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# **Simplicity 1A with 4-Stage and VAV/Economizer Expansion Modules**

## **Relating Setpoints, Inputs, and Outputs To The Sequence Of Operation**

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## **Introduction**

The various combinations of the Simplicity 1A, 4-Stage Expansion module, and VAV/Economizer Expansion module provides us with the capability of performing all of the necessary unit functions on our 3 through 25 ton packaged products. The Simplicity 1A provides all of the inputs and outputs for unit control as well as safety monitoring on models with 2 mechanical cooling stages. The 4-Stage Expansion module expands that capability to 4 mechanical cooling stages. The VAV/Economizer Expansion module adds the economizer function, demand ventilation, power exhaust, hot gas reheat, and duct pressure and supply air temperature control for VAV models, along with a few other control features for current and future functions. The VAV/Economizer Expansion module is configurable for both constant volume and variable air volume applications. VAV units have supply air temperature reset features, including the capability of allowing an external analog input for supply air temperature reset. Economizer operation can be set up for dry bulb, single enthalpy, or dual enthalpy changeover. An added economizer feature allows a 3<sup>rd</sup> party analog input to take direct control of the economizer actuator.

The 3 controls can be used in various combinations. The Simplicity 1A combined with the 4-Stage Expansion module is used on basic 4-stage mechanical cooling models. This combination would require binary inputs for cooling and heating modes.

The VAV/Expansion module can be added to this combination to provide all of the functions listed above for both constant volume and vav applications. With the VAV/Economizer Expansion module, cooling and heating stages can be controlled with binary inputs or by either the space or return air temperature sensor. Unoccupied and occupied cooling and heating setpoints can be programmed into the VAV/Economizer Expansion module. This module also includes a time clock and scheduling functions.

The VAV/Economizer Expansion module can also be added to the Simplicity 1A (without the 4-Stage Expansion module) to provide all of the above-mentioned capabilities to models with 2 mechanical cooling stages.

In order to fully set up, operate, and troubleshoot the various combinations of these controls, the technician must have an understanding of the inputs, outputs, and setpoints. In addition, the technician must be capable of relating this information to the sequence of operation for a specific board function. Access to the setpoints and all of the unit operating data can only be done through communications. The most convenient access

tool is our Simplicity PC software. Direct access to all of the setpoints and data can also be made by a 3<sup>rd</sup> party using the Modbus RTU communication protocol.

The first section of this guide provides details on the inputs and outputs of the controllers and also identifies on which of the 3 controllers each input and output is located. The second section describes the use of each of the setpoints. The final section relates the inputs, outputs, and setpoints to the sequence of operation for each specific function of the controller.

## **INPUTS**

### **Temperature Sensors**

1. ST, C, and SSO (VAV/Economizer Expansion Module)
  - a. Space Temperature sensor, offset slide adjustment, and unoccupied override
  - b. 10k thermistor, type 3 across ST and C
  - c. Offset is 0-20k with 10k being no offset across SSO and C
  - d. Unoccupied override is accomplished by shorting ST and C
  - e. Used for:
    - i. Cool and heat staging on CV units
    - ii. Supply air temperature reset on VAV
2. SAT and C (VAV/Economizer Expansion Module)
  - a. Supply Air Temperature
  - b. 10k thermistor, type 3
  - c. Used for:
    - i. VAV supply air temperature control
    - ii. Economizer control for both CV and VAV
    - iii. Supply air temperature limiting for both heating and cooling, CV and VAV
3. RAT and C (VAV/Economizer Expansion Module)
  - a. Return Air Temperature
  - b. 10k thermistor, type 3
  - c. Used for:
    - i. Cool and heat staging when no space sensor present or when space sensor fails
    - ii. VAV morning warm-up
    - iii. VAV occupied heating
4. OAT and C (VAV/Economizer Expansion Module)
  - a. Outside Air Temperature
  - b. 10k thermistor, type 3
  - c. Used for:
    - i. Economizer changeover, dry bulb, single enthalpy, and dual enthalpy
    - ii. Compressor and heating cutouts
5. SLT, LLT, EST, CST, and C (VAV/Economizer Expansion Module)
  - a. Suction Line, Liquid Line, Evaporator Saturation, and Condenser Saturation Temperature
  - b. 10 k thermistor, type 3

- c. For future use

Note: The space temp (ST), return air temp (RAT), and outside air temp (OAT) inputs on the 4-Stage Expansion module are only used for monitoring these values through communications when the VAV/Economizer Expansion module is not present. These inputs have no functions attached to them. The supply air temp (SAT) input on the 4-Stage Expansion module can be used for supply air temperature limiting.

## **Humidity Sensors**

1. OH, C, and R (VAV/Economizer Expansion Module)
  - a. Outside Air Humidity
  - b. 0-10 vdc across OH and C proportional to 0-100% RH
  - c. R is 24 vac output to power sensor
  - d. Used for economizer changeover, single and dual enthalpy
2. RH, C, and R (VAV/Economizer Expansion Module)
  - a. Return Air Humidity
  - b. 0-10 vdc across RH and C proportional to 0-100% RH
  - c. R is 24 vac output to power sensor
  - d. Uses
    - i. Economizer changeover, dual enthalpy
    - ii. Temperature/Humidity Control function
    - iii. Reheat function
3. DH, C, and R (VAV/Economizer Expansion Module)
  - a. Duct/Supply Air Humidity
  - b. 0-10 vdc across DH and C proportional to 0-100% RH
  - c. R is 24 vac output to power sensor
  - d. Used for modulating hot gas reheat (when available as a factory option)

## **Pressure Sensors**

1. DUCT PRES, C, and R (VAV/Economizer Expansion Module)
  - a. Duct Static Pressure
  - b. 0-5 vdc across Duct Press and C
  - c. R is 24 vac output to power transducer
  - d. Transducer pressure range is 0-5 iwc
  - e. Related analog output FAN 2-10 vdc
  - f. Used to measure supply duct pressure. Control compares actual pressure to setpoint to modulate VFD speed or inlet guide vane position for duct pressure control on VAV
2. BLDG PRES (VAV/Economizer Expansion Module)
  - a. Building pressure
  - b. 0-5 vdc across Duct Press and C

- c. R is 24 vac output to power transducer
- d. Transducer pressure range +/- 0.25 iwc
- e. Related analog output EXH 2-10 vdc
- f. Used to measure building pressure. Control compares actual pressure to setpoint to modulate power exhaust discharge dampers or VFD speed to control building pressure on CV or VAV

## **Thermostat**

1. Y1 and Y2 (Simplicity 1A)
  - a. Cooling stage 1 and cooling stage 2
  - b. 24 vac
  - c. Used for CV only
2. Y3 and Y4 (4-Stage Expansion Module)
  - a. Cooling stage 3 and cooling stage 4
  - b. 24 vac
  - c. Used for CV only
3. W1 and W2 (Simplicity 1A)
  - a. Heating stage 1 and heating stage 2
  - b. 24 vac
  - c. Used for CV and Unoccupied VAV
4. G (Simplicity 1A)
  - a. Indoor fan
  - b. 24 vac
5. OCC (VAV/Economizer Expansion Module)
  - a. Occupied/unoccupied mode
  - b. 24 vac
  - c. Setup option called Occupied Input Enable must be turned ON
  - d. Special note – the OCC terminal on the Simplicity 1A controller is used to position the economizer to min position when the indoor blower is running. It is used for this function only when the VAV/Economizer Expansion module is not present. When the VAV/Economizer Expansion module is present or if BAS Economizer option has been ordered, the OCC terminal on the Simplicity 1A has no function.
6. P and P1 (Simplicity 1A)
  - a. Remote control of the economizer minimum position
  - b. 0-270 ohm potentiometer
  - c. Can not be used when VAV/Economizer Expansion module is present or when BAS Economizer option has been ordered.

## **Safety Circuits**

1. HPS1 and HPS2 (Simplicity 1A)
  - a. High pressure switch for compressor circuits 1 and 2
  - b. Normally closed switch
  - c. One pin for each switch is 24 vac output, the other is the feedback
  - d. If switch opens 3 times in 2 hours a hard lockout occurs
2. HPS3 and HPS4 (4-Stage Expansion Module)
  - a. High pressure switch for compressor circuits 3 and 4
  - b. Normally closed switch
  - c. One pin for each switch is 24 vac output, the other is the feedback
  - d. If switch opens 3 times in 2 hours a hard lockout occurs
3. LPS1 and LPS2 (Simplicity 1A)
  - a. Low pressure switch for compressor circuits 1 and 2
  - b. Normally closed switch
  - c. One pin for each group is 24 vac output, the other is the feedback
  - d. If the switch opens 3 times in one hour a hard lockout occurs
4. LPS3 and LPS4 (4-Stage Expansion Module)
  - a. Low pressure switch for compressor circuits 3 and 4
  - b. Normally closed switch
  - c. One pin for each group is 24 vac output, the other is the feedback
  - d. If the switch opens 3 times in one hour a hard lockout occurs
5. FS1 and FS2 (Simplicity 1A)
  - a. Suction line freezestats for compressor circuits 1 and 2
  - b. Normally closed switch
  - c. One pin for each group is 24 vac output, the other is the feedback
  - d. If the switch opens 3 times in two hours a hard lockout occurs
6. FRZ3 and FRZ4 (4-Stage Expansion module)
  - a. Suction line freezestats for compressor circuits 3 and 4
  - b. Normally closed switch
  - c. One pin for each group is 24 vac output, the other is feedback
  - d. If the switch opens 3 times in two hours a hard lockout occurs
7. FAN OVER (Simplicity 1A)
  - a. Fan fault
  - b. Monitors supply fan vfd for over-current condition
  - c. Normally closed circuit
  - d. One pin is 24 vac output, the other is the feedback
  - e. If not used the pins will be jumped
8. LIMIT (Simplicity 1A)
  - a. Limit switch circuit for heat stage 1
  - b. 24 vac
  - c. Monitors for presence of 24 vac through the limit switches
  - d. Must have 24 vac present at all times
9. LIMIT2 (VAV/Economizer Expansion module)
  - a. 24 vac

- b. Configurable for either monitoring a limit switch for 2<sup>nd</sup> stage heat or for monitoring an alarm condition on a VFD.
  - c. Setup parameter Input For VFD Failure determines input configuration
  - d. If used to monitor a limit switch, presence of 24 vac indicates that the limit switch circuit is good, no alarm.
  - e. If used to indicate a vfd failure, presence of 24 vac indicates a vfd alarm condition
10. MV (Simplicity 1A)
- a. Gas valve verification
  - b. 24 vac
  - c. Looks for 24 vac presence anytime the matching heat output is active
  - d. Starts the fan on timer for the blower
11. MV (VAV/Economizer Expansion module)
- a. 2 Gas valve verification for heat stage
  - b. 24 vac
  - c. Looks for 24 vac presence anytime the matching heat output is active
12. FS and R
- a. Hydronic Heat Freeze Stat (VAV/Economizer Expansion Module)
  - b. Normally closed switch
  - c. R is 24 vac output
  - d. Hydronic coil freezestat is field provided and installed.

