Dual Duct Controller – One Air Velocity Sensor – Electronic Output

(Firmware Revision SD10)

Application 2035: Dual Duct Constant Volume – Two Inlet Damper Actuators with Optional Reheat

Overview

In Application 2035, the controller provides independent control of the hot duct and cold duct inlet actuators to provide a constant volume of air to the space during occupied periods and a lower constant volume of air during unoccupied periods. In heating mode, the controller operates reheat to maintain the room temperature setpoint. See Figure 2035-1 and Figure 2035-2.

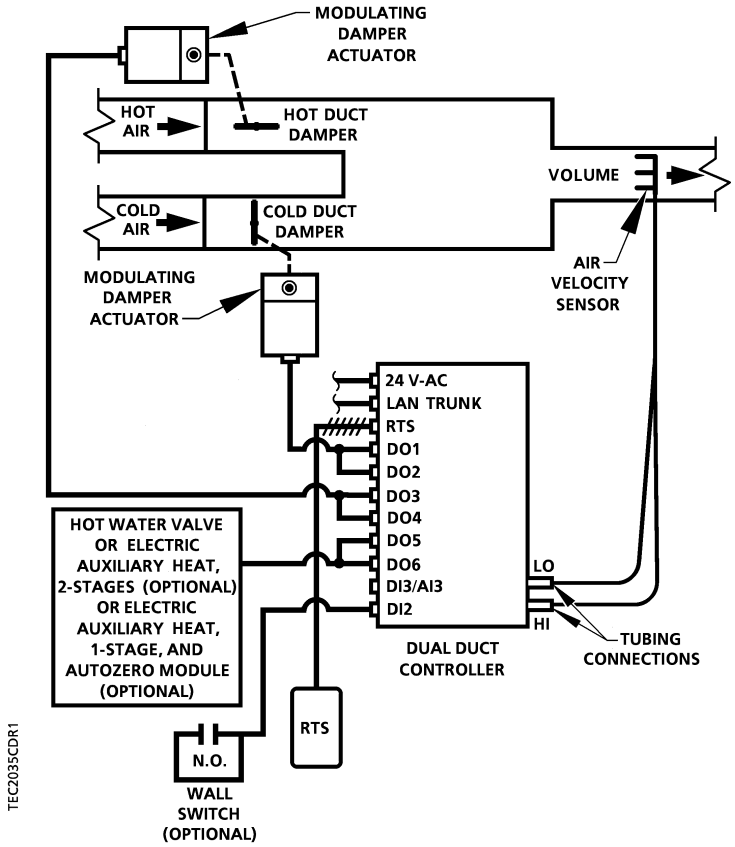
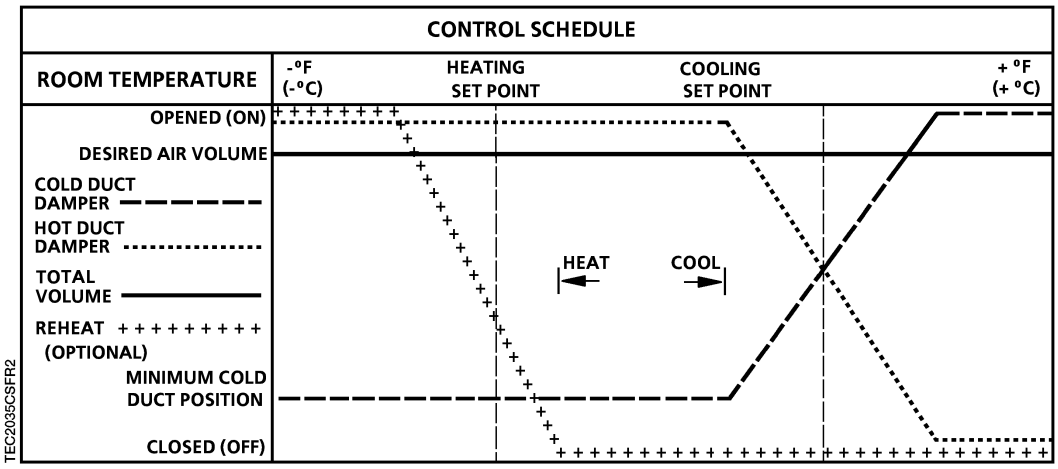


Figure 2035-1. Application 2035 Control Drawing.



