SIEMENS

Terminal Box Controller—Electronic Output

VAV Cooling or Heating

Application 21

Application Note

(Firmware Revision: VV06)

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Overview

In Application 21, the controller modulates the supply air damper of the terminal box for cooling and heating. In order for it to work properly, the central air handling unit must provide cool supply air in cooling mode and warm air in heating mode.

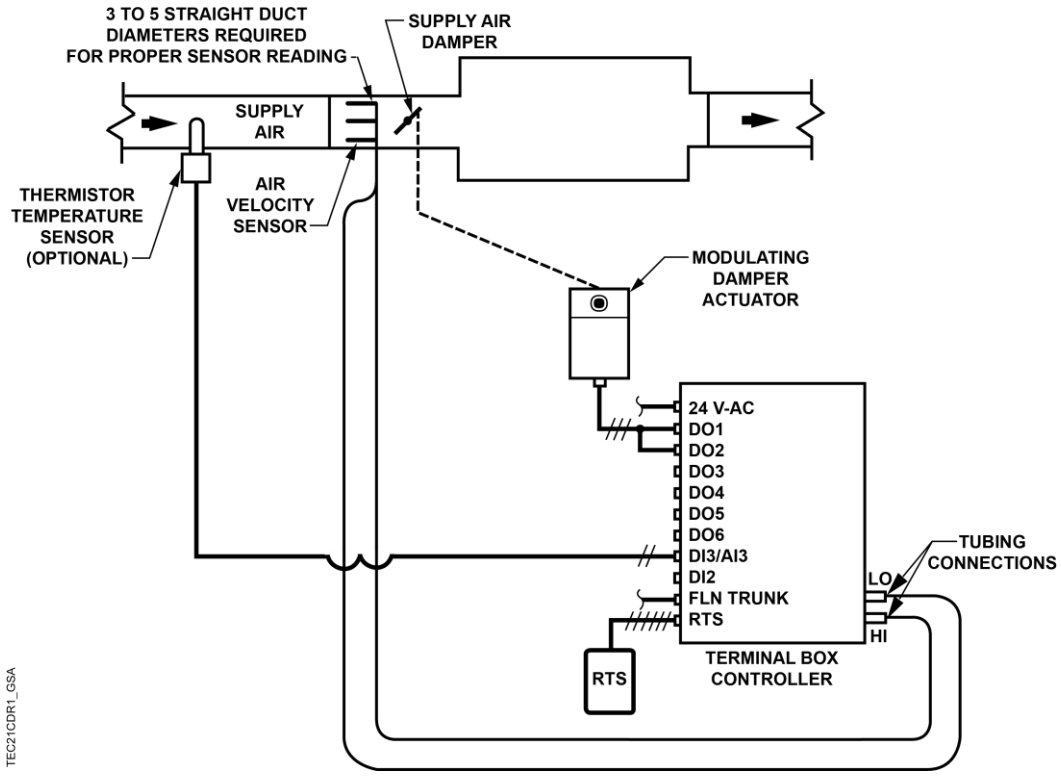
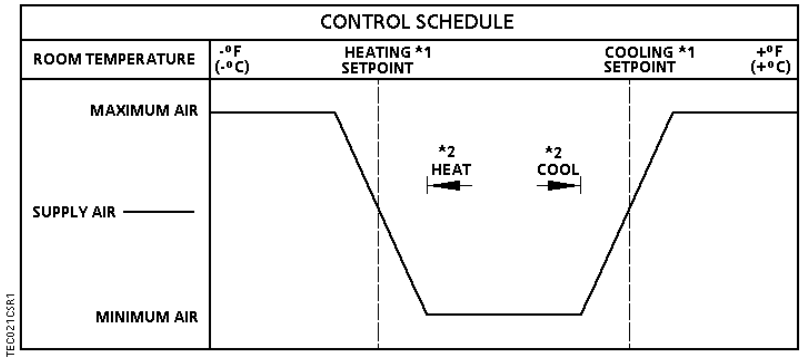


Figure 21-1. Application 21 Control Drawing.



