, H2, and H3 heat outputs.

Operation

Operation details include:

BI Input

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

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

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

Optimal Start

Historical data determines when 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. The control goes into Occupied mode thereafter.

Schedule

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

If the value is equal to or below the morning warm-up return air temp setpoint, all heating stages operate for at least 5 minutes. If the value is above the morning warm-up return air temp 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

Setpoints and related data includes:

- VAV Occupied Heating Enabled (HtgOcc-En) ON
- VAV Occupied Heating Setpoint (VAHtgOcc-SP)
- Operational Space Temperature (OprST)

Inputs

Inputs include:

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

Outputs

Outputs include:

- 24 VAC from H1, H2, and H3 heat outputs

Operation

Operation details include:

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 two minute cool to heat changeover delay has expired, all heat stages energize with approximately 30 seconds 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, 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

Setpoints and related data includes:

- VAV Unoccupied Heating Enable (HtgUnocc-En) ON
- VAV Unoccupied Heating Setpoint (VAVHtgUnocc-Sp)
- Operational Space Temperature (OprST)
- Off During Unoccupied (OffDurUnocc) No

Inputs

Inputs include:

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

Outputs

Outputs include:

- 24 VAC from H1, H2, and H3 heat outputs

Operation

Operation details include:

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 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, 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

Setpoints and related data includes:

- Duct Pressure Setpoint (DctPrs-SP)
- Duct Static Pressure (DctPrs)
- Duct Pressure Shutdown Setpoint (DctShutdownSp)

Inputs

Includes include:

- 0 to 5 VDC from the duct pressure sensor to terminal DCT PRS.

Outputs

Outputs include:

- 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 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 include: 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

Setpoints and related data include:

- Economizer Damper Minimum Position Low Speed Fan (LowSpeedFan-MinPos)
- Economizer Minimum Position Setpoint (Econ-MinPos)
- FAN Control Type - Variable Speed (FanCtl-Type)

Operation

Operation details include:

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 50%, the Economizer Damper position is the Economizer Damper Minimum Position Low Speed Fan.

When the VFD output is between 100% and 50%, the Economizer Damper is position proportionally between Economizer Minimum Position Setpoint and 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

Setpoints and related data includes:

- 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)

Note: The Fixed Variable Economizer Minimum Position sequence uses the same parameters. See the Economizer section for details.

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 Economizer Minimum Position Setpoint and 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

Setpoints and related data includes:

- 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 and the FAN output is energized and 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

Setpoints and related data:

- Fresh Air Intake Setpoint (MOAFlow-Sp)
- Fresh Air Intake Value (Fr-Air)
- Fresh Air Max Sensor Range (MOA-Range)

Inputs

Inputs include:

- 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

Setpoints and related data include:

- 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

Outputs include 2 to 10 VDC from ECON terminal to economizer actuator.

Operation

Must be in Occupied Status with Indoor Fan Operating. If Low Ambient Minimum Position is in effect it overrides Demand Ventilation operation.

If 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** Demand Ventilation Setpoint +101 ppm and +200 ppm, the operating minimum position increases 1% per minute.
- **greater** than Demand Ventilation Setpoint +200 ppm, the operating minimum position increases 2% per minute.

When the CO2 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 minium 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 overrides all other minimum position functions.

Free Cooling Changeover Options

Four types of free cooling changeover options are available: dry bulb, single enthalpy, dual enthalpy, and Auto.

Setpoints and Related Data

Note: All the setpoints are Free Cooling setpoints.

Setpoints and related data:

- Economizer Free Cooling Type (FreeClg-Sel)

- Free Cooling Current Mode (FreeClg-Mode)
- All Compressors OFF in Free Cooling (AllCompOff-Econ)
- Economizer Outdoor Air Temp Enable Setpoint (EconOAT-SpEn)
- Economizer Outdoor Air Enthalpy Setpoint (EconOAEnth-Sp)
- VAV Cooling Supply Air Temp Upper Setpoint (SATUp-Sp)
- VAV Cooling Supply Air Temp Lower Setpoint (SATLo-Sp)
- Outdoor Air Enthalpy (OA-Enth)
- Return Air Enthalpy (RA-Enth)

Inputs

Inputs include:

- 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:

- Return and operational outdoor air temperature = dry bulb changeover
- Return and operational outdoor air temperature and outside air humidity = single enthalpy
- Return and operational outdoor air temperature and operational space and outside air humidity = dual enthalpy
- If either the return or 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:

- Return and operational outdoor air temperature = dry bulb changeover
- Return and operational outdoor air temperature and outside air humidity = single enthalpy
- Return and operational outdoor air temperature and operational space and outside air humidity = dual enthalpy

- If either the return or 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:

- Return and operational outdoor air temperature = dry bulb changeover
- Return and operational outdoor air temperature and outside air humidity = single enthalpy
- If either the return or outside 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:

- 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

Changeover Methods

Dry Bulb Changeover

This section applies when 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 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 Free Cooling Operation (Option A Thermostat)

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 True (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 Temp Upper Setpoint +/-0.5°F. If 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 SAT to VAV Cooling Supply Air Temp Upper Setpoint +/-0.5°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 economizer modulates to get SAT to Upper SAT Setpoint
+/-0.5°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 SAT to Upper SAT Setpoint +/-0.5°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 receiving the Y4 input, the fourth compressor output energizes.

