SIEMENS

BACnet PTEC Controller

Heat Pump - Multiple Heating and Cooling Heat Pump with Mixed Air Control and Internal Reversing Valve Control, Application 6674

Application Note

140-1151
2014-07-17

Restricted

Building Technologies

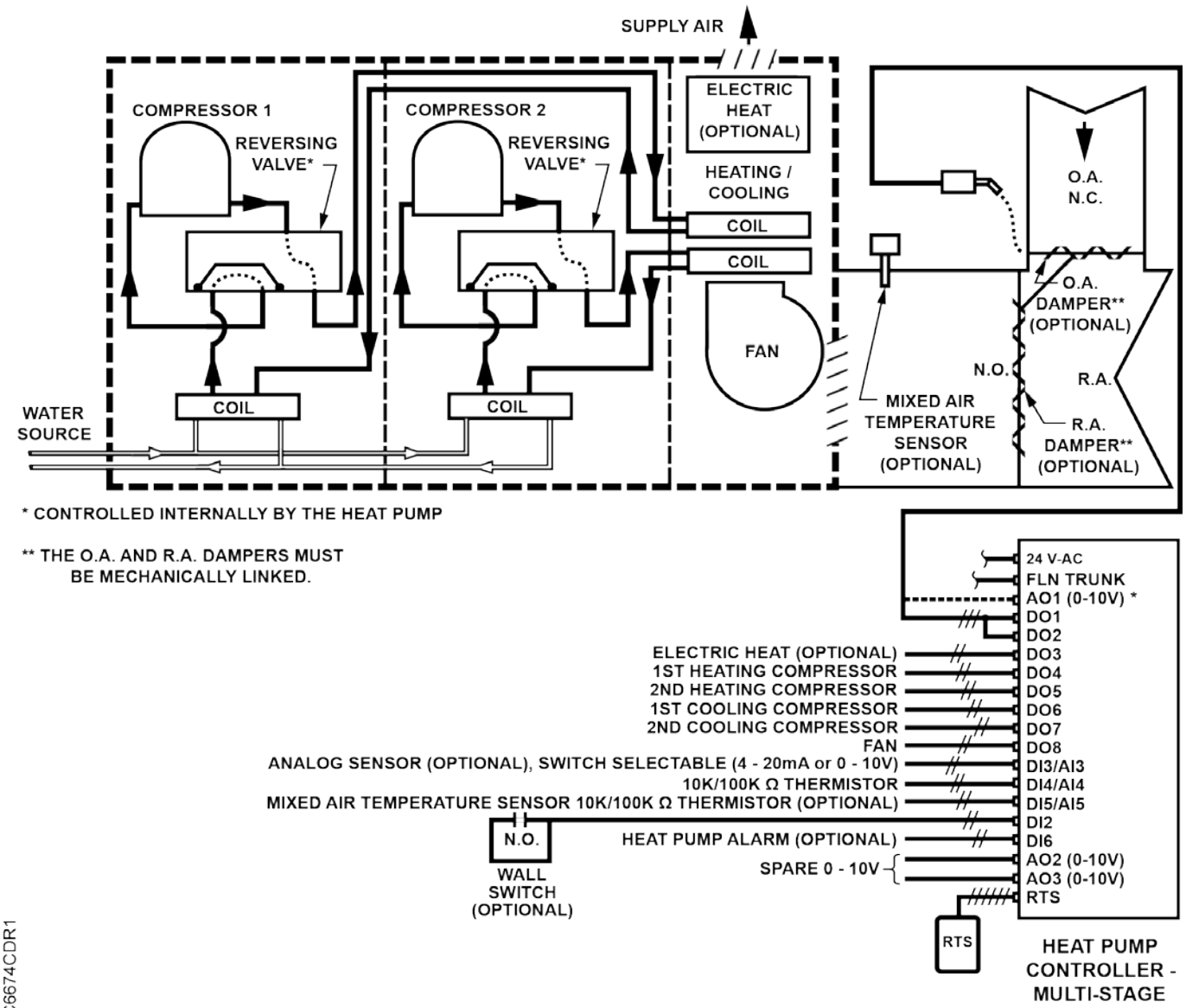
Table of Contents

Overview

NOTE:
For information on applications with Firmware Revision B*x*40 or earlier, see InfoLink and/or Asset Portal for documentation.

In Application 6674, 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 outdoor air ventilation and 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 and analog spring return or a floating control damper motor.

