SIEMENS

BACnet PTEC Controller

Unit Conditioner - Two-Pipe Fan Coil Unit Cooling or Heating, Application 6550

Application Note

140-0946
2014-06-11

Building Technologies

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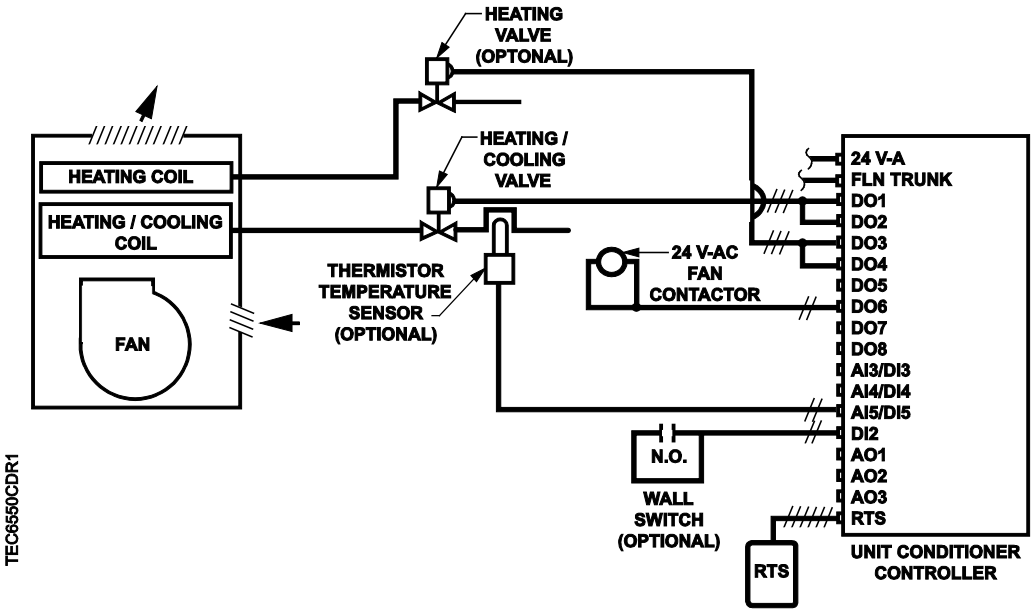
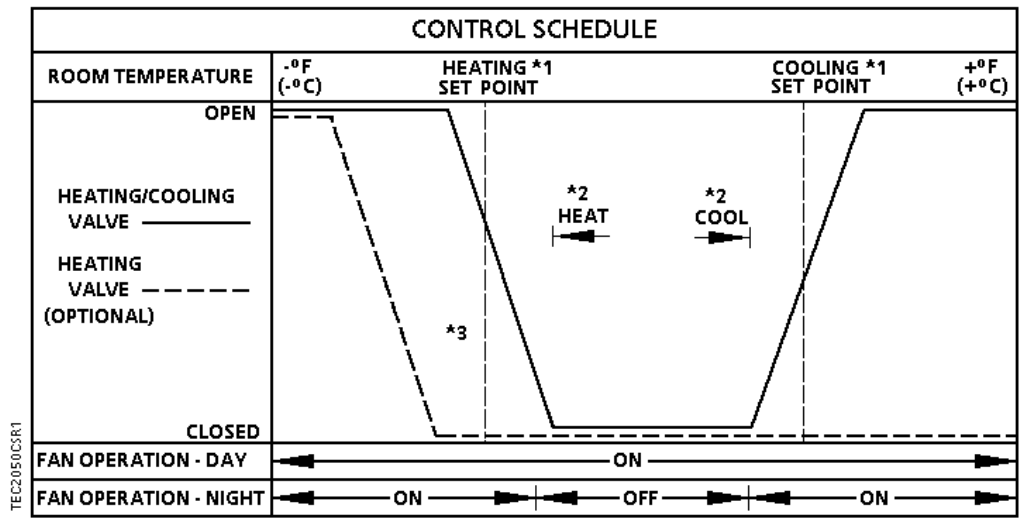
Overview

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

In Application 6550, the controller modulates a valve in the fan coil unit for heating or cooling mode. It can also control an optional second valve for heating. The fan coil unit also has a fan to circulate room air. In order for the fan coil unit to work properly, the central plant must provide chilled water in the cooling mode and hot water in the heating mode.