1. See *Sequence of Operation, Control Temperature Setpoints*
2. See *Sequence of Operation, Heating/Cooling Switchover*
3. If reheat is not used, this application operates only in cooling mode.
4. The reheat can be either a two-position valve, hot water valve or time modulated electric reheat. See *Sequence of Operation, Optional Auxiliary Heat*.
5. This application supports two volume setpoints: one for occupied periods and one for unoccupied periods. See *Sequence of Operation, Control Volume Setpoints*.

Figure 2035-2. Application 2035 Control Schedule.

Hardware Inputs

Analog

- Air velocity sensor
- Room temperature sensor
- Room temperature setpoint dial (optional)

Digital

- Unoccupied mode override (optional)
- Wall switch (optional)

Hardware Outputs

Analog

- None

Digital

- Damper actuator (two required)
- Stage 1 electric auxiliary heat (optional)
- Stage 2 electric auxiliary heat (optional) or Autozero Module (optional)
- Valve actuator (optional)

Ordering Notes

Dual Duct Controller – One Air Velocity Sensor – Electronic Output	540-106
Dual Duct Controller – One Air Velocity Sensor – Electronic Output with Autozero Module*	540-107*

*This controller is used in applications:

- Where it is not possible, due to operational restrictions, to calibrate the air velocity transducer by fully closing the damper (for example, clean rooms, laboratories),
- When a minimum position damper stop is used.

See *APOGEE Configuration and Sizing Guidelines* on InfoLink for product numbers.

Autozero Module (optional) damper actuator (two required)
Terminal Equipment Controller room temperature sensor
Valve actuator (optional)

Point Database

Table 2035-1 presents the point database information for Application 2035.

Sequence of Operation

The following paragraphs present the sequence of operation for Application 2035, "Dual Duct Constant Volume–Two Inlet Damper Actuators with Optional Reheat".

NOTE: The controller first meets the volume setpoint requirement of the space and then it controls to the room temperature setpoint requirement. The controller satisfies the airflow requirement of the dual duct even if doing so causes the temperature of the space to drift from its temperature setpoint.

Control Volume Setpoints

FLOW STPT (Point 93) changes depending on the controller's current operational mode (occupied or unoccupied).

Occupied Mode – FLOW STPT holds 100% which corresponds to the value of OCC FLOW (Point 32).

Unoccupied Mode – FLOW STPT holds the percentage which corresponds to the value of UNOCC FLOW (Point 31). That percentage is UNOCC FLOW ÷ OCC FLOW × 100% (0% corresponds to 0 CFM).

Control Temperature Setpoints

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

Occupied Mode – CTL STPT holds the value of OCC HTG STPT (Point 7) in heating mode or OCC CLG STPT (Point 6) in cooling mode. However, if the room temperature sensor has a setpoint dial and STPT DIAL (Point 14) = YES, CTL STPT holds the value of RM STPT DIAL (Point 13).

If the setpoint dial is used and RM STPT DIAL < RM STPT MIN (Point 11), CTL STPT holds the value of RM STPT MIN. If RM STPT DIAL > RM STPT MAX (Point 12), CTL STPT holds the value of RM STPT MAX.

Unoccupied Mode – CTL STPT holds the value of UOC HTG STPT (Point 9) in heating mode or UOC CLG STPT (Point 8) in cooling mode.

NOTE: The value of CTL TEMP (Point 78) is the same as 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). 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 (Figure 2035-1, Figure 2035-3, and Figure 2035-4), and WALL SWITCH (Point 18) = YES, the controller monitors the status of DI 2. When DI 2 (Point 24) is ON (the switch is closed), OCC.UNOCC will be set to OCC indicating that the controller is in occupied mode. When DI 2 is OFF (the switch is open), OCC.UNOCC will be set to UNOCC indicating that the controller is in unoccupied mode.

