SIEMENS

BACnet Heat Pump Controller - Electronic Output

Application Notes

Application 2573: Multi-Compressor with Mixed Air Control and Reversing Valve

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Overview

In Application 2573, the controller controls a multi-stage heat pump with a reversing valve controlled by the heat pump controller. In addition to compressors, this heat pump may also be equipped with electric heat for auxiliary heat and mixed air control for free cooling. The mixed air control can use either a spring return or a floating control damper motor (Figure 1).

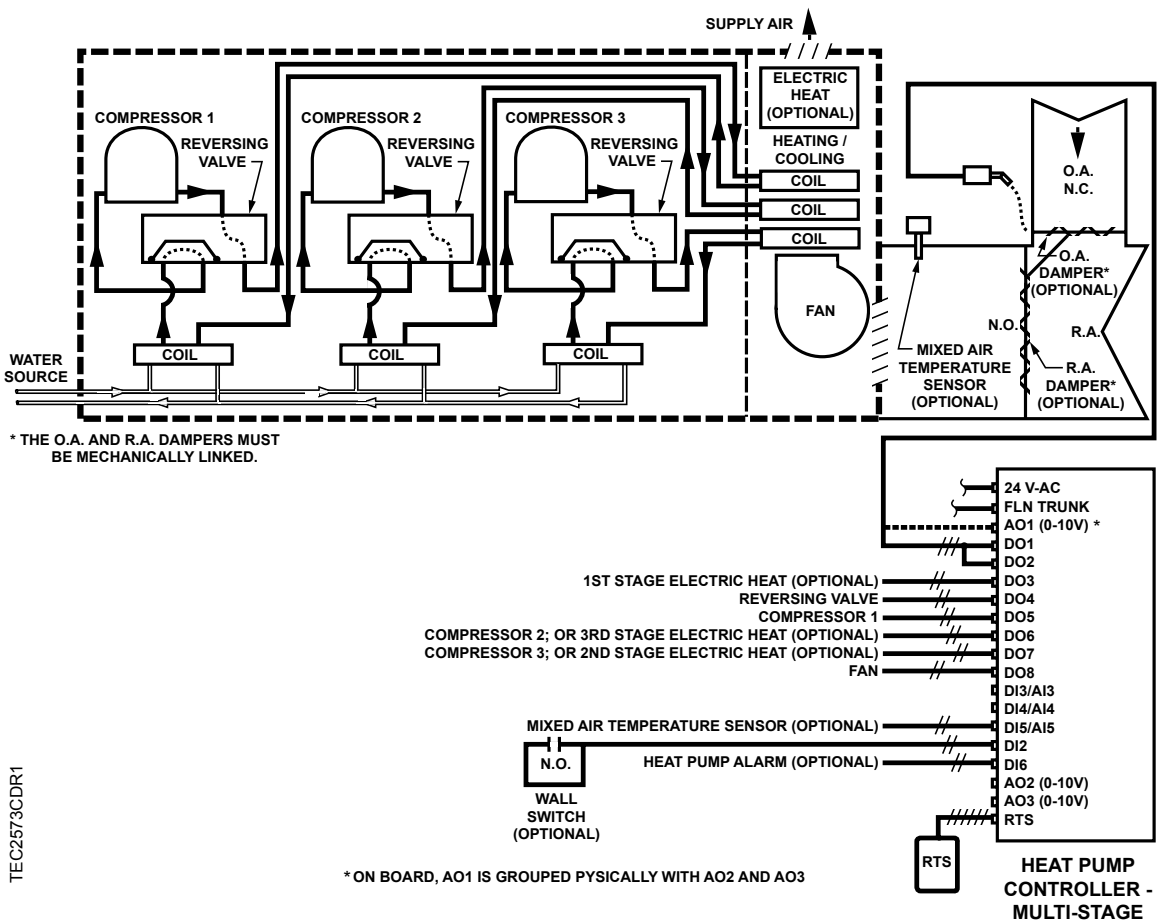

Figure 1. Application 2573 Control Diagram.

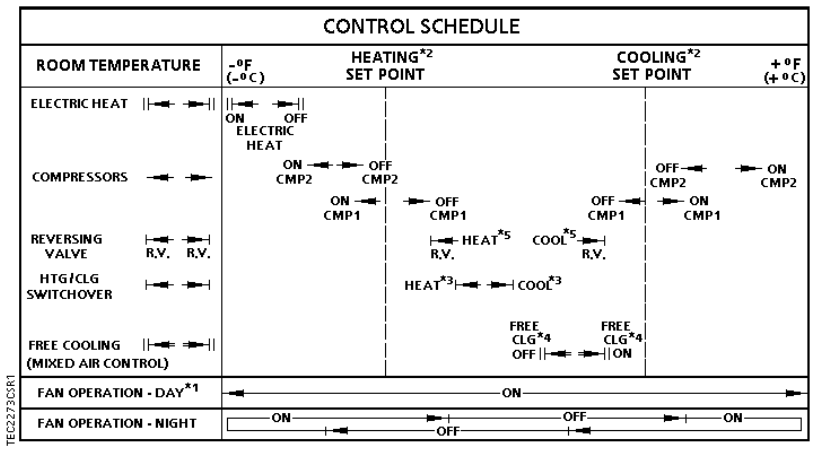

Figure 2. Application 2573 Control Schedule.

See *Sequence of Operation*, *Fan Operation, Control Temperature Setpoints, Heating/Cooling Switchover, Mixed Air Control and Compressor Operation*.

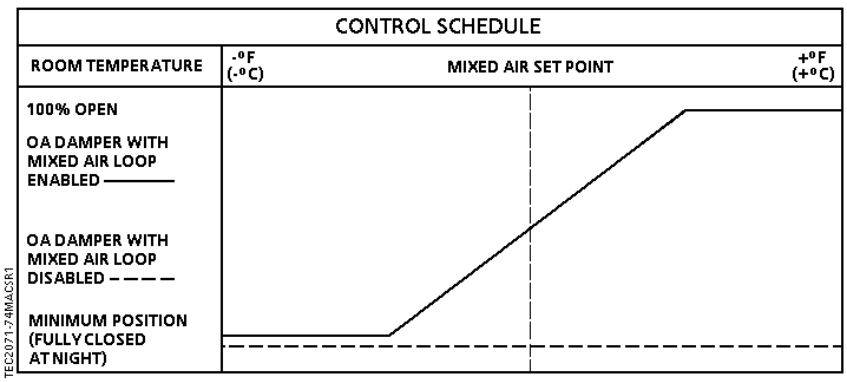

Figure 3. Application 2573 Control Schedule for Mixed Air Control.