## **Other Inputs**

- 1. ECON (Simplicity 1A)
  - a. 24 vac input that returns from the economizer module when present.
  - b. Presence of 24 vac on Y1 and ECON is required to energize compressor stage 1 and the first stage of cooling. With 24 vac on Y1 but not on ECON unit is assumed to be in free cooling mode.
- 2. IAQ, C, and R (VAV/Economizer Expansion Module)
  - a. Indoor Air Quality CO<sub>2</sub> Sensor
  - b. 0-10 vdc across terminals IAQ and C
  - c. R is 24 vac output to power sensor
  - d. Sensor range must be programmed (default 0-2000 ppm)
  - e. Related analog output ECON 2-10 vdc
  - f. Demand Ventilation must be enabled
  - g. Used to measure CO<sub>2</sub> level in space and modulate economizer dampers to keep CO<sub>2</sub> level at setpoint
- 3. OAQ, C, and R (VAV/Economizer Expansion Module)
  - a. Outdoor Air Quality CO<sub>2</sub> Sensor
  - b. 0-10 vdc across terminals OAQ and C
  - c. R is 24 vac to power sensor

- d. OAQ sensor and IAQ sensor must have the same range
- e. Related analog output ECON 2-10 vdc
- f. Differential Air Quality must be enabled
- g. Used for comparative demand ventilation
- 4. APS (VAV/Economizer Expansion module)
  - a. Air proving switch
  - b. Normally open switch
  - c. One APS pin is 24 vac output
- 5. DF (VAV/Economizer Expansion Module)
  - a. Dirty Filter Indicator
  - b. Normally open switch
  - c. One DF pin is a 24 vac output
- 6. REM (VAV/Economizer Expansion module)
  - a. Remote 0-10 vdc input
  - b. 0-10 vdc from an external source
  - c. Configurable input for either 3<sup>rd</sup> party control of the economizer actuator or for SAT reset on VAV units
  - d. Setup parameters Remote Control For 3<sup>rd</sup> Party BAS and Remote Control for BAS Economizer determine input configuration
- 7. PUR (VAV/Economizer Expansion module)
  - a. Smoke Purge
    - a. 24 vac
    - b. With a 24 vac input to Purge:
      - i. All heating and cooling is de-energized
      - ii. Economizer output goes to 10 vdc
      - iii. FAN binary output is energized
      - iv. Supply fan VFD output goes to 10 vdc
      - v. EXH binary output is energized
      - vi. Power exhaust output goes to 10 vdc
      - vii. VAV BOX output is energized

## **OUTPUTS**

- 1. FAN (Simplicity 1A)
  - a. 24 vac
  - b. Used to:
    - i. Energize indoor blower motor on CV and VAV w/IGV
    - ii. Enable the vfd on VAV models
- 2. FAN (VAV/Economizer Expansion module)
  - a. 2-10 vdc
  - b. Supply fan vfd speed control or IGV damper actuator position on VAV
  - c. Related input DUCT PRES
- 3. EXH (VAV/Economizer Expansion module)
  - a. On the binary output plug P6
  - b. 24 vac

- c. Used to energize the power exhaust contactor on non-modulating and modulating/discharge dampers options, or to enable the power exhaust vfd on vfd options
- 4. EXH (VAV/Economizer Expansion module)
  - a. On the modulating output plug P24
  - b. 2-10 vdc
  - c. Power exhaust VFD speed control or discharge damper actuator position
  - d. Related input BLDG PRES
  - e. Power exhaust must be set up for modulating or vfd
- 5. ECON (VAV/Economizer Expansion module)
  - a. 2-10 vdc
  - b. Economizer actuator damper position
  - c. Related inputs
    - i. OAT
    - ii. OH
    - iii. RH
    - iv. SAT
  - d. Positions economizer damper to
    - i. Minimum position
    - ii. Control SAT to either Economizer 1<sup>st</sup> Stage or Economizer 2<sup>nd</sup> Stage setpoint on CV
    - iii. Control SAT to either VAV Lower Cooling SAT or VAV Upper Cooling SAT setpoint
    - iv. Control CO2 level
- 6. HWV (VAV/Economizer Expansion module)
  - a. 2-10 vdc
  - b. Hot water valve
  - c. Related inputs:
    - i. SAT+ and SAT-
    - ii. FSP and FSI
  - d. Hydronic Heat setup parameter must be turned ON
  - e. Modulates hydronic heat water valve to maintain either Hydronic Heat Stage 1 SAT or Hydronic Heat Stage 2 SAT setpoint
- 7. VAV BOX (VAV/Economizer Expansion module)
  - a. Normally open contact
  - b. Capable of switching 24 vac
  - c. Used to signal that VAV system is in heating mode
- 8. HGR (VAV/Economizer Expansion module)
  - a. 24 vac
  - b. Used to energize a hot gas reheat valve
- 9. MOD HGR (VAV/Economizer Expansion module)
  - a. 2-10 vdc
  - b. Used to drive a modulating hot gas reheat valve
- 10. C1 and C2 (Simplicity 1A)
  - a. 24 vac
  - b. 1<sup>st</sup> and 2<sup>nd</sup> stage compressor

11. C3 and C4 (4-Stage Expansion module)
  - a. 24 vac
  - b. 3<sup>rd</sup> and 4<sup>th</sup> stage compressor
12. CN-FAN (Simplicity 1A)
  - a. 24 vac
  - b. Condenser fan output #1
13. CF2 (4-Stage Expansion module)
  - a. 24 vac
  - b. Condenser fan output #2
14. H1, H2, and H3
  - a. 24 vac
  - b. Heat stages on electric and gas heat
15. G-OUT (Simplicity 1A)
  - a. 24 vac
  - b. Used to energize the indoor blower contactor on constant volume units or to enable the vfd on vav units
16. Y-OUT (Simplicity 1A)
  - a. 24 vac connected through the control to the Y1 input
  - b. Used to power the economizer module terminal 1 on units without VAV/Economizer Expansion module
17. OCC (Simplicity 1A)
  - a. 24 vac connected to the OCC input
  - b. Used to power terminal N on the economizer to get minimum position any time the blower runs on units with VAV/Economizer Expansion module
18. P and P1 (Simplicity 1A)
  - a. Connected to the P and P1 input terminals
  - b. On units without VAV/Economizer Expansion module P and P1 are connected to the P and P1 terminals on the economizer module
  - c. P and P1 are used for the remote minimum position potentiometer
19. H1 and H2 (Simplicity 1A)
  - a. 24 vac
  - b. Heat stages 1 and 2 for constant volume units
20. H1 and H2 (VAV/Economizer Expansion module)
  - a. 24 vac
  - b. Heat stages 1 and 2 for units with the VAV/Economizer Expansion module option

## **SETPOINTS**

The following setpoints can be accessed only through communications. The most convenient access tool is the Simplicity PC software. Direct access to all of the setpoints and data can also be made by a 3<sup>rd</sup> party using the Modbus RTU communication protocol.

### **General Equipment Setup**

1. Compressors Available for cooling
  - a. Determines how many compressor cooling stages are available
  - b. Range 2-4
  - c. Default 2
2. Heat Stages Available
  - a. Determines how many heat stages are available
  - b. Range 0-3, 0 = disabled
  - c. Default 2
3. CV/VAV
  - a. Determines whether the control will operate as a constant volume or variable air volume control
  - b. CV = 0, VAV = 1
  - c. Default 1
4. Fan On Delay For Heat
  - a. Sets the fan on time delay on a call for 1<sup>st</sup> stage heat
  - b. Range 0-30 seconds
  - c. Default 30 seconds
5. Fan Off Delay For Heat
  - a. Sets the fan off delay when the last stage of heat is turned
  - b. Range 0-255 seconds
  - c. Default 60 seconds
6. Fan On Delay For Cooling
  - a. Sets the fan on delay on a call for 1<sup>st</sup> stage cooling
  - b. Allows evap coil to become colder before air is distributed to space; quicker dehumidification
  - c. Range 0-30 seconds
  - d. Default 0
7. Fan Off Delay For Cooling
  - a. Sets the fan off delay when the last stage of cooling is turned off

