Setpoint Determination ................................................................. 22
Occupied Heating and Cooling Operation ........................................ 22
  Compressor Operation ............................................................... 22
  Heating Operation ................................................................. 22
Unoccupied Heating and Cooling Operation ...................................... 23
  Compressor Operation ............................................................... 23
  Heating Operation ................................................................. 23
Fixed Variable Fan Control (Intellispeed) ........................................ 23
  Setpoints and Related Data ...................................................... 23
  Inputs .................................................................................... 23
  Outputs .................................................................................. 23
  Operation ............................................................................... 23
Temperature and Humidity Control .................................................. 24
  Setpoints and Related Data ...................................................... 24
  Inputs .................................................................................... 24
  Outputs .................................................................................. 24
  Operation ............................................................................... 24
VAV Sequences ................................................................................. 24
  VAV Occupied Cooling .............................................................. 24
Supply Air Temperature (SAT) Control ............................................ 24
  Setpoints and Related Data ...................................................... 24
Supply Air Temperature Setpoint Determination ................................. 25
  Operation ............................................................................... 25
  Without Thermostat Input ....................................................... 25
  With Thermostat Input ............................................................ 26
VAV Unoccupied Cooling ................................................................. 26
  Setpoints and Related Data ...................................................... 26
  Outputs .................................................................................. 26
  Operation ............................................................................... 26
  Single-Zone VAV (SZ VAV) ........................................................ 26
Setpoints and Related Data ................................................................. 26
Inputs ................................................................................................. 27
Outputs .............................................................................................. 27
Operation ........................................................................................... 27
  Discharge Air Temperature Reset ................................................... 27
  Free Cooling ................................................................................... 28
  Normal Operation (No Free Cooling) ................................................. 28
Morning Cool-down ........................................................................ 28
Setpoints and Related Data ............................................................... 28
Inputs ................................................................................................. 29
Outputs .............................................................................................. 29
Operation ........................................................................................... 29
VAV Heating ...................................................................................... 29
Morning Warm-Up ........................................................................... 29
Setpoints and Related Data ............................................................... 29
Inputs ................................................................................................. 30
Outputs .............................................................................................. 30
Operation ........................................................................................... 30
  BI Input ......................................................................................... 30
  Optimal Start ................................................................................. 30
  Schedule ....................................................................................... 30
VAV Occupied Heating ..................................................................... 30
Setpoints and Related Data ............................................................... 30
Inputs ................................................................................................. 30
Outputs .............................................................................................. 31
Operation ........................................................................................... 31
VAV Unoccupied Heating ................................................................ 31
Setpoints and Related Data ............................................................... 31
Inputs ................................................................................................. 31
Outputs .............................................................................................. 31
Operation ........................................................................................... 31
Duct Pressure Control ................................................................. 32
Setpoints and Related Data .......................................................... 32
Inputs ......................................................................................... 32
Outputs ....................................................................................... 32
Operation ..................................................................................... 32
Economizer Sequences ................................................................. 32
  Minimum Position Sequences ..................................................... 32
  Minimum Position ................................................................. 32
  VAV Economizer Minimum Position Reset .................................. 33
    Setpoints and Related Data ..................................................... 33
    Operation .............................................................................. 33
  Fixed Variable .......................................................................... 33
    Setpoints and Related Data ..................................................... 33
    Operation .............................................................................. 33
  Low Ambient Minimum Position ............................................... 34
    Setpoints and Related Data ..................................................... 34
    Operation .............................................................................. 34
  Air Monitoring Station Reset .................................................... 34
    Setpoints and Related Data ..................................................... 34
    Inputs ..................................................................................... 34
    Operation .............................................................................. 34
  Demand Ventilation ................................................................. 34
    Setpoints and Related Data ..................................................... 35
    Outputs ................................................................................. 35
    Operation .............................................................................. 35
  Free Cooling Changeover Options ............................................. 35
    Setpoints and Related Data ..................................................... 35
    Inputs ..................................................................................... 36
  Changeover Options ................................................................. 36
    Auto ..................................................................................... 36
    Dual Enthalpy ........................................................................ 36
    Single Enthalpy ...................................................................... 36
Dry Bulb .................................................................................................................. 37
Changeover Methods ................................................................................................. 37
  Dry Bulb Changeover ............................................................................................... 37
  Single Enthalpy Changeover ................................................................................. 37
  Dual Enthalpy Changeover ..................................................................................... 37
CV Free Cooling Operation (Option A Thermostat) .................................................. 37
  Cooling Stages Set to One for Single Compressor Unit ...................................... 37
  Cooling Stages Set to Two for a Two Compressor Unit ....................................... 37
  Cooling Stages Set to Four for a Four Compressor Unit ..................................... 38
CV Option B Thermostat Sequence .......................................................................... 38
  Cooling Stages Set to One for Single Compressor Unit ...................................... 38
  Cooling Stages Set to Two or more for Multiple Compressor Units .................... 38
Sensor ....................................................................................................................... 39
  CV Option A Occupied ......................................................................................... 39
  CV Option B Occupied ......................................................................................... 39
  CV Option A and Option B Unoccupied ............................................................... 40
  VAV Unit Sensor Option A ................................................................................. 40
  VAV Unit Sensor Option B ................................................................................. 40
Economizer Loading ................................................................................................. 41
Setpoints and Related Data ...................................................................................... 41
Operation .................................................................................................................. 41
Power Exhaust .......................................................................................................... 41
  Non-Modulating Power Exhaust ......................................................................... 41
    Setpoints .............................................................................................................. 41
    Inputs ................................................................................................................... 41
    Outputs ............................................................................................................... 41
    Operation ............................................................................................................ 41
  Modulating Power Exhaust .................................................................................. 42
    Setpoints .............................................................................................................. 42
    Inputs ................................................................................................................... 42
    Outputs ............................................................................................................... 42
Operation .................................................................................................................. 42

Modulating Power Exhaust with VFD ................................................................. 42
Setpoints and Related Data .................................................................................. 42
Inputs ....................................................................................................................... 42
Outputs .................................................................................................................... 42
Operation .................................................................................................................. 43

Low Ambient Operation ....................................................................................... 43
Setpoints and Related Data .................................................................................. 43
Operation .................................................................................................................. 43

Lead/Lag (Compressor Equalized Runtime) ....................................................... 43
Setpoints and Related Data .................................................................................. 43
Operation .................................................................................................................. 44
  Constant Volume or VAV, No Hot Gas Reheat, No Hot Gas Bypass ................. 44
  Constant Volume, No Hot Gas Reheat, Yes Hot Gas Bypass Enable ............... 44
  Constant Volume or VAV, Yes Hot Gas Reheat, Yes/No Hot Gas Bypass Enable 44
  VAV, No Hot Gas Reheat, Yes Hot Gas Bypass Enable .................................. 44

Hot Gas Reheat ....................................................................................................... 44
Setpoints and Related Data .................................................................................. 44
Inputs ....................................................................................................................... 44
Outputs .................................................................................................................... 44
Operation .................................................................................................................. 45
  Normal Occupied Operation Mode ................................................................. 45
  Alternate Mode ................................................................................................. 45

Freezestat Alarm .................................................................................................... 45

ERV Interaction ..................................................................................................... 46
Setpoints and Related Data .................................................................................. 46
Outputs .................................................................................................................... 46
Operation .................................................................................................................. 46

Space Temperature Alarming ............................................................................... 46
Setpoints and Related Data .................................................................................. 46
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scheduling/Occupancy Determination</td>
<td>47</td>
</tr>
<tr>
<td>Operation</td>
<td>47</td>
</tr>
<tr>
<td>Inputs</td>
<td>47</td>
</tr>
<tr>
<td>Operation</td>
<td>47</td>
</tr>
<tr>
<td>Hardware Reset</td>
<td>48</td>
</tr>
<tr>
<td>Unit Protection</td>
<td>48</td>
</tr>
<tr>
<td>Low Voltage</td>
<td>48</td>
</tr>
<tr>
<td>Setpoints and Related Data</td>
<td>48</td>
</tr>
<tr>
<td>Inputs</td>
<td>48</td>
</tr>
<tr>
<td>Outputs</td>
<td>48</td>
</tr>
<tr>
<td>Operation</td>
<td>48</td>
</tr>
<tr>
<td>High Pressure Switch</td>
<td>48</td>
</tr>
<tr>
<td>Setpoints and Related Data</td>
<td>48</td>
</tr>
<tr>
<td>Inputs</td>
<td>49</td>
</tr>
<tr>
<td>Outputs</td>
<td>49</td>
</tr>
<tr>
<td>Operation</td>
<td>49</td>
</tr>
<tr>
<td>Low Pressure Switch</td>
<td>49</td>
</tr>
<tr>
<td>Setpoints and Related Data</td>
<td>49</td>
</tr>
<tr>
<td>Inputs</td>
<td>49</td>
</tr>
<tr>
<td>Outputs</td>
<td>49</td>
</tr>
<tr>
<td>Operation</td>
<td>49</td>
</tr>
<tr>
<td>Evaporator Coil - Freeze Condition</td>
<td>50</td>
</tr>
<tr>
<td>Setpoints and Related Data</td>
<td>50</td>
</tr>
<tr>
<td>Inputs</td>
<td>50</td>
</tr>
<tr>
<td>Outputs</td>
<td>50</td>
</tr>
<tr>
<td>Operation</td>
<td>50</td>
</tr>
<tr>
<td>Fan Overload</td>
<td>51</td>
</tr>
<tr>
<td>Setpoints and Related Data</td>
<td>51</td>
</tr>
<tr>
<td>Section</td>
<td>Page</td>
</tr>
<tr>
<td>----------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Inputs</td>
<td>51</td>
</tr>
<tr>
<td>Outputs</td>
<td>51</td>
</tr>
<tr>
<td>Operation</td>
<td>51</td>
</tr>
<tr>
<td>Shut Down (SD)</td>
<td>51</td>
</tr>
<tr>
<td>Setpoints and Related Data</td>
<td>51</td>
</tr>
<tr>
<td>Inputs</td>
<td>51</td>
</tr>
<tr>
<td>Outputs</td>
<td>51</td>
</tr>
<tr>
<td>Operation</td>
<td>51</td>
</tr>
<tr>
<td>Limit</td>
<td>52</td>
</tr>
<tr>
<td>Setpoints and Related Data</td>
<td>52</td>
</tr>
<tr>
<td>Inputs</td>
<td>52</td>
</tr>
<tr>
<td>Outputs</td>
<td>52</td>
</tr>
<tr>
<td>Operation</td>
<td>52</td>
</tr>
<tr>
<td>Main Valve (MV)</td>
<td>52</td>
</tr>
<tr>
<td>Setpoints and Related Data</td>
<td>52</td>
</tr>
<tr>
<td>Inputs</td>
<td>52</td>
</tr>
<tr>
<td>Outputs</td>
<td>52</td>
</tr>
<tr>
<td>Operation</td>
<td>52</td>
</tr>
<tr>
<td>Heat Pump</td>
<td>53</td>
</tr>
<tr>
<td>Setpoints and Related Data</td>
<td>53</td>
</tr>
<tr>
<td>Inputs</td>
<td>53</td>
</tr>
<tr>
<td>Outputs</td>
<td>53</td>
</tr>
<tr>
<td>Operation</td>
<td>53</td>
</tr>
<tr>
<td>Cooling</td>
<td>53</td>
</tr>
<tr>
<td>Heating</td>
<td>54</td>
</tr>
<tr>
<td>Defrost</td>
<td>54</td>
</tr>
<tr>
<td>Refrigeration System Settings</td>
<td>55</td>
</tr>
<tr>
<td>Load Shed and Redline (California Title 24 Compliance)</td>
<td>56</td>
</tr>
<tr>
<td>Direct Load Shed</td>
<td>56</td>
</tr>
<tr>
<td>Setpoints and Related Data</td>
<td>56</td>
</tr>
<tr>
<td>Inputs</td>
<td>57</td>
</tr>
<tr>
<td>Operation</td>
<td>57</td>
</tr>
</tbody>
</table>
Indirect Load Shed (Graduated) ............................... 57
Setpoints and Related Data ............................... 57
Inputs ....................................................... 57
Operation ................................................. 57