1. See Sequence of Operation, *Heating/Cooling Setpoints*.
2. See Sequence of Operation, *Heating/Cooling Switchover Logic*.

Figure 21-2. Application 21 Control Schedule.

Hardware Outputs

Damper Actuator

Hardware Inputs

Air Velocity Sensor

Room Temperature Sensor

Duct Temperature Sensor (optional)

Point Display

Table 21-1 presents point display information for Application 21.

Ordering Notes

See *APOGEE Automation Configuration and Sizing Guidelines* on InfoLink for product numbers.

Terminal Box Controller—Electronic Output (540-100N-GS)

Duct Temperature Sensor (100kΩ)

Room Temperature Sensor

Damper Actuator

Sequence of Operation

Application 21 modulates the supply air damper of the terminal box for cooling and heating. In order for it to work properly, the central air handling unit must provide cool supply air in the cooling season and warm air in the heating season.

Day and Night Modes

In STAND-ALONE mode, the Terminal Box Controller—Electronic Output stays in DAY mode all the time. If the controller is connected to a field panel, the field panel can automatically send a command to switch the controller between DAY and NIGHT mode.

When the override switch on the room sensor is pressed during NIGHT mode, the controller switches to DAY mode for the time set in OVRD TIME (Point 20). The controller returns to NIGHT mode after OVRD TIME elapses.

The override switch on the room sensor will only have an effect on the controller when the controller is in NIGHT mode.

Control Temperature Setpoints

This application has a number of different room temperature setpoints (DAY HTG STPT, NGT CLG STPT, RM STPT DIAL, etc.). The application actually controls to CTL STPT. CTL STPT is set to different values depending on its override status, the time of day, whether or not a temperature deadband (zero energy band) has been configured, and the type of RTS used.

CTL STPT is Overridden:

If CTL STPT is overridden, that value is used regardless of any other settings. This disables the setpoint deadband feature.

CTL STPT in Night Mode:

The controller is in Night Mode if DAY.NGT = NGT and NGT OVRD = NGT.

When the controller is in night mode, CTL STPT holds the value of NGT CLG STPT or NGT HTG STPT depending on the value of HEAT.COOL. When the controller is in night mode the value of RM STPT DIAL is ignored.

CTL STPT in Day Mode:

The controller is in Day Mode if DAY.NGT = DAY or NGT OVRD = DAY.

Without setpoint dial:

When the controller is in day mode and STPT DIAL = NO, CTL STPT holds the value of DAY CLG STPT or DAY HTG STPT depending on the value of HEAT.COOL.

With setpoint dial:

When the controller is in day mode and STPT DIAL = YES. CTL STPT is set based on the value of the setpoint dial and the setpoint deadband. The setpoint deadband exists to allow the controller to provide a separation of the heating and cooling temperature setpoints when a setpoint dial is enabled. The setpoint deadband is the difference between the cooling and heating day setpoints (DAY CLG STPT - DAY HTG STPT). The setpoint deadband can be disabled by setting DAY HTG STPT equal to DAY CLG STPT. When DAY HTG STPT does not equal DAY CLG STPT, a setpoint deadband (or zero energy band) is used.

The following values are used in the calculation of CTL STPT:

- *Dial value* is the value of RM STPT DIAL limited between the value of RM STPT MIN and RM STPT MAX.
- *Deadband* is the value of the difference between DAY CLG STPT and DAY HTG STPT, half of which is applied to establish the current heating and cooling setpoints.
  - – *Deadband* = (DAY CLG STPT – DAY HTG STPT)

CTL STPT is calculated as follows:

With Deadband Disabled:

CTL STPT = *Dial value*

With Deadband enabled in Heat Mode:

