SIEMENS

BACnet PTEC Heat Pump Controller

Application 6574 - Multiple Heating and Cooling with Mixed Air Control and Internal Reversing Valve

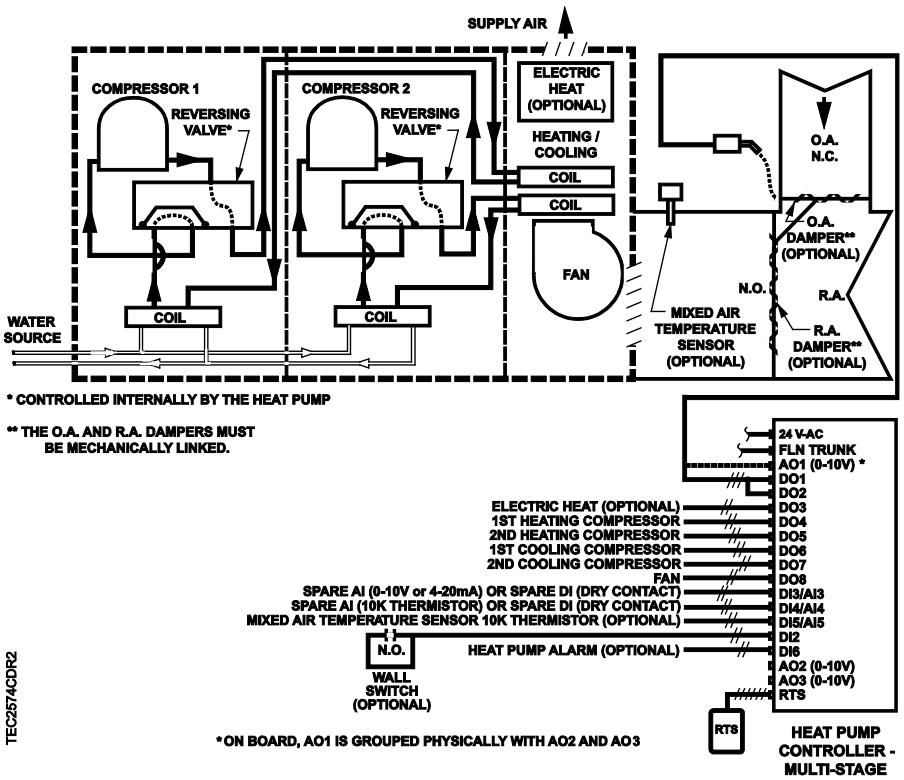
Application Note

Table of Contents

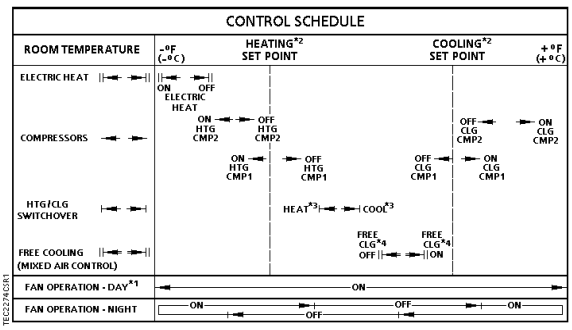
Overview

In Application 6574, the controller controls one or two heating compressors for heating and one or two cooling compressors for cooling. The reversing valve is controlled internally by the heat pump. In addition to compressors, this heat pump may also be equipped with electric heat for auxiliary heat and mixed air control for free cooling. This application also controls small air handling units with two position heating and cooling control. The mixed air control can use either a spring return or a floating control damper motor.

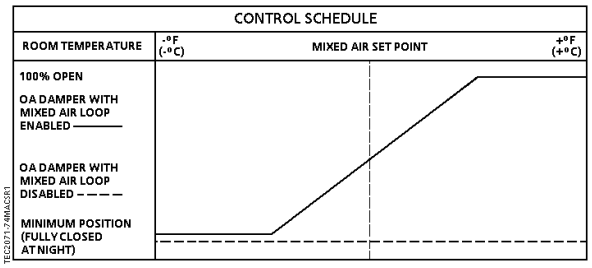
Application 6574 is based on Application 2584 of the preceding revision of Siemens BACnet Heat Pump Controller. Application 6574 is identical to 2584 except for any differences listed in the table below.



Application 6574 - Multiple Heating and Cooling with Mixed Air Control and Internal Reversing Valve.



Application 6574 Control Schedule.



