SIEMENS

TEC Custom Solutions Application 2435:

Fan Coil Unit Cooling and Electric Heat with Pulse Counter

TEC-0352.08

This document contains the following topics:

Overview

NOTE: For the latest on Custom Solution Applications and Controllers, visit the Custom Solutions website. (http://iknow.us.abatos.com/customsolutions/custom_solutions.htm)

In Application 2435, the controller modulates a valve or damper for cooling and controls up to three stages of electric heat for heating in the fan coil unit. The fan coil unit also has a fan to circulate room air. In order for this application to work properly, a central plant must provide chilled water to the cooling valve. This application can also be used to control a pressure dependent terminal box with electric heat. If a damper is being controlled, then the central plant must supply chilled air in the cooling mode in order for the terminal box to work properly. Refer to Figures 2435-1 through 2435-4.

This application also has a Pulse Counter and can read a 4-20mA input. These are useful for energy metering.

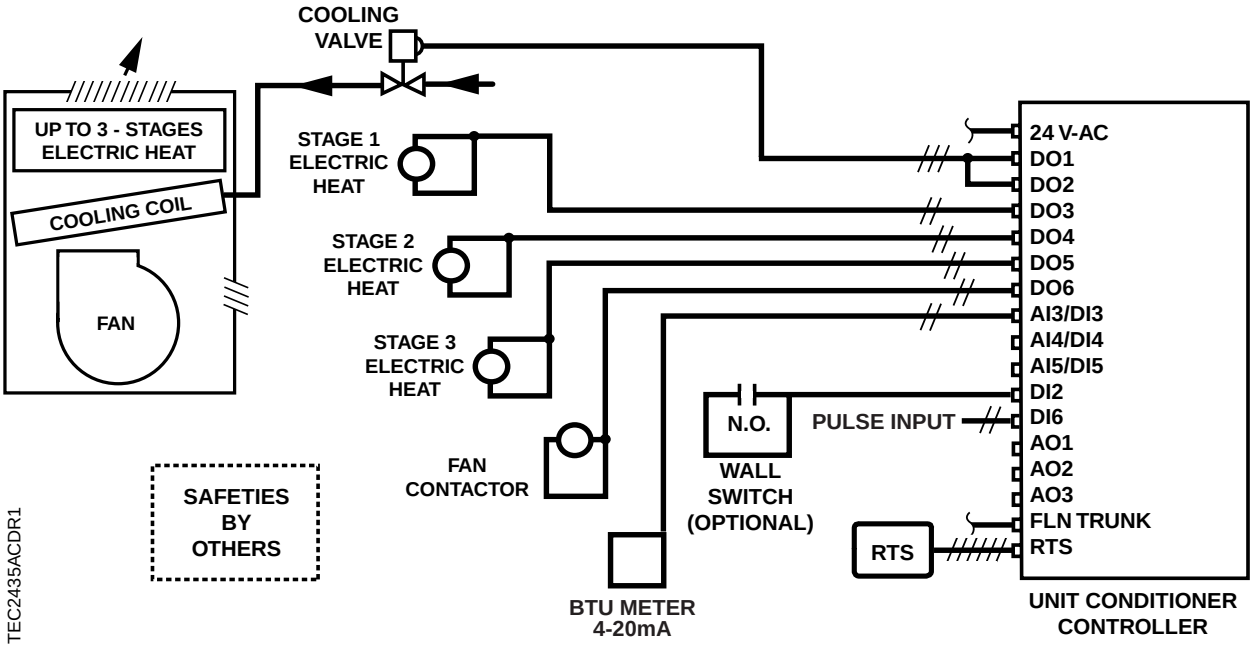
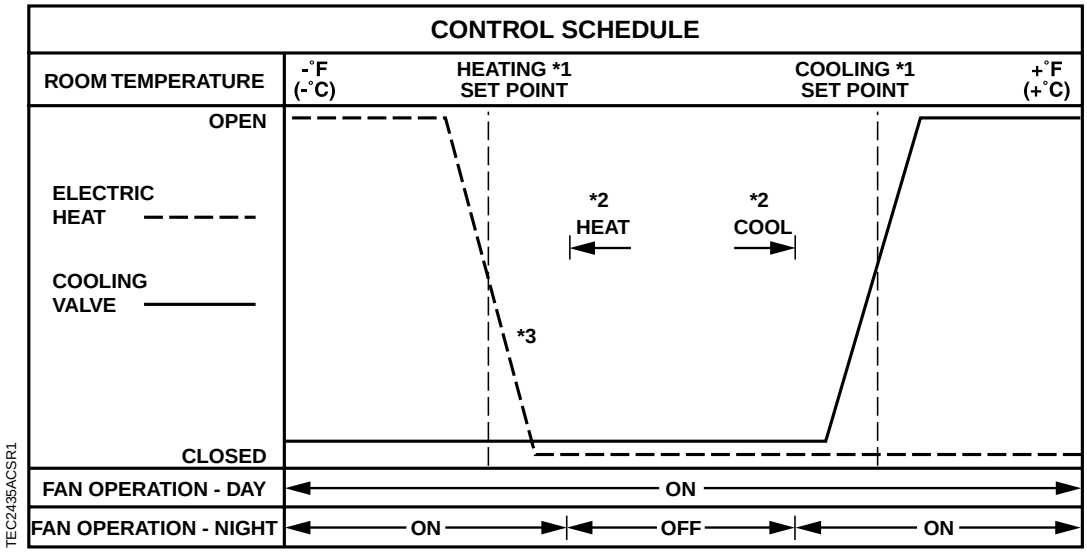


