

Application 2503 Constant Volume AHU with 2-Position 100 % OA Damper Cold Water Cooling and/or Hot Water Heating

Table of Contents

Application 2503 Overview	2
Hardware Inputs.....	7
Hardware Outputs.....	7
Sequence of Operation.....	8
Application 2503 Action Table	8
Shared I/O.....	10
Enable/Disable Points.....	10
Control Temperature Setpoint.....	11
Occupied and Unoccupied Modes	11
Unoccupied Mode Override Switch.....	11
Heating/Cooling Switchover.....	12
Control Loops.....	12
Morning Warm-up/Cool down Determination.....	13
Warm-up Mode Operation	14
Cool down Mode Operation	14
Occupied Heating Operation.....	15
Occupied Cooling Operation.....	15
Unoccupied Heating/Cooling Mode Determination.....	16
Unoccupied Heating Operation	17
Unoccupied Cooling Operation	17
Unoccupied Mode Operation	18
Fail-safe Operation.....	19
Room Temperature Sensor Failure	23
Fan and Damper Operation	23
AOV Control of Hot water and Cold Water Valves	24
Hot Water Valve AOV Calculations:	24
Cold Water Valve AOV Calculations:	24
Application 2503 and CSAL Applications.....	24
CAV 100% OA, CC Sequence of Operation	26
CAV 100% OA, CC w/o LTD Sequence of Operation.....	27
CAV 100% OA, HC LTD Sequence of Operation	28
CAV 100% OA, HC, CC Sequence of Operation	29
Application Notes	31
Wiring Diagrams.....	32

Application 2503 Overview

Application 2503 is an Air Handling Unit (AHU) TEC application that controls a constant volume fan, a 2-position 100% OA damper, a heating valve and a cooling valve.

Application 2503 has 2 PID Loops. A cooling PID loop in the room modulates the cooling valve in order to maintain the room temperature setpoint whenever cooling is needed. Similarly, a heating PID loop in the room modulates the heating valve in order to maintain the room temperature setpoint whenever heating is needed. The application also has heating / cooling switchover logic in it that will prevent the heating valve and the cooling valve from modulating at the same time.

Available modes of operation:

- Occupied/Unoccupied
- Unoccupied Heating
- Unoccupied Cooling
- Warm-up/Cool down

Application 2503 also has built in failsafe ways to respond to various alarms, such as:

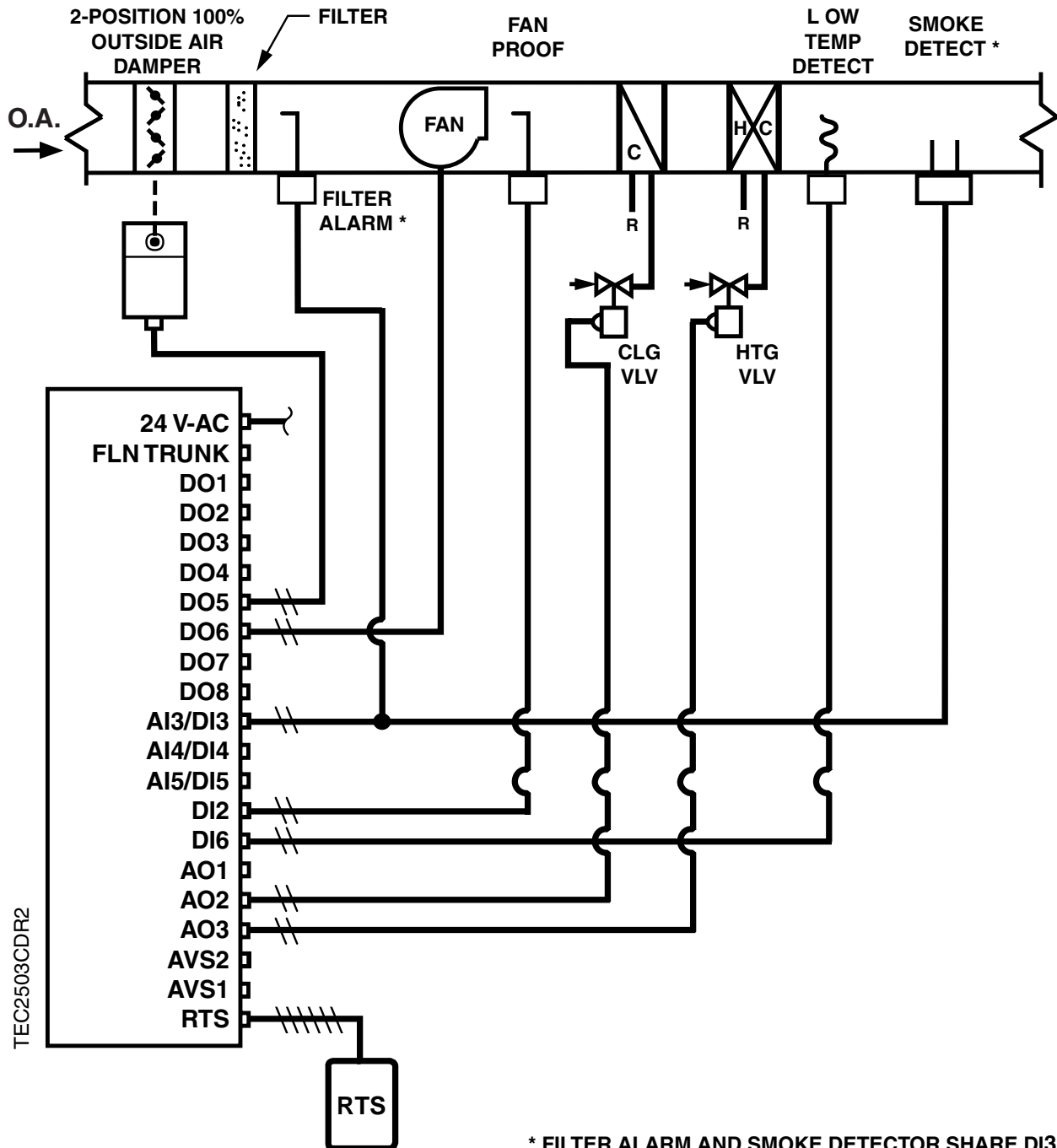
- Low Temperature Detection
- Fan Proof Alarm
- General Alarm (Smoke detector, dirty filters, etc.)

If any of these fail-safe features are not needed, they can be disabled and the I/O becomes available for other uses.

Also included in application 2503 is an unoccupied override feature that is compatible with tenant billing.

At the end of this document is a list of CSAL applications that application 2503 is capable of supporting. The CSAL applications call for supply air temperature control and Application 2503 does not support a supply air temperature sensor. However, application 2503 can support the room temperature control equivalents of these CSAL applications. Also included is a table that shows how to adjust points and configure application 2503 to support these CSAL applications.

Refer to Figures 2503-1 through 22503-6.



* FILTER ALARM AND SMOKE DETECTOR SHARE DI3

Figure 2503-1. Application 2503 Control Drawing.

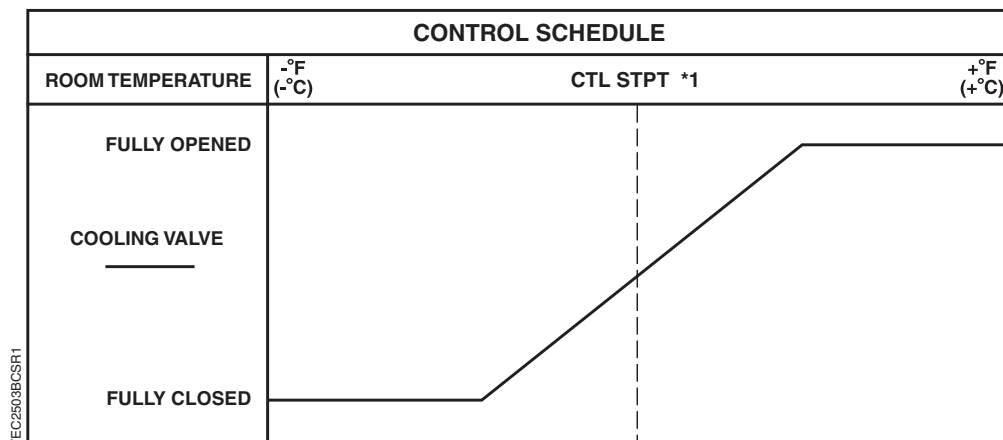
CONTROL SCHEDULE		
ROOM TEMPERATURE	$^{\circ}\text{F}$ ($^{\circ}\text{C}$)	$^{\circ}\text{F}$ ($^{\circ}\text{C}$)
OPENED ON	SEE NOTES 1, 2, 3, & 4	
100% OUTSIDE AIR 2-POSITION DAMPER ———		
FAN — — — —		
OFF CLOSED	SEE NOTES 3 & 4	

TEC2502&2503ACSR1

Figure 2503-2. Application 2503 Fan and Damper Control Schedule.

NOTES:

1. Application 2503 always opens the 2-position damper and turns on the fan at the same time. If required, the damper can open before the fan turns on. To accomplish this, install an end switch on the damper whose normally opened contact is wired directly into the fan's start/stop circuitry. When the damper closes, so does the contact, which then starts the fan.
2. The fan is on and the 2-position damper is opened during Warm-up, Cool down, Occupied Heating, Occupied Cooling, Unoccupied Cooling and unoccupied heating modes.
3. The fan is off and the damper is closed during Unoccupied mode, low temperature detection failure mode and general alarm failure mode.
4. The control of the fan and the damper is unaffected by a fan proof failure.



TEC2503BCSR1

Figure 2503-3. Application 2503 Cooling Valve Control Schedule for Cooldown, Occupied Cooling and Unoccupied Cooling Modes.

* Note: See the Control Temperature Setpoint section.

