SIEMENS

TEC Custom Solutions Fan Coil Applications 2419 and 2428 with 4-20mA Temperature Input

TEC-0905-3.08

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NOTES: Application 2419 is based on and has the same functionality as Application 2050 (*Two-Pipe Fan Coil Unit Cooling or Heating*). **The difference is that the control loops in Application 2419 receive room temperature input from a 4-20mA sensor connected to AI 3 instead of from the room stat.** Also, Application 2419 runs on a Custom Solution controller (Figure 2419-4) that has a wider variety of spare I/O terminations than does the standard Unit Conditioner Controller running Application 2050.

Application 2428 is based on and has the same functionality as Application 2052 (*Fan Coil Unit Cooling Electric Heat*). **The difference is that the control loops in Application 2428 receive room temperature input from an expanded temperature range 4-20mA sensor connected to AI 3 instead of from the room stat.** (In Application 2428, this 4-20mA sensor is a third party 100 Ohm RTD with expanded temperature range of 20 – 120 Deg. F). Also, Application 2428 runs on a Custom Solution controller (Figure 2428-3) that has a wider variety of spare I/O terminations than does the standard Unit Conditioner Controller running Application 2052.

Application 2419
Two-Pipe Fan Coil Unit Cooling or Heating with 4-20mA Temperature Input

This section contains the following topics:

- Overview
  - Hardware Inputs
  - Hardware Outputs
  - Ordering Notes
- Sequence Of Operation
  - Control Temperature Set Points
  - Day and Night Modes
  - Night Mode Override Switch
  - Heating/Cooling Switchover
  - Control Loops
  - Cooling Operation
  - Heating Operation
  - Hot Water Reheat
  - Sequencing Logic (optional)
  - Fan Operation
  - Calibration
  - Fail-Safe Operation
- Application Notes
- Wiring Diagrams
- Point Database

Overview

In Application 2419, 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 2419 is based on and has the same functionality as Application 2050 (*Two-Pipe Fan Coil Unit Cooling or Heating*). **The difference is that the control loops in Application 2419 receive room temperature input from a 4-20mA sensor connected to AI 3 instead of from the room stat.** Also, Application 2419 runs on a Custom Solution controller that has a wider variety of spare I/O terminations than does the standard Unit Conditioner Controller running Application 2050. Refer to Figures 2419-1 and 2419-2.

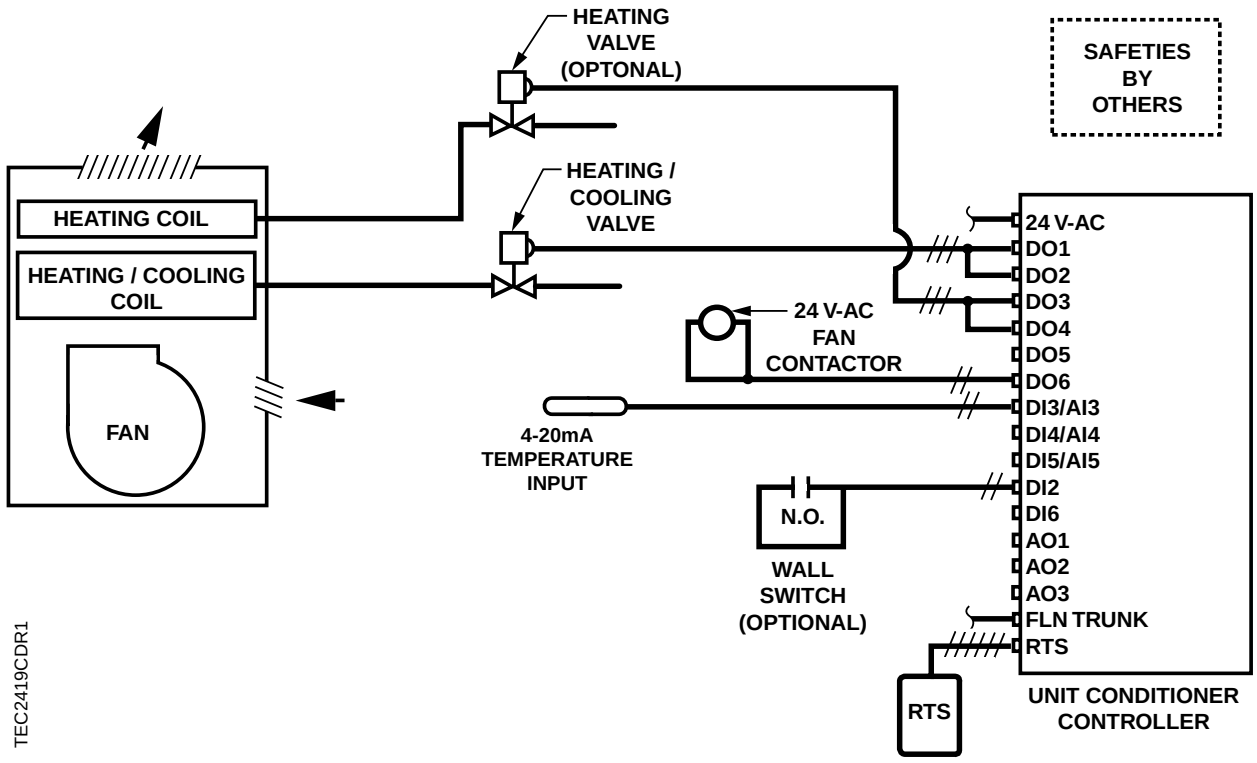
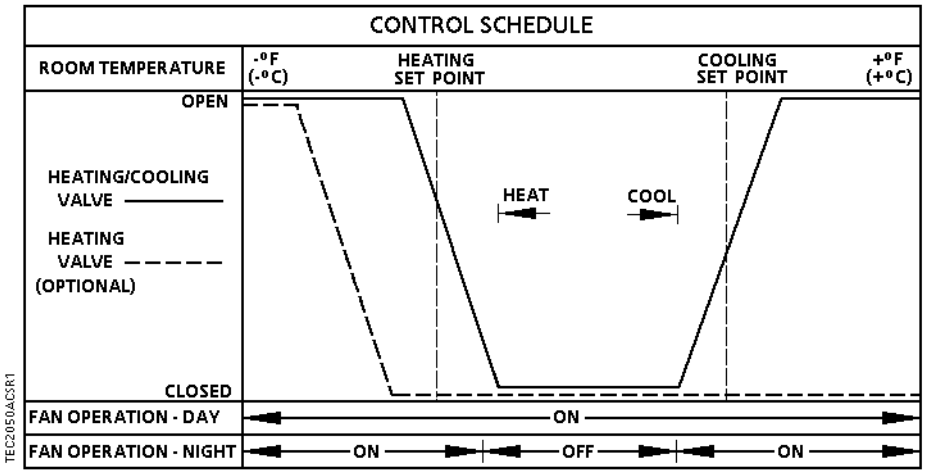


