SEQUENCE OF OPERATION FOR ALC CONTROL

AIR SOURCE HEATPUMP
100% OUTSIDE AIR

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SEQUENCE OF OPERATION

The ALC controller is turned on by a switch located on its front upper left corner. Several Occupancy Control options are available for starting the unit. These can be selected from the BACview display pad on the Controls screen (requires user password). The Resident Program has an adjustable scheduler that uses the internal time clock to allow for separate Sequences for Occupied and Unoccupied periods. This can be accessed from the BACview display pad on the Schedules screen (requires user password). NOTE: All temperature-related events have an additional 10 second (fixed) “delay on make” to allow temperatures to settle.

OCCUPIED MODE:
When the BACview Schedule calls for the start of the Occupied Mode, and the ALC controller has verified that there are no fault or shutdown conditions, after a 30 second (fixed) delay the unit goes into Occupied Mode:

1. Outdoor Air Damper (OD):
   - After the unit goes into Occupied Mode, the Outdoor Air (OA) damper will open. As the OA damper opens, the Outdoor Air Damper Actuator (OADA) auxiliary switches close.
   - The OA damper stays open until the system reaches the end of the Occupied Mode period. It will remain open until the supply fan turns off. After the supply fan turns off, the OA damper will close.

2. Supply Fan (SF):
   - As the OA damper opens, the OADA auxiliary switch will close and the SF will turn on.
   - The SF will run for 60 seconds (fixed) before cooling, dehumidification, or heating will be enabled.
     - The SF shall operate continuously while the unit is in the Occupied Mode. When the system reaches the end of the Occupied Mode period, the SF will continue to run for an additional 2 minutes before turning off.
   - **SF-VSC**: Supply Fan with Variable Speed Control.
     - The SF-VSC will modulate its speed based upon the SF Differential Pressure Transmitter (SF-DPT) signal and the supply duct static pressure set point.
     - **Optional**: For constant air volume (CAV), select “Manual Override” in the BACview keypad and input the required speed (%) as determined in the field by Test and Balancing.

3. Exhaust Fan (EF):
   - At the same time the SF turns on, the EF will be enabled to run.
   - The EF shall be enabled to run while the unit is in the Occupied Mode. When the system reaches the end of the Occupied Mode period, the EF will be enabled to run for an additional 2 minutes before turning off.
   - **EF-VSC**: Exhaust Fan with Variable Speed Control.
     - If the Zone Differential Pressure Transmitter (ZN-DPT) signal is above the building static pressure set point, the EF-VSC will modulate its speed based upon the ZN-DPT and the set point. If the ZN-DPT signal is below the building static pressure set point, the EF will modulate down to 0% (adjustable) speed.
     - **Optional**: For constant air volume (CAV), select “Manual Override” in the BACview keypad and input the required speed (%) as determined in the field by Test and Balancing.

4. Cooling Mode:
   - Reversing Valve is “OFF” in Cooling Mode.
   - Cooling Mode is available when the Outdoor Air Temperature (OAT) is 1°F (fixed) above the OAT cooling lower limit (55°F, adjustable) and there is a demand for cooling.
     - When the Outdoor Air Temperature (OAT) is 1°F (adjustable) or more above the OAT cooling set point (70°F, adjustable), compressor #1 turns on.
     - When the SAT is 2°F (adjustable) or more above the SAT cooling set point (70°F, adjustable), compressor #2 turns on -- not less than 30 minutes (adjustable) after compressor #1 turned on.
     - When the SAT is 2°F (adjustable) or more below the SAT cooling set point (70°F, adjustable), compressor #2 turns off.
     - When the OAT is 1°F (adjustable) or more below the OAT cooling set point (70°F, adjustable), compressor #1 turns off.
     - Minimum SF-VSC modulation shall be 50% (adjustable; 50% min.).
     - **Optional**: When enabled, if there is a call for 1st stage cooling, 2nd stage cooling will be enabled after a 10-minute (adjustable) delay. Both compressors modulate based upon the cooling set point. Default is “OFF”.
     - Compressor enabling logic includes a 5-minute (fixed) minimum run-time and a 5-minute (fixed) minimum timeoff delay to prevent compressor short cycling.