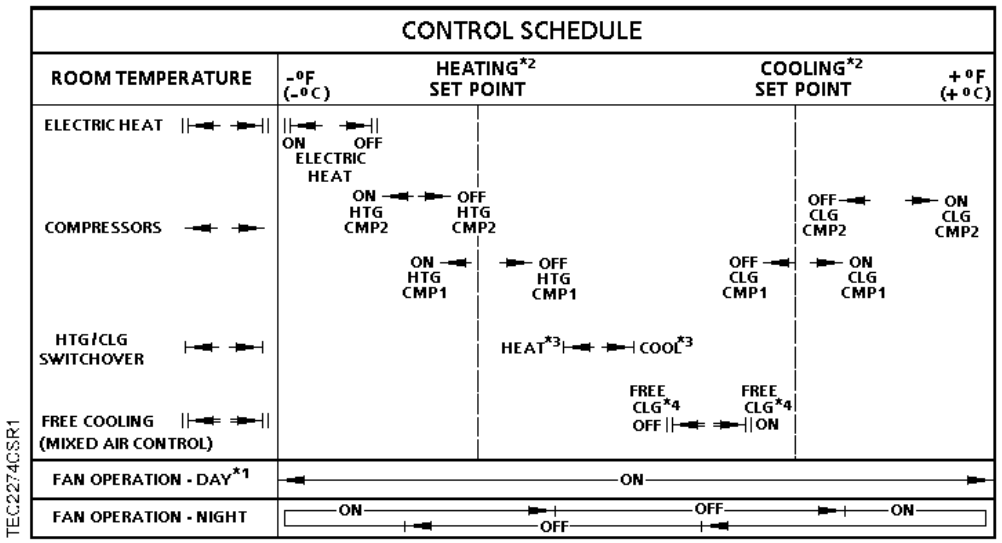
Application 6674 is based on Application 2584 of the preceding revision of Siemens BACnet Heat Pump Controller.



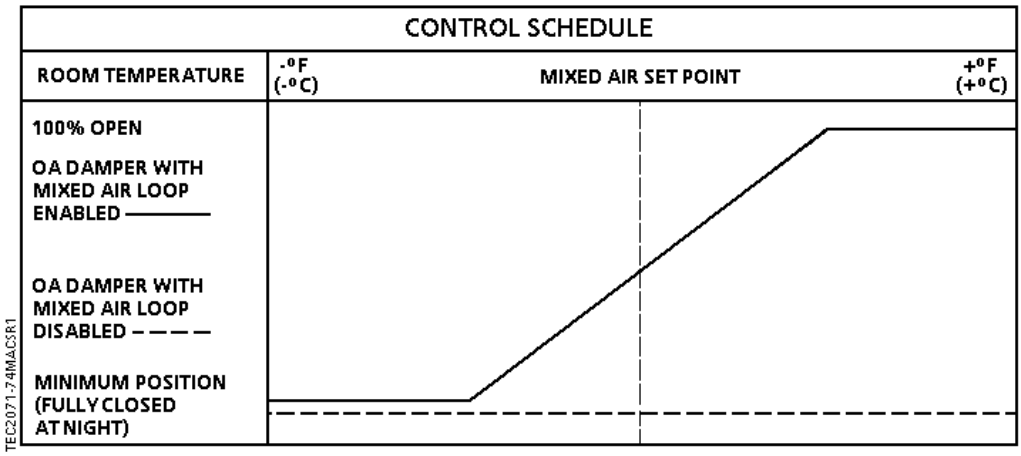
TEC6674CDR1

Room unit can also provide monitoring for humidity and/or CO2

Application 6674 - Multiple Heating and Cooling with Mixed Air Control and Internal Reversing Valve.



Application 6674 Control Schedule.



Mixed Air Control Schedule

BACnet

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

Product	Supported BIBBs	BIBB Name
BTEC/PTEC	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
	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 (10K or 100K thermistor software selectable)
- Room Unit (with optional humidity and/or CO2 sensing)
- Room temperature setpoint dial (optional)
- Spare temperature sensor (10K or 100K thermistor software selectable)
- Spare 0-10V or 4-20mA

Digital

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

NOTE:
Digital Room Units (Firmware Revision 26 and later) will update their controlled inputs without putting them Out Of Service. However, a command from an external source through the digital room unit will put the associated BACnet Input point Out Of Service.

Room Unit Identification

- For Analog Room Units – The revision number is visually identified by its case.
- For Digital Room Units (Firmware Revision 25 or earlier) – The revision number displays for 5 seconds when the room unit is first powered up. These room units will display `laptop` when a laptop is connected and will no longer update room temperature sensor values.
- For Digital Room Units (Firmware Revision 26 and later) – The revision number displays for 5 seconds when the room unit is first powered up or when a laptop is disconnected. These room units will continue to display and update the room temperature sensor values when a laptop is connected.

Hardware Outputs

Analog

- Mixed air damper actuator (optional)
- Spare 0-10 Vdc (one to three)

Digital

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

Ordering Notes

550-490PA	Siemens BACnet PTEC Heat Pump - Multi-Stage Controller

Sequence of Operation

The following paragraphs present the sequence of operation for Application 6674 - Multiple Heating & Cooling Heat Pump with Mixed Air Control & Internal Reversing Valve Control.

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 using the 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.

CTL STPT is Overridden:

If CTL STPT is overridden, that value is used regardless of any other settings. This disables the setpoint deadband feature.

