

Application 2335

VAV Series Fan Powered with Hot Water Reheat and Humidity Override

TEC 0112.08

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Overview

In Application 2335, the controller modulates the supply air damper of the terminal box for cooling and modulates a hot water valve for heating. When in heating, the terminal box either maintains minimum airflow or modulates the supply air damper. The terminal box also has a series fan for air circulation. When the humidity is too high, the fan is on, the airflow is at maximum and temperature control is provided by the heating valve. When the humidity is low enough, the application reverts to normal temperature control. In order for the terminal box to work properly, the central air handling unit must provide cool supply air. Refer to Figures 2335-1 through 2335-3.

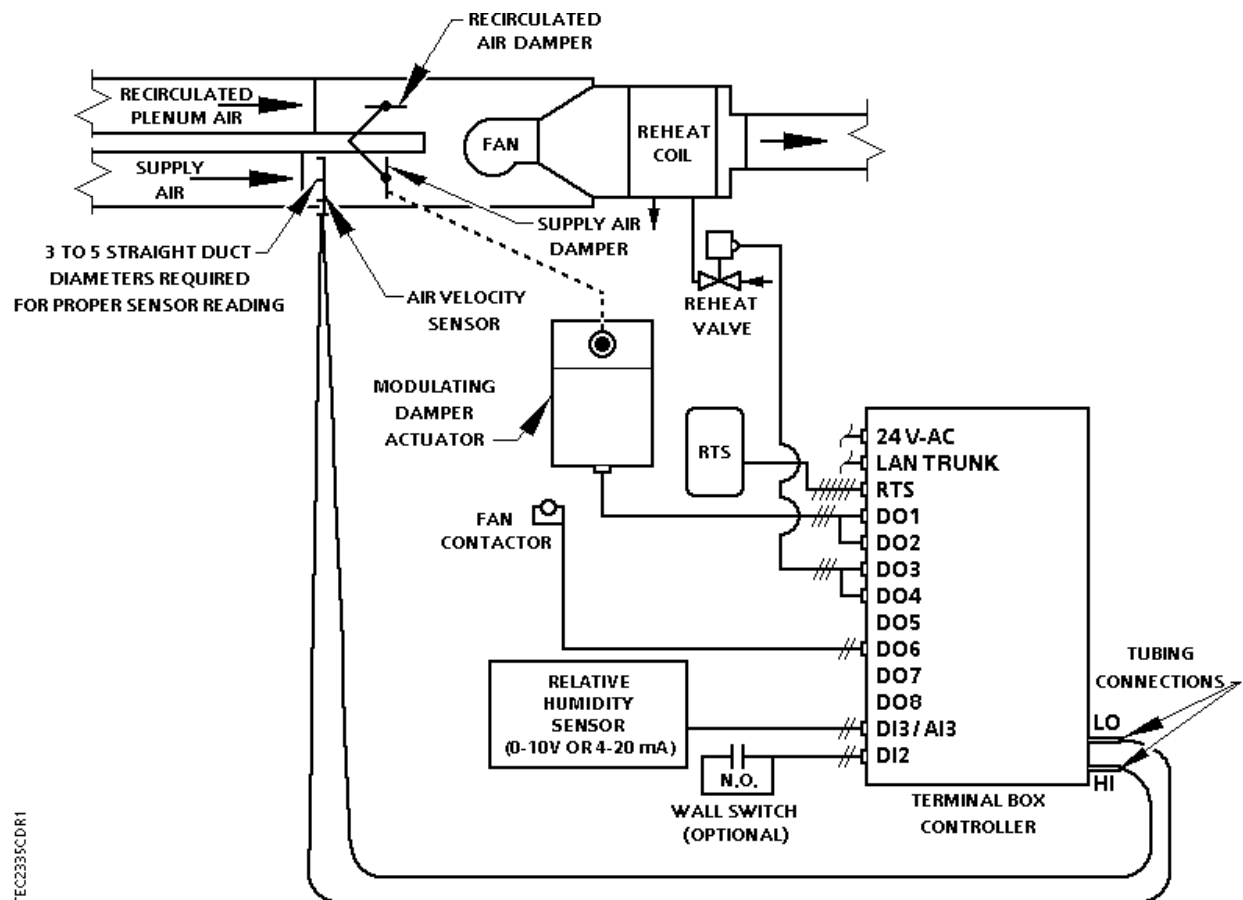
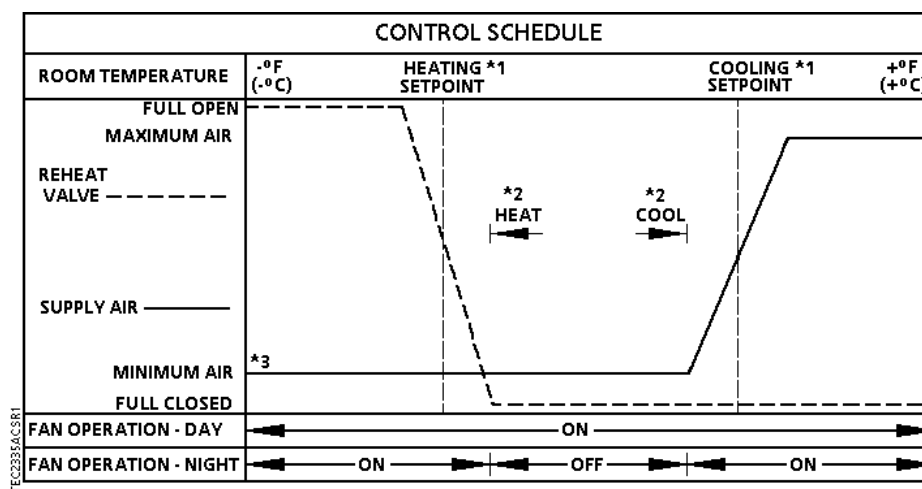
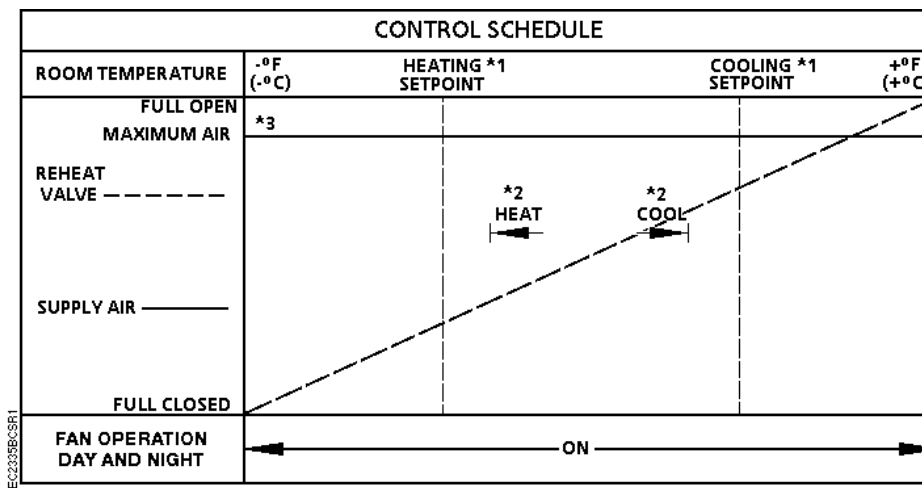