**Digital Compressors:**
- The ALC controls the capacity of the digital compressor by rapidly loading and unloading the compressor in 15 second intervals.
- The digital compressor will modulate based upon the SAT sensor and set point (70°F, adjustable).
5. Dehumidification Mode:
- Reversing Valve is “OFF” in Dehumidification Mode.
- Dehumidification Mode is available if the OAT is 1°F (fixed) above the dehumidification lower limit of 60°F (adjustable) and there is no call for heating.
- When the Outdoor Air Dew Point (OADP) is 1°F (adjustable) or more above the Supply Air Dew Point (SADP) set point (53°F, adjustable), Dehumidification Mode is enabled. After the minimum time-off delay, compressor #1 turns on.
- When the SADP is 2°F (adjustable) or more above the SADP set point (53°F, adjustable), and after minimum time-off delay, compressor #2 turns on -- not less than 10 minutes (adjustable) after compressor #1 turned on. Both compressors respond in sequence and run at full cooling.
- HGRH is enabled to operate as necessary based upon the SAT dehumidification set point (70°F, adjustable).
- When SADP is 1°F (adjustable) or more below SADP set point (53°F, adjustable), compressor #2 turns off.
- When the OADP is 2°F (adjustable) or more below the SAT dehumidification set point (53°F, adjustable), compressor #1 turns off and Dehumidification Mode is disabled.
- Digital Compressors:
  - The ALC controls the capacity of the digital compressor by rapidly loading and unloading the compressor in 15 second intervals.
  - The digital compressor will modulate based upon the SAT sensor and SAT heating set point (70°F, adjustable).
- Hot Gas Reheat (HGRH) – On/Off:
  - When the SAT is 1°F (adjustable) or more below the SAT dehumidification set point, HGRH turns on and cycles based upon the SAT dehumidification set point.
  - When the SAT is 2°F (adjustable) or more above the SAT dehumidification set point, HGRH turns off.

6. Heating Mode:
- Heating Mode is available when the OAT is 1°F (fixed) below the OAT heating upper limit (60°F, adjustable) and there is a demand for heating.
- Reversing Valve is “ON” in Heating Mode.
- When the OAT is 1°F (adjustable) or more below the OAT heating set point (55°F, adjustable), compressor #1 turns on.
- When the SAT is 2°F (adjustable) or more below the SAT heating set point (70°F, adjustable), compressor #2 turns on -- not less than 10 minutes (adjustable) after compressor #1 turned on.
- When the SAT is 2°F (adjustable) or more above the SAT heating set point (70°F, adjustable), compressor #2 turns off.
- When the OAT is 2°F (adjustable) or more above the OAT heating set point (55°F, adjustable), compressor #1 turns off.
- Heat pump operation shall be disabled if the SF-VSC modulation drops below 85% (adjustable).
- Optional: When enabled, if there is a call for 1st stage heating, 2nd stage heating will be enabled after a 10-minute (adjustable) delay. Both compressors modulate based upon the heating set point. Default is “OFF”.
- Compressor enabling logic includes a 5-minute (fixed) minimum run-time as well as the 5-minute (fixed) minimum time-off delay to prevent compressor short cycling.
- Digital Compressor:
  - The ALC controls the capacity of the digital compressor by rapidly loading and unloading the compressor in 15 second intervals.
  - The digital compressor will modulate based upon the SAT sensor and SAT heating set point (70°F, adjustable).
- If there is a current call for 1st stage heating and compressor #1 is shut down due to an alarm (HPS1, LPS1, or DX LAT1), compressor #2 will be turned on to take its place until it returns.
- Defrost Mode: On defrost mode, the reversing valve will switch to cooling to defrost the built-up ice on the condenser coil.
- The unit is equipped with a Defrost Timer. The defrost timer provides a selectable time interval between defrost cycles. It will allow a 10 minute defrost every 30/60/90 minutes as long as the defrost thermostat is closed. The timer is factory set at 60 minutes. The time interval may be changed to 30 or 90 minutes if desired (disconnect power to the unit before moving the jumper). The hold input on the defrost timer allows the timer to accumulate time.
while the compressor is running in heating mode. A warm outdoor coil causes the defrost thermostat to open which will prevent time accumulation or end the Defrost period. The defrost timer allows up to a 10 minutes defrost cycle if the defrost thermostat is closed. When the defrost period ends, either by opening of the defrost thermostat or after the 10 minutes defrost period has elapsed, the timer is reset. By shorting the two test terminals together on the defrost timer, a 60 minute delay is reduced to 14 seconds and a 10 minute delay is reduced to 2.3 seconds for testing purposes.