Mixed Air Control Schedule

	Previous Revision	2009 Revision	2010 Revision
Application Numbers	2573 and 2574, 2590 (slave)	2893 and 2894 2849 (slave)	6573 and 6574, 6590 (slave)
Rev string	BM20	BK22 (September 2009)	BE30 (May 2010)
New Feature(s)	-	• New Points: 65, 66, 69, 70, 124, 125, 126, 127 (original points numbered 65, 66, 69, 70 are re-numbered to 102, 103, 104, 105) • Ability to Enable/Disable the commanding of critical DOs • Relative Setpoint Adjustment option • RH & T support for Series 3000 room stats • Flash/upgrade pass through using Series 1000, 2000, or 3000 stats (no need to connect directly to controller) • AI 5 OFFSET (Point 125) – calibrate aux temp at AI5if necessary for fine tuning sensor/temp accuracy (Note: AI 4 OFFSET (Point 124) is also available)	• New Points: 65, 66, 69, 70, 122, 123, 124, 125, 126, 127 (original points numbered 65, 66, 69, 70 are re-numbered to 102, 103, 104, 105) • Ability to Enable/Disable the commanding of critical DOs • Relative Setpoint Adjustment option • RH & T support for Series 2200 and 3200 type Room Units • Flash/upgrade pass through using Series 1000, 2000, or 2200 and 3200 type Room Units (no need to connect directly to controller) • AI 5 OFFSET (Point 125) – calibrate aux temp at AI5if necessary for fine tuning sensor/temp accuracy (Note: AI 4 OFFSET (Point 124) is also available)

BACnet

The controller communicates using BACnet MS/TP protocol for open communications on BACnet MS/TP networks.

Product	Supported BIBBs	BIBB Name
BTEC	DS-RP-B B	Data Sharing-Read Property-B
	DS-RPM-B	Data Sharing-Read Property Multiple-B
	DS-WP-B	Data Sharing-Write Property-B
	DM-DDB-B	Device Management-Dynamic Device Binding-B
	DM-DOB-B	Device Management-Dynamic Object Binding-B
	DM-DCC-B	Device Management-Device Communication Control-B

Product	Supported BIBBs	BIBB Name
	DM-RD-B	Device Management-Reinitialize Device-B
	DM-BR-B	Device Management-Backup and Restore-B
	DM-OCD-B	Device Management-Object Creation and Deletion-B

Hardware Inputs

Analog

- Mixed air temperature sensor (optional)
- Room Unit
- 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

- Fan
- Floating control damper actuator (optional)
- Stage 1 electric heat (optional)
- Stage 1 cooling compressor (optional)
- Stage 2 cooling compressor (optional)
- Stage 1 heating compressor (optional)
- Stage 2 heating compressor (optional)

Sequence of Operation

The following paragraphs present the sequence of operation for Siemens BACnet PTEC Heat Pump Controller Application 6574 - Multiple Heating and Cooling with Mixed Air Control and Internal Reversing Valve.

Control Temperature Setpoints

This application has a number of different room temperature setpoints (DAY HTG STPT, NGT CLG STPT, RM STPT DIAL, etc.). The application actually controls to CTL STPT. CTL STPT is set to different values depending on its override status, the time of day, whether or not a temperature deadband (zero energy band) has been configured, and the type of RTS used.

Selection of RTS type:

The point STAT TYPE can be set to NORMAL (default) or OFFSET. When STAT TYPE = OFFSET, an optional Relative Setpoint Adjustment feature can be used. For more information see the Relative Setpoint Adjustment (optional) section.

CTLSTPT in Day Mode:

If the controller is in day mode and STPT DIAL = YES (and a setpoint dial is present), RM STPT DIAL will be used to determine the value of CTL STPT.

If RM STPT DIAL is Failed but has been overridden, CTL STPT will be Normal and the current value of RM STPT DIAL will be used to determine the value of CTL STPT. If RM STPT DIAL is Failed and not overridden, CTL STPT will be Failed and the last known good value of RM STPT DIAL will be used to determine the value of CTL STPT.

If the controller is in day mode and STPT DIAL = NO, CTL STPT will hold the value of DAY CLG STPT or DAYHTG STPT. Also, CTLSTPT will have a status of Normal even if RM STPT DIAL is Failed.

CTL STPT in Night Mode:

In night mode, CTL STPT holds the value of NGT CLG STPT or NGT HTG STPT regardless of whether a setpoint dial is used. Also, CTL STPT will always have a status of Normal, even if RM STPT DIAL is Failed.

CTL STPT is Overridden:

When CTL STPT is overridden, CTL STPT will equal its overridden value and the application will have no effect on the value of CTL STPT. Also, CTL STPT will always have a status of Normal, even if RM STPT DIAL is Failed.

Setpoint Dial and Deadband:

When a setpoint dial is being used during day mode, the value of CTL STPT depends in part on whether a deadband is being used.

When DAY HTG STPT equals DAY CLG STPT, a deadband is not being used and the value of CTL STPT is limited to the range RM STPT MIN to RM STPT MAX, regardless of the value/position of the setpoint dial. For instance,

- CTL STPT will equal RM STPT MAX if RM STPT DIAL > RM STPT MAX.
- CTL STPT will equal RM STPT MIN if RM STPT DIAL < RM STPT MIN.
  - otherwise, CTL STPT will equal RM STPT DIAL.

When DAY HTG STPT does not equal DAY CLG STPT, a deadband (or zero energy band) is being used.