Application 6550 Two-Pipe Fan Cooling or Heating Control Diagram.



Application 6550 Control Schedule.

NOTES:
1. See *Control Temperature Setpoints*.
2. See *Heating/Cooling Switchover*.
3. The reheat valve is modulated.

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

- Pipe temperature sensor
- Room temperature sensor
- Room temperature setpoint dial (optional)

Digital

- Night mode override (optional)
- Wall switch (optional)

Hardware Outputs

Analog

- Spare AO 1, AO 2, and AO 3 (0-10V)

Digital

- Fan (switched 24 Vac, pilot duty)
- 1st valve actuator (required)
- 2nd valve actuator (optional)

Ordering Notes

550-496P	Siemens BACnet PTEC Unit Conditioner Controller

Sequence of Operation

The following paragraphs present the sequence of operation for the Siemens BACnet PTEC Unit Conditioner Controller.

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.

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 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:

- *Dial value* is the value of RM STPT DIAL limited between the value of RM STPT MIN and RM STPT MAX.
- *Deadband* is the value of the difference between DAY CLG STPT and DAY HTG STPT, half of which is applied 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 = *Dial value*

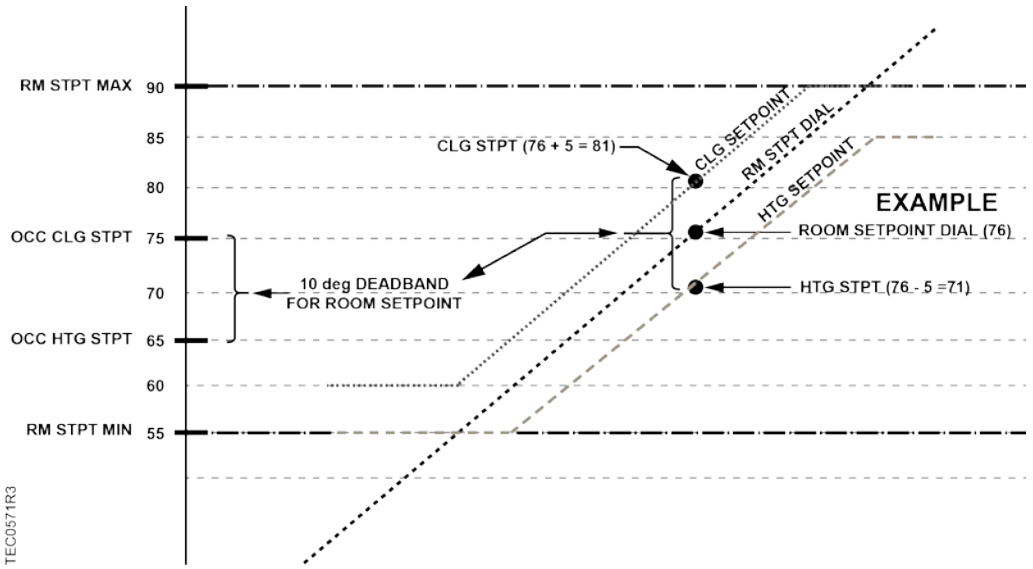
With Deadband enabled in Heat Mode:

CTL STPT = *Dial value* – 0.5 * *Deadband* (limited between the value of RM STPT MIN and RM STPT MAX)

With Deadband enabled in Cool Mode:

CTL STPT = *Dial value* + 0.5 * *Deadband* (limited between the value of RM STPT MIN and RM STPT MAX)

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



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.

