

Application 2346

Fan Coil Unit, Cooling and Electric Heat with Dehumidification and 2 Speed Fan — Electronic Output

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Overview

In Application 2346, the controller energizes a valve for cooling and dehumidification and controls up to three stages of electric heat in the fan coil unit. The fan coil unit also has a 2 speed fan to circulate room air. The central plant must supply chilled water to the cooling valve for the fan coil unit to work properly in both the cooling mode and the dehumidification mode. Refer to Figures 2346-1 through 2346-3.

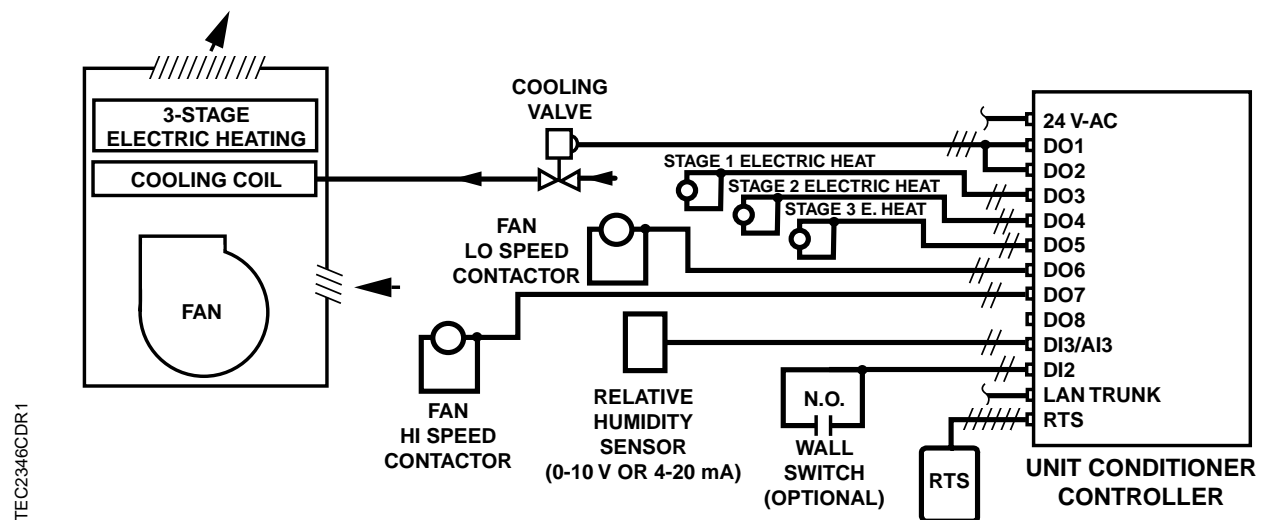
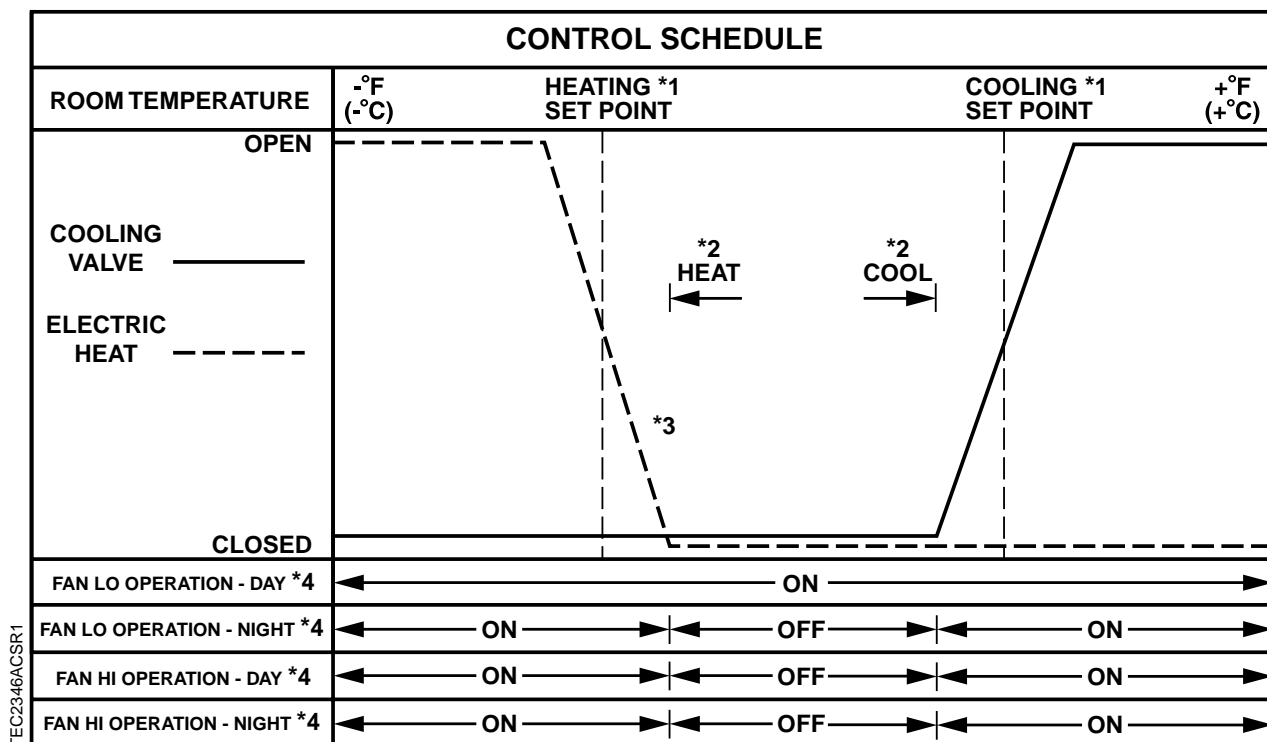