In this case, the controller operates as follows:

When HEAT.COOL equals HEAT

1. If RM STPT DIAL > than RM STPT MAX, then:
   - If [RM STPT MAX – 0.5 * (DAY CLG STPT – DAY HTG STPT)] > RM STPT MAX, then CTL STPT will equal RM STPT MAX.
   - If [RM STPT MAX – 0.5 * (DAY CLG STPT – DAY HTG STPT)] < RM STPT MIN, then CTL STPT will equal RM STPT MIN.
   - ⇨ otherwise, CTL STPT will equal RM STPT MAX – 0.5 * (DAY CLG STPT – DAY HTG STPT).
2. If RM STPT DIAL < than RM STPT MIN, then:
   - If [RM STPT MIN – 0.5 * (DAY CLG STPT – DAY HTG STPT)] > RM STPT MAX, then CTL STPT will equal RM STPT MAX.
   - If [RM STPT MIN – 0.5 * (DAY CLG STPT – DAY HTG STPT)] < RM STPT MIN, then CTL STPT will equal RM STPT MIN.
   - ⇨ otherwise, CTL STPT will equal RM STPT MIN – 0.5 * (DAY CLG STPT – DAY HTG STPT).
3. If RM STPT MAX > RM STPT DIAL > RM STPT MIN, then:
   - If [RM STPT DIAL – 0.5 * (DAY CLG STPT – DAY HTG STPT)] > RM STPT MAX, then CTL STPT will equal RM STPT MAX.
   - If [RM STPT DIAL – 0.5 * (DAY CLG STPT – DAY HTG STPT)] < RM STPT MIN, then CTL STPT will equal RM STPT MIN.
   - ⇨ otherwise, CTL STPT will equal RM STPT DIAL – 0.5 * (DAY CLG STPT – DAY HTG STPT).

When HEAT.COOL equals COOL

1. If RM STPT DIAL > than RM STPT MAX, then:
   - If [RM STPT MAX + 0.5 * (DAY CLG STPT – DAY HTG STPT)] > RM STPT MAX, then CTL STPT will equal RM STPT MAX.
   - If [RM STPT MAX + 0.5 * (DAY CLG STPT – DAY HTG STPT)] < RM STPT MIN, then CTL STPT will equal RM STPT MIN.

⇨ otherwise, CTL STPT will equal RM STPT MAX + 0.5 * (DAY CLG STPT – DAY HTG STPT).

2. If RM STPT DIAL < than RM STPT MIN, then:
   - If [RM STPT MIN + 0.5 * (DAY CLG STPT – DAY HTG STPT)] > RM STPT MAX, then CTL STPT will equal RM STPT MAX.
   - If [RM STPT MIN + 0.5 * (DAY CLG STPT – DAY HTG STPT)] < RM STPT MIN, then CTL STPT will equal RM STPT MIN.
   - ⇨ otherwise, CTL STPT will equal RM STPT MIN + 0.5 * (DAY CLG STPT – DAY HTG STPT).
3. If RM STPT MAX > RM STPT DIAL > RM STPT MIN, then:
   - If [RM STPT DIAL + 0.5 * (DAY CLG STPT – DAY HTG STPT)] > RM STPT MAX, then CTL STPT will equal RM STPT MAX.
   - If [RM STPT DIAL + 0.5 * (DAY CLG STPT – DAY HTG STPT)] < RM STPT MIN, then CTL STPT will equal RM STPT MIN.
   - ⇨ otherwise, CTL STPT will equal RM STPT DIAL + 0.5 * (DAY CLG STPT – DAY HTG STPT).

Relative Setpoint Adjustment (Optional)

When STAT TYPE =OFFSET, the point STPT SPAN can be used to keep the temperature range that is available to the user of a setpoint dial constrained to a narrow range. Series 2200 room unit should be used for this option. These room sensors have a slider with red and blue colored bands indicating warmer/cooler, instead of a preprinted 55 to 95 degree temperature scale. When STAT TYPE = OFFSET, moving the slider up/down adjusts the room temperature a few degrees above/below the day heating or cooling setpoint. The maximum amount of adjustment is configured in STPT SPAN. For example, if STPT SPAN is set to 2.0, then moving the slider all the way up would add only 2 degrees to the day heating (or cooling) setpoint. Similarly, 2 degrees would be subtracted if the slider were moved all the way down. Between these extremes the offset is proportionately scaled.

Room Temperature Offset (Optional)

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

CTL TEMP = ROOM TEMP + TEMP OFFSET

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 TEMP 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. 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 DI 2 (see the Control Diagram(s)), and WALL SWITCH = YES, the controller monitors the status of DI 2. When the status of DI 2 is ON (the switch is closed), then DAY.NGT will be set to DAY indicating that the controller is in day mode. When the status of DI 2 is OFF (the switch is open), then 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, if the controller is operating stand-alone, then the controller stays in day mode all the time. If the controller is operating with centralized control (that is, it is connected to a field panel), then the field panel can send an operator or PPCL command to override the status of DAY.NGT. See *Powers Process Control Language (PPCL) User's Manual* (125-1896) and *Field Panel User's Manual* (125-3019 or 125-3020) 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, pressing the override switch will reset the controller to day operational mode for the time period that is set in OVRD TIME. The status of NGT OVRD changes to DAY. After the override time elapses, the controller returns to night mode and the status of 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, the controller switches from heating to cooling mode by setting HEAT.COOL to COOL:

- HTG LOOPOUT < SWITCH LIMIT.
- CTL TEMP > CTL STPT by at least the value set in SWITCH DBAND.
- CTL TEMP > the appropriate cooling setpoint minus SWITCH DBAND.

