

## TEC Custom Solutions Application 2417:

### Constant Volume with Hot Water Reheat and 4-20mA Temperature Input

TEC-0905-2.08

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## Overview

In Application 2417, the controller provides a constant volume of air to the room during occupied periods, and a lower constant volume of air to the room during unoccupied periods. Reheat is provided by modulating a hot water valve. In order for the application to work properly, the central air handling unit must provide pre-conditioned air to the terminal box.

Application 2417 is based on and has the same functionality as Application 2033 (*Constant Volume with Hot Water Reheat*). **The difference is that the control loops in Application 2417 receive room temperature input from a 4-20mA sensor connected to AI 3 instead of from the room stat.** Also, Application 2417 runs on a Custom Solution controller that has a wider variety of spare I/O terminations than does the standard Constant Volume Controller running Application 2033. Refer to Figures 2417-1 and 2417-2.

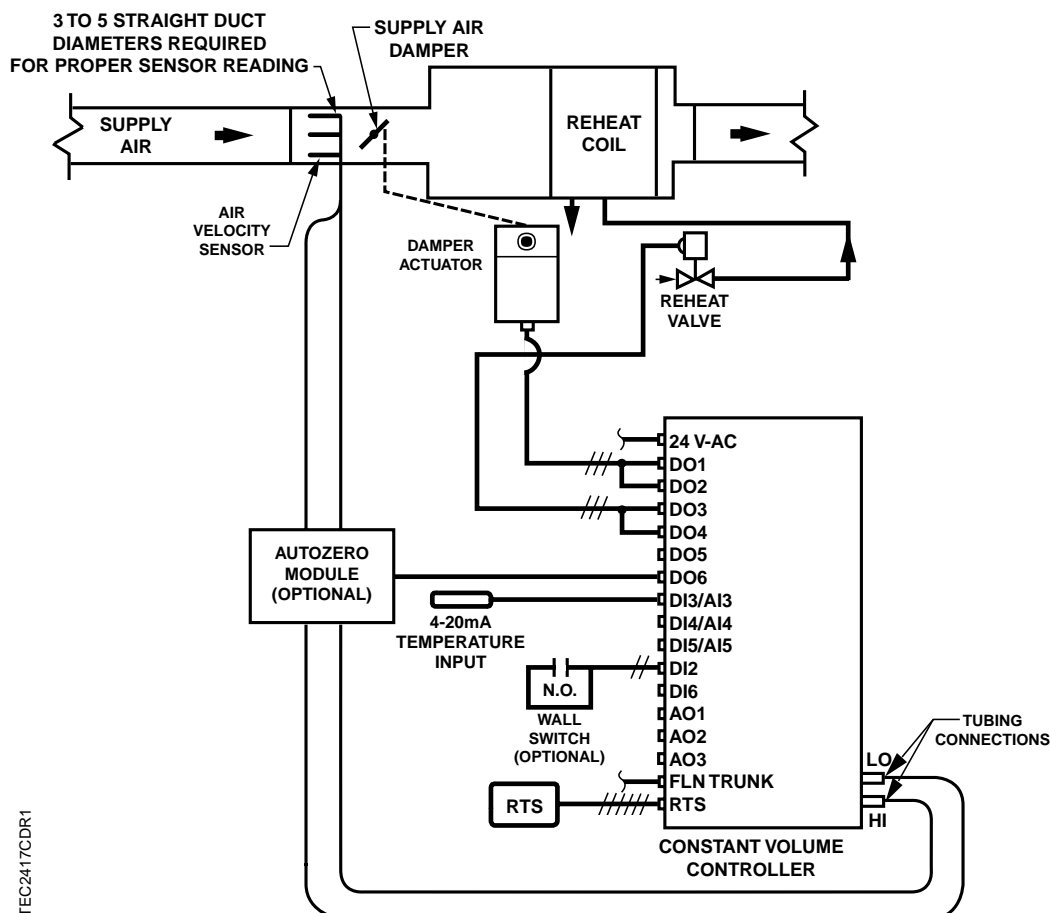
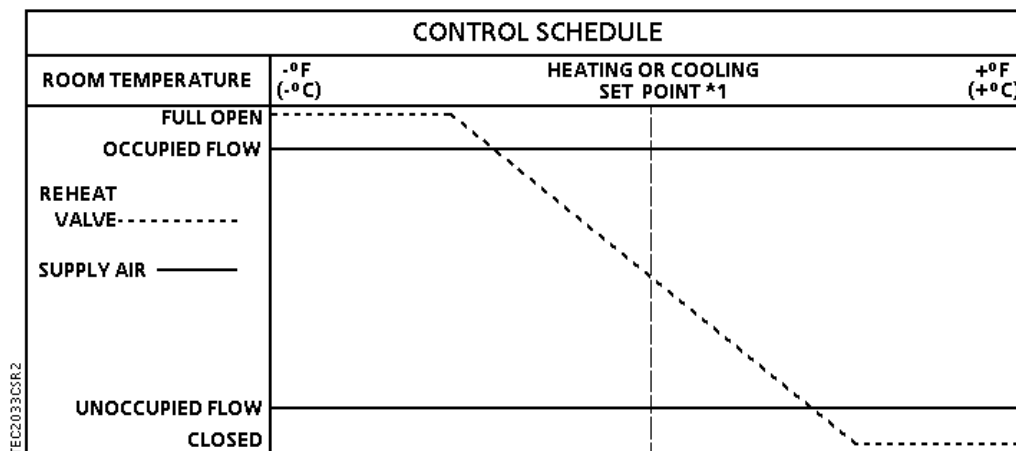