- During defrost cycle, the auxiliary heat will energize based upon the SAT set point.

- **Auxiliary Heat:**
  - After either heat pump has been enabled, when the SAT is 2°F (adjustable) or more below the SAT heating set point (70°F, adjustable), and after a 10-minute (adjustable) delay period, auxiliary heating will be enabled. When the SAT is equal to the SAT heating set point (70°F, adjustable), auxiliary heating will be disabled.

- **Modulated Auxiliary Heat:**
  - On demand for auxiliary heating, the ALC controller modulates the gas furnace controller to control the gas flow based upon the SAT heating set point (70°F, adjustable).

7. **Emergency Heating Mode:**

- Compressors are “OFF” in Emergency Heating Mode.
- Emergency Heating mode is selectable using the BACview display pad or Building Automation System (BAS) (default is “OFF”). Emergency Heating mode will automatically be turned on if both heat pump compressors fail or are disabled due to either the OAT going below the Compressor Disable set point of 26°F (adjustable) or the SF-VSC modulating below 85% (adjustable).
- Emergency Heating Mode is available when the OAT is below the OAT heating upper limit (60°F, adjustable) and there is a demand for heating.
- **Modulated Emergency Heat:**
  - On demand for emergency heating, the ALC controller modulates the gas furnace controller to control the gas flow based upon the SAT heating set point (70°F, adjustable).

**UNOCCUPIED MODE:**

- When the Occupancy Control indicates the end of the Occupied Mode, the compressor(s) and outdoor fan(s) will turn off (subject to minimum run-time). The SF and EF will continue to run for 2 minutes before turning off.
- After this, the OA damper will close. The unit is now off.

**Safety Switches:**

- **High Pressure Switch (HPS1):** If HPS1 is open, compressor #1 will turn off and the ALC controller will issue an alarm. After manually resetting HPS1, the HPS1 alarm will reset. Following a minimum time off delay, compressor #1 will turn on. If the ALC controller records 3 high pressure start/restart failure incidents within 1 hour, compressor #1 is locked out and the ALC controller will issue an alarm. The compressor lock-out can be reset in the BACview display pad or by cycling the power of the ALC controller.
- This sequence is the same for compressor #2, Y2, and HPS2.

- **Low Pressure Switch (LPS1):** If LPS1 is open after the LPS1 by-pass time, the ALC controller will issue an alarm and compressor #1 turns off. After 30 seconds (fixed), the LPS1 alarm will reset. Following a minimum time off delay, compressor #1 will turn on. If the ALC controller records 3 low pressure start/restart failure incidents within 1 hour, compressor #1 is locked out and the ALC controller will issue an alarm. The compressor lock-out can be reset in the BACview display pad or by cycling the power of the ALC controller.
- This sequence is the same for compressor #2, Y2, and LPS2.

**Safety Shutdown:**

- If a compressor fails to start 3 times in an hour due to high pressure switch lock out.
- If a compressor fails to start 3 times in an hour due to low pressure switch lock out.
- If a compressor fails to start 3 times in an hour due to DX leaving air temperature lock out.
- If the ALC controller detects an SAT sensor failure.

