

## TEC Custom Solutions

### Application 2434:

### Unit Conditioner 3-Stage Cooling and Hot Water Heat

TEC-0358.08

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## Overview

**NOTE:** For the latest on Custom Solution Applications and Controllers, visit the [Custom Solutions website](#).

In Application 2434, the controller energizes a maximum of three stages of cooling and controls a hot water valve for heating. In order for the application to work properly, the central plant must provide hot water in the heating season. This application also monitors the open/close status of a window via DI 2, and will modify the control sequence depending on the window status.

Refer to Figures 2434-1 thru 2434-3.

**NOTE:** Because Application 2434 uses DI 2 to monitor the open/closed status of a window, it is not able to support the Wall Switch feature for manually changing the controller from night mode operational control to day mode operational control.

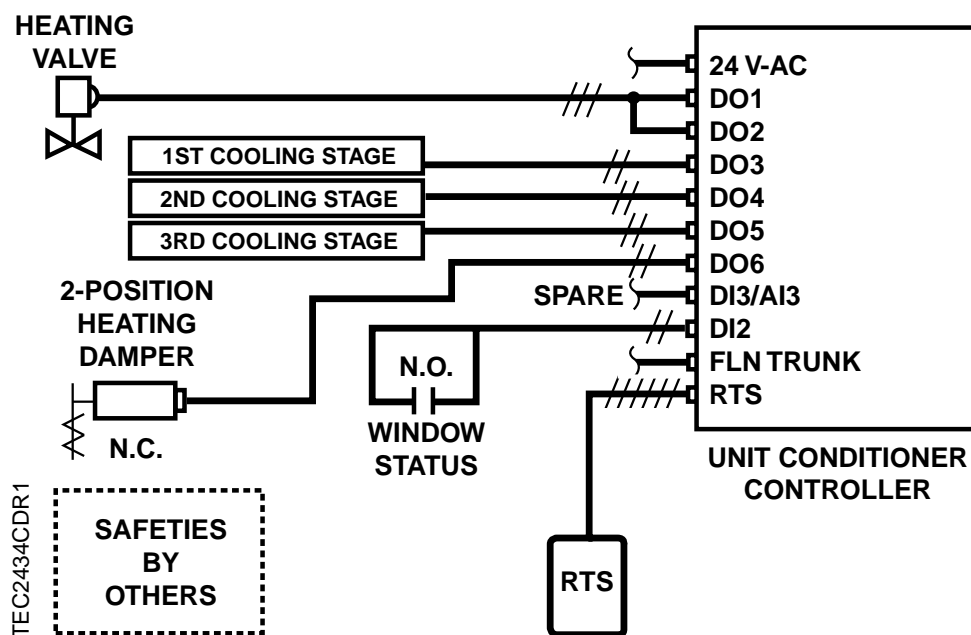
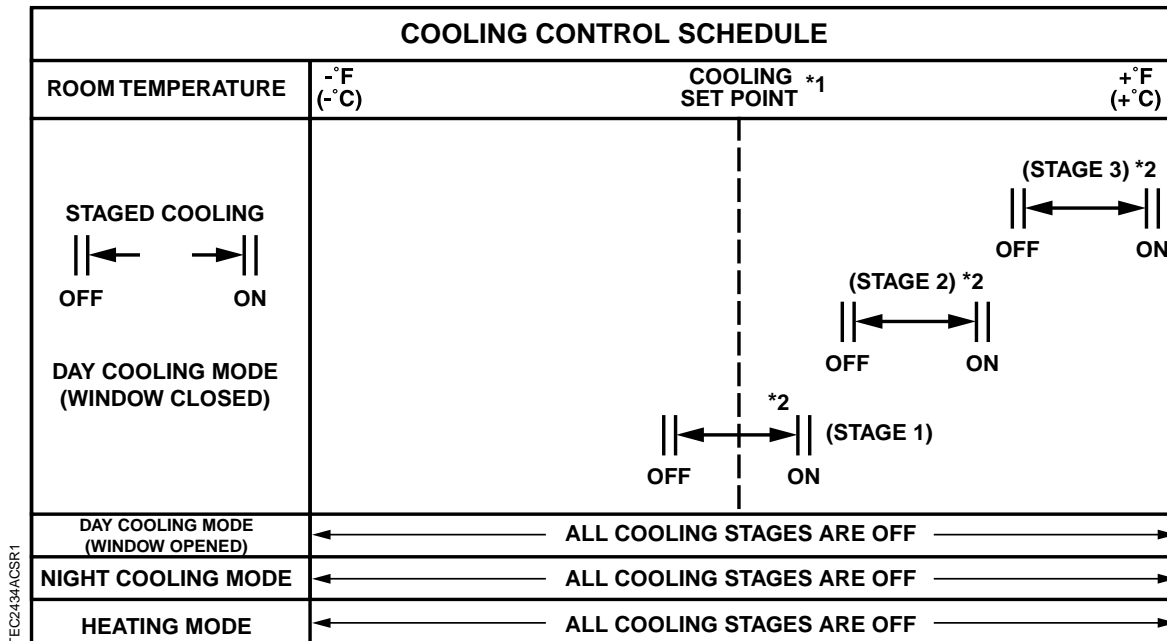
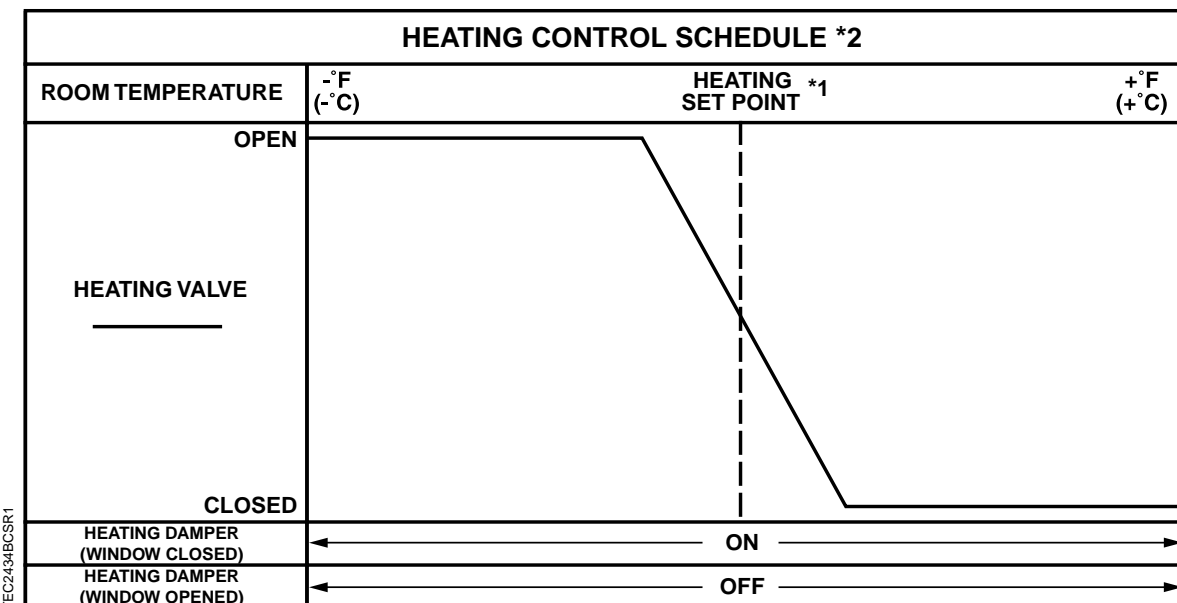