Heating/Cooling Switchover

There are three options for the heating/cooling switchover for this application. In order for the controller to function properly, one of the following three options must be used:

1. A temperature sensor is attached to the supply water pipe. The controller uses the measured temperature point, SUPPLY TEMP, to determine whether it is in heating or cooling mode.
   When SUPPLY TEMP < COOL TEMP, the controller sets HEAT.COOL to COOL, switching the controller to cooling mode.
   When SUPPLY TEMP > HEAT TEMP, the controller sets HEAT.COOL to HEAT, switching the controller to heating mode.
2. If the controller is connected to a field panel, the field panel can command SUPPLY TEMP.
   When SUPPLY TEMP is commanded below the value of COOL TEMP, the controller sets HEAT.COOL to COOL, switching the controller to cooling mode.

When SUPPLY TEMP is commanded above the value of HEAT TEMP, the controller sets HEAT.COOL to HEAT, switching the controller to heating mode.

3. If the controller is connected to a field panel, the field panel can switch the controller between heating and cooling modes by commanding HEAT.COOL to HEAT or COOL.

Control Loops

The Siemens BACnet PTEC Unit Conditioner Controller is controlled by two Proportional, Integral, and Derivative (PID) temperature loops.

The two temperature loops are a cooling loop and a heating loop. The active temperature loop maintains room temperature at the value in CTL STPT. See Control Temperature Setpoints [→ 7].

Cooling Operation

In cooling mode, the controller uses CTL STPT and CTL TEMP as inputs for the cooling loop.

The central plant must provide chilled water. The output of the cooling loop is CLG LOOPOUT, which modulates the heating/cooling valve; VLV 1 COMD. HTG LOOPOUT is set to 0%.

Heating Operation

In heating mode, the controller uses CTL STPT and CTL TEMP as inputs for the heating loop.

The central plant must provide hot water. The output of the heating loop is HTG LOOPOUT, which modulates the heating/cooling valve, VLV 1 COMD and the optional second heating valve, VLV 2 COMD. CLG LOOPOUT is set to 0%.

Hot Water Coil

The heating loop modulates the heating valve(s) in order to warm-up the space as follows:

- If there is only one heating valve, VALVE CNT = 1. The position of the heating valve, VLV 1 COMD, is calculated using the following formula:
  (HTG LOOPOUT – VLV 1 START) / (VLV 1 END – VLV 1 START) x 100%, limited between 0 and 100%.
  As the demand for heating rises, the valve will begin opening when HTG LOOPOUT rises above VLV 1 START, and will be fully open when HTG LOOPOUT reaches VLV 1 END. VLV 2 COMD will not be used.
- If there are two heating valves, VALVE CNT = 2. The position of the first heating valve, VLV 1 COMD, is calculated as above. Similarly, the position of the second heating valve, VLV 2 COMD, is calculated using the following formula:
  (HTG LOOPOUT – VLV 2 START) / (VLV 2 END – VLV 2 START) × 100%, limited between 0 and 100%.
  As the demand for heating rises, the second valve will begin opening when HTG LOOPOUT rises above VLV 2 START, and will be fully open when HTG