BACnet

The BACnet Multi-Compressor Heat Pump Controller with Mixed Air Control and Reversing Valve communicates using BACnet MS/TP protocol for open communications on BACnet MS/TP networks.

Table 1. Supported BIBBS.

Product	Supported BIBBs	BIBB Name
	DS-RP-B	Data Sharing-ReadProperty-B
	DS-RPM-B	Data Sharing-ReadPropertyMultiple-B
	DS-WP-B	Data Sharing-WriteProperty-B
	DM-DDB-B	Device Management-Dynamic Device Binding-B
	DM-DOB-B	Device Management-Dynamic Object Binding-B
BTEC	DM-DDC-B	Device Management-Device Communication Control-B

Hardware Inputs

Analog

- Mixed air temperature sensor (optional)
- Room temperature sensor
- Room temperature setpoint dial (optional)

Digital

- Heat pump alarm (optional)
- Night mode override (optional)
- Wall switch (optional)

Hardware Outputs

Analog

- Spring return damper actuator (optional)

Digital

- Compressor 1
- Compressor 2 (optional); or, stage 3 electric heat (optional)
- Compressor 3 (optional); or, stage 2 electric heat (optional)
- Floating control damper actuator (optional)
- Fan
- Stage 1 electric heat (optional)
- Reversing valve

Ordering Notes

BACnet Heat Pump Controller - Electronic Output	550-790A

See *APOGEE Automation Configuration and Sizing Guidelines* on *InfoLink* for product numbers.

Damper Actuator (spring return or floating)
Mixed Air Temperature Sensor
Terminal Equipment Controller Room Temperature Sensor

Point Database

Table 2 presents the point database information for Application 2573.

Sequence of Operation

The following paragraphs present the sequence of operation for Application 2573, “BACnet Multi-Compressor Heat Pump Controller with Mixed Air Control and Reversing Valve”.

Control Temperature Setpoints

Depending on the controller’s current operational mode (day or night), CTL STPT (Point 92) holds the value of one of the following setpoints:

Day Mode – CTL STPT holds the value of DAY CLG STPT (Point 6) or DAY HTG STPT (Point 7). If the room temperature sensor has a setpoint dial and STPT DIAL (Point 14) = YES, CTL STPT holds the value of RM STPT DIAL (Point 13).

If the setpoint dial is used and RM STPT DIAL < RM STPT MIN (Point 11), CTL STPT holds the value of RM STPT MIN. If RM STPT DIAL > RM STPT MAX (Point 12), CTL STPT holds the value of RM STPT MAX.

Night Mode – CTL STPT holds the value of NGT CLG STPT (Point 8) or NGT HTG STPT (Point 9).

Room Temperature Offset

The Room Temperature Offset feature is optional.

RMTMP OFFSET (Point 22) is a user-adjustable offset that will compensate for deviations between the value of ROOM TEMP (Point 4) and the actual room temperature. This corrected value is displayed in CTL TEMP (Point 78).

CTL TEMP (Point 78) = ROOM TEMP (Point 4) + RMTMP OFFSET (Point 22).

EXAMPLE: If the actual room temperature is 72.0°F, and the value of ROOM TEMP is 73.0°F, then the value entered into RMTMP OFFSET is –1.0. In this case, the value of ROOM TEMP would read 73.0°F, but the value of CTL TEMP would read 72.0°F.

Day and Night Modes

The day/night status of the space is determined by the status of DAY.NGT (Point 29). The control of this point differs depending on whether the controller is monitoring the status of a wall switch or if the controller is connected to a field panel.

When a wall switch is physically connected to the termination strip on the controller at DI 2 (see Figure 1 and Figure 5), and WALL SWITCH (Point 18) = YES, the controller monitors the status of DI 2. When DI 2 (Point 24) is ON (the switch is closed), DAY.NGT will be set to DAY indicating that the controller is in day mode. When DI 2 is OFF (the switch is open), DAY.NGT will be set to NIGHT indicating that the controller is in night mode.

When WALL SWITCH = NO, the controller does not monitor the status of the wall switch, even if one is connected to it. In this case, the controller is operating stand-alone, it stays in day mode all the time. If the controller is operating with centralized control, connected to a field panel, the field panel can send an operator or PPCL command to override the status of DAY.NGT. See *APOGEE Powers Process Control Language (PPCL) User's Manual (125-1896)* and *APOGEE Field Panel User's Manual (125-3000)* for more information.

Night Mode Override Switch

If an override switch is present on the room temperature sensor and a value (in hours) other than zero has been entered into OVRD TIME (Point 20), pressing the override switch will reset the controller to day mode for the time period set in OVRD TIME. The status of NGT OVRD (Point 21) changes to DAY. After the override time elapses, the controller returns to night mode and NGT OVRD changes back to NIGHT.

The override switch on the room sensor will only affect the controller when in night mode.

Heating/Cooling Switchover

The heating/cooling switchover determines whether the controller is in heating or cooling mode by monitoring the room temperature and the demand for heating and cooling (as determined by the temperature control loops).

If the following conditions are met for the length of time set in SWITCH TIME (Point 86), the controller switches from heating to cooling mode by setting HEAT.COOL (Point 5) to COOL:

- HTG LOOPOUT (Point 80) < SWITCH LIMIT (Point 85).
- CTL TEMP (Point 78) > CTL STPT (Point 92) by at least the value set in SWITCH DBAND (Point 90).
- CTL TEMP (Point 78) > the appropriate cooling setpoint minus SWITCH DBAND (Point 90).

