SIEMENS

TEC Custom Solution 2851

Four-Pipe Fan Coil Heating and Cooling with 4-20mA Temperature Input

TEC-0372.08

Overview

In Application 2851, the controller modulates separate valves in the fan coil unit for cooling and 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 and hot water.

Application 2851 is based on and has the same functionality as Application 2051 (*Four-Pipe Fan Coil Unit Cooling and Heating*). **The difference is that the control loops in Application 2851 receive room temperature input from a 4-20mA sensor connected to AI 3 instead of from the room stat.** (Application 2851 requires a 4-20mA sensor with a range of 40-90 degrees F.) Also, Application 2851 runs on a Custom Solution controller (Figure 2851-3) that has a wider variety of spare I/O terminations than does the standard Unit Conditioner Controller running Application 2051. Refer to Figures 2851-1 and 2851-3.

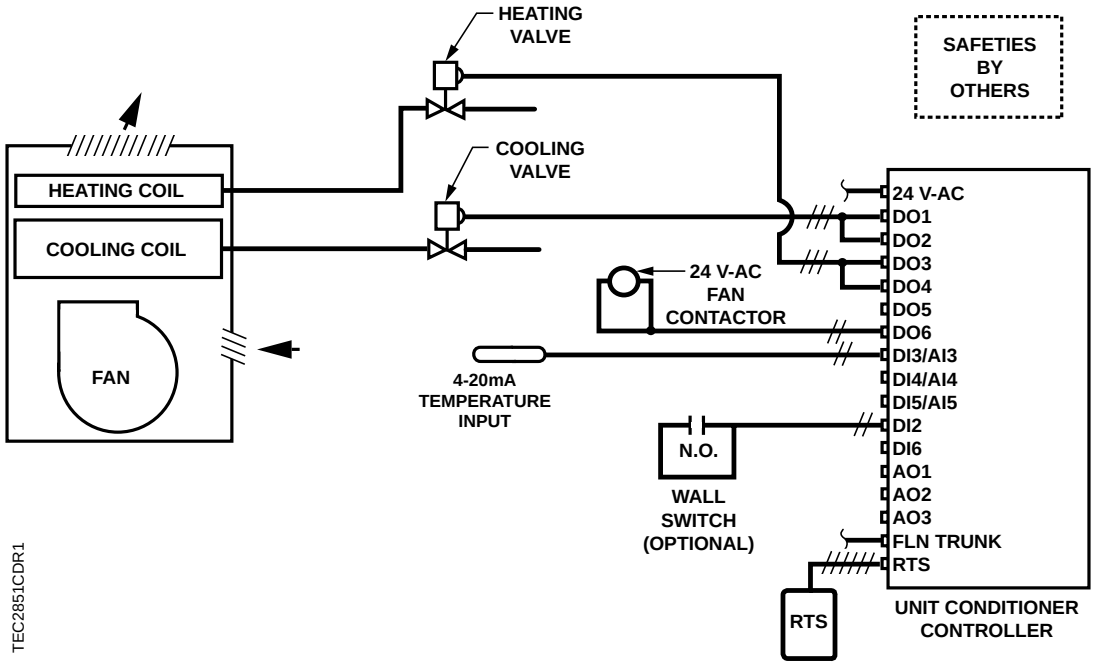
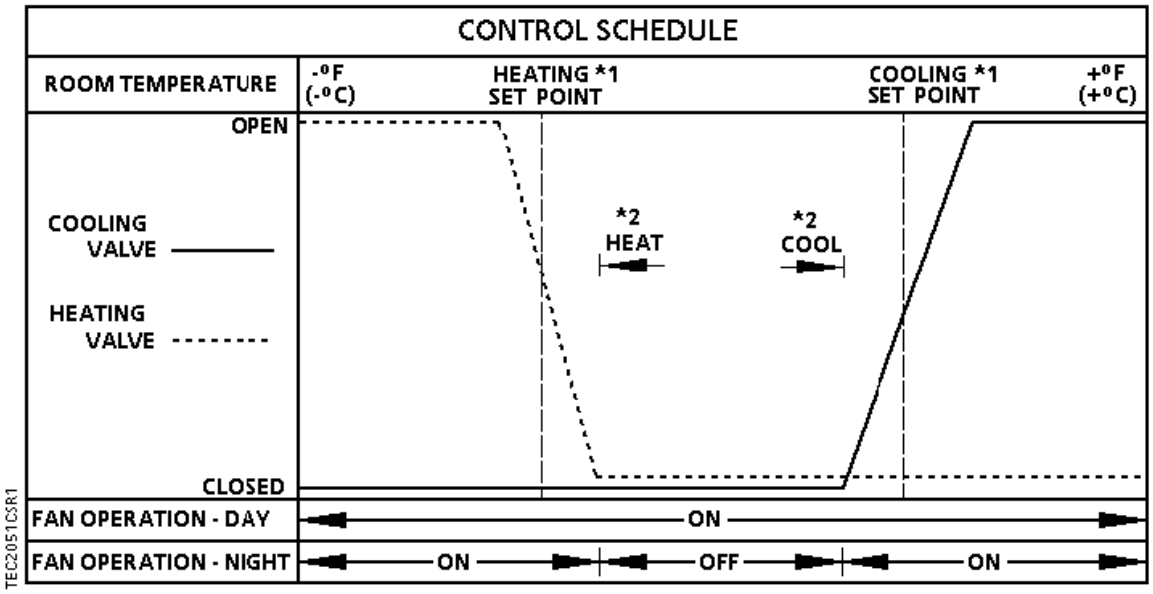


