SIEMENS

TEC Custom Solutions Application 2431

Discharge Temp Control with Room-Load Heat/Cool Switchover

TEC-0573.08

This document contains the following topics:

Overview

NOTE: For the latest on Custom Solution Applications and Controllers, visit the Custom Solutions website.

In Application 2431, the controller modulates a hot water valve to control the discharge air temperature. The PID Loop that controls this hot water valve has a different setpoint depending on whether the room is in heating mode or cooling mode. A heating/cooling switchover that senses room load determines whether the room is in heating mode or cooling mode.

In application 2431, the hot water valve is completely shut at night and under control during the day. To work properly, this application requires that the central air handling unit provide supply air. Refer to Figures 2431-1 and 2431-2.

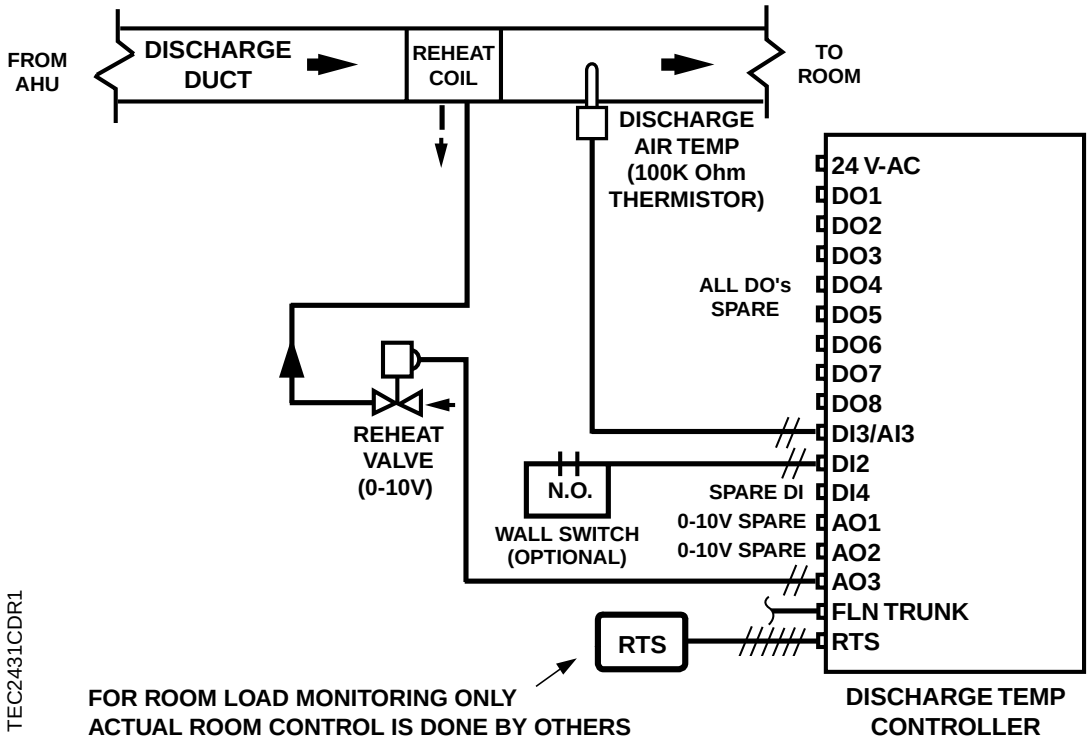
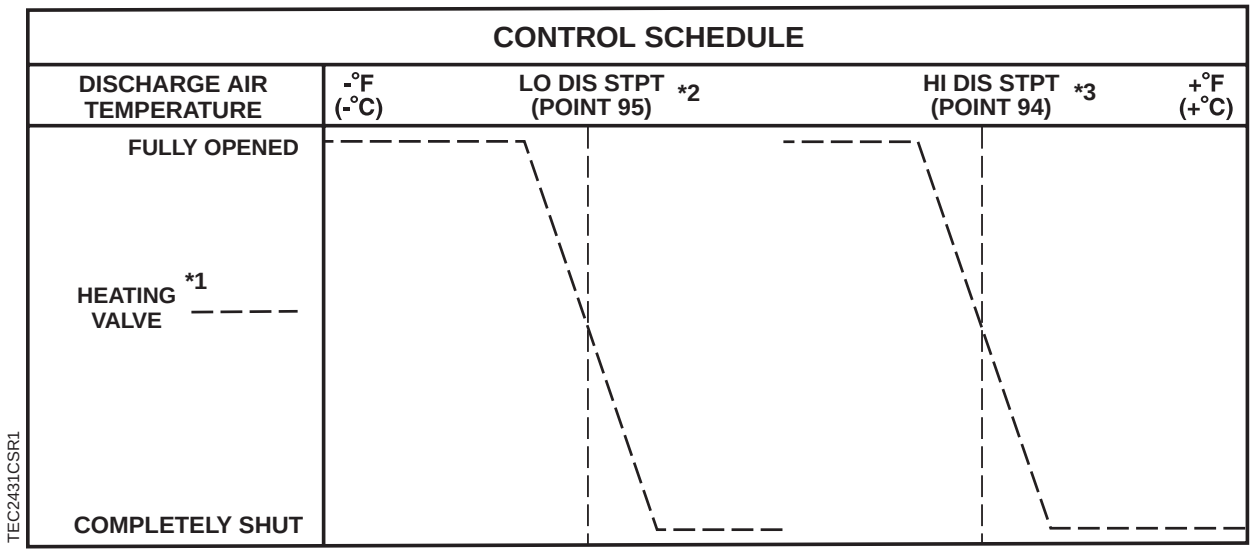