If the following conditions are met for the length of time set in SWITCH TIME (Point 86), the controller switches from cooling to heating mode by setting HEAT.COOL (Point 5) to HEAT:

- CLG LOOPOUT (Point 79) < SWITCH LIMIT (Point 85).
- CTL TEMP (Point 78) < CTL STPT (Point 92) by at least the value set SWITCH DBAND (Point 90).
- CTL TEMP (Point 78) < the appropriate heating setpoint plus SWITCH DBAND (Point 90).

Control Loops

The heat pump is controlled by three Proportional, Integral, and Derivative (PID) control loops; two temperature loops and a mixed air loop.

The two temperature loops are a cooling loop and a heating loop and the value of HEAT.COOL (Point 5) determines which is active. The active temperature loop maintains room temperature at the value in CTL STPT (Point 92). See *Control Temperature Setpoints* . The inputs to the temperature loops are CTL TEMP (Point 78) and CTL STPT. The outputs are CLG LOOPOUT (Point 79) and HTG LOOPOUT (Point 80).

The two temperature loops perform the overall sequencing of the heat pump equipment; they determine when to turn the compressors, fan, and stages of electric heat ON and OFF and when to enable or disable mixed air control.

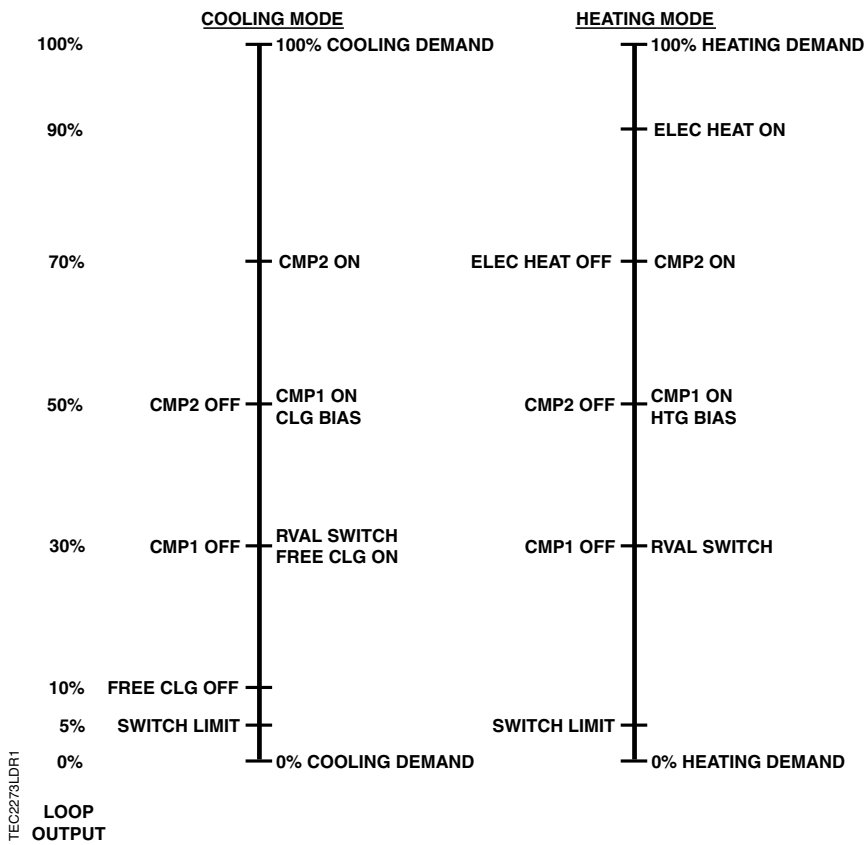

Figure 4. Heating and Cooling Loops.

The values used in this diagram are for example purposes only. They may be set to different values to suit your specific needs.

In heating mode, as the room temperature drops below the heating setpoint, the heating loop calls for more heating (the heating loop output rises). In cooling mode, if the room temperature rises above the cooling setpoint, the cooling loop calls for more cooling (the cooling loop output rises). The output of the inactive loop will remain at zero (Figure 4).

The ladder diagrams in Figure 4 show the heating and cooling loop sequencing of multiple compressors with one stage of electric heat. The diagrams show the outputs of the heating and cooling loops as vertical bars from 0 to 100%. The right side of each ladder diagram reflects a rising loop output. The left side of each ladder diagram reflects a falling loop output.

No action occurs when the loop outputs rise above or drop below the values of CLG BIAS (Point 66) and HTG BIAS (Point 70). The purpose of these points is to provide a starting place for the loops at startup.

Cooling Loop – CLG LOOPOUT (Point 79) must be greater than RVAL SWITCH (Point 84) before the reversing valve will switch from heating to cooling. When the reversing valve is in cooling mode, the compressors operate as cooling compressors. Before turning on any compressors, the controller will try to use free cooling if it is enabled by the field panel.

CLG LOOPOUT (Point 79) must be greater than FREE CLG ON (Point 61) before free cooling will be used. The controller accomplishes free cooling by enabling the mixed air loop to modulate the mixed air damper. COMPRESSOR 1 (Point 45) will not be allowed to turn ON until CLG LOOPOUT becomes greater than CMP1 ON (Point 82). COMPRESSOR 1 will not be allowed to turn OFF until CLG LOOPOUT drops below CMP1 OFF (Point 83).

When a second compressor is available, EHEAT3.CMP2 (Point 46) will not be allowed to turn ON until CLG LOOPOUT (Point 79) becomes greater than CMP2 ON (Point 16). EHEAT3.CMP2 will not be allowed to turn OFF until CLG LOOPOUT drops below CMP2 OFF (Point 17).

When a third compressor is available, EHEAT2.CMP3 (Point 47) will not be allowed to turn ON until CLG LOOPOUT (Point 79) becomes greater than CMP3 ON (Point 34). EHEAT2.CMP3 will not be allowed to turn OFF unless CLG LOOPOUT drops below CMP3 OFF (Point 35).

CLG LOOPOUT (Point 79) must be less than FREE CLG OFF (Point 62) before free cooling will be turned OFF. The controller turns OFF free cooling by disabling the mixed air loop. When the loop is disabled, the mixed air damper will be set to either minimum position for day mode or to 0% open for night mode.

When CLG LOOPOUT (Point 79) becomes less than SWITCH LIMIT (Point 85), the controller will be allowed to change to heating mode if all other criteria for the change have been met.