Figure 2419-1. Application 2419 Control Drawing.



1. Refer to Sequence of Operation, “Control Temperature Set Points”.
2. Refer to Sequence of Operation, “Heating/Cooling Switchover”.
3. The reheat valves are shown operating sequenced (optional). The reheat valves can operate sequenced, parallel, or overlapping with each other (optional). Refer to “Sequencing Logic”.

Figure 2419-1. Application 2419 Control Schedule.

Hardware Inputs

Analog

- 4-20mA RTD
- room temperature sensor
- room temperature set point dial (optional)

Digital

- night mode override (optional)
- wall switch (optional)

Hardware Outputs

Analog

- none

Digital

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

Ordering Notes

Custom Solution Fan Coil Unit Cooling/Heating Controller with 4-20mA Temperature Input — Part No. 540-863N (Custom Solution 266) (**Note:** This Custom Solution includes two applications. 2419 and 2428.)

- Application 2419: 4-20mA Temperature Sensor 536-200

Sequence of Operation

The following paragraphs present the sequence of operation for Application 2419, “Two-Pipe Fan Coil Unit Cooling or Heating with 4-20mA Temperature Input.”

Control Temperature Set Points

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

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

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

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

NOTE: The value of the point CTL TEMP (number 78) is the same as the value of the point ROOM TEMP (number 15), unless CTL TEMP is overridden.

Day and Night Modes

The day/night status of the space is determined by the status of the point DAY.NGT (number 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 2419-1 and 2419-4), and the point WALL SWITCH (number 18) equals YES, the controller monitors the status of DI 2. When the status of the point DI 2 (number 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 the point 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 the point OVRD TIME (number 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 the point NGT OVRD (number 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

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:

a A temperature sensor is attached to the supply water pipe. The controller uses the measured temperature point, SUPPLY TEMP (number 15), to determine whether it is in heating or cooling mode.

When SUPPLY TEMP is below the value of the point COOL TEMP (number 61), the controller sets the point HEAT.COOL (number 5) to COOL, switching the controller to cooling mode.
When SUPPLY TEMP is above the value of the point HEAT TEMP (number 62), the controller sets the point HEAT.COOL (number 5) to HEAT, switching the controller to heating mode.

b If the controller is connected to a field panel, the field panel can command the supply temperature point, SUPPLY TEMP (number 15).

When SUPPLY TEMP is commanded below the value of the point COOL TEMP (number 61), the controller sets the point HEAT.COOL (number 5) to COOL, switching the controller to cooling mode.
When SUPPLY TEMP is commanded above the value of the point HEAT TEMP (number 62), the controller sets the point HEAT.COOL (number 5) to HEAT, switching the controller to heating mode.

c If the controller is connected to a field panel, the field panel can switch the controller between heating and cooling modes by commanding the point HEAT.COOL (number 5) to HEAT or COOL.

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 the point CTL STPT (number 92). Refer to “Control Temperature Set Points”.

Cooling Operation

In cooling mode, the controller uses the points CTL STPT (number 92) and CTL TEMP (number 78) as the inputs to the cooling loop. The central plant must provide chilled water. The output of the cooling loop is the point CLG LOOPOUT (number 79) which modulates the heating/cooling valve point, VLV 1 COMD (number 48). The point HTG LOOPOUT (number 80) is set to 0%.

Heating Operation

In heating mode, the controller uses the points CTL STPT (number 92) and CTL TEMP (number 78) as the inputs to the heating loop. The central plant must provide hot water. The output of the heating loop is the point HTG LOOPOUT (number 80) which modulates the heating/cooling valve point, VLV 1 COMD (number 48) and the optional second heating valve point, VLV 2 COMD (number 52). The point CLG LOOPOUT (number 79) is set to 0%.

Hot Water Reheat

The heating loop modulates the heating/cooling valve and the optional second heating valve in order to warm-up the space as follows:

- If there is only one heating valve, VALVE CNT (number 88) is equal to 1. The position of the heating/cooling valve, point VLV 1 COMD (number 48), is calculated using the following formula:

  (HTG LOOPOUT – VLV 1 START) ÷ (VLV 1 END – VLV 1 START) × 100%, limited between 0 and 100%.
  As the demand for heating rises, the valve will begin opening when the HTG LOOPOUT (number 80) rises above the point VLV 1 START (number 16), and will be fully open when HTG LOOPOUT reaches VLV 1 END (number 17). The point VLV 2 COMD (number 52) will not be used.