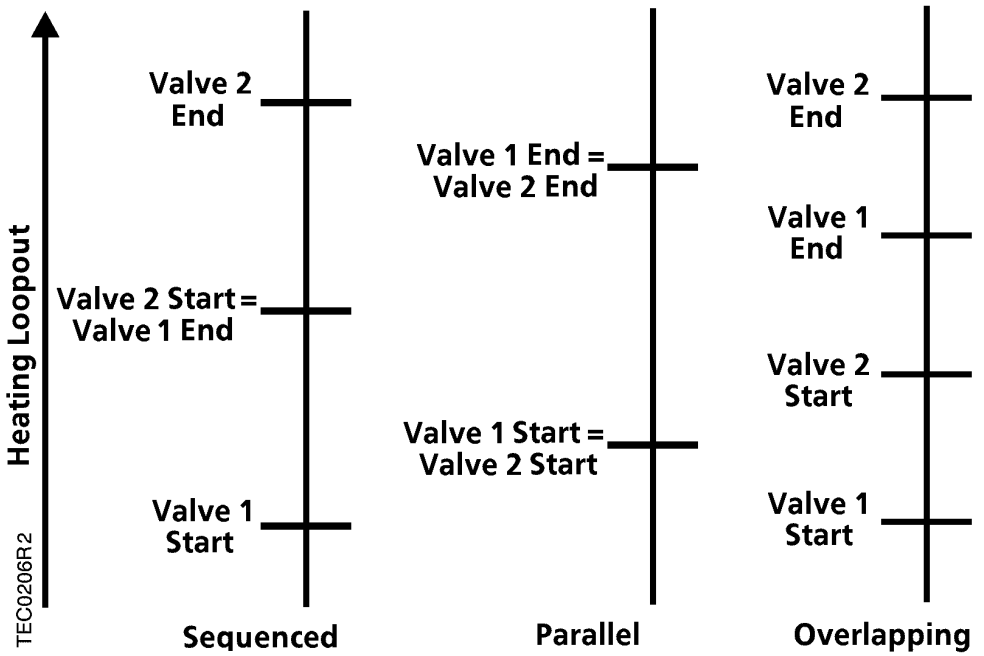
LOOPOUT reaches VLV 2 END. See Sequencing Logic (optional) for information on how the two heating valves can be sequenced.

NOTE:
If a valve's start and end point values are set to the same value, the valve will not be used.

VLV 1 START and VLV 1 END are used to calculate the heating/cooling valve position only in the heating mode. In cooling mode, these points are not used. In cooling mode, VLV 1 COMD = CLG LOOPOUT.

Sequencing Logic (Optional)

In heating mode, this application includes logic that allows two heating valves to operate in sequence, parallel, or overlapping. This algorithm is very similar to the spring range sequencing of valves and dampers. Portions of the output of the heating loop, HTG LOOPOUT, will drive the two heating valves from 0 to 100%. See the following three examples. The ladder diagrams below show sequenced, parallel, and overlapping valve operations. The vertical bars show the output of heating loopout from 0 to 100%. The horizontal bars (valve 1 start, valve 1 end, etc.) show the action that occurs when the loop output rises above the horizontal bar. The relative positions shown on the graphs are for illustration purposes only and may differ from the examples.



Example 1

Assume that your system has two hot water valves that are to operate in sequence. If:

- VLV 1 START=0%
- VLV 1 END = 50%

- VLV 2 START=50%
- VLV 2 END = 100%

then,

- When HTG LOOPOUT = 0%, VLV 1 COMD will equal 0% open and VLV 2 COMD will equal 0% open.
- When HTG LOOPOUT = 25%, VLV 1 COMD will equal 50% open and VLV 2 COMD will equal 0% open.
- When HTG LOOPOUT = 50%, VLV 1 COMD will equal 100% open and VLV 2 COMD will equal 0% open.
- When HTG LOOPOUT = 75%, VLV 1 COMD will equal 100% open and VLV 2 COMD will equal 50% open.
- When HTG LOOPOUT = 100%, VLV 1 COMD will equal 100% open and VLV 2 COMD will equal 100% open.

Example 2

Assume that your system has two hot water valves that are to operate in parallel. If:

- VLV 1 START=0%
- VLV 1 END = 100%
- VLV 2 START=0%
- VLV 2 END = 100%

then,

- When HTG LOOPOUT = 0%, VLV 1 COMD and VLV 2 COMD will equal 0% open.
- When HTG LOOPOUT = 50%, VLV 1 COMD and VLV 2 COMD will equal 50% open.
- When HTG LOOPOUT = 100%, VLV 1 COMD and VLV 2 COMD will equal 100% open.

Example 3

Assume that your system has two hot water valves that are to operate overlapping. If:

- VLV 1 START=0%
- VLV 1 END = 75%
- VLV 2 START=25%
- VLV 2 END = 100%

then,

- When HTG LOOPOUT = 0%, VLV 1 COMD and VLV 2 COMD will equal 0% open.
- When HTG LOOPOUT = 37.5%, VLV 1 COMD will equal 50% open and VLV 2 COMD will equal 15.5% open.
- When HTG LOOPOUT = 62.5%, VLV 1 COMD will equal 83% open and VLV 2 COMD will equal 50% open.
- When HTG LOOPOUT = 100%, VLV 1 COMD and VLV 2 COMD will equal 100% open.

