

TEC Custom Solutions Application 2460 Water to Air Heat Pump with 1-Stage Electric Heat, Multi-Speed Fan and Motion Sensor

TEC 0583.08

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Overview

Application 2460 was designed for hotel use. It controls a single stage heat pump with a reversing valve, 1 additional stage of electric heat, a 2-position outdoor air damper and a multi-speed fan (off-lo-hi). Occ/Unoc status is determined via the interaction of a door switch and a motion sensor.

Other features in application 2460 include:

- A fan speed push button that controls the speed of the fan during occupied mode.
- A power failure recovery sequence that prevents every TEC in the building running application 2460 from starting all at once after a return from power failure. (During recovery, the fan, compressor and electric heat are off and the 2-position outdoor air damper is closed.)
- An unbundle-able point that can be used at the field panel to enable/disable the electric heat. For example, the electric heat could be disabled if the outdoor air temperature rises above a certain value. When disabled in this manner, the electric heat stays off regardless of room load.
- Two room temperature PID loops (heating and cooling). To avoid reset windup, 2460 contains logic that will disable an inactive PID loop.
- A heat/cool switchover feature based on room load.
- The ability to monitor fan status via a DI and supply air temperature via an AI.
- Minimum ON and OFF times for the compressor.
- Logic to prevent the fan from turning off until both the electric heat and compressor have been off for 30 seconds (+/- one LOOP TIME).
- Logic to prevent the compressor and electric heat from being on at the same time.

See Figures 2460-1 and 2460-2

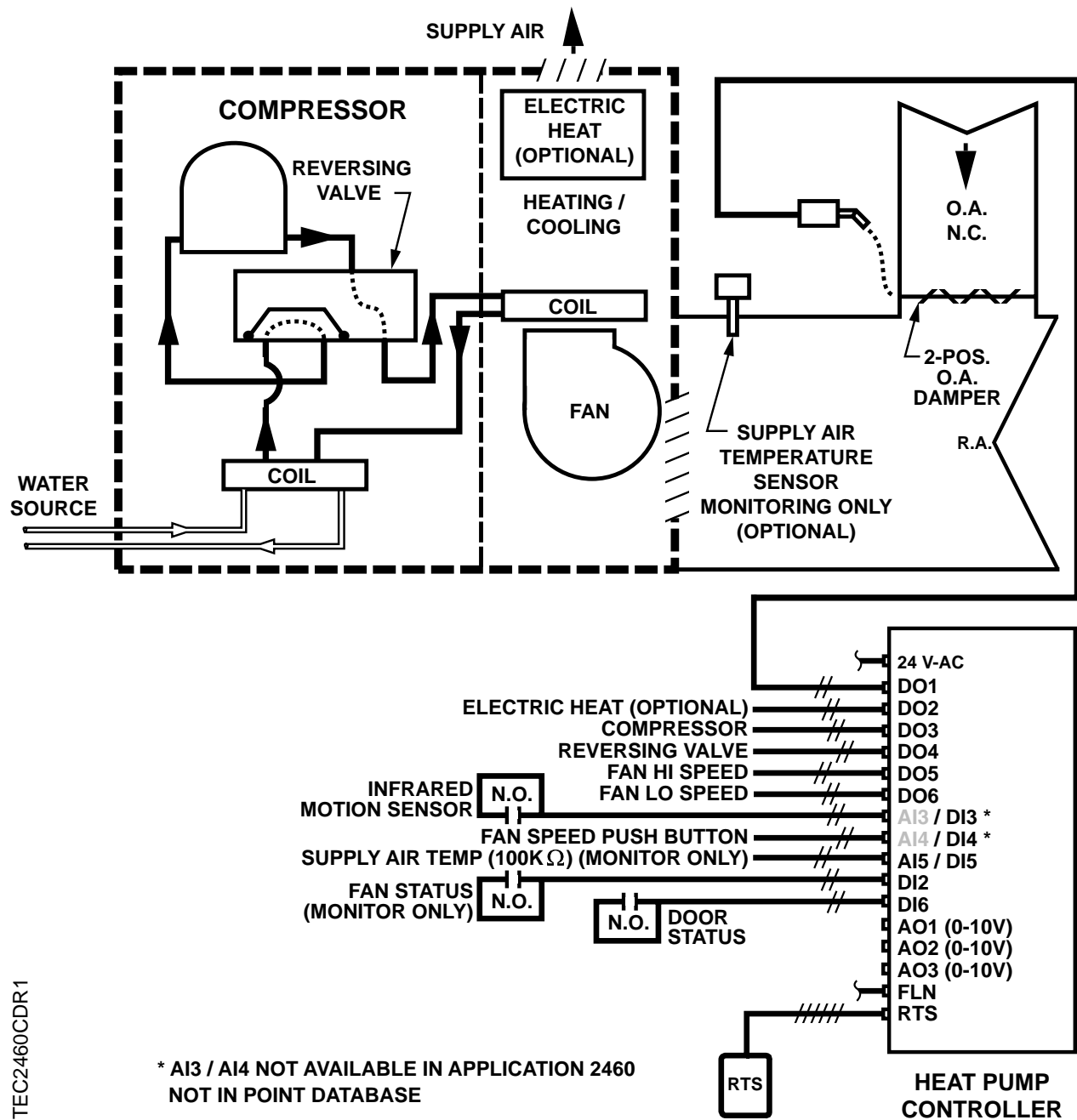
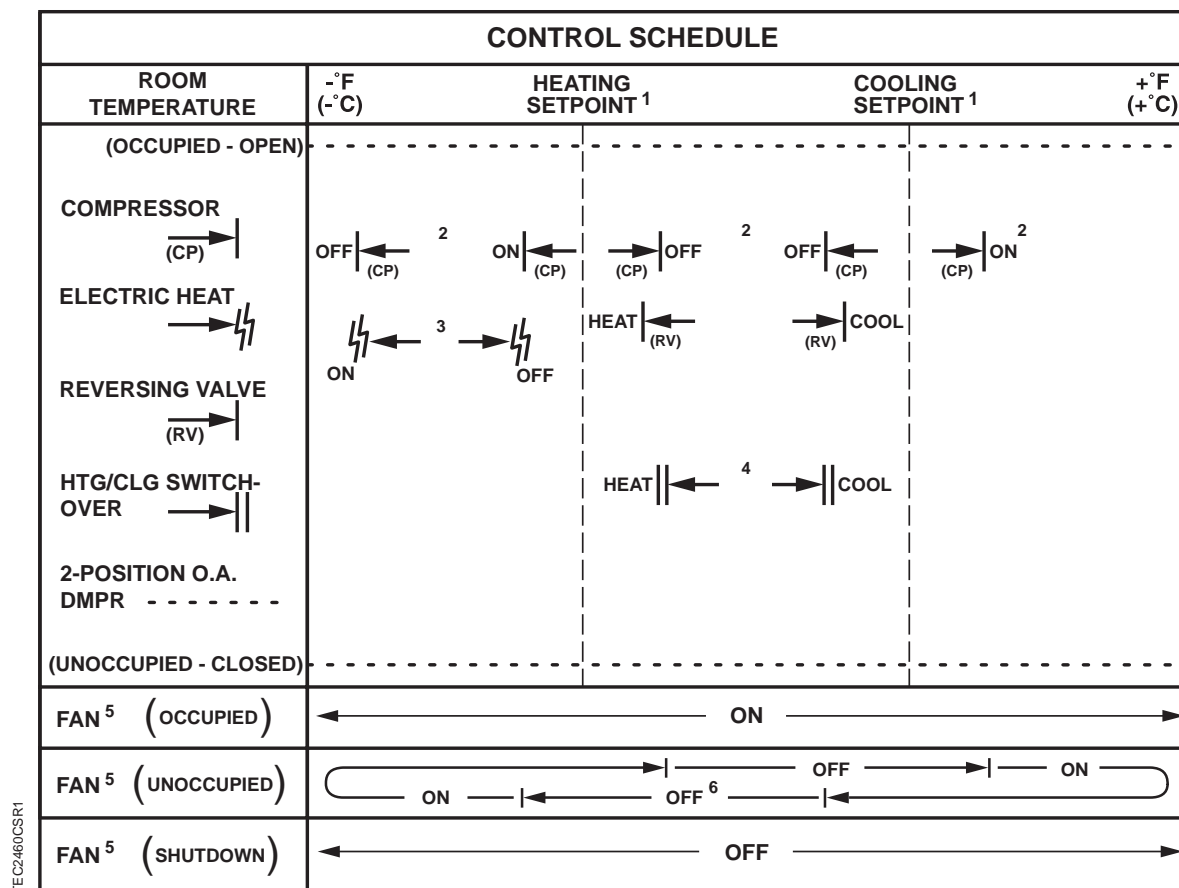