Figure 2431-1. Application 2431 Control Drawing.



1. This control schedule shows day-time heating valve operation. At night, the heating valve is shut.
2. This set point is used when HEAT.COOL (Point 05) equals COOL.
3. This set point is used when HEAT.COOL (Point 05) equals HEAT.

Figure 2431-2. Day Mode Heating Valve Operation.

Hardware Inputs

Analog

- Discharge air temperature sensor (100K Ohm thermistor)
- Room temperature sensor
- Room temperature set point dial (optional)

Digital

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

Hardware Outputs

Analog

- Heating valve

Digital

- None

Ordering Notes

The Discharge Temperature Controller with Room-Load Heat/Cool Switchover may be ordered as Part No. 550-953A or as Custom Solution 268.

Sequence of Operation

The following paragraphs present the sequence of operation for Application 2431, *Discharge Temp Control with Room-Load Heat/Cool Switchover*.

Control Temperature Set Points

Depending on the controller's current operational mode (day or night), the control temperature set point, CTL STPT (Point 92) holds the value of one of the following set points:

Day Mode – In day mode, CTL STPT holds the value of DAY CLG STPT (Point 6) or DAY HTG STPT (Point 7). If the room temperature sensor has a set point dial and STPT DIAL (Point 14) is set to YES, then CTL STPT holds the value of RM STPT DIAL (Point 13).

If the set point dial is used and the value of RM STPT DIAL is less than the value of RM STPT MIN (Point 11), then CTL STPT holds the value of RM STPT MIN. If the value of RM STPT DIAL is greater than the value of RM STPT MAX (Point 12), then CTL STPT holds the value of RM STPT MAX.

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

NOTE: The value of CTL TEMP (Point 78) is the same as the value of ROOM TEMP (Point 4), unless CTL TEMP is overridden.

Day and Night Modes

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

When a wall switch is physically connected to the termination strip on the controller at DI 2 (Figures 2431-1 and 2431-3), and WALL SWITCH (Point 18) equals YES, the controller monitors the status of DI 2. When the status of DI 2 (Point 24) 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 equals 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. Refer to Powers Process Control Language (PPCL) User's Manual (125-1896) and Field Panel User's Manual (125-1895) for more information.

NOTE: For the rest of this document, "day mode" will mean that either DAY.NGT or NIGHT OVRD (or both) is equal to DAY, and "night mode" will mean that both DAY.NGT and NGT OVRD are equal to NIGHT.

Night Mode Override Switch

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

It is only when the controller is in night mode that the override switch on the room sensor will have any effect on the controller.

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

- HTG LOOPOUT (Point 80) is less than SWITCH LIMIT (Point 85).
- CTL TEMP (Point 78) is above CTL STPT (Point 92) by at least the value set in SWITCH DBAND (Point 90).
- CTL TEMP is greater than the appropriate cooling set point minus SWITCH DBAND.

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

- CLG LOOPOUT (Point 79) is less than SWITCH LIMIT.
- CTL TEMP is below CTL STPT by at least the value set in SWITCH DBAND.
- CTL TEMP is less than the appropriate heating set point plus SWITCH DBAND.

Control Loops

This terminal box controller contains three Proportional, Integral, and Derivative (PID) control loops; two room temperature loops and a discharge temperature loop.