- b. Range 0-255 seconds
  - c. Default 30 seconds
- 8. Turn Off Continuous Fan When Starting Heat
  - a. When in occupied mode with continuous fan operation, this turns the fan off on a call for 1<sup>st</sup> stage heat for the time period programmed for Fan On Delay For Heat
  - b. Range On-Off
  - c. Default Off
- 9. Hot Gas Reheat Enable
  - a. Must be turned on to control a hot gas reheat coil
  - b. Range On-Off
  - c. Default Off
- 10. Hot Gas Reheat Alternate Option
  - a. Must be turned on for alternate hot gas reheat sequence of operation
  - b. Range On-Off
  - c. Default Off
- 11. Hot Gas Reheat Humidity Setpoint
  - a. Humidity value that return air will be controlled to using the reheat function.
  - b. Range 0-100%
  - c. Default 50%
- 12. Variable Hot Gas Reheat Enable
  - a. Must be turned on to use the analog hot gas reheat output (future use)
  - b. Range On-Off
  - c. Default Off
- 13. Dirty Filter Switch Enable
  - a. Must be turned on if dirty filter switch is present
  - b. Range On-Off
  - c. Default Off
- 14. Continuous Fan With Space Sensor Option
  - a. Allows continuous fan in the occupied mode on constant volume units
  - b. Range On-Off
  - c. Default On
- 15. Lead Lag/Equalize Runtime On Compressors
  - a. Equalizes runtime on compressors
  - b. Range On-Off
  - c. Default Off
- 16. Run Test Enable
  - a. Toggles the run test sequence on.
  - b. After run test sequence is completed this parameter will be automatically turned off.
- 17. Hot Gas Bypass On Compressor #1
  - a. Modifies the Lead Lag/Equalize Runtime On Compressors sequence on VAV models to stage on compressor 1 first under low load conditions
  - b. Range On-Off
  - c. Default Off

18. Low Ambient Kit Installed
  - a. Automatically changes the Cooling Lockout On OAT to 0<sup>0</sup> F
  - b. Range On-Off
  - c. Default Off
  
19. Thermostat Only Control Enable
  - a. De-activates the space sensor from any heating and cooling staging functions.
  - b. Control will respond only to binary thermostat inputs
  - c. Range On-Off
  - d. Default Off
20. Duct Pressure Setpoint
  - a. Supply duct pressure is controlled to this setpoint on VAV models.
  - b. Range 0-5 iwc
  - c. Default 1.5 iwc
21. Duct Pressure Shutdown Setpoint
  - a. Protects supply duct from excessive pressure
  - b. All outputs are shut down if duct pressure exceeds this value
  - c. Range 0-5 iwc
  - d. Default 4.5 iwc
22. CV-VFD: OCC
  - a. Used on constant volume units with a vfd.
  - b. Determines the analog output to the vfd when in occupied mode with no call for heat or cool
  - c. Range 0-100%
  - d. Default 100%
23. CV-VFD: C1 Only
  - a. Used on constant volume units with vfd
  - b. Determines analog output to the vfd when only one compressor output is on
  - c. Range 0-100%
  - d. Default 100%
24. CV-VFD: H1 Only
  - a. Used on constant volume units with vfd
  - b. Determines analog output to vfd when only one heat output is on
  - c. Range 0-100%
  - d. Default 100%
25. CV-VFD: All Compressor Outputs On
  - a. Used on constant volume units with vfd
  - b. Determines analog output to vfd if more than one compressor output is on
  - c. Range 0-100%
  - d. Default 100%
26. CV-VFD: All Heat Outputs On

- a. Used on constant volume units with vfd
- b. Determines analog output to vfd if more than one heat stage is on
- c. Range 0-100%
- d. Default 100%

27. Input For VFD Failure

- a. Configures the LIMIT terminal input for detection of a vfd failure.
- b. If turned on, presence of 24 vac indicates a vfd alarm
- c. Range On-Off
- d. Default Off

28. Space Temperature Alarm Temperature

- a. Determines how many degrees deviation of space temperature from the current operating setpoint the control will allow before causing an alarm.
- b. Trends the space temp anytime the space temp is outside of the current operating setpoints by the this amount
- c. Control must have been operating in a mode for at least 10 minutes before trending begins.
- d. Range 0-25<sup>0</sup> F, 0 = disabled
- e. Default 5<sup>0</sup> F

29. Space Temperature Alarm Time

- a. Time period before space temperature alarm is indicated.
- b. Timer is set when space temp is outside of the current operating setpoint by more than the value programmed for Space Temperature Alarm Temperature.
- c. Any time the space temp moves toward setpoint, timer is reset.
- d. Range 0-120 minutes, 0 = disabled
- e. Default 60 minutes

30. Space Temperature Sensor Offset Range

- a. Determines how many degrees the space sensor slide bar will adjust the occupied setpoints. Does not change the unoccupied setpoints.
- b. Example: a value of 3 will allow the current operating setpoints to be adjusted by +/- 3<sup>0</sup>
- c. Range 0-5<sup>0</sup> F
- d. Default 3<sup>0</sup>

31. Space Sensor Fault Override (Construction Mode)

- a. Prohibits a space temp sensor alarm or clears an existing space sensor alarm
- b. Also prohibits SAT reset on VAV units when turned on and no space sensor is installed.
- c. Range On-Off
- d. Default Off

32. Ignore Address Button Single Push

- a. Prohibits changing of the Modbus address by pushing the Address Button
  - b. Range On-Off
  - c. Default Off
33. Accept Comm Value For OAT
- a. Allows a communicated value to be sent to the Modbus register that contains the outside air temperature value.
  - b. The outside air temperature sensor input is ignored and all OAT errors are cleared
  - c. Range On-Off
  - d. Default Off
34. Accept Comm Value For OH
- a. Allows communicated value to be sent to the Modbus register that contains the outside air humidity value.
  - b. The outside humidity sensor input is ignored and all OH errors are cleared
  - c. Range On-Off
  - d. Default Off
35. Accept Comm Value For RH
- a. Allows a communicated value to be sent to the Modbus register that contains the return air humidity value.
  - b. The return humidity sensor input is ignored and all RH errors are cleared.
  - c. Range On-Off
  - d. Default Off

## **Cooling Setup**

1. Cooling Mode Enable
  - a. Must be turn on if cooling is to be used
  - b. Range On-Off
  - c. Default On
2. Minimum Run Time For Cooling
  - a. Minimum time a compressor must run before the output is turned off
  - b. Range 1-10 minutes
  - c. Default 3 minutes
3. Unoccupied Cooling Setpoint
  - a. Used on constant volume models only
  - b. Range 45-99<sup>0</sup> F
  - c. Default 85<sup>0</sup> F
4. Occupied Cooling Setpoint
  - a. Used on constant volume models only
  - b. Range 45-99<sup>0</sup> F
  - c. Default 72<sup>0</sup> F

5. VAV Cooling SAT Upper Setpoint
  - a. Value that supply air temp is controlled to when the setpoint is reset based on the reset criteria OR the top end of the supply air temp reset scale when the REM input is configured for SAT reset.
  - b. Also used for the economizer 1<sup>st</sup> stage supply air temperature setpoint
  - c. 40-70° F
  - d. Default 60° F
  
6. VAV Cooling SAT Lower Setpoint
  - a. Value that supply air is controlled to when the setpoint is not reset based on the reset criteria OR the bottom end of the supply air temp reset scale when the REM input is configured for SAT reset.
  - b. Also used for the economizer 2<sup>nd</sup> stage supply air temperature setpoint
  - c. Range 40-70° F
  - d. Default 55° F
  
7. VAV Cooling SAT Reset Setpoint
  - a. Value that either space (if installed) or return air temp is compared to for supply air temperature reset.
  - b. If space or return temp is more than 2° lower than this reset setpoint and supply air is being controlled to the VAV Cooling SAT Lower Setpoint, it will be reset to the the Upper Setpoint.
  - c. If space or return temp is more than 2° higher than this reset setpoint and the supply air is being controlled to the VAV Cooling SAT Upper Setpoint it will be reset to the Lower Setpoint.
  - d. Range 40-85° F
  - e. Default 72° F
  
8. Temperature/Humidity Control Enable
  - a. Turns the temperature/humidity control function on
  - b. Range On-Off
  - c. Default Off
  
9. Max Temperature/Humidity Offset
  - a. The maximum amount of degrees that the current operating cooling setpoint will be lowered by the temperature/humidity control function
  - b. Range 0-5° F
  - c. Default 3° F
  
10. Temperature/Humidity Setpoint
  - a. Humidity value that is used in the temperature/humidity function.
  - b. When the return humidity is equal to or greater than the value programmed in “THum Percent Humidity That = 1° F Of Offset”, the current operating cooling setpoint will be lowered by 1° F
  - c. 1° F will be subtracted from the current operating cooling setpoint for every multiple of the “THum Percent Humidity That = 1° F Of Offset” that the humidity is above the Thum Humidity Setpoint.
  - d. Range 20-80%
  - e. Default 50%
  
11. Temperature/Humidity Value That = 1° F Of Offset

- a. Value that the return humidity must be over the Temperature/Humidity Setpoint before the current operating cooling setpoint is lowered by 1<sup>0</sup> F
- b. Range 1-10%
- c. Default 5%

12. Remote Control For Third Party BAS Enable

- a. Allows a third party to provide a 2-10 vdc input to terminal REM to reset supply air temperature setpoint
- b. 2 vdc will put the sat setpoint at the VAV Cooling SAT Lower Setpoint
- c. 10 vdc will put the sat setpoint at the VAV Cooling SAT Upper Setpoint
- d. Reset will ramp linearly between the Lower and Upper setpoints as the input changes from 2-10 vdc
- e. Range On-Off
- f. Default Off

13. OAT Cooling Lockout Temperature

- a. All cooling will be locked out below this temperature
- b. Range 0-100<sup>0</sup> F, 0 = disabled
- c. Default 45<sup>0</sup>

14. SAT Limit For Cooling Enable

- a. Turns the SAT Limit For Cooling function on
- b. This is a safety feature that de-energize compressors to prevent the SAT from dropping to extremely low temperatures
- c. Range On-Off
- d. Default On

15. SAT Limit For Cooling Setpoint

- a. Lowest SAT that will be allowed before a compressor stage is de-energized by the SAT Limit For Cooling function.
- b. Range 40-65<sup>0</sup> F
- c. Default 50<sup>0</sup>

16. SAT Alarm Setpoint For Cooling

- a. Temperature used to cause an alarm when the SAT does not drop below it after all compressor stages have been operating for 10 minutes.
- b. If the OAT is more than 20<sup>0</sup> F warmer than the setpoint and the economizer is open more than 20%, the economizer will be closed. After 10 minutes, if the SAT falls below the SAT Alarm Setpoint For Cooling, an Economizer Minimum Position Alarm will be set and the economizer will remain closed until the cooling demand is satisfied.
- c. After the cooling demand is satisfied, the economizer will be moved back to minimum position.
- d. Range 0-80<sup>0</sup> F, 0 = disabled
- e. Default 0<sup>0</sup>

17.VAV LEAD LAG

14.105.3 VAV Operation

14.105.3.1 Assumptions

14.105.3.1.1. The first compressor is the only compressor that is equipped with Hot Gas Bypass. VAV units always have Hot Gas Bypass on the first compressor. This system diverts hot gas from the compressor back to the distributor when the Suction pressure gets too low. This is a modulating system.