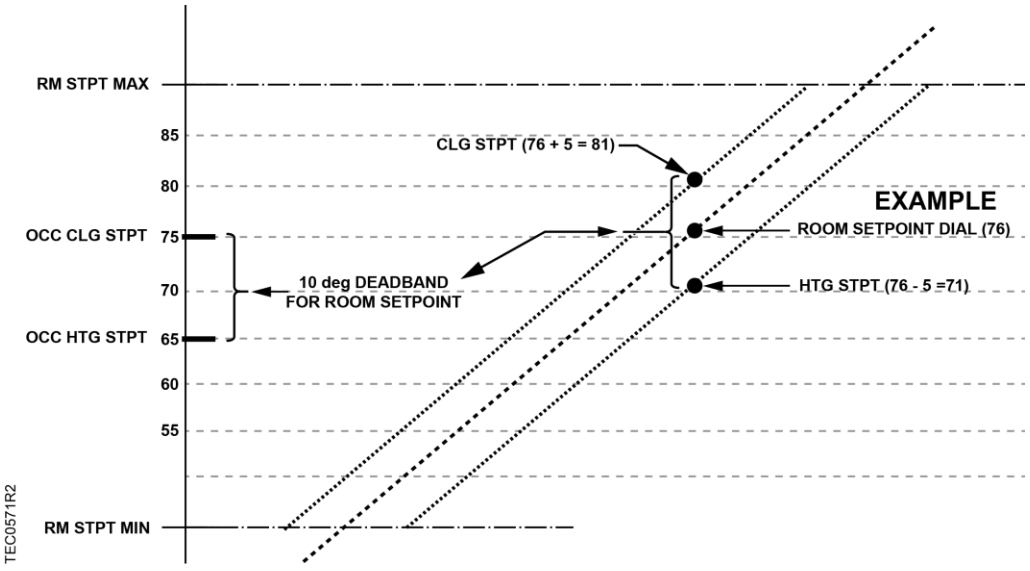
CTL STPT = *Dial value* – 0.5 × *Deadband* (limited between the value of RM STPT MIN and RM STPT MAX)

With Deadband enabled in Cool Mode:

CTL STPT = *Dial value* + 0.5 × *Deadband* (limited between the value of RM STPT MIN and RM STPT MAX).

NOTE:

If RM STPT DIAL is failed, it maintains the last known value.



Heating/Cooling Switchover Logic

There are two options for the heating/cooling switchover logic for this application. In order for the controller to function properly, one of the following options must be used:

Stand-alone Control

A temperature sensor is installed in the supply air ductwork. The controller uses the measured temperature SUPPLY TEMP (Point 15), to determine whether it is in heating or cooling mode.

- When SUPPLY TEMP (Point 15) is below the value of COOL TEMP (Point 61), the controller sets HEAT.COOL (Point 5) to COOL, switching the controller to cooling mode.
- When SUPPLY TEMP (Point 15) is above the value of HEAT TEMP (Point 62), the controller sets HEAT.COOL (Point 5) to HEAT, switching the controller to heating mode.

Centralized Control

- If the controller is connected to a field panel, the field panel can command SUPPLY TEMP (Point 15).

  When SUPPLY TEMP (Point 15) is commanded below the value of COOL TEMP (Point 61), the controller sets HEAT.COOL (Point 5) to COOL, switching the controller to cooling mode.

  When SUPPLY TEMP (Point 15) is commanded above the value of HEAT TEMP (Point 62), the controller sets HEAT.COOL (Point 5) to HEAT, switching the controller to heating mode.
- If the controller is connected to a field panel, the field panel can switch the controller between heating and cooling modes by commanding HEAT.COOL (Point 5) to HEAT or COOL.

Control Loops

The terminal box is controlled by three PID control loops: two temperature loops and a flow loop.

Temperature Loops

The two temperature loops are a heating and a cooling loop. The active temperature loop maintains CTL STPT (Point 92). See *Heating/Cooling Setpoints*.

The output of the temperature loop, CLG LOOPOUT (Point 79), or HTG LOOPOUT (Point 80), becomes the setpoint for the flow loop, FLOW STPT (Point 93).