Heating Loop – HTG LOOPOUT (Point 80) must be greater than the value of RVAL SWITCH (Point 84) before the reversing valve will switch from cooling to heating. When the reversing valve is in heating mode, the compressors operate as heating compressors. COMPRESSOR 1 (Point 45) will not be allowed to turn ON until HTG LOOPOUT becomes greater than CMP1 ON (Point 82). COMPRESSOR 1 will not be allowed to turn OFF until HTG LOOPOUT drops below CMP1 OFF (Point 83).

When a second compressor is available, EHEAT3.CMP2 (Point 46) will not be allowed to turn ON until HTG LOOPOUT (Point 80) becomes greater than CMP2 ON (Point 16). EHEAT3.CMP2 will not be allowed to turn OFF until HTG LOOPOUT drops below CMP2 OFF (Point 17). HTG LOOPOUT must be greater than EHEAT 1 ON (Point 81) before ELEC HEAT 1 (Point 43) is turned ON.

When a third compressor is available, EHEAT 2.CMP3 (Point 47) will not be allowed to turn ON until HTG LOOPOUT (Point 80) becomes greater than CMP3 ON (Point 34). EHEAT2.CMP3 will not be allowed to turn OFF until HTG LOOPOUT drops below CMP3 OFF (Point 35).

When HTG LOOPOUT (Point 80) drops below CMP2 ON (Point 16), ELEC HEAT 1 (Point 43) will shut OFF. EHEAT3.CMP2 (Point 46) will not be allowed to turn OFF until HTG LOOPOUT drops below CMP2 OFF (Point 17).

When HTG LOOPOUT (Point 80) drops below the value of SWITCH LIMIT (Point 85), the controller will be allowed to change to cooling mode if all other criteria for the change have been met.

Mixed Air Loop – The heat pump is controlled by two Proportional, Integral, and Derivative (PID) control loops: a cooling loop and a heating loop. This section describes the mixed air control loop.

The mixed air loop controls only the mixed air portion of the application. The inputs to the mixed air loop are MA TEMP (Point 15) and MA STPT (Point 93). The output is DMPR COMD (Point 48).

Mixed Air Control

Day Mode – If the fan is ON, the mixed air damper, DMPR COMD (Point 48), will be set to minimum position (as stored in DMPR MIN POS (Point 10)) when at least one of the following conditions occurs:

- HEAT.COOL (Point 5) = HEAT. Free cooling is not needed in the heating season.
- MA TEMP (Point 15) is failed. When this point is failed, mixed air control is not possible.
- FREE CLG (Point 23) = DISABL. The outside air temperature is too warm to be used for free cooling. During day mode, the damper is at its minimum position. During night mode, the damper is at its closed position.
- CLG LOOPOUT (Point 79) < FREE CLG OFF (Point 62). The cooling load is so small that no cooling is required.

If the fan is OFF, DMPR COMD (Point 48) will be set to 0%.

DMPR COMD will be modulated by the mixed air temperature control loop when all of the following conditions have been met:

- HEAT.COOL (Point 5) = COOL.
- MA TEMP (Point 15) is normal. (Not failed.)
- FREE CLG (Point 23) = ENABLE. The outside air is cool enough to be used for free cooling.
- CLG LOOPOUT (Point 79) > FREE CLG ON (Point 61). The cooling load is large enough to require cooling.
- DMPR COMD (Point 48) > DMPR MIN POS (Point 10).

DMPR COMD (Point 48) will not be set below minimum position (DMPR COMD = DMPR MIN POS (Point 10)). This is done to make sure that the ventilation requirements are being met.

Night Mode – DMPR COMD (Point 48) = 0% OPEN if at least one of the following conditions occurs:

- HEAT.COOL (Point 5) = HEAT. Free cooling is not needed in the heating season.
- MA TEMP (Point 15) is failed. When this point is failed, mixed air control is not possible.
- NGT MA CTL (Point 91) = NO. Mixed air control is not being used during the night mode.
- FREE CLG (Point 23) = DISABL. The outside air is too warm to be used for free cooling.
- CLG LOOPOUT (Point 79) < FREE CLG OFF (Point 62). The cooling load is so small that no cooling is required.

DMPR COMD (Point 48) will be modulated by the mixed air temperature control loop when all of the following conditions have been met:

- HEAT.COOL (Point 5) = COOL.
- MA TEMP (Point 15) is normal. (Not failed)
- NGT MA CTL (Point 91) = YES. (See *Application Notes*.)
- FREE CLG (Point 23) = ENABLE. The outside air is cool enough to be used for free cooling.
- CLG LOOPOUT (Point 79) > FREE CLG ON (Point 61). The cooling load is large enough to require cooling.

If CLG LOOPOUT (Point 79) is between FREE CLG ON (Point 61) and FREE CLG OFF (Point 62) and all other conditions have been met for enabling the mixed air loop, the action taken will depend on the following:

- If CLG LOOPOUT (Point 79) was previously above FREE CLG ON (Point 61), the mixed air loop will remain enabled.
- If CLG LOOPOUT (Point 79) was previously below FREE CLG OFF (Point 62), the mixed air loop will remain disabled.

This will happen whether or not the heat pump is in day or night mode.

The mixed air damper motor can be either a spring return damper motor or a floating control damper motor.

- For a spring return damper, set DAMPER TYPE (Point 38) = SPRING. The mixed air loop will control the damper through its 0 – 10 volt analog output, AOV1 (Point 40), and DO 1 (Point 41) and DO 2 (Point 42) will be spare DOs.
- For a floating control damper, set DAMPER TYPE (Point 38) = FLOAT. The mixed air loop will control the damper through DO 1 (Point 41) and DO 2 (Point 42), and AOV1 (Point 40) will be a spare analog output.

CAUTION:

This application does not have built in low temperature detection for the mixed air dampers. The low temperature detection is handled differently depending on the type of damper used (spring return or floating control).

Spring Return Damper – Stand-alone low temperature detection can be accomplished with an external low limit thermostat. In order to do this, the damper should be set up to be normally closed and the external low temperature thermostat should cut power to the damper actuator upon reaching a low limit condition. When this happens, the spring will drive the damper shut.