Figure 2335-1. Application 2335 Control Drawing.



1. Refer to *Heating/cooling switchover*.
2. The airflow is shown at minimum flow throughout the entire heating mode (default setting).
3. Refer to *Control temperature set points*.

Figure 2335-2. Application 2335 Control Schedule.



1. Refer to *Control temperature set points*.
2. Refer to *Heating/cooling switchover*.
3. In heating mode, the flow will be controlling at HTG FLOW MAX (Point 34). In cooling mode, the flow will be controlling at CLG FLOW MAX (Point 32).

Figure 2335-3. Application 2335 Control Schedule in Humidity Override Mode.

Hardware Inputs

Analog

- Air Velocity Sensor
- Humidity Sensor (0 to 10V or 4 to 20 mA)*
- Room Temperature Sensor
- Room Temperature Set Point Dial (optional)

* A dedicated 24 Vdc power supply is required to drive the input circuit if a 4 to 20 mA sensor is used. Refer to the installation instructions for this controller.

Digital

- Night Mode Override (optional)
- Wall Switch (optional)

Hardware Outputs

Analog

- None

Digital

- Damper Actuator
- Fan
- Valve Actuator

Ordering Notes

Custom Solution number 223.

Point Database

Table 2335-1 presents the point database information for Application 2335.

Sequence of Operation

The following paragraphs present the sequence of operation for Application 2335, “VAV Series Fan Powered with Hot Water Reheat and Humidity Override.”