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

- CLG LOOPOUT < SWITCH LIMIT.
- CTL TEMP < CTL STPT by at least the value set SWITCH DBAND.
- CTL TEMP < the appropriate heating setpoint plus SWITCH DBAND.

Control Loops

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

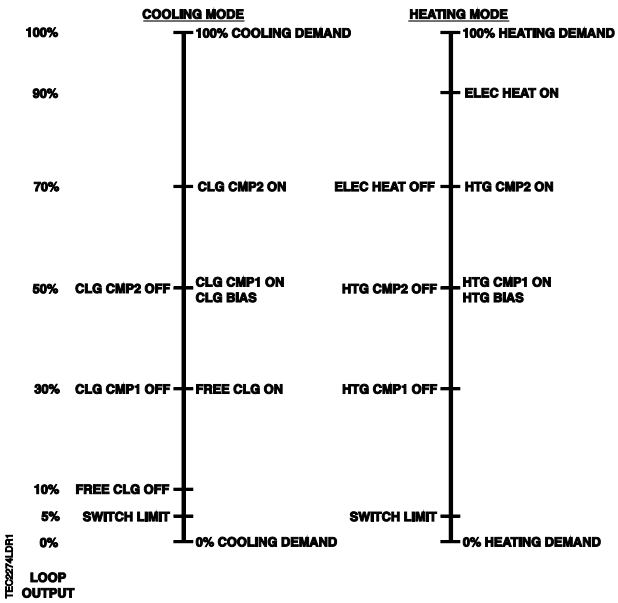
The two temperature loops are a cooling loop and a heating loop and the value of HEAT.COOL determines which is active. The active temperature loop maintains room temperature at the value in CTL STPT. The inputs to the temperature loops are CTL TEMP and CTL STPT. The outputs are CLG LOOPOUT and HTG LOOPOUT.

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.

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.

The ladder diagram shows 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 output rises above or drops below the values of CLG BIAS and HTG BIAS. The purpose of these points is to provide a starting place for the loops at startup.



Application 6574 Heating and Cooling Loops

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

Cooling Loop – CLG LOOPOUT must be greater than FREE CLG ON before free cooling will be used.

The controller accomplishes free cooling by enabling the mixed air loop to modulate the mixed air damper.

CLG CMP 1 will not be allowed to turn ON until CLG LOOPOUT becomes greater than the value of CLG CMP1 ON. CLG CMP 1 will not be allowed to turn OFF until CLG LOOPOUT drops below the value of CLG CMP1 OFF.

CLG CMP 2 will not be allowed to turn ON until CLG LOOPOUT becomes greater than the value of CLG CMP2 ON. CLG CMP 2 will not be allowed to turn OFF until CLG LOOPOUT drops below the value of CLG CMP2 OFF.

CLG LOOPOUT must be less than the value of FREE CLG OFF 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 sent to either minimum position for day mode or to 0% open for night mode.

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

Heating Loop – HTG LOOPOUT must be greater than ELEC HEAT ON before ELEC HEAT is turned ON.

When HTG LOOPOUT drops below HTG CMP2 ON, ELEC HEAT will shut OFF.

HTG CMP 1 will not be allowed to turn ON until HTG LOOPOUT becomes greater than the value of HTG CMP1 ON. HTG CMP 1 will not be allowed to turn OFF until HTG LOOPOUT drops below the value of HTG CMP1 OFF.

HTG CMP 2 will not be allowed to turn ON until HTG LOOPOUT becomes greater than the value of HTG CMP2 ON. HTG CMP 2 will not be allowed to turn OFF until HTG LOOPOUT drops below the value of HTG CMP2 OFF.

When HTG LOOPOUT drops below the value of SWITCH LIMIT, 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 and MA STPT. The output is DMPR COMD.

Mixed Air Control

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

- HEAT.COOL = HEAT. Free cooling is not needed in the heating season.
- MA TEMP is failed. When this point is failed, mixed air control is not possible.

- FREE CLG = 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 < FREE CLG OFF. The cooling load is so small that no cooling is required.

If the fan is OFF, DMPR COMD 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 = COOL.
- MA TEMP is normal. (Not failed.)
- FREE CLG = ENABLE. The outside air is cool enough to be used for free cooling.
- CLG LOOPOUT > FREE CLG ON. The cooling load is large enough to require cooling.
- DMPR COMD > DMPR MIN POS.

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

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

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

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

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

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

- If CLG LOOPOUT was previously above FREE CLG ON, the mixed air loop will remain enabled.
- If CLG LOOPOUT was previously below FREE CLG OFF, the mixed air loop will remain disabled.

NOTE:
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 = SPRING. The mixed air loop will control the damper through its 0 – 10 volt analog output, AOV1, and DO 1 and DO 2 will be spare DOs.
- For a floating control damper, set DAMPER TYPE = FLOAT. The mixed air loop will control the damper through DO 1 and DO 2, and AOV1 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 needs to be unbundled. Even though this is possible, make sure that the customer will allow it before attempting it.

Compressor Operation

NOTE:
To prevent damage to the heat pump, the default setting of HP DO OVRD does not allow operator command of compressors. See the *Overriding Critical Heat Pump DOs* section for more information.