Floating Control Damper – Stand-alone low temperature detection is not possible. A PPCL program can be written to close the damper when a low temperature situation occurs. In order to do this, an outside air temperature sensor needs to be connected to the field panel and DMPR COMD (Point 48) needs to be unbundled. Even though this is possible, make sure that the customer will allow it before attempting it.

Reversing Valve Operation

To prevent damage to the heat pump, REV VALVE (Point 44) is not operator commandable at the portable operator's terminal or the field panel.

The status of REV VALVE (Point 44) determines the operation of the heat pump's compressors (heating or cooling).

The reversing valve changes from heating to cooling when the following conditions have been met:

- HEAT.COOL (Point 5) = COOL.
- Compressor stage 1 has been OFF longer than the time stored in RVAL SW TIME (Point 89).
- CLG LOOPOUT (Point 79) > the value set in RVAL SWITCH (Point 84).

The reversing valve changes from cooling to heating when the following conditions have been met:

- HEAT.COOL (Point 5) = HEAT.
- Compressor stage 1 has been OFF longer than the time stored in RVAL SW TIME (Point 89).
- HTG LOOPOUT (Point 80) > the value set in RVAL SWITCH (Point 84).

Compressor Operation

To prevent damage to the heat pump, COMPRESSOR 1 (Point 45), EHEAT3.CMP2 (Point 46), and EHEAT2.CMP3 (Point 47) are not operator commandable at the portable operator's terminal or the field panel.

When HEAT.COOL (Point 5) and REV VALVE (Point 44) are both in cooling mode, the output of the cooling loop controls the staging of the compressors.

When HEAT.COOL (Point 5) and REV VALVE (Point 44) are both in heating mode, the output of the heating loop controls the staging of the compressors.

When HEAT.COOL (Point 5) and REV VALVE (Point 44) are in opposite states, the compressors are turned OFF. If a compressor has been ON it will not shut OFF until its minimum ON timer has expired. The following paragraphs explain the compressor staging.

If CMP TOTL (Point 75) = 0, the application does not control COMPRESSOR 1 (Point 45).

If CMP TOTL (Point 75) ≥ 1, the application controls COMPRESSOR 1 (Point 45) as follows:

- If the loop that is currently active (either CLG LOOPOUT (Point 79) or HTG LOOPOUT (Point 80)), is greater than CMP1 ON (Point 82) and the first compressor has been OFF for at least the time set in CMP1 MIN OFF (Point 87), COMPRESSOR 1 (Point 45) is turned ON.
- COMPRESSOR 1 (Point 45) is turned OFF when the loop that is currently active is less than CMP1 OFF (Point 83) provided the following conditions have been met:
  - The first compressor has been ON for at least the time set in CMP1 MIN ON (Point 88).
  - EHEAT3.CMP2 (Point 46) is OFF for more than 30 seconds. If the heat pump is not equipped with the second compressor, this is not applicable.
  - EHEAT2.CMP3 (Point 47) is OFF. If the heat pump is not equipped with the third compressor, this is not applicable.

If CMP TOTL (Point 75) = 1, the application does not control EHEAT3.CMP2 (Point 46).

If CMP TOTL (Point 75) = 2, the application controls EHEAT3.CMP2 (Point 46) as follows:

- EHEAT3.CMP2 (Point 46) is turned ON when the loop that is currently active is greater than CMP2 ON (Point 16) provided that the following conditions have been met:
  - The second compressor has been OFF for at least the time set in CMP2 MIN OFF (Point 27).
  - The first compressor has been ON for at least 30 seconds to lessen the demand of having more than one compressor start at once.
- EHEAT3.CMP2 (Point 46) is turned OFF when the loop that is currently active is less than CMP2 OFF (Point 17) provided that the following conditions have been met:
  - The second compressor has been ON for at least the time set in CMP2 MIN ON (Point 28).
  - EHEAT2.CMP3 (Point 47) is OFF for more than 30 seconds. If the heat pump is not equipped with the third compressor, this is not applicable.

If CMP TOTL (Point 75) = 2, the application does not control EHEAT2.CMP3 (Point 47).

If CMP TOTL (Point 75) = 3, the application controls EHEAT2.CMP3 (Point 47) as follows:

- EHEAT2.CMP3 (Point 47) is turned ON when the loop that is currently active is greater than CMP3 ON (Point 34) provided that the following conditions have been met:
  - The third compressor has been OFF for at least the time set in CMP3 MIN OFF (Point 36).
  - The first compressor has been ON for at least 30 seconds to lessen the demand of having more than one compressor start at once.
  - The second compressor has been ON for at least 30 seconds to lessen the demand of having more than one compressor start at once.
- EHEAT2.CMP3 (Point 47) is turned OFF when the loop that is currently active is less than CMP3 OFF (Point 35) provided that the following conditions have been met:
  - The third compressor has been ON for at least the time set in CMP3 MIN ON (Point 37).

Electric Heat (optional)

If no stages of electric heat are being used (EHTG STG CNT (Point 76) = 0), this control is omitted.

In this section, EHEAT3.CMP2 (Point 46) and EHEAT2.CMP3 (Point 47) refer to the stages of electric heat.

If at least one stage of electric heat is being used (EHTG STG CNT (Point 76) > 0), and either HEAT.COOL (Point 5) or REV VALVE (Point 44) = COOL, all stages of electric heat are OFF.

When at least one stage of electric heat is being used and both HEAT.COOL (Point 5) and REV VALVE (Point 44) = HEAT, the electric heat is controlled as follows:

- If EHTG STG CNT (Point 76) ≥ 1 and HTG LOOPOUT (Point 80) > EHEAT 1 ON (Point 81), the first stage of electric heat, ELEC HEAT 1 (Point 43), is turned ON.
- If EHTG STG CNT (Point 76) ≥ 2 and HTG LOOPOUT (Point 80) > EHEAT 2 ON (Point 94), the second stage of electric heat, EHEAT2.CMP3 (Point 47), is turned ON.
- If EHTG STG CNT (Point 76) ≥ 2 and HTG LOOPOUT (Point 80) < EHEAT 1 ON (Point 81), EHEAT2.CMP3 (Point 47) is turned OFF.
- If EHTG STG CNT (Point 76) = 3 and HTG LOOPOUT (Point 80) > EHEAT 3 ON (Point 95), the third stage of electric heat, EHEAT3.CMP2 (Point 46) is turned ON.
- If EHTG STG CNT (Point 76) = 3 and HTG LOOPOUT (Point 80) < EHEAT 2 ON (Point 94), EHEAT3.CMP2 (Point 46) is turned OFF.
- The first stage of electric heat will turn OFF differently depending on the number of compressors being used:

– If HTG LOOPOUT (Point 80) < CMP1 ON (Point 82) and CMP TOTL (Point 75) = 0 or 1, ELEC HEAT 1 (Point 43) is turned OFF.