- If the controller is in cooling mode, CTL FLOW MIN (Point 76) is set to CLG FLOW MIN (Point 31) and CTL FLOW MAX (Point 77) is set to CLG FLOW MAX (Point 32).
- If the controller is in heating mode, CTL FLOW MIN (Point 76) is set to HTG FLOW MIN (Point 33) and CTL FLOW MAX (Point 77) is set to HTG FLOW MAX (Point 34).

Advanced PID algorithm for the temperature control loops is employed to provide stability and to reduce unnecessary changes in the Flow setpoint when the room temperature is at or near the room temperature setpoint.

Flow Loop

The flow loop maintains FLOW STPT (Point 93) by modulating the supply air damper, DMPR COMD (Point 48). The flow loop maintains the airflow between the limits set in CTL FLOW MIN (Point 76) and CTL FLOW MAX (Point 77).

FLOW (Point 75) is the input value for the flow loop. It is calculated as a percentage based on where AIR VOLUME (Point 35) is between CTL FLOW MIN (Point 76) and CTL FLOW MAX (Point 77).

- If AIR VOLUME (Point 35) = CTL FLOW MIN (Point 76), FLOW (Point 75) = 0%
- If AIR VOLUME (Point 35) = CTL FLOW MAX (Point 77), FLOW (Point 75) = 100%

In addition to the existing options for floating control actuator full stroke actions; all floating control actuators are provided with additional logic to fully drive open or closed when commanded to 100% or 0%.

Application Notes

If temperature swings in the room are excessive, or if there is trouble maintaining the setpoint, or if the damper is oscillating while FLOW STPT (Point 93) is constant, the cooling loop, the heating loop, or both require tuning. See *APOGEE Automation Service Procedures* on InfoLink for more information.

NOTE:
The Terminal Box Controller, as shipped from the factory, keeps all associated equipment OFF. The controller and its equipment are released to application control at startup.

CAUTION:

The controller's DOs control 24 Vac loads only. The maximum rating is 12 VA for each DO. Use an interposing 220V 4-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