STPT SPAN is used to determine how the room unit setpoint will be used. Default of zero (0) indicates it will use standard/absolute values and values greater than zero indicates it is in the offset mode. For more information, see the following sections.

CTL STPT in Night Mode:

The controller is in Night Mode if DAY.NGT = NGT and NGT OVRD = NGT.

When the controller is in night mode, CTL STPT holds the value of NGT CLG STPT or NGT HTG STPT depending on the value of HEAT.COOL. When the controller is in night mode, the value of RM STPT DIAL is ignored.

CTL STPT in Day Mode:

The controller is in Day Mode if DAY.NGT = DAY or NGT OVRD = DAY.

Without setpoint dial:

When the controller is in day mode and STPT DIAL = NO, CTL STPT holds the value of DAY CLG STPT or DAY HTG STPT depending on the value of HEAT.COOL.

With setpoint dial:

When the controller is in day mode and STPT DIAL = YES, CTL STPT holds a value based on RM STPT DIAL depending on your room unit model/revision.

The following sections describe the value of CTL STPT based on room unit type and configuration:

- CTL STPT using Standard/Absolute Mode (Digital Room Unit, Revision 26 and later)
- CTL STPT using Warmer/Cooler Mode (Digital Room Unit, Revision 26 and later)
- CTL STPT using Standard/Absolute Mode (Analog or Digital Room Unit)
- CTL STPT using Warmer/Cooler Mode (Analog Room Unit Only)

NOTE:
If RM STPT DIAL is failed, it maintains the last known value.

CTL STPT Using Standard/Absolute Mode (Digital Room Unit, Revision 26 and later)

Digital Room Unit (2200/2300 Series Firmware Revision 26 and later)

For all new digital room units, the value displayed and reported by the room unit is linked to the current heat/cool mode. When the mode changes, the value is automatically updated based on the new heat/cool mode.

When STPT SPAN is set to 0, the room setpoint adjustment on the digital room unit will function in a standard mode. The range of the adjustment will be based on RM STPT MIN and RM STPT MAX.

CTL STPT is set equal to RM STPT DIAL. The values for RM STPT MIN and RM STPT MAX will be applied to limit RM STPT DIAL before it is copied into CTL STPT.

CTL STPT Using Warmer/Cooler Mode (Digital Room Unit, Revision 26 and later)

Digital Room Unit (2200/2300 Series Firmware Revision 26 and later)

NOTE:
The warmer-cooler function is only available with BACnet PTEC controllers (standard 66xx apps).

When STPT SPAN is set to a value > 0, the room setpoint adjustment on the digital room unit will function in a warmer/cooler mode. The range of the adjustment will be calculated based on the current DAY CLG STPT or DAY HGT STPT and the STPT SPAN value. This will allow the Room Setpoint Dial to be incremented up or down from these setpoints by STPT SPAN.

CTL STPT is set equal to RM STPT DIAL. The values for RM STPT MIN and RM STPT MAX will be applied to limit RM STPT DIAL before it is copied into CTL STPT.

When SPTP SPAN > 0, the minimum and maximum values for RM STPT DIAL are calculated as follows:

- Minimum lowest adjusted setpoint value is equal to DAY CLG STPT or DAY HTG STPT - STPT SPAN
- Maximum highest adjusted setpoint value is equal to DAY CLG STPT or DAY HTG STPT + STPT SPAN

Example in Cooling Mode

If the STPT SPAN is set to 2.0 degrees, and the DAY CLG STPT is 76°F, you can step up or down the room unit to adjust the RM STPT DIAL from 74°F to 78°F.

CTL STPT Using Standard/Absolute Mode (Analog or Digital Room Unit)

Analog (Series 1000) or Digital Room Units (Firmware Revision 25 or earlier)

NOTE:
2200/2300 digital room units with Firmware Revision 25 or earlier are only compatible with standard room unit functionality (no warmer/cooler).

When STPT SPAN is set to 0, CLT STPT is set based on the value of the setpoint dial and the setpoint deadband.

The setpoint deadband exists to allow the controller to provide a separation of the heating and cooling temperature setpoints when a setpoint dial is enabled.

The setpoint deadband is the difference between the cooling and heating day setpoints (DAY CLG STPT DAY – HTG STPT). The setpoint deadband can be disabled by setting DAY HTG STPT equal to DAY CLG STPT. When DAY HTG STPT does not equal DAY CLG STPT, a setpoint deadband (or zero energy band) is used.

The following values are used in the calculation of CTL STPT:

- *Deadband* is the value of the difference between DAY CLG STPT and DAY HTG STPT and is used to establish the current heating and cooling setpoints.
- *Deadband* = (DAY CLG STPT – DAY HTG STPT)

CTL STPT is calculated as follows:

With Deadband disabled:

CTL STPT = RM STPT DIAL

With Deadband enabled in Heat Mode:

CTL STPT = RM STPT DIAL – 0.5 * *Deadband*

With Deadband enabled in Cool Mode:

CTL STPT = RM STPT DIAL + 0.5 * *Deadband*

CTL STPT is limited between the value of RM STPT MIN and RM STPT MAX

CTL STPT Using Warmer/Cooler Mode (Analog Room Unit Only)

Analog Room Unit (Series 1000)

NOTE:
The warmer-cooler function for analog room units (Series 1000) use the warmer/cooler scale of units with a warmer/cooler housing.