When WALL SWITCH = 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, it stays in occupied mode all the time. If the controller is operating with centralized control (that is, connected to a field panel), the field panel can send an operator or PPCL command to override the status of OCC.UNOCC. See *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 OVRD TIME (Point 20), by pressing the override switch a room occupant can reset the controller to occupied operational mode for the time period that is set in OVRD TIME. The status of UNOCC OVRD (Point 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.

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 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) < 5.2%.
- CTL TEMP (Point 78) > CTL STPT (Point 92) by at least the value set in SWITCH DBAND (Point 90).
- CTL TEMP > the appropriate cooling setpoint minus SWITCH DBAND.

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

- CLG LOOPOUT (Point 79) < 5.2%.
- CTL TEMP < CTL STPT by at least the value set SWITCH DBAND.
- CTL TEMP < the appropriate heating setpoint plus SWITCH DBAND.
- AUX HTG USED (Point 82) = YES.

Control Loops

The dual duct controller is controlled by three Proportional, Integral, and Derivative (PID) control loops; two temperature loops and a flow loop.

The two temperature loops are a cooling loop and a heating loop. The active temperature loop maintains room temperature at the value in CTL STPT (Point 92). See *Sequence of Operation, Control Temperature Setpoints*.

Cooling Loop – In cooling mode, the cooling loop modulates the hot duct damper in order to maintain the space temperature. More specifically, the value of HTG DMP CMD (Point 52) is inversely proportional to CLG LOOPOUT (Point 79). When CLG LOOPOUT is 0%, the hot duct damper is completely opened (HTG DMP CMD is 100%) and when CLG LOOPOUT is 100%, the hot duct damper is completely closed (HTG DMP CMD is 0%).

Heating Loop – In heating mode, the hot duct damper is completely opened (HTG DMP CMD is 100%) and the output of the heating loop, HTG LOOPOUT (Point 80), controls the auxiliary heat (if used). If auxiliary heat is not used, this application only operates in cooling mode and the heating loop is disabled.

The cold duct damper point, CLG DMP CMD (Point 48) is not directly involved in temperature control. Instead, it is controlled by the flow loop in order to maintain the desired air volume. The cooling damper will not be closed below the value of CLG DMP MIN (Point 60).

Flow Loop – When the controller is in occupied mode, FLOW STPT (Point 93) is set to 100%, corresponding to OCC FLOW (Point 32). When the controller is in unoccupied mode, FLOW STPT is set to the percentage corresponding to UNOCC FLOW (Point 31).

The flow loop maintains FLOW STPT primarily by modulating CLG DMP CMD between 100% open and CLG DMP MIN (Point 60). The flow loop maintains the airflow at the limits set in UNOCC FLOW and OCC FLOW. If the cooling damper reaches CLG DMP MIN (or 0% in unoccupied mode) and the flow is still above the flow setpoint, the heating damper will close to satisfy the flow setpoint. The flow loop takes precedence over the temperature loop.

FLOW (Point 75) is the input value for the flow loop. It is calculated as a percentage based on where AIR VOLUME (Point 35) is between 0 CFM and OCC FLOW.

- If AIR VOLUME = 0 CFM, FLOW is 0% flow.
- If AIR VOLUME = OCC FLOW, FLOW is 100% flow.

If FLOW > 100%, AIR VOLUME > OCC FLOW.

Occupied Cooling Operation

In occupied cooling operation, the controller modulates the hot duct damper to closed as the cooling load increases. The controller modulates the cold duct damper point, CLG DMP CMD (Point 48), to maintain the volume setpoint, FLOW STPT (Point 93).

Occupied Heating Operation

In occupied heating operation, the controller modulates the hot duct damper to maintain room temperature to provide as much of the airflow requirements of the dual duct as possible. The controller modulates the cold duct damper to provide any additional airflow that is necessary to maintain the volume setpoint, FLOW STPT (Point 93). The controller operates the auxiliary heat and the hot duct damper to maintain the room temperature setpoint, CTL STPT (Point 92).