Fan Operation

NOTE:
If this application is controlling a damper instead of a cooling valve, the fan operation is not applicable because there is no fan.

Day Mode – The fan may be set to stay ON at all times or to cycle to save energy. If CYCLE FAN = NO, the fan will be ON during the day. If CYCLE FAN = YES, the fan will cycle according to the following conditions:

Night Mode – The fan cycles using the same three conditions described in the day mode section above, regardless of the setting of CYCLE FAN. If NGT OVRD = DAY (indicating that the night mode override button has been pressed), the fan is controlled as in day mode.

Calibration

The controller regularly calibrates the damper based on the value of CAL TIMER. A value of 12 indicates that the controller will calibrate the damper once every 12 hours.

The calibration consists of driving the damper closed, and then resetting the value of DMPR POS to 0. The damper is then released to normal control.

NOTE:
If mechanical stops are installed to provide minimum airflow, the damper will be calibrated to those stops.

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%.

AI 4/AI 5 OFFSET (Optional)

AI 4 OFFSET works like RMTMP OFFSET. It can be used to calibrate AI 4 aux temp sensor input if necessary. The actual temperature plus AI 4 OFFSET will equal AI 4 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 how to handle loss of data when used with a digital room unit.

Room Temperature

- When the digital room unit (Series 2200/2300) is used, STAT SUPV enables loss of communication indication:
  - Temperature sensing with a value of 1.
  - Relative humidity sensing with a value of 2.
  - CO2 sensing with a value of 4.
- Communication for Series 2200 sensor baud rate must be set to 1200.
- When the analog room unit (Series 1000/2000) is used, default temperature sensing (0) is enabled (relative humidity and CO2 sensing are not available and should not be selected).

Other Inputs (only available on Digital Room Unit)

- Use the following table to enable communications supervision of room temperature, relative humidity or CO2 for additive values of 2 or 4.

STAT SUPV Value * (additive)	Description (include values to enable feature)
1	Room temperature sensing
2	Relative Humidity (RH) sensing
4	CO_2 sensing

⚠ CAUTION

Digital Room Units that have the RH and/or the CO2 feature will always update the present value and put the associated points (RM TEMP, RM RH, and RM CO2) in override mode, preventing external (or PPCL) commands from being used. STAT SUPV is only provided to allow these points to report a FAIL mode when the room unit fails to update these points.

If an alternative source is selected you must insure that the room unit is not provided with the same sensor option.

See *Sensors and Transducers Configuration and Sizing* for part numbers and ordering information.

Room CO2

RM CO2 displays the CO_2 value in units of parts-per-million (PPM). RM CO2 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.