Figure 2460-1. Application 2460 Control Drawing.



1. See *Control Temperature Setpoint* section.
2. See *Compressor Operation* section.
3. See *Electric Heat* section.
4. See *Heating/Cooling Switchover* section.
5. See *Fan Operation* section.
6. In unoccupied mode, the fan shuts off once the compressor and electric heat have been off at least 30 seconds.

Figure 2460-2. Application 2460 Control Schedule

Hardware inputs

Analog

- Room temperature sensor
- Room temperature setpoint dial (optional)
- Supply Air Temperature Sensor (optional)

Digital

- Fan speed push button
- Motion Sensor
- Fan status (optional)

- Door Switch

Hardware outputs

Analog (0-10V)

- Cooling valve actuator
- Heating valve actuator

Digital

- Fan – Lo Speed
- Fan – Hi Speed
- Electric Heat (Optional)
- Compressor
- Reversing Valve
- 2-Position, 100% OA Damper

Ordering Notes

P/N 540-863V

Sequence of Operation

The following paragraphs present the sequence of operation for Application 2460, Water to Air Heat Pump with 1-Stage Electric Heat, Multi-Speed Fan and Motion Sensor.

Application 2460 Action Table

Table 1. Application 2460 Action Table.

	Occupied Mode		Unoccupied Mode				Shutdown Mode	
	Occ Htg	Occ Clg	Unoc Htg Regular ¹	Unoc Htg Vacant ¹	Unoc Clg Regular ¹	Unoc Clg Vacant ¹	Return from Pwr Failure	Shutdown
CTL STPT	OCC HTG STPT or RM STPT DIAL ²	OCC CLG STPT or RM STPT DIAL ²	UOC HTG STPT	VAC HTG STPT	UOC CLG STPT	VAC CLG STPT	VAC CLG STPT or VAC HTG STPT	VAC CLG STPT or VAC HTG STPT
FAN	On at Lo Speed if button never pushed, else follows fan speed push button. ³		Cycles based on Rm Load ⁴		Cycles based on Rm Load ⁴		Off (Immediately)	Shuts off after Compressor and Electric Heat have been Off long enough
REVERS-ING VALVE	Heating	Cooling	Heating		Cooling		Stays in Last Commanded State	Stays in Last Commanded State
COM-PRESSOR	Cycles based on Rm Load. (Obeys Minimum On and Off Timers.) Shuts Off if E-Heat is On.	Cycles based on Rm Load. (Obeys Minimum On and Off Timers.)	Cycles based on Rm Load. (Obeys Minimum On and Off Timers.) Shuts Off if Electric Heat is On.		Cycles based on Rm Load. (Obeys Minimum On and Off Timers.)		Off (Immediately)	Shuts Off after Minimum On Timer times out
ELEC. HEAT	Cycles based on Rm Load if Enabled. Otherwise, Off.	Off	Cycles based on Rm Load if Enabled. Otherwise, Off.		Off		Off	Off
OA DAMPER	Opened	Closed	Closed		Closed		Closed	Closed
	1 - Unoc Regular means the application has been in unoccupied mode for less time than the amount stored in VACANT TIME (Point 32). Unoc Vacant means it has been in unoccupied mode longer than the amount stored in VACANT TIME. Unoc Regular assumes the room occupant will return relatively soon. Unoc Vacant means the occupant has been gone many hours or the hotel has a vacancy in the room. Control in Regular and Vacant is identical except for Heating/Cooling setpoints. 2 - See <i>Control Temperature Setpoint</i> section for important information on how CTL STPT is determined during occupied mode. 3 - Fan speed push button toggles fan through available speeds: Off > Lo > Hi > Off > Lo > Hi... etc. When toggled off, fan waits until electric heat or compressor has been off long enough before shutting off. Button is disabled during this waiting period. 4 - Compressor and electric heat require minimum Off time before Fan will shut off. When on, Fan default is Lo speed.							

Shared I/O

AI 5 and DI 5 share controller board terminations. If AI 5 is being used, DI 5 is unavailable and vice versa.

Enumerated Points

Application 2460 has two enumerated points, MODE (Point 30) and HC.ENDIS (Point 22). MODE shows the occ, unoc, or shutdown mode status of the room. HC.ENDIS determines whether the application is heating only, cooling only, or if it uses both heating and cooling modes. See Table 2.

Table 2. Enumerated Points in Application 2460.