When each cooling demand is removed, 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+/- 0.5°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 SAT to Upper SAT Setpoint +/-0.5°F.

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

At any time if the economizer remains at 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 SAT to the Upper SAT Setpoint +/-0.5°F.

With a Stage 2 cooling demand (Y2 input), the economizer modulates to get 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 SAT is greater than the Lower SAT Setpoint +5°F, the compressor output energizes.

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

If the economizer position drops below 100% and does not reach minimum position, and returns to 100% and remains for 5-minutes, the next available compressor energizes and additional compressors energize as described in the *Stage 2 Cooling Demand (Y2 Input)* until all the compressors energize.

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

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

Sensor

CV Option A Occupied

With 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 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 based on Table 2.

Table 2: 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 soon as the staged percent command begins to increase, the economizer remains at 100%. If the operating space temperature drops to less than 0.6F 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

With 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 moduate to control to the Lower SAT Setpoint +/-0.5°F.

If the economizer position remains at 100% for 5 consecutive minutes and 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 minute time period, and the SAT is greater than the Lower SAT Setpoint +5°F, the second compressor output energizes. This process repeats every 5 minutes as long as the economizer position is at 100% until all the compressors energize.

If the economizer position drops below 100% and does not reach minimum position, and returns to 100% and remains for 5-minutes, and the SAT is greater than the Lower SAT Setpoint +5°F, the next available compressor energizes and additional compressors energize until all the compressors energize.

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

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

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

With 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.

Table 3: 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 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

With 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 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 minute time period, and the SAT is greater than the operating VAV SAT Setpoint +5°F, the second compressor output energizes. This process repeats every 5 minutes as long as the economizer position is at 100% until all the compressors energize.

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

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

If all compressor outputs de-engerize and 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

Setpoints and Related Data:

- Economizer Loading Enable (EconLoad-En) ON

Operation

Operation details include:

Economizer loading function works only when only one compressor is operating.

If 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.

Power Exhaust

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

Non-Modulating Power Exhaust

Setpoints

Setpoints and related data includes:

- 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

Outputs include:

- 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

Setpoints and related data includes:

- 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

Input includes a

- 0 to 5 VDC from building pressure sensor to terminals BLDG PRES

Outputs

Outputs include:

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

Operation

Operation details include:

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

Modulating Power Exhaust with VFD

Setpoints and Related Data

Setpoints and related data includes:

- Power Exhaust Fan Type (ExFType)   Variable Frequency Fan
- Building Pressure Setpoint (Bldg-Sp)
- Building Pressure Reading (Bldg-Pres)

Inputs

Inputs include:

- 0 to 5 VDC from building pressure sensor to terminal BLDG PRES

Outputs

Outputs include:

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

Operation

Operation details include:

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.

Low Ambient Operation

Setpoints and Related Data

Setpoints and Related Data:

- Cooling OAT Cutout Enable (ClgOATCutout-En) Yes
- Cooling OAT Cutout (ClgOATCutout)
- Low Amb 10 On 5 Off Setpoint (LowAmb10On5OffSp)

Operation

Operation detail include:

If Cooling OAT Cutout Enable is Yes, the compressor operation is not permitted if the OAT is less than the Cooling OAT Cutout.

If Cooling OAT Cutout Enable is No, the compressors cycle 10 minutes On and 5 minutes Off if the OAT is less than the LowAmb10On5Off Setpoint.

If a compressor is in the 10 min 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.

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

Lead/Lag (Compressor Equalized Runtime)

Setpoints and Related Data

Setpoints and related data includes

- 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

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 stage off 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 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.

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

VAV, No Hot Gas Reheat, Yes Hot Gas Bypass Enable

If fan operation is above 50%, see the <Heading Reference>Constant Volume or VAV, Yes Hot Gas Reheat, Yes/No Hot Gas Bypass Enable section for details.

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

Hot Gas Reheat

Setpoints and Related Data

Setpoints and related data includes:

- 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)

Inputs

Inputs include:

- operational space humidity (OprSH)

Outputs

Outputs include:

- 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 no demand for cooling, C1 output energizes and the AUX-HGR output energizes.

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, 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 HGR Enabled for Unoccupied Operation is enabled, during unoccupied mode the control works the same as described above, except it 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 no demand for cooling, C1 and AUX-HGR outputs energize, and C2 energizes.

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, 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, C1 and C2 outputs energize and AUX-HGR de-energizes.

Note: If HGR Enabled for Unoccupied Operation is enabled, during unoccupied mode the control works the same as described above, except it uses the HGR Unoccupied Humidity Setpoint instead.

Table 4 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 4: Dehumidification Sequence in Normal and Alternate Mode

Request	Normal Mode			Alternate Mode		
	HGR	C1	C2	HGR	C1	C2
Dehumidification	On	On	Off	On	On	Off
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.

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
- 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

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

Setpoints and related data includes:

- Power Exhaust Fan Type (ExFType)   Variable Frequency Fan
- Fan Control Type (FanCtlType) Variable Speed
- ERV Installed
- ERV Unoccupied Fan
- Eff Occupancy
- ERD State

Outputs

Outputs include:

- 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 5.

Table 5: Energy Recovery Determination

ERV Installed	ERV Unocc Fan	Eff Occupany	State
Disable	*	*	OFF
Enable	Enable	*	ON
Enable	Disable	Occupied	ON
Enable	Disable	Unoccupied	OFF
* Means this state has no effect on the output.			