Figure 2435-1. Application 2435 Control Drawing (Fan Coil).



1. Refer to the *Control Temperature Set Points* section.
2. Refer to the *Heating/Cooling Switchover* section.
3. The electric heat is time modulated. This allows it to be controlled proportionally rather than with deadbands.

Figure 2435-2. Application 2435 Control Schedule (with Fan).

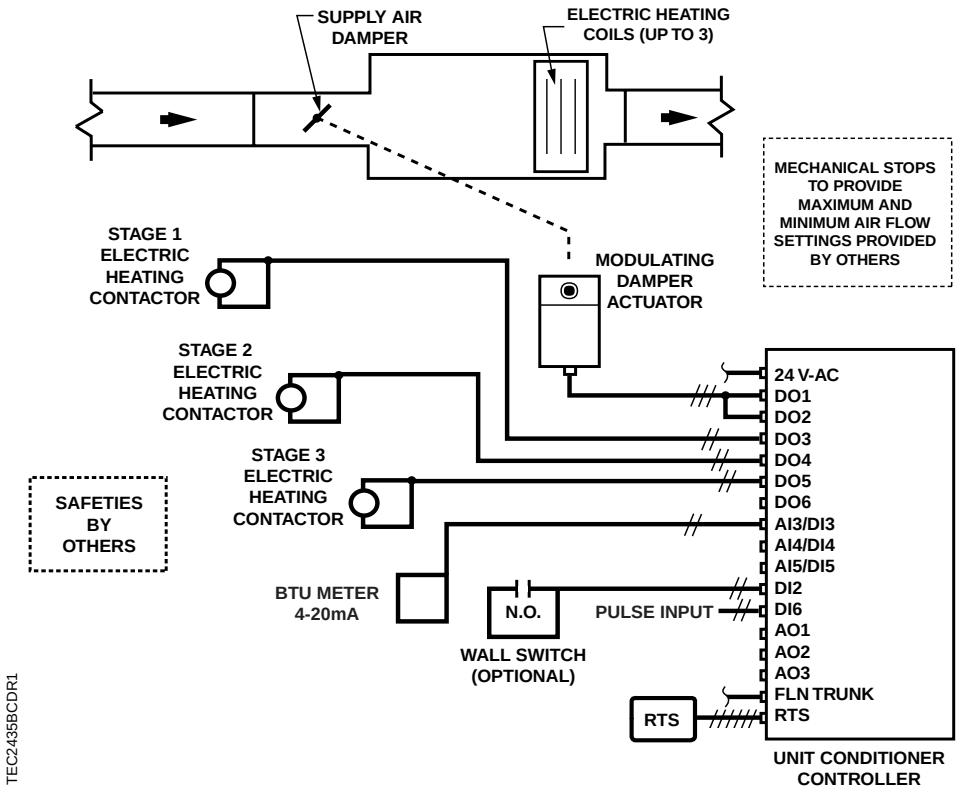
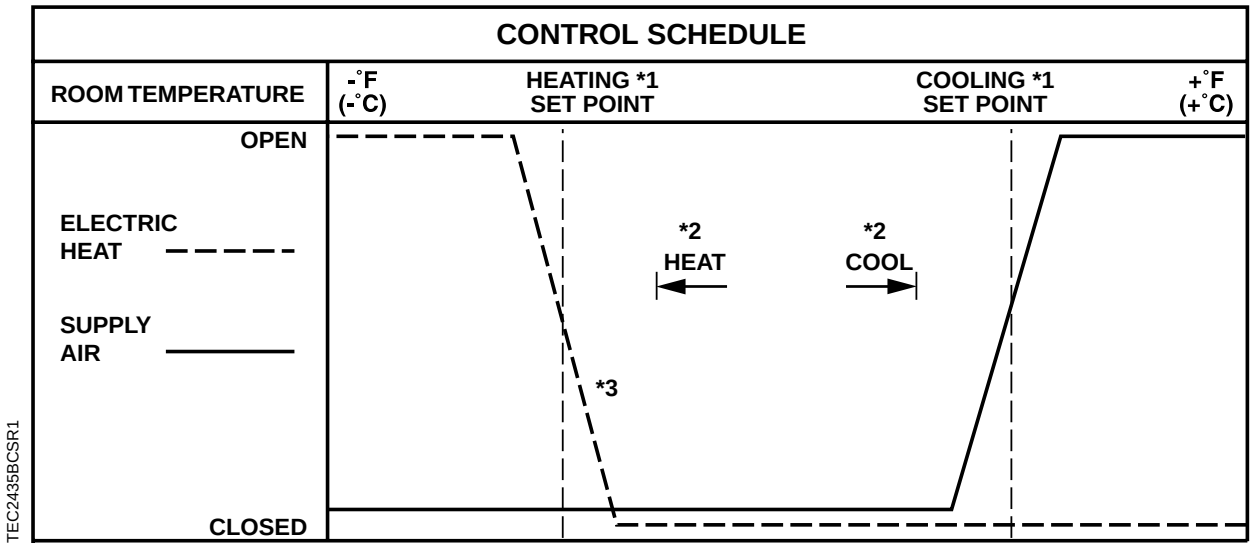


