SIEMENS

Terminal Box Controller—Electronic Output

VAV Parallel Fan Powered with Electric Reheat

Application 26

Application Note

(Firmware Revision: VV06)

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Overview

In Application 26, the controller modulates the supply air damper of the terminal box for cooling and controls stages of electric reheat for heating. When in heating, the terminal box maintains minimum airflow. The terminal box also has a parallel fan which recirculates the room air. In order for the terminal box to work properly, the central air handling unit must provide supply air.

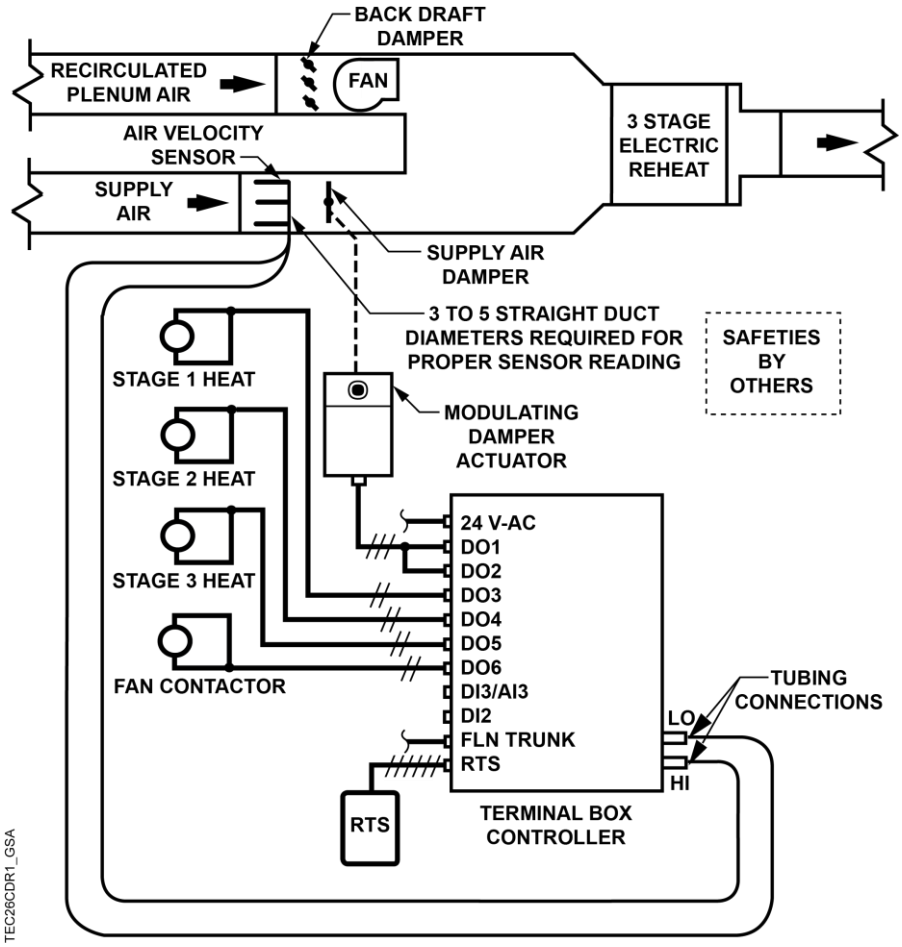
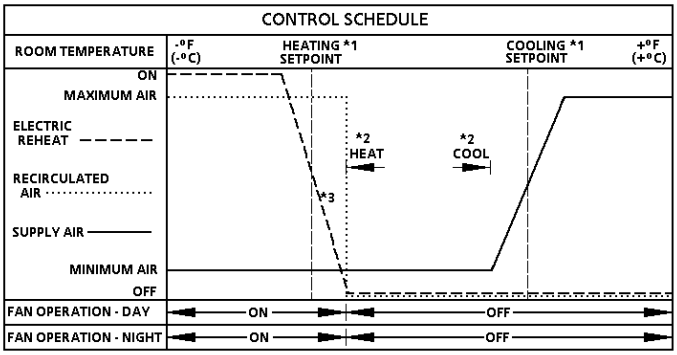


Figure 26-1. Application 26 Control Drawing.



1. See Sequence of Operation, *Heating/Cooling Setpoints*.
2. See Sequence of Operation, *Heating/Cooling Switchover Logic*.
3. The electric reheat is time modulated. This allows it to be controlled proportionally rather than with deadbands.

Figure 26-2. Application 26 Control Schedule.

Hardware Outputs

Damper Actuator

Stage 1 Electric Reheat

Stage 2 Electric Reheat (optional)

Stage 3 Electric Reheat (optional)

Fan

Hardware Inputs

Air Velocity Sensor

Room Temperature Sensor

Point Display

Table 26-1 presents point display information for Application 26.

Ordering Notes

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

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

Room Temperature Sensor

Damper Actuator

Sequence of Operation

Application 26 modulates the supply air damper of the terminal box for cooling and controls stages of electric reheat for heating. When heating, the supply air damper is set to minimum position. The terminal box also has a parallel fan which recirculates the room air. In order for the terminal box to work properly, the central air handling unit must provide supply air.