Figure 2851-1. Application 2851 Control Drawing.



1 See Sequence of Operation, Control Temperature Setpoints.
2. See Sequence of Operation, Heating/Cooling Switchover.

Figure 2851-2. Application 2851 Control Schedule.

Hardware Inputs

Analog

- 4-20mA (for room temperature sensor, 40-90 deg F)
- 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 (cooling)
- 2nd valve actuator (heating)

Ordering Notes

Custom Solution Fan Coil Unit Cooling/Heating Controller with 4-20mA Temperature Input — Part No. 540-863W

- Application 2851 requires a 4-20mA sensor with a range of 40-90 deg. F.

Sequence of Operation

The following paragraphs present the sequence of operation for Application 2851, “Four-Pipe Fan Coil Unit Cooling and Heating with 4-20mA Temperature Input.”

Control Temperature Set Points

The 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 (Point 92). CTL STPT is set to different values as explained in the following:

CTL STPT is Overridden - When CTL STPT is overridden it will equal its overridden value and the application will have no effect on the value of CTL STPT. Also when CTL STPT is overridden, it will always have a status of Normal, even if the Status of RM STPT DIAL (Point 13) is Failed.

Night Mode – In night mode, CTL STPT holds the value of NGT CLG STPT (Point 08) or NGT HTG STPT (Point 09). This is true whether or not a setpoint dial is being used. Also during night mode, CTL STPT will always have a status of Normal, even if the status of RM STPT DIAL is Failed.

Day Mode (setpoint dial not used) – In the day mode when a setpoint dial is not being used, then CTL STPT holds the value of DAY CLG STPT (Point 06) or DAY HTG STPT (Point 07). Also, CTL STPT will always have a Status of Normal, even if the Status of RM STPT DIAL is Failed.

Room Temperature Setpoint Dial

When STPT DIAL (Point 14) = NO, a room temperature setpoint dial is not being used. A setpoint dial is being used when STPT DIAL is YES. When a setpoint dial is present, it is only used when both of the following 2 conditions hold:

- The controller is in Day mode.
- CTL STPT is not overridden.

If these 2 conditions are both true, then:

- When RM STPT DIAL (Point 13) has a status of Normal, CTL STPT will have a status of Normal. The current value of RM STPT DIAL will be used to determine the value of CTL STPT.
- When RM STPT DIAL has a status of Failed and RM STPT DIAL is overridden, CTL STPT will have a status of Normal. The current value of RM STPT DIAL will be used to determine the value of CTL STPT.
- When RM STPT DIAL has a status of Failed and RM STPT DIAL is not overridden, CTL STPT will have a status of Failed. The last known good value of RM STPT DIAL will be used to determine the value of CTL STPT.

When a setpoint dial is being used, the actual value of CTL STPT will depend on whether or not a deadband being used. The following 2 sections will explain this further. In both of these sections, the following assumptions are made:

- A setpoint dial is being used.
- The controller is in Day mode.
- CTL STPT is not overridden.

Setpoint dial used without a deadband

When DAY HTG STPT equals DAY CLG STPT, a setpoint deadband is not being used. (A space where the deadband is not used may be more comfortable than a space where the deadband is being used.) If a setpoint deadband is not being used, then:

1. CTL STPT will equal RM STPT MAX (Point 12) if RM STPT DIAL > RM STPT MAX.
2. CTL STPT will equal RM STPT MIN (Point 11) if RM STPT DIAL < RM STPT MIN.
3. Otherwise, CTL STPT will equal RM STPT DIAL.