This application can support from 0 to 2 cooling compressors (as defined by the value of CLG CMP TOTL) and from 0 to 2 heating compressors (as defined by the value of HTG CMP TOTL).

When HEAT.COOL = COOL, HTG LOOPOUT will be set to 0. CLG LOOPOUT will also equal 0 until all of the heating compressors have been OFF for at least their minimum OFF time. This is a safety feature that prevents the simultaneous operation of the heating and cooling compressor DOs.

When the heating compressors have been OFF for the MIN OFF time, CLG LOOPOUT is placed under normal control.

As cooling demand increases, the cooling compressors are controlled as follows:

- CLG CMP 1 will turn ON when CLG LOOPOUT > CLG CMP1 ON provided that the first cooling compressor has been OFF for at least the time set in CLG1 MIN OFF.
- If CLG CMP TOTL = 2, CLG CMP 2 will turn ON when CLG LOOPOUT > CLG CMP2 ON provided that the following conditions are met:

- The second cooling compressor has been OFF for at least the time set in CLG2 MIN OFF.
- The first cooling compressor has been ON for at least 30 seconds. (This creates less

demand than having more than one compressor start at once).

As cooling demand decreases, the cooling compressors are controlled as follows:

- CLG CMP 2 will turn OFF when CLG LOOPOUT < CLG CMP2 OFF provided that the second cooling compressor has been ON for at least the time set in CLG2 MIN ON.
- CLG CMP 1 will turn OFF when CLG LOOPOUT < CLG CMP1 OFF provided that the following conditions are met:
  - The first cooling compressor has been ON for at least the time set in CLG1 MIN ON.
  - The second cooling compressor has been OFF for at least 30 seconds. This will prevent the first cooling compressor from turning OFF before the second cooling compressor is OFF.

When HEAT.COOL = HEAT, CLG LOOPOUT will be set to 0. HTG LOOPOUT will also equal 0 until all of the cooling compressors have been OFF for at least their minimum OFF time. This is a safety feature that prevents the simultaneous operation of the heating and cooling compressor DOs.

When the cooling compressors have been OFF for the MIN OFF time, HTG LOOPOUT is placed under normal control.

As heating demand increases, the heating compressors are controlled as follows:

- HTG CMP 1 will turn ON when HTG LOOPOUT > HTG CMP1 ON provided that the first heating

compressor has been OFF for at least the time set in HTG1 MIN OFF.

- If HTG CMP TOTL is 2, HTG CMP 2 will turn ON when HTG LOOPOUT > HTG CMP2 ON provided that the following conditions are met:
  - The second heating compressor has been OFF for at least the time set in HTG2 MIN OFF.
  - The first heating compressor has been ON for at least 30 seconds. (This creates less demand than having more than one compressor start at once.)

As heating demand decreases, the heating compressors are controlled as follows:

- HTG CMP 2 will turn OFF when HTG LOOPOUT < HTG CMP2 OFF provided that the second heating compressor has been ON for at least the time set in HTG2 MIN ON.
- HTG CMP 1 will turn OFF when HTG LOOPOUT < HTG CMP1 OFF provided that the following conditions are met:
  - The first heating compressor has been ON for at least the time set in HTG1 MIN ON.
  - The second heating compressor has been OFF for at least 30 seconds. This will prevent the first heating compressor from turning OFF before the second heating compressor is OFF.

Electric Heat (Optional)

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

In this section, EHEAT3.CMP2 and EHEAT2.CMP3 refer to the stages of electric heat.

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

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

- If EHTG STG CNT ≥ 1 and HTG LOOPOUT > EHEAT 1 ON, the first stage of electric heat, ELEC HEAT 1, is turned ON.
- If EHTG STG CNT ≥ 2 and HTG LOOPOUT > EHEAT 2 ON, the second stage of electric heat, EHEAT2.CMP3, is turned ON.
- If EHTG STG CNT ≥ 2 and HTG LOOPOUT < EHEAT 1 ON, EHEAT2.CMP3 is turned OFF.
- If EHTG STG CNT = 3 and HTG LOOPOUT > EHEAT 3 ON, the third stage of electric heat, EHEAT3.CMP2 is turned ON.
- If EHTG STG CNT = 3 and HTG LOOPOUT < EHEAT 2 ON, EHEAT3.CMP2 is turned OFF.
- The first stage of electric heat will turn OFF differently depending on the number of compressors being used:
  - If HTG LOOPOUT < CMP1 ON and CMP TOTL = 0 or 1, ELEC HEAT 1 is turned OFF.
  - If HTG LOOPOUT < CMP2 ON and CMP TOTL = 2, ELEC HEAT 1 is turned OFF.
  - If HTG LOOPOUT < CMP3 ON and CMP TOTL = 3, ELEC HEAT 1 is turned OFF.

If the stage of electric heat is being used (EHTG STG CNT = 1) and HEAT.COOL = COOL, the stage of electric heat is OFF.