Figure 2434-1. Application 2434 Control Drawing.



1. Refer to *Control Temperature Set Points*.
2. Refer to *Cooling Operation*.

Figure 2434-2. Cooling Control Schedule.



1. Refer to *Control Temperature Set Points*.
2. This control schedule shows how the heating is controlled when HEAT.COOL (Point 5) equals HEAT. When HEAT.COOL equals COOL, the heating valve will be closed and the heating damper will be OFF.

Figure 2434-3. Heating Control Schedule.

## Hardware Inputs

### Analog

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

### Digital

- Night mode override (optional)
- Window status

## Hardware Outputs

### Analog

- None

### Digital

- Heating valve actuator (uses 2 DOs)
- 2- position heating damper actuator
- Stage 1 cooling (2-position valve actuator); or, cooling compressor
- Stage 2 cooling (2-position valve actuator); or, cooling compressor
- Stage 3 cooling (2-position valve actuator); or, cooling compressor

## Ordering Notes

You can order the Unit Conditioner controller with 3-stage cooling and hot water heat as Part No. 550-720A, or you can order it as Custom Solution number 269.

## Sequence of Operation

The following paragraphs present the sequence of operation for Application 2434: *Unit Conditioner 3-Stage Cooling and Hot Water Heat*.

### Control Temperature Set Points

Depending on the controller's current operational mode (day or night), the control temperature set point, CTL STPT (Point 92), holds the value of one of the following set points:

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

**Night Mode** – In night mode, CTL STPT holds the value of NGT CLG STPT (Point 8) or NGT HTG STPT (Point 9).

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

### Day and Night Modes

"Day mode" means that **either** DAY.NGT (Point 29) or NGT OVRD (Point 21) equals DAY; "night mode" means that **both** DAY.NGT and NGT OVRD equal NIGHT. The control of DAY.NGT is explained in this section; the control of NGT OVRD is explained in the *Night Mode Override Switch* section.

The control of DAY.NGT depends on whether the controller is connected to a field panel. If the controller is operating stand-alone, then the controller stays in day mode all the time. If the controller is operating with centralized control (connected to a field panel), then the field panel can send an operator or PPCL command to override the status of DAY.NGT. Refer to *Powers Process Control Language (PPCL) User's Manual* (125-1896) and *Field Panel User's Manual* (125-1895) for more information.

### Night Mode Override Switch

If an override switch is present on the room temperature sensor, and a value (in hours) other than zero has been entered into OVRD TIME (Point 20), then a room occupant can press the override switch and reset the controller to day mode for the amount of time stored in OVRD TIME. The status of NGT OVRD (Point 21) changes to DAY and remains there until the override time elapses, at which point NGT OVRD changes back to NIGHT and the controller returns to night mode.

Only during night mode can the override switch have any effect on the controller.

### Heating/Cooling Switchover

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

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

- HTG LOOPOUT (Point 80) is less than SWITCH LIMIT (Point 85).
- CTL TEMP (Point 78) is above CTL STPT (Point 92) by at least the value set in SWITCH DBAND (Point 90).
- CTL TEMP is greater than the appropriate cooling set point minus SWITCH DBAND.

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

- CLG LOOPOUT (Point 79) is less than SWITCH LIMIT.
- CTL TEMP is below CTL STPT by at least the value set in SWITCH DBAND.
- CTL TEMP is less than the appropriate heating set point plus SWITCH DBAND.

## Control Loops

The application is controlled by two Proportional, Integral, and Derivative (PID) temperature loops (one heating, one cooling). The active temperature loop maintains room temperature at the CTL STPT (Point 92) value. Refer to *Control Temperature Set Points*.

## Cooling Operation

The controller uses CTL STPT (Point 92) and CTL TEMP (Point 78) as the inputs to the cooling loop. The cooling loop controls up to three stages of cooling as defined by the value of CLG STG CNT (Point 75). During cooling operation, HTG LOOPOUT (Point 80) is set to 0% and the heating valve is closed.

The staged cooling will operate only if all of the following are true:

- HEAT.COOL (Point 5) equals COOL.
- Either DAY.NGT (Point 29) or NGT OVRD (Point 21) equals DAY.
- DI 2 (Point 24) equals CLOSED. (When DI 2 equals CLOSED, it means the window is closed.)

### Staged Cooling Operation

**CLG STG 1** (Point 43) turns ON when CLG LOOPOUT (Point 79) is greater than CLG 1 ON (Point 71), provided that CLG STG 1 has been OFF for at least the time set in CLG MIN OFF (Point 77).

**CLG STG 2** (Point 44) turns ON when CLG LOOPOUT is greater than CLG 2 ON (Point 73), provided that CLG STG 2 has been OFF for at least the time set in CLG MIN OFF.

**CLG STG 3** (Point 45) turns ON when CLG LOOPOUT is greater than CLG 3 ON (Point 88), provided that CLG STG 3 has been OFF for at least the time set in CLG MIN OFF.

**CLG STG 3** will turn OFF when CLG LOOPOUT is less than CLG 3 OFF (Point 89), provided that CLG STG 3 has been ON for at least the time set in CLG MIN ON (Point 76).

**CLG STG 2** will turn OFF when CLG LOOPOUT is less than CLG 2 OFF (Point 74), provided that CLG STG 2 has been ON for at least the time set in CLG MIN ON (Point 76).

**CLG STG 1** will turn OFF when CLG LOOPOUT is less than CLG 1 OFF (Point 72), provided that CLG STG 1 has been ON for at least the time set in CLG MIN ON.

All cooling stages will be OFF whenever any of the following is true:

- HEAT.COOL (Point 5) equals HEAT.
- Both DAY.NGT (Point 29) and NGT OVRD (Point 21) equal NIGHT.
- DI 2 (Point 24) equals OPENED. (If DI 2 = OPENED, it means the window is opened.)