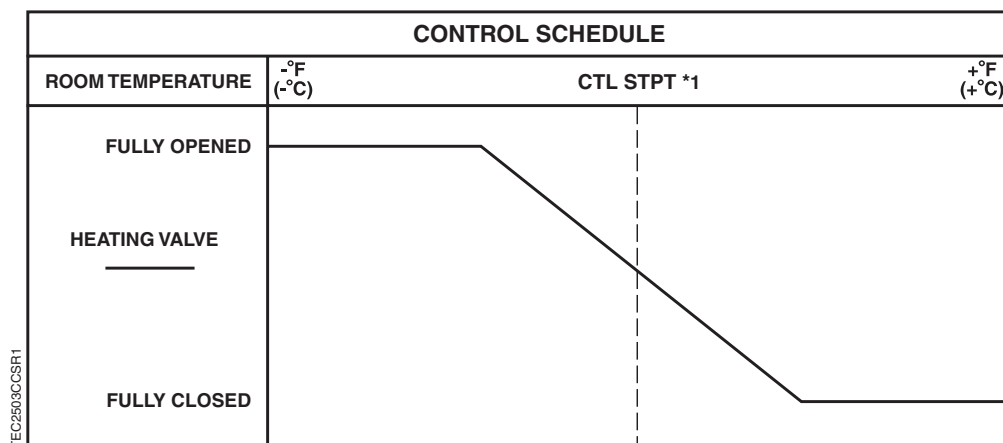


Figure 2503-4. Application 2503 Heating Valve Control Schedule for Warmup, Occupied Heating and Unoccupied Heating Modes

* Note: See the Control Temperature Setpoint section.

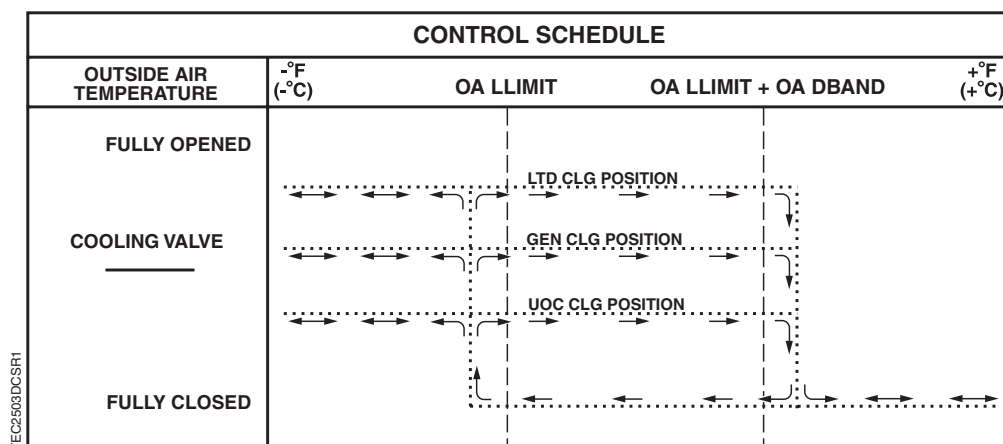


Figure 2503-5. Application 2503 Cooling Valve Control Schedule for Unoccupied and Safety Modes.

NOTES:

- When the outside air temperature is cold enough, the cooling valve will be:
 - set to LTD CLG POS (Point 60) during a low temperature detection alarm.
 - set to GEN CLG POS (Point 61) during a general alarm (smoke detection or dirty filter)
 - set to UOC CLG POS (Point 62) during the unoccupied mode or a fan proof failure.

When the outside air temperature is warm enough, the cooling valve will be shut during the unoccupied mode and during all of the failure modes.

2. LTD CLG POS, GEN CLG POS and UOC CLG POS can all be set differently from one another, if desired. Any or all of these points can be set to 0 % opened or 100 % opened. (LTD CLG POS is not required to be greater than GEN CLG POS and GEN CLG POS is not required to be greater than UOC CLG POS.)
3. Application 2503 supports 3 unoccupied modes: an unoccupied heating mode, an unoccupied cooling mode and an unoccupied "coast" mode, between heating and cooling. The unoccupied mode referred to in this figure is the unoccupied "coast" mode. During warm weather, this is a shutdown mode, during cold weather this is an equipment protection mode.

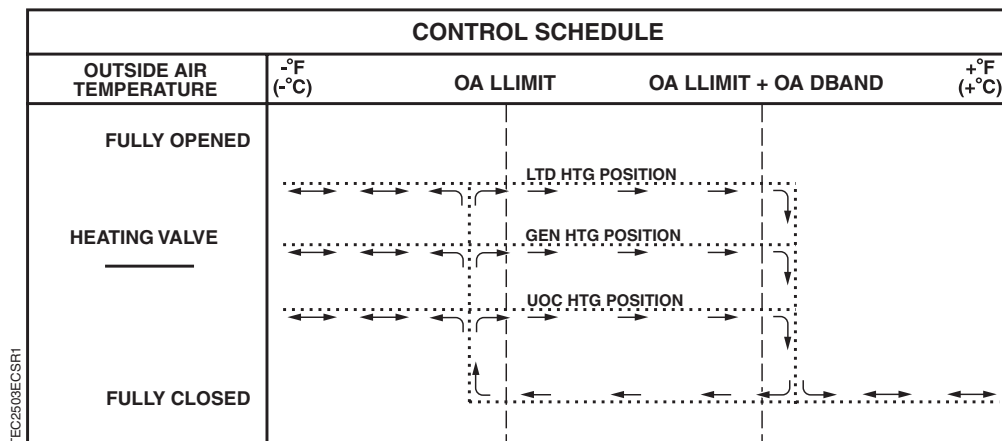


Figure 2503-6. Application 2503 Heating Valve Control Schedule for Unoccupied and Safety Modes.

NOTES:

1. When the outside air temperature is cold enough, the heating valve will be:
 - set to LTD HTG POS (Point 49) during a low temperature detection alarm.
 - set to GEN HTG POS (Point 50) during a general alarm (smoke detection or dirty filter)
 - set to UOC HTG POS (Point 51) during the unoccupied mode or a fan proof failure.

When the outside air temperature is warm enough, the heating valve will be shut during the unoccupied mode and during all of the failure modes.

2. LTD CLG POS, GEN HTG POS and UOC HTG POS can all be set differently from one another, if desired. Any or all of these points can be set to 0 % opened or 100 % opened. (LTD CLG POS is not required to be greater than GEN HTG POS and GEN HTG POS is not required to be greater than UOC HTG POS.)

3. Application 2503 supports 3 unoccupied modes: an unoccupied heating mode, an unoccupied cooling mode and an unoccupied "coast" mode, between heating and cooling. The unoccupied mode referred to in this figure is the unoccupied "coast" mode. During warm weather, this is a shutdown mode, during cold weather this is an equipment protection mode.

Hardware Inputs

Analog

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

Digital

- Low temperature detection thermostat (LTDT)
- General Alarm (e.g. smoke detector, dirty filter alarm, etc.)
- Fan proof
- Night mode override (optional)

Hardware Outputs

Analog (0-10V)

- Cooling valve actuator
- Heating valve actuator

Digital

- Fan
- 2-Position, 100% OA Damper

Sequence of Operation

The following paragraphs present the sequence of operation for Application 2503, “Constant Volume AHU with 2-Position 100 % OA Damper Cold Water Cooling and / or Hot Water Heating”

Application 2503 Action Table

Figure 2503-7 is a summary of the actions performed by Application 2503. For a more detailed description, of how Application 2503 works, refer to the remaining sections in this document. There are 3 unoccupied modes; unoccupied heating mode, unoccupied cooling mode and unoccupied mode.

The application goes into unoccupied mode, during the unoccupied period, when unoccupied heating or unoccupied cooling are **not** required.

DIALRM.ENDIS (Point 56), **MODE.ENDIS** (Point 23) and **HC.ENDIS** (Point 22) are enable/disable points. Refer to the *Enable/ Disable Points* section of this document for information on how to set up these points.

Figure 2503-7. Application 2503 Action Table.

	OA DMPR	FAN	HTG VLV	CLG VLV
UOC HTG ^{11, 15}	Opened	On After DMPR Opens ¹⁰	HTG VLV modulated to maintain UOC HTG STPT	Closed
UOC CLG ^{12, 16}	Opened	On After DMPR Opens ¹⁰	Closed	CLG VLV modulated to maintain UOC CLG STPT
Unocc OA > OA Limit	Closed	Off	Closed	Closed
Unocc OA ≤ OA Limit	Closed	Off	HTG VLV maintained at UOC HTG POS	CLG VLV maintained at UOC CLG POS
Warm-up ^{13, 15}	Opened	On After DMPR Opens ¹⁰	HTG VLV modulated to maintain WRMUP STPT .	Closed
Cool down ^{14, 16}	Opened	On After DMPR Opens ¹⁰	Closed	CLG VLV modulated to maintain COOLDN STPT .
OCC HTG ¹⁵	Opened	On After DMPR Opens ¹⁰	HTG VLV modulated to maintain OCC HTG STPT (or RM STPT DIAL).	Closed
OCC CLG ¹⁶	Opened	On After DMPR Opens ¹⁰	Closed	CLG VLV modulated to maintain OCC CLG STPT (or RM STPT DIAL).
Room Temperature Sensor Failure ¹⁷	(Note 17)	(Note 17)	(Note 17)	(Note 17)

continued on next page. . .

Figure 2503-7. Application 2503 Action Table.