Point Name	Point Value and Status			
	0	1	2	3
MODE (Point 30)	Shutdown	Unoccupied	Occupied (default)	N/A - cannot hold this value
HC.ENDIS (Point 22)	N/A - cannot hold this value	Heating enabled	Cooling enabled	Heating/Cooling enabled (default)

NOTES: If MODE is mistakenly set to an undefined value, the application treats MODE as though it equals 2, the default. This ensures the fan is ON when the application is unsure of the occ/unoc status of the room.

If HC.ENDIS is mistakenly set to an undefined value, the application treats HC.ENDIS as though it equals 3, the default.

Mode Control

Application 2460 determines the operational mode by looking at the status of the door switch (DOOR DI 6, Point 26) and the motion sensor (MOTION DI 3, Point 25).

DOOR DI 6 = OPENED:

- When DOOR DI6 is OPENED, application 2460 considers the door to be open. When the door is open the controller will be in occupied mode (MODE (Point 30) = 2) so long as the door stays open less than the time stored in OPEN TIME (Point 34).
- Application 2460 will be in shutdown mode (MODE = 0) if the door remains open longer than OPEN TIME. Once in shutdown, the application will remain there until the door closes.

DOOR DI 6 = CLOSED:

When DOOR DI 6 is CLOSED, application 2460 considers the door to be closed. Determining the proper value for MODE when the door is closed is more complex than when the door is open.

If Application 2460 was in the shutdown mode before the door was closed, then:

- The application goes into unoccupied mode when the door closes (MODE is set to 1). Once the door closes, the application does not look at the motion sensor right away—it waits until the door has been closed for the amount of time stored in FALSE TIME (Point 35). During this waiting period the application remains in unoccupied mode.

NOTE: FALSE TIME (Point 35) – In Application 2460, the contact in the motion sensor (MOTION DI3, Point 25) remains CLOSED for 30 seconds after motion is detected. This could cause problems if not for the point FALSE TIME. For example, let's say the door is closed and Ted is getting ready to leave for the day. As he walks to the door the motion sensor detects his presence. Then he opens the door and leaves, closing the door behind him. The room is now unoccupied, but MOTION DI 3 is still CLOSED due to Ted's presence moments ago. If the application checked MOTION DI 3, it would think the room was occupied and set MODE to 2. This situation is avoided with FALSE TIME, because by the time the door has been closed longer than FALSE TIME, MOTION DI 3 will have returned to OPENED.

- Once the door has remained closed longer than FALSE TIME, the application checks the status of MOTION DI 3:
 - If MOTION DI 3 is OPENED, motion has not been detected and the application will remain in the unoccupied mode from this point forward until either motion is detected or the door is opened.
 - If MOTION DI 3 is CLOSED, motion has been detected and the application will go into the occupied mode (MODE will be set to 2). From this point forward, the application will remain in the occupied mode as long as the door remains closed, regardless of the value of the motion sensor.

If Application 2460 was in the occupied mode before the door was closed, then:

- The application will remain in the occupied mode when the door closes (MODE will remain set to 2). The application will not look at the motion sensor, MOTION DI3 until the door has been closed longer than the time stored in FALSE TIME (Point 35).
- Once the door has remained closed longer than FALSE TIME, the application checks the status of MOTION DI3:
 - If MOTION DI3 is OPENED, motion has not been detected and the application will remain in the occupied mode for at least as long as the time stored in CLOSE TIME (Point 33). If motion still hasn't been detected after CLOSE TIME has expired, the application will go into the unoccupied mode (MODE will be set to 1). From this point forward, the application will remain in the unoccupied mode until either motion is detected or the door is opened.
 - If MOTION DI3 is CLOSED, motion has been detected and the application will remain in the occupied mode as long as the door remains closed, regardless of the value of the motion sensor.

Control Temperature Setpoint

In Application 2460, the value of CTL STPT (Point 92) depends on the current operational mode of the controller (occupied, unoccupied, or shutdown) and whether a setpoint dial is used. See Table 3.

Table 3. Control Temperature Setpoint Determination in Application 2460.

IF STP DIAL =	AND		THEN CTL STPT =
NO	Application 2460 in occupied mode		OCC CLG STPT or OCC HTG STPT
YES	OCC CLG STPT \leq OCC HTG STPT (occupied mode)		RM STPT DIAL (limited to range RM STPT MIN to RM STPT MAX)
	OCC CLG STPT > OCC HTG STPT (occupied mode)	HEAT.COOL = HEAT	RM STPT DIAL – 0.5 * (OCC CLG STPT – OCC HTG STPT) (<u>not</u> limited to range RM STPT MIN to RM STPT MAX)
		HEAT.COOL = COOL	RM STPT DIAL + 0.5 * (OCC CLG STPT – OCC HTG STPT) (<u>not</u> limited to range RM STPT MIN to RM STPT MAX)
YES or NO	Unoccupied mode for less time than VACANT TIME (Point 32)		UOC CLG STPT or UOC HTG STPT
	Unoccupied mode for longer than VACANT TIME (Point 32)		VACANT C STP or VACANT H STP
	Shutdown mode or power failure recovery		VACANT C STP or VACANT H STP

In application 2460, when a setpoint dial is used for occupied temperature control, the option exists of whether to configure a deadband (or zero energy band) around CTL STPT. This deadband can make the application more energy efficient, although not having it may provide greater comfort to room occupants. When the deadband is configured, the application uses the value of the room setpoint dial to calculate and provide separate heating and cooling setpoints.

To configure the deadband, set STPT DIAL to YES and set OCC CLG STPT greater than OCC HTG STPT. When this is done, CTL STPT will equal:

- RM STPT DIAL – 0.5 * (OCC CLG STPT – OCC HTG STPT) when HEAT.COOL = HEAT
- RM STPT DIAL + 0.5 * (OCC CLG STPT – OCC HTG STPT) when HEAT.COOL = COOL

EXAMPLE: If OCC CLG STPT = 76, OCC HTG STPT = 72, and RM STPT DIAL has been set to 73, CTL STPT will equal 71 in heating mode and 75 in cooling, providing a band of 4 degrees in which the application senses no room load.

To not have the deadband when a setpoint dial is used for occupied temperature control, set OCC CLG STPT equal or less than OCC HTG STPT. When this is done, CTL STPT will equal the value of RM STPT DIAL, providing control with a single setpoint (dial value) for both heating and cooling.