Self Test Sequencer ........................................ 57
Setpoints and Related Data ............................... 57
Inputs ....................................................... 57
Outputs ..................................................... 58
Operation ................................................. 58
Results ...................................................... 60
Timing ....................................................... 61

Air Proving Switch (APS) Setup ........................... 61
Setpoints and Related Data ............................... 61
Inputs ....................................................... 62
Operation ................................................. 62

Fan Control Type Set to Single Speed or Fixed Variable, APS Set to None ................................. 62
Fan Control Type Set to Single Speed or Fixed Variable, APS Set to CV ................................. 62
Fan Control Type Set to Single Speed, Variable Speed, or Fixed Variable, APS Set to Variable Volume 62

Pump Out Operation ......................................... 62

Overview ................................................... 62
Parameters .................................................. 62
Operation ................................................. 62

Alarms ....................................................... 63
Alarm List ................................................... 63
FDD Alarms .................................................. 72
SMART Equipment Unit Controls Sequence of Operation Overview

Introduction
This document provides an overview of the Johnson Controls® Series 5, 10, 20, and 40 Package Equipment unit controls system components, supported features, and operating modes particular to each type of system.

Summary of Changes
The following information is new or revised:
• Heating Parameters, Gas Heat Setup, Gas Heat Setup, and Hydronic Heat for the general system.
• Single-Zone VAV (SZ VAV) outputs, operation, discharge air temperature reset.
• Minimum Position operation information.
• Cooling Stages Set to One for Single Compressor Unit in the CV Free Cooling Operation (Option A) section.
• Hot Gas Reheat information incorporated.
• Unit Protection information updated.
• Load Shed and Redline (California Title 24 Compliance) information incorporated.
• Air Proving Switch (APS) Setup information incorporated.
• FDD Alarms table updated.

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.

Adaptive Tuning
Adaptive Tuning allows you to change the cooling and heating reaction time for the staged percent command.

Adaptive Tuning is only available on four-stage units. All units have the feature, but it only operates on the four-stage unit. On the single- and dual-stage units, adaptive tuning turns on and off, but does not function. When adaptive tuning is turned On, the adaptive tuning learning feature enables.

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)

No Heat Setup
Heating Enabled is set to Off.

Gas Heat Setup
Heating Enabled is set to ON
Number of Heating Stages: 1, 2, or 3
Number of Gas Valves: 1, 2, or 3
Heating Type is set to Staged

Electric Heat
Heating Enabled is set to ON
Number of Heating Stages: 1, 2, or 3
Number of Gas Valves is set to 0
Heating Type is set to Staged

Hydronic Heat
Heating Enabled is set to ON.
Heating Type is set to Proportional.

Cooling Parameters
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 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 pass 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 pass 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 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 pass 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 pass 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 pass without a communicated value, the UI displays Value Timed Out and the next highest priority input is used.

Outdoor Air Humidity Input (OAH) is used if the humidity sensor is connected to the OAH terminals.

### Operational Indoor Air Quality (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 (IAQRanged)

#### 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) 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 (IAQRanged) 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 (IAQRanged)

Indoor Air Quality Source (IAQSrc) describes the input currently in use for Operational Indoor Air Quality (OprIAQ).

- **BAS Override**: indicates Network Override Indoor Air Quality
- **Local Input**: indicates Indoor Air Quality sensor
- **Unreliable**: indicates no valid related input is available and demand ventilation economizer functions that use Operational Indoor Air Quality are not permitted

Network Override Indoor Air Quality (NetIAQ) is used if a value is set or communicated within the past 15 minutes. If 15 minutes pass without a communicated value, the UI displays Value Timed Out and the next highest priority input is used.

Indoor Air Quality (IAQ) is used if the IAQ sensor is connected to the IAQ and COM terminals.
Operational Outdoor Air Quality

**Setpoints and Related Data**
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 to 10 VDC input from the sensor to match the actual ppm measured by the sensor.

**Note:** Network Override Outdoor Air Quality (NetOAQ) is not bound by the Outdoor Air Quality Sensor Range (OAQRange).

Outdoor Air Quality Source (OAQSrc) describes the related input in current use for Operational Outdoor Air Quality (OprOAQ):
- **BAS Override:** indicates Network Override Outdoor Air Quality
- **Local Input:** indicates Outdoor Air Quality sensor
- **Unreliable:** indicates no valid related input is available for and the differential demand ventilation economizer function that uses Operational Outdoor Air Quality (OprOAQ) is not permitted

Network Override Outdoor Air Quality (NetOAQ) is used if a value is set or communicated within the past 15 minutes. If 15 minutes pass without a communicated value, the UI displays Value Timed Out and the next highest priority input is used.

Outdoor Air Quality Input (OAQ) is used if the OAQ sensor is connected to the OAQ and COM terminals.

**Operational Purge**

**Setpoints and Related Data**
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.
Packaged Equipment Operation

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
• 24 VAC to HPS1 through HPS4 and LPS1 through LPS4
• evaporator coil temperature sensor EC1, EC2, EC3, and EC4
• 24 VAC to terminals Y1 through Y4
• 24 VAC to terminals W1 through W3
• operational outdoor air temperature (OprOAT) from the sensor to the OAT terminal or a communicated value

Outputs
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 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 energizes 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
• 24 VAC to HPS1 through HPS4 and LPS1 through LPS4
• evaporator coil temperature sensors EC1, EC2, EC3, and EC4
• operational space temperature (OprST)
• operational outdoor air temperature (OprOAT)

Outputs
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
Setpoint Determination
Figure 1 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.

Table 1: PID Percent Command

<table>
<thead>
<tr>
<th>No. Stages</th>
<th>1st Stage</th>
<th>2nd Stage</th>
<th>3rd Stage</th>
<th>4th Stage¹</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>On</td>
<td>Off</td>
<td>On</td>
<td>Off</td>
</tr>
<tr>
<td>1</td>
<td>100%</td>
<td>90%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>50%</td>
<td>45%</td>
<td>100%</td>
<td>95%</td>
</tr>
<tr>
<td>3</td>
<td>33.3%</td>
<td>30%</td>
<td>66%</td>
<td>63.2%</td>
</tr>
<tr>
<td>4</td>
<td>25%</td>
<td>22.5%</td>
<td>50%</td>
<td>47.5%</td>
</tr>
</tbody>
</table>

¹ The 4th Stage applies to cooling operation only.

Compressor Operation
This section assumes Free Cooling is not available.

If the operating space temperature is 0.6°F or greater than the operating cooling setpoint, the staged percent command increases. Compressors turn on based on 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 the order in which they turned on. For example, the first compressor to turn on is the last compressor to turn off.

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

Compressor Operation

This section assumes Free Cooling is not available.

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

Heating Operation

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

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 5).

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 2: PID Percent Command

<table>
<thead>
<tr>
<th>No. Stages</th>
<th>1st Stage</th>
<th>2nd Stage</th>
<th>3rd Stage</th>
<th>4th Stage1</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>On</td>
<td>Off</td>
<td>On</td>
<td>Off</td>
</tr>
<tr>
<td>1</td>
<td>100%</td>
<td>90%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>50%</td>
<td>45%</td>
<td>100%</td>
<td>95%</td>
</tr>
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<td>30%</td>
<td>66%</td>
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</tr>
<tr>
<td>4</td>
<td>25%</td>
<td>22.5%</td>
<td>50%</td>
<td>47.5%</td>
</tr>
</tbody>
</table>

1. The 4th Stage applies to cooling operation 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:
• Thermostat Only Input   False
• SZ VAV Enabled (SZAVEn)   On
• Fan Control Type (FanCtl-Type) 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)
• 24 VAC for H1, H2, H3

**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 required, the supply fan begins to ramp up to 100%, and heating stages energize in 30-second intervals until the VAV Unoccupied Heating Setpoint is reached.