- If there are two heating valves, VALVE CNT is equal to 2. The position of the first heating valve, VLV 1 COMD, is calculated as above. Similarly, the position of the optional 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 (number 22), and will be fully open when HTG LOOPOUT reaches VLV 2 END (number 23). Refer to “Sequencing Logic” for information on how the two heating valves can be sequenced.

NOTES: 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 heating mode. In cooling mode, these points are not used. In cooling mode, VLV 1 COMD equals CLG LOOPOUT (number 79).

Sequencing Logic (optional)

In heating mode, this application includes logic that allows two heating valves to operate either 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, point HTG LOOPOUT (number 80), will drive the two heating valves from 0 to 100%. Refer to the following three examples. The ladder diagrams in Figure 2419-3 shows 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.

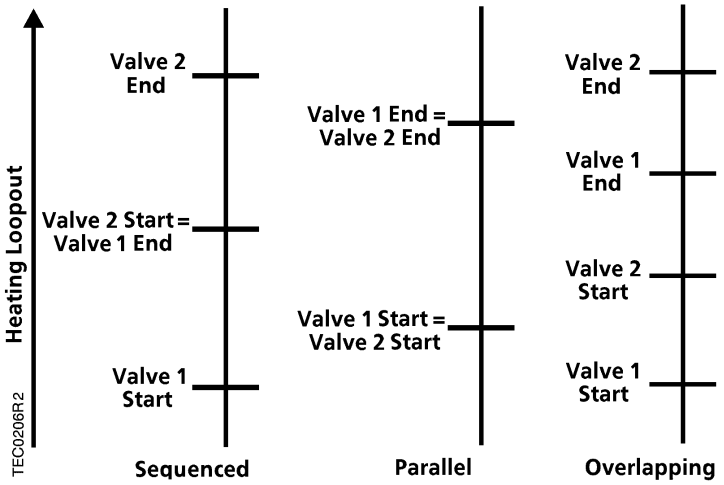


Figure 2419-3. Sequenced, Parallel, and Overlapping Loop Operations with Hot Water Reheat.

Example 1: Assume that your system has two hot water valves that are to operate in sequence. If,

- VLV 1 START (number 16) equals 0%
- VLV 1 END (number 17) equals 50%
- VLV 2 START (number 22) equals 50%
- VLV 2 END (number 23) equals 100%

then,

- when HTG LOOPOUT equals 0%, the point VLV 1 COMD (number 48) will equal 0% open and the point VLV 2 COMD (number 52) will equal 0% open.
- when HTG LOOPOUT equals 25%, VLV 1 COMD will equal 50% open and VLV 2 COMD will equal 0% open.

- when HTG LOOPOUT equals 50%, VLV 1 COMD will equal 100% open and VLV 2 COMD will equal 0% open.
- when HTG LOOPOUT equals 75%, VLV 1 COMD will equal 100% open and VLV 2 COMD will equal 50% open.
- when HTG LOOPOUT equals 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 equals 0%
- VLV 1 END equals 100%
- VLV 2 START equals 0%
- VLV 2 END equals 100%

then,

- when HTG LOOPOUT equals 0%, VLV 1 COMD and VLV 2 COMD will equal 0% open.
- when HTG LOOPOUT equals 50%, VLV 1 COMD and VLV 2 COMD will equal 50% open.
- when HTG LOOPOUT equals 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 equals 0%
- VLV 1 END equals 75%
- VLV 2 START equals 25%
- VLV 2 END equals 100%

then,

- when HTG LOOPOUT equals 0%, VLV 1 COMD and VLV 2 COMD will equal 0% open.
- when HTG LOOPOUT equals 37.5%, VLV 1 COMD will equal 50% open and VLV 2 COMD will equal 17% open.
- when HTG LOOPOUT equals 62.5%, VLV 1 COMD will equal 83% open and VLV 2 COMD will equal 50% open.
- when HTG LOOPOUT equals 100%, VLV 1 COMD and VLV 2 COMD will equal 100% open.

Fan Operation

Day Mode – The fan may be set to stay ON at all times or to cycle to save energy. If the point CYCLE FAN (number 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:

1. If either valve points, VLV 1 COMD (number 48) or VLV 2 COMD (number 52), is open more than the value of the point STAGE FAN (number 84), the fan will turn ON.

2. If both valves are closed below the value of the point SWITCH LIMIT (number 85), the fan will turn OFF.

3. If neither of the above two conditions is met, then the condition of the fan remains unchanged.

NOTE: The above conditions are true whether a second heating valve is being used or not. If the second valve is not being used, it is not looked at by the fan.

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

Calibration

The controller will regularly calibrate the valve(s) based on the value of CAL TIMER (Point 96). A value of 12 indicates that the controller will calibrate the valve(s) once every 12 hours.

The calibration consists of driving the valve(s) closed, and then resetting the value of the point VLV 1 POS (number 49) to 0. If a second valve is used, then the point VLV 2 POS (number 53) is also set to 0. The actuators are then released to normal control.

Fail-Safe Operation

If the room temperature sensor fails or the pipe 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 if there is trouble in maintaining the set point, then either the cooling loop, the heating loop or both need to be tuned. Refer to *APOGEE Automation Service Procedures* (125-3013) on InfoLink for more information.

2. The Unit Conditioner Controller – Electronic Output, as shipped from the factory, keeps all associated equipment OFF. Refer to *APOGEE Automation Start-up Procedures* (125-3014) 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 second heating valve is not being controlled by the application, then 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 the point VLV 2 COMD (number 52). Refer to *APOGEE Automation Start-up Procedures* (125-3014) on InfoLink for more information.