Setpoint dial used with a deadband

When DAY HTG STPT does not equal DAY CLG STPT, a setpoint deadband (or zero energy band) is being used. (A space where the deadband is used can be more energy efficient than a space where the deadband is not being used.) If a setpoint deadband is being used, then:

When HEAT.COOL (Point 5) equals HEAT.

1. If RM STPT DIAL > than RM STPT MAX, then:
   a. If [RM STPT MAX – 0.5 * (DAY CLG STPT – DAY HTG STPT)] > RM STPT MAX, then CTL STPT will equal RM STPT MAX.
   b. If [RM STPT MAX – 0.5 * (DAY CLG STPT – DAY HTG STPT)] < RM STPT MIN, then CTL STPT will equal RM STPT MIN.
   c. Otherwise, CTL STPT will equal RM STPT MAX – 0.5 * (DAY CLG STPT – DAY HTG STPT).
2. If RM STPT DIAL < than RM STPT MIN, then:
   a. If [RM STPT MIN – 0.5 * (DAY CLG STPT – DAY HTG STPT)] > RM STPT MAX, then CTL STPT will equal RM STPT MAX.
   b. If [RM STPT MIN – 0.5 * (DAY CLG STPT – DAY HTG STPT)] < RM STPT MIN, then CTL STPT will equal RM STPT MIN.
   c. Otherwise, CTL STPT will equal RM STPT MIN – 0.5 * (DAY CLG STPT – DAY HTG STPT).
3. If RM STPT MAX > RM STPT DIAL > RM STPT MIN, then:
   a. If [RM STPT DIAL – 0.5 * (DAY CLG STPT – DAY HTG STPT)] > RM STPT MAX, then CTL STPT will equal RM STPT MAX.
   b. If [RM STPT DIAL – 0.5 * (DAY CLG STPT – DAY HTG STPT)] < RM STPT MIN, then CTL STPT will equal RM STPT MIN.
   c. Otherwise, CTL STPT will equal RM STPT DIAL – 0.5 * (DAY CLG STPT – DAY HTG STPT).

When HEAT.COOL (Point 5) equals COOL.

1. If RM STPT DIAL > than RM STPT MAX, then:
   a. If [RM STPT MAX + 0.5 * (DAY CLG STPT – DAY HTG STPT)] > RM STPT MAX, then CTL STPT will equal RM STPT MAX.
   b. If [RM STPT MAX + 0.5 * (DAY CLG STPT – DAY HTG STPT)] < RM STPT MIN, then CTL STPT will equal RM STPT MIN.
   c. Otherwise, CTL STPT will equal RM STPT MAX + 0.5 * (DAY CLG STPT – DAY HTG STPT).
2. If RM STPT DIAL < than RM STPT MIN, then:
   a. If [RM STPT MIN + 0.5 * (DAY CLG STPT – DAY HTG STPT)] > RM STPT MAX, then CTL STPT will equal RM STPT MAX.
   b. If [RM STPT MIN + 0.5 * (DAY CLG STPT – DAY HTG STPT)] < RM STPT MIN, then CTL STPT will equal RM STPT MIN.
   c. Otherwise, CTL STPT will equal RM STPT MIN + 0.5 * (DAY CLG STPT – DAY HTG STPT).
3. If RM STPT MAX > RM STPT DIAL > RM STPT MIN, then:
   a. If [RM STPT DIAL + 0.5 * (DAY CLG STPT – DAY HTG STPT)] > RM STPT MAX, then CTL STPT will equal RM STPT MAX.
   b. If [RM STPT DIAL + 0.5 * (DAY CLG STPT – DAY HTG STPT)] < RM STPT MIN, then CTL STPT will equal RM STPT MIN.
   c. Otherwise, CTL STPT will equal RM STPT DIAL + 0.5 * (DAY CLG STPT – DAY HTG STPT).

NOTE: The value of the point CTL TEMP (Point 78) is the same as the value of the point ROOM TEMP (Point 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 (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 2851-1 and 2851-3), and the point WALL SWITCH (Point 18) equals YES, the controller monitors the status of DI 2. When the status of the point 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, 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 (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 the point 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 bymonitoring 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).
- CTL TEMP > the appropriate cooling set point minus SWITCH DBAND.

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

- CLG LOOPOUT (Point 79) < SWITCH LIMIT.