14.105.3.2 The first time the control needs to start a compressor, it will store the VFD output and the current SAT. If the VFD output is more than 50 percent, it will start the compressor with the least amount of runtime. If the VFD is less than 50%, it will start with compressor number 1. If starting a compressor other than number one did not cause the SAT to drop below the VAV SAT Setpoint by more than 5 degrees, store the 50% for the VFD and the SAT differential after three minutes. If this first compressor drops the SAT below the controlling setpoint by more than 5 degrees, do not store the VFD value, run it for the minimum runtime, turn it off, and start compressor number one. On the next start, the VFD must be at 75% or more to start with any compressor other than number one. After a compressor is started, use the last stored SAT differential to decide if another compressor can be started, without dropping the SAT more than 5 degrees below the SAT Trip Point

## **Heating Setup**

1. Heating Mode Enable
  - a. Must be turned on if heating is to be used
  - b. Range On-Off
  - c. Default On
2. Unoccupied Heating Setpoint
  - a. For constant volume units this is the unoccupied heating setpoint.
  - b. For VAV units, when the VAV Unoccupied Heating is turned on and the control status is unoccupied, this setpoint will be compared to the Space Sensor value and used to bring all stages of heat when the Space Temp is 1.5<sup>0</sup> F lower than setpoint
  - c. Range 45-95<sup>0</sup> F
  - d. Default 60<sup>0</sup>
3. Occupied Heating Setpoint
  - a. For constant volume units this is the occupied heating setpoint
  - b. For VAV units, when the VAV Occupied Heating is turned on, this setpoint is compared to Space Temp determine if heating is needed in the occupied mode
  - c. Range 45-95<sup>0</sup> F
  - d. Default 68<sup>0</sup>
4. VAV Unoccupied Heat Enable
  - a. Allows a VAV unit to operate heat in the unoccupied mode based on the Unoccupied Heating Setpoint compared to Space Temperature
  - b. Range On-Off
  - c. Default Off
5. VAV Occupied Heat Enable

- a. Allows a VAV unit to operate heat in the occupied mode based on the Occupied Heating Setpoint and the VAV Occupied Heat sequence of operation
  - b. Range On-Off
  - c. Default Off
6. Hydronic Heat Enable
- a. Must be turned on if hydronic heat function is used
  - b. Range On-Off
  - c. Default Off
7. Hydronic Heat Reverse Actuated Valve
- a. Must be turned on if the hot water valve is to be closed at 10 vdc
  - b. Range On-Off
  - c. Default Off
8. Variable Heat Proportional Output
- a. If turned on, the Hydronic Heat output will be proportional to the difference between SAT and the Hydronic Heat Setpoint.
  - b. Range On-Off
  - c. Default Off
9. Hydronic Heat Stage 1 SAT Setpoint
- a. Control will modulate hydronic heat valve to maintain SAT to this value on a call for 1<sup>st</sup> stage heat.
  - b. Range 80-180<sup>0</sup> F
  - c. Default 120<sup>0</sup>
10. Hydronic Heat Stage 2 SAT Setpoint
- a. Control will modulate hydronic heat valve to maintain SAT to this value on a call for 2<sup>nd</sup> stage heat.
  - b. Range 80-180<sup>0</sup> F
  - c. Default 150<sup>0</sup>
11. SAT Tempering With Hydronic Heat Enable
- a. Must be turned on if hydronic heat is to be used to temper cold outside air in the occupied mode
  - b. Range On-Off
  - c. Default Off
12. SAT Tempering With Hydronic Heat Setpoint
- a. When in an occupied mode and economizer not in free cooling and no compressors running, control will modulate the hydronic heat valve to maintain SAT to within +/-1<sup>0</sup> of this setpoint
  - b. Range 40-60<sup>0</sup> F
  - c. Default 50<sup>0</sup>
13. Morning Warm-Up Enable
- a. Must be turned on if morning warm cycle is desired on a VAV unit.
  - b. Range On-Off
  - c. Default Off
14. Morning Warm-Up & VAV Heat RAT Setpoint

- a. On VAV models, control will cycle heat on and off based on this RAT value.
  - b. Range 50-85<sup>0</sup> F
  - c. Default 70<sup>0</sup>
15. OAT Heating Lockout Temperature
- a. All heating will be locked off when the OAT goes 1<sup>0</sup> F above this value
  - b. Range 0-100<sup>0</sup> F, 0 = lockout function disabled
  - c. Default 75<sup>0</sup>
16. SAT Limit For Heating Enable
- a. Must be turned on if SAT is to be protected from excessively high temperatures.
  - b. When this function is used the SAT sensor must be relocated outside of the unit in the supply duct
  - c. Range On-Off
  - d. Default On
17. SAT Limit For Heating Setpoint
- a. When the SAT exceeds this value, the highest heat stage will be turned off.
  - b. Range 100-180<sup>0</sup> F
  - c. Default 135<sup>0</sup>
18. SAT Alarm Setpoint For Heating
- a. Temperature used to cause and alarm when the SAT does not rise above it when all heating stages have been energized for 10 minutes.
  - b. If the OAT is more than 20<sup>0</sup> colder than the setpoint and the economizer is open more than 20%, the control will close the economizer will be closed. After 10 minutes if the SAT rises above the SAT Alarm Setpoint For Heating, an Economizer Minimum Position Alarm will be set and the economizer will remain closed until the heating demand is satisfied.
  - c. After the heating demand is satisfied, the economizer will move back to minimum position.
  - d. Range 0-120<sup>0</sup> F, 0 = function disabled
  - e. Default 0 disabled

## **Schedule Related Setup**

1. Occupied Thermostat or Communications Flag Input Enable
  - a. Must be turned on if a binary input on the OCC terminal of the VAV/Economizer Expansion module OR a communicated occupied command is to be used for scheduling of the unoccupied/occupied modes.
  - b. If turned off the VAV/Economizer Expansion module will use the internal clock and schedule.
  - c. Range On-Off
  - d. Default On
2. Network Occupied Flag

- a. If Occupied Thermostat or Communication Flag Enable is on and this flag is written to a value of 1, the control will be in an occupied mode until this value is written to as 0.
  - b. Range On (1) – Off (0)
3. Intelli-Start Enable
- a. Must be turned on if Unoccupied Recovery function is to be used.
  - b. The Unoccupied Recovery function calculates how many minutes before the occupied time that it must start the unit so that the occupied setpoints are satisfied at the programmed occupied time.
  - c. Occupied Thermostat or Communications Flag Input Enable must be off if the Intelli-Start function is used.
  - d. Range On-Off
  - e. Default Off
4. Pre-Occupancy Purge Enable
- a. Must be turned on if the pre-occupancy purge function is to be used.
  - b. Range On-Off
  - c. Default Off
5. Pre-Occupancy Purge Time
- a. Determines when the pre-occupancy purge will begin
  - b. Range 00:00 – 23:59
  - c. Default 4:00

Simplicity PC System Options tab  
 Pre-occupancy Purge Enabled  
 ON = for days when occupancy is scheduled, the blower operates and economizer damper is opened for 1 hour after the time of day selected in Simplicity Controls  
 Pre-occupancy Purge Time (Hour of Day)  
 Pre-occupancy Purge Time (Minutes of Day)  
 Economizer damper modulates closed if SAT is above 90°F or below 45°F

6. Meter Of Unoccupied Override Enable
- a. Must be on if unoccupied override time is to be tracked.
  - b. The accumulated time is stored in EEPROM and can be viewed through communications only.
  - c. The accumulated time can only be reset to 0 by writing to it through communications
  - d. Range On-Off
  - e. Default Off
7. Unoccupied Override Time Period
- a. Sets the length of the unoccupied override time
  - b. Range 0-240 minutes, 0 = disabled
  - c. Default 60 minutes

8. Daylight Savings Time Adjustment Enable
  - a. If this is on the control will automatically adjust the clock for daylight savings time
  - b. Range On-Off
  - c. Default On

## **Economizer and Power Exhaust Setup**

1. Economizer Enable
  - a. Must be on if economizer function is to be used.
  - b. Range On-Off
  - c. Default On
2. Economizer Minimum Position
  - a. Economizer minimum position during the occupied mode
  - b. Range 0-100%
  - c. Default 20%
3. Economizer OAT Enable Setpoint
  - a. On a dry bulb economizer, if the OAT is below this value the control will use the economizer for free cooling with a call for 1<sup>st</sup> stage.
  - b. Range 40-80<sup>0</sup> F
  - c. Default 55<sup>0</sup>
4. Remote Control For BAS Economizer Enable
  - a. If turned on, this allows a 3<sup>rd</sup> party to control the position of the economizer using a 2-10 vdc input on terminal REM.
  - b. Range On-Off
  - c. Default Off
5. Demand Ventilation Enable
  - a. Must be on if demand ventilation function is to be used.
  - b. Range On-Off
  - c. Default Off
6. Demand Ventilation Setpoint
  - a. CO2 level that is to be maintained in the conditioned space (+/-100 ppm)
  - b. Range 0-5000 ppm
  - c. Default 1000 ppm
7. Maximum Demand Ventilation Economizer Position
  - a. Maximum position that the economizer will be allowed to open when in a demand ventilation mode.
  - b. Range 0-100%
  - c. Default 50%
8. Demand Ventilation Sensor Range
  - a. Must match the range of the CO<sub>2</sub> sensor that is being used.
  - b. Range 0-5000 ppm
  - c. Default 2000 ppm
9. Differential AQ Enable