## Heating Valve Operation

When HEAT.COOL (Point 5) equals HEAT, the controller uses CTL STPT (Point 92) and CTL TEMP (Point 78) as the inputs to the heating loop. The output of the heating loop is HTG LOOPOUT (Point 80), which modulates the hot water valve point, VLV COMD (Point 52) in order to warm up the space. During heating operation, CLG LOOPOUT (Point 79) is set to 0%.

## Heating Damper Operation

HTG DMPR DO6 (Point 46) will be ON only when **both** of the following are true:

- HEAT.COOL (Point 5) equals HEAT
- DI 2 (Point 24) equals CLOSED. (When DI 2 equals CLOSED, it means that the window is closed.)

HTG DMPR DO6 will be OFF if **either** of the following is true:

- HEAT.COOL equals COOL
- DI 2 equals OPENED. (When DI 2 equals OPENED, it means the window is opened.)

## Calibration

The controller will regularly calibrate the heating valve based on the value of CAL TIMER (Point 96). A value of 12 means calibration will occur once every 12 hours. During calibration, the heating valve is driven closed and VLV POS (Point 53) is reset to 0. Afterward the valve is automatically released to normal control.

## Fail-Safe Operation

If USE SAFETY (Point 87) is set to NO, then the failsafe operation is skipped. This is useful when an RTS is not hooked up to the TEC.

If USE SAFETY is set to YES and ROOM TEMP (Point 4) fails, then the reheat valve is commanded to fully opened, the heating damper will be ON, and all cooling stages will be OFF.

If USE SAFETY is set to YES and RM STPT DIAL (Point 13) fails, the last known operational value of RM STPT DIAL is used.

## Application Notes

1. If the temperature swings in the room are excessive, or if there is trouble maintaining the set point, then either the cooling loop, the heating loop or both need to be tuned. Refer to *APOGEE Automation Service Procedures* on InfoLink for more information.
2. The controller as shipped from the factory keeps all associated equipment OFF. Refer to Equipment Controllers in *APOGEE Automation Start-up Procedures* on InfoLink for information on how to release the controller and its equipment to application control.
3. Spare DOs can be used as auxiliary points that are controlled by the field panel after being defined in the field panel's database. If DO1 and DO2 are not being used to control a floating valve or to control staged heating or cooling, then they can be used as auxiliary motor points. You must make sure that the motor setup and motor timing are correctly enabled before you unbundle VLV COMD (Point 52) for DO 1 and DO 2. Refer to *APOGEE Automation Start-up Procedures* on InfoLink for more information.



## Wiring Diagram



### CAUTION:

The controller's DOs control 24 Vac loads only. The maximum rating is 12 VA for each DO. Use an interposing 220V relay module (P/N 550-054) for any of the following:

- VA requirements higher than the maximum
- 110 or 220 Vac requirements
- DC power requirements
- Separate transformers used to power the load