Figure 2346-1. Application 2346 Control Drawing.



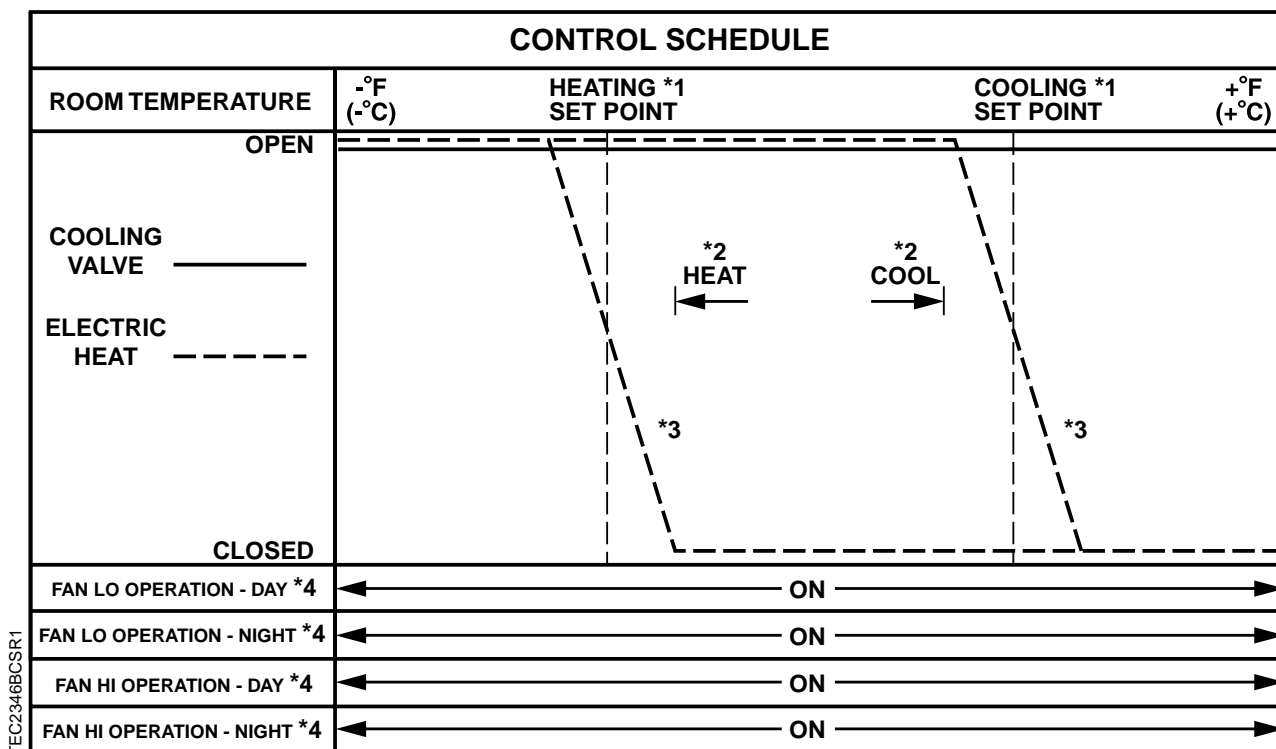
¹ Refer to *Control Temperature Set Points* section.