When SPTP SPAN > 0, the minimum and maximum values for RM STPT DIAL are calculated as follows:

- Minimum lowest adjusted setpoint value is equal to DAY CLG STPT or DAY HTG STPT - STPT SPAN
- Maximum highest adjusted setpoint value is equal to DAY CLG STPT or DAY HTG STPT + STPT SPAN

The full range of the analog room unit slider will be mapped to a range of minimum setpoint value to maximum setpoint value.

CTL STPT is set equal to RM STPT DIAL. The values for RM STPT MIN and RM STPT MAX will be applied to limit RM STPT DIAL before it is copied into CTL STPT.

Example in Cooling Mode

If the STPT SPAN is set to 2.0 degrees, and the DAY CLG STPT is 76°F, the room unit slider will adjust the cooling setpoint from 74°F to 78°F.

Heating/Cooling Switchover

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 in SWITCH DBAND
- CTL TEMP < the appropriate heating setpoint minus SWITCH DBAND

When the STPT DIAL = NO, the heating/cooling switchover values are determined by DAY HTG STPT and DAY CLG STPT.

When the STPT DIAL = YES, the following sections describe the values used for the heating/cooling switchover points based on room unit type and configuration.

See the appropriate sections:

- Heating/Cooling Switchover Using Standard/Absolute Mode (Digital Room Unit, Revision 26 and later) [➞ 13]
- Heating/Cooling Switchover Using Warmer/Cooler Mode (Digital Room Unit, Revision 26 and later) [➞ 14]
- Heating/Cooling Switchover Using Standard/Absolute Mode (Analog Room Unit) [➞ 14]
- Heating/Cooling Switchover Using Warmer/Cooler Mode (Analog Room Unit) [➞ 15]

Heating/Cooling Switchover using Standard/Absolute Mode (Digital Room Unit, Revision 26 and later)

Recommended Configuration: Digital Room Units (2200/2300 Series Firmware Revision 26 and later)

For new digital room units, the graphic or actual value displayed and reported by the room unit is linked to the current heat/cool mode. When the mode changes, the value is automatically updated based on the new heat/cool mode.

- When the controller is in cooling mode, the heating switchover setpoint is as follows:
  Heating switchover point is equal to RM STPT DIAL – DAY CLG STPT + DAY HTG STPT
- When the controller is in heating mode, the cooling switchover setpoint is as follows:
  Cooling switchover point is equal to RM STPT DIAL – DAY HTG STPT + DAY CLG STPT

Example

DAY CLG STPT = 74 and DAY HTG STPT = 70

In cooling mode, when the user adjusts the setpoint value on the room unit to 76, the heating switchover point will equal 72 - SWITCH DBAND.

Heating switchover point: 76 – 74 + 70 = 72 - SWITCH DBAND

When the room temperature drops below heating switchover point and the switchover conditions are met, the controller switches to heating mode, the new value for the setpoint displays and RM STPT DIAL is 72 degrees.

Heating/Cooling Switchover Using Warmer/Cooler Mode (Digital Room Unit, Revision 26 and later)

Digital Room Unit (2200/2300 Series Firmware Revision 26 and later)

For new digital room units, the graphic or actual value displayed and reported by the room unit is linked to the current heat/cool mode. When the mode changes, the value is automatically updated based on the new heat/cool mode.

The RM STPT DIAL will display the current temperature setpoint based on a plus or minus position or increment entered by the user at the room unit.

When SPTP SPAN > 0, the minimum and maximum values for RM STPT DIAL are calculated as follows:

- Minimum lowest adjusted setpoint value is equal to DAY CLG STPT or DAY HTG STPT - STPT SPAN
- Maximum highest adjusted setpoint value is equal to DAY CLG STPT or DAY HTG STPT + STPT SPAN

The heat/cool switchover mechanism is the same as in standard/absolute mode.

- When the controller is cooling mode, the heating switchover setpoint is as follows:
  Heating switchover point is equal to RM STPT DIAL – DAY CLG STPT + DAY HTG STPT
- When the controller is heating mode, the cooling switchover setpoint is as follows:
  Cooling switchover point is equal to RM STPT DIAL – DAY HTG STPT + DAY CLG STPT

Heating/Cooling Switchover Using Standard/Absolute Mode (Analog Room Unit)

Analog (Series 1000) or Digital Room Units (Firmware Revision 25 or earlier)

The difference between day heating and day cooling setpoint establishes the separation for heat/cool switchover points (deadband = DAY CLG STPT – DAY HTG STPT).