Control Temperature Set Points

Depending on the controller’s current operational mode (day or night), the control temperature set, 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 the 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 2335-1 and 2335-4), 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), 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, 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 the 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 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:

- The HTG LOOPOUT (Point 80) is less than SWITCH LIMIT (Point 85).
- The 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:

- The CLG LOOPOUT (Point 79) is less than SWITCH LIMIT.
- The 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 terminal box is controlled by three Proportional, Integral, and Derivative (PID) control loops; a heating loop, a cooling loop, and a flow loop.

Heating Loop – When the humidity override is not in effect, the heating loop uses the value of CTL STPT (Point 92) and CTL TEMP (Point 78) to generate the heating loopout which is then used to generate the FLOW STPT (Point 93). FLOW STPT is calculated between HTG FLOW MIN (Point 33) and HTG FLOW MAX (Point 34). Refer to *Control temperature set points*.

Cooling Loop – When the humidity override is not in effect, the cooling loop uses the value of CTL STPT and CTL TEMP to generate the cooling loopout which is then used to generate FLOW STPT. FLOW STPT is calculated between CLG FLOW MIN (Point 31) and CLG FLOW MAX (Point 32). Refer to *Control temperature set points*.

Flow Loop – The flow loop maintains the airflow between CTL FLOW MIN (Point 76) and CTL FLOW MAX (Point 77) by modulating DMPR COMD (Point 10).

Hot Water Reheat

The heating loop modulates the heating valve to warm up the room. In normal cooling mode, the heating valve is closed. The heating valve will be used to warm up the room in the cooling mode if the humidity override is in effect.

Calibration

Air Velocity Transducer – Calibration of the controller's internal air velocity transducers is periodically required to maintain accurate air velocity readings. The CAL SETUP (Point 95) is set with the desired calibration option during controller start-up. Depending upon the value of CAL SETUP, calibration may be set to take place automatically or manually. If the status of the CAL AIR (Point 94) is YES, then calibration is in progress.

The damper is commanded closed to get a zero airflow reading during calibration.

Hot Water Valve – Calibration of a hot water valve is done by commanding the valve to closed.

At the end of a calibration sequence, CAL AIR returns to NO automatically. A status of NO indicates that the controller is not in a calibration sequence.

NOTE: The Autozero Module means of calibration is not available with fan powered applications.

Humidity Override

This application continuously checks whether or not it should be in humidity override or in normal temperature control. It does this by looking at the value of ROOM RH (Point 15). If ROOM RH is greater than the RH HI LIMIT (Point 60), then the humidity override is in effect. The application initiates the humidity override by turning ON the RH OVERRIDE (Point 62). If ROOM RH is less than RH LO LIMIT (Point 61), then the humidity override is no longer in effect. The application ends the humidity override by turning RH OVERRIDE OFF. When RH OVERRIDE is OFF, the application performs its normal temperature control sequence. When ROOM RH is between the values of RH HI LIMIT and RH LO LIMIT, the humidity override will be in its last commanded state. This deadband prevents the application from quickly switching back and forth between humidity override and normal temperature control.

In cooling mode, when the humidity override is ON, the application controls as follows:

- The FLOW STPT (Point 93) is set to 100%. This causes the amount of air stored in the CLG FLOW MAX (Point 32) to flow from the supply duct.
- The fan is ON.
- The reheat valve controls the room temperature. (VLV COMD (Point 52) = 100% - CLG LOOPOUT (Point 79)).

In heating mode, when the humidity override is ON, the application controls as follows:

- FLOW STPT is set to 100%. This causes the amount of air stored in the HTG FLOW MAX (Point 34) to flow from the supply duct.
- The fan is ON.
- The reheat valve controls the room temperature. (VLV COMD = 100% - HTG LOOPOUT (Point 80)).

Fan Operation



CAUTION:

On series fan powered terminal boxes, the terminal box fan must be controlled/interlocked to start either before or at the same time as the central air handler. Failure to do so may cause the terminal box fan to rotate backwards and cause consequent damage at start-up.

In day mode, FAN (Point 46) is ON all of the time.

In night mode, the fan is controlled as follows:

The fan will turn ON when at least one of the following two conditions has been met:

- The hot water valve, VLV COMD (Point 52), is open greater than the value stored in STAGE FAN (Point 83).
- The airflow out of the supply duct, point FLOW (Point 75), is greater than the value stored in SERIES ON (Point 26).