NOTE: In occupied mode, if STP DIAL = YES and OCC CLG STPT is set to a value equal to or less than OCC HTG STPT, CTL STPT is limited to the range RM STPT MIN to RM STPT MAX. However, if during occupied mode STP DIAL = YES and OCC CLG STPT has been set greater than OCC HTG STPT, then CTL STPT is **not** limited to the range RM STPT MIN to RM STPT MAX — in certain cases where the setpoint dial is set at or near a temperature extreme (all the way warm or all the way cool), CTL STPT might end up outside the min/max temperature range. One way to minimize this possibility is to set the min and max room temp setpoints 1 or 2 degrees higher/lower than you would normally. That is, if STPT DIAL is set to YES and you are going to be running the application with OCC CLG STPT set greater than OCC HTG STPT to increase energy efficiency, and you want the room minimum to be, say, 62 degrees, then add one or two degrees and set RM STPT MIN to 63 or 64. Reduce RM STPT MAX by the same amount (if you want it to be 86 degrees, set it to 84 or 85). This is a practical way to reduce the application's ability to control past the min/max setpoints when STP DIAL = YES and OCC CLG STPT has been set greater than OCC HTG STPT.

NOTE: Unless overridden, CTL TEMP (Point 78) will equal ROOM TEMP (Point 4) + TEMP OFFSET (Point 3).

Room Temperature Offset

NOTE: The Room Temperature Offset feature is optional.

TEMP OFFSET (Point 3) is a user-adjustable offset that will compensate for deviations between the value of ROOM TEMP (Point 4) and the actual room temperature. This corrected value is displayed in CTL TEMP (Point 78).

$$\text{CTL TEMP (Point 78)} = \text{ROOM TEMP (Point 4)} + \text{TEMP OFFSET (Point 3)}$$

EXAMPLE: If the actual room temperature is 72.0°F, and the value of ROOM TEMP is 73.0°F, then the value entered into TEMP OFFSET is -1.0. In this case, the value of ROOM TEMP would read 73.0°F, but the value of CTL TEMP would read 72.0°F.

Heating/Cooling Switchover

For Heat/Cool Switchover to work, heating and cooling must both be enabled (HC.ENDIS, Point 22 = 3).

From Heat to Cool

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 by setting HEAT.COOL (Point 5) to COOL:

- HTG LOOPOUT (Point 80) is below SWITCH LIMIT.
- CTL TEMP (Point 78) is greater than the sum of CTL STPT (Point 92) plus SWITCH DBAND (Point 90).
- CTL TEMP is greater than the appropriate cooling setpoint minus SWITCH DBAND.

From Cool to Heat

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

- CLG LOOPOUT (Point 79) is below SWITCH LIMIT.
- CTL TEMP is less than CTL STPT minus SWITCH DBAND.
- CTL TEMP is less than the appropriate heating setpoint plus SWITCH DBAND.

NOTE: Application 2460 performs Heat/Cool Switchover based on room load. Other criteria such as time of year or outside air temperature require unbundling HEAT.COOL at the field panel and using PPCL to control it.

Control Loops

The heat pump is controlled by two Proportional, Integral, and Derivative (PID) control loops (a cooling loop and a heating loop). Each loop uses CTL STPT (Point 92) and CTL TEMP (Point 78) to modulate the value of its respective loopout point, CLG LOOPOUT (Point 79) or HTG LOOPOUT (Point 80).

The cooling loop is active whenever HEAT.COOL (Point 5) = COOL and the fan is on. The heating loop is active whenever HEAT.COOL = HEAT and the fan is on. Neither loop is active when the fan is off (the loopout point will equal 0).

NOTE: The fan will be off if:

- The controller is in shutdown mode or recovering from power failure.
- During unoccupied mode, FAN LO DO6 (Point 46) has been manually commanded OFF and FAN HI DO5 (Point 45) is OFF.
- During occupied mode, with the fan at Hi speed, the room occupant pushes the fan speed push button (DI, Point 27) to turn the fan off.

In the case of power failure recovery the fan shuts off immediately. In other cases it is subject to minimum off times for the electric heat and/or compressor before being allowed to shut off. See *Fan Operation* for more information.

Occupied Heating

When MODE (Point 30) equals 2 and HEAT.COOL (Point 5) equals HEAT, Application 2460 is in the occupied heating mode.

During occupied heating, the 2-position outside air damper (OA DMPR DO 1, Point 41) is open.

Electric Heat and Compressor Operation in Occupied Heating Mode

In application 2460, the electric heat and compressor are never allowed on at the same time. The fan must be on for either the compressor or the electric heat to be on. The default setting for the fan is to be on at Lo speed, where it will stay unless the fan speed push button is pushed which toggles the fan to Hi speed. See *Fan Operation* for more information.

If the fan is running and has not been commanded off, the application cycles electric heat (EHEAT DO2, Point 42) and/or the compressor (COMP DO3, Point 43) based on the value of HTG LOOPOUT (Point 80) to maintain CTL TEMP (Point 78) at the value stored in CTL STPT (Point 92).

If electric heat is present and enabled (EHTG STG CNT (Point 76) = 1, EHEAT EN.DIS (Point 31) = ENABL), then for heavy heating loads the application will cycle only the electric heat, and for moderate heating loads the application will cycle only the compressor. If electric heat is disabled or not present, then only the compressor is cycled.

If the fan is at Hi speed and the fan speed push button is pushed to toggle the fan to Off, then:

- If the compressor (COMP DO3) is on, it is commanded off. The compressor must obey the minimum on time in CMP1 MIN ON (Point 88) before shutting off. Once the compressor is off, a 30 second timer is initiated; after the 30 seconds elapses the fan shuts off.
- If an electric heat stage exists and is on (EHEAT DO2, Point 42 = ON), it will shut off. Once the electric heat is off, a 30 second timer is initiated; after the 30 seconds elapses the fan shuts off.

If the fan is off, the compressor and the electric heat will remain off. The compressor and the electric heat will not be allowed to turn on again until the fan is operating either at Lo speed or Hi speed. (A push of the fan speed push button brings the fan back to Lo speed.)

Occupied Cooling

When MODE (Point 30) equals 2 and HEAT.COOL (Point 5) equals COOL, Application 2460 is in the occupied cooling mode.

During occupied cooling, the 2-position outside air damper (OA DMPR DO1, Point 41) is open. Electric heat is off.

Compressor Operation in Occupied Cooling Mode

During occupied cooling, the fan must be on for the compressor to be on. The default setting for the fan is to be on at Lo speed, where it will stay unless the fan speed push button is pushed which toggles the fan to Hi speed. See *Fan Operation* for more information.

If the fan is running and has not been commanded off, the application cycles the compressor (COMP DO3, Point 43) based on the value of CLG LOOPOUT (Point 79) to maintain CTL TEMP (Point 78) at the value stored in CTL STPT (Point 92).

If the fan is at Hi speed and the fan speed push button is pushed to toggle the fan to Off, then:

- If the compressor (COMP DO3) is on, it is commanded off. The compressor must obey the minimum on time in CMP1 MIN ON (Point 88) before shutting off.
- The fan will shut off as soon as COMP DO3 has been OFF for at least 30 seconds.