² Refer to *Heating/Cooling Switchover* section.

³ The electric heat is time modulated. This allows it to be controlled proportionally rather than with deadbands.

⁴ Refer to *Fan Operation* section.

Figure 2346-2. Application 2346 Control Schedule (Dehumidification = OFF).



¹ Refer to *Control Temperature Set Points* section.

² Refer to *Heating/Cooling Switchover* section.

³ The electric heat is time modulated. This allows it to be controlled proportionally rather than with deadbands.

⁴ Refer to *Fan Operation* section.

Figure 2346-3. Application 2346 Control Schedule (Dehumidification = ON).

Hardware Inputs

Analog

- Room temperature sensor
- Room temperature set point dial (optional)

Digital

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

Hardware Outputs

Analog

- None

Digital

- Fan Lo Speed (switched 24 Vac, pilot duty)
- Fan Hi Speed (switched 24 Vac, pilot duty)
- Stage 1 electric heat
- Stage 2 electric heat
- Stage 3 electric heat
- Valve actuator

Ordering Notes

Custom Solution number 235.

Sequence of Operation

The following paragraphs present the sequence of operation for Application 2346, “Fan Coil Unit, Cooling and Electric Heat with Dehumidification and 2 Speed Fan — Electronic Output.”

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 06) or DAY HTG STPT (Point 07). 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 08) or NGT HTG STPT (Point 09).

NOTE: The value of CTL TEMP (Point 78) is the same as the value of ROOM TEMP (Point 04), 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 2346-1 and 2346-4), 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), 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, 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.

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 and remains there until the override time elapses, at which time 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).

When dehumidification is not needed, the heating/cooling switchover works as follows:

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 05) 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.

When dehumidification is being done, the heating/cooling switchover feature is disabled and the HEAT.COOL point remains in its current state. Once disabled, the heating/cooling switchover feature will not be re-enabled until the TEC is no longer performing dehumidification.

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 the *Control Temperature Set Points* section.

Dehumidification Determination

The need for dehumidification is determined as follows:

Day Mode

- If the relative humidity as measured by ROOM RH (Point 15) is greater than the value of RH HI LIMIT (Point 16), then dehumidification is needed and DEHUM MODE (Point 75) is turned ON.
- If ROOM RH is less than the value of RH LO LIMIT (Point 17), then dehumidification is not needed and DEHUM MODE is turned OFF.

If neither of the above two conditions is met, then the value of DEHUM MODE remains unchanged.

Night Mode – When NIGHT DEHUM (Point 76) is set to NO, DEHUM MODE is OFF throughout the entire night mode. When NIGHT DEHUM is set to YES, the value of DEHUM MODE is determined as it is during the day mode.