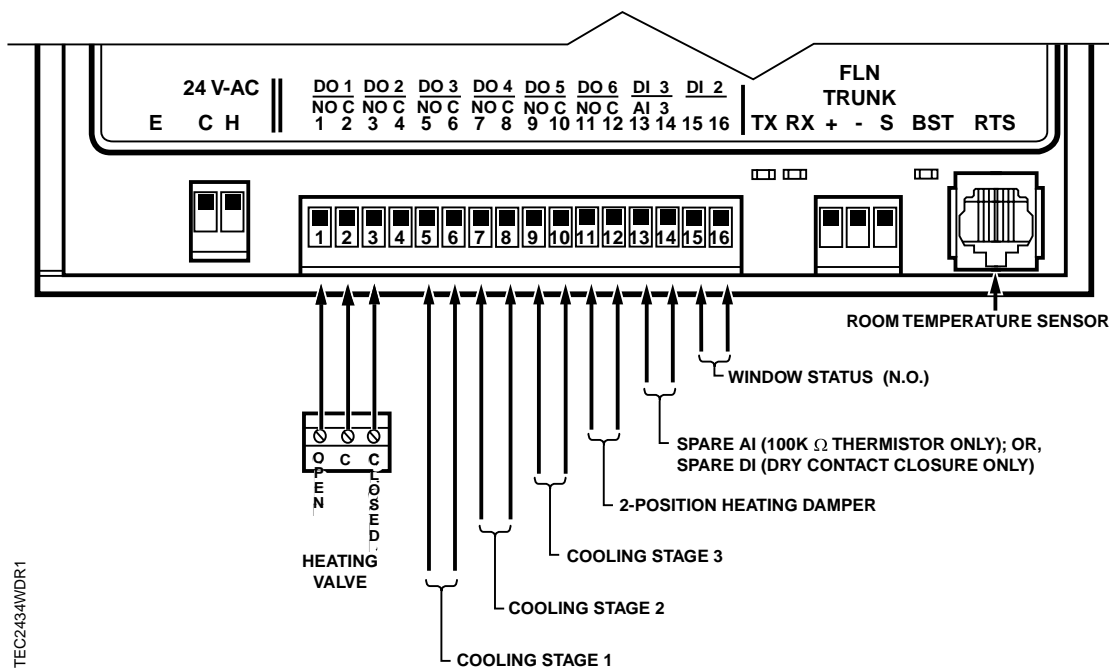


Figure 2434-4. Wiring Diagram for Application 2434.

## Point Database

Point Database for Application 2434.

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	2485	--	1	0	--	--
{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	DAY CLG STPT	74.0 (23.44888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
07	DAY HTG STPT	70.0 (21.20888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
08	NGT CLG STPT	82.0 (27.92888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
09	NGT HTG STPT	65.0 (18.40888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
11	RM STPT MIN	55.0 (12.80888)	DEG F (DEG C)	0.25 (0.14)	48.0(8.88888)	--	--
12	RM STPT MAX	90.0 (32.40888)	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}	AUX TEMP	74.0 (23.495556)	DEG F (DEG C)	0.5 (0.28)	37.5(3.055556)	--	--
{19}	DI OVRD SW	OFF	--	--	--	ON	OFF
20	OVRD TIME	0	HRS	1	0	--	--
{21}	NGT OVRD	NIGHT	--	--	--	NIGHT	DAY
{24}	DI 2	OPENED	--	--	--	CLOSED	OPENED
{25}	DI 3	OFF	--	--	--	ON	OFF
{29}	DAY.NGT	DAY	--	--	--	NIGHT	DAY
{41}	DO 1	OFF	--	--	--	ON	OFF
{42}	DO 2	OFF	--	--	--	ON	OFF
{43}	CLG STG 1	OFF	--	--	--	ON	OFF
{44}	CLG STG 2	OFF	--	--	--	ON	OFF
{45}	CLG STG 3	OFF	--	--	--	ON	OFF
{46}	HTG DMPR DO6	OFF	--	--	--	ON	OFF
{52}	VLV COMD	0.0	PCT	0.4	0.0	--	--
{53}	VLV POS	0.0	PCT	0.4	0.0	--	--
55	MTR 1 TIMING	130	SEC	1	0	--	--
57	MTR1 ROT ANG	90	--	1	0	--	--
58	MTR SETUP	3	--	1	0	--	--
59	DO DIR. REV	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.

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Point Database for Application 2434.

Point Number	Descriptor	Factory Default (SI Units)	Engr Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
63	CLG P GAIN	20.0 (36.0)	--	0.25 (0.45)	0.0	--	--
64	CLG I GAIN	0.01 (0.018)	--	0.001 (0.0018)	0.0	--	--
65	CLG D GAIN	0 (0.0)	--	2 (3.6)	0	--	--
66	CLG BIAS	0.0	PCT	0.4	0.0	--	--
67	HTG P GAIN	10.0 (18.0)	--	0.25 (0.45)	0.0	--	--
68	HTG I GAIN	0.01 (0.018)	--	0.001 (0.0018)	0.0	--	--
69	HTG D GAIN	0 (0.0)	--	2 (3.6)	0	--	--
70	HTG BIAS	0.0	PCT	0.4	0.0	--	--
71	CLG 1 ON	30.0	PCT	0.4	0.0	--	--
72	CLG 1 OFF	10.0	PCT	0.4	0.0	--	--
73	CLG 2 ON	60.0	PCT	0.4	0.0	--	--
74	CLG 2 OFF	40.0	PCT	0.4	0.0	--	--
75	CLG STG CNT	3	--	1	0	--	--
76	CLG MIN ON	120	SEC	1	0	--	--
77	CLG MIN OFF	120	SEC	1	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	--	--
85	SWITCH LIMIT	5.2	PCT	0.4	0.0	--	--
86	SWITCH TIME	10	MIN	1	0	--	--
{87}	USE SAFETY	YES	--	--	--	YES	NO
88	CLG 3 ON	90.0	PCT	0.4	0.0	--	--
89	CLG 3 OFF	70.0	PCT	0.4	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)	--	--
96	CAL TIMER	12	HRS	1	0	--	--
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.