- When the controller is in cooling mode, the heating switchover setpoint is as follows:
  Heating switchover point is equal to RM STPT DIAL – 0.5 * the deadband
- When the controller is in heating mode, the cooling switchover setpoint is as follows:
  Cooling switchover point is equal to RM STPT DIAL + 0.5 * the deadband

Heating/Cooling Switchover Using Warmer/Cooler Mode (Analog Room Unit)

Analog Room Unit (Series 1000)

The RM STPT DIAL will display the current temperature setpoint based on a plus or minus position or increment entered by the user at the room unit.

The amount of offset that can be entered with the analog room unit is limited to a value of minus STPT SPAN to plus STPT SPAN.

- When the controller is in cooling mode, the heating switchover setpoint is as follows:
  Heating switchover point is equal to DAY CLG STPT, plus the amount of offset entered
- When the controller is in heating mode, the cooling switchover setpoint is as follows:
  Cooling switchover point is equal to DAY HTG STPT, plus the amount of offset entered

Room Temperature, Room Temperature Offset and CTL TEMP

ROOM TEMP is the temperature that is being sensed by the room temperature sensor (RTS).

RMTMP OFFSET (or TEMP OFFSET) is a user-adjustable offset that will compensate for deviations between the value of ROOM TEMP and the actual room temperature.

CTL TEMP is the room temperature that is used for control purposes. In other words, what the application is trying to do is to maintain CTL TEMP at the control setpoint.

When CTL TEMP is not overridden, CTL TEMP and ROOM TEMP are related by the following equation:

CTL TEMP = ROOM TEMP + RMTMP OFFSET (or TEMP OFFSET)

If CTL TEMP is not overridden, then:

- The current value of ROOM TEMP (normal or overridden) is used to determine the value of CTL TEMP.
- If ROOM TEMP has a status of Failed, then last known good value of ROOM TEMP is used to determine the value of CTL TEMP.

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* in the *Overview* section), 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 is 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 is 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 *BACnet Field Panel User's Manual* (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 it is in night mode.

Control Loops

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

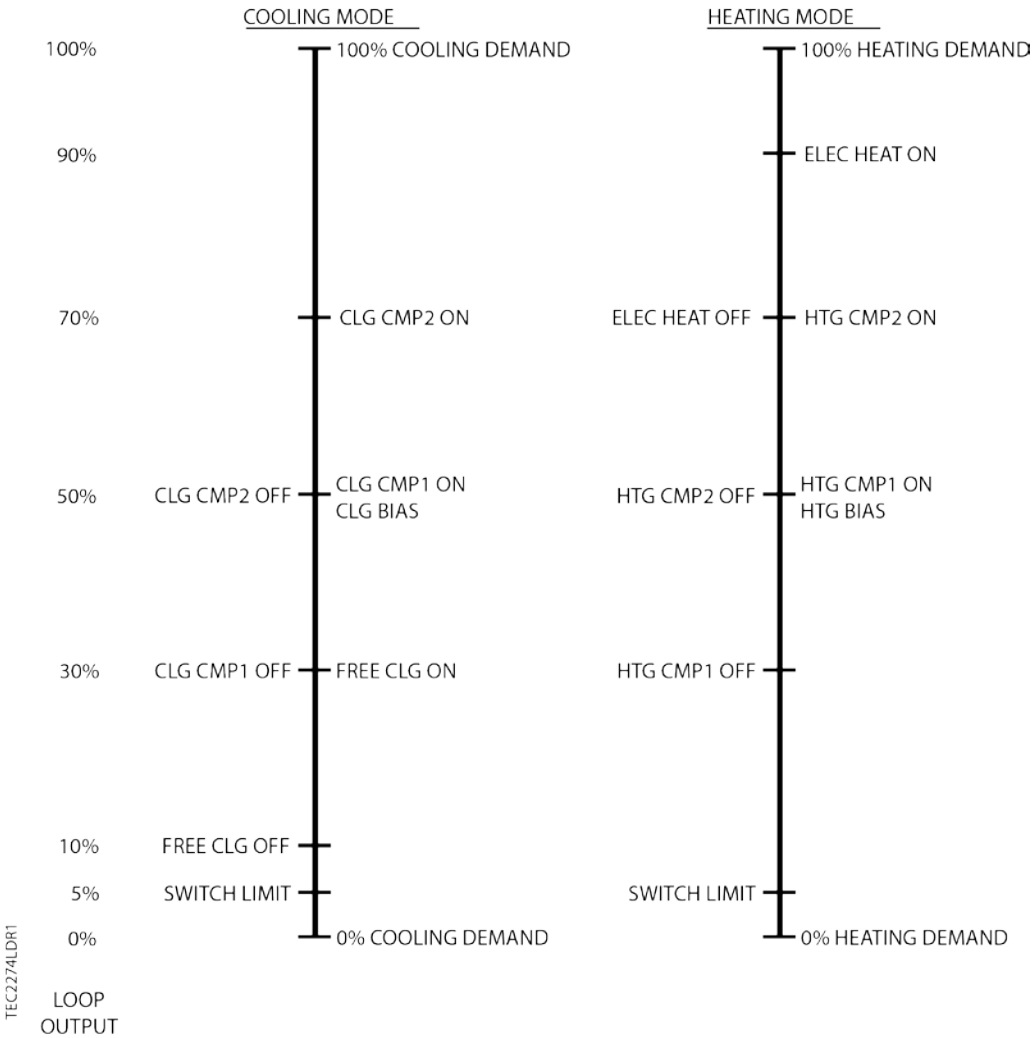
The two temperature loops are a cooling loop and a heating loop and the value of HEAT.COOL determines which is active. The active temperature loop maintains room temperature at the value in CTL STPT. The inputs to the temperature loops are CTL TEMP and CTL STPT. The outputs are CLG LOOPOUT and HTG LOOPOUT.