Figure 2435-3. Application 2435 Control Drawing (no Fan).



1. Refer to the *Control Temperature Set Points* section.
2. Refer to the *Heating/Cooling Switchover* section.
3. The electric heat is time modulated. This allows it to be controlled proportionally rather than with deadbands.

Figure 2435-4. Application 2435 Control Schedule (no Fan).

Hardware Inputs

Analog

- 4-20mA input (optional)
- Room temperature sensor
- Room temperature set point dial (optional)

Digital

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

Hardware Outputs

Analog

- None

Digital

- fan (switched 24 Vac, pilot duty)
- Stage 1 electric heat
- Stage 2 electric heat
- Stage 3 electric heat
- Valve or damper actuator

Ordering Notes

You can order the Fan Coil controller (cooling with electric heat and pulse counter) as custom solution number 270, or as Part No. 540-863M.

Sequence of Operation

The following paragraphs present the sequence of operation for Application 2435, *Fan Coil Unit Cooling and Electric Heat w/ Pulse Counter*.

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 – 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, 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), 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, and if the controller is operating stand-alone (not connected to a field panel), then the controller stays in day mode all the time. If the controller is operating with centralized control (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.

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 of the time period 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 the 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 SWITCH DBAND.
- CTL TEMP is less than the appropriate heating set point plus SWITCH DBAND.

Control Loops

The fan coil unit is controlled by two Proportional, Integral, and Derivative (PID) temperature loops.

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 (Point 92). Refer to *Control Temperature Set Points* for more information.

Cooling operation

In cooling mode, the controller uses CTL STPT (Point 92) and CTL TEMP (Point 78) as the inputs to the cooling loop. If a valve is being controlled, then the central plant must provide chilled water. If a damper is being controlled, then the central plant must provide cool air. The output of the cooling loop is CLG LOOPOUT (Point 79) which modulates either the cooling valve or the supply air damper point, VLV COMD (Point 48). HTG LOOPOUT (Point 80) is set to 0%.

Heating operation

In heating mode, the controller uses CTL STPT (Point 92) and CTL TEMP (Point 78) as the inputs to the heating loop. The output of the heating loop is HTG LOOPOUT (Point 80) which modulates the electric reheat in order to warm up the space. CLG LOOPOUT (Point 79) is set to 0%, which means that the valve is closed or the damper is resting on its mechanical stop.