The fan will turn OFF only when the following two conditions have been met:

1. The hot water valve, VLV COMD, is open less than the value stored in the SWITCH LIMIT (Point 85).
2. The airflow out of the supply duct, FLOW, is less than the value stored in the SERIES OFF (Point 27).

Fail-safe Operation

If the air velocity sensor fails, then the controller uses pressure dependent control. The temperature loop controls the operation of the damper.

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

If the relative humidity sensor fails, then the humidity will remain in its last commanded state, specifically, RH OVERRIDE (Point 62).

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. If the FLOW (Point 75) is oscillating while the FLOW STPT (Point 93) is constant, then the flow loop requires tuning. Refer to *APOGEE Automation Service Procedures* on InfoLink for more information.
2. The Terminal Box Controller with Dehumidification Sequence – Electronic Output, as shipped from the factory, keeps all associated equipment OFF. Refer to the Start-up document for this controller for information on how to release the controller and its equipment to application control.
3. The RH HI LIMIT (Point 60) should be set equal to or greater than RH LO LIMIT (Point 61). If RH HI LIMIT is set less than RH LO LIMIT, then the humidity override will not work properly.

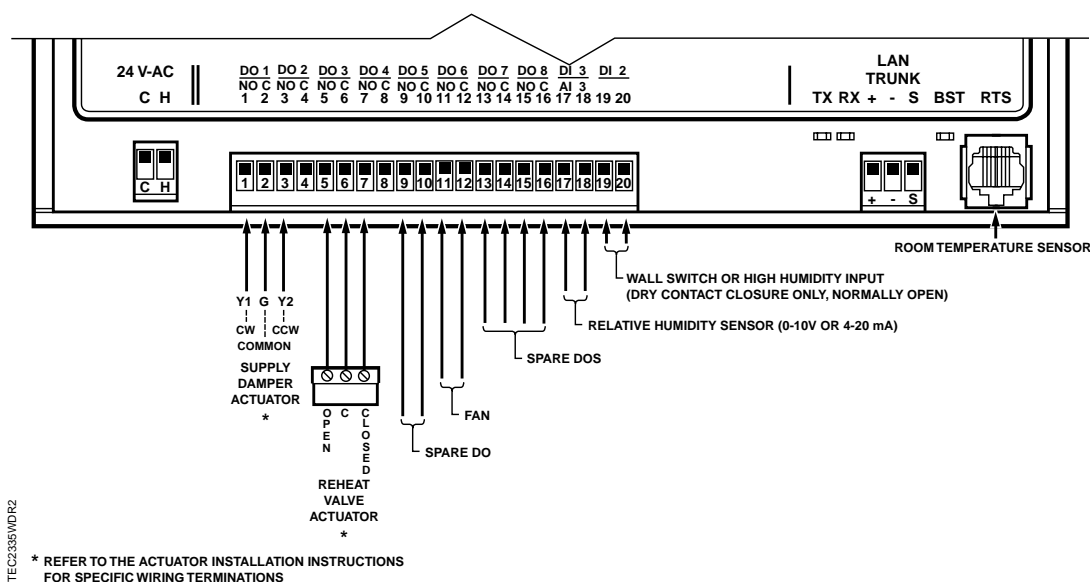
Wiring Diagrams

The point wiring for Application 2335 is shown in Figure 2335-4.