Cooling Operation without Dehumidification

In cooling mode when DEHUM MODE (Point 75) is OFF, the controller uses CTL STPT (Point 92) and CTL TEMP (Point 78) as the inputs to the cooling loop. In order for this loop to work properly the central plant must provide chilled water to the cooling valve. The output of the cooling loop is CLG LOOPOUT (Point 79) which modulates the cooling valve, VLV COMD (Point 48). When CLG LOOPOUT is less than CLG START (Point 73), the cooling valve is completely closed. The higher CLG LOOPOUT is above CLG START, the more the cooling valve will open. When CLG LOOPOUT is greater than CLG END (Point 74), the cooling valve is completely open.

HTG LOOPOUT (Point 80) is set to 0%.

Cooling Operation with Dehumidification

In cooling mode when DEHUM MODE is ON, the cooling valve is 100% opened all the time. The controller uses CTL STPT (Point 92) and CTL TEMP (Point 78) as the inputs to the cooling loop. In the cooling and dehumidification mode, the cooling loop controls the electric heat stages to accomplish temperature control as follows: As the cooling load increases, CLG LOOPOUT (Point 79) increases. As CLG LOOPOUT increases, $100\% - \text{CLG LOOPOUT}$ decreases. When $100\% - \text{CLG LOOPOUT}$ is less than HTG START (Point 71), all of the electric heat stages will be OFF. Since the cooling valve is already fully opened in order to perform dehumidification, the TEC is performing maximum cooling. As the cooling load gets smaller, CLG LOOPOUT decreases and $100\% - \text{CLG LOOPOUT}$ increases. As $100\% - \text{CLG LOOPOUT}$ increases above HTG START, the electric heat stages are turned ON and OFF according to a time modulated duty cycle (see *Electric Reheat* for more information). The higher $100\% - \text{CLG LOOPOUT}$ is above HTG START, the longer the electric heat stages are turned ON and the shorter they are turned OFF. When $100\% - \text{CLG LOOPOUT}$ is above HTG END (Point 72), all of the electric heat stages will be turned ON and will remain ON. During the cooling and dehumidification mode, HTG LOOPOUT (Point 80) is set to 0%.

Heating Operation

In heating mode when DEHUM MODE (Point 75) is OFF, 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. When HTG LOOPOUT is less than HTG START (Point 71), all of the electric heat stages are OFF. As HTG LOOPOUT increases above HTG START, the electric heat stages are turned ON and OFF (see *Electric Reheat* section for more information). The higher HTG LOOPOUT is above HTG START, the longer the electric heat stages are turned ON and the shorter they are turned OFF. When HTG LOOPOUT is above HTG END (Point 72), all of the electric heat stages will be turned ON and will remain ON.

In the heating mode when DEHUM MODE is OFF, the cooling valve is closed and CLG LOOPOUT (Point 79) is set to 0%.

In the heating mode when DEHUM MODE is ON, the cooling valve is fully opened.

In the heating mode when DEHUM MODE is ON, the electric heat stages are controlled exactly the same as they are in the heating mode when DEHUM MODE is OFF.

Electric Reheat



CAUTION:

Verify that the equipment is supplied with safeties by others to ensure that there is airflow across the heating coils when they are 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 the cooling mode without dehumidification, the electric heat is OFF at all times.

Example: HTG START (Point 71) equals 0 and HTG END (Point 72) equals 100. If the duty cycle is 10 minutes (HTG STG TIME (Point 89) is set to 10 minutes) and the heating loop is calling for 60% of heating (HTG LOOPOUT (Point 80) is set to 60%), then for every 10 minute period, the stages of electric auxiliary heat cycle as follows:

	Stage 1:		Stage 2:		Stage 3:	
	minutes ON	minutes OFF	minutes ON	minutes OFF	minutes ON	minutes 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

Dehumidification Mode – Both FAN LO DO 6 (Point 46) and FAN HI DO 7 (Point 47) are ON throughout the entire dehumidification mode.