Figure 2417-1. Application 2417 Control Drawing.



1. Refer to Sequence of Operation, "Control Temperature Set Points".

**Figure 2417-2. Application 2417 Control Schedule.**

## Hardware Inputs

### Analog

- 4-20mA RTD
- air velocity sensor
- room temperature sensor
- room temperature set point dial (optional)

### Digital

- night mode override (optional)
- wall switch (optional)

## Hardware Outputs

### Analog

- none

### Digital

- Autozero Module (optional)
- damper actuator
- valve actuator

## Ordering Notes

Custom Solution Constant Volume Controller with Hot Water Reheat and 4-20mA Temperature Input — Part No. 540-865C (Custom Solution 265)

- 4-20mA Temperature Sensor      536-200

## Sequence of Operation

The following paragraphs present the sequence of operation for Application 2417, “Constant Volume with Hot Water Reheat and 4-20mA Temperature Input.”

## Control Temperature Set Points

Depending on the controller’s current operational mode (occupied or unoccupied), the control temperature set point, CTL STPT (number 92) holds the value of one of the following set points:

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

If the set point dial is used and the value of RM STPT DIAL is less than the value of the point RM STPT MIN (number 11), then CTL STPT holds the value of RM STPT MIN. If the value of RM STPT DIAL is greater than the value of the point RM STPT MAX (number 12), then CTL STPT holds the value of RM STPT MAX.

**Unoccupied Mode** – In unoccupied mode, CTL STPT holds the value of the point UOC CLG STPT (number 8) in cooling mode and the point UOC HTG STPT (number 9) in heating mode. The set point dial is not used in unoccupied mode.

**NOTES:** The value of the point CTL TEMP (number 78) is the same as the value of the point ROOM TEMP (number 15), unless CTL TEMP is overridden.

Application 2417 will not automatically switch between heating and cooling. If a seasonal switchover (e.g., summer to winter) is to occur, then the field panel must command HEAT.COOL (number 5). This allows the controller to use the appropriate set points for the season.

## Occupied and Unoccupied Modes

The occupied/unoccupied status of the space is determined by the status of the point OCC.UNOCC (number 29). The control of this point differs depending on whether the controller is monitoring the status of a wall switch or if the controller is connected to a field panel.

When a wall switch is physically connected to the termination strip on the controller at DI 2 (Figures 2417-1 and 2417-3), and the point WALL SWITCH (number 18) equals YES, the controller monitors the status of DI 2. When the status of the point DI 2 (number 24) is ON (the switch is closed), then OCC.UNOCC will be set to OCC indicating that the controller is in occupied mode. When the status of DI 2 is OFF (the switch is open), then OCC.UNOCC will be set to UNOCC indicating that the controller is in unoccupied mode.