When the ERV State is ON, and applied to a VAV unit with exhaust vfd's, the EX VFD output is controlled by tracking the VFD OUTPUT of the supply fan.

When the ERV Installed is Disabled, the exhaust vfd's are controlled based on building static pressure. See Modulating power exhaust with VFD operation described in an earlier section of this manual.

When the ERV installed is enabled and ERV Unoc Fan is Disabled, the exhaust outputs are turned off in the unoccupied mode.

On any unit without exhaust vfd’s, the ERV installed parameter should be set to Disabled.

Space Temperature Alarming

Setpoints and Related Data

Setpoints and related data includes:

- 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

Inputs include:

- 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 setpoint for another 10 minutes, the timer starts again.

Scheduling/Occupancy Determination

Setpoints and Related Data

Setpoints and related data includes:

- Occupancy Mode (OccMode)
- Network Temporary Occupancy Request (NetTempOcc)
- Network Occupancy Request (NetOcc)
- Temporary Occupancy Timeout (TempOccTimeout)

Inputs

Inputs include:

- Occupancy Input (OCC)
- Schedule Occupancy (accessible via MAP or NAE Only)
- Temporary Occupancy Input (TempOCC)
- Netsensor Request (no EM values)

Outputs

Outputs include:

- Occupancy Input Source (OccSrc)
- Operational Occupancy (OprOcc)

Operation

Note: This section presumes the UCB is not part of a 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 Netsensor 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, Temporary Occupancy Input, and Netsensor Occupancy Request. The following applies:

- If Temporary Occupancy Input is false, then the Operational Occupancy is based strictly off the Schedule Occupancy. This is changeable via 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, Network Temporary Occupancy Request is false, then base Operational Occupancy on Scheduled Occupancy.
- 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.

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

- Outputs Disabled Due to Low Input Voltage (UCBLowVolt)
- Outputs Limited Due to Low Input Voltage (UCBBrownOut)

Inputs

- Supply Voltage to UCB - UCB 24VAC Input (UCB24VForOutp)

Outputs

All relay outputs

Operation

The UCB monitors the 24 VAC for Low Voltage Conditions and has two thresholds; one at 16 VAC and one at 19.2 VAC.

If the UCB needs to turn on a relay output it determines if the voltage is above 19.2 VAC before it energizes the output. If the voltage is not above 19.2 VAC, it holds off additional relay outputs and displays the appropriate alarm on the LCD. Any relay outputs that are already energized continues in that state.

If the voltage drops below 16 VAC it 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

- Number of Cooling Stages Installed (#ClgStgs)
- Compressor Stage Command (Ci for i=1to 4)
- High Pressure Limit (HPSi for i=1..4)
- High Pressure Lockout (HPSi-LO for i=1 to 4)
- Reset Lockouts(ResetLO)

Inputs

Contact closure from appropriate refrigerant circuit high pressure switch
(HPS1, HPS2, HPS3, HPS4)

Outputs

Output relay for appropriate refrigerant circuit (C1, C2, C3, C4)

Operation

The control only reads this input when it has the compressor relay turned on. If the HPS opens for more than two line cycles, the UCB turns off the compressor relay and start 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 run time. If the HPS opens three times within two hours of run time, it locks out the compressor and flags an Alarm on the LCD. While the UCB has all compressors locked out, it turns off the condenser fan.

Anytime 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. Changing the value from NO to YES resets the lockout condition.

Low Pressure Switch

Setpoints and Related Data

- 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

Contact closure from appropriate refrigerant circuit low pressure switch
(LPS1, LPS2, LPS3, LPS4)

Outputs

Output relay for appropriate refrigerant circuit (C1, C2, C3, C4)

Operation

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

Once the output relay has been energized, LPS does not affect the compressor output until the compressor has been running for the minimum time. If 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 LPS trips toward a lockout is disabled (LPS never locks out compressors).

After the minimum time (30 seconds or 2 minutes), if LPS 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 LPS has closed.

The UCB logs the first incident and tracks run time. If not in Low Ambient conditions and LPS opens three times within one hour of run time, it locks out the compressor relay and flags an Alarm on the UI.

Note: To manually reset the lockout condition, navigate to the ResetLO point in the User Interface. Change the value from NO to YES to reset the lockout condition.

Evaporator Coil - Freeze Condition

Setpoints and Related Data

- 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

10k NTC Type 3 Thermistor for each installed cooling circuit evaporator -
(EC1, EC2, EC3, EC4)

Outputs

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

Operation

If an evaporator temperature below Freeze-Sp (26 °F default) 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 temp is above Freeze-Sp and there is still a call for Y.

While this condition is True, Compressor (Cx) does not run.

The UCB logs the first incident and tracks run time. If the evaporator temperature alarms three times within two hours of run time, it lock outs the compressor output relay and flags an Alarm.

Exception to lockout of compressor output relay: While the unit is operating in Low Ambient 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 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 Freeze Condition.

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

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

Off resets any FSx error counts less than 3 (since 3 would produce a lockout), stops any FSx LCD alarm.

Note: To manually reset the lockout condition, navigate to the ResetLO point in the User Interface. Changing the value from NO to YES resets the lockout condition.