When the stage of electric heat is being used and HEAT.COOL = HEAT, the electric heat is controlled as follows:

- If HTG LOOPOUT > ELEC HEAT ON, the electric heat point, ELEC HEAT, is turned ON.
- ELEC HEAT will turn OFF differently depending on the number of heating compressors being used (as determined by HTG CMP TOTL).
  - If HTG CMP TOTL = 0 or 1 and HTG LOOPOUT < HTG CMP1 ON, ELEC HEAT is turned OFF.
  - If HTG CMP TOTL = 2 and HTG LOOPOUT < HTG CMP2 ON, ELEC HEAT is turned OFF.

AI4/AI5 OFFSET (Optional)

AI 4 OFFSET works like RMTMP OFFSET. It can be used to calibrate AI4 aux temp sensor input if necessary. The actual temperature plus AI 4 OFFSET will equal AI4 display temperature.

AI 5 OFFSET works the same as AI 4 OFFSET.

Room Unit Operation

Stat Supervision

STAT SUPV is a configurable, enumerated point (values are additive). This point tells the controller what kind of room unit is connected and how to respond to a loss of communication between a Series 2200 and 3200 type Room Units and the controller.

The default value for STAT SUPV is zero, no response (also for Series 1000/2000 stats). A value of 1 means that if communication is lost for at least one minute, CTL TEMP will have a status of Failed. A value of 3 means that both CTL TEMP and RM RH will be Failed after a loss of communication for at least one minute.

CO2 Monitoring

RM CO2 displays the CO_2 value in units of parts-per-million (PPM). RM CO2 can be unbundled for monitoring purposes.

Room RH

RM RH displays the relative humidity value in percent. RM RH can be unbundled for monitoring purposes.

Fan Operation

NOTE:
To prevent damage to the heat pump, the default setting of HP DO OVRD does not allow operator command of the fan. See the *Overriding Critical Heat Pump DOs* section for more information.

Day Mode – FAN is ON when CYCLE FAN = 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:

- Free cooling is being provided by the mixed air control loop.
- 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:

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

PPCL STATUS

PPCL STATUS displays LOADED or EMPTY.

LOADED = PPCL programming is present in the controller. A new application number must be assigned (12000 through 12999).

EMPTY = NO PPCL programming is present.

Damper Status Operation (Optional)

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

Centralized Alarm Monitoring

DI 6 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 Critical Heat Pump DOs

This application includes a setup point that enables or disables ON and OFF commands to critical DOs. Specifically, the fan, reversing valve (Application 6573), and compressor(s) cannot be directly commanded ON or OFF unless the point HP DO OVRD is set to ENABLE. When HP DO OVRD is set to DISABL, commands to the fan, reversing valve and compressor DO points are ignored regardless of BACnet command priority. Commands to electric heat DOs and any spare DOs are always allowed. Physical points DO1 and DO2 can never be overridden when configured for motor control. However, the position of the attached motor is always commandable via DMPR COMD.

⚠ CAUTION

HP DO OVRD should be set to ENABLE only when there is a complete understanding of the consequences.
Since the direct control will override the applications minimum on and off time safeties, improper use of the DO commands can cause permanent equipment damage. Also, during normal daily operation, the override of critical DOs should only be done via a BACnet command. If a digital output is overridden via the MMI port, the point may be left in an incorrect internal state upon release. If during commissioning an override command must be issued via the MMI port, it is critical that the point be manually commanded off before the point is released.

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 and HTG LOOPOUT 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 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 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. This lessens the demand of having all the electrical equipment starting at once.

Fail Mode Operation

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

Application Notes

- 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.
- 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 and CTL STPT.
- In this application the maximum configurations are as follows:
  - The maximum of HTG CMP TOTL = 2.
  - The maximum of CLG CMP TOTL = 2.
  - The maximum of EHTG STG CNT = 1.

If these limits are exceeded, CMP TOTL will be set to 0 and EHTG STG CNT will be set to 0. These points will remain at 0 until they are set correctly. (This prevents the

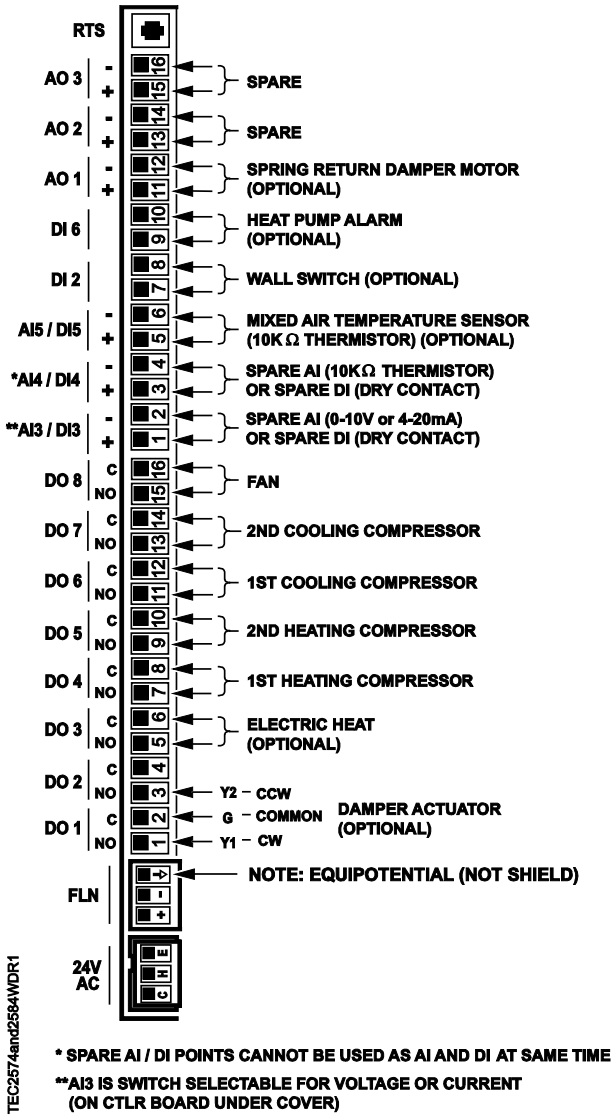
application from trying to use the same DO as both a compressor and a stage of electric heat.)