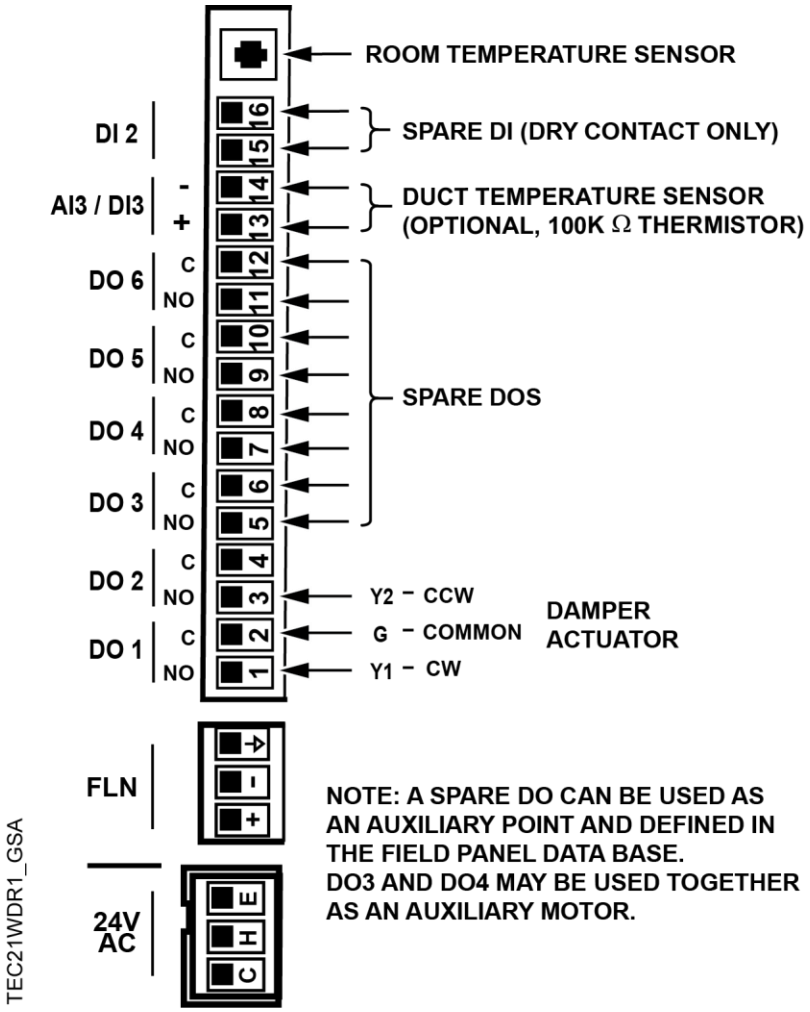


Figure 21-3. Wiring Diagram for Application 21.

Table 21-1. Point Database for Application 21.

Point Number	Descriptor	Factory Default (metric)	Engr. Units (metric)	Slope (metric)	Intercept (metric)	On Text	Off Text
01	CTLR ADDRESS	99	–	1	0	–	–
02	APPLICATION	91	–	1	0	–	–
{04}	ROOM TEMP	74.00 (23.45)	DEG F (DEG C)	0.250 (0.14)	48.00 (8.89)	–	–
{05}	HEAT.COOL	COOL	–	–	–	HEAT	COOL
06	DAY CLG STPT	74.00 (23.45)	DEG F (DEG C)	0.250 (0.14)	48.00 (8.89)	–	–
07	DAY HTG STPT	70.00 (21.21)	DEG F (DEG C)	0.250 (0.14)	48.00 (8.89)	–	–
08	NGT CLG STPT	82.00 (27.93)	DEG F (DEG C)	0.250 (0.14)	48.00 (8.89)	–	–
09	NGT HTG STPT	65.00 (18.41)	DEG F (DEG C)	0.250 (0.14)	48.00 (8.89)	–	–
11	RM STPT MIN	55.00 (12.81)	DEG F (DEG C)	0.250 (0.14)	48.00 (8.89)	–	–
12	RM STPT MAX	90.00 (32.41)	DEG F (DEG C)	0.250 (0.14)	48.00 (8.89)	–	–
{13}	RM STPT DIAL	74.00 (23.45)	DEG F (DEG C)	0.250 (0.14)	48.00 (8.89)	–	–
14	STPT DIAL	NO	–	–	–	YES	NO
{15}	SUPPLY TEMP	74.0 (23.66)	DEG F (DEG C)	0.5 (0.28)	37.5 (3.06)	–	–
{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
{29}	DAY.NGT	DAY	–	–	–	NIGHT	DAY
31	CLG FLOW MIN	219.607849 (1115.576538)	CFM (LPS)	15.686275 (79.684036)	0.000000	–	–
32	CLG FLOW MAX	2196.078369 (11155.764648)	CFM (LPS)	15.686275 (79.684036)	0.000000	–	–
33	HTG FLOW MIN	219.607849 (1115.576538)	CFM (LPS)	15.686275 (79.684036)	0.000000	–	–

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 the next page...

Table 21-1. Point Database for Application 21.