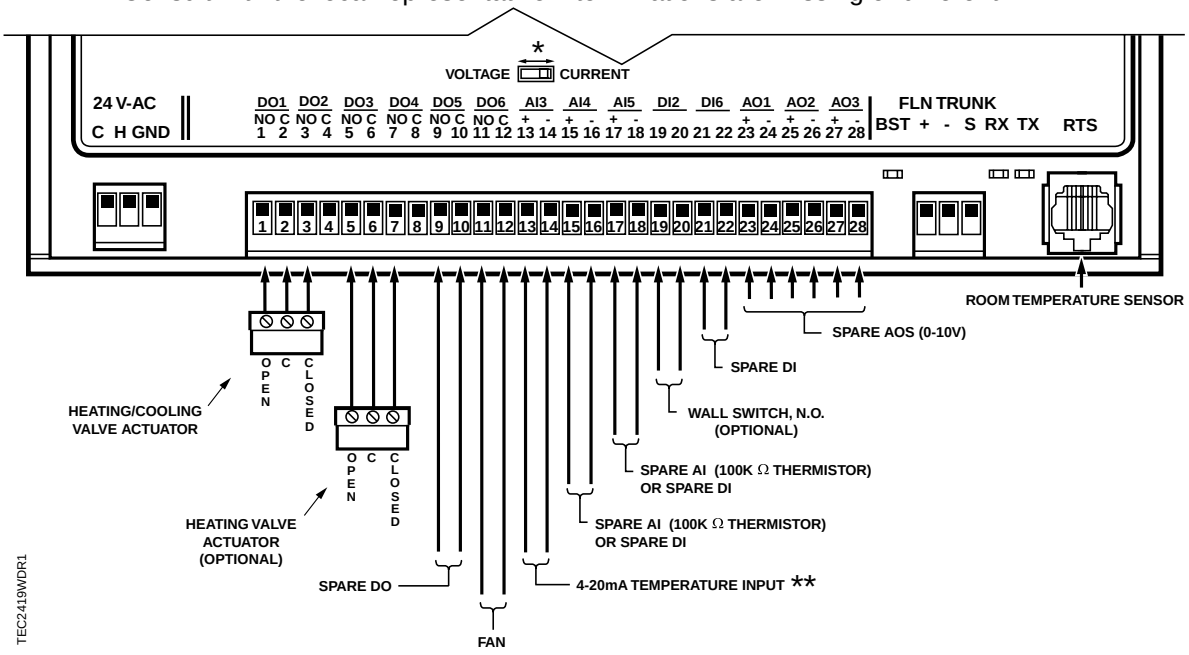
Wiring Diagram

CAUTION:

The controller's DOs control 24 Vac loads only. The maximum rating is 12 VA for each DO. Use an interposing 220V relay 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.

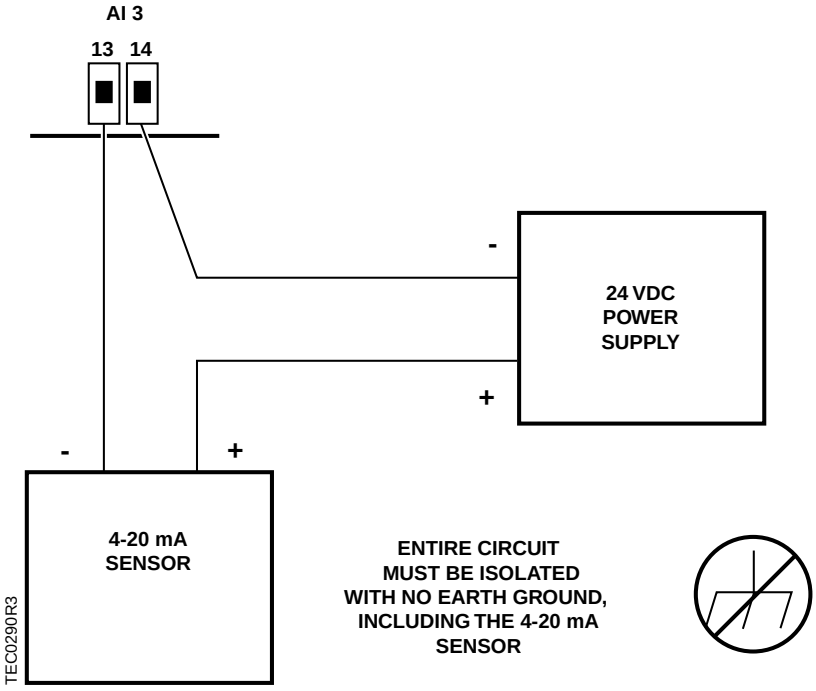


* Dipswitch for AI 3 on controller's circuit board (under controller's cover) must be in *current* position.
**The 4-20mA sensor must be wired as per instructions in Figure 2419-5.

Figure 2419-4. Application 2419 Wiring Diagram.

CAUTION:

Refer to Figure 2419-5 for how to wire the 4-20mA temperature sensor. Failure to follow instructions will cause equipment damage.



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 2419-5. Special Wiring Requirements for 4-20 mA Temperature Sensor.

CAUTION:

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

Figure 2419-5. Wiring Instructions for 4-20mA Sensor.

Point Database

Table 2419-1. Point Database for Application 2419.