- a. Must be turned on if demand ventilation is to be controlled by the difference between the OAQ and IAQ sensors as compared to the Differential Air Quality Setpoint.
  - b. If CO<sub>2</sub> level of the outside air is higher than the inside air, the economizer outside air dampers will be closed completely in spite of the minimum position.
  - c. Range On-Off
  - d. Default Off
10. Outside Air Humidity Sensor Enable
- a. Must be turned on if an outside air humidity sensor is used for single enthalpy economizer changeover
  - b. Range On-Off
  - c. Default Off
11. Economizer Outside Air Enthalpy Setpoint
- a. When the outside air enthalpy is below this value the economizer will be used for free cooling.
  - b. Range 10-50 btu/lb
  - c. Default 27 btu/lb
12. Return Air Humidity Sensor Enable
- a. Must be turned on if return humidity is to be used for hot gas reheat functions or if return enthalpy is to be used for differential enthalpy economizer changeover
  - b. Range On-Off
  - c. Default Off
13. Differential Enthalpy Mode Enable
- a. Must be turned on if differential enthalpy function is to be used.
  - b. Range On-Off
  - c. Default Off
14. Economizer Loading To Control SAT
- a. Must be turned on if economizer loading function is to be used.
  - b. When all but the last compressor has been turned off due to excessively low SAT, the economizer will be modulated to maintain no less than the current SAT setpoint and no greater than the SAT setpoint plus 5<sup>0</sup> F.
  - c. OAT must be greater than 60<sup>0</sup> F for the economizer loading function.
  - d. Range On-Off
  - e. Default On
15. Comfort Ventilation Mode For Cooling Enable
- a. Must be turned on if the comfort ventilation function is to be used in the cooling mode.
  - b. Range On-Off
  - c. Default Off
16. Comfort Ventilation Mode For Heating Enable
- a. Must be turned on if the comfort ventilation function is to be used in the heating mode.

- b. In the occupied mode, any time the unit is not operating with an active heating or cooling mode, the control will attempt to keep the SAT between the Comfort Ventilation Upper and Lower Setpoints.
  - c. Range On-Off
  - d. Default Off
17. Comfort Ventilation Upper Setpoint
- a. Upper end of the SAT control range when in a comfort ventilation mode.
  - b. Range 60-85<sup>0</sup> F
  - c. Default 80<sup>0</sup>
18. Comfort Ventilation Lower Setpoint
- a. Lower end of the SAT control range when in a comfort ventilation mode.
  - b. Range 60-85<sup>0</sup> F
  - c. Default 70<sup>0</sup>
19. Low Ambient Economizer Minimum Position
- a. Minimum position of the economizer when the OAT is below the Low Ambient Economizer Temperature Setpoint
  - b. Range 0-100%, 0 = disabled
  - c. Default 0
20. Low Ambient Economizer Temperature Setpoint
- a. Economizer minimum position is changed to the Low Ambient Economizer Minimum Position if the OAT is below this value.
  - b. Range 0-60<sup>0</sup> F, 0 = disabled
  - c. Default 0
21. Power Exhaust Enable
- a. Must be turned on if any power exhaust function is used.
  - b. Range On-Off
  - c. Default On
22. Modulating Power Exhaust Enable
- a. Must be turned on if power exhaust with modulating discharge dampers is used.
  - b. Must be off if power exhaust vfd is used.
  - c. Range On-Off
  - d. Off
23. Exhaust VFD Installed Enable
- a. Must be turned on if power exhaust with vfd is used.
  - b. Must be off if power exhaust with modulating discharge dampers is used.
  - c. Range On-Off
  - d. Default Off
24. Building Pressure Sensor Enable
- a. Must be turned on if modulating exhaust with discharge dampers OR modulating exhaust with vfd is used.
  - b. Range On-Off
  - c. Default Off
25. Building Pressure Setpoint
- a. Power exhaust is energized and modulated to keep the building pressure to this value +/-0.015 iwc

- b. Range -0.250 to +0.025 iwc
  - c. Default 0.100 iwc
26. Exhaust Damper Position For Exhaust Fan To Turn On
- a. For modulating power exhaust with discharge dampers, exhaust fan is turned on when the discharge damper position is above this value.
  - b. Range 0-100%
  - c. Default 80%
27. Exhaust Damper Position For Exhaust Fan To Turn Off
- a. For modulating power exhaust with discharge dampers, exhaust fan is turned off when the discharge damper position is below this value.
  - b. Range 0-100%
  - c. Default 20%
28. Economizer Damper Position For Exhaust Fan To Turn On
- a. For non-modulating power exhaust, exhaust fan is turned on when the economizer damper position is above this value.
  - b. Range 0-100%
  - c. Default 60%
29. Economizer Damper Position For Exhaust Fan To Turn Off
- a. For non-modulating power exhaust, exhaust fan is turned off when the economizer damper position is below this value.
  - b. Range 0-100%
  - c. Default 20%
30. ERV Installed
- Must be turned on if an ERV is installed. **you turn the ERV enable on and the EXH output will track the blower vfd. you have to have power exhaust on, exhaust vfd on as well**
- a. When in an occupied mode or an unoccupied override mode, the control will turn on the exhaust relay anytime the indoor blower is on.
  - b. On vav models, the analog exhaust vfd output will mimic the supply fan analog output.
  - c. Range On-Off
  - d. Default Off
31. ERV Unoccupied Fan Enable
- a. If turned on, the exhaust relay will be energized anytime the indoor blower is on, even in the unoccupied mode.
  - b. Range On-Off
  - c. Default Off

## **Other Funtions**

1. Redline
  - a. This is a communicated value
  - b. When the value is turned on 50% of the cooling capacity is locked out and a 5-minute timer is started.
  - c. 50% cooling lockout is as follows:

- i. On a 2-compressor unit, compressor 2 is locked out
    - ii. On a 3-compressor unit, compressors 2 and 3 are locked out
    - iii. On a 4-compressor unit, compressors 3 and 4 are locked out
  - d. Each time the value is turned on, the 5-minute timer is restarted.
  - e. When the timer expires, normal operation is resumed.
- 2. Loadshed
  - a. This is a communicated value
  - b. When the value is turned on all compressors are locked out and a 5-minute timer is started
  - c. Each time the value is turned on, the 5-minute timer is restarted.
  - d. When the timer expires, normal operation is resumed.

## **Relating Setpoints, Inputs, and Outputs to Sequence of Operation**

### **Power Exhaust Options**

#### **Non-Modulating Power Exhaust**

- 1. Setpoints
  - a. Economizer Enable ON
  - b. Power Exhaust Enable ON



- b. Energizes the exhaust fan when exhaust damper output is above Exhaust Damper Position For Exhaust Fan On. Example: If ON setpoint is 50%, with a total exhaust damper output range of 2-10 vdc, the exhaust fan will be energized when the exhaust damper output is more than 6 volts.
- c. De-energizes the exhaust fan when the exhaust damper output is below Exhaust Damper Position For Exhaust Fan Off.

### **Modulating Power Exhaust with VFD**

1. Setpoints and related data
 

a. Power Exhaust Enable	ON
b. Modulating Power Exhaust Enable	OFF
c. Exhaust VFD Installed Enable	ON
d. Building Pressure Sensor Enabled	ON
e. Building Pressure Setpoint	IWC
f. Building Pressure Reading	IWC
2. Inputs
  - a. 0-5 vdc from building pressure sensor to terminal BLDG PRES on VAV/Economizer Expansion module. Sensor has a pressure range of +/- 0.25 iwc.
3. Outputs
  - a. 24 vac from EXH on VAV/Economizer Expansion module to enable the VFD
  - b. 2-10 vdc from EXH on VAV/Economizer Expansion module for VFD speed control
4. Operation
  - a. VFD is enabled from 24 vac output from EXH terminal any time the indoor blower is turned on.
  - b. VFD speed will be modulated between 20 Hz (4.6 vdc) and 60 Hz (10 vdc) to keep building pressure at setpoint. Control band is +/-5% of building pressure setpoint. If analog output from EXH is lower than 4.6 vdc, drive will be off.

## **VAV Supply Air Temperature Control**

### **Standard Control**

1. Setpoints and related data
 

a. Remote Control For 3 <sup>rd</sup> Party BAS	OFF
b. VAV Cooling SAT Upper Setpoint	Degrees
c. VAV Cooling SAT Lower Setpoint	Degrees

- d. VAV Cooling SAT Reset Setpoint                      Degrees
- e. Cooling Mode Enable                                      ON
- f. Supply Air Temperature                                  Degrees
- g. Return Air Temperature                                  Degrees
- h. Space Temperature                                        Degrees
- i. Compressors                                                 2-4

2. Inputs

- a. 10k NTC supply air temperature sensor to terminals SAT and C
- b. 10k NTC return air temperature sensor to terminals RAT and C
- c. 24 vac to HPS1 through HPS4 and to LPS1 through LPS4
- d. 24 vac to FS1 and FS2 on the Simplicity 1A and to FRZ3 and FRZ4 on the 4-Stage Expansion module

3. Outputs

- a. 24 vac from C1, C2, C3, and C4 compressor outputs
- b. 24 vac from CN FAN on the Simplicity 1A and CF2 on the 4-Stage Expansion module for condenser fan outputs

4. Determining the Supply Air Temperature Setpoint

- a. Control must be in an occupied mode and not in morning warm-up
- b. If return air temperature (or space temperature if sensor is installed) is above the VAV Cooling SAT Reset Setpoint and outside air is suitable for free cooling, the economizer will modulate and/or the compressors will be staged to control the supply air temperature within +/- 1 degrees F of the VAV Cooling SAT Lower Setpoint. This sequence is the same as described in the section on economizer free cooling operation.
- c. If the return air temperature (or space temperature if sensor is installed) is below the VAV SAT Reset Setpoint and outside air is suitable for free cooling, the economizer will modulate and/or the compressors will be staged to control the supply air temperature with +/- 1 degrees F of the VAV Cooling SAT Upper Setpoint. This sequence is the same as described in the section on economizer free cooling operation.
- d. If the return air temperature (or space temperature is sensor is installed) is above the VAV Cooling SAT Reset Setpoint and the outside air is NOT suitable for free cooling, the compressors will be staged to control the supply air temperature to +/-5<sup>0</sup> F of the VAV Cooling SAT Lower Setpoint.
- e. If the return air temperature (or space temperature if sensor is installed) is below the VAV Cooling SAT Reset Setpoint and the outside air is NOT suitable for free cooling, the compressors will be staged to control the supply air temperature to +/-5<sup>0</sup> of the VAV Cooling SAT Upper Setpoint.
- f. If no reset is desired, no space sensor must be present and the setpoint Space Sensor Fault Override must be turned ON.