If the fan is off, the compressor will remain off. The compressor will not be allowed to turn on again until the fan is operating either at Lo speed or Hi speed. (A push of the fan speed push button brings the fan back to Lo speed.)

Unoccupied Heating

When MODE (Point 30) equals 1 and HEAT.COOL (Point 5) equals HEAT, Application 2460 is in the unoccupied heating mode.

During unoccupied heating:

- The 2-position outside air damper (OA DMPR DO1, Point 41) is closed.
- The fan runs at Lo speed (FAN LO DO6, Point 46 = ON) whenever the compressor (COMP DO3) or the electric heat (EHEAT DO2) are on. The fan shuts off after EHEAT DO2 and COMP DO3 have both been off for more than 30 seconds.
- FAN HI DO5 (Point 45) = OFF and the fan speed push button is ignored.
- Unless overridden, CTL STPT will equal UOC HTG STP (Point 9) if the application has been in the unoccupied heating mode for less than VACANT TIME (Point 32). Otherwise, CTL STPT will equal VACANT H STP (Point 17).

Electric Heat and Compressor Operation in Unoccupied Heating Mode

In application 2460, the electric heat and compressor are never allowed on at the same time.

During unoccupied heating, the application cycles electric heat (EHEAT DO2, Point 42) and/or the compressor (COMP DO3, Point 43) based on the value of HTG LOOPOUT (Point 80) to maintain CTL TEMP (Point 78) at the value stored in CTL STPT (Point 92).

If electric heat is present and enabled (EHTG STG CNT (Point 76) = 1, EHEAT EN.DIS (Point 31) = ENABL), then for heavy heating loads the application will cycle only the electric heat, and for moderate heating loads the application will cycle only the compressor. If electric heat is disabled or not present, then only the compressor is cycled.

Unoccupied Cooling

When MODE (Point 30) equals 1 and HEAT.COOL (Point 5) equals COOL, Application 2460 is in the unoccupied cooling mode.

During unoccupied cooling:

- The 2-Position Outside Air Damper, OA DMPR DO 1 (Point 41), is closed.
- Electric heat, if present, is off.
- The fan runs at Lo speed (FAN LO DO6, Point 46 = ON) whenever the compressor (COMP DO3) is on. The fan shuts off after COMP DO3 has both been off for more than 30 seconds.
- FAN HI DO5 (Point 45) = OFF and the fan speed push button is ignored.
- Unless overridden, CTL STPT will equal UOC CLG STP (Point 8) if the application has been in the unoccupied cooling mode for less than VACANT TIME (Point 32). Otherwise, CTL STPT will equal VACANT C STP (Point 16).
- The compressor (COMP DO3, Point 43) is cycled based on the value of CLG LOOPOUT (Point 79) to maintain CTL TEMP (Point 78) at the value stored in CTL STPT (Point 92).

Shutdown Mode

When MODE (Point 30) equals 0, Application 2460 is in shutdown mode. Application 2460 goes into shutdown when DOOR DI6 (Point 28) has remained opened longer than OPEN TIME (Point 34).

During shutdown, the 2-position outside air damper (OA DMPR DO1, Point 41) is closed. Electric heat is off.

If the compressor (COMP DO3, Point 43) turned on just before the application entered shutdown, it must wait until the minimum on time in CMP1 MIN ON (Point 88) expires before shutting off. Otherwise, the compressor shuts off immediately.

The fan will shut off (both FAN HI DO5 (Point 45) and FAN LO DO6 (Point 46) = OFF) after both the electric heat and the compressor have been off for at least 30 seconds.

Electric Heat

NOTE: To prevent damage to the heat pump, EHEAT DO2 (Point 42) is not operator commandable at the portable operator's terminal or the field panel if DO2 is controlling a stage of electric heat (EHTG STG CNT (Point 76) does not equal 0). If EHTG STG CNT = 0, EHEAT DO2 is a spare DO that is fully operator commandable.

EHEAT DO2 will be off if **any** of the following are true:

- Recovering from power failure.
- Shutdown mode (MODE, Point 30 = 0).
- Electric heat staging points set incorrectly (EHEAT 1 ON (Point 81) set less than or equal to CMP1 ON (Point 82)).
- HEAT.COOL (Point 5) = COOL.
- EHEAT EN.DIS (Point 31) = DISABL.
- The fan is off (both FAN HI DO5 (point 45) and FAN LO DO6 (Point 46) = OFF).
- Room occupant pushes fan speed push button (FANSPEED DI4, Point 26) during occupied mode while fan is at Hi speed (to shut it off).
- CMP TOTL (Point 75) does not equal 0 and REV VALVE (Point 44) equals COOL.

EHEAT DO2 will cycle when **all** of the following are true:

- Application not recovering from power failure.
- Not in shutdown (MODE does not = 0, application is either occupied or unoccupied).
- The fan is on (either FAN LO DO6 or FAN HI DO5 is ON).
- Electric heat staging points set correctly (EHEAT 1 ON is greater than CMP1 ON).
- HEAT.COOL = HEAT.
- EHEAT EN.DIS = ENABLE.
- CMP TOTL = 0 or REV VALVE = HEAT.

Electric Heat Cycling

The electric heat and the compressor are not allowed to be on at the same time.

Electric heat will cycle differently depending on whether a compressor is present.

When a compressor is present (CMP TOTL, Point 75 = 1) and HTG LOOPOUT (Point 80) rises above EHEAT 1 ON:

1. The application signals the compressor (COMP DO3) to shut off.
2. COMP DO3 shuts off after it has been on longer than CMP 1 ON.
3. EHEAT DO2 turns ON as soon as COMP DO3 is OFF.

If a compressor is not present (CMP TOTL = 0), then:

- If HTG LOOPOUT rises above EHEAT 1 ON, EHEAT DO2 turns ON.
- If HTG LOOPOUT drops below CMP1 ON, EHEAT DO2 turns OFF.
- If HTG LOOPOUT is between EHEAT 1 ON and CMP1 ON, EHEAT DO2 remains in its last commanded state.

Electric Heat Enable/Disable

Application 2460 uses EHEAT EN.DIS (Point 31) but does not control it. In order for EHEAT.EN.DIS to change value, it must be unbundled and controlled at a field panel.

EHEAT EN.DIS can be used to lockout the electric heat when the outside air temperature gets too warm.

If application 2460 is to operate standalone, make sure EHEAT EN.DIS equals ENABLE. Otherwise, the electric heat can never turn on.