The point numbers of Points that can be unbundled appear in brackets { }

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	2483	--	1	0	--	--
{04}	RTS 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	40.0 (4.444444)	DEG F (DEG C)	0.2 (0.111111)	40.0(4.444444)	--	--
07	DAY HTG STPT	40.0 (4.444444)	DEG F (DEG C)	0.2 (0.111111)	40.0(4.444444)	--	--
08	NGT CLG STPT	40.0 (4.444444)	DEG F (DEG C)	0.2 (0.111111)	40.0(4.444444)	--	--
09	NGT HTG STPT	40.0 (4.444444)	DEG F (DEG C)	0.2 (0.111111)	40.0(4.444444)	--	--
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}	ROOM TEMP	40.0 (4.444444)	DEG F (DEG C)	0.2 (0.111111)	40.0(4.444444)	--	--
16	VLV 1 START	0.0	PCT	0.4	0.0	--	--
17	VLV 1 END	100.0	PCT	0.4	0.0	--	--
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
22	VLV 2 START	0.0	PCT	0.4	0.0	--	--
23	VLV 2 END	0.0	PCT	0.4	0.0	--	--
{24}	DI 2	OFF	--	--	--	ON	OFF
{25}	DI 3	OFF	--	--	--	ON	OFF
{27}	DI 5	OFF	--	--	--	ON	OFF
{28}	DI 6	OFF	--	--	--	ON	OFF
{29}	DAY.NGT	DAY	--	--	--	NIGHT	DAY
{30}	SUPPLY TEMP	37.5 (3.055556)	DEG F (DEG C)	0.5 (0.28)	37.5(3.055556)	--	--
{31}	AI 5	37.5 (3.055556)	DEG F (DEG C)	0.5 (0.28)	37.5(3.055556)	--	--
{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}	DO 3	OFF	--	--	--	ON	OFF
{44}	DO 4	OFF	--	--	--	ON	OFF
{45}	DO 5	OFF	--	--	--	ON	OFF
{46}	FAN	OFF	--	--	--	ON	OFF
{48}	VLV 1 COMD	0.0	PCT	0.4	0.0	--	--
{49}	VLV 1 POS	0.0	PCT	0.4	0.0	--	--
51	MTR 1 TIMING	130	SEC	1	0	--	--
{52}	VLV 2 COMD	0.0	PCT	0.4	0.0	--	--
{53}	VLV 2 POS	0.0	PCT	0.4	0.0	--	--
55	MTR 2 TIMING	130	SEC	1	0	--	--
56	MTR1 ROT ANG	90	--	1	0	--	--
57	MTR2 ROT ANG	90	--	1	0	--	--
58	MTR SETUP	0	--	1	0	--	--
59	DO DIR. REV	0	--	1	0	--	--
60	CYCLE FAN	NO	--	--	--	YES	NO
61	COOL TEMP	65.0 (18.455556)	DEG F (DEG C)	0.5 (0.28)	37.5(3.055556)	--	--
62	HEAT TEMP	80.0 (26.855556)	DEG F (DEG C)	0.5 (0.28)	37.5(3.055556)	--	--
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	40.0 (4.444444)	DEG F (DEG C)	0.2 (0.111111)	40.0(4.444444)	--	--
{79}	CLG LOOPOUT	0.0	PCT	0.4	0.0	--	--
{80}	HTG LOOPOUT	0.0	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	--	--
88	VALVE CNT	1	--	1	0	--	--
{92}	CTL STPT	40.0 (4.444444)	DEG F (DEG C)	0.2 (0.111111)	40.0(4.444444)	--	--
96	CAL TIMER	12	HRS	1	0	--	--
98	LOOP TIME	5	SEC	1	0	--	--
{99}	ERROR STATUS	0	--	1	0	--	--

Application 2428
Fan Coil Unit Cooling and Electric Heat with Expanded Range 4-20mA Temperature Input

This section contains the following topics:

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  - Electric Reheat
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  - Fail-Safe Operation
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- Wiring Diagrams
- Point Database

Overview

In Application 2428, the controller energizes a maximum of two stages of cooling and a maximum of three stages of electric heat in the fan coil unit. The fan coil unit also has a fan to circulate room air.

Application 2428 is based on and has the same functionality as Application 2052 (*Fan Coil Unit Cooling Electric Heat*). **The difference is that the control loops in Application 2428 receive room temperature input from an expanded temperature range 4-20mA sensor connected to AI 3 instead of from the room stat.** (In Application 2428, this 4-20mA sensor is a third party 100 Ohm RTD with expanded temperature range of 20 – 120 Deg. F). Also, Application 2428 runs on a Custom Solution controller that has a wider variety of spare I/O terminations than does the standard Unit Conditioner Controller running Application 2052. Refer to Figures 2428-1 and 2428-2.