5. Compressor Staging

- a. If the supply air temperature is above the current VAV Cooling SAT Setpoint by more than 5<sup>0</sup> and the minimum off times are at 0, a compressor will be energized and a 5-minute timer is started.

- b. If the supply air temperature is still above the current VAV Cooling SAT Setpoint after 5 minutes, another compressor will be energized.
  - c. If the supply air temperature is below the current VAV Cooling SAT Setpoint by more than 5<sup>0</sup> and the minimum run times are at 0, the last compressor stage to be turned on will be de-energized and a 5-minute timer is started.
  - d. After the 5-minute timer has expired, the need to energize or de-energize a compressor stage will be determined by the relationship of the supply air temperature and the current VAV Cooling SAT Setpoint control band.
  - e. The supply air temperature will be stored before any compressor is started. Once a compressor has been started and running for 5 minutes, the supply air temperature drop will be stored.
  - f. This stored temperature drop will be used to determine if another compressor will be energized. If bringing on another compressor will drop the supply air temperature more than 5 degrees below the current VAV Cooling SAT Setpoint, it will not bring the next compressor on.
  - g. If the supply air temperature drops below the SAT Limit For Cooling Setpoint, the last compressor to be turned on will be de-energized as soon as the minimum run time has expired.
6. Special Notes
- a. The function called Supply Air Temperature For Cooling and its related SAT Limit For Cooling Setpoint is a safety limit setpoint to prevent the supply air temperature from dropping too low and endangering the compressors.

### **Supply Air Temperature Reset using Remote Input**

1. Setpoints and related data
  - a. Remote Control For 3<sup>rd</sup> Party BAS Enable    ON
  - b. Remote Control For BAS Econo Enable        OFF
  - c. VAV Cooling SAT Upper Setpoint                Degrees
  - d. VAV Cooling SAT Lower Setpoint                Degrees
  - e. VAV SAT Reset Setpoint                            Degrees
  - f. Cooling Mode Enable                                ON
  - g. Supply Air Temperature                            Degrees
  - h. Compressors                                            2-4
2. Inputs
  - a. 10k NTC supply air temperature sensor to terminals SAT and C
  - b. 2-10 vdc to terminal REM
  - c. 24 vac to HPS1 through HPS4 and to LPS1 through LPS4
3. Outputs
  - a. 24 vac from C1, C2, C3, and C4 compressor outputs
  - b. 24 vac from CF1 and CF2 condenser fan outputs
4. Operation
  - a. Control must be in an occupied mode and not in morning warm-up

- b. With a 2 vdc input on REM the supply air temperature will be controlled to the VAV Cooling SAT Lower Setpoint.
- c. With a 10 vdc input on REM the supply air temperature will be controlled to the VAV Cooling SAT Upper Setpoint.
- d. Supply air temperature setpoint will ramp linearly between the VAV Cooling SAT Lower and VAV Cooling SAT Upper setpoints as the dc input ramps between 2 and 10 vdc.
- e. If the input goes below 1.5 vdc the compressors will be staged off and locked out.
- f. If the input goes below 1.0 vdc the fan will be turned off.
- g. The use of the economizer and the staging of compressors and the corresponding control bands are the same as described above in the Standard Control section.

## **VAV Gas and Electric Heating Functions**

### **Morning Warm-UP**

1. Setpoints and related data
  - a. Morning Warm-Up (MWUP) Enable                    ON
  - b. MWUP And VAV Heat RAT Setpoint                Degrees
  - c. Heat Mode Enable                                    ON
  - d. Return Air Temperature                            Degrees
  - e. Heat Stages                                            1 to 3
2. Inputs
  - a. 10k NTC return air temperature sensor to terminals RAT and C
  - b. 24 vac to limit switch safety terminal LIMIT on Simplicity 1A
  - c. 24 vac to limit switch safety terminal LIM2 on VAV/Economizer Expansion module
  - d. 24 vac to gas valve verification terminals MV on both Simplicity 1A and VAV/Economizer Expansion module
3. Outputs
  - a. 24 vac for heat stages from terminals H1 and H2 on VAV/Economizer Expansion module
4. Operation
  - a. If the Occupied Thermostat Or Communications Flag Input Enable is turned off and the Intelli-Start function is turned on, the Intelli-Start function will determine when to start the morning warm-up period and the morning warm-up mode will end at the programmed occupied time.
  - b. If the Occupied Thermostat Or Communications Flag Input Enable is turned off and Intelli-Start is turned off, the morning warm-up period will start 1 hour before the programmed occupied time period and end at the programmed occupied time.

- c. If the Occupied Thermostat Or Communications Flag Input Enable is turned on, the morning warm-up period will begin when the control is given an occupied command and the morning warm-up period will last for 1 hour.
- d. During the morning warm-up period, the return air temperature is compared to the Morning Warm-Up RAT setpoint. If the return air temperature is more than 2 degrees below the Morning Warm-UP RAT setpoint, all heat stages will be energized with an approximate 30 second delay between stages.
- e. Any time the heating is energized, the VAV Box contact will be closed.
- f. All heat stages will remain energized until the return air temperature reaches the Morning Warm-Up RAT setpoint at which time all heat stages will be de-energized as long as each stages minimum run time has elapsed.
- g. Heat will continue to be energized based on the relationship between return air temperature and the Morning Warm-Up RAT setpoint until the morning warm-up time period expires.
- h. If the Morning Warm-up RAT Setpoint is not achieved at the end of the morning warm-up time period, the unit will enter the occupied VAV cooling mode.

### **VAV Occupied Heating with Space Sensor**

1. Setpoints and related data
  - a. VAV Occupied Heating ON
  - b. VAV Occupied Heating setpoint Degrees
  - d. Morning Warm-Up RAT setpoint Degrees
  - e. Heat Mode Enable ON
  - f. Return Air Temperature Degrees
  - g. Space Temperature Sensor Degrees
  - h. Heat Stages 1 to 3
2. Inputs
  - a. 10k NTC return air temperature sensor to terminals RAT and C
  - b. 10k NTC space temperature sensor to terminals ST and C
  - c. 24 vac to limit switch safety terminal LIMIT terminal on Simplicity 1A
  - d. 24 vac to limit switch safety terminal LIM2 on VAV/Economizer Expansion module
  - e. 24 vac to gas valve verification terminals MV on both Simplicity 1A and VAV/Economizer Expansion module
3. Outputs
  - a. 24 vac for heat stages from terminals H1 and H2 on VAV/Economizer Expansion module
4. Operation
  - a. Control must be in an occupied mode and not in morning warm-up
  - b. If the space temperature drops 2 degrees below the VAV Occupied Heating setpoint AND the return air temperature is below the Morning

Warm-Up RAT setpoint, all heat stages will be energized with an approximate 30 second delay between stages.

- c. Heat will remain energized until return air temperature reaches the morning Warm-Up setpoint.
- d. Heat will continue to cycle on and off based on the Morning Warm-Up RAT setpoint until the space temperature reaches the VAV Occupied Heating setpoint.
- e. Any time the heating is energized, the VAV Box contact will be closed.

### **VAV Unoccupied Heating**

1. Setpoints and related data
  - a. VAV Unoccupied Heating Enable ON
  - b. Unoccupied Heating Setpoint Degrees
  - c. Heat Mode Enable ON
  - d. Space Temperature Sensor Degrees
  - e. Heat Stages 1 to 3
2. Inputs
  - a. 10k NTC space sensor to terminals ST and C
  - b. 24 vac to limit switch safety terminal LIMIT on Simplicity 1A
  - c. 24 vac to limit switch safety terminal LIM2 on VAV/Economizer Expansion module
  - d. 24 vac to gas valve verification terminals MV on both Simplicity 1A and VAV/Economizer Expansion module
3. Outputs
  - a. 24 vac for heat stages from H1 and H2 on VAV/Economizer Expansion module
4. Operation
  - a. Unit must be in an unoccupied mode and a space sensor must be installed
  - b. If the space temperature is 1.5<sup>0</sup> F below the Unoccupied Heating Setpoint, all heat stages will be energized.
  - c. Heat will be de-energized when the space temperature reaches the Unoccupied Heating Setpoint.

### **VAV Duct Pressure Control**

1. Setpoints and related data
  - a. Duct Pressure Setpoint 0-5 IWC
  - b. Duct Static Reading IWC

- c. Duct Pressure Shutdown Setpoint                      0-5 IWC
- 2. Inputs
  - a. 0-5 vdc from duct pressure sensor to terminal DUCT PRES. Sensor has a pressure range of 0 to 5.0 iwc.
- 3. Outputs
  - a. 24 vac from FAN on Simplicity 1A to energize fan motor or enable VFD
  - b. 2-10 vdc from FAN terminal on VAV/Economizer Expansion module for positioning of inlet guide vanes or setting speed of the VFD
- 4. Operation
  - a. When the fan is energized, the 2-10 vdc output from FAN terminal on the VAV/Economizer Expansion module will be used to maintain the supply duct pressure to within +/-5% of the Duct Pressure Setpoint.
  - b. If the duct pressure reaches the Duct Pressure Shutdown Setpoint, the fan and all other operating functions of the unit will be de-energized.
  - c. If the unit is in a heating mode, the control will continue 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 to their maximum position to guarantee adequate airflow to keep the heat section high temperature limit switches from opening.