When dehumidification is not needed, FAN LO DO 6 operates as follows:

Day Mode (Lo Speed) – The fan's low speed (FAN LO DO 6) can be set to stay ON at all times or cycle to save energy. If CYCLE FAN (Point 60) is set to NO, then the fan's low speed will be ON during the day. If CYCLE FAN is set to YES, then the fan's low speed will cycle according to the following conditions:

- If the first heating stage is ON or if CLG LOOPOUT (Point 79) is greater than the value of FAN CLG LOW (Point 30), then the fan's low speed will turn ON.
- If the first heating stage is OFF and has been OFF for a period of time longer than HTG STG TIME (Point 89), and CLG LOOPOUT is less than FAN CLG LOW – 2%, then the fan's low speed will turn OFF.

If neither of the above two conditions is met, then the condition of the fan's low speed remains unchanged.

Night Mode (Lo Speed) – The fan's low speed (FAN LO DO 6) cycles using the same 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's low speed is controlled as in day mode.

When dehumidification is not needed, FAN HI DO 7 operates as follows:

Day Mode (Hi Speed) – The fan's high speed will cycle in the day mode, regardless of the value of CYCLE FAN. During the day the fan's high speed will cycle differently depending on what mode (heating or cooling) the controller is in.

Day Cooling Mode (HEAT.COOL = COOL)

- If CLG LOOPOUT (Point 79), is greater than the value of FAN CLG HIGH (Point 31), then the fan's high speed (FAN HI DO 7) will turn ON.
- If CLG LOOPOUT is less than FAN CLG HIGH – 2%, then the fan's high speed will turn OFF.

If neither of the above two conditions is met, then the condition of the fan's high speed remains unchanged.

Day Heating Mode (HEAT.COOL = HEAT)

- If HTG LOOPOUT (Point 80) is greater than the value of FAN HTG HIGH (Point 32) and FAN LO DO 6 is ON, then the fan's high speed will turn ON.
- If HTG LOOPOUT is less than FAN HTG HIGH – 2%, then the fan's high speed will turn OFF.

If neither of the above two conditions is met, then the condition of the fan's high speed remains unchanged.

Night Mode (Hi Speed) – The fan's high speed (FAN HI DO 7) is controlled the same during night mode as it is in day mode.

Calibration

The controller will regularly calibrate the cooling valve 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 closed and then resetting the value of VLV POS (Point 49) to 0. The actuator is then released to normal control.

Fail-safe Operation

If the room 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 the *Apogee Automation Service Procedures Manual* (125-3013) for more information.
2. The Unit Conditioner Controller, as shipped from the factory, keeps all associated equipment OFF. Refer to the "Equipment Controllers" tab in the *Apogee Automation Start-up Procedures Manual* (125-3014) 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 DOs. Refer to the *Apogee Automation Start-up Procedures Manual* (125-3014) for more information.