When WALL SWITCH equals NO, the controller does not monitor the status of the wall switch, even if one is connected to it. In this case, if the controller is operating stand-alone, then the controller stays in occupied mode all the time. If the controller is operating with centralized control (that is, it is connected to a field panel), then the field panel can send an operator or PPCL command to override the status of the point OCC.UNOCC. Refer to *Powers Process Control Language (PPCL) User's Manual* (125-1896) and *Field Panel User's Manual* (125-1895) 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 the point OVRD TIME (number 20), then by pressing the override switch a *room* occupant can reset the controller to occupied operational mode for the amount of time that is set in OVRD TIME. The status of the point UNOCC OVRD (number 21) changes to OCC. After the override time elapses, the controller returns to unoccupied mode and the status of UNOCC OVRD changes back to UNOCC.

It is only when the controller is in unoccupied mode that the override switch on the room temperature sensor will have any effect on the controller.

## Control Loops

**Flow Loop** – The flow loop maintains FLOW STPT (number 93) by modulating the supply air damper point, DMPR COMD (number 48). The flow loop maintains the air flow at either OCC FLOW (number 32) or UNOCC FLOW (number 31) depending on the value of OCC.UNOCC.

The point FLOW (number 75) is the input value for the flow loop. It is calculated as a percentage based on where the point AIR VOLUME (number 35) is between 0 CFM (LPS) and OCC FLOW. In the following text, this percentage will be referred to as % flow.

- If AIR VOLUME equals 0 CFM (LPS), then FLOW is 0% flow.
- If AIR VOLUME equals OCC FLOW, then FLOW is 100% flow.

The FLOW STPT percentage that corresponds to UNOCC FLOW is calculated as:  $(\text{UNOCC FLOW} \div \text{OCC FLOW}) \times 100\% \text{ flow}$ .

For example: If,

UNOCC FLOW equals 250 CFM, and if OCC FLOW equals 1000 CFM

then, in unoccupied mode the FLOW STPT

$$\begin{aligned} &= (250 \text{ CFM} \div 1000 \text{ CFM}) \times 100\% \text{ flow} \\ &= 0.25 \times 100\% \text{ flow} \\ &= 25\% \text{ flow} \end{aligned}$$

Since 25% of 1000 CFM equals 250 CFM, the flow set point in unoccupied mode will be 25%.

UNOCC FLOW can be set less than or equal to, but not greater than OCC FLOW.

**Temperature Loop** – The temperature loop will modulate the point HTG LOOPOUT (number 80) and control the hot water valve in order to maintain the room temperature in both heating and cooling modes.

## Hot Water Reheat

The temperature loop modulates the heating valve in order to maintain the room temperature set point. The reheat valve will be modulated whenever necessary to maintain the room temperature regardless of the status of HEAT.COOL (number 5).

## Calibration

Calibration of the controller's internal air velocity transducers is periodically required to maintain accurate air velocity readings. The point CAL SETUP (number 95) is set with the desired calibration option during controller startup. Depending upon the value of CAL SETUP, calibration may be set to take place automatically or manually. If the status of the point CAL AIR (number 94) is YES, then calibration is in progress.

- For a controller used without an Autozero Module (point CAL MODULE, (number 87)=NO), the damper is commanded closed to get a zero airflow reading during calibration.
- For a controller used with an Autozero Module (CAL MODULE=YES), calibration occurs without closing the damper.

**NOTE:** The first time after start-up or initialization, the controller will calibrate the dampers as if not using an Autozero Module, although the Autozero Module will be activated. All subsequent calibrations will use the Autozero Module only.

At the end of a calibration sequence, CAL AIR returns to NO automatically. A status of NO indicates that the controller is not in a calibration sequence.

The Autozero Module is enabled when it is wired to DO 6 and the point CAL MODULE (number 87) is set to YES.

## Damper Status Operation

Under normal operation the point DMPR STATUS (number 84) reads "CAL". However, if using an Autozero Module, it is possible after a period of operation for the calculated damper position point, DMPR POS (number 49), to differ from the actual (physical) damper position.

If this occurs, the controller will *automatically* compensate for any difference by setting DMPR STATUS to "RECAL" which readjusts the value of DMPR POS. DMPR STATUS will be set to "RECAL" if all of the following conditions are true:

- DMPR POS = 100%
- Air velocity (AIR VOLUME (number 35) ÷ DUCT AREA (number 97)) > 200 FPM
- FLOW (number 75) < FLOW STPT (number 93)

-or-

- DMPR POS = 0%
- Air velocity (AIR VOLUME ÷ DUCT AREA) > 200 FPM
- FLOW > FLOW STPT

If DMPR STATUS has been changed to “RECAL” in response to one of the conditions described above, then do one of the following:

1. If flow is now being properly controlled, then set DMPR STATUS to “CAL” and release it.
2. If flow is still not being properly controlled (i.e., one of the conditions described above is still present) or if it is important that the damper position be accurate, then initialize the controller.