– If HTG LOOPOUT (Point 80) < CMP2 ON (Point 16) and CMP TOTL (Point 75) = 2, ELEC HEAT 1 (Point 43) is turned OFF.

– If HTG LOOPOUT (Point 80) < CMP3 ON (Point 34) and CMP TOTL (Point 75) = 3, ELEC HEAT 1 (Point 43) is turned OFF.

Fan Operation

To prevent damage to the heat pump, FAN (Point 50) is not operator commandable at the portable operator's terminal or the field panel.

Day Mode – FAN (Point 50) is ON when CYCLE FAN (Point 60) = NO. If CYCLE FAN = YES, the fan control in day mode is the same as it is in night mode.

Night Mode – The fan is controlled as follows:

The fan will turn ON when at least one of the following two conditions has been met:

1. Free cooling is being provided by the mixed air control loop.
2. At least one compressor or stage of electric heat is ON.

The fan will turn OFF only after the following two conditions have been met:

1. Free cooling is not being provided by the mixed air control loop.
2. All compressors and stages of electric heat have been OFF for at least 30 seconds.

Damper Status Operation (optional)

If the heat pump has a damper, it is set at the value of DMPR MIN POS (Point 10) during day mode and is fully closed during night mode.

Power Failure Recovery

Upon return from a power failure, the heating and cooling compressors are kept OFF, the optional electric heat (if used), is kept OFF and the fan is kept OFF. In addition to the equipment being OFF, both CLG LOOPOUT (Point 79) and HTG LOOPOUT (Point 80) are set to 0. This situation will remain in effect until the power failure recovery period is over for this controller.

The controller returns to normal control when its power failure recovery period is over. The power failure recovery time for a heat pump is based on the following formula:

RETURN DELAY + (CTLR ADDRESS × 10 seconds)

RETURN DELAY (Point 3) is useful for water to air heat pumps because it allows the central equipment to be running before the heat pumps start coming back on-line. This gives the water loop a chance to stabilize its temperature before the compressors start using it and therefore minimizes the chance that the heat pumps will trip the high temperature/pressure alarms.

CTLR ADDRESS (Point 1) is used so the power failure recovery time of the controllers will be different from each other even if they all have the same value for RETURN DELAY (Point 3). This lessens the demand of having all the electrical equipment starting at once.

Centralized Alarm Monitoring

DI 6 (Point 26) can be used to monitor an input that changes state when the heat pump is in alarm. DI 6 can be unbundled to send alarm information to the field panel for centralized alarm monitoring.

Overriding DOs

This application is designed to prevent you from directly commanding critical DOs ON or OFF. Specifically, the fan, reversing valve, and compressor(s) cannot be directly commanded ON or OFF. Commanding these DOs can only be done indirectly by overriding the output of the loop currently under control (either CLG LOOPOUT (Point 79) or HTG LOOPOUT (Point 80)). This is done to protect the equipment.

You will be able to directly turn the stages of electric heat and any spare DOs ON or OFF. Also, you will always be able to command the damper via DMPR COMD (Point 48).

Fail-safe Operation

If the room temperature sensor fails, the controller operates using the last known temperature value.

Application Notes

1. If the heat pump cycles excessively, temperature swings in the room are excessive, or there is trouble maintaining the setpoint, the cooling loop, the heating loop or both need to be tuned. See *iKnow Troubleshooting Tool* for more information.

2. BACnet Heat Pump Controller - Electronic Output, as shipped from the factory, keeps all associated equipment OFF. See the *Equipment Controllers* section in the *APOGEE Automation Start-up Procedures* on InfoLink for information on how to release the controller and its equipment to application control.

3. Running the mixed air loop during night mode can increase energy savings by taking advantage of free cooling at night to pre-cool the building in time for day mode. This can lessen the need to use mechanical cooling during day mode. Pre-cooling the building this way can also improve the indoor air quality because this type of cooling is accomplished with fresh air.

Some field panel involvement is necessary to pre-cool the building with this application. For instance, the field panel needs to adjust the night cooling setpoint downward whenever the outside can be used for free cooling at night. This would require unbundling FREE CLG (Point 23) and CTL STPT (Point 92).

4. In this application the maximum configurations are as follows:

    - The maximum of CMP TOTL (Point 75) = 3.
    - The maximum of EHTG STG CNT (Point 76) = 3.
    - The maximum of CMP TOTL (Point 75) plus EHTG STG CNT (Point 76) = 4.

    If these limits are exceeded, CMP TOTL (Point 75) will be set to 0 and EHTG STG CNT (Point 76) will be set to 0. These points will remain at 0 until they are set correctly. (This prevents the application from trying to use the same DO as both a compressor and a stage of electric heat.)

Wiring Diagram

The point wiring for Application 2573 is shown in Figure 5.

CAUTION:

The controller's DOs control 24 Vac loads only. The maximum rating is 12 VA for each DO. Use an interposing 220V 4-relay module for any of the following:

- VA requirements higher than the maximum
- 110 or 220 Vac requirements
- DC power requirements
- Separate transformers used to power the load.