Fan Overload

Setpoints and Related Data

Setpoints and related data includes:

- Unit Locked Out Supply Fan Overload (FanOvrload-LO)
- Reset Lockouts (ResetLO)

Inputs

Contact closure from Fan Overload (FanOvrload)

Outputs

Output relay for Fan, Compressors, and Condenser Fans

Operation

Anytime 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 run time. If the Fan Overload contact opens three times within two 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. It retries the Fan each time the switch closes.

Note: This Alarm is only reset via a power down, or via the ResetLO command from the LCD.

Shut Down (SD)

Setpoints and Related Data

No setpoints and related data are specific to the Unit Protection - SD.

Inputs

Contact closure - Shutdown Input/Smoke Detector (SD)

Outputs

No outputs are unique to Unit Protection-SD.

Operation

An time the contact opens, all power is removed to the output relay coils. This immediately de-energizes all relay outputs. An alarm is generated and displayed on the UCB.

Note: Any additional unit interrupt devices such as float switches, external shutdown relays, etc. should 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

24VAC monitoring at the Limit input on the UCB (Limit, Lim2, Lim3)

Outputs

Output relay for Fan, 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 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 disable heating.

Note: To manually reset the lockout condition, navigate to the ResetLO point in the UI. Change the value from NO to YES to reset the lockout condition.

Main Valve (MV)

Setpoints and Related Data

- Number of Gas Valves Installed (#GasVlvs)
- Reset Lockouts(ResetLO)

Inputs

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

- 24 VAC from terminal W1

Outputs

Output relay for Fan

Operation

Any time the UCB senses W1 and does not read voltage at the Gas valve for a continuous five-minute period it flags an alarm and generates an alarm on the UI. If GV re-appears after the alarm, the alarm is reset and normal operation occurs. If W1 goes away, the UCB resets the alarm.

Anytime the UCB senses GV voltage without W1 the UCB energizes the fan relay immediately. If the voltage remains for a continuous five-minute period it flags an alarm, locks On the fan relay, and displays the alarm on the UI. 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 UI. Change the value from NO to YES to reset the lockout condition.

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

Setpoints and Related Data include:

- Number of Cooling Stages Installed
- Number of Heating Stages Installed
  (Any and all compressors are considered one stage)
- Number of Heat Pump Stages #HtPumpStgs
  (Should be the same as Cooling Stages Installed)
- Number of Refrigeration Systems #RefrigSys
  (Number of physical coolant circuits)
- Defrost Curve Selection

Inputs

Inputs include:

- Operational Space Temperature (zone control)
- Applicable Thermostat Inputs (Tstat-Only control)
  - Y1
  - Y2

    - W1
    - W2
- CC1
- CC2
- OAT
- LIMIT

Outputs

Outputs include:

- C1
- C2
- FAN
- CN-FAN
- H1 [as Rev Valve]
- H2 [Aux Heat]

Operation

Operation detail include:

Cooling

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

Exception*:* 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

If a first stage of heating is called for (thermostat or zone sensor/network), **all** available compressors stage on, with a 30 second time 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 a second stage of heating is called for, 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, defined as:

- H1 output is energized
- C1 and/or C2 output is energized
- CN-FAN output is energized

Initiation of the defrost cycle is prevented by temperature sensor input if:

- Operational Outdoor Air Temperature (OprOAT) is less than -25°F ±1°F or greater than 50°F ±1°F
- CC1 and CC2 Condenser Coil Temperatures are both greater than 40°F ±1°F

Within the boundaries of Operational Outdoor Air Temperature (OprOAT) greater than -25°F ±1°F or less than 50°F ±1°F and 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 (Figure 3).