	OA DMPR	FAN	HTG VLV	CLG VLV
General Alarm, OA > OA Limit 3, 4, 7, 9	Closed	Off	Closed	Closed
General Alarm, OA < OA Limit 3, 4, 7, 9	Closed	Off	HTG VLV maintained at GEN HTG POS	CLG VLV maintained at GEN CLG POS
LTD ALARM 1, 2, 8, 9	Closed	Off	HTG VLV maintained at LTD HTG POS	CLG VLV maintained at LTD CLG POS
Fan Proof Alarm OA > OA Limit 5, 6, 9	Normal Control	Normal Control	Closed	Closed
Fan Proof Alarm OA < OA Limit 5, 6, 9	Normal Control	Normal Control	HTG VLV maintained at UOC HTG POS	CLG VLV maintained at UOC CLG POS

NOTES:

- When DIALRM.ENDIS (Point 56) is set to ltdt enabled, the LTD alarm mode behaves as in the table. When DIALRM.ENDIS is not set to ltdt enabled, LTD DI 6 (Point 26) is spare, and that DI state does not trigger the LTD ALARM mode in the application.
- When the LTD is used, then LTDT CONTACT (Point 52) determines which state of the LTD DI is the alarm State.
- When DIALRM.ENDIS is set to gen alarm enabled, the general alarm mode behaves as in the table. When DIALRM.ENDIS is not set to gen alarm enabled, the GEN ALRM DI3 (Point 25) is spare, and that DI state does not trigger the general alarm mode in the application.
- GEN CONTACT (Point 55) determines which state of the GEN ALRM DI3 is the alarm state. The General Alarm is meant for such things as Smoke Detectors and Dirty Filter Alarms.
- When DIALRM.ENDIS is set to fan proof enabled, the fan proof alarm mode behaves as in the table. When DIALRM.ENDIS is not set to fan proof enabled, the FAN DI 2 (Point 24) is spare, and that DI state does not trigger the fan proof alarm mode in the application.
- When the fan fails to proof, an alarm will be given. The OA damper and Fan will be under normal Control (In other words, the fan and damper will be controlled as though the fan proof alarm is not occurring.) Both the Heating Valve and Cooling Valve will do unoccupied mode control when a fan proof alarm occurs. The fan proof has a higher priority in the application than normal control, but has a lower priority than the LTD Alarm and the General Alarm.
- The general alarm operates 24 / 7. It always supersedes the fan proof alarm and normal control. When this alarm and LTD occur at the same time, the application does LTD control. If no LTD is occurring, then the application does general alarm control.
- If used, the LTD is also a 24 / 7 alarm. It always supersedes the general alarm, the fan proof alarm and normal control.
- This application will work best when the physical devices connected to the LTD DI and General Alarm DI are all manual reset devices. However, it is not recommended that the physical device connected to the Fan Proof DI be a manual reset device.
- The application actually turns the Fan On at the same time that it Opens the Damper. In order for the fan to turn on only after the damper is opened, the customer will have to install a damper end switch that has a contact in the fan's On / Off circuitry that doesn't close until the damper is opened.
- The unoccupied heating is only used when MODE.ENDIS (Point 23) is uoc htg enabled.
- The unoccupied cooling is only used when MODE.ENDIS is uoc clg enabled.
- The warm-up mode is only used when MODE.ENDIS is warm-up enabled.
- The cool down mode is only used when MODE.ENDIS is cool down enabled.
- Not used unless HC.ENDIS (Point 22) heating enabled. If HC.ENDIS is not heating enabled, then AOV3 (Point 40) is a spare.
- Not used unless HC.ENDIS cooling enabled. If HC.ENDIS is not cooling enabled, then AOV2 (Point 39) is a spare.
- When ROOM TEMP (Point 4) has failed, the application will use the last know good value of ROOM TEMP. The rest of the application will behave as though the room temperature sensor did not fail.

Shared I/O

Application 2503 has AIs and DIs that share the same terminations, one or the other (but not both) can be used. AI 3 shares a termination with DI 3, AI 4 shares a termination with DI 4 and AI 5 shares terminations with DI 5. If AI 3 or AI 4 (AI 5) is being used, then DI 3 or DI 4 (DI 5) is unavailable.

In application 2503, the general purpose alarm (DI 3) is meant for such things as a smoke detector or a dirty filter alarm. The general purpose alarm feature must be disabled in order to use AI 3/DI 3 for another purpose, see *Enable/Disable Points*.

Enable/Disable Points

The application has the ability to enable and disable a number of features (making unused I/O available for other uses.) These points are analog values that determine whether certain features are being enabled or disabled.

- DIALRM.ENDIS (Point 56) determines whether or not a DI is being used as an alarm.
- MODE.ENDIS (Point 23) indicates if UOC HTG, UOC CLG, WARMUP or COOLDOWN modes are being used by the application.
- HC.ENDIS (Point 22) determines if the application is heating only, cooling only or if it uses both heating and cooling modes.

The Table shows what is enabled when a particular point is at a particular value. The number in parenthesis is the default value of the point. The default enables everything possible in the point.

	DIALRM.ENDIS (7)	MODE.ENDIS (15)	HC.ENDIS (3)
0	none	none	N/A
1	gen alarm enabled	uoc htg enabled	heating enabled
2	ltdt enabled	uoc clg enabled	cooling enabled
4	fan proof enabled	warmup enabled	--
8	--	cooldown enabled	--

If DIALRM.ENDIS has a value of 6, it means the low temperature detector and the fan proof are enabled, while the general alarm is disabled. When a point has a value of 0, it means that every feature associated with it is disabled.

HC.ENDIS has an intercept of 1. HC.ENDIS cannot be set to zero.

HC.ENDIS was defined this way because it makes no sense to disable both heating and cooling on the same job. When HC.ENDIS has a value of 1, the application is heating only. When HC.ENDIS has a value of 2, the application is cooling only. When HC.ENDIS has a value of 3, the application uses both the heating and cooling modes. A -- in a cell means the point doesn't use that value.

Control Temperature Setpoint

Depending on the controller's current operational mode (occupied, unoccupied, warmup or cooldown), the control temperature setpoint, CTL STPT (Point 92) holds the value of one of the following setpoints:

Warm-up Mode – In warmup mode, CTL STPT holds the value of WRMUP STPT (Point 3).

Cool down Mode – In cooldown mode, CTL STPT holds the value of COOLDN STPT (Point 10).

Occupied Mode – In occupied mode, CTL STPT holds the value of OCC CLG STPT (Point 6) or OCC HTG STPT (Point 7). If the room temperature sensor has a setpoint dial and STPT DIAL (Point 14) is set to YES, then CTL STPT holds the value of RM STPT DIAL (Point 13).

If the setpoint dial is used and the value of RM STPT DIAL is less than the value of RM STPT MIN (Point 11), 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), CTL STPT holds the value of RM STPT MAX.

Unoccupied Mode – In unoccupied mode, CTL STPT holds the value of UOC CLG STPT (Point 8) or UOC HTG STPT (Point 9).

The value of CTL TEMP (Point 78) is the same as the value of ROOM TEMP (Point 4), unless CTL TEMP is overridden.

Occupied and Unoccupied Modes

The occupied/unoccupied status of the space is determined by the status of OCC.UNOCC (Point 29). If the controller is operating stand-alone (not connected to a field panel), the controller stays in the last commanded mode. If the controller is operating with centralized control (connected to a field panel), the field panel can send an operator or PPCL command to override the status of OCC.UNOCC. See the *Powers Process Control Language (PPCL) User's Manual* (125-1896) and *Field Panel User's Manual* (125-3000) for more information.

Unoccupied 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), a room occupant can reset the controller to occupied mode for the length of time set in OVRD TIME by pressing the override switch. The status of UNOCC OVRD (Point 21) changes to OCC and remains there until OVRD TIME elapses, UNOCC OVRD changes back to UNOCC and the controller returns to unoccupied mode.

The override switch on the room sensor will only affect a controller when in unoccupied mode.

If OCC.UNOCC (Point 29) changes from UNOCC to OCC during an unoccupied override period, UNOCC OVRD will immediately change from OCC to UNOCC instead of waiting for the amount of time in OVRD TIME to elapse before changing from UNOCC to OCC. This can be useful when UNOCC OVRD is unbundled in a field panel and used for tenant billing. Also, if OVRD time is set to zero during an unoccupied period, UNOCC OVRD will immediately change from OCC to UNOCC.

Heating/Cooling Switchover

This section describes how the heating/cooling switchover feature works when both heating and cooling are enabled (HC.ENDIS (Point 22) = 3).

If **all** of 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) is below SWITCH LIMIT.
- CTL TEMP (Point 78) > CTL STPT (Point 92) + SWITCH DBAND (Point 90).
- CTL TEMP > the appropriate cooling setpoint - SWITCH DBAND.

If **all** of 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) is below SWITCH LIMIT.
- CTL TEMP < CTL STPT - SWITCH DBAND.
- CTL TEMP < the appropriate heating setpoint + SWITCH DBAND.

Application 2503 performs heating/cooling switchover based on room load. To perform heating/cooling switchover based on some other criteria, such as time of year, outside air temperature or supply air temperature, unbundle the HEAT.COOL point at a field panel and use PPCL to control it.

Heating only - set HC.ENDIS = 1, AOV2 (Point 39) is a spare and is available for other uses.

Cooling only - set HC.ENDIS = 2, AOV3 (Point 40) is a spare and is available for other uses.

Control Loops

The air handling unit is controlled by two Proportional, Integral, and Derivative (PID) control loops: a room cooling loop and a room heating loop.

Room Cooling Loop – The room cooling loop uses CTL STPT (Point 92) and CTL TEMP (Point 78) to modulate the value of CLG LOOPOUT (Point 79). CLG VLV CMD (Point 66) is set = CLG LOOPOUT. This loop is active during cooling mode and inactive during heating mode. The cooling valve is closed during heating mode. When this loop is disabled, CLG LOOPOUT will = 0.