Day and Night Modes

In STAND-ALONE mode, the controller 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 modes.

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:

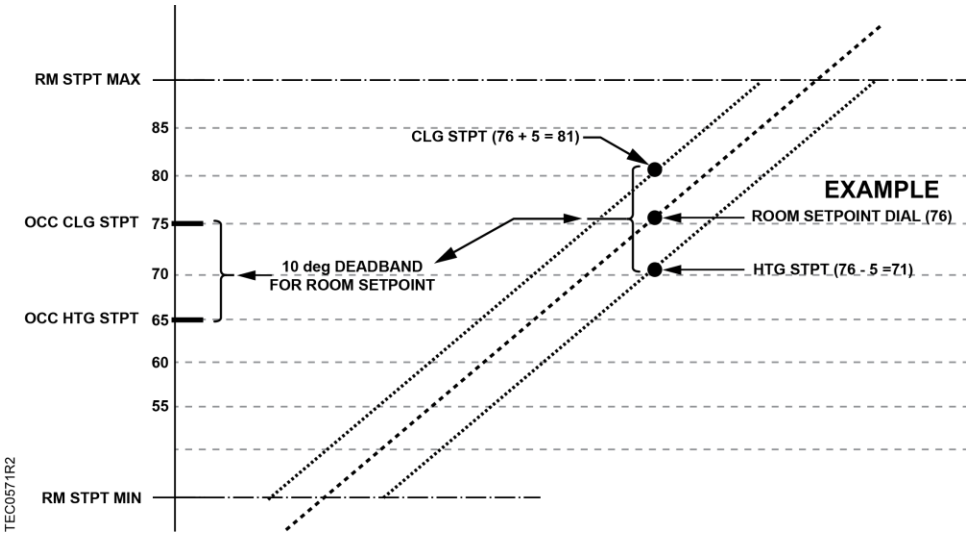
CTL STPT = *Dial value* – 0.5 × *Deadband* (limited between the value of RM STPT MIN and RM STPT MAX)

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

The heating/cooling switchover logic determines whether the controller is in heating or cooling mode by monitoring the room temperature and the demand for heating and cooling (as determined by the temperature control loops).

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

- HTG LOOPOUT (Point 80) < SWITCH LIMIT (Point 85).
- CTL TEMP (Point 78) > CTL STPT (Point 92) by at least the value set in SWITCH DBAND (Point 90).

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

- CLG LOOPOUT (Point 79) < SWITCH LIMIT (Point 85).
- CTL TEMP (Point 78) < CTL STPT (Point 92) by at least the value set in SWITCH DBAND (Point 90).

Control Loops

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

Temperature Loops

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

Cooling Mode – CLG LOOPOUT (Point 79) becomes the setpoint for the flow loop, FLOW STPT (Point 93). 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).

Heating Mode – FLOW STPT (Point 93) is set to 0%. This maintains minimum airflow through the terminal box. 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 the 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%.

Electric Reheat

The heating loop controls staged electric heat to warm the room. The electric heat is time modulated using a duty cycle.

Example

1. There is one stage of electric heat.
2. The duty cycle period is five minutes.
3. The heating loop is calling for 50% of heating. (HTG LOOPOUT (Point 80) = 50%).

In this situation, during every 5-minute period the electric heat would be ON for 2.5 minutes and OFF for 2.5 minutes.

With three stages of heat rather than one:

1. The first stage of heat would be ON all the time.
2. The second stage of heat would cycle between 2.5 minutes ON and 2.5 minutes OFF.
3. The third stage of heat would be OFF all the time.

In DAY mode, it is assumed that the air handling unit provides supply air to the terminal box all the time.

In cooling mode, the electric heat is OFF.

Fan Operation

The FAN (Point 46) is ON in both DAY and NIGHT modes when the electric heat is ON. The FAN will not turn OFF unless the electric heat has been OFF for at least one duty cycle, STAGE TIME (Point 89).

In cooling mode, the FAN (Point 46) is OFF.

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.

Application Notes

If temperature swings in the room are excessive or if there is trouble maintaining the setpoint, the cooling loop, the heating loop, or both require tuning. If the damper is oscillating while FLOW STPT (Point 93) is constant, the flow loop will 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