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 temperature 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% < Zone Heating Loop Output < 40%, then
  \[ \text{OprSZVAVClgSP} = \text{VAVHtgOcc-SP} + 2^\circ F \]
• If 40% < Zone Heating Loop Output < 75%, then
  \[ \text{OprSZVAVClgSP} = \text{VAVHtgOcc-SP} + 10^\circ F \]
• If 75% < Zone Heating Loop Output, then
  \[ \text{OprSZVAVClgSP} = \text{DATMaxHtgSP} \]

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

• If 0% < Zone Cooling Loop Output < 30%,
  then \[ \text{OprSZVAVClgSP} = \text{VAVClgOcc-SP} - 2^\circ F \]
• If 30% < Zone Cooling Loop Output < 70%,
  then \[ \text{OprSZVAVClgSP} = \text{VAVClgOcc-SP} - 8^\circ F \]
• If 70% < Zone Cooling Loop Output < 100%,
  then \[ \text{OprSZVAVClgSP} = \text{SATClgMinSP} \]
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 include:

- 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 5-minute stabilization period, and then operating space temperature is compared to morning cool-down return air temp setpoint.

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

The compressors energize until 5 minutes pass and the operating space temperature is below the morning cool-down setpoint or the early start period expires. 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 5-minute stabilization period and then operating space temperature is compared to morning cool-down return air temp setpoint.

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

The compressors energize until 5 minutes pass and the operating space temperature is below the morning cool-down setpoint or the early start period expires. 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 include:

• 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 5-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 pass 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 5-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

**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 2-minute cool to heat changeover delay has expired, all heat stages energize with approximately 30 seconds of delay between stages.

Heat remains energized until the operational space temperature reaches the VAV Occupied Heating Setpoint + 1°F.

Any time the control enters the heat mode, 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 include:

• 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

**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-second 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 the high-fan speed setting, the Economizer Damper position is the Economizer Minimum Position Setpoint.
When the VFD output reaches then fan low-speed setting, the Economizer Damper position is the Economizer Damper Minimum Position Low Speed Fan.
When the VFD output is between the fan high speed and fan low speed settings, the Economizer Damper is position proportionally between 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)
- Air Enable (FRSHAir-En)

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 CO₂ level is greater than the Demand Ventilation Setpoint +100 ppm, the current operating minimum position increases as follows;

With a CO₂ 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 minimum position. The economizer then modulates to control the supply air temperature at 50°F.

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

If Differential AQ Enable is On and the OAQ is greater than or equal to the IAQ by more than the Demand Ventilation Differential Setpoint, the outside air dampers close completely and 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 +/-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 +/-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 +/-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 +/-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+/- 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 +/-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 +/-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 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 the chart below.

Table 3: PID Percent Command

<table>
<thead>
<tr>
<th>No. Stages</th>
<th>1st Stage</th>
<th>2nd Stage</th>
<th>3rd Stage</th>
<th>4th Stage¹</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>On</td>
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<td>On</td>
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<tr>
<td>3</td>
<td>33.3%</td>
<td>30%</td>
<td>66%</td>
<td>63.2%</td>
</tr>
<tr>
<td>4</td>
<td>25%</td>
<td>22.5%</td>
<td>50%</td>
<td>47.5%</td>
</tr>
</tbody>
</table>

1. 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 0.6°F above the operating cooling setpoint, the staged percent command holds the current value.

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

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

CV Option B Occupied

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 modulate 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-energize 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.

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 +1.8°F, 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.

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**Table 4: PID Percent Command**

<table>
<thead>
<tr>
<th>No. Stages</th>
<th>1st Stage</th>
<th>2nd Stage</th>
<th>3rd Stage</th>
<th>4th Stage[^1]</th>
</tr>
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<tbody>
<tr>
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<td>22.5%</td>
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<td>47.5%</td>
</tr>
</tbody>
</table>

[^1]: The 4th Stage applies to cooling operation only.

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SMART Equipment Unit Controls Sequence of Operation Overview
If all compressor outputs de-energize 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 from 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-minute On cycle and the evaporator temperature (EC1 through EC4) drops below 26°F, the compressor output de-energizes and the 5-minute ASCD starts. After the 5-minute ASCD expires, the compressor output is permitted.

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

**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-energizes 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 **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)
- HGR Humidity Setpoint Differential (HGR-Diff)

**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. The control remains in this state until the humidity drops below the HGR-Diff Setpoint.

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. The control remains in this state until the humidity drops below the HGR-Diff Setpoint.

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 5 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 5: Dehumidification Sequence in Normal and Alternate Mode

<table>
<thead>
<tr>
<th>Request</th>
<th>Normal Mode</th>
<th>Alternate Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HGR</td>
<td>C1</td>
</tr>
<tr>
<td>Dehumidification</td>
<td>On</td>
<td>Off</td>
</tr>
<tr>
<td>One Stage of Cooling (Y1)</td>
<td>Off</td>
<td>On</td>
</tr>
<tr>
<td>Two Stages of Cooling (Y2)</td>
<td>Off</td>
<td>On</td>
</tr>
</tbody>
</table>

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 6.

Table 6: Energy Recovery Determination

<table>
<thead>
<tr>
<th>ERV Installed</th>
<th>ERV Unocc Fan</th>
<th>Eff Occupancy</th>
<th>State</th>
</tr>
</thead>
<tbody>
<tr>
<td>Disable</td>
<td>*</td>
<td>*</td>
<td>OFF</td>
</tr>
<tr>
<td>Enable</td>
<td>Enable</td>
<td>*</td>
<td>ON</td>
</tr>
<tr>
<td>Enable</td>
<td>Disable</td>
<td>Occupied</td>
<td>ON</td>
</tr>
<tr>
<td>Enable</td>
<td>Disable</td>
<td>Unoccupied</td>
<td>OFF</td>
</tr>
</tbody>
</table>

* Means this state has no effect on the output.

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

When the ERV Installed is Disabled, the exhaust VFDs are controlled based on building static pressure. See Modulating power exhaust with VFD 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 VFDs, the ERV installed parameter should be set to Disabled.

(CV into own section)

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)
• 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 and Netsensor Occupancy Request. The following applies:

- If Temporary Occupancy Input is false, then the Operational Occupancy is based strictly off the Schedule Occupancy. The Schedule Occupancy 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 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.

**Hardware Reset**

Hardware resets are linked to various conditions and settings, including free stat, High Pressure Switch event, Limit Switch 1. See the Shut Down (SD) section for operation information.

**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=1 to 4)
• High Pressure Limit (HPSi for i=1 to 4)
• High Pressure Lockout (HPSi-LO for i=1 to 4)
• Reset Lockouts(ResetLO)

**Inputs**
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 2 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.

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

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

**Note:** To manually reset the lockout condition, navigate to the ResetLO point in the User Interface. 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 2 hours of run time, it locks out 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.

Any time 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**

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

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

If the UCB senses W1 and a Fan Overload fault, it does not lock out the Fan. As long as there is a W1 present. 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**

Any 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 or external shutdown relays, 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**
- 24 VAC 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 5-minute period, it flags an alarm and generates an alarm on the UI. If GV reappears after the alarm, the alarm is reset and normal operation occurs. If W1 goes away, the UCB resets the alarm.

Any time the UCB senses GV voltage without W1 the UCB energizes the fan relay immediately. If the voltage remains for a continuous 5-minute period 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**

All available compressor outputs are energized.

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 de-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).

**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.

**Load Shed and Redline (California Title 24 Compliance)**

**Direct Load Shed**

**Setpoints and Related Data**

No setpoints or related data.
**Inputs**
Direct Load Shed (DirLoadShd)

**Operation**
Operation details include:
If the Direct Load Shed is set to YES, the compressors stage off for 5 minutes. After the 5-minute disable period, the compressors stage on and the communicated value returns to NO.

**Indirect Load Shed (Graduated)**

**Setpoints and Related Data**
Setpoints and related data includes:
- Load Shed Active (LoadShedEnable)
- Load Shed Rate Limit (LoadShedRateLim)
- Load Shed Adjust (LoadShedAdjust)

**Inputs**
No inputs apply to indirect LoadShed.

**Operation**
When the effective setpoint reaches the operational cooling setpoint (Load Shed Active set to YES), the Load Shed Rate Limit gradually increases the setpoint over a 1-hour period. The default for Load Shed Rate Limit is 0.066 degrees per minute (4 degrees per hour). The Load Shed Adjust default is 4 degrees. The gradual adjust methods eliminates the compressors from staging on and off rapidly.

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

Table 7: Expected Self Test Outcomes

<table>
<thead>
<tr>
<th>Test Mode</th>
<th>Fan</th>
<th>CF1</th>
<th>C1</th>
<th>C2</th>
<th>H1</th>
<th>H2</th>
<th>CF2</th>
<th>C3</th>
<th>C4</th>
<th>H3</th>
<th>ECON</th>
<th>EX</th>
<th>VFD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fan Test</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>0%</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Compressor Test 1</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>0%</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Compressor Test 2</td>
<td>ON</td>
<td>ON</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>0%</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Compressor Test 3</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>ON</td>
<td>0%</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Compressor Test 4</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
<td>0%</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Heating 1 Test</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>0%</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Heating 2 Test</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>0%</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Heating 3 Test</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>ON</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Economizer Test</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>Ramp until SAT changes +/- 2°F</td>
<td>0%</td>
<td></td>
</tr>
<tr>
<td>Power Exhaust Test</td>
<td>ON</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>OFF</td>
<td>0%</td>
<td>Ramp until BLD PRS drops &gt;.05 in. wc</td>
<td></td>
</tr>
</tbody>
</table>
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 8.

### Table 8: Self Test Sequencer UI Commands

<table>
<thead>
<tr>
<th>UI Command</th>
<th>Smart Equipment Control Reaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pause</td>
<td>Causes the sequence to hold any outputs ON for 10 minutes. This excludes safety trips.</td>
</tr>
<tr>
<td>Reset</td>
<td>Erases the previous Self Test results and prepares the Self Test Sequencer for another test run.</td>
</tr>
<tr>
<td>Cancel</td>
<td>Stops the Self Test Sequencer and returns the SEC to normal operation.</td>
</tr>
</tbody>
</table>

### Results

You can view the results from the Self Test Sequencer on the Local UI. Results are also viewable from a USB flash drive if it is plugged into the UCB before you initiate a Self Test. The results are put into a folder on the flash drive. Possible result categories are described in Table 9.