When in cooling mode, the heating valve is closed.

Electric Heat

CAUTION:

Verify that the equipment is supplied with safeties by others to ensure airflow across the heating coils when they are energized. **If this application is controlling a damper, then minimum position stops must be provided to ensure airflow across the electric heat elements.**

The heating loop controls up to three stages of electric reheat to warm up the room. The electric reheat is time modulated using a duty cycle as shown in the following example. When the controller is in cooling mode, the electric heat is OFF at all times.

Example: If the duty cycle is 10 minutes (STAGE TIME (Point 89) equals 10 minutes) and the internal control signal is calling for 60% of heating, then for every 10-minute period, the stages of electric heat cycle as follows:

	Stage 1: minutes		Stage 2: minutes		Stage 3: minutes	
	ON	OFF	ON	OFF	ON	OFF
With 1 stage of electric heat:	6	4	--	--	--	--
With 2 stages of electric heat:	10	0	2	8	--	--
With 3 stages of electric heat:	10	0	8	2	0	10

CLG LOOPOUT (Point 79) is set to 0%.

Fan Operation

NOTE: If this application is controlling a damper instead of a cooling valve, then 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 (Point 60) is set to NO, then the fan will be ON during the day. If CYCLE FAN is set to YES, then the fan will cycle according to the following conditions:

- If the first heating stage is ON or the cooling valve point, VLV COMD (Point 48), is open more than the value of STAGE FAN (Point 84), then the fan will turn ON.
- If the first heating stage is OFF and has been OFF for a period of time longer than the length of time stored in HTG STG TIME (Point 89), and the cooling valve is closed below the value of SWITCH LIMIT (Point 85), then the fan will turn OFF.
- If neither of the above two conditions is met, then the condition of the fan remains unchanged.

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 (Point 21) is set to DAY (indicating that the night mode override button has been pressed), then the fan is controlled as in day mode.

Pulse Counting

The controller can count and totalize DI 6 (Point TBD) pulses, if desired. Pulse counting is done as follows:

- If PULSE EDGE (Point TBD) equals 1.0, then the number of rising DI 6 pulses is totalized and stored in PULSE COUNT (Point TBD).
- If PULSE EDGE equals 2.0, then the number of falling DI 6 pulses is totalized and stored in PULSE COUNT.
- If PULSE EDGE equals 3.0, then the number of rising and falling DI 6 pulses is totalized and stored in PULSE COUNT.
- If PULSE EDGE does not equal 1.0, 2.0, or 3.0, then DI 6 pulses are not totalized and PULSE COUNT is frozen at its current value.

NOTES: DI 6 may have several pulses per LOOP TIME (Point 98). The TEC will keep track of DI 6 pulses at a maximum rate of 25 HZ.

32,767 is the maximum value PULSE COUNT can have. When the number of pulses is greater than 32,767, PULSE COUNT is reset to 0.

Calibration

The controller will regularly calibrate the cooling valve or damper, whichever is being used, based on the value of CAL TIMER (Point 96). A value of 12 indicates that the controller will calibrate the actuator once every 12 hours.

The stages of electric heat are turned off during calibration. The calibration consists of driving the cooling valve or damper closed, and then resetting the value of VLV POS (Point 49) to 0. The actuator is then released to normal control. The electric heat stages are released to normal control after the actuator has been released to normal control.

Fail-Safe Operation

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

Application Notes

1. If the temperature swings in the room are excessive or there is trouble maintaining the set point, then either the cooling loop, the heating loop, or both need to be tuned. Refer to *APOGEE Automation Service Procedures* on InfoLink for more information.