Fail Mode Operation

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

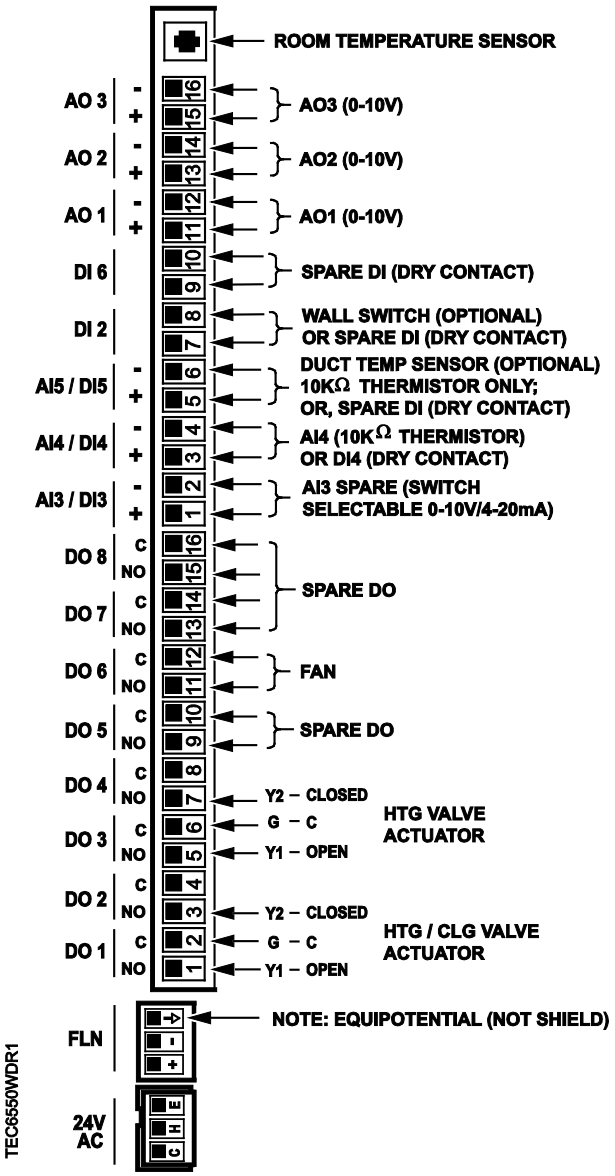
Application Notes

- The controller keeps all associated equipment OFF. See the appropriate *Start-up Procedures* for information on how to release the controller and its equipment to application control.
- Spare DOs can be used as auxiliary points that are controlled by the field panel after being defined in the field panel's database. If a second heating valve is not being controlled by the application, DO 3 and DO 4 may be used as auxiliary motor points. If using a pair of spare DOs to control a motor, you must make sure that the motor setup, motor timing, and motor rotation angle are enabled correctly before you unbundle VLV 2 COMD.

See the *Start-up Procedures* on Asset Portal or InfoLink for more information.

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 6550 - Two-Pipe Fan Coil Unit Cooling or Heating.

Application 6550 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	6591	--	0-32767	--	--
AO	3	RMTMP OFFSET	0.0 (0.0)	DEG F (DEG C)	-63.75	--	--
AI	{04}	ROOM TEMP	74.0 (23.44888)	DEG F (DEG C)	48-111.75	--	--
BO	{05}	HEAT.COOL	COOL	--	Binary	HEAT	COOL
AO	6	DAY CLG STPT	74.0 (23.44888)	DEG F (DEG C)	48-111.75	--	--
AO	7	DAY HTG STPT	70.0 (21.20888)	DEG F (DEG C)	48-111.75	--	--
AO	8	NGT CLG STPT	82.0 (27.92888)	DEG F (DEG C)	48-111.75	--	--
AO	9	NGT HTG STPT	65.0 (18.40888)	DEG F (DEG C)	48-111.75	--	--
AO	11	RM STPT MIN	55.0 (12.80888)	DEG F (DEG C)	48-111.75	--	--
AO	12	RM STPT MAX	90.0 (32.40888)	DEG F (DEG C)	48-111.75	--	--
AI	{13}	RM STPT DIAL	74.0 (23.44888)	DEG F (DEG C)	48-111.75	--	--
BO	14	STPT DIAL	NO	--	Binary	YES	NO
AI	{15}	SUPPLY TEMP	74.0 (23.495556)	DEG F (DEG C)	37.5-165	--	--
AO	16	VLV 1 START	0	PCT	0-102	--	--
AO	17	VLV 1 END	100	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	VLV 2 START	0	PCT	0-102	--	--
AO	23	VLV 2 END	0	PCT	0-102	--	--
BI	{24}	DI 2	OFF	--	Binary	ON	OFF
BI	{25}	DI 3	OFF	--	Binary	ON	OFF
BI	{26}	DI 4	OFF	--	Binary	ON	OFF
BI	{28}	DI 6	OFF	--	Binary	ON	OFF
BO	{29}	DAY.NGT	DAY	--	Binary	NIGHT	DAY