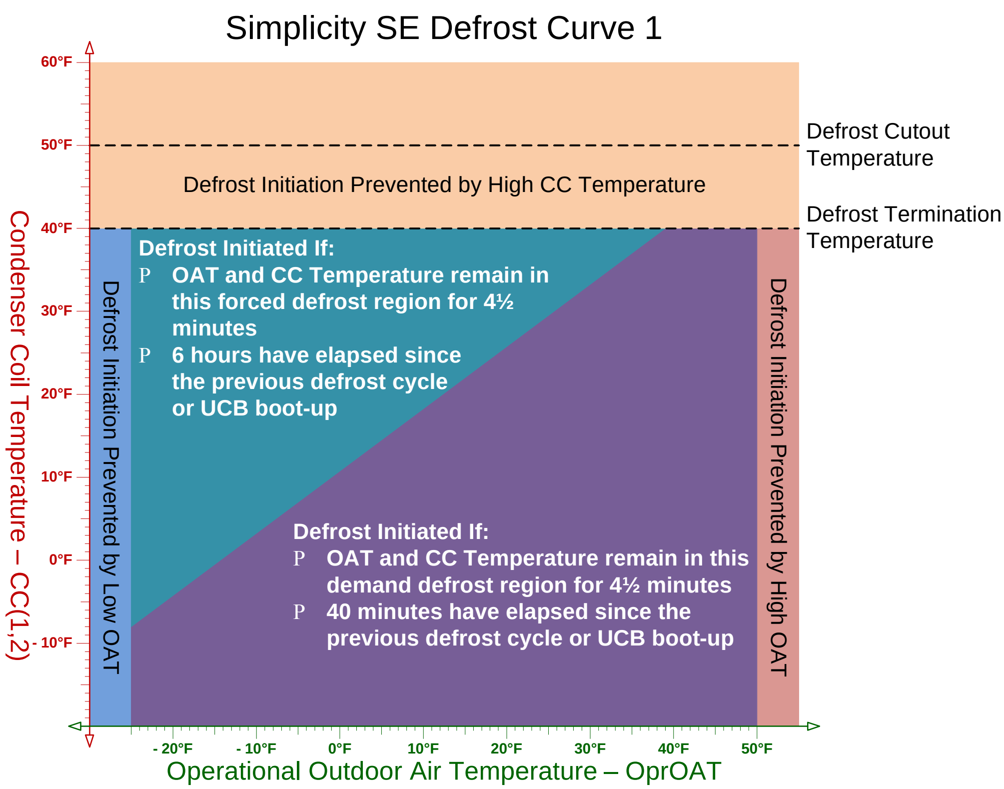

Figure 3: Defrost Curves

Note: There is a ±1°F tolerance between demand defrost and forced defrost regions for defrost cycle initiation (the diagonal line in Figure 3).

Refrigeration System Settings

If the Number Of Refrigeration Systems (#RefrigSys) is set to 1; when the intersection of Operational Outdoor Air Temperature (OprOAT) and Condenser Coil Temperature 1 (CC1) remain in the demand defrost region for 4½ minutes, the defrost cycle is initiated if:

- 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 boot-up
- Defrost Curve selection 6 - 30 minutes have elapsed since the previous defrost cycle or UCB boot-up

If the Number Of Refrigeration Systems (#RefrigSys) is set to 2 or more; when the intersection of Operational Outdoor Air Temperature (OprOAT) and either Condenser Coil Temperature 1 (CC1) or 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.

If the Number Of Refrigeration Systems (#RefrigSys) is set to 1; when the intersection of Operational Outdoor Air Temperature (OprOAT) and Condenser Coil Temperature 1 (CC1) remain in the forced defrost region for 4½ minutes, the defrost cycle is initiated if:

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

If the Number Of Refrigeration Systems (#RefrigSys) is set to 2 or more; when the intersection of Operational Outdoor Air Temperature (OprOAT) and either Condenser Coil Temperature 1 (CC1) or Condenser Coil Temperature 2 (CC2) forced defrost region for 4½ minutes, the defrost cycle is initiated if:

- 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:

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

If the Number Of Refrigeration Systems (#RefrigSys) is set to 1, the defrost cycle continues until terminated by:

- Defrost Curve selection 1, 2, 3, 4 or 5 - 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 - 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 terminated by:

- Defrost Curve selection 1, 2, 3, 4 or 5 - both Condenser Coil Temperature 1 (CC1) and 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.

Self Test Sequencer

Setpoints and Related Data

Setpoints and related data includes:

- 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

Inputs include:

- 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

Outputs include:

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

Operation

Self Test Sequencer steps through unit subsystems, one at a time, depending on what hardware options the control has been programmed with. See Table for the possible test, results.

Each test has a stabilize period before energizing the corresponding equipment. Only during the Fan Test, is everything off or 0% actuated. 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 Local UI. **The Fan Test must prove airflow before proceeding with any other test.**

Table shows the expected outputs for the Self Test. The shaded cells indicate the output turns during the self test.

Table 6: Expected Self Test Outcomes

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%
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 I.W.C

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

- 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 OAT is within 2 degrees of SAT, the Economizer Test prompts the UI, for 10 minutes, for verification that the Economizer is opening (for example, Outdoor is 72°F, supply to space is 71°F). Visual inspection of the Economizer status is required.

You can perform commands from the UI during the Self Test. The commands and control reactions to those commands are described in Table 7.

Table 7: 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. Possible result categories are described in Table 8.

Table 8: Self Test Results (not accurately matched result to category)

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
Heating Stages (H1, H2, H3)	Fail - HPS
	Fail - LPS
	Fail - LS
	Fail - GV Off
	Pass
	Warning - SAT no increased
Economizer	Fail - Damper
	Pass
Power Exhaust	Warning - BSP not dropped
	Pass

Timing

Table 9 shows the Self Test Time..

Table 9: 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	4050

Alarms

Alarm List

Alarms are categorized into three groups based on severity: critical, service priority, and service. Table 10 describes the non-FDD alarms. .

Table 10: Alarms

Severity	Alarm	How It Happens
Critical	C1 Locked Out Due to High Pressure	Three HPS1 trips within two hours.
	C2 Locked Out Due to High Pressure	Three HPS2 trips within two hours.
	C3 Locked Out Due to High Pressure	Three HPS3 trips within two hours.
	C4 Locked Out Due to High Pressure	Three HPS4 trips within two hours.
	C1 Locked Out Due to Low Pressure	Three LPS1 trips within one hour.
	C2 Locked Out Due to Low Pressure	Three LPS2 trips within one hour.
	C3 Locked Out Due to Low Pressure	Three LPS3 trips within one hour.
	C4 Locked Out Due to Low Pressure	Three LPS4 trips within one hour.
	C1 Locked Out Due to Coil Freeze	Three FS1 trips within two hours. (Evap Coil Temp < Evap Coil Temp Cutout SP)
	C2 Locked Out Due to Coil Freeze	Three FS2 trips within two hours. (Evap Coil Temp < Evap Coil Temp Cutout SP)
	C3 Locked Out Due to Coil Freeze	Three FS3 trips within two hours. (Evap Coil Temp < Evap Coil Temp Cutout SP)
	C4 Locked Out Due to Coil Freeze	Three FS4 trips within two 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 one hour.
	HS2 Locked Out Due to Limit Switch	Three LS2 trips within one hour.
	HS3 Locked Out Due to Limit Switch	Three LS3 trips within one 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: Alarms