### Table 9: Self Test Results

<table>
<thead>
<tr>
<th>Test (Result Category)</th>
<th>Possible Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fan (Fan)</td>
<td>Fail - APS On Early</td>
</tr>
<tr>
<td></td>
<td>Fail - APS Off</td>
</tr>
<tr>
<td></td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Fail</td>
</tr>
<tr>
<td>Compressors (C1, C2, C3, C4)</td>
<td>Fail - HPS</td>
</tr>
<tr>
<td></td>
<td>Fail - Frz</td>
</tr>
<tr>
<td></td>
<td>Fail - LPS</td>
</tr>
<tr>
<td></td>
<td>Fail - LS</td>
</tr>
<tr>
<td></td>
<td>Warning - SAT not dropped</td>
</tr>
<tr>
<td></td>
<td>Pass</td>
</tr>
<tr>
<td>Heating Stages (H1, H2, H3)</td>
<td>Fail - HPS</td>
</tr>
<tr>
<td></td>
<td>Fail - LPS</td>
</tr>
<tr>
<td></td>
<td>Fail - LS</td>
</tr>
<tr>
<td></td>
<td>Fail - GV Off</td>
</tr>
<tr>
<td></td>
<td>Pass</td>
</tr>
<tr>
<td></td>
<td>Warning - SAT not increased</td>
</tr>
<tr>
<td>Economizer</td>
<td>Fail - Damper</td>
</tr>
<tr>
<td></td>
<td>Pass</td>
</tr>
<tr>
<td>Power Exhaust</td>
<td>Warning - BSP not dropped</td>
</tr>
<tr>
<td></td>
<td>Pass</td>
</tr>
</tbody>
</table>
Timing

Table 10 shows the Self Test Time.

### Table 10: Self Test Time

<table>
<thead>
<tr>
<th>Test Portion</th>
<th>Time (Seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fan Test Stabilize</td>
<td>30</td>
</tr>
<tr>
<td>Fan Test Check (APS)</td>
<td>90</td>
</tr>
<tr>
<td>Fan Test Check (None, Prompt Time)</td>
<td>90</td>
</tr>
<tr>
<td>Fan Test Check (Variable, DPS)</td>
<td>30</td>
</tr>
<tr>
<td>C1 Stabilize</td>
<td>180</td>
</tr>
<tr>
<td>C1 Check</td>
<td>180</td>
</tr>
<tr>
<td>C2 Stabilize</td>
<td>180</td>
</tr>
<tr>
<td>C2 Check</td>
<td>180</td>
</tr>
<tr>
<td>C3 Stabilize</td>
<td>180</td>
</tr>
<tr>
<td>C3 Check</td>
<td>180</td>
</tr>
<tr>
<td>C4 Stabilize</td>
<td>180</td>
</tr>
<tr>
<td>C4 Check</td>
<td>180</td>
</tr>
<tr>
<td>H1 Stabilize</td>
<td>180</td>
</tr>
<tr>
<td>H1 Check</td>
<td>60</td>
</tr>
<tr>
<td>H2 Stabilize</td>
<td>180</td>
</tr>
<tr>
<td>H2 Check</td>
<td>60</td>
</tr>
<tr>
<td>H3 Stabilize</td>
<td>180</td>
</tr>
<tr>
<td>H3 Check</td>
<td>60</td>
</tr>
<tr>
<td>H3 Stabilize</td>
<td>180</td>
</tr>
<tr>
<td>Economizer Stabilize</td>
<td>180</td>
</tr>
<tr>
<td>Economizer Check (before prompt)</td>
<td>600</td>
</tr>
<tr>
<td>Economizer Check (prompt)</td>
<td>600</td>
</tr>
<tr>
<td>Power Exhaust Stabilize</td>
<td>180</td>
</tr>
<tr>
<td>Power Exhaust Check</td>
<td>90</td>
</tr>
<tr>
<td>Total if all Tests are run to full timeout</td>
<td>4230</td>
</tr>
</tbody>
</table>

Air Proving Switch (APS) Setup

Setpoints and Related Data

- Air Proving Switch Setup
  - Constant Volume
  - Variable Volume
  - None
- Fan Control Type
  - Single Speed
  - Not Used
  - Fixed Variable
  - Variable Speed
Inputs
Air Proving Switch (APS)
Duct Pressure 0 to 5 VDC (DCT PRS)

Operation

**Fan Control Type Set to Single Speed or Fixed Variable, APS Set to None**
Fan command energizes fan output. No APS mechanism is required.

**Fan Control Type Set to Single Speed or Fixed Variable, APS Set to CV**
With any Fan command, the APS must close within 60 seconds. If the APS does not close within the 60 seconds, the fan command and all heating/cooling outputs turn off. The alarm, “unit locked out due to APS” appears.
After the APS is proven, if it opens for more than 2 seconds, the fan output de-energizes (turns off). If the APS does not close within the 60 seconds, the fan command and all heating/cooling outputs turn off. The alarm, “unit locked out due to APS” appears.
The fan retries after 30 minutes of any unit lock out.
If the APS is closed when the fan command is OFF, the “unit lock out due to APS” appears. The Fan command remains OFF.

**Fan Control Type Set to Single Speed, Variable Speed, or Fixed Variable, APS Set to Variable Volume**
Note: If the Fan Control Type is set to Variable Speed, APS set-up automatically sets to Variable Volume. The parameter no longer appears in the menu.
With any Fan command, duct pressure must reach 0.10 in/w.c. within 60 seconds. If the pressure point does not close within the 60 seconds, the fan command and all heating/cooling outputs turn off. The alarm unit locked out due to APS appears.
After the pressure point is proven if the duct pressure drops below the 0.10 in./w.c. for more than 2 seconds, the fan command and all heating/cooling outputs turn off. The alarm unit locked out due to APS appears.
The fan retries after 30 minutes of any unit lock out.

**Pump Out Operation**

**Overview**

**Parameters**
Parameters include:
- Pump Out Enabled  ON

**Operation**
With split system heat pumps, pump out enable should never be turned ON.
See the Thermostat or Sensor sections in *Constant Volume (CV) Sequences* if Pump Out is turned OFF.
If pump out is turned ON, when the C1 output energizes, the condenser fan (CN-Fan) energizes when either the low pressure switch 1 (LPS1) opens or 5 minutes elapse.
If C1 is energized, and the accumulated C1 runtime is greater than 1 hour more than C2 accumulated runtime, C2 energizes for 5-minutes.
If C2 is energized, and the accumulated C2 runtime is greater than 1 hour more than the C1 accumulated runtime, C1 energizes for 5 minutes.

**Alarms**

**Alarm List**

Alarms are categorized into three groups based on severity: critical, service priority, and service. Table 11 describes the non-FDD alarms.

<table>
<thead>
<tr>
<th>Severity</th>
<th>Alarm</th>
<th>How It Happens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical</td>
<td>C1 Locked Out Due to High Pressure</td>
<td>Three HPS1 trips within 2 hours.</td>
</tr>
<tr>
<td></td>
<td>C2 Locked Out Due to High Pressure</td>
<td>Three HPS2 trips within 2 hours.</td>
</tr>
<tr>
<td></td>
<td>C3 Locked Out Due to High Pressure</td>
<td>Three HPS3 trips within 2 hours.</td>
</tr>
<tr>
<td></td>
<td>C4 Locked Out Due to High Pressure</td>
<td>Three HPS4 trips within 2 hours.</td>
</tr>
<tr>
<td></td>
<td>C1 Locked Out Due to Low Pressure</td>
<td>Three LPS1 trips within 1 hour.</td>
</tr>
<tr>
<td></td>
<td>C2 Locked Out Due to Low Pressure</td>
<td>Three LPS2 trips within 1 hour.</td>
</tr>
<tr>
<td></td>
<td>C3 Locked Out Due to Low Pressure</td>
<td>Three LPS3 trips within 1 hour.</td>
</tr>
<tr>
<td></td>
<td>C4 Locked Out Due to Low Pressure</td>
<td>Three LPS4 trips within 1 hour.</td>
</tr>
<tr>
<td></td>
<td>C1 Locked Out Due to Coil Freeze</td>
<td>Three FS1 trips within 2 hours.</td>
</tr>
<tr>
<td></td>
<td>C2 Locked Out Due to Coil Freeze</td>
<td>Three FS2 trips within 2 hours.</td>
</tr>
<tr>
<td></td>
<td>C3 Locked Out Due to Coil Freeze</td>
<td>Three FS3 trips within 2 hours.</td>
</tr>
<tr>
<td></td>
<td>C4 Locked Out Due to Coil Freeze</td>
<td>Three FS4 trips within 2 hours.</td>
</tr>
<tr>
<td></td>
<td>Exhaust Fan VFD Failure</td>
<td>EX VFD BI trips (must be set up as Exhaust or Variable Frequency Fan)</td>
</tr>
<tr>
<td></td>
<td>HS1 Locked Out Due to Limit Switch</td>
<td>Three LS1 trips within 1 hour.</td>
</tr>
<tr>
<td></td>
<td>HS2 Locked Out Due to Limit Switch</td>
<td>Three LS2 trips within 1 hour.</td>
</tr>
<tr>
<td></td>
<td>HS3 Locked Out Due to Limit Switch</td>
<td>Three LS3 trips within 1 hour.</td>
</tr>
<tr>
<td></td>
<td>Unit Shutdown Due to Smoke, etc.</td>
<td>SD input loses 24 VAC.</td>
</tr>
<tr>
<td></td>
<td>Supply Fan VFD Failure</td>
<td>Fan VFD Input trips (must be set up as NOT Single Speed)</td>
</tr>
<tr>
<td></td>
<td>No Heat-Cool Due to Unreliable Space-T</td>
<td>Input Unreliable</td>
</tr>
<tr>
<td></td>
<td>4-Stage Communication Failure</td>
<td>4-Stage board goes from Online to Offline.</td>
</tr>
<tr>
<td></td>
<td>Economizer Communication Failure</td>
<td>Economizer board goes from Online to Offline.</td>
</tr>
</tbody>
</table>
### Table 11: Alarms (Part 2 of 9)