Object Type a)	Object Instance (Point Number)	Object Name (Descriptor)	Factory Default (SI Units) b)	Eng Units (SI Units)	Range	Active Text	Inactive Text
AI	{30}	AI 3	0	PCT	0-102	--	--
AI	{31}	AI 4	74.0 (23.495556)	DEG F (DEG C)	37.5-165	--	--
AO	{32}	AOV1	0	VOLTS	0-10.23	--	--
AO	{33}	AOV2	0	VOLTS	0-10.23	--	--
AO	{34}	AOV3	0	VOLTS	0-10.23	--	--
BO	{41}	DO 1	OFF	--	Binary	ON	OFF
BO	{42}	DO 2	OFF	--	Binary	ON	OFF
BO	{43}	DO 3	OFF	--	Binary	ON	OFF
BO	{44}	DO 4	OFF	--	Binary	ON	OFF
BO	{45}	DO 5	OFF	--	Binary	ON	OFF
BO	{46}	FAN	OFF	--	Binary	ON	OFF
BO	{47}	DO 7	OFF	--	Binary	ON	OFF
AO	{48}	VLV 1 COMD	0	PCT	0-102	--	--
AO	{49}	VLV 1 POS	0	PCT	0-102	--	--
BO	{50}	DO 8	OFF	--	Binary	ON	OFF
AO	51	MTR 1 TIMING	130	SEC	0-511	--	--
AO	{52}	VLV 2 COMD	0	PCT	0-102	--	--
AO	{53}	VLV 2 POS	0	PCT	0-102	--	--
AO	55	MTR 2 TIMING	130	SEC	0-511	--	--
AO	56	MTR1 ROT ANG	90	--	0-255	--	--
AO	57	MTR2 ROT ANG	90	--	0-255	--	--
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	COOL TEMP	65.0 (18.455556)	DEG F (DEG C)	37.5-165	--	--
AO	62	HEAT TEMP	80.0 (26.855556)	DEG F (DEG C)	37.5-165	--	--
AO	63	CLG P GAIN	20.0 (36.0)	--	0-63.75	--	--
AO	64	CLG I GAIN	0.01 (0.018)	--	0-1.023	--	--
AO	65	CLG D GAIN	0 (0.0)	--	0-510	--	--
AO	66	CLG BIAS	0	PCT	0-102	--	--
AO	67	HTG P GAIN	10.0 (18.0)	--	0-63.75	--	--
AO	68	HTG I GAIN	0.01 (0.018)	--	0-1.023	--	--
AO	69	HTG D GAIN	0 (0.0)	--	0-510	--	--
AO	70	HTG BIAS	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	{78}	CTL TEMP	74.0 (23.44888)	DEG F (DEG C)	48-111.75	--	--
AO	{79}	CLG LOOPOUT	0	PCT	0-102	--	--
AO	{80}	HTG LOOPOUT	0	PCT	0-102	--	--
AO	84	STAGE FAN	10	PCT	0-102	--	--
AO	85	SWITCH LIMIT	5.2	PCT	0-102	--	--
AO	88	VALVE CNT	1	--	0-255	--	--
AO	{92}	CTL STPT	74.0 (23.44888)	DEG F (DEG C)	48-111.75	--	--
AO	96	CAL TIMER	12	HRS	0-255	--	--
AO	98	LOOP TIME	5	SEC	0-255	--	--
AO	{99}	ERROR STATUS	0	--	0-255	--	--
AO	122	AI 4 OFFSET	0.0 (0.0)	DEG F (DEG C)	-63.75	--	--
AO	123	AI 5 OFFSET	0.0 (0.0)	DEG F (DEG C)	-63.75	--	--
AO	124	STAT SUPV	0	--	0-255	--	--
AI	{125}	RM CO2	1000	PPM	0-8191	--	--
AI	{126}	RM RH	50	PCT	0-102	--	--
BO	{127}	PPCL STATE	EMPTY	--	Binary	LOADED	EMPTY

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.

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