Room Heating Loop – The room heating loop uses CTL STPT (Point 92) and CTL TEMP (Point 78) to modulate the value of HTG LOOPOUT (Point 80). HTG VLV CMD (Point 70) is set = HTG LOOPOUT. This loop is active during heating mode and inactive during cooling mode. The heating valve closed during cooling mode. When this loop is disabled, HTG LOOPOUT will = 0.

Morning Warm-up/Cool down Determination

This section focuses on how Application 2503 enters and exits warm-up and cool down mode. Morning warm-up or cool down occurs after the controller switches from unoccupied mode to occupied mode, upon power-up or when the controller is reset. During morning warm-up or cool down, the controller provides heating or cooling until the temperature of the space reaches the value of CTL STPT (Point 92) plus or minus the value of MORN DBAND (Point 89).

The warm-up mode occurs only if all of the following circumstances are true:

- Warmup is enabled (see *Enable/Disable Points*).
- LOW TEMP DET (Point 87) = OFF
- GEN ALARM (Point 83) and FAN STATUS (Point 84) = NORMAL.
- OCC.UNOCC (Point 29) has just changed from Unoccupied to Occupied (OCC.UNOCC currently equals OCC but equaled UNOCC one LOOP TIME (Point 98) ago).
- HEAT.COOL (Point 5) = HEAT.
- The room temperature is not warm enough.
CTL TEMP (Point 78) < (CTL STPT (Point 92) – MORN DBAND (Point 74))

When all these circumstances occur, WRUMP.COOLDN (Point 30) is turned ON.

CTL STPT will equal WRMUP STPT (Point 3) during the warmup period. Normal occupied mode heating operation begins when the temperature of the room reaches the value of WRMUP STPT minus MORN DBAND. For example, if CTL STPT is 72°F (22.2°C) and MORN DBAND is 3°F (1.6°C), then normal occupied heating operation begins when the temperature of the room reaches 69°F (20.6°C). The application will go into normal occupied heating by turning WARMUP.COOLDN OFF.

The cool down mode occurs only if all of the following circumstances are true:

- Cooldown is enabled (see *Enable/Disable Points*).
- LOW TEMP DET = OFF
- GEN ALARM and FAN STATUS = NORMAL.
- OCC.UNOCC (Point 29) has just changed from unoccupied to occupied (OCC.UNOCC currently equals OCC but equaled UNOCC one LOOP TIME (Point 98) ago).
- HEAT.COOL (Point 5) = COOL.

- The room temperature is not cool enough.
CTL TEMP (Point 78) > (CTL STPT (Point 92) + MORN DBAND (Point 74))

When all these circumstances occur, WRUMP.COOLDN (Point 30) is turned ON.

CTL STPT will equal COOLDN STPT (Point 10) during the cooldown period. Normal occupied cooling operation begins when the temperature of the room reaches the value of COOLDN STPT plus MORN DBAND. The application will go into normal occupied heating by turning WARMUP.COOLDN OFF.

Once the application commands WRMUP.COOLDN to OFF, WRMUP.COOLDN will remain off for the rest of the occupied period. This means the application cannot go into warm-up or cool down mode more than once per day. It also means the application cannot switch from warm-up mode to cool down mode or vice versa.

As an added safety, it is a good idea to command WRMUP.COOLDN to OFF in the field panel when the desired occupancy time occurs. (This can be done in Time of Day Programming.) After commanding WARMUP.COOLDN to OFF, execute a release command at the field panel in order to release control of WRMUP.COOLDN back to the TEC. This will prevent the possibility of the TEC getting stuck in the warm-up or cool down mode all day.

Warm-up Mode Operation

The next 2 sections will focus on what Application 2503 does in warm-up and cool down mode.

The following actions occur during the Warmup mode

- FAN DO 6 (Point 46) = ON and OA DMPR DO 5 (Point 45) is OPENED.
- The room temperature cooling PID loop and supply air temperature cooling PID loop are disabled and the cooling valve is shut, CLG VLV CMD (Point 66) = 0.
- CTL STPT (Point 92) = WRMUP STPT (Point 3).

The room temperature heating loop is enabled and controls the heating valve, HTG VLV CMD (Point 70) in order to maintain CTL TEMP (Point 78) = CTL STPT.

Cool down Mode Operation

The following actions occur during the Cooldown mode

- FAN DO 6 (Point 46) = ON and OA DMPR DO 5 (Point 45) is OPENED.
- The room temperature heating PID loop is disabled and the heating valve is shut, HTG VLV CMD (Point 70) = 0.
- CTL STPT (Point 92) will be = COOLDN STPT (Point 10).
- The room temperature cooling loop is enabled and controls the cooling valve, CLG VLV CMD (Point 66) to maintain CTL TEMP (Point 78) = CTL STPT.

Both Warmup and Cooldown are pre-conditioning modes. The next 2 sections will focus on when pre-conditioning is over and normal heating or cooling is occurring.

Occupied Heating Operation

In order for the occupied heating mode to occur, the following conditions must hold:

- LOW TEMP DET (Point 87) must = OFF
- GEN ALARM (Point 83) and FAN STATUS (Point 84) must = NORMAL.
- WRMUP.COOLDN (Point 30) must = OFF.
- OCC.UNOCC (Point 29) and/or UNOCC OVRD (Point 21) must = OCC.
- HEAT.COOL (Point 5) must HEAT.

The following actions occur during the occupied heating mode

- FAN DO 6 (Point 46) = ON and OA DMPR DO 5 (Point 45) is OPENED.
- The room temperature cooling PID loop is disabled and the cooling valve is shut (CLG VLV CMD, (Point 66) = 0.
- CTL STPT (Point 92) will either = OCC HTG STPT (Point 7), or RM STPT DIAL (Point 13) depending on the value of STPT DIAL (Point 14). If RM STPT DIAL is used, it will be subjected to the limits imposed by RMP STPT MAX (Point 12) and RM STPT MIN (Point 11).
- The room temperature heating loop is enabled and controls the heating valve, HTG VLV CMD (Point 70) to maintain CTL TEMP (Point 78) = CTL STPT.

Occupied Cooling Operation

In order for the occupied cooling mode to occur, the following conditions must hold:

- LOW TEMP DET (Point 87) must = OFF.
- GEN ALARM (Point 83) and FAN STATUS (Point 84) must = NORMAL.
- WRMUP.COOLDN (Point 30) must = OFF.
- OCC.UNOCC (Point 29) and/or UNOCC OVRD (Point 21) must = OCC.
- HEAT.COOL (Point 5) must = COOL.

The following actions occur during the occupied cooling mode

- FAN DO 6 (Point 46) = ON and OA DMPR DO 5 (Point 45) is OPENED.

- The room temperature heating PID loop and the supply air temperature heating PID loop are disabled and the heating valve is shut, HTG VLV CMD (Point 70) = 0.
- CTL STPT (Point 92) will either = OCC CLG STPT (Point 6) or RM STPT DIAL (Point 13) depending on the value of STPT DIAL (Point 14). If RM STPT DIAL is used, it will be subjected to the limits imposed by RMP STPT MAX (Point 12) and RM STPT MIN (Point 11).
- The room temperature cooling loop is enabled and controls the cooling valve, CLG VLV CMD (Point 66) to maintain CTL TEMP (Point 78) = CTL STPT.

Unoccupied Heating/Cooling Mode Determination

Application 2503 uses the values of UOC HTG (Point 53) and UOC CLG (Point 54) to determine the operational mode; unoccupied heating or unoccupied cooling mode. This section describes how application 2503 determines the values of UOC HTG and UOC CLG.

If MODE.ENDIS (Point 23) has unoccupied heating mode disabled, the application will never go into unoccupied heating mode (UOC HTG will remain OFF). Likewise, if MODE.ENDIS has unoccupied cooling mode disabled, the application will never go into unoccupied cooling mode (UOC CLG will remain OFF). (See *Enable/ Disable Points* for information on how to enable and disable unoccupied heating and unoccupied cooling modes). In the remainder of this section, it is assumed that both unoccupied heating and unoccupied cooling mode are enabled.

If OCC.UNOCC (Point 29) and/or UNOCC OVRD (Point 21) = OCC, both UOC HTG and UOC CLG = OFF.

If both OCC.UNOCC and UNOCC OVRD = UNOCC, the values of UOC HTG and UOC CLG are determined as follows:

If HEAT.COOL (Point 5) = HEAT:

- UOC CLG = OFF.
- UOC HTG = ON whenever $\text{CTL TEMP (Point 78)} \leq \text{CTL STPT (Point 92)}$. (Note: unless overridden, CTL STPT will equal UOC HTG STPT (Point 9) at this point.)
- UOC HTG = OFF whenever $\text{CTL TEMP} \geq \text{CTL STPT} + \text{UOC DBAND (88)}$.
- Whenever $\text{CTL TEMP} > \text{CTL STPT}$ and $< \text{CTL STPT} + \text{UOC DBAND}$, UOC HTG will remain in its last commanded state.

If HEAT.COOL (Point 5) = COOL:

- UOC HTG = OFF.
- UOC CLG = ON whenever $\text{CTL TEMP (Point 78)} \geq \text{CTL STPT}$. (Note: Unless overridden, CTL STPT = UOC CLG STPT (Point 8) at this point.)
- UOC CLG = OFF whenever $\text{CTL TEMP} \leq \text{CTL STPT} - \text{UOC DBAND}$.

- Whenever CTL TEMP < CTL STPT and > CTL STPT - UOC DBAND, UOC CLG will remain in its last commanded state.

The next two sections will focus on what application 2503 does in the unoccupied heating and unoccupied cooling modes.