Severity	Alarm	How It Happens
Service Priority	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
	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 10: Alarms

Severity	Alarm	How It Happens
Service	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)

Table 10: Alarms

Severity	Alarm	How It Happens
Service (Continued)	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
	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
	C1 Refrigerant Low	FDD Alarm, see Table 11.
	C2 Refrigerant Low	FDD Alarm, see Table 11.
	C3 Refrigerant Low	FDD Alarm, see Table 11.
	C4 Refrigerant Low	FDD Alarm, see Table 11.
	C1 Excessive Refrigerant Flow	FDD Alarm, see Table 11.
	C2 Excessive Refrigerant Flow	FDD Alarm, see Table 11.
	C3 Excessive Refrigerant Flow	FDD Alarm, see Table 11.
	C4 Excessive Refrigerant Flow	FDD Alarm, see Table 11.
	C1 Inefficient Compressor	FDD Alarm, see Table 11.
	C2 Inefficient Compressor	FDD Alarm, see Table 11.
	C3 Inefficient Compressor	FDD Alarm, see Table 11.
	C4 Inefficient Compressor	FDD Alarm, see Table 11.
	C1 Refrigerant Flow Restriction	FDD Alarm, see Table 11.

Table 10: Alarms

Severity	Alarm	How It Happens
Service (Continued)	C2 Refrigerant Flow Restriction	FDD Alarm, see Table 11.
	C3 Refrigerant Flow Restriction	FDD Alarm, see Table 11.
	C4 Refrigerant Flow Restriction	FDD Alarm, see Table 11.
	C1 High Side Heat Transfer Problem	FDD Alarm, see Table 11.
	C2 High Side Heat Transfer Problem	FDD Alarm, see Table 11.
	C3 High Side Heat Transfer Problem	FDD Alarm, see Table 11.
	C4 High Side Heat Transfer Problem	FDD Alarm, see Table 11.
	C1 Low Side Heat Transfer Problem	FDD Alarm, see Table 11.
	C2 Low Side Heat Transfer Problem	FDD Alarm, see Table 11.
	C3 Low Side Heat Transfer Problem	FDD Alarm, see Table 11.
	C4 Low Side Heat Transfer Problem	FDD Alarm, see Table 11.
	C1 Reduce Evaporator Airflow	FDD Alarm, see Table 11.
	C2 Reduce Evaporator Airflow	FDD Alarm, see Table 11.
	C3 Reduce Evaporator Airflow	FDD Alarm, see Table 11.
	C4 Reduce Evaporator Airflow	FDD Alarm, see Table 11.
	C1 Add Charge	FDD Alarm, see Table 11.
	C2 Add Charge	FDD Alarm, see Table 11.
	C3 Add Charge	FDD Alarm, see Table 11.
	C4 Add Charge	FDD Alarm, see Table 11.
	C1 Insufficient Refrigerant Flow	FDD Alarm, see Table 11.
	C2 Insufficient Refrigerant Flow	FDD Alarm, see Table 11.
	C3 Insufficient Refrigerant Flow	FDD Alarm, see Table 11.
	C4 Insufficient Refrigerant Flow	FDD Alarm, see Table 11.
	C1 Recover Charge	FDD Alarm, see Table 11.
	C2 Recover Charge	FDD Alarm, see Table 11.
	C3 Recover Charge	FDD Alarm, see Table 11.
	C4 Recover Charge	FDD Alarm, see Table 11.
	C1 Non-Condensables Present	FDD Alarm, see Table 11.
	C2 Non-Condensables Present	FDD Alarm, see Table 11.
	C3 Non-Condensables Present	FDD Alarm, see Table 11.
	C4 Non-Condensables Present	FDD Alarm, see Table 11.
	C1 Liquid Temp Greater Than Cond Temp	FDD Alarm, see Table 11.
	C2 Liquid Temp Greater Than Cond Temp	FDD Alarm, see Table 11.
	C3 Liquid Temp Greater Than Cond Temp	FDD Alarm, see Table 11.
	C4 Liquid Temp Greater Than Cond Temp	FDD Alarm, see Table 11.
	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.