Wiring Diagram

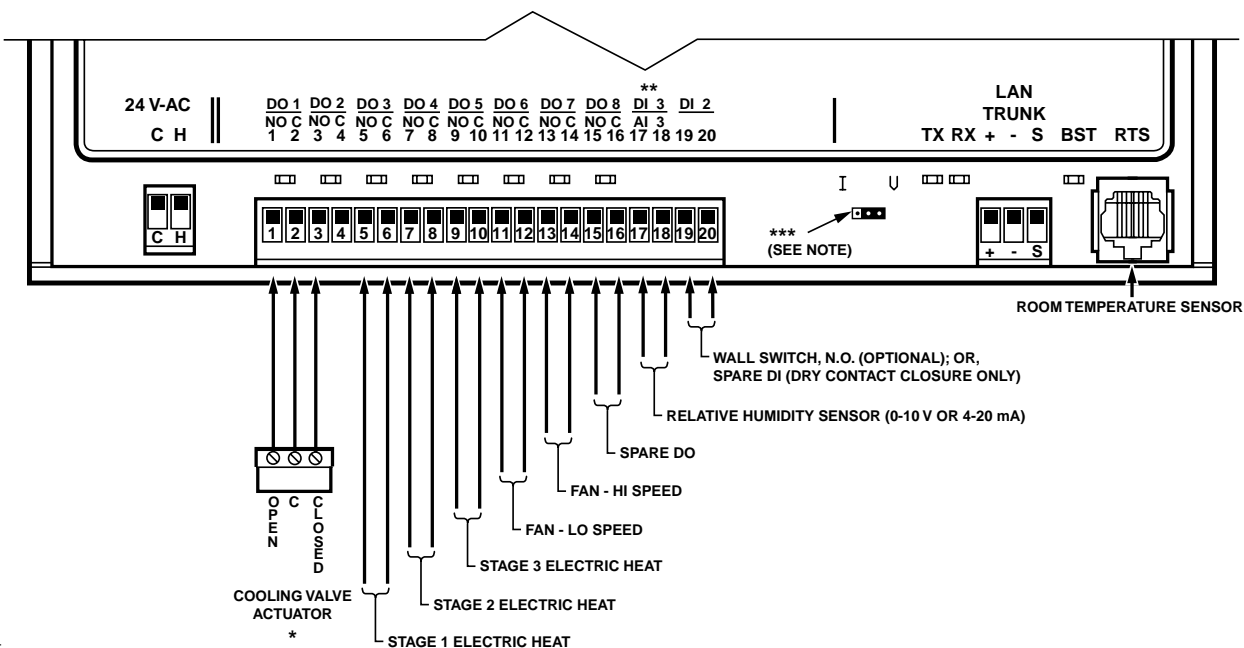
The point wiring for Application 2346 is shown in Figure 2346-4.



CAUTION:

The Unit Conditioner Controller's digital outputs (DOs) control 24 Vac loads only. The maximum rating is 12 VA for each DO. Use an interposing 220 V 4-relay module for any of the following:

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



TEC2346WDR1

*** REFER TO THE ACTUATOR INSTALLATION INSTRUCTIONS
FOR SPECIFIC WIRING TERMINATIONS**

** See Figure 2346-5 for wiring of 4-20 mA sensor.

*** Jumper set to current ("I") position if 4-20 mA sensor is used, or voltage ("V") position for 0-10 V sensor.

Figure 2346-4. Application 2346 Wiring Diagram.