- This revision makes it possible to upgrade/flash the controller using Series 1000, 2000, or Series 2200 and 3200 type Room Units as a pass through to the controller. In other words you do not have to connect to the controller directly.

Wiring Diagram

⚠ CAUTION

The controller's DOs control 24 Vac loads only. The maximum rating is 12 VA for each DO. An external interposing relay is required 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.
(for example part number 540-147, Terminal Equipment Controller Relay Module)



Application 6574 Wiring Diaram

Application 6574 Point Database

Object Type [a]	Object Instance (Point Number)	Object Name (Descriptor)	Factory Default (SI Units) [b]	Eng Units (SI Units)	Range	Active Text	Inactive Text
AO	1	CTLR ADDRESS	99	--	0-255	--	--
AO	2	APPLICATION	6590	--	0-32767	--	--
AO	3	RETURN DELAY	10	MIN	0-255	--	--
AI	4	ROOM TEMP	74.0 (23.45)	DEG F (DEG C)	48-111.75	--	--
BO	5	HEAT.COOL	COOL	--	Binary	HEAT	COOL
AO	6	DAY CLG STPT	74.0 (23.45)	DEG F (DEG C)	48-111.75	--	--
AO	7	DAY HTG STPT	70.0 (21.21)	DEG F (DEG C)	48-111.75	--	--
AO	8	NGT CLG STPT	82.0 (27.93)	DEG F (DEG C)	48-111.75	--	--
AO	9	NGT HTG STPT	65.0 (18.41)	DEG F (DEG C)	48-111.75	--	--
AO	10	DMPR MIN POS	14.8	PCT	0-102	--	--
AO	11	RM STPT MIN	55.0 (12.81)	DEG F (DEG C)	48-111.75	--	--
AO	12	RM STPT MAX	90.0 (32.41)	DEG F (DEG C)	48-111.75	--	--
AI	13	RM STPT DIAL	74.0 (23.45)	DEG F (DEG C)	48-111.75	--	--
BO	14	STPT DIAL	NO	--	Binary	YES	NO
AI	15	MA TEMP	74.0 (23.496)	DEG F (DEG C)	37.5-165	--	--
AO	16	HTG CMP2 ON	70	PCT	0-102	--	--
AO	17	HTG CMP2 OFF	50	PCT	0-102	--	--
BO	18	WALL SWITCH	NO	--	Binary	YES	NO
BI	19	DI OVRD SW	OFF	--	Binary	ON	OFF
AO	20	OVRD TIME	0	HRS	0-255	--	--
BO	21	NGT OVRD	NIGHT	--	Binary	NIGHT	DAY
AO	22	RMTMP OFFSET	0.0 (0.0)	DEG F (DEG C)	-63.75	--	--

Object Type [a]	Object Instance (Point Number)	Object Name (Descriptor)	Factory Default (SI Units) [b]	Eng Units (SI Units)	Range	Active Text	Inactive Text
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	HTG2 MIN OFF	3	MIN	0-255	--	--
AO	28	HTG2 MIN ON	3	MIN	0-255	--	--
BO	29	DAY.NGT	DAY	--	Binary	NIGHT	DAY
AO	30	CLG CMP1 ON	50	PCT	0-102	--	--
AO	31	CLG CMP1 OFF	30	PCT	0-102	--	--
AO	32	CLG1 MIN OFF	3	MIN	0-255	--	--
AO	33	CLG1 MIN ON	3	MIN	0-255	--	--
AO	34	CLG CMP2 ON	90	PCT	0-102	--	--
AO	35	CLG CMP2 OFF	70	PCT	0-102	--	--
AO	36	CLG2 MIN OFF	3	MIN	0-255	--	--
AO	37	CLG2 MIN ON	3	MIN	0-255	--	--
BO	38	DAMPER TYPE	FLOAT	--	Binary	SPRING	FLOAT
AO	39	AO DIR.REV	0	--	0-255	--	--
AO	40	AOV1	0	VOLTS	0-10.23	--	--
BO	41	DO 1	OFF	--	Binary	ON	OFF
BO	42	DO 2	OFF	--	Binary	ON	OFF
BO	43	ELEC HEAT	OFF	--	Binary	ON	OFF
BO	44	HTG CMP 1	OFF	--	Binary	ON	OFF
BO	45	HTG CMP 2	OFF	--	Binary	ON	OFF
BO	46	CLG CMP 1	OFF	--	Binary	ON	OFF
BO	47	CLG CMP 2	OFF	--	Binary	ON	OFF
AO	48	DMPR COMD	0	PCT	0-102	--	--
AO	49	DMPR POS	0	PCT	0-102	--	--
BO	50	FAN	OFF	--	Binary	ON	OFF
AO	51	MTR TIMING	130	SEC	0-511	--	--
AI	52	AI 3	0	PCT	0-102	--	--
AI	53	AI 4	74.0 (23.496)	DEG F (DEG C)	37.5-165	--	--
AO	54	AOV2	0	VOLTS	0-10.23	--	--