<table>
<thead>
<tr>
<th>Severity</th>
<th>Alarm</th>
<th>How It Happens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Critical</td>
<td>Outputs Disabled Due to Low Input V</td>
<td>Blackout Conditions</td>
</tr>
<tr>
<td>Critical</td>
<td>Outputs Limited Due Brownout Input V</td>
<td>Brownout Conditions</td>
</tr>
<tr>
<td>Critical</td>
<td>Unit Locked Out Due to APS</td>
<td>Three APS trips within 1.5 hours. (if APS is installed or based on Duct Pressure if Variable Speed Fan enabled).</td>
</tr>
<tr>
<td>Critical</td>
<td>Unit Locked Out Due to Supply Fan OL</td>
<td>Three FAN OVR trips within two hours.</td>
</tr>
<tr>
<td>Critical</td>
<td>Unit Locked Out Due to High Duct-P</td>
<td>Duct Static Pressure is greater than the High Duct Static Pressure Setpoint.</td>
</tr>
<tr>
<td>Service</td>
<td>Evaporator Coil Temp 1 Sensor Failure</td>
<td>Input unreliable and Number of Cooling Stages &gt;= 1</td>
</tr>
<tr>
<td>Service</td>
<td>Condenser Coil Temp 1 Sensor Failure</td>
<td>Input unreliable and Number of Cooling Stages &gt;= 1</td>
</tr>
<tr>
<td>Service</td>
<td>Evaporator Coil Temp 2 Sensor Failure</td>
<td>Input unreliable and Number of Cooling Stages &gt;= 2</td>
</tr>
<tr>
<td>Service</td>
<td>Condenser Coil Temp 2 Sensor Failure</td>
<td>Input unreliable and Number of Cooling Stages &gt;= 2</td>
</tr>
<tr>
<td>Service</td>
<td>Evaporator Coil Temp 3 Sensor Failure</td>
<td>Input unreliable and Number of Cooling Stages &gt;= 3</td>
</tr>
<tr>
<td>Service</td>
<td>Condenser Coil Temp 3 Sensor Failure</td>
<td>Input unreliable and Number of Cooling Stages &gt;= 3</td>
</tr>
<tr>
<td>Service</td>
<td>Evaporator Coil Temp 4 Sensor Failure</td>
<td>Input unreliable and Number of Cooling Stages &gt;= 4</td>
</tr>
<tr>
<td>Service</td>
<td>Condenser Coil Temp 4 Sensor Failure</td>
<td>Input unreliable and Number of Cooling Stages &gt;= 4</td>
</tr>
<tr>
<td>Service</td>
<td>Building Pressure Sensor Failure</td>
<td>Input unreliable</td>
</tr>
<tr>
<td>Service</td>
<td>Outdoor Air Temperature Sensor Failure</td>
<td>Input unreliable</td>
</tr>
<tr>
<td>Service</td>
<td>Return Air Temperature Sensor Failure</td>
<td>Input unreliable and Variable Speed Fan</td>
</tr>
<tr>
<td>Service</td>
<td>Supply Air Temperature Sensor Failure</td>
<td>Input Unreliable AND (Econ Comm Status = Online OR Mixed Air Sequencer = DAT Control)</td>
</tr>
<tr>
<td>Service</td>
<td>Unit Shutdown Due to Supply Fan Overload</td>
<td>FAN OVR Trip (but less than three in one hour as that would cause 'Unit Locked Out Due to Supply Fan OL')</td>
</tr>
<tr>
<td>Service</td>
<td>Main Controller Calibration Error</td>
<td>Missing Cal Data</td>
</tr>
<tr>
<td>Service</td>
<td>FDDM Controller Calibration Error</td>
<td>Missing Cal Data</td>
</tr>
<tr>
<td>Service</td>
<td>Econ Controller Calibration Error</td>
<td>Missing Cal Data</td>
</tr>
<tr>
<td>Service</td>
<td>4-Stage Controller Calibration Error</td>
<td>Missing Cal Data</td>
</tr>
<tr>
<td>Service</td>
<td>Unit Shutdown Due to Air Proving Switch</td>
<td>Cmd but no proof for &gt;= 90 seconds (if this happens less than three in 1.5 hours; otherwise that would cause 'Unit Locked Out Due to APS')</td>
</tr>
<tr>
<td>Service</td>
<td>FDDS Controller Calibration Error</td>
<td>Missing Cal Data</td>
</tr>
<tr>
<td>Severity</td>
<td>Alarm</td>
<td>How It Happens</td>
</tr>
<tr>
<td>----------</td>
<td>-------</td>
<td>----------------</td>
</tr>
<tr>
<td>Service</td>
<td>Duct Pressure Sensor Failure</td>
<td>Input Unreliable and Variable Speed Fan</td>
</tr>
<tr>
<td></td>
<td>Return Air Humidity Sensor Failure</td>
<td>Input unreliable</td>
</tr>
<tr>
<td></td>
<td>Outdoor Air Humidity Sensor Failure</td>
<td>Input unreliable</td>
</tr>
<tr>
<td></td>
<td>Supply Humidity Sensor Failure</td>
<td>Input unreliable</td>
</tr>
<tr>
<td></td>
<td>Indoor Air Quality Sensor Failure</td>
<td>Input unreliable</td>
</tr>
<tr>
<td></td>
<td>Outdoor Air Quality Sensor Failure</td>
<td>Input unreliable</td>
</tr>
<tr>
<td></td>
<td>Fresh Air Intake Sensor Failure</td>
<td>Input unreliable</td>
</tr>
<tr>
<td></td>
<td>Mixed Air Temp Sensor Failure</td>
<td>Input unreliable</td>
</tr>
<tr>
<td></td>
<td>Space Indoor temp Sensor Failure</td>
<td>Input unreliable</td>
</tr>
<tr>
<td></td>
<td>Space Offset Sensor Failure</td>
<td>Input unreliable</td>
</tr>
<tr>
<td></td>
<td>C1 Shutdown Due to High Pressure</td>
<td>HPS1 Trip</td>
</tr>
<tr>
<td></td>
<td>C2 Shutdown Due to High Pressure</td>
<td>HPS2 Trip</td>
</tr>
<tr>
<td></td>
<td>C3 Shutdown Due to High Pressure</td>
<td>HPS3 Trip</td>
</tr>
<tr>
<td></td>
<td>C4 Shutdown Due to High Pressure</td>
<td>HPS4 Trip</td>
</tr>
<tr>
<td></td>
<td>C1 Shutdown Due to Low Pressure</td>
<td>LPS1 Trip</td>
</tr>
<tr>
<td></td>
<td>C2 Shutdown Due to Low Pressure</td>
<td>LPS2 Trip</td>
</tr>
<tr>
<td></td>
<td>C3 Shutdown Due to Low Pressure</td>
<td>LPS3 Trip</td>
</tr>
<tr>
<td></td>
<td>C4 Shutdown Due to Low Pressure</td>
<td>LPS4 Trip</td>
</tr>
<tr>
<td></td>
<td>C1 Shutdown Due to Coil Freeze</td>
<td>FS1 Trip (Evap Coil Temp &lt; Evap Coil Temp Cutout SP)</td>
</tr>
<tr>
<td></td>
<td>C2 Shutdown Due to Coil Freeze</td>
<td>FS2 Trip (Evap Coil Temp &lt; Evap Coil Temp Cutout SP)</td>
</tr>
<tr>
<td></td>
<td>C3 Shutdown Due to Coil Freeze</td>
<td>FS3 Trip (Evap Coil Temp &lt; Evap Coil Temp Cutout SP)</td>
</tr>
<tr>
<td></td>
<td>C4 Shutdown Due to Coil Freeze</td>
<td>FS4 Trip (Evap Coil Temp &lt; Evap Coil Temp Cutout SP)</td>
</tr>
<tr>
<td></td>
<td>Low Outdoor Air Temp Cooling Cutout</td>
<td>OAT &lt; OAT Cooling Cutout</td>
</tr>
<tr>
<td></td>
<td>Econ Economizing When it Should Not</td>
<td>Economizer Damper % Command &gt; Min OA Position + FDD Damper Min Position Tolerance</td>
</tr>
<tr>
<td></td>
<td>Econ Not Economizing When It Should</td>
<td>Economizer Damper % Command &lt; Min OA Position + FDD Damper Min Position Tolerance</td>
</tr>
<tr>
<td></td>
<td>Economizer Damper Not Modulating</td>
<td>ABS(Economizer Damper % Command - Economizer Damper Position) &gt; FDD Economizer Damper Allowed Error</td>
</tr>
<tr>
<td></td>
<td>Economizer Letting In Excess Outdoor Air</td>
<td>(Economizer Damper % Command &gt; Min OA Position + FDD Damper Min Position Tolerance AND Ramp Min OA) OR (Economizer Damper % Command &gt; FDD Damper Min Position Tolerance AND Ramp Closed)</td>
</tr>
<tr>
<td></td>
<td>HS1 Shutdown Due to Limit Switch</td>
<td>LS1 Trip</td>
</tr>
<tr>
<td></td>
<td>HS2 Shutdown Due to Limit Switch</td>
<td>LS2 Trip</td>
</tr>
<tr>
<td></td>
<td>HS3 Shutdown Due to Limit Switch</td>
<td>LS3 Trip</td>
</tr>
<tr>
<td></td>
<td>HS1 Off Due to Gas Valve</td>
<td>H1 with no GV1 for &gt;=6 minutes</td>
</tr>
<tr>
<td></td>
<td>HS2 Off Due to Gas Valve</td>
<td>H2 with no GV2 for &gt;=6 minutes</td>
</tr>
<tr>
<td></td>
<td>HS3 Off Due to Gas Valve</td>
<td>H3 with no GV3 for &gt;=6 minutes</td>
</tr>
<tr>
<td></td>
<td>Dirty Filter</td>
<td>DFS Trip</td>
</tr>
<tr>
<td>Severity (Continued)</td>
<td>Alarm</td>
<td>How It Happens</td>
</tr>
<tr>
<td>----------------------</td>
<td>-------</td>
<td>----------------</td>
</tr>
<tr>
<td>FDD 1 Communication Failure</td>
<td>FDD Master Online -&gt; Offline</td>
<td></td>
</tr>
<tr>
<td>FDD 2 Communication Failure</td>
<td>FDD Slave Online -&gt; Offline</td>
<td></td>
</tr>
<tr>
<td>Unit has Received a Purge Request</td>
<td>PURGE-S on Econ trip</td>
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</tr>
<tr>
<td>Excessive Supply Air Temp Cooling</td>
<td>SAT &lt; Excessive SAT Cooling Sp AND SAT Limit for Cooling Enable</td>
<td></td>
</tr>
<tr>
<td>HS1 Gas Valve Failure</td>
<td>GV1 on without H1 for &gt;= 5 seconds</td>
<td></td>
</tr>
<tr>
<td>HS2 Gas Valve Failure</td>
<td>GV2 on without H2 for &gt;= 5 seconds</td>
<td></td>
</tr>
<tr>
<td>HS3 Gas Valve Failure</td>
<td>GV3 on without H3 for &gt;= 5 seconds</td>
<td></td>
</tr>
<tr>
<td>Excessive Supply Air Temp Heating</td>
<td>SAT &gt; Excessive SAT Heating Sp AND SAT Air Temp Limit for Heat Enabled</td>
<td></td>
</tr>
<tr>
<td>Space Temperature Cooling Alarm</td>
<td>Space Temp &gt; Operating Cooling SP for more than 60 minutes</td>
<td></td>
</tr>
<tr>
<td>C1 Refrigerant Low</td>
<td>FDD Alarm, see Table 12.</td>
<td></td>
</tr>
<tr>
<td>C2 Refrigerant Low</td>
<td>FDD Alarm, see Table 12.</td>
<td></td>
</tr>
<tr>
<td>C3 Refrigerant Low</td>
<td>FDD Alarm, see Table 12.</td>
<td></td>
</tr>
<tr>
<td>C4 Refrigerant Low</td>
<td>FDD Alarm, see Table 12.</td>
<td></td>
</tr>
<tr>
<td>C1 Excessive Refrigerant Flow</td>
<td>FDD Alarm, see Table 12.</td>
<td></td>
</tr>
<tr>
<td>C2 Excessive Refrigerant Flow</td>
<td>FDD Alarm, see Table 12.</td>
<td></td>
</tr>
<tr>
<td>C3 Excessive Refrigerant Flow</td>
<td>FDD Alarm, see Table 12.</td>
<td></td>
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<tr>
<td>C4 Excessive Refrigerant Flow</td>
<td>FDD Alarm, see Table 12.</td>
<td></td>
</tr>
<tr>
<td>C1 Inefficient Compressor</td>
<td>FDD Alarm, see Table 12.</td>
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</tr>
<tr>
<td>C2 Inefficient Compressor</td>
<td>FDD Alarm, see Table 12.</td>
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</tr>
<tr>
<td>C3 Inefficient Compressor</td>
<td>FDD Alarm, see Table 12.</td>
<td></td>
</tr>
<tr>
<td>C4 Inefficient Compressor</td>
<td>FDD Alarm, see Table 12.</td>
<td></td>
</tr>
<tr>
<td>C1 Refrigerant Flow Restriction</td>
<td>FDD Alarm, see Table 12.</td>
<td></td>
</tr>
<tr>
<td>C2 Refrigerant Flow Restriction</td>
<td>FDD Alarm, see Table 12.</td>
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<tr>
<td>C3 Refrigerant Flow Restriction</td>
<td>FDD Alarm, see Table 12.</td>
<td></td>
</tr>
<tr>
<td>C4 Refrigerant Flow Restriction</td>
<td>FDD Alarm, see Table 12.</td>
<td></td>
</tr>
<tr>
<td>C1 High Side Heat Transfer Problem</td>
<td>FDD Alarm, see Table 12.</td>
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</tr>
<tr>
<td>C2 High Side Heat Transfer Problem</td>
<td>FDD Alarm, see Table 12.</td>
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</tr>
<tr>
<td>C3 High Side Heat Transfer Problem</td>
<td>FDD Alarm, see Table 12.</td>
<td></td>
</tr>
<tr>
<td>C4 High Side Heat Transfer Problem</td>
<td>FDD Alarm, see Table 12.</td>
<td></td>
</tr>
<tr>
<td>C1 Low Side Heat Transfer Problem</td>
<td>FDD Alarm, see Table 12.</td>
<td></td>
</tr>
<tr>
<td>C2 Low Side Heat Transfer Problem</td>
<td>FDD Alarm, see Table 12.</td>
<td></td>
</tr>
<tr>
<td>C3 Low Side Heat Transfer Problem</td>
<td>FDD Alarm, see Table 12.</td>
<td></td>
</tr>
<tr>
<td>C4 Low Side Heat Transfer Problem</td>
<td>FDD Alarm, see Table 12.</td>
<td></td>
</tr>
<tr>
<td>C1 Reduce Evaporator Airflow</td>
<td>FDD Alarm, see Table 12.</td>
<td></td>
</tr>
<tr>
<td>C2 Reduce Evaporator Airflow</td>
<td>FDD Alarm, see Table 12.</td>
<td></td>
</tr>
<tr>
<td>C3 Reduce Evaporator Airflow</td>
<td>FDD Alarm, see Table 12.</td>
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### Service (Continued)