NOTE: If the auxiliary heat is not used, this application operates in cooling mode only.

Optional Auxiliary Heat

If AUX HTG USED (Point 82) = YES, this application also controls auxiliary heat. The value of AUX HTG TYPE (Point 83) indicates the type of auxiliary heat control. If AUX HTG USED = NO, no auxiliary heat is used and HEAT.COOL (Point 5) is set to COOL.

CAUTION:

If using electric heat, the verify that the equipment is supplied with safeties by others to ensure that there is airflow across the heating coils when they are to be energized or equipment damage may result.

Do not set UNOCC FLOW (Point 31) to zero.

Hot Water Auxiliary Heat – If AUX HTG TYPE = HW and CAL MODULE (Point 87) = NO, the application controls auxiliary hot water heat. The heating loop modulates the heating valve point, VALVE COMD (Point 37) in order to warm the space. When the controller is in cooling mode, the heating valve is closed.

Electric Auxiliary Heat – If AUX HTG TYPE = ELEC, the heating loop controls up to two stages of electric reheat to warm up the room. The electric reheat is time modulated using a duty cycle as shown in the following example. When the controller is in cooling mode, the electric heat is OFF at all times.

Example

If the duty cycle is 10 minutes (STAGE TIME (Point 89) = 10 minutes) and the heating loop is calling for 60% of heating (HTG LOOPOUT (Point 80) = 60%), for every 10 minute period, the stages of electric auxiliary heat cycle as follows:

	Stage 1: minutes		**Stage 2: minutes**	
	ON	**OFF**	**ON**	**OFF**
With 1 stage of electric heat:	6	4	–	–
With 2 stages of electric heat:	10	0	2	8

Calibration

Air Velocity Transducer – Calibration of the controller's internal air velocity transducer is periodically required to maintain accurate air velocity readings. CAL SETUP (Point 95) is set with the desired calibration option during controller start-up. Depending on the value of CAL SETUP, calibration may be set to take place automatically or manually when the override switch is pressed on the room temperature sensor. If CAL AIR (Point 94) = YES, calibration is in progress.

- For a controller used without an Autozero Module (CAL MODULE (Point 87) = NO), the dampers are commanded closed simultaneously to get zero airflow readings during calibration.
- For a controller used with an Autozero Module (CAL MODULE = YES), calibration occurs without closing the dampers.

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.

Hot Water Valve – Calibration of a hot water valve (if used) is performed simultaneously with calibration of the air velocity transducers and is accomplished by commanding the valve closed. Calibration of the valve is not affected by the presence of Autozero Modules.

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

The Autozero Module is used during calibration when it is wired to DO 6 and CAL MODULE is set to YES.

Damper Status Operation

Under normal operation DMPR STATUS (Point 84) reads CAL. However, when using an Autozero Module, it is possible after a period of operation for the calculated damper position points, CLG DMP POS (Point 49) and HTG DMP POS (Point 53), 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 the damper position points. DMPR STATUS will be set to RECAL if all of the following conditions are true:

- CLG DMP POS and HTG DMP POS = 100%
- Air velocity (AIR VOLUME (Point 35) ÷ DUCT AREA (Point 97)) > 200 FPM
- FLOW (Point 75) < FLOW STPT (Point 93)

- or -

- CLG DMP POS and HTG DMP 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, do one of the following:

1. If flow is now being properly controlled, 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 positions be accurate, initialize the controller.

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

Fail-Safe Operation

If the air velocity sensor point, AIR VOLUME (Point 35) is failed, the dampers are controlled in one of two ways:

- If FAIL MODE (Point 40) = OPEN, the controller sets CLG DMP CMD (Point 48) and HTG DMP CMD (Point 52) to 100% open.

- If FAIL MODE = CLOSED, the controller sets CLG DMP CMD and HTG DMP CMD to 0% open.