Table 10: Alarms

Severity	Alarm	How It Happens
Service (Continued)	Not Economizing - No Supply Air Sensor	Free Cooling Available and MA Sequencer = DAT Control and SAT Unreliable **or** SAT Unrealiable 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
	C1 Basic Data Not Available	FDD Alarm, see Table 11.
	C2 Basic Data Not Available	FDD Alarm, see Table 11.
	C3 Basic Data Not Available	FDD Alarm, see Table 11.
	C4 Basic Data Not Available	FDD Alarm, see Table 11.
	C1 Unit Off	FDD Alarm, see Table 11.
	C2 Unit Off	FDD Alarm, see Table 11.
	C3 Unit Off	FDD Alarm, see Table 11.
	C4 Unit Off	FDD Alarm, see Table 11.
	C1 Return Air Web-Bulb Temp Out of Range	FDD Alarm, see Table 11.
	C2 Return Air Web-Bulb Temp Out of Range	FDD Alarm, see Table 11.
	C3 Return Air Web-Bulb Temp Out of Range	FDD Alarm, see Table 11.
	C4 Return Air Web-Bulb Temp Out of Range	FDD Alarm, see Table 11.
	C1 Ambient Temp Too Low	FDD Alarm, see Table 11.
	C2 Ambient Temp Too Low	FDD Alarm, see Table 11.
	C3 Ambient Temp Too Low	FDD Alarm, see Table 11.
	C4 Ambient Temp Too Low	FDD Alarm, see Table 11.
	C1 Ambient Temp Too High	FDD Alarm, see Table 11.
	C2 Ambient Temp Too High	FDD Alarm, see Table 11.
	C3 Ambient Temp Too High	FDD Alarm, see Table 11.
	C4 Ambient Temp Too High	FDD Alarm, see Table 11.
	C1 Return Air Wet-Bulb Temp Too Low	FDD Alarm, see Table 11.
	C2 Return Air Wet-Bulb Temp Too Low	FDD Alarm, see Table 11.
	C3 Return Air Wet-Bulb Temp Too Low	FDD Alarm, see Table 11.
	C4 Return Air Wet-Bulb Temp Too Low	FDD Alarm, see Table 11.
	C1 Return Air Wet-Bulb Temp Too High	FDD Alarm, see Table 11.
	C2 Return Air Wet-Bulb Temp Too High	FDD Alarm, see Table 11.
	C3 Return Air Wet-Bulb Temp Too High	FDD Alarm, see Table 11.
	C4 Return Air Wet-Bulb Temp Too High	FDD Alarm, see Table 11.
	C1 Condensing Temp Less Than Ambient	FDD Alarm, see Table 11.
	C2 Condensing Temp Less Than Ambient	FDD Alarm, see Table 11.
	C3 Condensing Temp Less Than Ambient	FDD Alarm, see Table 11.
	C4 Condensing Temp Less Than Ambient	FDD Alarm, see Table 11.
	C1 Suction Temp Less Than Evap Temp	FDD Alarm, see Table 11.

Table 10: Alarms

Severity	Alarm	How It Happens
Service (Continued)	C2 Suction Temp Less Than Evap Temp	FDD Alarm, see Table 11.
	C3 Suction Temp Less Than Evap Temp	FDD Alarm, see Table 11.
	C4 Suction Temp Less Than Evap Temp	FDD Alarm, see Table 11.
	C1 Evap Temp Greater Than Ambient Temp	FDD Alarm, see Table 11.
	C2 Evap Temp Greater Than Ambient Temp	FDD Alarm, see Table 11.
	C3 Evap Temp Greater Than Ambient Temp	FDD Alarm, see Table 11.
	C4 Evap Temp Greater Than Ambient Temp	FDD Alarm, see Table 11.
	C1 Liquid Temp Less Than Ambient Temp	FDD Alarm, see Table 11.
	C2 Liquid Temp Less Than Ambient Temp	FDD Alarm, see Table 11.
	C3 Liquid Temp Less Than Ambient Temp	FDD Alarm, see Table 11.
	C4 Liquid Temp Less Than Ambient Temp	FDD Alarm, see Table 11.
	C1 Invalid Suction or Ambient Temp	FDD Alarm, see Table 11.
	C2 Invalid Suction or Ambient Temp	FDD Alarm, see Table 11.
	C3 Invalid Suction or Ambient Temp	FDD Alarm, see Table 11.
	C4 Invalid Suction or Ambient Temp	FDD Alarm, see Table 11.
	C1 Invalid RA Dry-Bulb or Web-Bulb Temp	FDD Alarm, see Table 11.
	C2 Invalid RA Dry-Bulb or Web-Bulb Temp	FDD Alarm, see Table 11.
	C3 Invalid RA Dry-Bulb or Web-Bulb Temp	FDD Alarm, see Table 11.
	C4 Invalid RA Dry-Bulb or Web-Bulb Temp	FDD Alarm, see Table 11.
	C1 Invalid Liquid and Suction Pressure	FDD Alarm, see Table 11.
	C2 Invalid Liquid and Suction Pressure	FDD Alarm, see Table 11.
	C3 Invalid Liquid and Suction Pressure	FDD Alarm, see Table 11.
	C4 Invalid Liquid and Suction Pressure	FDD Alarm, see Table 11.
	C1 Invalid Suction Temp	FDD Alarm, see Table 11.
	C2 Invalid Suction Temp	FDD Alarm, see Table 11.
	C3 Invalid Suction Temp	FDD Alarm, see Table 11.
	C4 Invalid Suction Temp	FDD Alarm, see Table 11.
	C1 Invalid Liquid and Suction Temp	FDD Alarm, see Table 11.
	C2 Invalid Liquid and Suction Temp	FDD Alarm, see Table 11.
	C3 Invalid Liquid and Suction Temp	FDD Alarm, see Table 11.
	C4 Invalid Liquid and Suction Temp	FDD Alarm, see Table 11.
	C1 Return Air Dry-Bulb Temp Too Low	FDD Alarm, see Table 11.
	C2 Return Air Dry-Bulb Temp Too Low	FDD Alarm, see Table 11.
	C3 Return Air Dry-Bulb Temp Too Low	FDD Alarm, see Table 11.
	C4 Return Air Dry-Bulb Temp Too Low	FDD Alarm, see Table 11.
	C1 Return Air Dry-Bulb Temp Too High	FDD Alarm, see Table 11.
	C2 Return Air Dry-Bulb Temp Too High	FDD Alarm, see Table 11.
	C3 Return Air Dry-Bulb Temp Too High	FDD Alarm, see Table 11.
	C4 Return Air Dry-Bulb Temp Too High	FDD Alarm, see Table 11.
	C1 El Below 75% Expected Performance	FDD Alarm, see Table 11.
	C2 El Below 75% Expected Performance	FDD Alarm, see Table 11.
	C3 El Below 75% Expected Performance	FDD Alarm, see Table 11.