- CTL TEMP < CTL STPT by at least the value set in SWITCH DBAND.
- CTL TEMP < the appropriate heating setpoint 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 (Point 92). Refer to “Control Temperature Set Points”.

Cooling Operation

In cooling mode, the controller uses the points CTL STPT (Point 92) and CTL TEMP (Point 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 (Point 79) which modulates the heating/cooling valve point, VLV 1 COMD (Point 48). The point HTG LOOPOUT (Point 80) is set to 0%.

Heating Operation

In heating mode, the controller uses the points CTL STPT (Point 92) and CTL TEMP (Point 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 (Point 80) which modulates
the hot water valve, VLV 2 COMD (Point 52), in order to warm up the space. CLG LOOPOUT (Point 79) is set to 0%.

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 (Point 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 POS (Point 49) or VLV 2 POS (Point 53), is open more than the value of the point STAGE FAN (Point 84), the fan will turn ON.

2. If both valves are closed below the value of the point SWITCH LIMIT (Point 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 (Point 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 valves closed, and then resetting the values of VLV 1 POS (Point 49) and VLV 2 POS (Point 53) to 0. The actuators are then released to normal control.

Fail-Safe Operation

If the room 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 cooling valve is not being controlled by the application, DO 1 and DO 2 may be used as auxiliary motor points. If a heating valve is not being controlled by the application, 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 VLV 1 COMD (Point 48) for DO 1 and DO 2 and VLV 2 COMD (Point 52) for DO 3 and DO 4. See APOGEE Automation Start-up Procedures on InfoLink for more information.

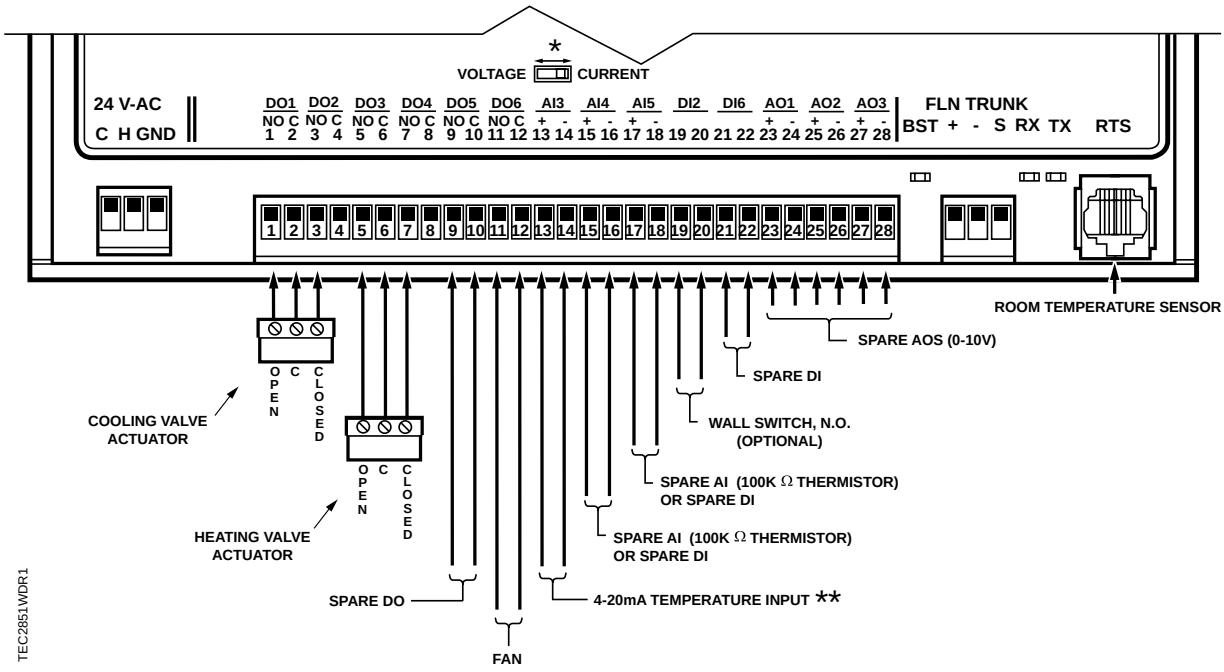
Wiring Diagram

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.