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

Application Notes

1. If temperature swings in the room are excessive or there is trouble maintaining the setpoint, either the cooling loop, the heating loop, or both need to be tuned. If FLOW (Point 75) is oscillating while FLOW STPT (Point 93) is constant, the flow loop requires tuning. See *APOGEE Maintenance and Troubleshooting Manual* on InfoLink for more information.

2. The Dual Duct Controller – One Air Velocity Sensor – Electronic Output, as shipped from the factory, keeps all associated equipment OFF. See the *Equipment Controllers* section in the *APOGEE Start-up Manual* 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. DO 5 and DO 6 may be used as auxiliary motor points. If using a pair of spare DOs to control a motor, you must unbundle the corresponding motor command point.

Wiring Diagrams

The point wiring for Application 2035 is shown in Figure 2035-3 and Figure 2035-4.

CAUTION:

The controller's DOs control 24 Vac loads only. The maximum rating is 12 VA for each DO. Use an interposing 220V 4-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

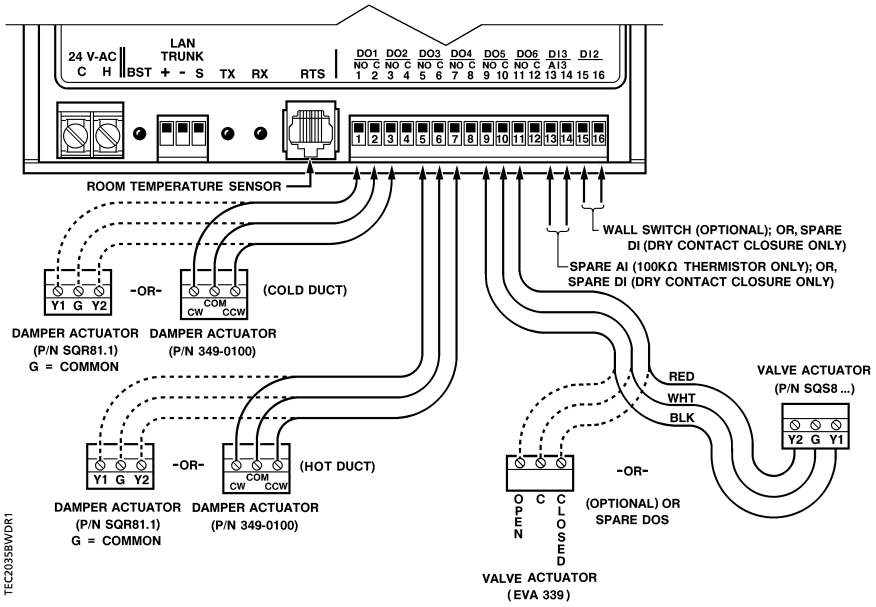


Figure 2035-3. Application 2035 Wiring Diagram with Hot Water Reheat.

CAUTION:

The controller's DOs control 24 Vac loads only. The maximum rating is 12 VA for each DO. Use an interposing 220V 4-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