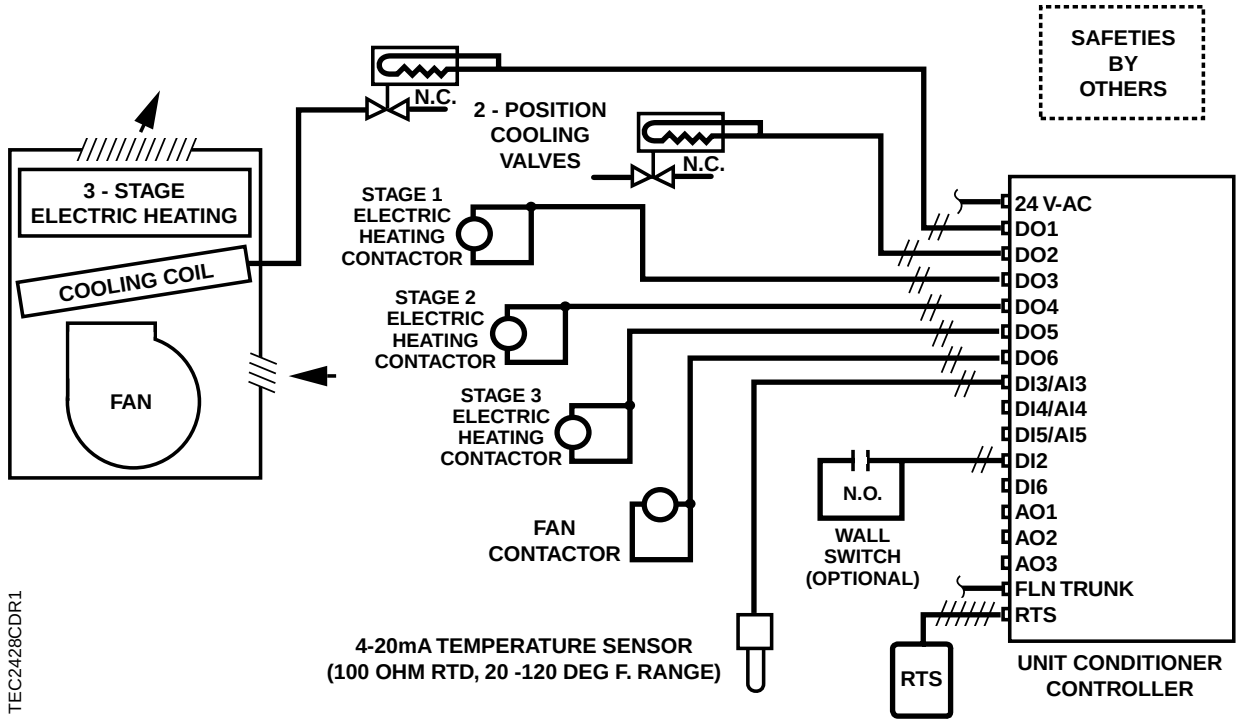
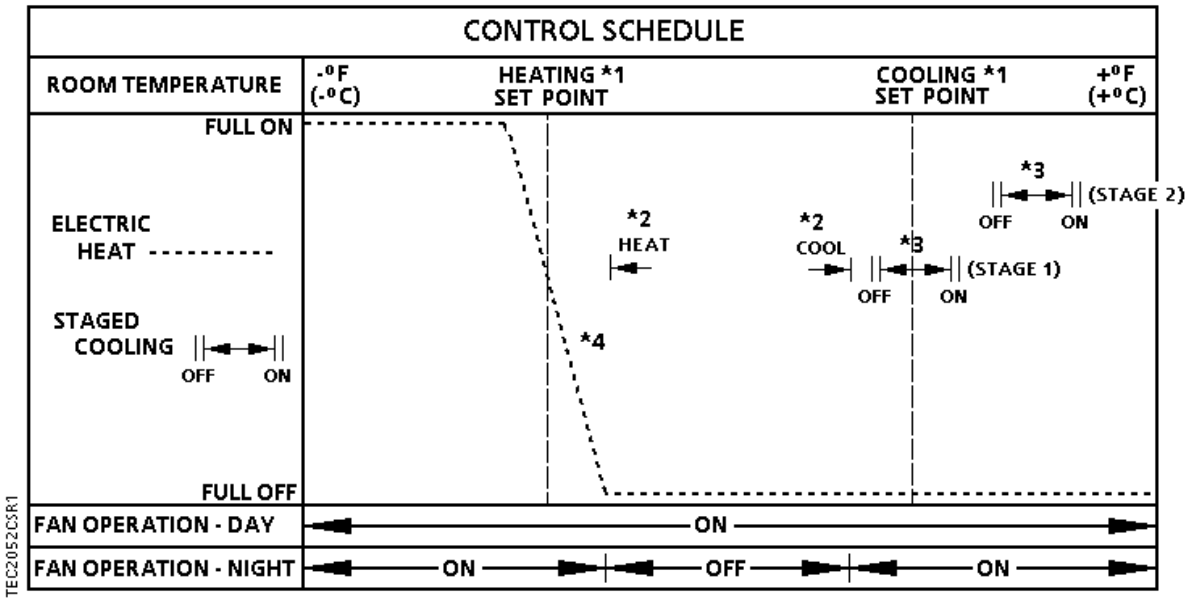


Figure 2428-1. Application 2428 Control Drawing.



1. Refer to Sequence of Operation, “Control Temperature Set Points”.
2. Refer to Sequence of Operation, “Heating/Cooling Switchover”.
3. Refer to Sequence of Operation, “Cooling Operation”.
4. The electric heat is time modulated. This allows it to be controlled proportionally rather than with deadbands.

Figure 2428-2. Application 2428 Control Schedule.

Hardware Inputs

Analog

- 4-20mA 100 Ohm RTD, 20 – 120 Deg. F (*third party sensor)*
- room temperature sensor
- room temperature set point dial (optional)

Digital

- night mode override (optional)
- wall switch (optional)

Hardware Outputs

Analog

- none

Digital

- fan (switched 24 Vac, pilot duty)
- stage 1 cooling (2-position valve actuator); or, cooling compressor
- stage 2 cooling (2-position valve actuator); or, cooling compressor
- stage 1 electric heat
- stage 2 electric heat
- stage 3 electric heat

Ordering Notes

Custom Solution Fan Coil Controller with Cooling, Electric Heat, and Expanded Range 4-20mA Temperature Input — Part No. 540-863N (Custom Solution 266) (**Note:** This Custom Solution includes two applications. 2419 and 2428.)

- Application 2428: 4-20mA Temperature Sensor is a third party temperture sensor (100 Ohm RTD) with an expanded temerature range of 20 – 120 Deg. F.

Sequence of Operation

The following paragraphs present the sequence of operation for Application 2428, “Fan Coil Unit Cooling and Electric Heat with Expanded Range 4-20mA Temperature Input.”

Control Temperature Set Points

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

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

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

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

NOTE: The value of the point CTL TEMP (number 78) is the same as the value of the point ROOM TEMP (number 15), unless CTL TEMP is overridden.