Unoccupied Heating Operation

In order for the unoccupied heating mode to occur, the following conditions must hold:

- LOW TEMP DET (Point 87) must = OFF.
- GEN ALARM (Point 83) and FAN STATUS (Point 84) must = NORMAL.
- unoccupied heating must be enabled. (See *Enable/Disable Points* for information on how to enable or disable unoccupied heating mode).
- WRMUP.COOLDN (Point 30) must = OFF.
- OCC.UNOCC (Point 29) and UNOCC OVRD (Point 21) must **both** = UNOCC.
- UOC HTG (Point 53) must = ON.

The following actions occur during the unoccupied heating mode

- FAN DO 6 (Point 46) = ON and OA DMPR DO 5 (Point 45) is OPENED.
- The room temperature cooling PID loop and the supply air temperature cooling PID loop are disabled and the cooling valve is shut, CLG VLV CMD (Point 66) = 0.
- CTL STPT (Point 92) = UOC HTG STPT (Point 9).
- The room temperature heating loop is enabled and controls the heating valve, HTG VLV CMD (Point 70) to maintain CTL TEMP (Point 78) = CTL STPT.

Unoccupied Cooling Operation

In order for unoccupied cooling mode to occur, the following conditions must hold:

- LOW TEMP DET (Point 87) must = OFF.
- GEN ALARM (Point 83) and FAN STATUS (Point 84) must = NORMAL.
- unoccupied cooling must be enabled (See *Enable/Disable Points* section for information on how to enable or disable the unoccupied cooling mode).
- WRMUP.COOLDN (Point 30) must = OFF.
- OCC.UNOCC (Point 29) and UNOCC OVRD (Point 21) must **both** = UNOCC.

- UOC CLG (Point 54) must ON.

The following actions occur during the unoccupied cooling mode

- FAN DO 6 (Point 46) = ON and OA DMPR DO 5 (Point 45) is OPENED.
- The room temperature heating PID loop and the supply air temperature heating PID loop are disabled and the heating valve is shut, HTG VLV CMD (Point 70) = 0.
- CTL STPT (Point 92) = UOC CLG STPT (Point 8).
- The room temperature cooling loop is enabled and controls the cooling valve, CLG VLV CMD (Point 66) to maintain CTL TEMP (Point 78) = CTL STPT.

Unoccupied Mode Operation

The unoccupied mode occurs during a period when neither unoccupied heating nor unoccupied cooling are needed. The following conditions must hold in order for unoccupied mode to occur:

- LOW TEMP DET (Point 87) must = OFF.
- GEN ALARM (Point 83) and FAN STATUS (Point 84) must = NORMAL.
- WRMUP.COOLDN (Point 30) must = OFF.
- OCC.UNOCC (Point 29) and UNOCC OVRD (Point 21) must **both** = UNOCC.
- UOC HTG (Point 53) must = OFF.
- UOC CLG (Point 54) must = OFF.

The following actions occur during the unoccupied mode

- FAN DO 6 (Point 46) = OFF and OA DMPR DO 5 (Point 45) is CLOSED.
- The room temperature heating and cooling PID loops are disabled. Both HTG LOOPOUT (Point 79) and CLG LOOPOUT (Point 80) = 0.
- The cooling valve's position is under deadband control based on the outside air temperature:
 - If $OA\ TEMP (Point\ 75) \geq OA\ LLIMIT (Point\ 76) + OA\ DBAND (Point\ 77)$, the cooling valve will be completely shut.
 - If $OA\ TEMP < OA\ LLIMIT$, the cooling valve's position will be maintained at UOC CLG POS (Point 62).
 - If $OA\ TEMP \geq OA\ LLIMIT$ and $< OA\ LLIMIT + OA\ DBAND$, the cooling valve's position will be maintained at its last commanded state (if it was last commanded closed, it will remain closed; if it was last commanded to UOC CLG POS, it will remain at UOC CLG POS).

- The heating valve's position is under deadband control based on the outside air temperature:
 - If $OA\ TEMP \geq OA\ LLIMIT + OA\ DBAND$, the heating valve will be completely shut.
 - If $OA\ TEMP < OA\ LLIMIT$, the heating valve's position will be maintained at UOC HTG POS (Point 51).
 - If $OA\ TEMP \geq OA\ LLIMIT$ and $< OA\ LLIMIT + OA\ DBAND$, the heating valve's position will be maintained at its last commanded state (if it was last commanded closed, it will remain closed; if it was last commanded to UOC HTG POS, it will remain at UOC HTG POS).

Fail-safe Operation

Application 2502 has a number of hierarchy based fail-safe features and can respond differently to each. They will be listed in order of priority, highest priority listed first.

Low Temperature Detection

The low temperature detector alarm has the highest priority. When a low temperature detection alarm occurs, the application goes into the low temperature detection alarm mode regardless of other happenings in the application.

In order for a low temperature detection alarm to occur, it must be enabled using DIALRM.ENDIS (Point 56) (see *Enable/Disable Points* for information on how to enable or disable the low temperature detection alarm). If the low temperature detection alarm is disabled, LTD DI 6 (Point 26) becomes a spare DI available for other uses. For the rest of this section, assume the low temperature detection alarm is enabled.

A low temperature detection thermostat (LTDT) connected to LTD DI 6 (Point 26) can be used to signal the controller when the temperature, sensed by the LTDT, is below the low temperature limit. The LTDT can be either normally opened or normally closed, depending on the value of LTDT CONTACT (Point 52).

Application 2503 goes into the low temperature detection mode when LOW TEMP DET (number 87) is ON. During the low temperature detection mode, the following actions occur in application 2503.

1. The fan shuts off and the 100% OA damper is closed.
2. The room loops are disabled (they are not needed during this mode and disabling them prevents reset windup) and their outputs are set to zero.
3. The cooling valve's position is maintained at LTD CLG POS (Point 60).
4. The heating valve's position is maintained at LTD HTG POS (Point 49).

When the low temperature condition is no longer occurring, the application will end the low temperature detection mode by setting LOW TEMP DET to OFF.

NOTES:

1. If a low temperature detection is used, it is strongly recommended that it be a manual reset device (if it goes into alarm, the device has to be manually reset for the alarm to clear).
2. If it is desired the cooling valve be shut throughout the entire low temperature detection mode, set LTD CLG POS to 0. If it is desired the cooling valve be completely opened throughout the entire low temperature detection period, the set LTD CLG POS to 100.
3. If it is desired that the heating valve be shut throughout the entire low temperature detection mode, set LTD HTG POS to 0. If it is desired that the heating valve be completely opened throughout the entire low temperature detection period, set LTD HTG POS to 100.

General Alarm

The general alarm has the 2nd highest priority.

In order for a general alarm to occur, the general alarm must be enabled using DIALRM.ENDIS (Point 56) (see *Enable/Disable Points* for information on how to enable or disable the general alarm). If the general alarm is disabled, GEN ALRM DI3 (Point 25) becomes a spare DI available for other uses. For the rest of this section, assume the general alarm is enabled.

A general alarm is smoke detection, dirty filters, high and/or low humidity, etc. When used, these alarming devices have to share the same DI (DI3). There are not enough DIs on the TEC for these alarming devices to have their own individual DI.

- GEN CONTACT (Point 55) = NCLOSE, a general alarm will occur when GEN ALRM DI3 is opened (OFF). If you have multiple devices connected to DI3 when GEN CONTACT is NCLOSE, each of them must be configured to alarm when their contact opens and they must be wired in series to each other.
- GEN CONTACT (Point 55) = NOPEN, a general alarm will occur when GEN ALRM DI3 is closed (ON). If you have multiple devices connected to DI3 when GEN CONTACT is NOPEN, each of them must be configured to alarm when their contact closes and they must be wired in parallel to each other.

When GEN ALRM DI3 is in the alarm state GEN ALARM (Point 83) = ALARM. The following actions occur:

1. The fan shuts off and the 100% OA damper is closed.
2. The room loops are disabled and their outputs are set to zero.
3. The cooling valve's position is under deadband control based on the outside air temperature:
 - If $OA\ TEMP (Point\ 75) \geq OA\ LLIMIT (Point\ 76) + OA\ DBAND (Point\ 77)$, the cooling valve will be completely shut.
 - If $OA\ TEMP < OA\ LLIMIT$, the cooling valve's position will be maintained at GEN CLG POS (Point 61).

- If $OA\ TEMP \geq OA\ LLIMIT$ and $< OA\ LLIMIT + OA\ DBAND$, the cooling valve's position will be maintained at its last commanded state (if it was last commanded closed, it will remain closed; if it was last commanded to GEN CLG POS, it will remain at GEN CLG POS).
4. The heating valve's position is under deadband control based on the outside air temperature:
- If $OA\ TEMP\ (Point\ 75) \geq OA\ LLIMIT\ (Point\ 76) + OA\ DBAND\ (Point\ 77)$, the heating valve will be completely shut.
 - If $OA\ TEMP < OA\ LLIMIT$, the heating valve's position will be maintained at GEN HTG POS (Point 50).
 - If $OA\ TEMP \geq OA\ LLIMIT$ and $< OA\ LLIMIT + OA\ DBAND$, the heating valve's position will be maintained at its last commanded state (if it was last commanded closed, it will remain closed; if it was last commanded to GEN HTG POS, it will remain at GEN HTG POS).

When the general alarm condition is now longer occurring, the application will end the general alarm by setting GEN ALARM to NORMAL.

NOTES:

1. It is strongly recommended that all of the devices hooked to GEN DI 3 be a manual reset devices (if a device goes into alarm, that device has to be manually reset for the alarm to clear).
2. If it is desired that the cooling valve be shut throughout the entire general alarm mode set GEN CLG POS to 0. If it is desired that the cooling valve be completely opened when there is a general alarm occurring and the outside air temperature is cold set GEN CLG POS to 100.
3. If it is desired that the heating valve be shut throughout the entire general alarm mode, then set GEN HTG POS to 0. If it is desired that the heating valve be completely opened when there is a general alarm occurring and the outside air temperature is cold, set GEN HTG POS to 100.