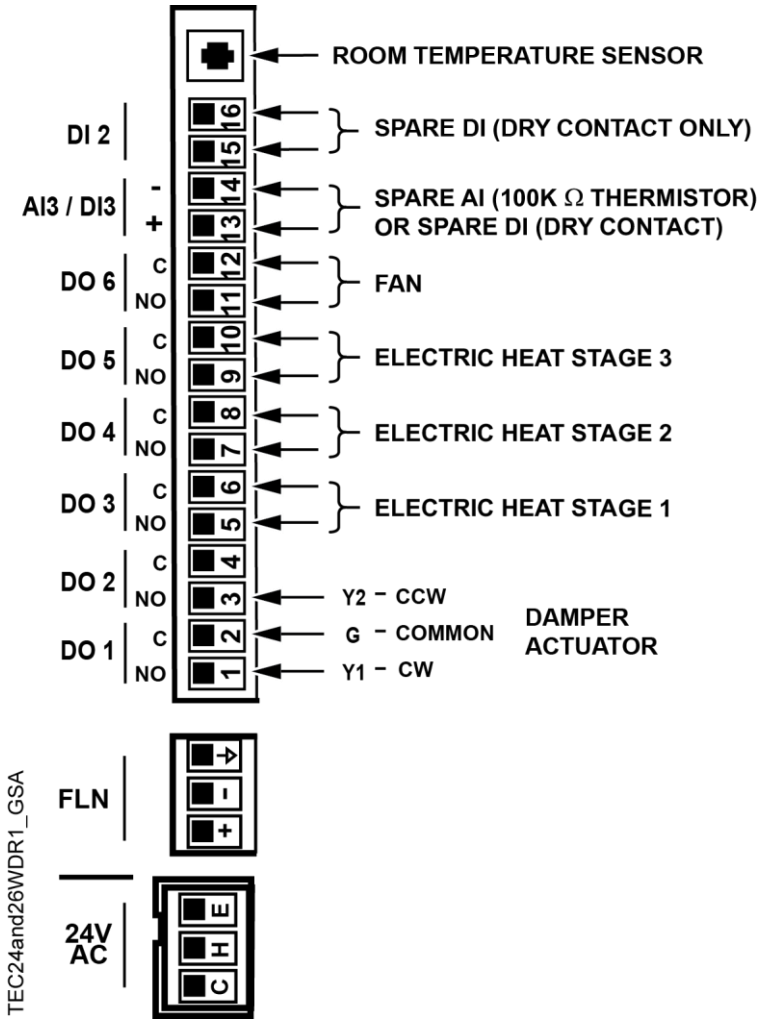


Figure 26-3. Point Wiring for Application 26.

Table 26-1. Point Database for Application 26.

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)	0.25 (0.14)	48.00 (8.89)	–	–
{05}	HEAT.COOL	COOL	–	–	–	HEAT	COOL
06	DAY CLG STPT	74.00 (23.449)	DEG F (DEG C)	0.25 (0.14)	48.00 (8.89)	–	–
07	DAY HTG STPT	70.00 (21.209)	DEG F (DEG C)	0.25 (0.14)	48.00 (8.89)	–	–
08	NGT CLG STPT	82.00 (27.929)	DEG F (DEG C)	0.25 (0.14)	48.00 (8.89)	–	–
09	NGT HTG STPT	65.00 (18.409)	DEG F (DEG C)	0.25 (0.14)	48.00 (8.89)	–	–
11	RM STPT MIN	55.00 (12.809)	DEG F (DEG C)	0.25 (0.14)	48.00 (8.89)	–	–
12	RM STPT MAX	90.00 (32.409)	DEG F (DEG C)	0.25 (0.14)	48.00 (8.89)	–	–
{13}	RM STPT DIAL	74.00 (23.449)	DEG F (DEG C)	0.25 (0.14)	48.00 (8.89)	–	–
14	STPT DIAL	NO	–	–	–	YES	NO
{15}	AUX 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
{25}	DI 3	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 26-1. Point Database for Application 26.

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}	HEAT STAGE 1	OFF	–	–	–	ON	OFF
{44}	HEAT STAGE 2	OFF	–	–	–	ON	OFF
{45}	HEAT STAGE 3	OFF	–	–	–	ON	OFF
{46}	FAN	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	–	–
56	DMPR ROT ANG	90	–	1	0	–	–
58	MTR SETUP	0	–	1	0	–	–
59	DO DIR. REV	0	–	1	0	–	–
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	0.012 (0.0216)	–	0.006 (0.0108)	0.000	–	–
69	HTG D GAIN	0	–	2 (3.600)	0	–	–
70	HTG BIAS	0.0	PCT	0.4	0.0	–	–

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. * 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 26-1. Point Database for Application 26.

Point Number	Descriptor	Factory Default (metric)	Engr. Units (metric)	Slope (metric)	Intercept (metric)	On Text	Off Text
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 (3.6)	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	–	–
{81}	AVG HEAT OUT	0	–	2	0	–	–
82	STAGE MAX	90.0	PCT	0.4	0.0	–	–
83	STAGE 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	STAGE COUNT	3	–	1	0	–	–
89	STAGE TIME	10	MIN	1	0	–	–
90	SWITCH DBAND	2.00 (1.12)	DEG F (DEG C)	0.25 (0.14)	0.000	–	–
{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	1.0000 (0.092903)	SQ FT (SQ M)	0.025 (0.002323)	0.000	–	–
98	LOOP TIME	5	SEC	1	0	–	–
{99}	ERROR STATUS	–	–	–	–	–	–

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