## **Economizer Functions**

### **General information**

1. In the unoccupied mode, economizer will not be commanded to minimum position. Free cooling will be used when outside air is suitable and there is a demand for cooling.
2. For dry bulb economizer operation, the outside air is considered suitable for free cooling if the outside air temperature is 1<sup>o</sup> below the Economizer OAT Enable Setpoint AND the outside air temperature no more than 10 degrees above the current VAV Cooling SAT Setpoint as described below.
3. Once in a free cooling mode, the outside air temperature must rise 1<sup>o</sup> above the Economizer OAT Enable Setpoint to exit the free cooling mode.
4. For single enthalpy economizer operation, the outside air is considered suitable for free cooling if the outside air enthalpy is 1 BTU/LB below the Economizer Outside Air Enthalpy Setpoint AND the outside air temperature is no more than 10 degrees above the current VAV Cooling SAT Setpoint as described below.
5. Once in a free cooling mode, the outside air enthalpy must rise 1 BTU/LB above the Economizer Outside Air Enthalpy Setpoint to exit free cooling.
6. With a demand for 1<sup>st</sup> stage cooling from a thermostat or from a space sensor or from a supply air temperature condition on a VAV unit, the supply air temperature will be controlled to the VAV Cooling SAT Upper Setpoint when in a free cooling mode.
7. With a demand for 2<sup>nd</sup> stage cooling from a thermostat or from a space sensor or from a supply air temperature condition on a VAV unit, the supply air

temperature will be controlled to the VAV Cooling SAT Lower Setpoint when in a free cooling mode.

### **Free Cooling For Constant Volume and VAV**

1. Setpoints and related data for Dry Bulb Changeover
  - a. Economizer Enable ON
  - b. VAV Cooling SAT Upper Setpoint 40-70<sup>0</sup> F
  - c. VAV Cooling SAT Lower Setpoint 40-70<sup>0</sup> F
  - d. Economizer Minimum Position 0-100%
  - e. Economizer OAT Enable Setpoint Degrees
  - f. Supply Air Temperature Degrees
  - g. Outside Air Temperature Degrees
  - h. Remote Control for BAS Econo Enable OFF
2. Setpoints and related data for Single Enthalpy Changeover
  - a. Economizer Enable ON
  - b. VAV Cooling SAT Upper Setpoint 40-70<sup>0</sup> F
  - c. VAV Cooling SAT Lower Setpoint 40-70<sup>0</sup> F
  - d. Economizer Minimum Position 0-100%
  - e. Outside Air Humidity Sensor Enable ON
  - f. Economizer Outside Air Enthalpy Setpoint 10-50 Btu/lb
  - g. Supply Air Temperature Degrees
  - h. Outside Air Temperature Degrees
  - i. Outside Air Humidity Percent
  - j. Remote Control for BAS Econo Enable OFF
3. Setpoints and related data for Dual Enthalpy Changeover
  - a. Economizer Enable ON
  - b. VAV Cooling SAT Upper Setpoint 40-70<sup>0</sup> F
  - c. VAV Cooling SAT Lower Setpoint 40-70<sup>0</sup> F
  - d. Economizer Minimum Position 0-100%
  - e. Outside Air Humidity Sensor Enable ON
  - f. Return Air Humidity Sensor Enable ON
  - g. Differential Enthalpy Mode Enable ON
  - h. Supply Air Temperature Degrees
  - i. Outside Air Temperature Degrees
  - j. Outside Air Humidity Percent
  - k. Return Air Humidity Percent
  - l. Remote Control for BAS Econo Enable OFF
4. Inputs
  - a. 10k NTC supply air temperature sensor to terminals SAT and C
  - b. 10k NTC outside air temperature sensor to terminals OAT and C
  - c. 0-10 vdc from outside air humidity sensor to terminals OH and C. Sensor only used for single and dual enthalpy changeover.



## Demand Ventilation

1. Setpoints and related data
  - a. Economizer Enable ON
  - b. Demand Ventilation Enable ON
  - c. Demand Ventilation Setpoint 0-5000 ppm
  - d. Max Demand Ventilation Econo Position 0-100%
  - e. Demand Ventilation Sensor Range 0-5000 ppm
  - f. Differential AQ Enable ON or OFF
  - g. Differential AQ Setpoint 0-5000 ppm
  - h. Indoor CO<sub>2</sub> ppm
  - i. Outdoor CO<sub>2</sub> ppm
  - j. Supply Air Temperature Degrees
2. Inputs
  - a. 0-10 vdc to terminal IAQ
  - b. 0-10 vdc to terminal OAQ (if differential AQ function is enabled)
  - c. 10k NTC supply air temperature sensor to terminals SAT and C
3. Outputs
  - a. 2-10 vdc from ECON terminal to economizer actuator
4. Operation
  - a. The economizer is modulated to keep the indoor CO<sub>2</sub> level to +/-100 ppm of the Demand Ventilation Setpoint.
  - b. While in a demand ventilation mode, if the supply air temperature drops below 45<sup>0</sup> F the economizer outside air dampers will be modulated closed until the supply air temperature rises above 50<sup>0</sup> F. The economizer will then modulate to control the supply air temperature to 50<sup>0</sup> F. (The exception to this occurs when Hydronic Heat Enable and SAT Tempering with Hydronic Heat Enable are both on. Hydronic heat will be used to control the supply air temperature.)
  - c. While in a demand ventilation mode, if the supply air temperature rises above 90<sup>0</sup> F the outside air dampers will be modulated closed until the supply air temperature drops below 85<sup>0</sup> F. The economizer will then modulate to control the supply air temperature to 85<sup>0</sup> F.
  - d. If Differential AQ Enable is on and the OAQ is higher than the IAQ, the outside air dampers will be closed completely.

## Comfort Ventilation

1. Setpoints and related data
  - a. Economizer Enable ON
  - b. Comfort Ventilation Mode For Clg Enable ON
  - c. Comfort Ventilation Mode For Htg Enable ON

- d. Comfort Ventilation Upper Setpoint            60-85<sup>0</sup> F
- e. Comfort Ventilation Lower Setpoint            60-85<sup>0</sup> F
- f. Supply Air Temperature                            Degrees
- g. Outside Air Temperature                         Degrees
- h. Space Temperature(if installed)                Degrees

2. Inputs

- a. Binary thermostat inputs if used or 10k NTC space sensor to terminals ST and C if installed
- b. 10k NTC supply air sensor to terminals SAT and C
- c. 10k NTC outside air sensor to terminals OAT and C

3. Outputs

- a. 2-10 vdc from ECON terminal to economizer actuator

4. General

- a. Comfort ventilation only functions in the occupied mode
- b. Any time the unit is not in an active cooling or heating mode, the control will attempt to control the supply air temperature between the Comfort Ventilation Upper and Lower Setpoints

5. Operation

- a. Upon exiting a cooling mode (thermostat or space sensor satisfied)
  - i. To be determined
- b. Upon exiting a heating mode (thermostat or space sensor satisfied)
  - i. To be determined
- c. When starting comfort ventilation without exiting a heating or cooling mode and the outside air temperature is between the Comfort Ventilation Setpoints
  - i. If the supply air temperature drops below the Comfort Ventilation Lower Setpoint the outside air dampers will be modulated open to bring the supply air temperature between the Comfort Ventilation Setpoints.
  - ii. If the supply air temperature rises above the Comfort Ventilation Upper Setpoint the outside air dampers will be modulated closed to bring the supply air temperature between the Comfort Ventilation Setpoints.
- d. When starting comfort ventilation without exiting a heating or cooling mode and the outside air temperature is below the Comfort Ventilation Lower Setpoint
  - i. If the supply air temperature rises above the Comfort Ventilation Upper Setpoint the outside air dampers will be modulated open to bring the supply air temperature between the Comfort Ventilation Setpoints.
  - ii. If the supply air temperature drops below the Comfort Ventilation Lower Setpoint and the economizer is at minimum position, the first stage of heat will be energized and the outside air dampers will be modulated to bring the supply air temperature between the Comfort Ventilation Setpoints.

- e. When starting comfort ventilation without exiting a heating or cooling mode and the outside air temperature is above the Comfort Ventilation Upper Setpoint
  - i. If the supply air temperature drops below the Comfort Ventilation Lower Setpoint the outside air dampers will be modulated open to bring the supply air temperature between the Comfort Ventilation Setpoints
  - ii. If the supply air temperature rises above the Comfort Ventilation Upper Setpoint the first stage compressor will be energized and a 5-minute timer started. If the supply air temperature does not drop between the Comfort Ventilation Setpoints in 5 minutes the second stage compressor will be energized and a 5-minute timer will be started. This process continues until the supply air temperature drops between the Comfort Ventilation Setpoints.
  - iii. If a compressor drops the supply air temperature below the Comfort Ventilation Lower Setpoint the outside air dampers will be modulated open to bring the supply air temperature between the Comfort Ventilation Setpoints.