Day and Night Modes

The day/night status of the space is determined by the status of the point DAY.NGT (number 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 2428-1 and 2428-4), and the point WALL SWITCH (number 18) equals YES, the controller monitors the status of DI 2. When the status of the point DI 2 (number 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 the point 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 the point OVRD TIME (number 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 the point NGT OVRD (number 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 switchoverheating or cooling mode by monitoring the room temperature and the demand for heating and cooling (as determined by the temperature control loops).

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

HTG LOOPOUT (number 80) is less than the point SWITCH LIMIT (number 85).

CTL TEMP (number 78) is above the point CTL STPT (number 92) by at least the value set in the point SWITCH DBAND (number 90).

CTL TEMP is greater than the appropriate cooling set point minus SWITCH DBAND.

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

CLG LOOPOUT (number 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

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 the point CTL STPT (number 92). Refer to “Control Temperature Set Points”.

Cooling Operation

In cooling mode, the controller uses the points CTL STPT (number 92) and CTL TEMP (number 78) as the inputs to the cooling loop. The cooling loop controls up to two stages of cooling as defined by the value of the point CLG STG CNT (number 75).

The first stage of cooling, point CLG STG 1 (number 41), will turn ON when the point CLG LOOPOUT (number 79) is greater than the point CLG 1 ON (number 71), provided that CLG STG 1 has been OFF for at least the time set in the point CLG MIN OFF (number 77).

The second stage of cooling, point CLG STG 2 (number 42), will turn ON when CLG LOOPOUT is greater than the point CLG 2 ON (number 73), provided that CLG STG 2 has been OFF for at least the time set in CLG MIN OFF.

CLG STG 2 will turn OFF, when CLG LOOPOUT is less than the point CLG 2 OFF (number 74), provided that CLG STG 2 has been ON for at least the time set in CLG MIN ON (number 76).

CLG STG 1 will turn OFF, when CLG LOOPOUT is less than the point CLG 1 OFF (number 72), provided that CLG STG 1 has been ON for at least the time set in the point CLG MIN ON.

The point HTG LOOPOUT (number 80) is set to 0%.

When in heating mode, both stages of cooling are OFF.

Heating Operation

In heating mode, the controller uses the points CTL STPT (number 92) and CTL TEMP (number 78) as the inputs to the heating loop. The output of the heating loop is the point HTG LOOPOUT (number 80) which modulates the electric reheat in order to warm up the space. The point CLG LOOPOUT (number 79) is set to 0%.

When in cooling mode, the heating valve is closed.

Electric Heat

CAUTION:
Verify that the equipment is supplied with safeties by others to ensure that there is air flow across the heating coils when they are to be energized.

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 (point HTG STG TIME (number 89) is set to 10 minutes) and the heating loop is calling for 60% of heating (point HTG LOOPOUT (number 80) is set to 60%), then for every 10 minute period, the stages of electric auxiliary 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

Fan Operation

Day Mode – The fan may be set to stay ON at all times or to cycle to save energy. If the point CYCLE FAN (number 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:

4. If the first heating stage, the first cooling stage or the second cooling stage is ON, then the fan will turn ON.

5. If the first heating stage is OFF and has been OFF for a complete duty cycle, the point HTG STG TIME (number 89), and the first and second cooling stages are OFF and have been OFF for the minimum off time, then the fan will turn OFF.

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

Fail-Safe Operation

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

Application Notes

1. If the temperature swings in the room are excessive, or if there is trouble in maintaining the set point, then either the cooling loop, the heating loop or both need to be tuned. Refer to *APOGEE Automation Service Procedures* (125-3013) on InfoLink for more information.

2. The Unit Conditioner Controller – Electronic Output, as shipped from the factory, keeps all associated equipment OFF. Refer to the *APOGEE Automation Start-up Procedures* (125-3014) 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. 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* (125-3014) on InfoLink for more information.

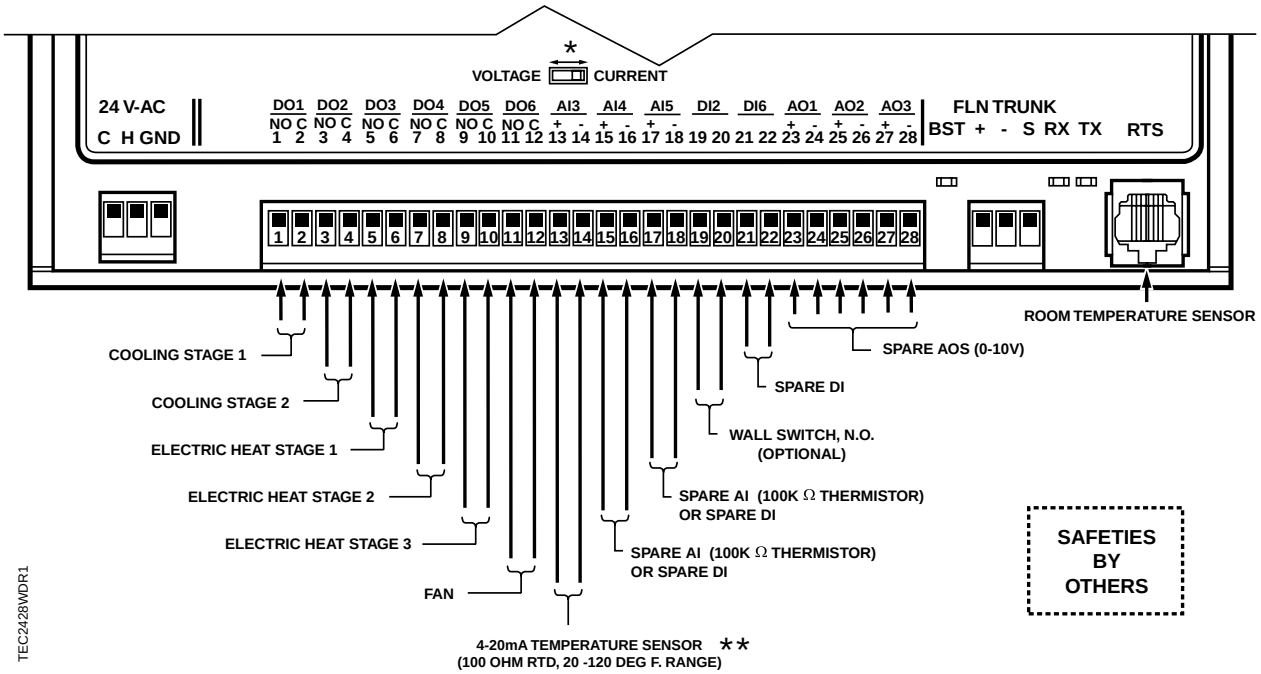
Wiring Diagram

CAUTION:

The controller's DOs control 24 Vac loads only. The maximum rating is 12 VA for each DO. Use an interposing 220V relay 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.

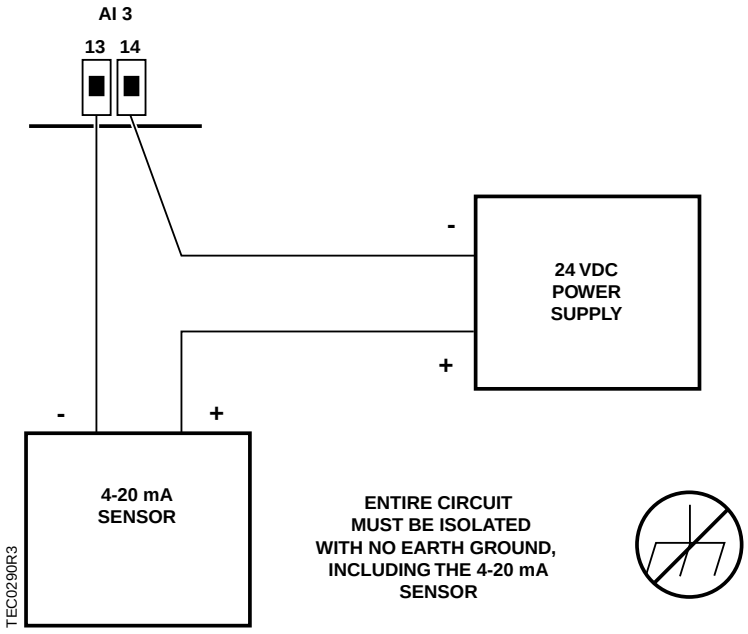


***** Dipswitch for AI 3 on controller's circuit board (under controller's cover) must be in *current* position.
******The 4-20mA sensor must be wired as per instructions in Figure 2428-4.

Figure 2428-3. Application 2428 Wiring Diagram.

CAUTION:

Refer to Figure 2428-4 for how to wire the 4-20mA temperature sensor. Failure to follow instructions will cause equipment damage.



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 2428-4. Special Wiring Requirements for 4-20 mA Sensor at AI3.

CAUTION:

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

Point Database

Table 2428-1. Point Database for Application 2428.

The point numbers of Points that can be unbundled appear in brackets { }

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	2483	--	1	0	--	--
{04}	RTS 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	20.0 (-6.66667)	DEG F (DEG C)	0.4 (0.222222)	20.0(-6.66667)	--	--
07	DAY HTG STPT	20.0 (-6.66667)	DEG F (DEG C)	0.4 (0.222222)	20.0(-6.66667)	--	--
08	NGT CLG STPT	20.0 (-6.66667)	DEG F (DEG C)	0.4 (0.222222)	20.0(-6.66667)	--	--
09	NGT HTG STPT	20.0 (-6.66667)	DEG F (DEG C)	0.4 (0.222222)	20.0(-6.66667)	--	--
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}	ROOM TEMP	20.0 (-6.66667)	DEG F (DEG C)	0.4 (0.222222)	20.0(-6.66667)	--	--
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}	AUX TEMP	37.5 (3.055556)	DEG F (DEG C)	0.5 (0.28)	37.5(3.055556)	--	--
{31}	AI 5	37.5 (3.055556)	DEG F (DEG C)	0.5 (0.28)	37.5(3.055556)	--	--
{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}	CLG STG 1	OFF	--	--	--	ON	OFF
{42}	CLG STG 2	OFF	--	--	--	ON	OFF
{43}	HTG STG 1	OFF	--	--	--	ON	OFF
{44}	HTG STG 2	OFF	--	--	--	ON	OFF
{45}	HTG STG 3	OFF	--	--	--	ON	OFF

{46}	FAN	OFF	--	--	--	ON	OFF
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	--	--
71	CLG 1 ON	40.0	PCT	0.4	0.0	--	--
72	CLG 1 OFF	20.0	PCT	0.4	0.0	--	--
73	CLG 2 ON	80.0	PCT	0.4	0.0	--	--
74	CLG 2 OFF	60.0	PCT	0.4	0.0	--	--
75	CLG STG CNT	2	--	1	0	--	--
76	CLG MIN ON	120	SEC	1	0	--	--
77	CLG MIN OFF	120	SEC	1	0	--	--
{78}	CTL TEMP	20.0 (-6.66667)	DEG F (DEG C)	0.4 (0.222222)	20.0(-6.66667)	--	--
{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	--	2	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	1.6 (0.888888)	DEG F (DEG C)	0.4 (0.222222)	0.0	--	--
{92}	CTL STPT	20.0 (-6.66667)	DEG F (DEG C)	0.4 (0.222222)	20.0(-6.66667)	--	--
98	LOOP TIME	5	SEC	1	0	--	--
{99}	ERROR STATUS	0	--	1	0	--	--