Fan Proof Alarm

The fan proof alarm has the 3rd highest priority.

In order for a fan proof alarm to occur, the fan proof alarm must be enabled using DIALRM.ENDIS (Point 56) (see *Enable/Disable Points* for information on how to enable or disable the fan proof alarm). If the fan proof alarm is disabled, FAN DI 2 (Point 24) becomes a spare DI available for other uses. For the rest of this section, assume the fan proof alarm is enabled.

A fan proof alarm occurs whenever the fan has been commanded ON but stays OFF or when the fan is commanded OFF but stays ON. After FAN DO 6 (Point 46) has been turned ON, FAN STATUS (Point 84) will be set to ALARM if FAN DI 2 remains OFF for longer than PROOF TIME (Point 57). After FAN DO 6 has been turned OFF, FAN STATUS will be set to ALARM if FAN DI 2 remains ON for longer than PROOF TIME.

When FAN STATUS equals ALARM, the following actions occur:

1. The fan and the 100% OA damper are normally controlled, controlled as though FAN STATUS = NORMAL. (If the fan doesn't proof on after it has been commanded on, you still want to give it a chance to proof). Everything else in application 2502 is treated as though it is in the unoccupied mode and both UOC HTG (Point 53) and UOC CLG (Point 54) are OFF.
2. The room loops are disabled and their outputs are set to zero.
3. The cooling supply air temperature loop is disabled and its output is set to zero.
4. The cooling valve's position is under deadband control based on the outside air temperature:
 - If $OA\ TEMP (Point\ 75) \geq OA\ LLIMIT (Point\ 76) + OA\ DBAND (Point\ 77)$, the cooling valve will be completely shut.
 - If $OA\ TEMP < OA\ LLIMIT$, the cooling valve's position will be maintained at UOC CLG POS (Point 62).
 - If $OA\ TEMP \geq OA\ LLIMIT$ and $< OA\ LLIMIT + OA\ DBAND$, the cooling valve's position will be maintained at its last commanded state (if it was last commanded closed, it will remain closed; if it was last commanded to UOC CLG POS, it will remain at UOC CLG POS).
5. The heating valve's position is under deadband control based on the outside air temperature:
 - If $OA\ TEMP \geq OA\ LLIMIT + OA\ DBAND$, the heating valve will be completely shut.
 - If $OA\ TEMP < OA\ LLIMIT$, the heating valve's position will be maintained at UOC HTG POS (Point 51).
 - If $OA\ TEMP \geq OA\ LLIMIT$ and $< OA\ LLIMIT + OA\ DBAND$, the heating valve's position will be maintained at its last commanded state (if it was last commanded closed, it will remain closed; if it was last commanded to UOC HTG POS, it will remain at UOC HTG POS).

When the Fan Proof alarm is no longer occurring, the application will end the fan proof alarm condition by setting FAN STATUS to NORMAL.

NOTES:

1. It is strongly recommended that the device that proves the fan and is connected to FAN DI 2 **not** be a manual reset device. This will give the fan a chance to proof without having to manually reset the device connected to DI 2.
2. If it is desired that the cooling valve be shut throughout the entire fan proof alarm mode, set UOC CLG POS to 0 (this will also keep the cooling valve closed throughout the entire unoccupied mode). If it is desired that the cooling valve be completely opened when there is a fan proof alarm occurring and the outside air temperature is cold, set UOC CLG POS to 100. (the cooling valve will also be controlled this way throughout the entire unoccupied mode.)

3. If it is desired that the heating valve be shut throughout the entire fan proof alarm mode, then set UOC HTG POS to 0 (Keep in mind however, that this will also keep the heating valve closed throughout the entire unoccupied mode.) If it is desired that the heating valve be completely opened when there is a fan proof alarm occurring and the outside air temperature is cold, the set UOC HTG POS to 100. (Keep in mind however, that the heating valve will also be controlled this way throughout the entire unoccupied mode.)

Room Temperature Sensor Failure

If ROOM TEMP (Point 4) is failed, the application will use the last known good value of ROOM TEMP. The rest of the application is unaffected by a room temperature sensor failure.

Fan and Damper Operation

The fan is off and the 2-position, 100% outside air damper is closed whenever the low temperature detector goes into alarm or there is a general alarm. The fan is also off and the damper is closed during the unoccupied mode provided that both UOC HTG (Point 53) and UOC CLG (Point 54) are equal to OFF.

The fan is on and the damper is opened during the following modes:

- Warmup
- Cooldown
- Occupied Heating
- Occupied Cooling
- Unoccupied Heating
- Unoccupied Cooling

A fan proof alarm does not affect the control of the fan or the damper if the fan was commanded on and the damper commanded opened before the fan proof failure, the fan will be commanded on and the damper will be commanded opened after the fan proof failure. If the fan was commanded off and the damper commanded closed before the fan proof failure, the fan will be commanded off and the damper will be commanded closed after the fan proof failure this gives the fan a chance to proof.

Application 2503 always opens the 2-position damper (OA DMPR DO5 (Point 45)) and turns on the fan (FAN DO 6 (Point 46)) at the same time. To open the damper before the fan turns on, install an end switch on the damper whose normally opened contact is wired directly into the fan's start/stop circuitry. When the damper closes, so does it's contact, which then starts the fan.

AOV Control of Hot water and Cold Water Valves

Application 2503 controls the hot water valve by adjusting the value of HTG VLV CMD (Point 70) and controls the cold-water valve by adjusting the value of CLG VLV CMD (Point 66). Both of these valves are actually connected to 0-10Volt AOVs. This section explains how the 0-100% valve command signals get converted into 0-10 V.

AO DIR.REV (Point 37) must be set correctly in order to determine which AOs are normally closed (direct acting) and which ones are normally opened (reverse acting). See the Startup documentation for more information on how to set AO DIR.REV to the proper value.

Hot Water Valve AOV Calculations:

The hot water valve resides on AOV3 (Point 40). The application uses AOV3 START (Point 36), AOV3 SPAN (Point 35) and HTG VLV CMD in the following way to determine the proper value of AOV3:

- If the hot water valve is normally closed (direct acting),
$$\text{AOV3} = \text{AOV3 START} + (\text{HTG VLV CMD} / 100) \times \text{AOV3 SPAN}$$
- If the hot water valve is normally opened (reverse acting),
$$\text{AOV3} = \text{AOV3 START} + [1 - (\text{HTG VLV CMD} / 100)] \times \text{AOV3 SPAN}$$

Cold Water Valve AOV Calculations:

The cold-water valve resides on AOV2 (Point 39). The application uses AOV2 START (Point 34), AOV2 SPAN (Point 33) and CLG VLV CMD in the following way to determine the proper value of AOV2:

- If the cold water valve is normally closed (direct acting),
$$\text{AOV2} = \text{AOV2 START} + (\text{CLG VLV CMD} / 100) \times \text{AOV2 SPAN}$$
- If the cold water valve is normally opened (reverse acting),
$$\text{AOV2} = \text{AOV2 START} + [1 - (\text{CLG VLV CMD} / 100)] \times \text{AOV2 SPAN}$$

Application 2503 and CSAL Applications

Application 2503 was designed to perform limited functionality of the following 4 CSAL applications:

- CAV 100% OA, CC.
- CAV 100% OA, CC w/o LTD.
- CAV 100% OA, HC.
- CAV 100% OA, HC, CC.

Application 2503 can not perform the full functionality of any of the CSAL Applications. The CSAL Applications require supply air temperature loops that Application 2503 does not have. Application 2503 was designed to perform the Room Temperature Loop equivalents of the CSAL Applications listed.

Some of the points in application 2503 need to be configured differently in order for application 2503 to perform (or come close to) the functionality of the different CSAL applications. The table which follows shows how to set points in application 2503 in such a way that application 2503 can perform (or come close to) the functionality of the different CSAL Applications. The sequence of operation and the hardware requirements for these CSAL applications are listed at the end of this section.

In the table that follows:

A number in parenthesis in a cell is the value of the point needed for that particular CSAL application.

N/A means not applicable (or, it doesn't matter what the point it set to because the way the other points are configured, application 2503 will never get to this point anyway.)

The word "set" means to override the point (Manually command the point and keep it there at operator priority. This will prevent application 2503 from changing the value of the point).

Figure 2503-8. CSAL Application Points.

	100% OA, CC	100% OA, CC w/o LTD	100% OA, HC	100% OA, HC, CC
HC.ENDIS	enable clg (2)	enable clg (2)	enable htg (1)	enable htg & clg (3)
MODE.ENDIS	enable uoc clg (2)	enable uoc clg (2)	enable uoc htg & warmup (5)	enable uoc htg, warmup & cooldown (13)
DIALRM.ENDIS	enable ltdt, gen alarm & fan proof (7)	enable gen alarm & fan proof (5)	enable ltdt, gen alarm & fan proof (7)	enable ltdt, gen alarm & fan proof (7)
LTD HTG POS	N/A	N/A	Set as desired.	Set as desired.
GEN HTG POS	N/A	N/A	Set as desired.	Set as desired.
UOC HTG POS	N/A	N/A	Set as desired.	Set as desired.
LTD CLG POS	Set to 100%	N/A	N/A	Set to 0%
GEN CLG POS	Set to 0%	Set to 100%	N/A	Set to 0%
UOC CLG POS	Set to 0%	Set to 0%	N/A	Set to 0%
OA LLIMIT	N/A	Set to 45 °F.	Set to 45 °F.	Set to 45 °F.