If these steps do not fix the problem of maintaining flow, then a mechanical problem might exist.

## Fail-Safe Operation

If the air velocity sensor fails, then the controller determines the status of the point FAIL MODE (number 40) and positions the damper accordingly. If FAIL MODE equals OPEN and the velocity sensor fails, then the damper will open. If FAIL MODE equals CLOSED (the default) and the velocity sensor fails, then the damper will close.

If the room temperature sensor fails, then the controller operates using the last known temperature value.

## Application Notes

1. If the temperature swings in the room are excessive, or if there is trouble in maintaining the room temperature set point, then the temperature loop needs to be tuned. If the point FLOW (number 75) is oscillating while the point FLOW STPT (number 93) is constant, then the flow loop requires tuning. Refer to *APOGEE Automation Service Procedures* (125-3013) on InfoLink for more information.
2. The Constant Volume Controller – Electronic Output, as shipped from the factory, keeps all associated equipment OFF. Refer to the “Equipment Controllers” section in *APOGEE Automation Start-up Procedures* (125-3014) on InfoLink for information on how to release the controller and its equipment to application control.
3. Spare DOs can be used as auxiliary points that are controlled by the field panel after being defined in the field panel’s database. If not using a heating valve, then the combination of DO 3 and DO 4 may be used as auxiliary motor points. If using this pair of spare DOs to control a motor, you must unbundle the point MTR2 COMD (number 52) and set the point MTR SETUP (number 58) as described in the *APOGEE Automation Start-up Procedures* (125-3014) on InfoLink.