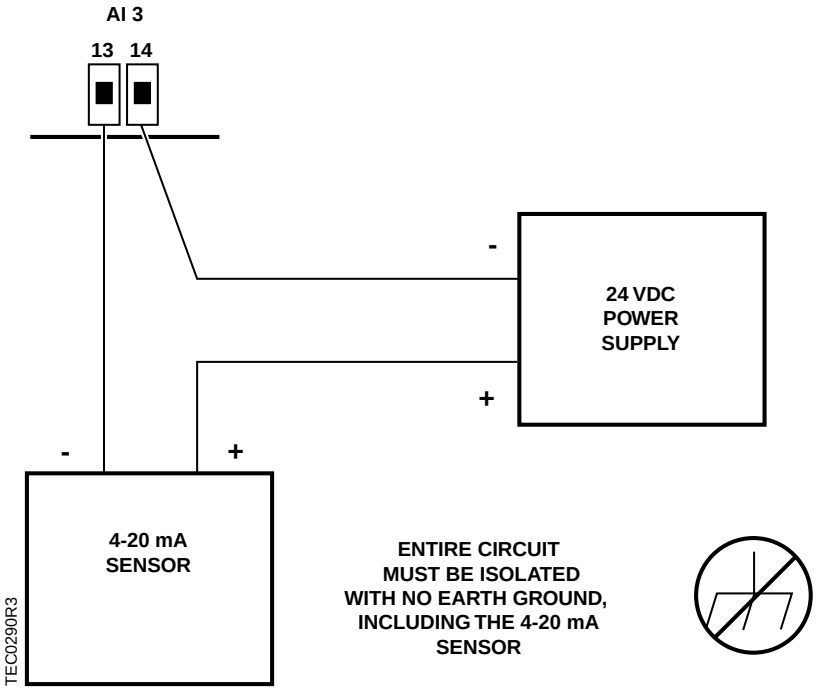


* Dipswitch for AI 3 on controller's circuit board (under controller's cover) must be in *current* position.
**The 4-20mA sensor must be wired as per instructions in Figure 2851-4.

Figure 2851-3. Application 2851 Wiring Diagram.

CAUTION:

Refer to Figure 2851-4 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 2851-4. 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.

Point Database

Table 2851-1. Point Database for Application 2851.

NOTE: 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 (23.45)	DEG F (DEG C)	0.25 (0.14)	48.0(8.89)	--	--
{05}	HEAT.COOL	COOL	--	--	--	HEAT	COOL
06	DAY CLG STPT	74.0 (23.45)	DEG F (DEG C)	0.2 (0.111111)	40.0 (4.44)	--	--
07	DAY HTG STPT	70.0 (21.21)	DEG F (DEG C)	0.2 (0.111111)	40.0 (4.44))	--	--
08	NGT CLG STPT	82.0 (27.93)	DEG F (DEG C)	0.2 (0.111111)	40.0 (4.44))	--	--
09	NGT HTG STPT	65.0 (18.41)	DEG F (DEG C)	0.2 (0.111111)	40.0 (4.44))	--	--
11	RM STPT MIN	55.0 (12.81)	DEG F (DEG C)	0.2 (0.111111)	40.0 (4.44))	--	--
12	RM STPT MAX	90.0 (32.41)	DEG F (DEG C)	0.2 (0.111111)	40.0 (4.44))	--	--
{13}	RM STPT DIAL	74.0 (23.45)	DEG F (DEG C)	0.25 (0.14)	48.0 (8.89)	--	--
14	STPT DIAL	NO	--	--	--	YES	NO
{15}	ROOM TEMP	74.0 (23.45)	DEG F (DEG C)	0.2 (0.111111)	40.0 (4.44)	--	--
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}	AI 4	37.5 (3.056)	DEG F (DEG C)	0.5 (0.28)	37.5 (3.056)	--	--
{31}	AI 5	37.5 (3.056)	DEG F (DEG C)	0.5 (0.28)	37.5 (3.056)	--	--
{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

Point Number	Descriptor	Factory Default (SI Units)	Engr Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
{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
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 (4.44)	DEG F (DEG C)	0.2 (0.111)	40.0 (4.44)	--	--
{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	--	--
86	SWITCH TIME	10.000	MIN	1	0.0		
90	SWITCH DBAND	1 (.560)	DEG F (DEG C)	0.2 (0.111)	0		
{92}	CTL STPT	40.0 (4.44)	DEG F (DEG C)	0.2 (0.111))	40.0 (4.44)	--	--
96	CAL TIMER	12	HRS	1	0	--	--
98	LOOP TIME	5	SEC	1	0	--	--
{99}	ERROR STATUS	0	--	1	0	--	--