<table>
<thead>
<tr>
<th>Severity</th>
<th>Alarm</th>
<th>How It Happens</th>
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<tbody>
<tr>
<td>Service</td>
<td>C4 Reduce Evaporator Airflow</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>Service</td>
<td>C1 Add Charge</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>Service</td>
<td>C2 Add Charge</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>Service</td>
<td>C3 Add Charge</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>Service</td>
<td>C4 Add Charge</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>Service</td>
<td>C1 Insufficient Refrigerant Flow</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>Service</td>
<td>C2 Insufficient Refrigerant Flow</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>Service</td>
<td>C3 Insufficient Refrigerant Flow</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>Service</td>
<td>C4 Insufficient Refrigerant Flow</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>Service</td>
<td>C1 Recover Charge</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>Service</td>
<td>C2 Recover Charge</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>Service</td>
<td>C3 Recover Charge</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>Service</td>
<td>C4 Recover Charge</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>Service</td>
<td>C1 Non-Condensables Present</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>Service</td>
<td>C2 Non-Condensables Present</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>Service</td>
<td>C3 Non-Condensables Present</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>Service</td>
<td>C4 Non-Condensables Present</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>Service</td>
<td>C1 Liquid Temp Greater Than Cond Temp</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>Service</td>
<td>C2 Liquid Temp Greater Than Cond Temp</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>Service</td>
<td>C3 Liquid Temp Greater Than Cond Temp</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>Service</td>
<td>C4 Liquid Temp Greater Than Cond Temp</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>Service</td>
<td>Hot H20 FS Open to Prevent Coil Freeze</td>
<td>Hydronic Heating Enabled and (HW Freeze BI trip and Unreliable OAT) or HW Freeze BI trip and OAT is less than 40°F</td>
</tr>
<tr>
<td>Service</td>
<td>Hot H20 FS Opened When It Should Not</td>
<td>Hydronic Heating Enabled and OAT is greater than 40°F and HW Freeze BI trip</td>
</tr>
<tr>
<td>Service</td>
<td>Space Temperature Heating Alarm</td>
<td>Space Temp is less than Operating Heating SP for more than 60 minutes.</td>
</tr>
<tr>
<td>Service</td>
<td>Not Economizing - No Supply Air Sensor</td>
<td>Free Cooling Available and MA Sequencer = DAT Control and SAT Unreliable or SAT Unreliable and MA Sequence = Zone Control and MA State = Mech and Free Cooling Available or Tstat Only and Mech and Free Cooling Available</td>
</tr>
<tr>
<td>Service</td>
<td>Using Return Instead of Space Temp</td>
<td>Effective Zone Source = Return Air Temp and Not TStat Only</td>
</tr>
<tr>
<td>Service</td>
<td>Air Proving Switch is Stuck Closed</td>
<td>APS is closed, but fan command is not given</td>
</tr>
<tr>
<td>Service</td>
<td>C1 Basic Data Not Available</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>Service</td>
<td>C2 Basic Data Not Available</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>Service</td>
<td>C3 Basic Data Not Available</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>Service</td>
<td>C4 Basic Data Not Available</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>Service</td>
<td>C1 Unit Off</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
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</table>
## Table 11: Alarms (Part 6 of 9)

<table>
<thead>
<tr>
<th>Severity</th>
<th>Alarm</th>
<th>How It Happens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Continued)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C2</td>
<td>Unit Off</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>C3</td>
<td>Unit Off</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>C4</td>
<td>Unit Off</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>C1</td>
<td>Return Air Web-Bulb Temp Out of Range</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>C2</td>
<td>Return Air Web-Bulb Temp Out of Range</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>C3</td>
<td>Return Air Web-Bulb Temp Out of Range</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>C4</td>
<td>Return Air Web-Bulb Temp Out of Range</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>C1</td>
<td>Ambient Temp Too Low</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>C2</td>
<td>Ambient Temp Too Low</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>C3</td>
<td>Ambient Temp Too Low</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>C4</td>
<td>Ambient Temp Too Low</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>C1</td>
<td>Ambient Temp Too High</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>C2</td>
<td>Ambient Temp Too High</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>C3</td>
<td>Ambient Temp Too High</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>C4</td>
<td>Ambient Temp Too High</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>C1</td>
<td>Return Air Wet-Bulb Temp Too Low</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>C2</td>
<td>Return Air Wet-Bulb Temp Too Low</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>C3</td>
<td>Return Air Wet-Bulb Temp Too Low</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>C4</td>
<td>Return Air Wet-Bulb Temp Too Low</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>C1</td>
<td>Condensing Temp Less Than Ambient</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>C2</td>
<td>Condensing Temp Less Than Ambient</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>C3</td>
<td>Condensing Temp Less Than Ambient</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>C4</td>
<td>Condensing Temp Less Than Ambient</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>C1</td>
<td>Suction Temp Less Than Evap Temp</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
</tbody>
</table>
Table 11: Alarms (Part 7 of 9)

<table>
<thead>
<tr>
<th>Severity</th>
<th>Alarm</th>
<th>How It Happens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service</td>
<td>(Continued)</td>
<td></td>
</tr>
</tbody>
</table>