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 6674 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.

The value of 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 can 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 third PID that controls 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.

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 happens whether or not the heat pump is in day or night mode.

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.

The mixed air damper actuator can be either a spring return analog or floating control damper actuator or a standard floating control damper actuator.

⚠ 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 non-spring return).

• Spring Return or Analog Floating Control Actuators – 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 (134-1504) should cut power to the damper actuator upon reaching a low limit condition. When this happens, the spring will drive the damper shut. Note: There are versions of the OpenAir damper actuators that have the spring return functionality for floating (3-position) control actuators.

• Non-Spring Return Floating Control Damper Actuators – Stand-alone low temperature control is not possible. A PPCL program can be written to close the damper when a low temperature situation occurs. To do this, an outside input air temperature sensor needs to be connected to the field panel (or spare controller input) and DMPR COMD needs to be controlled by PPCL in the PTEC or the field panel. 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 electric 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 electric 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 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.

Room Unit Operation

Sensor Select

SENSOR SEL is a configurable, enumerated point (values are additive). This point tells the controller what type of room unit is being used and how to handle loss of data. It also provides the ability to enable the optional RH, and CO2 sensors and which thermistor type is connected.

Room Temperature, Setpoint, RH and CO2

- When the digital room unit (Series 2200/2300) is used, SENSOR SEL selects the source temperature and setpoint and enables a loss of communications indication:
  - Temperature/Setpoint enable and supervision for fail communications (temperature) with a value of 1.
  - Relative humidity enable and supervision for fail communications with a value of 2.
  - CO2 enable and supervision for fail communications with a value of 4.
- When the analog room unit (Series 1000/2000) is used, default temperature sensing (0) from an analog room unit is enabled (relative humidity and CO2 sensing are not available and should not be selected).

Thermistor Inputs

- Default for either input is 10K.
- To enable 100K thermistor on input, see the following table for additive values of 8 or 16.

Other Inputs (only available on Digital Room Unit)

- Use the following table to select and enable communications supervision of room temperature/setpoint dial, relative humidity or CO2 for additive values of 1, 2 and 4.

SENSOR SEL Value * (additive)	Description (include values to enable feature)
1	Select Digital Room Unit (for temperature sensing and setpoint dial)
2	Relative Humidity (RH) sensing
4	CO_2 sensing
8	If short board: 100K Ω thermistor on AI 3 (else input is 10K Ω) If long board: 100K Ω thermistor on AI 5 (else input is 10K Ω)

SENSOR SEL Value * (additive)	Description (include values to enable feature)
16	Long board only: 100K Ω thermistor on AI 4 (else input is 10K Ω)

Room CO2

RM CO2 displays the CO_2 value in units of parts-per-million (PPM). RM CO2 (from the digital 2200/2300 room units) can be used with PPCL in the PTEC controller or unbundled for control or monitoring purposes.

Room RH

RM RH displays the relative humidity value in percent. RM RH can be used for PPCL in the PTEC or unbundled for control or monitoring purposes.

Room DEW POINT

The controller provides a calculation for DEW POINT temperature in Fahrenheit degrees (or Celsius degrees) using room temperature (using CLT TEMP) and room humidity (using RM RH). This calculation is valid for ranges of 55°F (12.8°C) to 95°F (35°C) and 20 to 100% relative humidity.

Room ENTHALPY

The controller provides a calculation for room Enthalpy using room temperature (using CLT TEMP) and room humidity (using RM RH). This calculation is valid for ranges of 55 F to 95 F and 20% to 100% relative humidity.

Auto Discovery

Auto Discovery allows you to automatically discover and identify PTEC controller devices on the BACnet MS/TP Network. There are two basic configurations:

- Devices not configured with an address. (Devices are discovered by their unique serial number.)
- Devices configured with an address and available for modification.

Auto Addressing

Auto Addressing allows you to automatically assign device addresses to a PTEC controller on the BACnet MS/TP Network. If a controller is not configured with a MAC address, you have the option to auto-address or manually address the controller. During this time the baud rate is automatically detected by the controller.

Controller(s) must be connected on the BACnet/IP network in order for automatic addressing to occur.