Object Type [a]	Object Instance (Point Number)	Object Name (Descriptor)	Factory Default (SI Units) [b]	Eng Units (SI Units)	Range	Active Text	Inactive Text
BI	55	DI 3	OFF	--	Binary	ON	OFF
AO	56	DMPR ROT ANG	90	--	0-255	--	--
BI	57	DI 4	OFF	--	Binary	ON	OFF
AO	58	MTR SETUP	0	--	0-255	--	--
AO	59	DO DIR.REV	0	--	0-255	--	--
BO	60	CYCLE FAN	NO	--	Binary	YES	NO
AO	61	FREE CLG ON	30	PCT	0-102	--	--
AO	62	FREE CLG OFF	10	PCT	0-102	--	--
AO	63	CLG P GAIN	10.0 (18.0)	--	0-63.75	--	--
AO	64	CLG I GAIN	0.01 (0.018)	--	0-1.023	--	--
AO	65	STPT SPAN	4.0 (2.24)	DEG F (DEG C)	0-63.75	--	--
BO	66	STAT TYPE	NORMAL	--	Binary	OFFSET	NORMAL
AO	67	HTG P GAIN	10.0 (18.0)	--	0-63.75	--	--
AO	68	HTG I GAIN	0.01 (0.018)	--	0-1.023	--	--
BO	69	HP DO OVRD	DISABL	--	Binary	ENABLE	DISABL
AO	70	STPT OFFSET	0.0 (0.0)	DEG F (DEG C)	-63.75	--	--
AO	71	MA P GAIN	5.0 (9.0)	--	0-63.75	--	--
AO	72	MA I GAIN	0.024 (0.0432)	--	0-1.023	--	--
AO	73	MA D GAIN	0 (0.0)	--	0-510	--	--
AO	74	MA BIAS	0	PCT	0-102	--	--
AO	75	HTG CMP TOTL	1	--	0-255	--	--
AO	76	EHTG STG CNT	1	--	0-255	--	--
AO	77	CLG CMP TOTL	1	--	0-255	--	--
AO	78	CTL TEMP	74.0 (23.45)	DEG F (DEG C)	48-111.75	--	--
AO	79	CLG LOOPOUT	0	PCT	0-102	--	--
AO	80	HTG LOOPOUT	0	PCT	0-102	--	--

Object Type [a]	Object Instance (Point Number)	Object Name (Descriptor)	Factory Default (SI Units) [b]	Eng Units (SI Units)	Range	Active Text	Inactive Text
AO	81	ELEC HEAT ON	90	PCT	0-102	--	--
AO	82	HTG CMP1 ON	50	PCT	0-102	--	--
AO	83	HTG CMP1 OFF	30	PCT	0-102	--	--
AO	85	SWITCH LIMIT	4.8	PCT	0-102	--	--
AO	86	SWITCH TIME	10	MIN	0-255	--	--
AO	87	HTG1 MIN OFF	3	MIN	0-255	--	--
AO	88	HTG1 MIN ON	3	MIN	0-255	--	--
AO	90	SWITCH DBAND	2.0 (1.12)	DEG F (DEG C)	0-63.75	--	--
BO	91	NGT MA CTL	NO	--	Binary	YES	NO
AO	92	CTL STPT	74.0 (23.45)	DEG F (DEG C)	48-111.75	--	--
AO	93	MA SETPT	55.0 (12.856)	DEG F (DEG C)	37.5-165	--	--
AO	96	CAL TIMER	12	HRS	0-255	--	--
AO	97	AOV3	0	VOLTS	0-10.23	--	--
AO	98	LOOP TIME	5	SEC	0-255	--	--
AO	99	ERROR STATUS	0	--	0-255	--	--
AO	102	CLG D GAIN	24 (43.2)	--	0-510	--	--
AO	103	CLG BIAS	50	PCT	0-102	--	--
AO	104	HTG D GAIN	24 (43.2)	--	0-510	--	--
AO	105	HTG BIAS	50	PCT	0-102	--	--
BO	122	PPCL STATE	EMPTY	--	Binary	LOADED	EMPTY
AI	123	RM CO2	1000	PPM	0-8191	--	--
AO	124	AI 4 OFFSET	0.0 (0.0)	DEG F (DEG C)	-63.75	--	--
AO	125	AI 5 OFFSET	0.0 (0.0)	DEG F (DEG C)	-63.75	--	--
AO	126	STAT SUPV	0	--	0-255	--	--
AI	127	RM RH	50	PCT	0-102	--	--

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

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

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