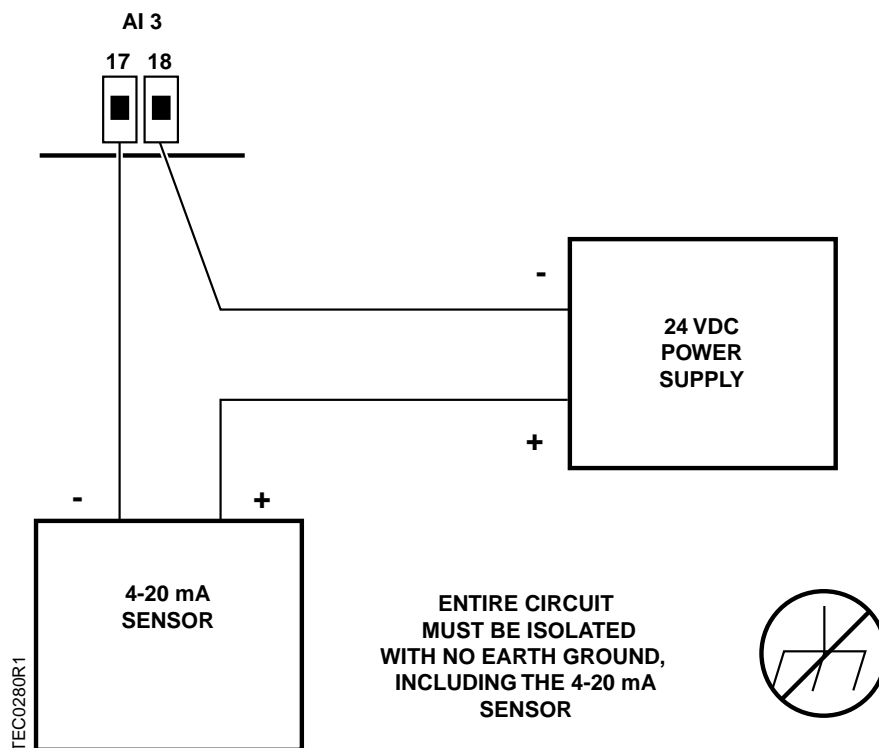
CAUTION:

The Terminal Box Controller with Dehumidification Sequence – Electronic Output controls 24 Vac loads only. The maximum rating is 12 VA for each DO. For higher VA requirements, 110 or 220 Vac requirements, or DC power requirements, use an interposing 220V 4-relay module.



NOTE: Refer to Figure 2335-5 for special wiring requirements of 4 to 20 mA sensor.

Figure 2335-4. Application 2335 Wiring Diagram.



NOTE: Each 4 to 20 mA sensor requires a dedicated 24 VDC power supply.

Figure 2335-5. Wiring Diagram for AI3 if a 4-20 mA Sensor is Used.

Table 2335-1. Point Database for Application 2335.

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	2382	--	1	0	--	--
{03}	DI 4	OFF	--	--	--	ON	OFF
{04}	ROOM TEMP	74.00 (23.44888)	DEG F (DEG C)	0.25 (0.14)	48 (8.88888)	--	--
{05}	HEAT.COOL	COOL	--	--	--	HEAT	COOL
06	DAY CLG STPT	74.00 (23.44888)	DEG F (DEG C)	0.25 (0.14)	48 (8.88888)	--	--
07	DAY HTG STPT	70.00 (21.20888)	DEG F (DEG C)	0.25 (0.14)	48 (8.88888)	--	--
08	NGT CLG STPT	82.00 (27.92888)	DEG F (DEG C)	0.25 (0.14)	48 (8.88888)	--	--
09	NGT HTG STPT	65.00 (18.40888)	DEG F (DEG C)	0.25 (0.14)	48 (8.88888)	--	--
{10}	DMPR COMD	0.0	PCT	0.4	0	--	--
11	RM STPT MIN	55.00 (12.80888)	DEG F (DEG C)	0.25 (0.14)	48 (8.88888)	--	--
12	RM STPT MAX	90.00 (32.40888)	DEG F (DEG C)	0.25 (0.14)	48 (8.88888)	--	--
{13}	RM STPT DIAL	74.00 (23.44888)	DEG F (DEG C)	0.25 (0.14)	48 (8.88888)	--	--
14	STPT DIAL	NO	--	--	--	YES	NO
{15}	ROOM RH	0.0	PCT	0.4	0	--	--
16	FLOW START	0.0	PCT	0.4	0	--	--
17	FLOW END	0.0	PCT	0.4	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

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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Table 2335-1. Point Database for Application 2335.

Point Number	Descriptor	Factory Default (SI Units)	Engr. Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
22	REHEAT START	0.0	PCT	0.4	0	--	--
23	REHEAT END	100.0	PCT	0.4	0	--	--
{24}	DI 2	OFF	--	--	--	ON	OFF
{25}	DI 3	OFF	--	--	--	ON	OFF
26	SERIES ON	20.0	PCT	0.4	0	--	--
27	SERIES OFF	10.0	PCT	0.4	0	--	--
{29}	DAY.NGT	DAY	--	--	--	NIGHT	DAY
31	CLG FLOW MIN	220 (103.8180)	CFM (LPS)	4 (1.8876)	0	--	--
32	CLG FLOW MAX	2200 (1038.1800)	CFM (LPS)	4 (1.8876)	0	--	--
33	HTG FLOW MIN	220 (103.8180)	CFM (LPS)	4 (1.8876)	0	--	--
34	HTG FLOW MAX	2200 (1038.1800)	CFM (LPS)	4 (1.8876)	0	--	--
{35}	AIR VOLUME	0 (0.0000)	CFM (LPS)	4 (1.8876)	0	--	--
36	FLOW COEFF	1.00	--	0.01	0	--	--
{40}	DMPR POS	0.0	PCT	0.4	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}	DO 7	OFF	--	--	--	ON	OFF
{49}	DO 8	OFF	--	--	--	ON	OFF
51	MTR1 TIMING	95	SEC	1	0	--	--
{52}	VLV COMD	0.0	PCT	0.4	0	--	--