1. A field panel is needed in order to perform time of day functions. For some of the CSAL applications the field panel will need to send outside air temperature information to the TEC (OA TEMP (point 75) needs to be unbundled at the field panel).
2. All of the CSAL applications require a smoke detector and a dirty filter alarm. These must share the same DI on the TEC. They are both connected to DI 3, and when they alarm they trigger a general alarm in the TEC (GEN ALARM (Point 83) = ALARM).
3. All of the CSAL applications require the damper to open before the fan turns on, see *Fan and Damper Operation* for details.
4. In the CAV 100% OA, HC, CC CSAL application is the requirement that "The heating and cooling coil valves modulate in sequence without overlap to maintain the supply air temperature setpoint". Application 2503 avoids simultaneous heating and cooling is by using heating/cooling switchover logic, see *Heating/Cooling Switchover* for more information. 2503 doesn't have a supply air temperature sensor, it will control the heating and cooling coil valves directly with its room temperature heating and cooling loops

CAV 100% OA, CC Sequence of Operation

The constant volume air handling unit consists of an outdoor air damper, pre-filter, cold water cooling coil and supply fan. The unit is DDC controlled using electric actuation.

The air handling unit is scheduled for automatic operation on a time of day basis for Occupied and Unoccupied modes. Within the Unoccupied mode, Night Cooling is available when the space temperature rises above 85°F (29°C). The latest start time is the scheduled occupancy for the space.

The air handling unit operates in Occupied, Unoccupied, Night Cooling and Safety modes as follows (all suggested setpoints and settings are adjustable.):

Occupied

The outdoor air damper opens and, after fully open, a damper actuator auxiliary switch starts the supply fan. The cooling coil valve modulates to maintain the supply air temperature setpoint.

Unoccupied

The supply fan is off, the outdoor air damper is closed, and the cooling coil valve is closed.

Night Cooling

The outdoor air damper opens and, after fully open, a damper actuator auxiliary switch starts the supply fan with the cooling coil valve modulating to maintain supply air setpoint for a maximum space temperature of 85°F (29°C).

Safety

The outdoor air damper actuator auxiliary switch stops the supply fan when the OA damper starts to close.

The smoke detector in the supply air stream de-energizes the supply fan upon activation. All dampers and valves position to their normal position after the fan is de-energized.

A low temperature detector in the outdoor air stream de-energizes the supply fan when temperatures below 38°F (3°C) are sensed. The cooling coil valve opens. All other dampers and valves position to their normal position after the fan is de-energized.

A current switch is installed in the supply fan starter. The DDC system uses this switch to confirm the fan is in the desired state (that is, on or off) and generates an alarm if status deviates from DDC start/stop control.

CAV 100% OA, CC Hardware Requirements

1	Filter Dirty Alarm	DI
1	Supply Fan	DO
1	Supply Fan Proof	DI
1	Supply Smoke Detector	DI
1	Cooling Coil Valve	AO
1	Low Temperature Detection Thermostat	DI
1	Space Temperature	AI
1	Supply Air Temperature*	AI

* Not available in Application 2503

CAV 100% OA, CC w/o LTD Sequence of Operation

The constant volume air handling unit consists of an outdoor air damper, pre-filter, cold water cooling coil and supply fan. The unit is DDC controlled using electric actuation.

The air handling unit is scheduled for automatic operation on a time of day basis for Occupied and Unoccupied. Within the Unoccupied mode, Night Cooling is available when the space temperature rises above 85°F (29°C). The latest start time is the scheduled occupancy for the space.

The air handling unit operates in Occupied, Unoccupied, Night Cooling and Safety modes as follows (All suggested setpoints and settings are adjustable.):

Occupied

The outdoor air damper opens and, after fully open, a damper actuator auxiliary switch starts the supply fan. The cooling coil valve modulates to maintain the supply air temperature setpoint.

Unoccupied

The supply fan is off, the outdoor air damper is closed and the cooling coil valve is closed.

Night Cooling

The outdoor air damper opens and, after fully open, a damper actuator auxiliary switch starts the supply fan with the cooling coil valve modulating to maintain supply air setpoint for a maximum space temperature of 85°F (29°C).

Safety

The outdoor air damper actuator auxiliary switch stops the supply fan when the OA damper starts to close.

The smoke detector in the supply air stream de-energizes the supply fan upon activation. When the OAT is less than 45°F (7°C), the cooling coil valve opens. When the OAT is 45°F (7°C) or above, the cooling coil valve closes. All other dampers and valves position to their normal position after the fan is de-energized.

A current switch is installed in the supply fan starter. The DDC system uses this switch to confirm the fan is in the desired state (that is, on or off) and generates an alarm if status deviates from DDC start/stop control.

CAV 100% OA, CC w/o LTD Hardware Requirements

1	Supply Fan	DO
1	Supply Fan Proof	DI
1	Supply Smoke Detector	DI
1	Filter Dirty Alarm	DI
1	Cooling Coil Valve	AO
1	Space Temperature	AI
1	Supply Air Temperature*	AI

* Not available in Application 2503

CAV 100% OA, HC LTD Sequence of Operation

The constant volume air handling unit consists of an outdoor air damper, pre-filter, hot water heating coil, and supply fan. The unit is DDC controlled using electric actuation.

The air handling unit is scheduled for automatic operation on a time of day basis for Occupied and Unoccupied modes. Within the Occupied mode, the system can enter the Warm-Up mode when the space temperature is below setpoint. The system stays in the Warm-Up mode until the mode setpoint is satisfied. Within the Unoccupied mode, Night Heating is available when the space temperature drops below 65°F (18°C).

The air handling unit operates in Warm-Up, Occupied, Unoccupied, Night Heating and Safety modes as follows (All suggested setpoints and settings are adjustable.):

Warm-Up

The outdoor air damper opens and, after fully open, a damper actuator auxiliary switch starts the supply fan. The heating coil valve modulates to maintain the supply air temperature setpoint. The system is prevented from entering the Warm-Up mode more than once per day.

Occupied

The outdoor air damper opens and, after fully open, a damper actuator auxiliary switch starts the supply fan. The heating coil valve modulates to maintain the supply air temperature setpoint.

Unoccupied (Normal Off)

The supply fan stops and the outdoor air damper closes. If the OAT is less than 45°F (7°C), the heating coil valve modulates to maintain the unoccupied supply air setpoint. If the OAT is 45°F (7°C) or above, the heating coil valve closes.

Night Heating

The outdoor air damper opens and, after fully open, a damper actuator auxiliary switch starts the supply fan with the heating coil valve open to maintain a minimum night setpoint of 65°F (18°C).

Safety

The outdoor air damper actuator auxiliary switch stops the supply fan when the OA damper starts to close.

The smoke detector in the supply air stream de-energizes the supply fan upon activation. When the OAT is less than 45°F (7°C), the heating coil valve modulates to maintain the supply air temperature at 45°F (7°C). When the OAT is 45°F (7°C) or above, the heating coil valve closes. All other dampers and valves position to their normal position after the fan is de-energized.

A low temperature detector in the discharge of the heating coil de-energizes the supply fan when temperatures below 38°F (3°C) are sensed. The heating coil valve modulates to maintain the supply air temperature at 45°F (7°C). All other dampers and valves position to their normal position after the fan is de-energized.

A current switch is installed in the supply fan starter. The DDC system uses this switch to confirm the fan is in the desired state (that is, on or off) and generates an alarm if status deviates from DDC start/stop control.

CAV 100% OA, HC Hardware Requirements

1	Supply Fan Proof	DI
1	Filter Dirty Alarm	DI
1	Supply Fan	DO
1	Supply Smoke Detector	DI
1	Heating Coil Valve	AO
1	Low Temperature Detection Thermostat	DI
1	Space Temperature	AI
1	Supply Air Temperature*	AI

* Not available in Application 2503

CAV 100% OA, HC, CC Sequence of Operation

The constant volume air handling unit consists of an outdoor air damper, pre-filter, hot water heating coil, cold water cooling coil, and supply fan. The unit is DDC controlled using electric actuation.

The air handling unit is scheduled for automatic operation on a time of day basis for Occupied and Unoccupied modes. Within the Occupied mode, the system can enter the Warm-Up mode when the space temperature is below setpoint or the Cool-Down mode when the space temperature is above setpoint. The system stays in the Warm-Up or Cool-Down mode until the mode setpoint is satisfied. Within the Unoccupied mode, Night Heating is available when the space temperature drops below 65°F (18°C).

The air handling unit operates in Warm-Up, Cool-Down, Occupied, Unoccupied, Night Heating and Safety modes as follows (All suggested setpoints and settings are adjustable.):

Warm-Up

The outdoor air damper opens and, after fully open, a damper actuator auxiliary switch starts the supply fan. The cooling coil valve remains closed. The heating coil valve modulates to maintain the supply air temperature setpoint. The system is prevented from entering the Warm-Up mode more than once per day.

Cool-Down

The outdoor air damper opens and, after fully open, a damper actuator auxiliary switch starts the supply fan. The heating coil valve remains closed. The cooling coil valve modulates to maintain the supply air temperature setpoint. The system is prevented from entering the Cool-Down mode more than once per day.

Occupied

The outdoor air damper opens and, after fully open, a damper actuator auxiliary switch starts the supply fan. The heating coil valve and cooling coil valve modulate in sequence without overlap to maintain the supply air temperature setpoint.

Unoccupied (Normal Off)

The supply fan stops, the cooling coil valve closes and the outdoor air damper closes. If the OAT is less than 45°F (7°C), the heating coil valve modulates to maintain the unoccupied supply air setpoint. If the OAT is 45°F (7°C) or above, the heating coil valve closes.

Night Heating

The outdoor air damper opens and, after fully open, a damper actuator auxiliary switch starts the supply fan with the heating coil valve open to maintain a minimum night setpoint of 65°F (18°C). The cooling coil valve remains closed.

Safety

The outdoor air damper actuator auxiliary switch stops the supply fan when the OA damper starts to close.