Point Number	Descriptor	Factory Default (metric)	Engr. Units (metric)	Slope (metric)	Intercept (metric)	On Text	Off Text
34	HTG FLOW MAX	2196.078369 (11155.764648)	CFM (LPS)	15.686275 (79.684036)	0.000000	–	–
{35}*	AIR VOLUME *	0.000000	CFM (LPS)	15.686275 (79.684036)	0.000000	–	–
36	FLOW COEFF	1.00	–	0.01	0.00	–	–
{41}	DO 1	OFF	–	–	–	ON	OFF
{42}	DO 2	OFF	–	–	–	ON	OFF
{43}	DO 3	OFF	–	–	–	ON	OFF
{44}	DO 4	OFF	–	–	–	ON	OFF
{45}	DO 5	OFF	–	–	–	ON	OFF
{46}	DO 6	OFF	–	–	–	ON	OFF
{48}	DMPR COMD	0.0	PCT	0.4	0.0	–	–
{49}	DMPR POS	0.0	PCT	0.4	0.0	–	–
51	MTR1 TIMING	95	SEC	1	0	–	–
{52}	MTR2 COMD	0.0	PCT	0.4	0.0	–	–
{53}	MTR2 POS	0.0	PCT	0.4	0.0	–	–
55	MTR2 TIMING	130	SEC	1	0	–	–
56	DMPR ROT ANG	90	–	1	0	–	–
58	MTR SETUP	0	–	1	0	–	–
59	DO DIR. REV	0	–	1	0	–	–
61	COOL TEMP	65.0 (18.62)	DEG F (DEG C)	0.5 (0.28)	0.0 (-17.78)	–	–
62	HEAT TEMP	80.0 (27.0)	DEG F (DEG C)	0.5 (0.28)	0.0 (-17.78)	–	–
63	CLG P GAIN	20.00 (36.00)	–	0.25 (0.45)	0.00	–	–
64	CLG I GAIN	0.012 (0.0216)	–	0.006 (0.0108)	0.000	–	–
65	CLG D GAIN	0	–	2 (3.6)	0	–	–
66	CLG BIAS	0.0	PCT	0.4	0.0	–	–
67	HTG P GAIN	10.00 (18.00)	–	0.25 (0.45)	0.00	–	–
68	HTG I GAIN	0.01 (0.0216)	–	0.006 (0.0108)	0.000	–	

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. * If this point is unbundled, you must enter a new slope at the field panel in order to display accurate readings in cfm (lps) Calculate the new slope as follows: New Slope = Default Slope × Duct Area.
4. Point numbers that appear in brackets { } may be unbundled at the field panel.

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Table 21-1. Point Database for Application 21.

Point Number	Descriptor	Factory Default (metric)	Engr. Units (metric)	Slope (metric)	Intercept (metric)	On Text	Off Text
69	HTG D GAIN	0	–	2 (3.6)	0	–	–
70	HTG BIAS	0.0	PCT	0.4	0.0	–	–
71	FLOW P GAIN	0.25	–	0.25	0.00	–	
72	FLOW I GAIN	0.018	–	0.006	0.000	–	–
73	FLOW D GAIN	0	–	2	0	–	–
74	FLOW BIAS	50.0	PCT	0.4	0.0	–	–
{75}	FLOW	-100	PCT	2	-100	–	–
{76}*	CTL FLOW MIN*	219.607849 (1115.576538)	CFM (LPS)	15.686275 (79.684036)	0.000000	–	–
{77}*	CTL FLOW MAX*	2196.078369 (11155.764648)	CFM (LPS)	15.686275 (79.684036)	0.000000	–	–
{78}	CTL TEMP	74.00 (23.45)	DEG F (DEG C)	0.25 (0.14)	48.00 (8.89)	–	–
{79}	CLG LOOPOUT	0.0	PCT	0.4	0.0	–	–
{80}	HTG LOOPOUT	0.0	PCT	0.4	0.0	–	–
{91}	TOTAL VOLUME	0.000000	CF (L)	15.686275 (4781.176758)	0.000000	–	–
{92}	CTL STPT	74.00 (23.45)	DEG F (DEG C)	0.25 (0.14)	48.00 (8.89)	–	–
{93}	FLOW STPT	76	PCT	2	-100	–	–
{94}	CAL AIR	NO	–	–	–	YES	NO
95	CAL SETUP	1	–	1	0	–	–
96	CAL TIMER	12	HRS	1	0	–	–
97	DUCT AREA	1.000 (0.092903)	SQ FT (SQ M)	0.025 (0.002323)	0.000000	–	–
98	LOOP TIME	5	SEC	1	0	–	–
{99}	ERROR STATUS	–	–	–	–	–	–

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. * If this point is unbundled, you must enter a new slope at the field panel in order to display accurate readings in cfm (lps). Calculate the new slope as follows: New Slope = Default Slope × Duct Area.
4. Point numbers that appear in brackets { } may be unbundled at the field panel.

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