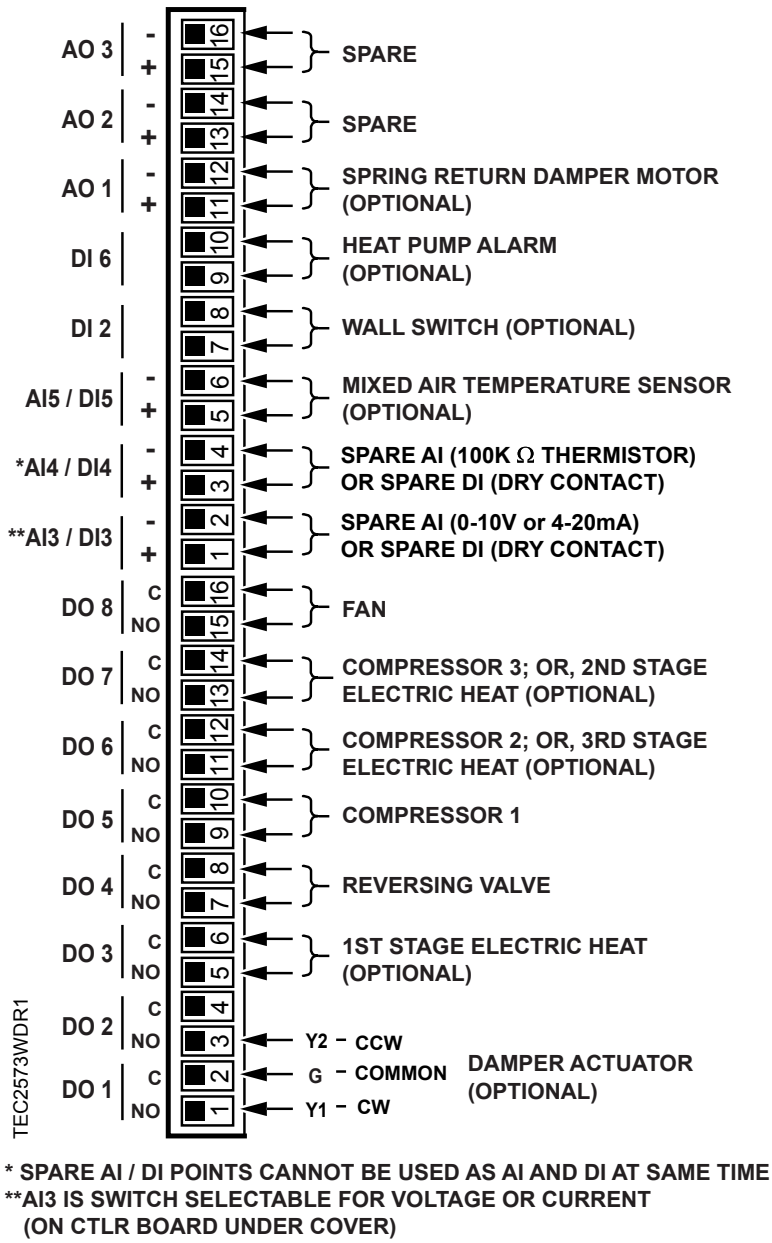

Figure 5. Application 2573 Wiring Diagram.

Table 2. Point Database for Application 2573.

Object Type[a]	Object Instance (Point Number)[b]	Object Name and Description	Factory Default (SI Units)[c]	Eng Units (SI Units)[c]	Range	Active Text	Inactive Text
AO	1	CTLR ADDRESS	99	–	0 to 255	–	–
AO	2	APPLICATION	2590	–	2573, 2574 and 2590	–	–
AO	3	RETURN DELAY	10	MIN	0 to 255	–	–
AI	{04}[d]	ROOM TEMP	74.0 (23.45)	DEG F (DEG C)	48.0 to 111.75	–	–
BO	{05}	HEAT.COOL	COOL	–	Binary	HEAT	COOL
AO	6	DAY CLG STPT	74.0 (23.45)	DEG F (DEG C)	48.0 to 111.75	–	–
AO	7	DAY HTG STPT	70.0 (21.21)	DEG F (DEG C)	48.0 to 111.75	–	–
AO	8	NGT CLG STPT	82.0 (27.93)	DEG F (DEG C)	48.0 to 111.75	–	–
AO	9	NGT HTG STPT	65.0 (18.41)	DEG F (DEG C)	48.0 to 111.75	–	–
AO	10	DMPR MIN POS	14.8	PCT	0.0 to 102.0	–	–
AO	11	RM STPT MIN	55.0 (12.81)	DEG F (DEG C)	48.0 to 111.75	–	–
AO	12	RM STPT MAX	90.0 (32.41)	DEG F (DEG C)	48.0 to 111.75	–	–
AI	{13}	RM STPT DIAL	74.0 (23.45)	DEG F (DEG C)	48.0 to 111.75	–	–
BO	14	STPT DIAL	NO	–	Binary	YES	NO
AI	{15}	MA TEMP	74.0 (23.496)	DEG F (DEG C)	37.5 to 165.0	–	–
AO	16	CMP2 ON	70	PCT	0.0 to 102.0	–	–
AO	17	CMP2 OFF	50	PCT	0.0 to 102.0	–	–
BO	18	WALL SWITCH	NO	–	Binary	YES	NO
BI	{19}	DI OVRD SW	OFF	–	Binary	ON	OFF
AO	20	OVRD TIME	0	HRS	0 to 255	–	–
BO	{21}	NGT OVRD	NIGHT	–	Binary	NIGHT	DAY

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Table 2. Point Database for Application 2573. ***(continued)***