Reversing Valve

NOTE: To prevent damage to the heat pump, REV VALVE (Point 44) is not operator commandable at the portable operator's terminal or the field panel if a compressor is present (CMP TOTL (Point 75) does not equal 0). If CMP TOTL = 0, REV VALVE (D04) is a spare DO that is fully operator commandable.

When a compressor is present, the reversing valve changes from heating to cooling when the following conditions have been met:

- HEAT.COOL (Point 5) equals COOL.
- The compressor (COMP DO3, Point 43) has been OFF longer than RVAL SW TIME (Point 89).
- CLG LOOPOUT (Point 79) is greater than the value set in RVAL SWITCH (Point 84).

The reversing valve changes from cooling to heating when the following conditions have been met:

- HEAT.COOL equals HEAT
- COMP DO3 has been OFF longer than RVAL SW TIME.
- HTG LOOPOUT (Point 80) is greater than the value set in RVAL SWITCH.

Compressor Operation

NOTE: To prevent damage to the heat pump, COMP DO3 (Point 43) is not operator commandable at the portable operator's terminal or the field panel if a compressor is present (CMP TOTL (Point 75) does not equal 0). If CMP TOTL equals 0, COMP DO3 is a spare DO that is fully operator commandable.

Compressor Off Conditions

The compressor (COMP DO3) will be off immediately in the event of power failure recovery and also if the fan is *manually* commanded off, as would be the case if FAN LO DO6 (Point 46) has been manually commanded OFF and FAN HI DO5 (Point 45) is OFF, or if during the occupied mode FAN HI DO5 has been manually commanded OFF and FAN LO DO6 is OFF.

The compressor will go through its shutdown sequence (that is, the compressor must wait for the time delay in CMP1 MIN ON (Point 88) to be satisfied before shutting off) if any of the following conditions is met:

- Shutdown (MODE, Point 30 = 0).
- CMP 1 ON (Point 82) is less than or equal to CMP 1 OFF (Point 83).
- Electric heat is present and enabled and EHEAT 1 ON (Point 81) is less than or equal to CMP1 ON.
- HEAT.COOL (Point 5) = COOL and REV VALVE (Point 44) = HEAT, or vice versa.
- Room occupant pushes fan speed push button (FAN SPEED DI4, Point 27) during occupied mode while fan is at Hi speed (to shut it off).

Normal Staging Control for Compressor

When HEAT.COOL equals COOL: Otherwise, COMP DO3 will remain its last commanded state

- The compressor (COMP DO3) turns on when CLG LOOPOUT (Point 79) rises above CMP 1 ON, provided COMP DO3 has been off longer than CMP1 MIN OFF (Point 87).
- The compressor turns off when CLG LOOPOUT falls below CMP 1 OFF, provided the time delay in CMP1 MIN ON is satisfied.

When HEAT.COOL equals HEAT, the compressor is staged differently depending on whether electric heat is present and enabled.

When HEAT.COOL equals HEAT **without** electric heat present:

- The compressor turns on when HTG LOOPOUT (Point 80) rises above CMP 1 ON, provided COMP DO3 has been off longer than CMP1 MIN OFF.
- The compressor turns off when heating loopout falls below CMP 1 OFF, provided the time delay in CMP1 MIN ON is satisfied.

When HEAT.COOL equals HEAT **with** electric heat present:

- The compressor turns on when HTG LOOPOUT (Point 80) rises above CMP 1 ON, provided COMP DO3 has been off longer than CMP1 MIN OFF.
- Once on, the compressor can turn off in either of two ways:
 - The compressor turns off if HTG LOOPOUT falls below CMP 1 OFF without ever having risen above EHEAT 1 ON (the time delay in CMP1 MIN ON must be satisfied before the compressor turns off).
 - The compressor turns off if HTG LOOPOUT rises above EHEAT 1 ON (the time delay in CMP1 MIN ON must be satisfied before the compressor turns off). Note that the electric heat and the compressor are not allowed to be on at the same time.

NOTE: When electric heat is present and enabled and the compressor has turned off because HTG LOOPOUT became greater than EHEAT 1 ON, the compressor will not turn back on again until HTG LOOPOUT drops below CMP 1 ON (to shut off the electric heat) and then rises back above CMP 1 ON. Once the compressor turns back on, it will stay on until HTG LOOPOUT either becomes greater than EHEAT 1 ON or falls back below CMP 1 OFF. In both cases the compressor will shut off as soon as the time delay in CMP1 MIN ON is satisfied.

Fan Operation

The fan is controlled by two points: FAN LO DO6 (Point 46) and FAN HI DO5 (Point 45). If one of these points is ON, the other must be OFF. Three speeds are possible: Off, Lo, and Hi. If FAN LO DO6 is ON, the fan is at Lo speed. If FAN HI DO5 is ON, the fan is at Hi speed. The fan is off when both fan speed points are OFF.

Fan Operation in Occupied Mode

When the application first enters the occupied mode (MODE = 2) the fan is at Lo speed. The fan will stay at Lo speed throughout the occupied mode unless the fan speed push button is pushed (FANSPEED DI4, Point 26), in which case the fan is toggled to Hi speed.

If the fan is at Hi speed and the fan speed push button is pushed to toggle the fan to Off, then:

- If the compressor (COMP DO3) is on, it is commanded off. The compressor must obey the minimum on time in CMP1 MIN ON (Point 88) before shutting off. Once the compressor is off, a 30 second timer is initiated; after the 30 seconds elapses the fan shuts off.
- If an electric heat stage exists and is on (EHEAT DO2, Point 42 = ON), it will shut off. Once the electric heat is off, a 30 second timer is initiated; after the 30 seconds elapses the fan shuts off.

Once the fan is off, neither the compressor nor electric heat will be allowed on until the fan is on. A push of the fan speed push button brings the fan back to Lo speed.

NOTES: After the fan speed pushbutton is pushed to toggle the fan off, the button (FANSPEED DI4) is temporarily disabled. Once the fan turns off the button is re-enabled.

FAN STAT DI2 (Point 24) is used for monitoring only; it has no control purpose.

Fan Operation in Unoccupied Mode

During the unoccupied mode (MODE = 1) the fan is on at Lo speed if either the compressor or the electric heat is on, otherwise the fan is off. Before turning off, FAN LO DO6 must wait until both the compressor and the electric heat have been off for at least 30 seconds.

Fan Operation in Shutdown Mode

The fan shuts off immediately during power failure recovery. If the application goes into shutdown mode (MODE, Point 30 = 0) with no power failure, the compressor and electric heat are commanded off (the compressor must obey the minimum on time in CMP1 MIN ON (Point 88) before shutting off) and the fan will shut off as soon as the compressor and electric heat have both been off at least 30 seconds.