<p>| C2 Suction Temp Less Than Evap Temp | FDD Alarm, see Table 12.                |
| C3 Suction Temp Less Than Evap Temp | FDD Alarm, see Table 12.                |
| C4 Suction Temp Less Than Evap Temp | FDD Alarm, see Table 12.                |
| C1 Evap Temp Greater Than Ambient Temp | FDD Alarm, see Table 12.                |
| C2 Evap Temp Greater Than Ambient Temp | FDD Alarm, see Table 12.                |
| C3 Evap Temp Greater Than Ambient Temp | FDD Alarm, see Table 12.                |
| C4 Evap Temp Greater Than Ambient Temp | FDD Alarm, see Table 12.                |
| C1 Liquid Temp Less Than Ambient Temp | FDD Alarm, see Table 12.                |
| C2 Liquid Temp Less Than Ambient Temp | FDD Alarm, see Table 12.                |
| C3 Liquid Temp Less Than Ambient Temp | FDD Alarm, see Table 12.                |
| C4 Liquid Temp Less Than Ambient Temp | FDD Alarm, see Table 12.                |
| C1 Invalid Suction or Ambient Temp | FDD Alarm, see Table 12.                |
| C2 Invalid Suction or Ambient Temp | FDD Alarm, see Table 12.                |
| C3 Invalid Suction or Ambient Temp | FDD Alarm, see Table 12.                |
| C4 Invalid Suction or Ambient Temp | FDD Alarm, see Table 12.                |
| C1 Invalid RA Dry-Bulb or Web-Bulb Temp | FDD Alarm, see Table 12.                |
| C2 Invalid RA Dry-Bulb or Web-Bulb Temp | FDD Alarm, see Table 12.                |
| C3 Invalid RA Dry-Bulb or Web-Bulb Temp | FDD Alarm, see Table 12.                |
| C4 Invalid RA Dry-Bulb or Web-Bulb Temp | FDD Alarm, see Table 12.                |
| C1 Invalid Liquid and Suction Pressure | FDD Alarm, see Table 12.                |
| C2 Invalid Liquid and Suction Pressure | FDD Alarm, see Table 12.                |
| C3 Invalid Liquid and Suction Pressure | FDD Alarm, see Table 12.                |
| C4 Invalid Liquid and Suction Pressure | FDD Alarm, see Table 12.                |
| C1 Invalid Suction Temp | FDD Alarm, see Table 12.                |
| C2 Invalid Suction Temp | FDD Alarm, see Table 12.                |
| C3 Invalid Suction Temp | FDD Alarm, see Table 12.                |
| C4 Invalid Suction Temp | FDD Alarm, see Table 12.                |
| C1 Invalid Liquid and Suction Temp | FDD Alarm, see Table 12.                |</p>
<table>
<thead>
<tr>
<th>Severity</th>
<th>Alarm</th>
<th>How It Happens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service (Continued)</td>
<td>C2 Invalid Liquid and Suction Temp</td>
<td>FDD Alarm, see Table 12.</td>
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<tr>
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<td>C3 Invalid Liquid and Suction Temp</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
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<td>C4 Invalid Liquid and Suction Temp</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td></td>
<td>C1 Return Air Dry-Bulb Temp Too Low</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td></td>
<td>C2 Return Air Dry-Bulb Temp Too Low</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td></td>
<td>C3 Return Air Dry-Bulb Temp Too Low</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td></td>
<td>C4 Return Air Dry-Bulb Temp Too Low</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td></td>
<td>C1 Return Air Dry-Bulb Temp Too High</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td></td>
<td>C2 Return Air Dry-Bulb Temp Too High</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td></td>
<td>C3 Return Air Dry-Bulb Temp Too High</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td></td>
<td>C4 Return Air Dry-Bulb Temp Too High</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
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<td>C1 El Below 75% Expected Performance</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
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<td>C2 El Below 75% Expected Performance</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
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<td>C3 El Below 75% Expected Performance</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
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<td>C4 El Below 75% Expected Performance</td>
<td>FDD Alarm, see Table 12.</td>
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<tr>
<td></td>
<td>C1 Cl Below 75% Expected Performance</td>
<td>FDD Alarm, see Table 12.</td>
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<td>C2 Cl Below 75% Expected Performance</td>
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<td>C3 Cl Below 75% Expected Performance</td>
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<td>C4 Cl Below 75% Expected Performance</td>
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</tr>
<tr>
<td></td>
<td>C1 EI+C1 Below 75% Expected Performance</td>
<td>FDD Alarm, see Table 12.</td>
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<tr>
<td></td>
<td>C2 EI+C1 Below 75% Expected Performance</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td></td>
<td>C3 EI+C1 Below 75% Expected Performance</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td></td>
<td>C4 EI+C1 Below 75% Expected Performance</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td></td>
<td>C1 FDD Not Functioning Sensor Unreliable</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td></td>
<td>C2 FDD Not Functioning Sensor Unreliable</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
</tbody>
</table>
### Table 11: Alarms (Part 9 of 9)

<table>
<thead>
<tr>
<th>Severity</th>
<th>Alarm</th>
<th>How It Happens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service</td>
<td>C3 FDD Not Functioning Sensor Unreliable</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td>(Continued)</td>
<td>C4 FDD Not Functioning Sensor Unreliable</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td></td>
<td>C1 FDD Not Monitoring Conditions</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td></td>
<td>C2 FDD Not Monitoring Conditions</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td></td>
<td>C3 FDD Not Monitoring Conditions</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td></td>
<td>C4 FDD Not Monitoring Conditions</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td></td>
<td>C1 FDD Not Monitoring Equipment Data</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td></td>
<td>C2 FDD Not Monitoring Equipment Data</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td></td>
<td>C3 FDD Not Monitoring Equipment Data</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
<tr>
<td></td>
<td>C4 FDD Not Monitoring Equipment Data</td>
<td>FDD Alarm, see Table 12.</td>
</tr>
</tbody>
</table>
**FDD Alarms**

The FDD alarms are described in Table 12.

<table>
<thead>
<tr>
<th>Severity</th>
<th>BACnet® State Number</th>
<th>FDD Alarm</th>
<th>Diagnosis</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service</td>
<td>235</td>
<td>C1, C2, C3, C4 Refrigerant Low</td>
<td>The system has lower than expected sub-cooling. This may indicate there is less refrigerant charge in the system than expected.</td>
<td>Consider adding refrigerant.</td>
</tr>
<tr>
<td></td>
<td>239</td>
<td>C1, C2, C3, C4 Excessive Refrigerant Flow</td>
<td>The low side pressure is high, the superheat is low, and the sub-cooling is low. There is excessive refrigerant flow into the evaporator. The superheat is low with a TxV unit. There is excessive refrigerant flow into the evaporator.</td>
<td>The TxV is overfeeding the refrigerant into the evaporator. One possible cause is something may be holding the TxV open when conditions would cause it to close, if it were functioning properly.</td>
</tr>
<tr>
<td></td>
<td>243</td>
<td>C1, C2, C3, C4 Inefficient Compressor</td>
<td>The low side pressure is far higher than would be expected in a normally operating system. The compressor appears to have lost significant pumping capacity.</td>
<td>If the compressor is a scroll compressor, consider reversing the direction of rotation. If the compressor cannot pump refrigerant at its design capacity, the compressor needs to be replaced.</td>
</tr>
<tr>
<td></td>
<td>247</td>
<td>C1, C2, C3, C4 Refrigerant Flow Restriction</td>
<td>Superheat is high and sub-cooling is high. The system has excessive refrigerant in the condenser and insufficient refrigerant in the evaporator. There is an excessive restriction to refrigerant flow.</td>
<td>Find and correct the excessive restriction to the refrigerant flow. The cause may be a plugged filter drier or it may be a restricted or faulty TxV.</td>
</tr>
<tr>
<td></td>
<td>251</td>
<td>C1, C2, C3, C4 High Side Heat Transfer Problem</td>
<td>Condenser is hot and there is not indication of overcharge. Also consider doing a standing pressure test for non-condensable to explain these results.</td>
<td>It is difficult for the condenser to reject heat. Possible causes include a dirty condenser coil or a condenser fan problem. Also consider doing a standing pressure test for non-condensable to explain these results.</td>
</tr>
</tbody>
</table>
The evaporator is colder than expected and the superheat is too low. There is no indication that the system is overcharged with refrigerant. Consider cleaning the evaporator coil or increasing indoor airflow by replacing filters, cleaning fan, adjusting fan belt or resolving return or supply.

The evaporating temperature (suction pressure) is low. The sub-cooling is lower than expected. This may indicate that there is less refrigerant charge in the system than expected. Consider cleaning the evaporator coil or increasing indoor airflow by replacing filters, cleaning fan, adjusting fan belt or resolving return or supply.

The evaporating temperature (suction pressure) is low. The supply air is colder than expected. This may indicate lower than expected airflow through the unit. The sub-cooling is lower than expected, this may indicate that there is less refrigerant charge in the system than expected. Consider cleaning the evaporator coil or increasing indoor airflow by replacing filters, cleaning fan, adjusting fan belt or resolving return or supply.

The evaporating temperature (suction pressure), superheat and sub-cooling are all higher than expected. Consider reducing the amount of airflow through the units to reduce the excessive heat load on the evaporator.

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. Consider adding refrigerant.