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

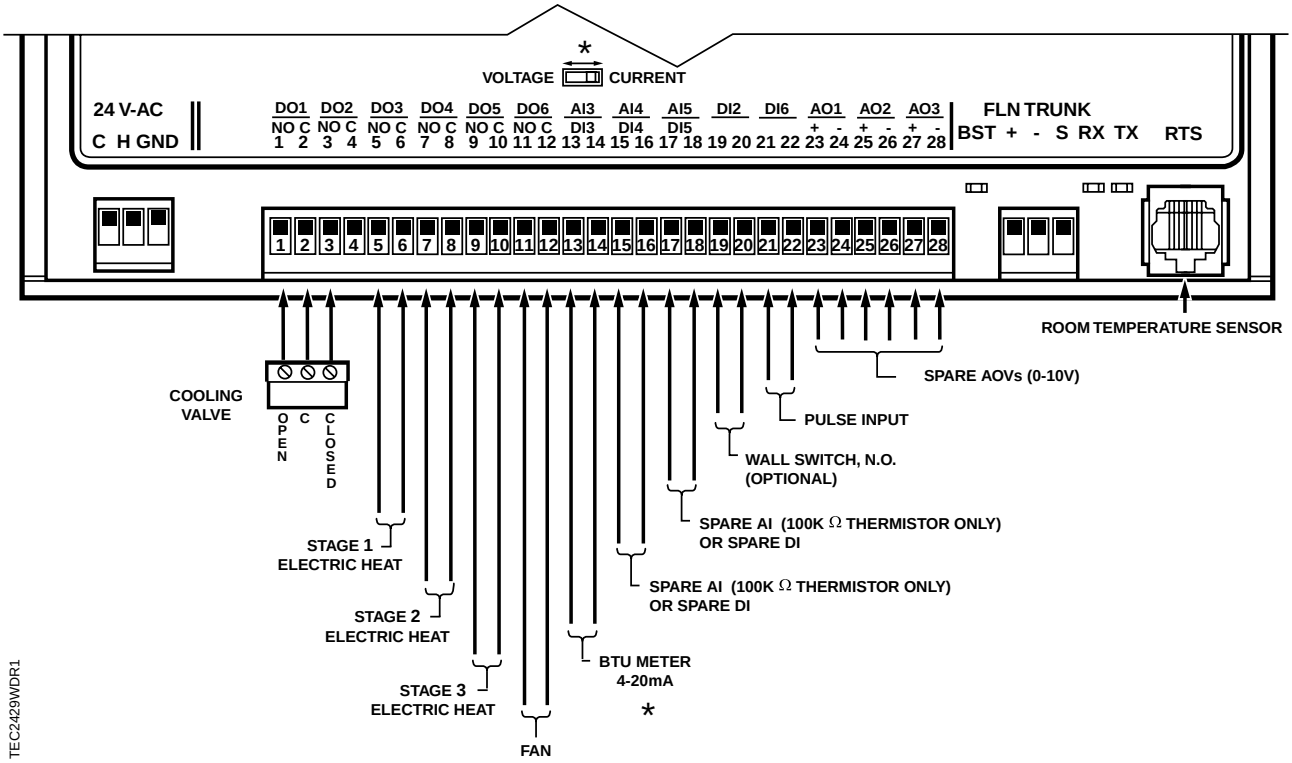
3. Spare DOs can be used as auxiliary points that are controlled by the field panel after being defined in the field panel's database. If a cooling valve is not being controlled by the application, then DO 1 and DO 2 may be used as auxiliary motor points. If using a pair of spare DOs to control a motor, you must make sure that the motor setup, motor timing, and motor rotation angle are enabled correctly before you unbundle VLV COMD (Point 48). DO 3, DO 4, and DO 5 control the stages of electric heat. If less than three stages are being controlled by the application, then the DOs that are not used will be spare. Refer to *APOGEE Automation Start-up Procedures* on InfoLink for more information.

Wiring Diagrams

CAUTION:

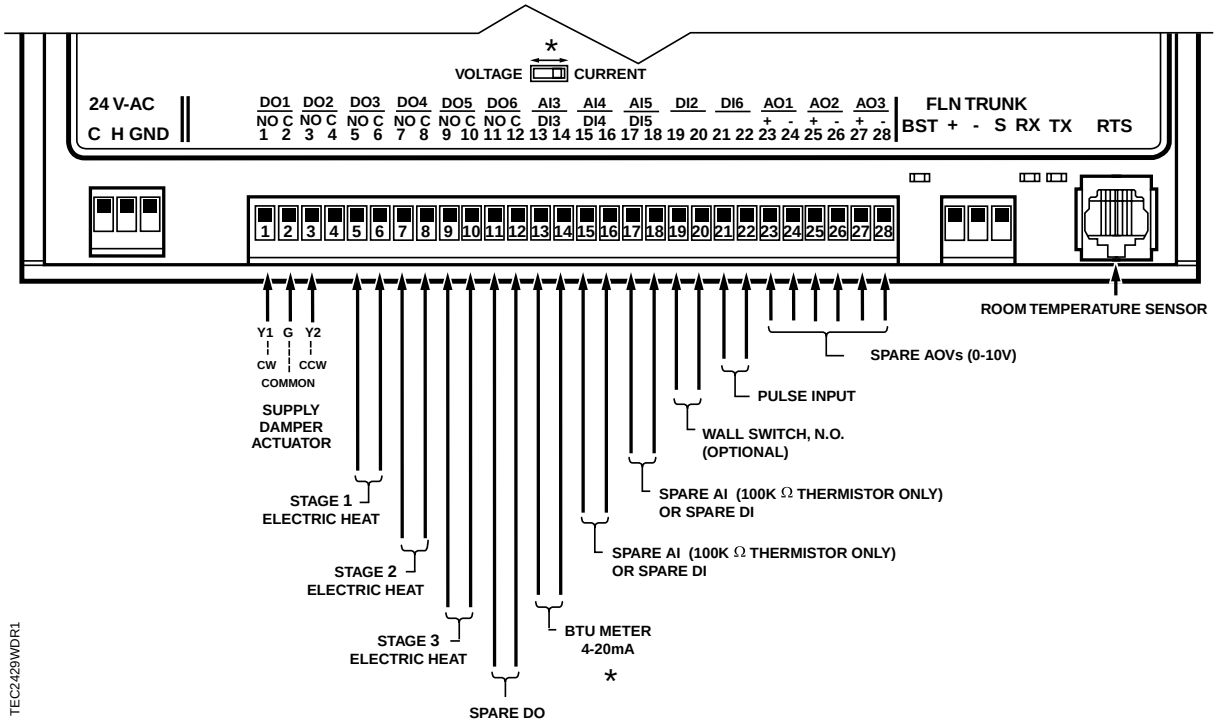
The controller's DOs control 24 Vac loads only. The maximum rating is 12 VA for each DO. Use an interposing 220V relay module (P/N 550-054) for any of the following:

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



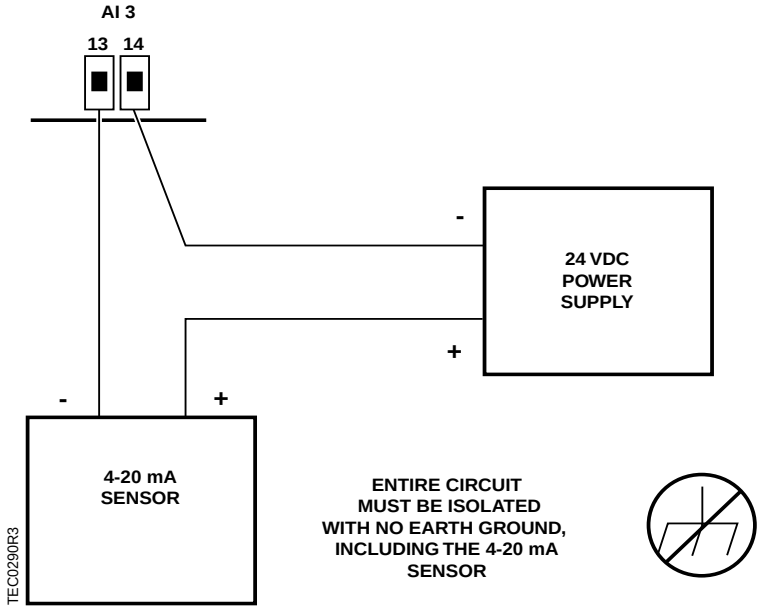
* The dipswitch for AI 3 (on circuit board under controller cover) must be set to *current* (I).
IMPORTANT: 4-20mA sensors require special wiring requirements. Refer to Figure 2435-7.

Figure 2435-5. Application 2435 Wiring Diagram (fan and cooling valve).



* The dipswitch for AI 3 (on circuit board under controller cover) must be set to *current* (I).
IMPORTANT: 4-20mA sensors require special wiring requirements. Refer to Figure 2435-7.

Figure 2435-6. Application 2435 Wiring Diagram (supply damper actuator and no fan DO).



CAUTION:

Equipment damage or loss of data may occur if the user does not follow procedure as specified.

NOTE: You can NOT use the same transformer to power the controller and a 4-20 mA sensor. The 4-20 mA sensor requires a SEPARATE dedicated power supply.

Figure 2435-7. Special Wiring Requirements for the 4-20mA Sensor used at AI 3.