## **Constant Volume**

### **Staging Control with Space Sensor**

1. Setpoints and related data
 

a. Thermostat Only Control Enable	OFF
b. Space Sensor Fault Override	OFF
c. Occupied Cooling Setpoint	45-95 degrees
d. Occupied Heating Setpoint	45-95 degrees
e. Unoccupied Cooling Setpoint	45-95 degrees
f. Unoccupied Heating Setpoint	45-95 degrees
g. Cooling Mode Enable	ON
h. Heating Mode Enable	ON
i. Space Temperature	Degrees
j. Compressors	2-4
k. Heat Stages	0-2
2. Inputs
  - a. 10k NTC space temperature sensor to terminals ST and C
  - b. 24 vac to limit switch safety terminal LIMIT on Simplicity 1A
  - c. 24 vac to gas valve verification terminal MV on Simplicity 1A
  - d. 24 vac to HPS1 through HPS4 and LPS1 through LPS4
  - e. 24 vac to FS1 and FS2 on Simplicity 1A
  - f. 24 vac to FRZ3 and FRZ4 on 4-Stage expansion
3. Outputs
  - a. 24 vac from C1, C2, C3, and C4 compressor outputs
  - b. 24 vac from CF1 and CF2 condenser fan outputs
  - c. 24 vac from H1 and H2 heat outputs
4. Operation



- d. Compressors 2-4
- e. Heat Stages 0-2
- 2. Inputs
  - a. 24 vac to limit switch safety terminal LIMIT on Simplicity 1A
  - b. 24 vac to gas valve verification terminal MV on Simplicity 1A
  - c. 24 vac to HPS1 thru HPS4 and LPS1 thru LPS4
  - d. 24 vac to terminals FS1 and FS2 on Simplicity 1A
  - e. 24 vac to terminals FRZ3 and FRZ4 on 4-Stage expansion
  - f. 24 vac to terminals Y1, Y2, G, W1, and W2
- 3. Outputs
  - a. 24 vac from C1, C2, C3, and C4 compressor outputs
  - b. 24 vac from CF1 and CF2 condenser fan outputs
  - c. 24 vac from H1 and H2 heat outputs
- 4. Operation
  - a. Compressors will be controlled by the Y1 thru Y4 inputs based on the following:
    - i. The anti-short cycle delay must be at 0 before a compressor is energized
    - ii. The minimum run timer must be at 0 before a compressor is de-energized, unless a safety device opens.
  - b. Heat stages will be controlled by the W1 and W2 inputs based on the following:
    - i. The minimum off time of 2 minutes must be expired before a heat staged is energized.
    - ii. The minimum run time of 3 minutes must be expired before a heat stage is de-energized.

### Temperature/Humidity Control Function

- 1. Setpoints and related data
  - a. Cooling Mode Enable ON
  - b. Thermostat Only Control Enable OFF
  - c. Occupied Cooling Setpoint 45-99 degrees
  - d. Unoccupied Cooling Setpoint 45-99 degrees
  - e. Temperature/Humidity Control Enable ON
  - f. Max Temp/Humidity Offset 0-5 degrees
  - g. Temperature/Humidity Setpoint 20-80%
  - h. Temp/Hum Value That = 1<sup>0</sup> Offset 1-10%
  - i. Compressors 2-4
  - j. Space Temperature Degrees
  - k. Return Air Humidity Sensor Enable ON
  - l. Return Air Humidity Percent
- 2. Inputs
  - a. All those listed in the Staging Control with Space Sensor section
  - b. 0-10 vdc from return air humidity sensor to terminal RH and C
- 3. Outputs
  - a. All those listed in the Staging Control with Space Sensor section

#### 4. Operation

- a. The control lowers the current Operating Cooling Setpoint when the return humidity is above the Temperature/Humidity Setpoint by the value entered in the setpoint Temp/Hum Value That = 1<sup>0</sup> Offset.
- b. 1<sup>0</sup> will be subtracted for every multiple of Temp/Hum Percent Humidity That = 1<sup>0</sup>, up to but not exceeding the Max Temp/Humidity Offset
- c. Example – in an occupied mode with an Occupied Cooling Setpoint of 72, a Temperature/Humidity Setpoint of 50%, and the Temp/Hum Value That = 1<sup>0</sup> Offset at 5%:
  - i. If the return humidity rises to 55%, the Occupied Cooling Setpoint will be lowered to 71<sup>0</sup>
  - ii. If the return humidity rises to 60%, the Occupied Cooling Setpoint will be lowered to 70<sup>0</sup>

## **Hydronic Heat**

### **Constant Volume**

1. Setpoints and related data
  1. Occupied Heating Setpoint 45-99 degrees
  2. Unoccupied Heating Setpoint 45-99 degrees
  3. Heating Enable ON
  4. Heat Stages 2
  5. Hydronic Heat Enable ON
  6. Hydronic Heat Reverse Actuated Valve OFF-ON
  7. Hydronic Heat Stage 1 SAT Setpoint 80-180 degrees
  8. Hydronic Heat Stage 2 SAT Setpoint 80-180 degrees
  9. Supply Air Temperature Degrees
  10. Outside Air Temperature Degrees
  11. Return Air Temperature Degrees
  12. Space Temperature Degrees
2. Inputs
  1. 10k NTC supply air sensor to terminals SAT and C
  2. 10k NTC outside air sensor to terminals OAT and C
  3. 10k NTC return air sensor to terminals RAT and C(if not using a space sensor)
  4. 10k NTC space sensor to terminals ST and C
  5. 24 vac to W1 and W2 if using a thermostat
  6. 24 vac through a water coil freezestat to terminal FSHW.
3. Outputs
  1. 2-10 vdc from HWV to the hot water valve
4. Freezestat alarm
  1. A freezestat must be field-supplied and field-installed
  2. When 24 vac is not present on terminal FSHW and:
    - i. the outdoor air temperature is greater than 40<sup>0</sup> F, no action is taken and the unit operates normally



- |                                       |                |
|---------------------------------------|----------------|
| d. Heat Stages                        | 2              |
| e. Morning Warmup Enable              | OFF-ON         |
| f. VAV Occupied Heating Enable        | OFF-ON         |
| g. VAV Unoccupied Heating Enable      | OFF-ON         |
| h. Morning Warmup RAT Setpoint        | 50-85 degrees  |
| i. Hydronic Heat Enable               | ON             |
| j. Hydronic Heat Stage 2 SAT Setpoint | 80-180 degrees |
| k. Supply Air Temperature             | Degrees        |
| l. Outside Air Temperature            | Degrees        |
| m. Return Air Temperature             | Degrees        |
| n. Space Temperature                  | Degrees        |
2. Inputs
    - a. 10k NTC supply air sensor to terminals SAT and C
    - b. 10k NTC outside air sensor to terminals OAT and C
    - c. 10k NTC return air sensor to terminals RAT and C
    - d. 10k NTC space sensor to terminals ST and C
    - e. 24 vac through a water coil freezestat to terminal FSHW
  3. Outputs
    - a. 2-10 vdc from HWV to hot water valve
  4. Freezestat alarm
    - a. A water coil freezestat must be field-supplied and field-installed
    - b. When 24 vac is not present on terminal FSHW and:
      - i. the outdoor air temperature is greater than 40<sup>0</sup> F, no action is taken and the unit operates normally
      - ii. the outdoor air temperature is 40<sup>0</sup> F or less, the hot water valve is opened 100%, the indoor fan is de-energized, the outside air dampers are fully closed, and all compressors and all other fans are de-energized.
    - c. The control will return to normal if either:
      - i. 24 vac is present on FSHW, or
      - ii. the outdoor air temperature rises above 45<sup>0</sup> F
  5. Operation
    - a. A demand for heating must be generated by one of the following:
      - i. Morning warmup
      - ii. Occupied heating
      - iii. Unoccupied heating
    - b. When a heating demand is generated the hot water valve will be modulated to control the supply air temperature to the Hydronic Heat Stage 2 SAT Setpoint.
    - c. Once the heating demand is satisfied the hot water valve will be closed.

### **Supply Air Tempering with Hydronic Heat**

1. Setpoints and related data
  - a. All appropriate setpoints and data as listed in VAV and Constant Volume Hydronic Heat

- b. Supply Air Tempering With Hydronic Heat Enable ON
- c. Supply Air Tempering With Hydronic Heat Setpoint 40-60 degrees
- 2. Inputs
  - a. Same as listed in VAV and Constant Volume Hydronic Heat
- 3. Outputs
  - a. Same as listed in VAV and Constant Volume Hydronic Heat
- 4. Operation
  - a. Supply air tempering can only function if the following conditions are met:
    - i. the control must be in an occupied mode
    - ii. the economizer must be at its minimum position or forced open greater than minimum position by the demand ventilation function
  - b. The hot water valve will be modulated to maintain the supply air temperature to the Supply Air Tempering With Hydronic Heat Setpoint  $\pm 1^{\circ}$
  - c. If the economizer is operating in a free cooling mode, the supply air temperature will be controlled to the lower of either the operating supply air temperature setpoint or the Supply Air Tempering With Hydronic Heat Setpoint

## **Hot Gas Reheat Function**

- 1. Setpoints and related data
  - a. Hot Gas Reheat Enable ON
  - b. Hot Gas Reheat Humidity Setpoint 0-100%
  - c. Hot Gas Reheat Alternate Operation OFF-ON
- 2. Inputs
  - a. 0-10 vdc from return humidity sensor to terminals RH and C
- 3. Outputs
  - a. 24 vac from HGR to energize the hot gas reheat solenoid
- 4. Operation – Standard Mode
  - a. If there is a demand for 1<sup>st</sup> stage cooling the control will energize compressor stage 1 with no hot gas reheat.
  - b. If there is a demand for 2<sup>nd</sup> stage cooling the control will energize compressor stages 1 and 2 with no hot gas reheat.
  - c. With no demand for cooling and the return humidity above the Hot Gas Reheat Humidity Setpoint by at least 5%, the control will energize compressor stage 1 and the hot gas reheat solenoid.
- 5. Operation – Alternative Mode
  - a. With no demand for cooling and the return humidity above the Hot Gas Reheat Humidity Setpoint by at least 5%, the control will energize compressor stages 1 and 2 and the hot gas reheat solenoid.

- b. With a demand for the 1<sup>st</sup> stage of cooling and the return humidity above the Hot Gas Reheat Humidity Setpoint by at least 5%, the control will energize compressor stages 1 and 2 and the hot gas reheat solenoid.
- c. With a demand for both 1<sup>st</sup> and 2<sup>nd</sup> stage cooling and the return humidity is above the Hot Gas Reheat Humidity Setpoint by at least 5%, the control will energize compressor stages 1 and 2 with no hot gas reheat.
- d. When the demand for 2<sup>nd</sup> stage of cooling is satisfied and the return humidity is still above the Hot Gas Reheat Humidity by at least 5%, the hot gas reheat solenoid will be energized and both compressor stages 1 and 2 will remain on.