Damper Operation

Application 2460 controls a 2-position outside air damper for ventilation (OA DMPR DO1, Point 41) that is opened during occupied mode (MODE, Point 30 = 2) and closed otherwise.

Power Failure Recovery

Upon return from power failure:

- Compressor, electric heat and fan are kept OFF.
- 2- position outside air damper is kept closed.
- CLG LOOPUT (Point 79) and HTG LOOPOUT (Point 80) are both set to 0.

The heat pump returns to normal control after its recovery period is over. The recovery period is based on the formula $\text{RETURN DELAY} * (\text{CTLR ADDRESS} \times 10 \text{ seconds})$. This formula prevents the demand penalty that would occur if all the electric equipment started at the same time.

Overriding DOs

Application 2460 is designed to prevent you from directly commanding critical DOs ON or OFF. Specifically,

- If CMP TOTL (Point 75) = 1, you cannot directly turn COMP DO3 (Point 43) ON or OFF or directly command the reversing valve on DO4. This protects the compressor.
- If EHTG STG CNT (Point 76) = 1, you cannot directly turn EHEAT DO2 (Point 42) ON or OFF. This prevents the electric heat from being turned on while the fan is off.

If you want to control COMP DO3 or EHEAT DO2 when a compressor and/or electric heat are present, then you need to set HTG LOOPOUT (Point 80) or CLG LOOPOUT (Point 79) to an appropriate value and let the application do the controlling. This should be done when MODE (Point 30) does not equal shutdown (0), but instead equals unoccupied (1) or occupied (2).

Although the fan DOs are critical, you can manually command them ON/OFF. Application 2460 has safeties that shut off the compressor and electric heat if the fan DOs are overridden to OFF. See the *Electric Heat* and *Compressor Operation* sections for more information.

Spare DOs

- If EHTG STG CNT = 0, then EHEAT DO2 is a spare DO that is fully operator commandable.
- If CMP TOTL = 0, then COMP DO3 and REV VALVE (DO4) are spare DOs that are fully operator commandable.

NOTE: DO1 is directly commandable whether a 2-position damper is connected to it or not.



CAUTION:

Application 2460 will not turn both fan DOs on at the same time. However, if you manually command FAN LO DO6 to ON and let the application control FAN HI DO5, then in the occupied mode FAN HI DO5 will turn ON if the room occupant pushes the fan speed push button to turn it ON. This means FAN LO DO6 and FAN HI DO5 will be on at the same time. Likewise, if FAN HI DO5 is overridden ON and the application is left to control FAN LO DO6, then FAN LO DO6 will turn on when the room first enters the occupied mode. Again, FAN LO DO6 and FAN HI DO5 will be on at the same time. These 2 DOs will also be on at the same time if you simply command them both ON. If you don't want these DOs on at the same time, then if you manually command one of them ON, you must manually command the other one OFF. Furthermore, it is highly recommended that you provide external interlocks with the fan relays to prevent both stages from energizing at the same time.

Fail-Safe Operation

This section explains what Application 2460 does when the room temperature sensor and/or the room temperature setpoint dial fail.

Room Temperature Sensor

If the room temperature sensor fails while CTL TEMP (Point 78) is not overridden or being adjusted by a field panel, ROOM TEMP (Point 4) and CTL TEMP both display as Failed and CTL TEMP will be set equal to the last known good value of ROOM TEMP. Room temperature control will proceed using this value of CTL TEMP.

If the room temperature sensor fails while CTL TEMP is overridden or being adjusted by a field panel, ROOM TEMP will display as Failed but CTL TEMP will display as NORMAL while it continues to be overridden/adjusted. Room temperature control will proceed using the overridden/adjusted value of CTL TEMP.

If ROOM TEMP is unbundled in a field panel and defined as alarmable, an alarm will be annunciated across the network if ROOM TEMP fails.

Room Temperature Setpoint Dial

If all of the following are true...

- A room temperature setpoint dial exists and STPT DIAL (Point 14) = YES.
- RM STPT DIAL (Point 13) is Failed.
- MODE (Point 30) = 2 (occupied)
- CTL STPT (Point 92) not overridden/not being adjusted by field panel.

...then RM STPT DIAL and CTL STPT both display as Failed and the last known good value of RM STPT DIAL will be used to determine the value of CTL STPT. Room temperature control will proceed using this value of CTL TEMP.

During unoccupied mode (MODE = 1), the room setpoint dial is ignored. If RM STPT DIAL fails, it will display as Failed but the application will control normally as it would otherwise.

If RM STPT DIAL is unbundled in a field panel and defined as alarmable, an alarm will be annunciated across the network if RM STPT DIAL fails.

Application Notes

1. If the temperature swings in the room are excessive, or if there is trouble in maintaining the room setpoint, then either the room cooling loop, the room heating loop or both need to be tuned.
2. The Heat Pump TEC, as shipped from the factory, keeps all associated equipment OFF. See the start-up document for information on how to release the controller and its equipment to application control.
3. EHTG STG CNT (Point 76) tells the application whether there is a stage of electric heat on DO2. Valid values are 0 or 1. If EHTG STG CNT has any other value, application 2460 will treat it as though it has a value of 1.
4. CMP TOTL (Point 75) tells the application whether there is a stage of electric heat on DO3. Valid values are 0 or 1. If CMP TOTL has any other value, application 2460 will treat it as though it has a value of 1.

Wiring Diagram

The point wiring for Application 2460 is shown in Figure 2460-3.



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.