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 the following condition has been met:

- The compressor or stage of electric heat is ON.

The fan will turn OFF only after the following condition has been met:

- The compressor and stages of electric heat have been OFF for at least 30 seconds.

Damper Operation

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.

Floating Control Actuation Auto-correct

In addition to the existing options for floating control actuator full stroke actions, all floating control actuators are provided with additional logic to fully drive open or closed when commanded to 100% or 0%.

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.

The maximum number of PPCL dynamic points is 15.

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.

NOTE:
Centralized alarm monitoring has no direct effect on the control of the heat pump application.

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, (for Application 6673 , the reversing

valve), 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 using 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, and the optional electric heat (if used) is kept OFF; however, the fan turns ON. 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.

If the mixed air temperature sensor fails, the damper will be controlled at the minimum position (day) or closed (night).

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.

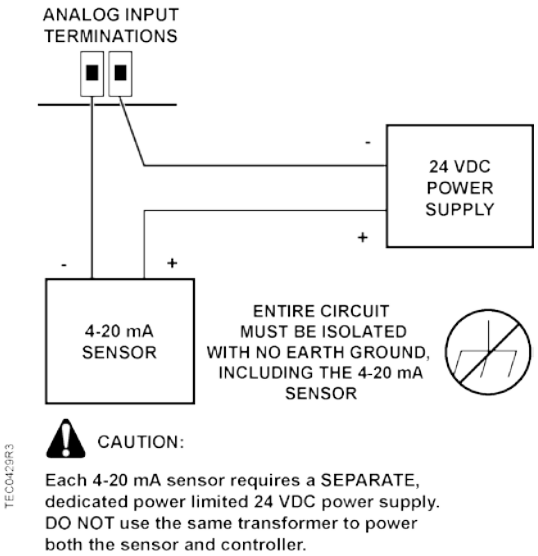
If these limits are exceeded, CMP TOTL will be set to 0 and EHTG STG CNT will be set to 0. These points will remain at 0 until they are set correctly. (This prevents the application from trying to use the same DO as both a compressor and a stage of electric heat.)

- 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

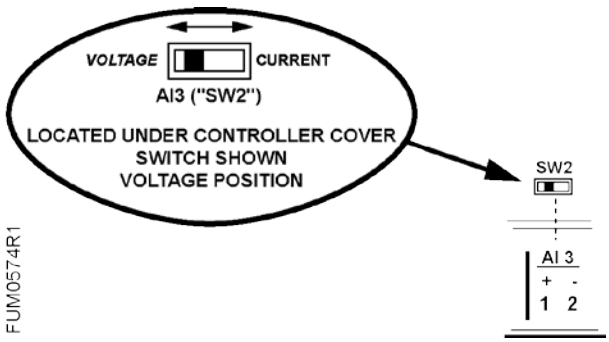
	**⚠ CAUTION** The controller's DOs control 24 Vac loads only. The maximum rating is 12 VA for each DO. An external interposing relay is required for any of the following: • VA requirements higher than the maximum • 110 or 220 Vac requirements • DC power requirements • Separate transformers used to power the load (for example part number 540-147, Terminal Equipment Controller Relay Module)