Point Database

Table 1. Point Database for Application 2435

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	2487	--	1	0	--	--
{04}	ROOM TEMP	74.0 (23.44888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
{05}	HEAT.COOL	COOL	--	--	--	HEAT	COOL
06	DAY CLG STPT	74.0 (23.44888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
07	DAY HTG STPT	70.0 (21.20888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
08	NGT CLG STPT	82.0 (27.92888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
09	NGT HTG STPT	65.0 (18.40888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
11	RM STPT MIN	55.0 (12.80888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
12	RM STPT MAX	90.0 (32.40888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
{13}	RM STPT DIAL	74.0 (23.44888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
14	STPT DIAL	NO	--	--	--	YES	NO
{15}	AI 3	4.0	MA	0.064	4.0	--	--
18	WALL SWITCH	NO	--	--	--	YES	NO
{19}	DI OVRD SW	OFF	--	--	--	ON	OFF
20	OVRD TIME	0	HRS	1	0	--	--
{21}	NGT OVRD	NIGHT	--	--	--	NIGHT	DAY
{24}	DI 2	OFF	--	--	--	ON	OFF
{25}	DI 3	OFF	--	--	--	ON	OFF
{26}	DI 4	OFF	--	--	--	ON	OFF
{27}	DI 5	OFF	--	--	--	ON	OFF
{28}	DI 6	OFF	--	--	--	ON	OFF
{29}	DAY.NGT	DAY	--	--	--	NIGHT	DAY
30	PULSE EDGE	0	--	1	0	--	--
{31}	PULSE COUNT	0	--	1	0	--	--
{32}	AOV1	0.0	VOLTS	0.01	0.0	--	--
{33}	AOV2	0.0	VOLTS	0.01	0.0	--	--
{34}	AOV3	0.0	VOLTS	0.01	0.0	--	--
{41}	DO 1	OFF	--	--	--	ON	OFF
{42}	DO 2	OFF	--	--	--	ON	OFF
{43}	HTG STG 1	OFF	--	--	--	ON	OFF
{44}	HTG STG 2	OFF	--	--	--	ON	OFF

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.

Continued on next page…

Point Number	Descriptor	Factory Default (SI Units)	Engr Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
{45}	HTG STG 3	OFF	--	--	--	ON	OFF
{46}	FAN	OFF	--	--	--	ON	OFF
{47}	AI 4	74.0 (23.495556)	DEG F (DEG C)	0.5 (0.28)	37.5(3.055556)	--	--
{48}	VLV COMD	0.0	PCT	0.4	0.0	--	--
{49}	VLV POS	0.0	PCT	0.4	0.0	--	--
{50}	AI 5	74.0 (23.495556)	DEG F (DEG C)	0.5 (0.28)	37.5 (3.055556)	--	--
51	MTR 1 TIMING	130	SEC	1	0	--	--
56	MTR1 ROT ANG	90	--	1	0	--	--
58	MTR SETUP	0	--	1	0	--	--
59	DO DIR. REV	0	--	1	0	--	--
60	CYCLE FAN	NO	--	--	--	YES	NO
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	--	--
{78}	CTL TEMP	74.0 (23.44888)	DEG F (DEG C)	0.25 (0.14)	48.0 (8.88888)	--	--
{79}	CLG LOOPOUT	0.0	PCT	0.4	0.0	--	--
{80}	HTG LOOPOUT	0.0	PCT	0.4	0.0	--	--
{81}	AVG HEAT OUT	0.0	PCT	0.4	0.0	--	--
82	HTG STG MAX	90.0	PCT	0.4	0.0	--	--
83	HTG STG MIN	10.0	PCT	0.4	0.0	--	--
84	STAGE FAN	10.0	PCT	0.4	0.0	--	--
85	SWITCH LIMIT	5.2	PCT	0.4	0.0	--	--
86	SWITCH TIME	10	MIN	1	0	--	--
88	HTG STG CNT	1	--	1	0	--	--
89	HTG STG TIME	10	MIN	1	0	--	--
90	SWITCH DBAND	1.0 (0.56)	DEG F (DEG C)	0.25 (0.14)	0.0	--	--
{92}	CTL STPT	74.0 (23.44888)	DEG F (DEG C)	0.25 (0.14)	48.0 (8.88888)	--	--
96	CAL TIMER	12	HRS	1	0	--	--
98	LOOP TIME	5	SEC	1	0	--	--
{99}	ERROR STATUS	0	--	1	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.