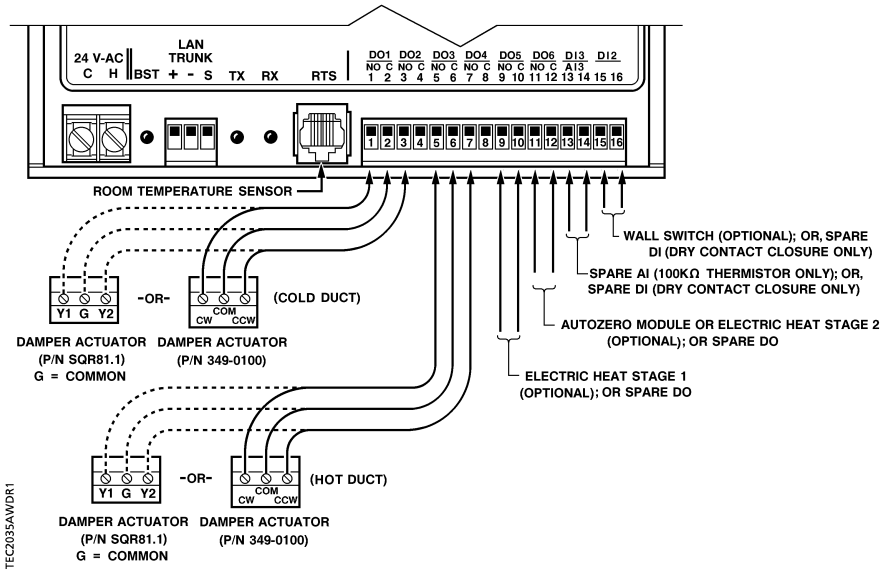


Figure 2035-4. Application 2035 Wiring Diagram with Electric Auxiliary Reheat.

Table 2035-1. Point Database for Application 2035.

Point Number	Descriptor	Factory Default (SI Units)	Engr. Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
01	CTLR ADDRESS	99.000	–	1.000	0.000	–	–
02	APPLICATION	2092	–	1.000	0.000	–	–
{04}	ROOM TEMP	74.000 (23.449)	DEG F (DEG C)	0.250 (0.140)	48.000 (8.889)	–	–
{05}	HEAT.COOL	COOL	–	–	–	HEAT	COOL
06	OCC CLG STPT	74.000 (23.449)	DEG F (DEG C)	0.250 (0.140)	48.000 (8.889)	–	–
07	OCC HTG STPT	70.000 (21.209)	DEG F (DEG C)	0.250 (0.140)	48.000 (8.889)	–	–
08	UOC CLG STPT	82.000 (27.929)	DEG F (DEG C)	0.250 (0.140)	48.000 (8.889)	–	–
09	UOC HTG STPT	65.000 (18.409)	DEG F (DEG C)	0.250 (0.140)	48.000 (8.889)	–	–
11	RM STPT MIN	55.000 (12.809)	DEG F (DEG C)	0.250 (0.140)	48.000 (8.889)	–	–
12	RM STPT MAX	90.000 (32.409)	DEG F (DEG C)	0.250 (0.140)	48.000 (8.889)	–	–
{13}	RM STPT DIAL	74.000 (23.449)	DEG F (DEG C)	0.250 (0.140)	48.000 (8.889)	–	–
14	STPT DIAL	NO	–	–	–	YES	NO
{15}	AUX TEMP	74.000 (23.496)	DEG F (DEG C)	0.500 (0.280)	37.500 (3.056)	–	–
18	WALL SWITCH	NO	–	–	–	YES	NO
{19}	DI OVRD SW	OFF	–	–	–	ON	OFF
20	OVRD TIME	0.000	HRS	1.000	0.000	–	–
{21}	UNOCC OVRD	UNOCC	–	–	–	UNOCC	OCC
{24}	DI 2	OFF	–	–	–	ON	OFF
{25}	DI 3	OFF	–	–	–	ON	OFF
{29}	OCC.UNOCC	OCC	–	–	–	UNOCC	OCC
31	UNOCC FLOW	220.000 (103.818)	CFM (LPS)	4.000 (1.888)	0.000	–	–
32	OCC FLOW	2200.000 (1038.180)	CFM (LPS)	4.000 (1.888)	0.000	–	–

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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Table 2035-1. Point Database for Application 2035.