The smoke detector in the supply air stream de-energizes the supply fan upon activation. When the OAT is less than 45 °F (7 degrees C), the heating coil valve modulates to maintain the supply air temperature at 45 degrees F (7 °C). When the OAT is 45 °F (7 °C) or above, the heating coil valve closes. All other dampers and valves position to their normal position after the fan is de-energized.

A low temperature detector in the discharge of the heating coil de-energizes the supply fan when temperatures below 38 °F (3 °C) are sensed. The heating coil valve modulates to maintain the supply air temperature at 45 °F (7 °C). All other dampers and valves position to their normal position after the fan is de-energized.

A current switch is installed in the supply fan starter. The DDC system uses this switch to confirm the fan is in the desired state (that is, on or off) and generates an alarm if status deviates from DDC start/stop control.

CAV 100% OA, HC, CC Hardware Requirements

1	Filter Dirty Alarm	DI
1	Supply Fan	DO
1	Supply Fan Proof	DI
1	Supply Smoke Detector	DI
1	Cooling Coil Valve	AO
1	Heating Coil Valve	AO
1	Heating Discharge Temperature	AI
1	Low Temperature Detection Thermostat	DI
1	Space Temperature	AI
1	Supply Air Temperature*	AI

* Not available in Application 2503

Application Notes

1. If the temperature swings in the room are excessive, or if there is trouble maintaining the room setpoint, either the room cooling loop, the room heating loop or both need to be tuned.
2. The AHU TEC Controller – 0-10V Output, as shipped from the factory, keeps all associated equipment OFF. See the Equipment Controllers tab in *APOGEE Automation Start-up Procedures* for information on how to release the controller and its equipment to application control.
3. Some of the actions of application 2503 depend on the outside air temperature. However, the TEC does not have an outside air temperature sensor connected to it. The way to get outside air temperature sensor information into application 2503 is to unbundle OA TEMP (Point 75) and adjust its value in a field panel.

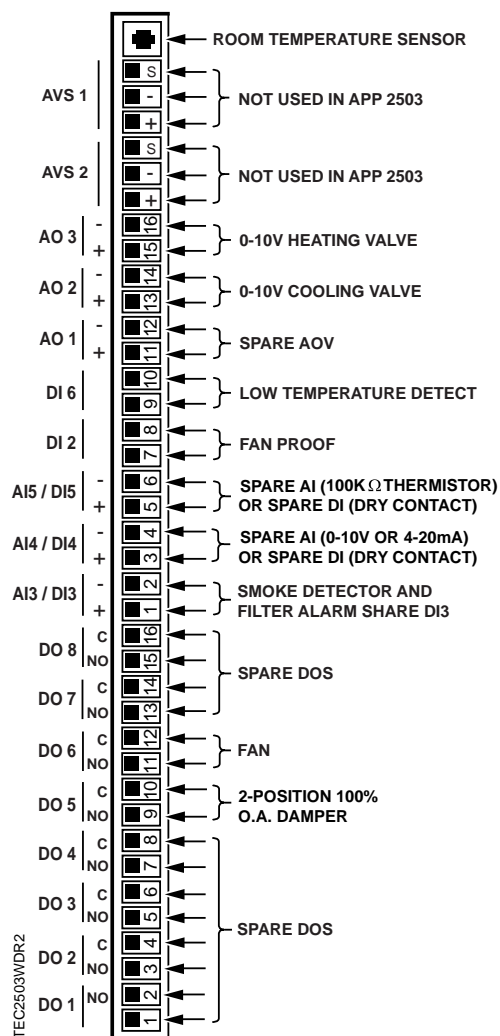
Wiring Diagrams

The point wiring for Application 2503 is shown in Figure 2503-7.



CAUTION:

The Controller's Digital Outputs (DOs) control 24 Vac loads only. The maximum rating is 12 VA for each DO. For higher VA requirements, 110 or 220 Vac requirements, DC power requirements or separate requirements used to power the load, use an interposing 220 V 4-relay module.



NOTES:

- A dip-switch behind AI 3 on the controller's circuit board (under the controller assembly's cover) must be set to the left (voltage position) or to the right (current position) if AI 3 is used to monitor a 0-10 V or a 4-20 mA sensor.
- SMOKE DETECTOR / FILTER ALARM - Point will shutdown unit when DIALRM.ENDIS is enabled, Disable DIALRM.ENDIS for spare DI monitoring.

Figure 2503-9. Application 2503 Wiring Diagram.

Table 2503-1. Point Database for Application 2503.

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	2588	--	1	0	--	--
03	WRMUP STPT	70.0 (21.20888)	DEG F (DEG C)	0.25 (0.14)	48.0 (8.88888)	--	--
{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	OCC CLG STPT	74.0 (23.44888)	DEG F (DEG C)	0.25 (0.14)	48.0 (8.88888)	--	--
07	OCC HTG STPT	70.0 (21.20888)	DEG F (DEG C)	0.25 (0.14)	48.0 (8.88888)	--	--
08	UOC CLG STPT	82.0 (27.92888)	DEG F (DEG C)	0.25 (0.14)	48.0 (8.88888)	--	--
09	UOC HTG STPT	65.0 (18.40888)	DEG F (DEG C)	0.25 (0.14)	48.0 (8.88888)	--	--
10	COOLDN STPT	74.0 (23.44888)	DEG F (DEG C)	0.25 (0.14)	48.0 (8.88888)	--	--
11	RM STPT MIN	52.5 (11.40888)	DEG F (DEG C)	0.25 (0.14)	48.0 (8.88888)	--	--
12	RM STPT MAX	74.25 (23.58888)	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}	AI 3	0.0	PCT	0.4	0.0	--	--
{19}	DI OVRD SW	OFF	--	--	--	ON	OFF
20	OVRD TIME	0	HRS	1	0	--	--
{21}	UNOCC OVRD	UNOCC	--	--	--	UNOCC	OCC
22	HC.ENDIS	3	--	1	1	--	--
23	MODE.ENDIS	15	--	1	0	--	--
{24}	FAN DI 2	OFF	--	--	--	ON	OFF
{25}	GEN ALRM DI3	OFF	--	--	--	ON	OFF
{26}	LTD DI 6	OFF	--	--	--	ON	OFF
{27}	DI 4	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.

continued on the next page...

Point Number	Descriptor	Factory Default (SI Units)	Engr Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
{28}	DI 5	OFF	--	--	--	ON	OFF
{29}	OCC.UNOCC	UNOCC	--	--	--	UNOCC	OCC
{30}	WRMUP.COOLDN	ON	--	--	--	ON	OFF
{31}	AI 4	0.0	PCT	0.4	0.0	--	--
{32}	AI 5	74.0 (23.496)	DEG F (DEG C)	0.5 (0.28)	37.5 (3.056)	--	--
33	AOV2 SPAN	10.0	VOLTS	0.01	0.0	--	--
34	AOV2 START	0.0	VOLTS	0.01	0.0	--	--
35	AOV3 SPAN	10.0	VOLTS	0.01	0.0	--	--
36	AOV3 START	0.0	VOLTS	0.01	0.0	--	--
37	AO DIR.REV	0	--	1	0	--	--
{38}	AOV1	0.0	VOLTS	0.01	0.0	--	--
{39}	AOV2	0.0	VOLTS	0.01	0.0	--	--
{40}	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
{45}	OA DMPR DO 5	CLOSE	--	--	--	OPEN	CLOSE
{46}	FAN DO 6	OFF	--	--	--	ON	OFF
{47}	DO 7	OFF	--	--	--	ON	OFF
{48}	DO 8	OFF	--	--	--	ON	OFF
49	LTD HTG POS	100.0	PCT	0.4	0.0	--	--
50	GEN HTG POS	100.0	PCT	0.4	0.0	--	--
51	UOC HTG POS	0.0	PCT	0.4	0.0	--	--
52	LTDT CONTACT	NCLOSE	--	--	--	NCLOSE	NOPEN
{53}	UOC HTG	OFF	--	--	--	ON	OFF
{54}	UOC CLG	OFF	--	--	--	ON	OFF
55	GEN CONTACT	NCLOSE	--	--	--	NCLOSE	NOPEN
56	DIALRM.ENDIS	7	--	1	0	--	--
57	PROOF TIME	30	SEC	1	0	--	--

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Point Number	Descriptor	Factory Default (SI Units)	Engr Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
59	DO DIR.REV	0	--	1	0	--	--
60	LTD CLG POS	100.0	PCT	0.4	0.0	--	--
61	GEN CLG POS	100.0	PCT	0.4	0.0	--	--
62	UOC CLG POS	0.0	PCT	0.4	0.0	--	--
63	CLG P GAIN	10.0 (18.0)	--	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 VLV CMD	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 VLV CMD	0.0	PCT	0.4	0.0	--	--
{75}	OA TEMP	38.5 (3.616)	DEG F (DEG C)	0.5 (0.28)	37.5 (3.056)	--	--
76	OA LLIMIT	45.0 (7.256)	DEG F (DEG C)	0.5 (0.28)	37.5 (3.056)	--	--
77	OA DBAND	2.0 (1.12)	DEG F (DEG C)	0.5 (0.28)	0.0	--	--
{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	--	--
{83}	GEN ALARM	NORMAL	--	--	--	ALARM	NORMAL
{84}	FAN STATUS	NORMAL	--	--	--	ALARM	NORMAL
85	SWITCH LIMIT	4.8	PCT	0.4	0.0	--	--
86	SWITCH TIME	10	MIN	1	0	--	--
{87}	LOW TEMP DET	OFF	--	--	--	ON	OFF
88	UOC DBAND	2.0 (1.12)	DEG F (DEG C)	0.25 (0.14)	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. Point numbers that appear in brackets {} may be unbundled at the field panel.

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Point Number	Descriptor	Factory Default (SI Units)	Engr Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
89	MORN DBAND	2.0 (1.12)	DEG F (DEG C)	0.25 (0.14)	0.0	--	--
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)	--	--
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.