## Wiring Diagrams

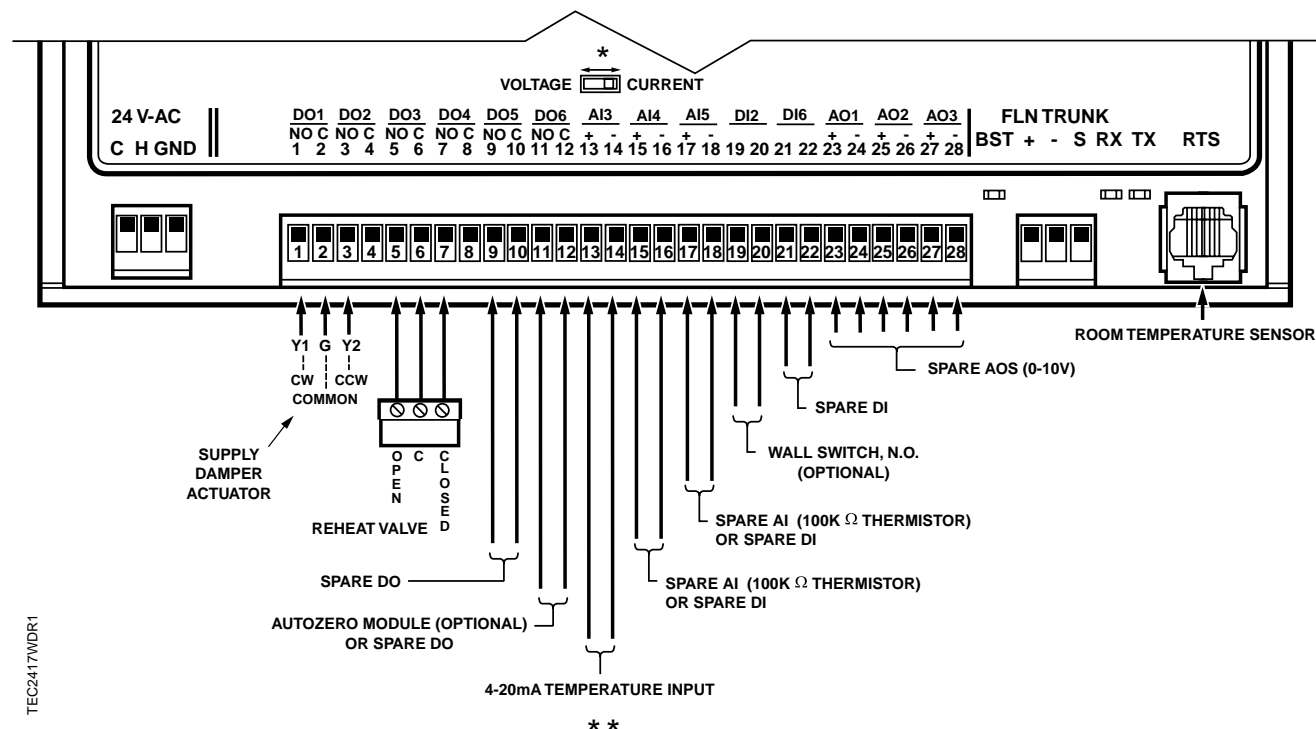


### CAUTION:

The controller's DOs control 24 Vac loads only. The maximum rating is 12 VA for each DO. Use an interposing 220V relay module for any of the following:

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

Consult with the local representative if terminations are missing or different.



\* Dipswitch for AI 3 on controller's circuit board (under controller's cover) must be in *current* position.

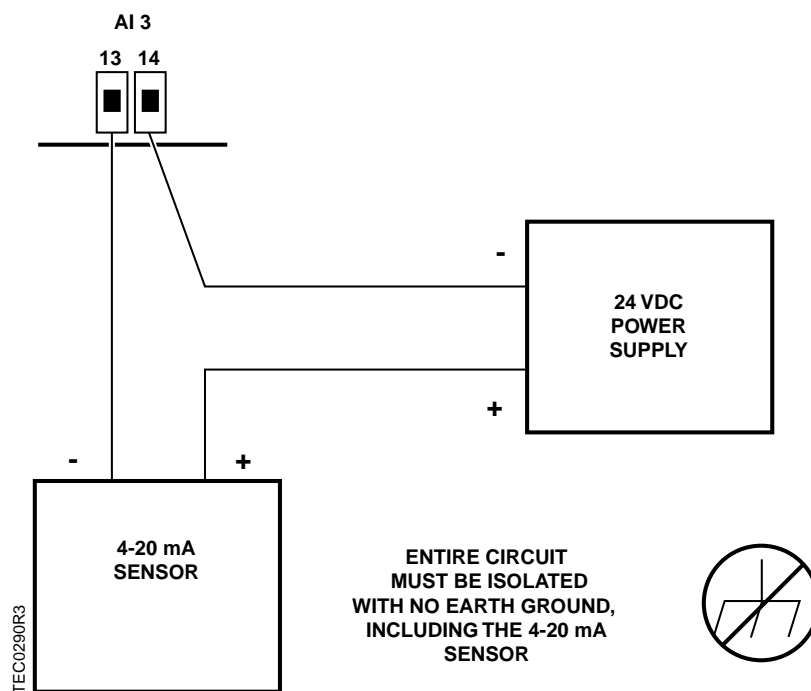
\*\* Refer to Figure 2417-4 for how to wire the 4-20mA sensor connected to AI 3. Failure to follow instructions will cause equipment damage.

**Figure 2417-3. Application 2417 Wiring Diagram.**



### CAUTION:

Refer to Figure 2417-4 for how to wire the 4-20mA temperature sensor. Failure to follow instructions will cause equipment damage.



**NOTE:** You can NOT use the same transformer to power the controller and a 4-20 mA sensor. The 4-20 mA sensor requires a **SEPARATE** dedicated power supply.

**Figure 2417-4. Special Wiring Requirements for 4-20 mA Temperature Sensor.**



**CAUTION:**

Equipment damage or loss of data may occur if the user does not follow procedure as specified.