**Standard Alarms:** (alarms require reset in the BACview or cycling the power of the ALC controller unless noted)

1. **OADA Alarm:** When the OADA fails to open or closes due to OADA-A (adj.) being open; following 2 minute (adjustable) delay. Unit will automatically shut down.
2. **OADA Hand:** When the OADA is commanded closed but the OADA-A (adj.) still indicates to the ALC it is open; following 2 minute (adjustable) delay.
3. **Supply Fan Alarm:** When the SF fails to start and the SF-APS does not confirm air flow to ALC, following 1 minute (adjustable) delay. Unit will automatically shut down.
4. **Supply Fan Hand:** When the SF is commanded off and the SF-APS still indicates air flow to ALC, following 1 minute (adjustable) delay. OA Damper (if existing) will be commanded to remain open.
5. **Supply Fan Run Time**: When the SF run time has exceeded the maximum run time allotted (adjustable).

6. **Exhaust Fan Alarm**: When the EF fails to start and the EF-APS does not confirm air flow to ALC, following 1 minute (adjustable) delay.

7. **Exhaust Fan Hand**: When the EF is commanded off and the EF-APS still indicates air flow to ALC, following 1 minute (adjustable) delay.

8. **Exhaust Fan Run Time**: When the EF run time has exceeded the maximum run time allotted (adjustable).

9. **Compressor #1 Alarm**: Compressor stops due to CC1-CS open; following 60 second (fixed) delay. Compressor lock out occurs if alarm happens 3 times in 1 hour (Compressor #1 STOP).

10. **Compressor #1 Hand**: Compressor is commanded off but the CC1-CS still indicates to the ALC it is on; following 60 second (fixed) delay.

11. **Compressor #1 Run Time**: When the C1 run time has exceeded the maximum run time allotted (adjustable).

12. **High Pressure Switch #1 Alarm**: Compressor stops due to HPS1 open; following 30 second (fixed) delay. Requires HPS1 manual reset. Compressor lock out occurs if alarm happens 3 times in 1 hour (High Pressure Switch #1 STOP).

13. **Low Pressure Switch #1 Alarm**: Compressor stops due to LPS1 open; following 90 second (fixed) delay. Compressor lock out occurs if alarm happens 3 times in 1 hour (Low Pressure Switch #1 STOP).

14. **Freeze Protection #1 Alarm**: Compressor stops due to DX LAT1 freeze condition; following 3 minute (adjustable) delay. Compressor lock out occurs if alarm happens 3 times in 1 hour (FP #1 STOP).

15. **Compressor #2 Alarm**: Compressor stops due to CC2-CS open; following 60 second (fixed) delay. Compressor lock out occurs if alarm happens 3 times in 1 hour (Compressor #2 STOP).

16. **Compressor #2 Hand**: Compressor is commanded off but the CC2-CS still indicates to the ALC it is on; following 60 second (fixed) delay.

17. **Compressor #2 Run Time**: When the C2 run time has exceeded the maximum run time allotted (adjustable).

18. **High Pressure Switch #2 Alarm**: Compressor stops due to HPS2 open; following 30 second (fixed) delay. Requires HPS2 manual reset. Compressor lock out occurs if alarm happens 3 times in 1 hour (High Pressure Switch #2 STOP).

19. **Low Pressure Switch #2 Alarm**: Compressor stops due to LPS2 open; following 90 second (fixed) delay. Compressor lock out occurs if alarm happens 3 times in 1 hour (Low Pressure Switch #2 STOP).

20. **Freeze Protection #2 Alarm**: Compressor stops due to DX LAT2 freeze condition, following 3 minute (adjustable) delay. Compressor lock out occurs if alarm happens 3 times in 1 hour (FP #2 STOP).

21. **Sensor Failure**: Readings exceed sensor limits, following 2 minute (fixed) delay. Alarms reset automatically.

22. **SAT Sensor Failure**: Open: -60.2°F, Short: 296°F. Unit will automatically shut down.


24. **Low SAT Alarm**: SAT low limit, 40°F (adjustable), following 10 minute (adjustable) delay. Unit will automatically shut down.

25. **Heat Failure**: In heating mode and the SAT falls below 50°F (adjustable), following 10 minute (adjustable) delay. Alarm resets automatically.