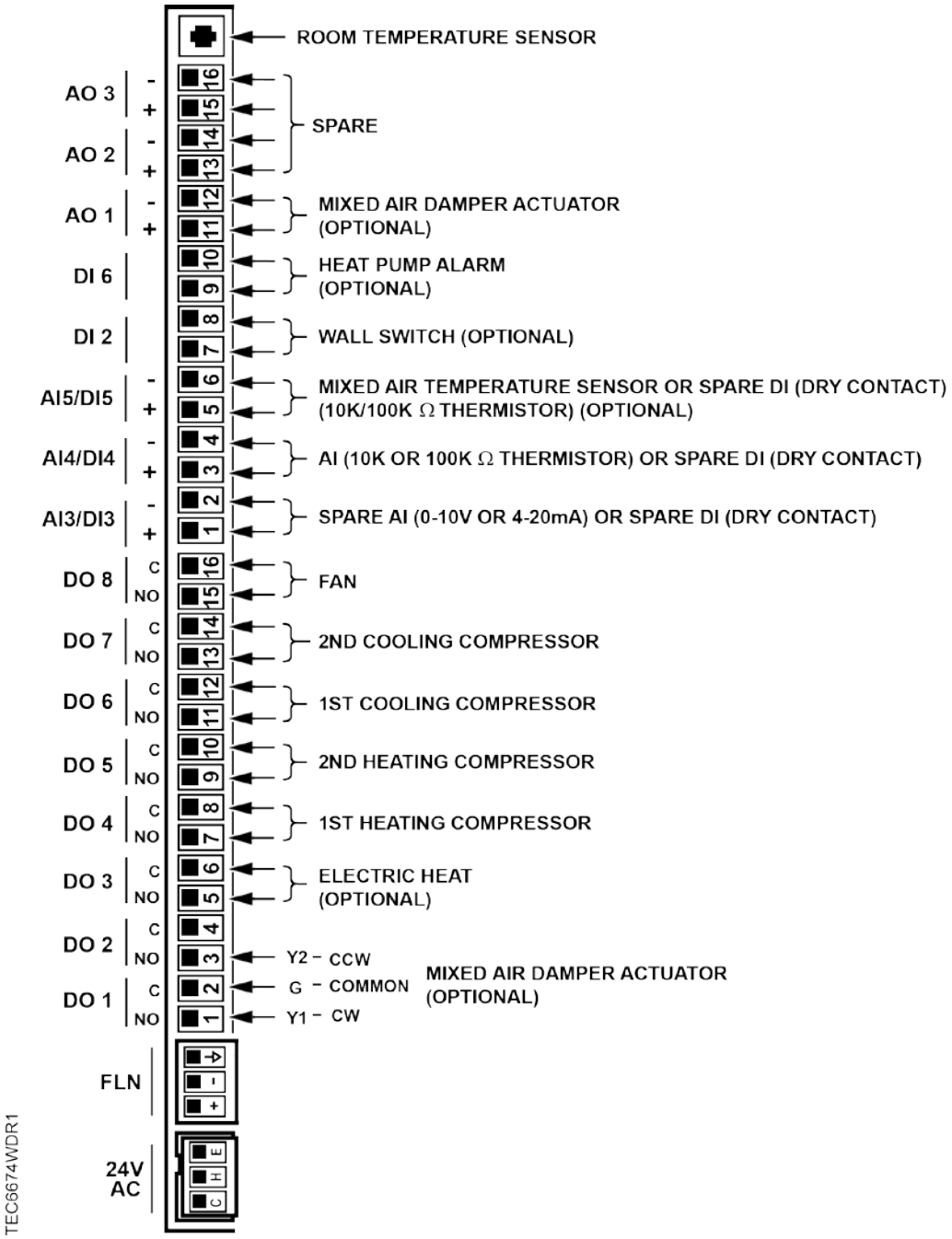
NOTE:
Thermistor inputs are 10K (default) or 100K software selectable (MA TEMP or AI 4).



Wiring for AI with a 4 to 20 mA Sensor.

NOTE:
If the voltage/current switch is set to current and a 4 to 20 mA sensor is connected to an AI, then special wiring requirements must be followed.





* Spare AI / DI points cannot be used as AI and DI at the same time.

Application 6674 - Multiple Heating and Cooling Heat Pump without Reversing Valve Control and with Mixed Air Control.

NOTE:
Refer to the controller board cover label for terminal connector IDs.

Application 6674 Point Database

Object Type[1]	Object Instance (Point Number)	Object Name (Descriptor)	Factory Default (SI Units)[2]	Eng Units (SI Units)	Range	Active Text	Inactive Text
AO	1	CTLR ADDRESS	255	--	0-255	--	--
AO	2	APPLICATION	6690	--	0-32767	--	--
AO	3	RETURN DELAY	10	MIN	0-255	--	--
AI	{04}	ROOM TEMP	74.0 (23.45)	DEG F (DEG C)	48-111.75	--	--
BO	{05}	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)	-31.75-32	--	--
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	--	--

Object Type[1]	Object Instance (Point Number)	Object Name (Descriptor)	Factory Default (SI Units)[2]	Eng Units (SI Units)	Range	Active Text	Inactive Text
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	--	--
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	--	--

Object Type[1]	Object Instance (Point Number)	Object Name (Descriptor)	Factory Default (SI Units)[2]	Eng Units (SI Units)	Range	Active Text	Inactive Text
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	0.0 (0.0)	DEG F (DEG C)	0-63.75	--	--
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	{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	--	--
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	101	CLG BIAS	50	PCT	0-102	--	--

Object Type[1]	Object Instance (Point Number)	Object Name (Descriptor)	Factory Default (SI Units)[2]	Eng Units (SI Units)	Range	Active Text	Inactive Text
AO	102	HTG BIAS	50	PCT	0-102	--	--
AO	103	CLG D GAIN	24 (43.2)	--	0-510	--	--
AO	104	HTG D GAIN	24 (43.2)	--	0-510	--	--
AO	{120}	ENTHALPY	0	BTU.LB	0-8191.75	--	--
AO	{121}	DEW POINT	-40.0 (-40.0)	DEG F (DEG C)	-40-1598.35	--	--
BO	{122}	PPCL STATE	EMPTY	--	Binary	LOADED	EMPTY
AI	{123}	RM CO2	1000	PPM	0-8191	--	--
AO	126	SENSOR SEL	0	--	0-255	--	--
AI	{127}	RM RH	50	PCT	0-102	--	--

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

2) A single value in a column means that the value is the same in English units and in SI units.

3) Point numbers that appear in brackets { } may be unbundled at the field panel.

Issued by
Siemens Industry, Inc.
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Document ID	140-1151	140-1151(AA)
Edition	2014-07-17	Restricted