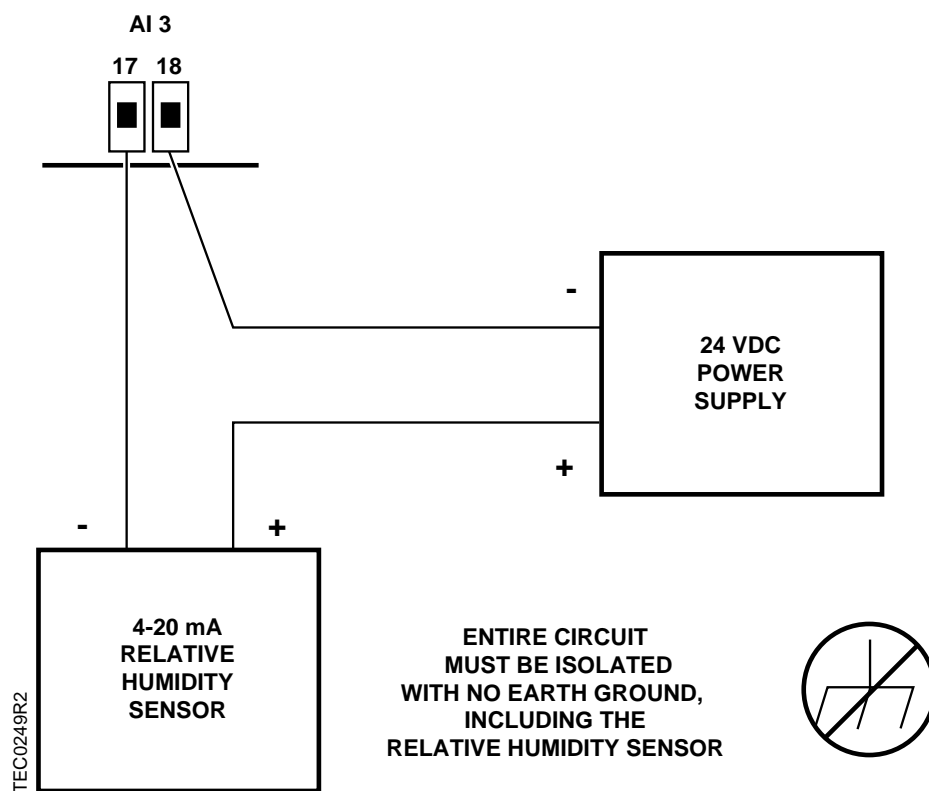


Figure 2346-5. Wiring Diagram for AI 3 if a 4- 20 mA Sensor is Used.

Table 2346-1. Point Database for Application 2346.

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	2390	--	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}	ROOM RH	0.0	PCT	0.4	0.0	--	--
16	RH HI LIMIT	56.0	PCT	0.4	0.0	--	--
17	RH LO LIMIT	50.0	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
{24}	DI 2	OFF	--	--	--	ON	OFF
25	AI3 VOLT.CUR	VOLT	--	--	--	CURRENT	VOLT
{29}	DAY.NGT	DAY	--	--	--	NIGHT	DAY
30	FAN CLG LOW	0.0	PCT	0.4	0.0	--	--
31	FAN CLG HIGH	60.0	PCT	0.4	0.0	--	--
32	FAN HTG HIGH	60.0	PCT	0.4	0.0	--	--
34	HEAT CMD	0.0	PCT	0.4	0.0	--	--
35	COOL CMD	0.0	PCT	0.4	0.0	--	--
{41}	DO 1	OFF	--	--	--	ON	OFF
{42}	DO 2	ON	--	--	--	ON	OFF
{43}	EHEAT1 DO3	ON	--	--	--	ON	OFF
{44}	EHEAT2 DO4	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.

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{45}	EHEAT3 DO5	OFF	--	--	--	ON	OFF
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Table 2346-1. Point Database for Application 2346.

Point Number	Descriptor	Factory Default (SI Units)	Engr Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
{46}	FAN LO DO 6	OFF	--	--	--	ON	OFF
{47}	FAN HI DO 7	ON	--	--	--	ON	OFF
{48}	VLV COMD	0.0	PCT	0.4	0.0	--	--
{49}	VLV POS	0.0	PCT	0.4	0.0	--	--
{50}	DO 8	OFF	--	--	--	ON	OFF
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	--	--
71	HTG START	0.0	PCT	0.4	0.0	--	--
72	HTG END	100.0	PCT	0.4	0.0	--	--
73	CLG START	0.0	PCT	0.4	0.0	--	--
74	CLG END	100.0	PCT	0.4	0.0	--	--
{75}	DEHUM MODE	OFF	--	--	--	ON	OFF
76	NIGHT DEHUM	NO	--	--	--	YES	NO
{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	--	--

- Points not listed are not used in this application.
- A single value in a column means that the value is the same in English units and in SI units.
- Point numbers that appear in brackets {} may be unbundled at the field panel.

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84	STAGE FAN	10.0	PCT	0.4	0.0	--	--
85	SWITCH LIMIT	5.2	PCT	0.4	0.0	--	--

Table 2346-1. Point Database for Application 2346.

Point Number	Descriptor	Factory Default (SI Units)	Engr Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
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.