Object Type[a]	Object Instance (Point Number)[b]	Object Name and Description	Factory Default (SI Units)[c]	Eng Units (SI Units)[c]	Range	Active Text	Inactive Text
AO	22	RMTMP OFFSET	0.0 (0.0)	DEG F (DEG C)	-31.75 to 32.0	–	–
BO	{23}	FREE CLG	DISABL	–	Binary	ENABLE	DISABL
BI	{24}	DI 2	OFF	–	Binary	ON	OFF
BI	{25}	DI 5	OFF	–	Binary	ON	OFF
BI	{26}	DI 6	OFF	–	Binary	ON	OFF
AO	27	CMP2 MIN OFF	3	MIN	0 to 255	–	–
AO	28	CMP2 MIN ON	3	MIN	0 to 255	–	–
BO	{29}	DAY.NGT	DAY	–	Binary	NIGHT	DAY
AO	34	CMP3 ON	90	PCT	0.0 to 102.0	–	–
AO	35	CMP3 OFF	70	PCT	0.0 to 102.0	–	–
AO	36	CMP3 MIN OFF	3	MIN	0 to 255	–	–
AO	37	CMP3 MIN ON	3	MIN	0 to 255	–	–
BO	38	DAMPER TYPE	FLOAT	–	Binary	SPRING	FLOAT
AO	39	AO DIR.REV	0	–	0 to 255	–	–
AO	{40}	AOV1	0	VOLTS	0.0 to 10.23	–	–
BO	{41}	DO 1	OFF	–	Binary	ON	OFF
BO	{42}	DO 2	OFF	–	Binary	ON	OFF
BO	{43}	ELEC HEAT 1	OFF	–	Binary	ON	OFF
BO	{44}	REV VALVE	COOL	–	Binary	HEAT	COOL
BO	{45}	COMPRESSOR 1	OFF	–	Binary	ON	OFF
BO	{46}	EHEAT3.CMP2	OFF	–	Binary	ON	OFF
BO	{47}	EHEAT2.CMP3	OFF	–	Binary	ON	OFF
AO	{48}	DMPR COMD	0	PCT	0.0 to 102.0	–	–
AO	{49}	DMPR POS	0	PCT	0.0 to 102.0	–	–
BO	{50}	FAN	OFF	–	Binary	ON	OFF
AO	51	MTR TIMING	130	SEC	0 to 511	–	–
AI	{52}	AI 3	0.0	PCT.	0.0 to 102.0	–	–

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Table 2. Point Database for Application 2573. ***(continued)***

Object Type[a]	Object Instance (Point Number)[b]	Object Name and Description	Factory Default (SI Units)[c]	Eng Units (SI Units)[c]	Range	Active Text	Inactive Text
AI	{53}	AI 4	37.5 (3.056)	DEG F (DEG C)	37.5 to 165.0	–	–
AO	{54}	AOV2	0	VOLTS	0.0 to 10.23	–	–
BI	{55}	DI 3	OFF	–	Binary	ON	OFF
AO	56	DMPR ROT ANG	90	–	0 to 255	–	–
BI	{57}	DI 4	OFF	–	Binary	ON	OFF
AO	58	MTR SETUP	0	–	0 to 255	–	–
AO	59	DO DIR.REV	0	–	0 to 255	–	–
BO	60	CYCLE FAN	NO	–	Binary	YES	NO
AO	61	FREE CLG ON	30	PCT	0.0 to 102.0	–	–
AO	62	FREE CLG OFF	10	PCT	0.0 to 102.0	–	–
AO	63	CLG P GAIN	10.0 (18.0)	–	0.0 to 63.75	–	–
AO	64	CLG I GAIN	0.01 (0.018)	–	0.0 to 1.023	–	–
AO	65	CLG D GAIN	24 (43.2)	–	0 to 510	–	–
AO	66	CLG BIAS	50	PCT	0.0 to 102.0	–	–
AO	67	HTG P GAIN	10.0 (18.0)	–	0.0 to 63.75	–	–
AO	68	HTG I GAIN	0.01 (0.018)	–	0.0 to 1.023	–	–
AO	69	HTG D GAIN	24 (43.2)	–	0 to 510	–	–
AO	70	HTG BIAS	50	PCT	0.0 to 102.0	–	–
AO	{71}	MA P GAIN	5.0 (9.0)	–	0.0 to 63.75	–	–
AO	{72}	MA I GAIN	0.024 (0.0432)	–	0.0 to 1.023	–	–
AO	{73}	MA D GAIN	0 (0.0)	–	0 to 510	–	–
AO	{74}	MA BIAS	0	PCT	0.0 to 102.0	–	–
AO	75	CMP TOTL	1	–	0 to 255	–	–
AO	76	EHTG STG CNT	1	–	0 to 255	–	–
AO	{78}	CTL TEMP	74.0 (23.45)	DEG F (DEG C)	48.0 to 111.75	–	–
AO	{79}	CLG LOOPOUT	0	PCT	0.0 to 102.0	–	–
AO	{80}	HTG LOOPOUT	0	PCT	0.0 to 102.0	–	–

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Table 2. Point Database for Application 2573. ***(continued)***

Object Type[a]	Object Instance (Point Number)[b]	Object Name and Description	Factory Default (SI Units)[c]	Eng Units (SI Units)[c]	Range	Active Text	Inactive Text
AO	81	EHEAT 1 ON	90	PCT	0.0 to 102.0	–	–
AO	82	CMP1 ON	50	PCT	0.0 to 102.0	–	–
AO	83	CMP1 OFF	30	PCT	0.0 to 102.0	–	–
AO	84	RVAL SWITCH	30	PCT	0.0 to 102.0	–	–
AO	85	SWITCH LIMIT	4.8	PCT	0.0 to 102.0	–	–
AO	86	SWITCH TIME	10	MIN	0 to 255	–	–
AO	87	CMP1 MIN OFF	3	MIN	0 to 255	–	–
AO	88	CMP1 MIN ON	3	MIN	0 to 255	–	–
AO	89	RVAL SW TIME	30	SEC	0 to 255	–	–
AO	90	SWITCH DBAND	2.0 (1.12)	DEG F (DEG C)	0.0 to 63.75	–	–
BO	{91}	NGT MA CTL	NO	–	Binary	YES	NO
AO	{92}	CTL STPT	74.0 (23.45)	DEG F (DEG C)	48.0 to 111.75	–	–
AO	{93}	MA SETPT	55.0 (12.856)	DEG F (DEG C)	37.5 to 165.0	–	–
AO	94	EHEAT 2 ON	94.8	PCT	0.0 to 102.0	–	–
AO	95	EHEAT 3 ON	98	PCT	0.0 to 102.0	–	–
AO	96	CAL TIMER	12	HRS	0 to 255	–	–
AO	{97}	AOV3	0	VOLTS	0.0 to 10.23	–	–
AO	98	LOOP TIME	5	SEC	0 to 255	–	–
AO	{99}	ERROR STATUS	0	–	0 to 255	–	–

[a] Object Types are; Analog Input (AI), Analog Output (AO), Binary Input (BI) and Binary Output (BO).

[b] Points not listed are not used in this application.

[c] A single value in a column means that the value is the same in English units and in SI units.

[d] Point numbers that appear in brackets {} may be unbundled at the field panel.