Room Temperature Loops – The two temperature loops are a cooling loop and a heating loop. The active room temperature uses CTL STPT (Point 92) to monitor room load. Refer to the *Control temperature Set Points* section.

When HEAT.COOL (Point 5) is COOL, the room cooling PID loop keeps track of the room's cooling load by adjusting the value of CLG LOOPOUT (Point 79). When CLG LOOPOUT is large, the room's cooling load is large. When CLG LOOPOUT is small, the room's cooling load is small. When HEAT.COOL equals HEAT, CLG LOOPOUT will equal 0 and the room cooling PID loop will be disabled.

When HEAT.COOL is HEAT, the room heating PID loop keeps track of the room's heating load by adjusting the value of HTG LOOPOUT (Point 80). When HTG LOOPOUT is large, the room's heating load is large. When HTG LOOPOUT is small, the room's heating load is small. When HEAT.COOL equals COOL, HTG LOOPOUT will equal 0 and the room heating PID loop will be disabled.

Discharge Temperature Loop – In addition to the room temperature loops, the application also has a heating PID loop that is used to control the temperature in the discharge duct. This loop will modulate a heating valve such that the discharge temperature is maintained at the value that is stored in DISCH STPT (Point 93.).

The discharge temperature loop is used year-round during the day mode. When HEAT.COOL equals HEAT, DISCH STPT will be set equal HI DIS STPT (Point 94). When HEAT.COOL equals COOL, DISCH STPT will be set equal to LO DIS STPT (Point 95).

When operational, the discharge air temperature loop controls the discharge air temperature by adjusting the value of DIS LOOPOUT (Point 75). DIS LOOPOUT is then used to control the heating valve by way of an internal, embedded table statement (this will be explained in greater detail in the next section).

When both DAY.NGT and NGT OVRD equal NIGHT, the discharge temperature PID Loop will be disabled and DIS LOOPOUT will be set to 0. When DIS LOOPOUT is 0, the heating valve in the discharge duct will be closed.

Heating Valve Control

The heating valve in the discharge duct is controlled by and internal Table Statement that is embedded into the application. The input into this table statement is DIS LOOPOUT (Point 75) and the output of this Table Statement is HTG VLV AO3 (Point 35). HTG VLV AO3 is a 0-10 Volt heating valve that is hooked up to AO 3. The way this Table Statement works is as follows:

When DIS LOOPOUT is 0, HTG VLV AO3 will be set to the voltage value that is stored in AOV3 CLOSE (Point 30). When DIS LOOPOUT is 100, HTG VLV AOV3 will be set to the voltage value that is stored in AOV3 OPEN (Point 31). When DIS LOOPOUT is between 0 and 100, the Table Statement will use linear interpolation to position HTG VLV AO3 to a value that is between AOV3 CLOSE and AOV3 OPEN.

Fail-Safe Operation

If the room temperature sensor fails, then DISCH STPT (Point 93) will be set to HI DIS STPT (Point 94). If the discharge temperature sensor fails, then the discharge temperature PID loop will be disabled (to prevent integrator wind-up) and the heating valve will be closed.

Application Notes

1. In this application, the room heating and cooling loops that actually control the space temperature are provided by others. Therefore, if the temperature swings in the room are excessive or if there is trouble in maintaining the set point, then the customer needs to contact a representative of the company that installed these loops and have them tune the loops properly. (The room PID loops in this application only monitor room load, they

do not perform any actual room control.)

However, the discharge air temperature PID loop is our responsibility. Therefore, if the temperature swings in the discharge duct are excessive or if there is trouble maintaining the discharge temperature setpoint, then the discharge temperature heating PID loop needs to be tuned. (There is no discharge temperature cooling loop.)

2. The controller as shipped from the factory keeps all associated equipment OFF. Refer to the *APOGEE Automation Start-up Procedures* on InfoLink for information on how to release the controller and its equipment to application control.

Wiring Diagram

CAUTION:

The controller's DOs control 24 Vac loads only. The maximum rating is 12 VA for each DO. Use an interposing 220V relay (P/N 550-052) module for any of the following:

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

Consult with the local representative if terminations are missing or different.