Superheat is getting high and sub-cooling is high. The system as excessive refrigerant in the condenser and insufficient refrigerant in the evaporator. There is some excessive restriction to refrigerant flow. There is more restriction to flow than expected, but perhaps not so much as would require an expensive repair. Consider slightly overcharging the system to bring down the superheat. Otherwise, find and correct the excessive restriction to the refrigerant flow. The cause may be a plugged filter dryer or it may be a restricted or faulty TxV.
Table 12: FDD Alarms (Part 3 of 7)

<table>
<thead>
<tr>
<th>Severity</th>
<th>BACnet® State Number</th>
<th>FDD Alarm</th>
<th>Diagnosis</th>
<th>Recommendation</th>
</tr>
</thead>
</table>
| Service (Cont.) | 271  
272  
273  
274 | C1, C2, C3, C4 Recover Charge | The system has higher than expected subcooling. This may indicate there is more refrigerant charge in the system than expected. | Consider recovering refrigerant. |
| | | The system has higher than expected subcooling and the condensing temperature (discharge pressure) is higher than expected at the ambient temperature. This may indicate there is more refrigerant charge in the system than expected. | Consider recovering refrigerant. |
| | | Superheat is getting high and subcooling is high. The system has excessive refrigerant in the condenser and insufficient refrigerant in the evaporator. This is some excessive restriction to refrigerant flow. | There is more restriction to flow than expected, but perhaps not so much as would require an expensive repair. Consider slightly overcharging the system to bring down the superheat. Otherwise, find and correct the excessive restriction to refrigerant flow. The cause may be a plugged filter dryer or it may be a restricted or faulty TxV. |
| | 199  
200  
201  
202 | C1, C2, C3, C4 Liquid Temp Greater Than Cond Temp | | Check LT>CT sensors. If confident in SP and ST sensors, add charge. |
### Table 12: FDD Alarms (Part 4 of 7)

<table>
<thead>
<tr>
<th>Severity</th>
<th>BACnet® State Number</th>
<th>FDD Alarm</th>
<th>Diagnosis</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service (Cont.)</td>
<td>171</td>
<td>C1, C2, C3, C4</td>
<td>Basic Data Not Available</td>
<td>An important sensor measurement is not available. Potential sensors include: SP, LP or DP, ST, LT, AMB, RWB, RA or RAH. Find which data point is not being collected and resolve the problem. Diagnostics should function thereafter.</td>
</tr>
<tr>
<td></td>
<td>172</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>173</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>174</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>303</td>
<td>C1, C2, C3, C4</td>
<td>Unit Off</td>
<td>The compressor appears to not be running because of the differences in the suction and liquid pressures are too small to prove operation, or the compressor has nearly no pumping capacity.</td>
</tr>
<tr>
<td></td>
<td>304</td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>305</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>306</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>175</td>
<td>C1, C2, C3, C4</td>
<td>Return Air Wet-Bulb Temp Out of Range</td>
<td>The measured ambient temperature is either less than 65°F, a limit in the diagnostic software, the sensor placement is incorrect, reading a low temperature, or there is a faulty ambient temperature sensor.</td>
</tr>
<tr>
<td></td>
<td>176</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>177</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>178</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>179</td>
<td>C1, C2, C3, C4</td>
<td>Ambient Temp Too Low</td>
<td>For fixed orifice only</td>
</tr>
<tr>
<td></td>
<td>180</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>181</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>182</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 12: FDD Alarms (Part 5 of 7)

<table>
<thead>
<tr>
<th>Severity</th>
<th>BACnet® State Number</th>
<th>FDD Alarm</th>
<th>Diagnosis</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service (Cont.)</td>
<td>183 184 185 186</td>
<td>C1, C2, C3, C4 Ambient Temp Too High</td>
<td>The measured ambient temperature is either over 115°F, a limit in the diagnostic software or the sensor placement is incorrect, reading a high temperature or there is a faulty ambient temperature sensor.</td>
<td>The ambient temperature is too high to make reasonable diagnosis.</td>
</tr>
<tr>
<td></td>
<td>187 188 189 190</td>
<td>C1, C2, C3, C4 Return Air Wet-Bulb Temp Too Low</td>
<td>The return air wet bulb temperature or the return air dry bulb temperature measurement is not valid. The current reading indicated the relative humidity is less than zero. Find the cause of the invalid data and resolve the problem in order for diagnostics to function.</td>
<td>The RWB is lower than RWB corresponding to 0% RAH for given RA.</td>
</tr>
<tr>
<td></td>
<td>191 192 193 194</td>
<td>C1, C2, C3, C4 Return Air Wet-Bulb Temp Too High</td>
<td>The measured return air wet bulb temperature is either over 76°F, a limit in the diagnostic software, or the sensor placement is incorrectly reading a high humidity, or there is a faulty return wet bulb.</td>
<td>The RWB is either above 76°F or higher than the RWB corresponding to 95% RAH for given RA.</td>
</tr>
<tr>
<td></td>
<td>195 196 197 198</td>
<td>C1, C2, C3, C4 Condensing Temp Less Than Ambient</td>
<td>The condensing temperature is below the ambient temperature. This indicates either the ambient sensor placement is incorrect, reading a high temperature, there is a faulty ambient temperature sensor or the condenser is wet and experiencing evaporative cooling.</td>
<td>The condensing temperature is below the ambient temperature. This indicates either a bad sensor or the information was not entered properly. Check the sensors and/or verify data was entered correctly.</td>
</tr>
<tr>
<td></td>
<td>203 204 205 206</td>
<td>C1, C2, C3, C4 Suction Temp Less Than Evap Temp</td>
<td>The suction temperature is less than the evaporator temperature. This indicates either the suction pressure or the suction line temperature or the refrigerant type expectation is invalid.</td>
<td>The suction temperature is below the evaporator temperature. This indicates either a bad sensor or the information was not entered properly. Check the sensor and/or verify the data was entered correctly.</td>
</tr>
<tr>
<td></td>
<td>207 208 209 210</td>
<td>C1, C2, C3, C4 Evap Temp Greater Than Ambient Temp</td>
<td>The evaporating temperature is above the ambient temperature. This indicates either a bad suction pressure sensor or ambient temperature sensor.</td>
<td>The evaporating temperature is above the ambient temperature. This indicates either a bad sensor or the information was not entered properly. Check the sensor and/or verify the data was entered correctly.</td>
</tr>
<tr>
<td></td>
<td>211 212 213 214</td>
<td>C1, C2, C3, C4 Liquid Temp Less Than Ambient Temp</td>
<td>The liquid temperature is below the ambient temperature. This indicates either a bad discharge pressure sensor or ambient temperature sensor.</td>
<td>The liquid temperature is below the ambient temperature. This indicates either a bad sensor or the information was not entered properly. Check the sensor and/or verify the data was entered correctly.</td>
</tr>
<tr>
<td></td>
<td>215 216 217 218</td>
<td>C1, C2, C3, C4 Invalid Suction or Ambient Temp</td>
<td>ST is high compared to ambient.</td>
<td></td>
</tr>
</tbody>
</table>
### Table 12: FDD Alarms (Part 6 of 7)

<table>
<thead>
<tr>
<th>Severity</th>
<th>BACnet® State Number</th>
<th>FDD Alarm</th>
<th>Diagnosis</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service (Cont.)</td>
<td></td>
<td></td>
<td>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 is not less than RA.</td>
<td></td>
</tr>
<tr>
<td>219, 220, 221, 222</td>
<td>C1, C2, C3, C4 Invalid RA Dry-Bulb or Wet-Bulb Temp</td>
<td></td>
<td>Tool set-up error, we don’t measure discharge temperature with a module.</td>
<td></td>
</tr>
<tr>
<td>223, 224, 225, 226</td>
<td>C1, C2, C3, C4 Invalid Liquid and Suction Pressure</td>
<td></td>
<td>Tool set-up error, we don’t measure discharge temperature with a module.</td>
<td></td>
</tr>
<tr>
<td>227, 228, 229, 230</td>
<td>C1, C2, C3, C4 Invalid Suction Temp</td>
<td></td>
<td>Tool set-up error, we don’t measure discharge temperature with a module.</td>
<td></td>
</tr>
<tr>
<td>279, 280, 281, 282</td>
<td>C1, C2, C3, C4 Return Air Dry-Bulb Temp Too Low</td>
<td></td>
<td>The measured return air temperature in either less than 62°F, a limit in the diagnostic software or the sensor placement is incorrect, reading a low temperature or there is a faulty return air temperature sensor.</td>
<td></td>
</tr>
</tbody>
</table>
### Table 12: FDD Alarms (Part 7 of 7)

<table>
<thead>
<tr>
<th>Severity (Cont.)</th>
<th>BACnet® State Number</th>
<th>FDD Alarm Diagnosis</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Service</td>
<td>283</td>
<td>C1, C2, C3, C4</td>
<td>The measured return air temperature in either more than 84°F, a limit in the diagnostic software or the sensor placement is incorrectly reading a high temperature, or there is a faulty return air temperature sensor. RA is too high for a reasonable diagnosis.</td>
</tr>
<tr>
<td></td>
<td>284</td>
<td>C1, C2, C3, C4</td>
<td>Efficiency index is below 75% of ideal.</td>
</tr>
<tr>
<td></td>
<td>285</td>
<td>C1, C2, C3, C4</td>
<td>The capacity of the system has degraded to a point where action is recommended. Capacity is increased by increasing the low side pressure or by reducing the superheat. Capacity Index is below 75% of ideal.</td>
</tr>
<tr>
<td></td>
<td>286</td>
<td>C1, C2, C3, C4</td>
<td>Efficiency and Capacity Index are both below 75% of ideal.</td>
</tr>
<tr>
<td></td>
<td>287</td>
<td>C1, C2, C3, C4</td>
<td>A local A1 reading is Unreliable (disconnected sensor). This error is on a per circuit basis.</td>
</tr>
<tr>
<td></td>
<td>288</td>
<td>C1, C2, C3, C4</td>
<td>Error reading the RWB, RDB, or OAT information.</td>
</tr>
<tr>
<td></td>
<td>289</td>
<td>C1, C2, C3, C4</td>
<td>There is an error with reading the equipment information.</td>
</tr>
<tr>
<td></td>
<td>290</td>
<td>C1, C2, C3, C4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>291</td>
<td>C1, C2, C3, C4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>292</td>
<td>C1, C2, C3, C4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>293</td>
<td>C1, C2, C3, C4</td>
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</tr>
<tr>
<td></td>
<td>294</td>
<td>C1, C2, C3, C4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>295</td>
<td>C1, C2, C3, C4</td>
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</tr>
<tr>
<td></td>
<td>296</td>
<td>C1, C2, C3, C4</td>
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<tr>
<td></td>
<td>297</td>
<td>C1, C2, C3, C4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>298</td>
<td>C1, C2, C3, C4</td>
<td></td>
</tr>
</tbody>
</table>

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.