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Table 2335-1. Point Database for Application 2335.

Point Number	Descriptor	Factory Default (SI Units)	Engr. Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
{53}	VLV POS	0.0	PCT	0.4	0	--	--
55	MTR2 TIMING	130	SEC	1	0	--	--
56	DMPR ROT ANG	90	--	1	0	--	--
58	MTR SETUP	0	--	1	0	--	--
59	DO DIR. REV	0	--	1	0	--	--
60	RH HI LIMIT	50.0	PCT	0.4	0	--	--
61	RH LO LIMIT	30.0	PCT	0.4	0	--	--
{62}	RH OVERRIDE	OFF	--	--	--	ON	OFF
63	CLG P GAIN	20.00 (36.00)	--	0.25 (0.45)	0	--	--
64	CLG I GAIN	0.010 (0.0180)	--	0.001 (0.0018)	0	--	--
65	CLG D GAIN	0 (0.0)	--	2 (3.6)	0	--	--
66	CLG BIAS	0.0	PCT	0.4	0	--	--
67	HTG P GAIN	10.00 (18.00)	--	0.25 (0.45)	0	--	--
68	HTG I GAIN	0.010 (0.0180)	--	0.001 (0.0018)	0	--	--
69	HTG D GAIN	0 (0.0)	--	2 (3.6)	0	--	--
70	HTG BIAS	0.0	PCT	0.4	0	--	--
71	FLOW P GAIN	0.00	--	0.05	0	--	--
72	FLOW I GAIN	0.010	--	0.001	0	--	--
73	FLOW D GAIN	0	--	2	0	--	--
74	FLOW BIAS	50.0	PCT	0.4	0	--	--
{75}	FLOW	0.00	PCT	0.25	0	--	--
{76}	CTL FLOW MIN	220 (103.8180)	CFM (LPS)	4 (1.8876)	0	--	--
{77}	CTL FLOW MAX	2200 (1038.1800)	CFM (LPS)	4 (1.8876)	0	--	--
{78}	CTL TEMP	74.00 (23.44888)	DEG F (DEG C)	0.25 (0.14)	48 (8.88888)	--	--

1. Points not listed are not used in this application.
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3. Point numbers that appear in brackets { } may be unbundled at the field panel.

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Table 2335-1. Point Database for Application 2335.

Point Number	Descriptor	Factory Default (SI Units)	Engr. Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
79}	CLG LOOPOUT	0.0	PCT	0.4	0	--	--
{80}	HTG LOOPOUT	0.0	PCT	0.4	0	--	--
83	STAGE FAN	10.0	PCT	0.4	0	--	--
85	SWITCH LIMIT	5.2	PCT	0.4	0	--	--
86	SWITCH TIME	10	MIN	1	0	--	--
90	SWITCH DBAND	1.00 (0.56)	DEG F (DEG C)	0.25 (0.14)	0	--	--
91	AI3 VOLT.CUR	VOLT	--	--	--	CURE NT	VOLT
{92}	CTL STPT	74.00 (23.44888)	DEG F (DEG C)	0.25 (0.14)	48 (8.88888)	--	--
{93}	FLOW STPT	0.00	PCT	0.25	0	--	--
{94}	CAL AIR	NO	--	--	--	YES	NO
95	CAL SETUP	4	--	1	0	--	--
96	CAL TIMER	12	HRS	1	0	--	--
97	DUCT AREA	1.000 (0.092920)	SQ. FT (SQ M)	0.025 (0.002323)	0	--	--
98	LOOP TIME	5	SEC	1	0	--	--
{99}	ERROR STATUS	0	--	1	0	--	--

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3. Point numbers that appear in brackets { } may be unbundled at the field panel.