Point Number	Descriptor	Factory Default (SI Units)	Engr. Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
{35}	AIR VOLUME	0.000	CFM (LPS)	4.000 (1.888)	0.000	–	–
36	FLOW COEFF	1.000	–	0.010	0.000	–	–
{37}	VALVE COMD	0.000	PCT	0.400	0.000	–	–
{38}	VALVE POS	0.000	PCT	0.400	0.000	–	–
39	MTR3 TIMING	130.000	SEC	1.000	0.000	–	–
40	FAIL MODE	OPEN	–	–	–	CLOSE	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}	CLG DMP CMD	0.000	PCT	0.400	0.000	–	–
{49}	CLG DMP POS	0.000	PCT	0.400	0.000	–	–
51	MTR1 TIMING	95.000	SEC	1.000	0.000	–	–
{52}	HTG DMP CMD	0.000	PCT	0.400	0.000	–	–
{53}	HTG DMP POS	0.000	PCT	0.400	0.000	–	–
55	MTR2 TIMING	95.000	SEC	1.000	0.000	–	–
56	DPR1 ROT ANG	90.000	–	1.000	0.000	–	–
57	DPR2 ROT ANG	90.000	–	1.000	0.000	–	–
58	MTR SETUP	0.000	–	1.000	0.000	–	–
59	DO DIR. REV	0.000	–	1.000	0.000	–	–
60	CLG DMP MIN	0.000	PCT	0.400	0.000	–	–
63	CLG P GAIN	20.000 (36.000)	–	0.250 (0.450)	0.000	–	–
64	CLG I GAIN	0.012 (0.022)	–	0.006 (0.011)	0.000	–	–
65	CLG D GAIN	0.000	–	2.000 (3.600)	0.000	–	–

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66	CLG BIAS	50.000	PCT	0.400	0.000	–	–

Table 2035-1. Point Database for Application 2035.

Point Number	Descriptor	Factory Default (SI Units)	Engr. Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
67	HTG P GAIN	10.000 (18.000)	–	0.250 (0.450)	0.000	–	–
68	HTG I GAIN	0.012 (0.022)	–	0.006 (0.011)	0.000	–	–
69	HTG D GAIN	0.000	–	2.000 (3.600)	0.000	–	–
70	HTG BIAS	50.000	PCT	0.400	0.000	–	–
71	FLOW P GAIN	0.000	–	0.250	0.000	–	–
72	FLOW I GAIN	0.018	–	0.006	0.000	–	–
73	FLOW D GAIN	0.000	–	2.000	0.000	–	–
{75}	FLOW	0.000	PCT	1.000	0.000	–	–
{78}	CTL TEMP	74.000 (23.449)	DEG F (DEG C)	0.250 (0.140)	48.000 (8.889)	–	–
{79}	CLG LOOPOUT	50.000	PCT	0.400	0.000	–	–
{80}	HTG LOOPOUT	0.000	PCT	0.400	0.000	–	–
{81}	AVG HEAT OUT	0.000	–	2.000	0.000	–	–
82	AUX HTG USED	NO	–	–	–	YES	NO
83	AUX HTG TYPE	HW	–	–	–	ELEC	HW
{84}	DMPR STATUS	CAL	–	–	–	RECAL	CAL
86	SWITCH TIME	10.000	MIN	1.000	0.000	–	–
87	CAL MODULE	NO	–	–	–	YES	NO
88	STAGE COUNT	1.000	–	1.000	0.000	–	–
89	STAGE TIME	10.000	MIN	1.000	0.000	–	–
90	SWITCH DBAND	1.000 (0.560)	DEG F (DEG C)	0.250 (0.140)	0.000	–	–
{92}	CTL STPT	74.000 (23.449)	DEG F (DEG C)	0.250 (0.140)	48.000 (8.889)	–	–
{93}	FLOW STPT	0.000	PCT	1.000	0.000	–	–
{94}	CAL AIR	NO	–	–	–	YES	NO
95	CAL SETUP	4.000	–	1.000	0.000	–	–

1. Points not listed are not used in this application.
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3. Point numbers that appear in brackets { } may be unbundled at the field panel.

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96	CAL TIMER	12.000	HRS	1.000	0.000	–	–

Table 2035-1. Point Database for Application 2035.

Point Number	Descriptor	Factory Default (SI Units)	Engr. Units (SI Units)	Slope (SI Units)	Intercept (SI Units)	On Text	Off Text
97	DUCT AREA	1.000 (0.093)	SQ. FT (SQ M)	0.025 (0.002)	0.000	–	–
98	LOOP TIME	5.000	SEC	1.000	0.000	–	–
{99}	ERROR STATUS	0.000	–	1.000	0.000	–	–

1. Points not listed are not used in this application.
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3. Point numbers that appear in brackets { } may be unbundled at the field panel.