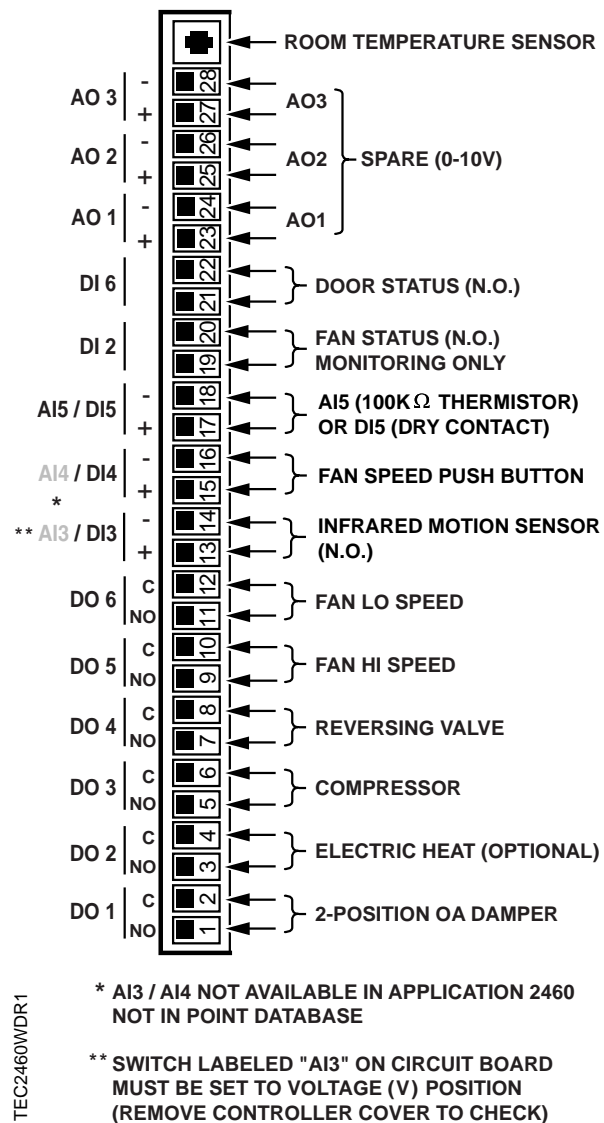


Figure 2460-3. Application 2460 Wiring Diagram.

Point Database

Table 2460-1. Point Database for Application 2460.

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	2467	--	1	0	--	--
03	TEMP OFFSET	0.0 (0.0)	DEG F (DEG C)	0.25 (0.14)	-31.75(-17.78)	--	--
{04}	ROOM TEMP	74.0 (23.45)	DEG F (DEG C)	0.25 (0.14)	48.0(8.89)	--	--
{05}	HEAT.COOL	COOL	--	--	--	HEAT	COOL
06	OCC CLG STPT	74.0 (23.45)	DEG F (DEG C)	0.25 (0.14)	48.0(8.89)	--	--
07	OCC HTG STPT	70.0 (21.21)	DEG F (DEG C)	0.25 (0.14)	48.0(8.89)	--	--
08	UOC CLG STPT	82.0 (27.93)	DEG F (DEG C)	0.25 (0.14)	48.0(8.89)	--	--
09	UOC HTG STPT	65.0 (18.41)	DEG F (DEG C)	0.25 (0.14)	48.0(8.89)	--	--
10	RETURN DELAY	10	MIN	1	0	--	--
11	RM STPT MIN	55.0 (12.81)	DEG F (DEG C)	0.25 (0.14)	48.0(8.89)	--	--
12	RM STPT MAX	90.0 (32.41)	DEG F (DEG C)	0.25 (0.14)	48.0(8.89)	--	--
{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}	SA TEMP AI5	74.0 (23.496)	DEG F (DEG C)	0.5 (0.28)	37.5(3.056)	--	--
16	VACANT C STP	84.0 (29.05)	DEG F (DEG C)	0.25 (0.14)	48.0(8.89)	--	--
17	VACANT H STP	55.0 (12.81)	DEG F (DEG C)	0.25 (0.14)	48.0(8.89)	--	--
22	HC.ENDIS	3	--	1	1	--	--
{24}	FAN STAT DI2	OFF	--	--	--	ON	OFF
{25}	MOTION DI3	OPENED	--	--	--	CLOSED	OPENED
{26}	FANSPEED DI4	OPENED	--	--	--	CLOSED	OPENED
{27}	DI 5	OFF	--	--	--	ON	OFF
{28}	DOOR DI6	OPENED	--	--	--	CLOSED	OPENED
{30}	MODE	2	--	1	0	--	--
{31}	EHEAT EN.DIS	DISABL	--	--	--	ENABLE	DISABL
32	VACANT TIME	15.0	HRS	0.25	0.0	--	--
33	CLOSE TIME	300	SEC	1	0	--	--

Points not listed are not used in this application.

A single value in a column means that the value is the same in English units and in SI units.

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

continued on the next page...

Table 2460-1. Point Database for Application 2460.

Point Number	Descriptor	Factory Default (SI Units)	Engr Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
34	OPEN TIME	240	SEC	1	0	--	--
35	FALSE TIME	270	SEC	1	0	--	--
{41}	OA DMPR DO1	OFF	--	--	--	ON	OFF
{42}	EHEAT DO2	OFF	--	--	--	ON	OFF
{43}	COMP DO3	OFF	--	--	--	ON	OFF
{44}	REV VALVE	COOL	--	--	--	HEAT	COOL
{45}	FAN HI DO5	OFF	--	--	--	ON	OFF
{46}	FAN LO DO6	OFF	--	--	--	ON	OFF
59	DO DIR.REV	0	--	1	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	24 (43.2)	--	2 (3.6)	0	--	--
66	CLG BIAS	50.0	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	24 (43.2)	--	2 (3.6)	0	--	--
70	HTG BIAS	50.0	PCT	0.4	0.0	--	--
75	CMP TOTL	1	--	1	0	--	--
76	EHTG STG CNT	1	--	1	0	--	--
{78}	CTL TEMP	74.0 (23.45)	DEG F (DEG C)	0.25 (0.14)	48.0(8.89)	--	--
{79}	CLG LOOPOUT	0.0	PCT	0.4	0.0	--	--
{80}	HTG LOOPOUT	0.0	PCT	0.4	0.0	--	--
81	EHEAT 1 ON	90.0	PCT	0.4	0.0	--	--
82	CMP1 ON	60.0	PCT	0.4	0.0	--	--
83	CMP1 OFF	30.0	PCT	0.4	0.0	--	--
84	RVAL SWITCH	30.0	PCT	0.4	0.0	--	--
85	SWITCH LIMIT	4.8	PCT	0.4	0.0	--	--
86	SWITCH TIME	10	MIN	1	0	--	--

Points not listed are not used in this application.

A single value in a column means that the value is the same in English units and in SI units.

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

continued on the next page...

Table 2460-1. Point Database for Application 2460.

Point Number	Descriptor	Factory Default (SI Units)	Engr Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
87	CMP1 MIN OFF	3	MIN	1	0	--	--
88	CMP1 MIN ON	3	MIN	1	0	--	--
89	RVAL SW TIME	30	SEC	1	0	--	--
90	SWITCH DBAND	2.0 (1.12)	DEG F (DEG C)	0.25 (0.14)	0.0	--	--
{92}	CTL STPT	74.0 (23.45)	DEG F (DEG C)	0.25 (0.14)	48.0(8.89)	--	--
96	CAL TIMER	12	HRS	1	0	--	--
98	LOOP TIME	5	SEC	1	0	--	--
{99}	ERROR STATUS	0	--	1	0	--	--
Points not listed are not used in this application. A single value in a column means that the value is the same in English units and in SI units. Point numbers that appear in brackets { } may be unbundled at the field panel.							