## Point Database

**Table 2417-1. Point Database for Application 2417.**

The point numbers of Points that can be unbundled appear in brackets { }

Point Number	Descriptor	Factory Default (SI Units)	Engr. Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
01	CTLR ADDRESS	99	--	1	0	--	--
02	APPLICATION	2482	--	1	0	--	--
{04}	RTS 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	70.0 (21.10944)	DEG F (DEG C)	0.2 (0.1111)	40.0(4.44444)	--	--
07	OCC HTG STPT	70.0 (21.10944)	DEG F (DEG C)	0.2 (0.1111)	40.0(4.44444)	--	--
08	UOC CLG STPT	65.0 (18.33194)	DEG F (DEG C)	0.2 (0.1111)	40.0(4.44444)	--	--
09	UOC HTG STPT	65.0 (18.33194)	DEG F (DEG C)	0.2 (0.1111)	40.0(4.44444)	--	--
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}	ROOM TEMP	40.0 (4.44444)	DEG F (DEG C)	0.2 (0.1111)	40.0(4.44444)	--	--
18	WALL SWITCH	NO	--	--	--	YES	NO
{19}	DI OVRD SW	OFF	--	--	--	ON	OFF
20	OVRD TIME	0	HRS	1	0	--	--
{21}	UNOCC OVRD	UNOCC	--	--	--	UNOCC	OCC
{24}	DI 2	OFF	--	--	--	ON	OFF
{25}	DI 3	OFF	--	--	--	ON	OFF
{26}	DI 4	OFF	--	--	--	ON	OFF
{27}	DI 5	OFF	--	--	--	ON	OFF
{28}	DI 6	OFF	--	--	--	ON	OFF
{29}	OCC.UNOCC	OCC	--	--	--	UNOCC	OCC
{31}	UNOCC FLOW	220 (103.818)	CFM ( LPS)	4 (1.8876)	0	--	--
{32}	OCC FLOW	2200 (1038.18)	CFM ( LPS)	4 (1.8876)	0	--	--
{35}	AIR VOLUME	0 (0.0)	CFM ( LPS)	4 (1.8876)	0	--	--
36	FLOW COEFF	1.0	--	0.01	0.0	--	--
40	FAIL MODE	CLOSED	--	--	--	CLOSED	OPEN
{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}	DO 5	OFF	--	--	--	ON	OFF

{46}	DO 6	OFF	--	--	--	ON	OFF
{48}	DMPR COMD	0.0	PCT	0.4	0.0	--	--
{49}	DMPR POS	0.0	PCT	0.4	0.0	--	--
{50}	AI 4	37.5 (3.055556)	DEG F (DEG C)	0.5 (0.28)	37.5(3.055556)	--	--
51	MTR1 TIMING	95	SEC	1	0	--	--
{52}	VLV COMD	0.0	PCT	0.4	0.0	--	--
{53}	VLV POS	0.0	PCT	0.4	0.0	--	--
{54}	AI 5	37.5 (3.055556)	DEG F (DEG C)	0.5 (0.28)	37.5(3.055556)	--	--
55	MTR2 TIMING	130	SEC	1	0	--	--
56	DPR1 ROT ANG	90	--	1	0	--	--
58	MTR SETUP	0	--	1	0	--	--
59	DO DIR.REV	0	--	1	0	--	--
{61}	AOV1	0.0 (0.01)	VOLTS ()	0.01 (0.0)	0.0(0.01)	--	--
{62}	AOV2	0.0 (0.01)	VOLTS ()	0.01 (0.0)	0.0(0.01)	--	--
{63}	AOV3	0.0 (0.01)	VOLTS ()	0.01 (0.0)	0.0(0.01)	--	--
67	HTG P GAIN	10.0 (18.0)	--	0.25 (0.45)	0.0	--	--
68	HTG I GAIN	0.012 (0.0216)	--	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	FLOW P GAIN	0.25	--	0.05	0.0	--	--
72	FLOW I GAIN	0.018	--	0.001	0.0	--	--
73	FLOW D GAIN	0	--	2	0	--	--
74	FLOW BIAS	50.0	PCT	0.4	0.0	--	--
{75}	FLOW	0.0	PCT	0.25	0.0	--	--
{78}	CTL TEMP	74.0 (23.33144)	DEG F (DEG C)	0.2 (0.1111)	40.0(4.44444)	--	--
{80}	HTG LOOPOUT	0.0	PCT	0.4	0.0	--	--
{84}	DMPR STATUS	CAL	--	--	--	RECAL	CAL
87	CAL MODULE	NO	--	--	--	YES	NO
{92}	CTL STPT	74.0 (23.33144)	DEG F (DEG C)	0.2 (0.1111)	40.0(4.44444)	--	--
{93}	FLOW STPT	0.0	PCT	0.25	0.0	--	--
{94}	CAL AIR	NO	--	--	--	YES	NO
95	CAL SETUP	4	--	1	0	--	--
96	CAL TIMER	12	HRS	1	0	--	--
97	DUCT AREA	1.0 (0.09292)	SQ. FT (SQ M)	0.025 (0.002323)	0.0	--	--
98	LOOP TIME	5	SEC	1	0	--	--
{99}	ERROR STATUS	0	--	1	0	--	--