Table 10: Alarms

Severity	Alarm	How It Happens
Service (Continued)	C4 EI Below 75% Expected Performance	FDD Alarm, see Table 11.
	C1 CI Below 75% Expected Performance	FDD Alarm, see Table 11.
	C2 CI Below 75% Expected Performance	FDD Alarm, see Table 11.
	C3 CI Below 75% Expected Performance	FDD Alarm, see Table 11.
	C4 CI Below 75% Expected Performance	FDD Alarm, see Table 11.
	C1 EI+C1 Below 75% Expected Performance	FDD Alarm, see Table 11.
	C2 EI+CI Below 75% Expected Performance	FDD Alarm, see Table 11.
	C3 EI+CI Below 75% Expected Performance	FDD Alarm, see Table 11.
	C4 EI+CI Below 75% Expected Performance	FDD Alarm, see Table 11.
	C1 FDD Not Functioning Sensor Unreliable	FDD Alarm, see Table 11.
	C2 FDD Not Functioning Sensor Unreliable	FDD Alarm, see Table 11.
	C3 FDD Not Functioning Sensor Unreliable	FDD Alarm, see Table 11.
	C4 FDD Not Functioning Sensor Unreliable	FDD Alarm, see Table 11.
	C1 FDD Not Monitoring Conditions	FDD Alarm, see Table 11.
	C2 FDD Not Monitoring Conditions	FDD Alarm, see Table 11.
	C3 FDD Not Monitoring Conditions	FDD Alarm, see Table 11.
	C4 FDD Not Monitoring Conditions	FDD Alarm, see Table 11.
	C1 FDD Not Monitoring Equipment Data	FDD Alarm, see Table 11.
	C2 FDD Not Monitoring Equipment Data	FDD Alarm, see Table 11.
	C3 FDD Not Monitoring Equipment Data	FDD Alarm, see Table 11.
	C4 FDD Not Monitoring Equipment Data	FDD Alarm, see Table 11.

FDD Alarms

The FDD alarms are described in Table 11.

Table 11: FDD Alarms

BACNet State	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 11: FDD Alarms

BACNet State	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 unit airflow per instruction manual
259 260 261 262	C1, C2, C3, C4 Reduced 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 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 Indicates A 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	Same as restriction. Follow same actions

Table 11: FDD Alarms

BACNet State	FDD ALARM	DIAGNOSIS EXPLANATION	RECOMMENDATION
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 cause of undercharge
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 unit electrical supply. Identify any high (wild) leg. Place on L2 if present -->Inspect low voltage transformer tap for correct selection -->Inspect 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, C4 Unit 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 integrity of sensor -->Inspect integrity of sensor wiring

Table 11: FDD Alarms

BACNet State	FDD ALARM	DIAGNOSIS EXPLANATION	RECOMMENDATION
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 proper application and placement of unit. Ensure 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 sensor reading -->Verify sensor integrity -->Verify sensor wiring
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 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 condensor coil sensor integrity -->Verify sensor wiring -->Inspect condenser coil for restriction ahead of the sensor

Table 11: FDD Alarms

BACNet State	FDD ALARM	DIAGNOSIS EXPLANATION	RECOMMENDATION
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	-->Unit may be operating in a low outdoor ambient condition -->Inspect the unit for proper application and unit placement -->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 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.	-->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 correct sensor location as connected to 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 sensor electrical connection point is correct
227 228 229 230	C1, C2, C3, C4 Invalid Suction Temp	Suction line temperature is > than the condensor temperature.	-->Inspect for proper sensor wiring connection point -->Inspect sensor integrity of both sensors
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 unit application is not installed to a process cooling environment -->Inspect 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 unit application is not installed to a process cooling environment -->Inspect return duct for unwanted infiltration -->Inspect sensor integrity

Table 11: FDD Alarms

BACNet State	FDD ALARM	DIAGNOSIS EXPLANATION	RECOMMENDATION
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 unit installation for application suitability -->Verify all system operations -->Verify adequacy of ductwork and outside air quantities -->Verify 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 unit installation for application suitibility -->Verify all system operations -->Verify adequacy of ductwork and outsidee air quantities -->Verify 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 unit installation for application suitability -->Verify all system operations -->Verify adequacy of ductwork and outside air quantities -->Verify 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 11: FDD Alarms

BACNet State	FDD ALARM	DIAGNOSIS EXPLANATION	RECOMMENDATION
295 296 297	C1, C2, C3, C4 FDD Not Monitoring	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 unit data is present in the control data parameters

Note: 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.

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