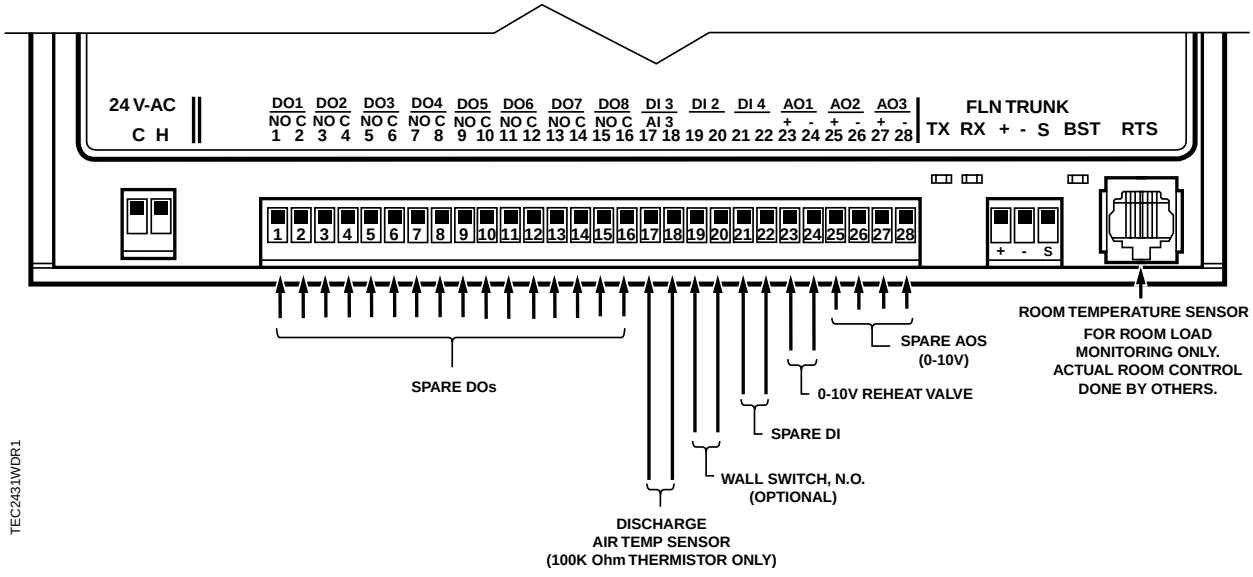


Figure 2431-3. Application 2431 Wiring Diagram.

Point Database

Table 2431-1. Point Database for Application 2431.

Point Number	Descriptor	Factory Default (SI Units)	Engr Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
01	CTLR ADDRESS	99	--	1	0	--	--
02	APPLICATION	2299	--	1	0	--	--
{04}	ROOM TEMP	74.0 (23.45)	DEG F (DEG C)	0.25 (0.14)	48.0(8.89)	--	--
{05}	HEAT.COOL	COOL	--	--	--	HEAT	COOL
06	DAY CLG STPT	74.0 (23.45)	DEG F (DEG C)	0.25 (0.14)	48.0(8.89)	--	--
07	DAY HTG STPT	70.0 (21.21)	DEG F (DEG C)	0.25 (0.14)	48.0(8.89)	--	--
08	NGT CLG STPT	82.0 (27.93)	DEG F (DEG C)	0.25 (0.14)	48.0(8.89)	--	--
09	NGT HTG STPT	65.0 (18.41)	DEG F (DEG C)	0.25 (0.14)	48.0(8.89)	--	--
11	RM STPT MIN	55.0 (12.81)	DEG F (DEG C)	0.25 (0.14)	48.0(8.89)	--	--
12	RM STPT MAX	90.0 (32.41)	DEG F (DEG C)	0.25 (0.14)	48.0(8.89)	--	--
{13}	RM STPT DIAL	74.0 (23.45)	DEG F (DEG C)	0.25 (0.14)	48.0(8.89)	--	--
14	STPT DIAL	NO	--	--	--	YES	NO
{15}	DISCH TEMP	74.0 (23.496)	DEG F (DEG C)	0.5 (0.28)	37.5(3.056)	--	--
18	WALL SWITCH	NO	--	--	--	YES	NO
{19}	DI OVRD SW	OFF	--	--	--	ON	OFF
20	OVRD TIME	1	HRS	1	0	--	--
{21}	NGT OVRD	DAY	--	--	--	NIGHT	DAY
{24}	DI 2	OFF	--	--	--	ON	OFF
{26}	DI 4	OFF	--	--	--	ON	OFF
{29}	DAY.NGT	DAY	--	--	--	NIGHT	DAY
30	AOV3 CLOSE	0.0	VOLTS	0.01	0.0	--	--
31	AOV3 OPEN	10.0	VOLTS	0.01	0.0	--	--
32	AO DIR.REV	0	--	1	0	--	--
{33}	AOV1	0.0	VOLTS	0.01	0.0	--	--
{34}	AOV2	0.0	VOLTS	0.01	0.0	--	--
{35}	HTG VLV AOV3	0.0	VOLTS	0.01	0.0	--	--
{37}	MTR3 COMD	0.0	PCT	0.4	0.0	--	--
{38}	MTR3 POS	0.0	PCT	0.4	0.0	--	--

1. Points not listed are not used in this application.
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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Point Number	Descriptor	Factory Default (SI Units)	Engr Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
39	MTR3 TIMING	130	SEC	1	0	--	--
{41}	DO 1	OFF	--	--	--	ON	OFF
{42}	DO 2	OFF	--	--	--	ON	OFF
{43}	DO 3	OFF	--	--	--	ON	OFF
{44}	DO 4	OFF	--	--	--	ON	OFF
{45}	DO 5	OFF	--	--	--	ON	OFF
{46}	DO 6	OFF	--	--	--	ON	OFF
{47}	DO 7	OFF	--	--	--	ON	OFF
{48}	MTR1 COMD	0.0	PCT	0.4	0.0	--	--
{49}	MTR1 POS	0.0	PCT	0.4	0.0	--	--
{50}	DO 8	OFF	--	--	--	ON	OFF
51	MTR1 TIMING	130	SEC	1	0	--	--
{52}	MTR2 COMD	0.0	PCT	0.4	0.0	--	--
{53}	MTR2 POS	0.0	PCT	0.4	0.0	--	--
55	MTR2 TIMING	130	SEC	1	0	--	--
56	DPR1 ROT ANG	90	--	1	0	--	--
57	DPR2 ROT ANG	90	--	1	0	--	--
58	MTR SETUP	0	--	1	0	--	--
59	DO DIR.REV	0	--	1	0	--	--
63	CLG P GAIN	20.0 (36.0)	--	0.25 (0.45)	0.0	--	--
64	CLG I GAIN	0.01 (0.018)	--	0.001 (0.0018)	0.0	--	--
65	CLG D GAIN	0 (0.0)	--	2 (3.6)	0	--	--
66	CLG BIAS	0.0	PCT	0.4	0.0	--	--
67	HTG P GAIN	10.0 (18.0)	--	0.25 (0.45)	0.0	--	--
68	HTG I GAIN	0.01 (0.018)	--	0.001 (0.0018)	0.0	--	--
69	HTG D GAIN	0 (0.0)	--	2 (3.6)	0	--	--
70	HTG BIAS	0.0	PCT	0.4	0.0	--	--
71	DIS P GAIN	0.4 (0.72)	--	0.05 (0.09)	0.0	--	--
72	DIS I GAIN	0.015 (0.027)	--	0.0002 (0.00036)	0.0	--	--
73	DIS D GAIN	0 (0.0)	--	1 (1.8)	0	--	--
74	DIS BIAS	50.0	PCT	0.2	0.0	--	--

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Point Number	Descriptor	Factory Default (SI Units)	Engr Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
{75}	DIS LOOPOUT	0.0	PCT	0.2	0.0	--	--
{78}	CTL TEMP	74.0 (23.45)	DEG F (DEG C)	0.25 (0.14)	48.0(8.89)	--	--
{79}	CLG LOOPOUT	0.0	PCT	0.4	0.0	--	--
{80}	HTG LOOPOUT	0.0	PCT	0.4	0.0	--	--
85	SWITCH LIMIT	4.8	PCT	0.4	0.0	--	--
86	SWITCH TIME	10	MIN	1	0	--	--
90	SWITCH DBAND	2.0 (1.12)	DEG F (DEG C)	0.25 (0.14)	0.0	--	--
{92}	CTL STPT	74.0 (23.45)	DEG F (DEG C)	0.25 (0.14)	48.0(8.89)	--	--
{93}	DISCH STPT	74.0 (23.496)	DEG F (DEG C)	0.5 (0.28)	37.5(3.056)	--	--
94	HI DIS STPT	82.0 (27.976)	DEG F (DEG C)	0.5 (0.28)	37.5(3.056)	--	--
95	LO DIS STPT	55.0 (12.856)	DEG F (DEG C)	0.5 (0.28)	37.5(3.056)	--	--
98	LOOP TIME	5	SEC	1	0	--	--
{99}	ERROR STATUS	0	--	1	0	--	--

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