SIEMENS

BACnet ATEC

Application 2861 – VAV Heating or Cooling

Application Note

Siemens Industry, Inc.

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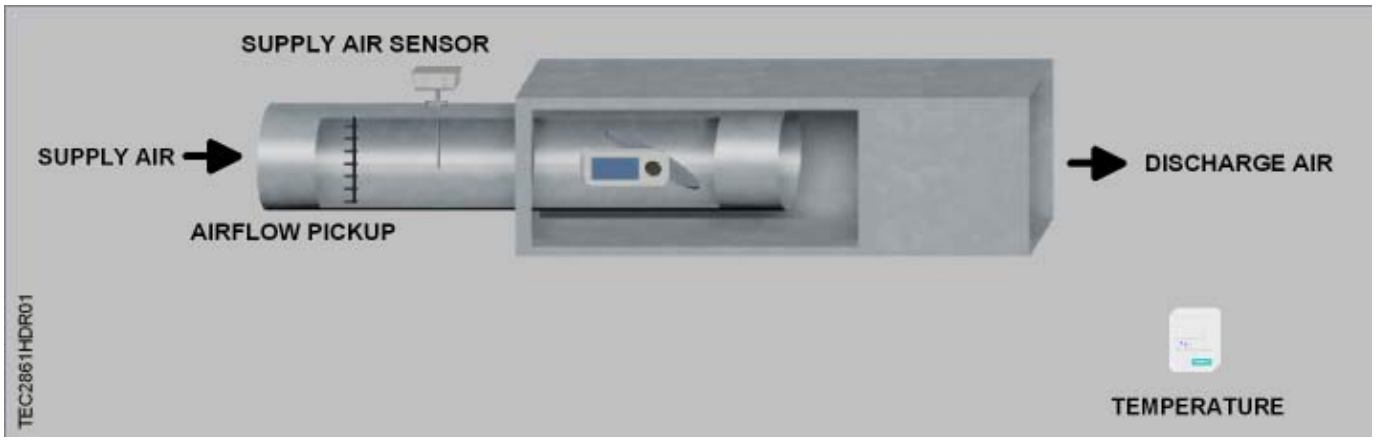
Overview

In Application 2861, the controller modulates the supply air damper of the terminal box for cooling and heating. In order for it to work properly, the central air-handling unit must provide cool supply air in cooling mode and warm air during heating mode.



Application 2861 Cooling and Heating Hardware Diagram.

BACnet ATEC Models

Part Number	Description
550-440	BACnet ATEC Model 0001, cooling only (GDE)
550-441	BACnet ATEC Model 0001, cooling only (GLB)
550-445	BACnet ATEC Model 2301, full feature (GDE)
550-446	BACnet ATEC Model 2301, full feature (GLB)

BACnet

The controller communicates using BACnet MS/TP protocol for open communications on BACnet MS/TP networks.

Product	Supported BIBBs	BIBB Name
BTEC	DS-RP-B B	Data Sharing-Read Property-B
	DS-RPM-B	Data Sharing-Read Property Multiple-B
	DS-WP-B	Data Sharing-Write Property-B
	DM-DDB-B	Device Management-Dynamic Device Binding-B
	DM-DOB-B	Device Management-Dynamic Object Binding-B
	DM-DDC-B	Device Management-Device Communication Control-B

Hardware Inputs

Analog

- Room temperature sensor
- Room temperature setpoint dial (optional)
- Spare UI1 (temperature sensor (10K thermistor) or percentage (0-10V/4-20ma)) *
- Spare UI2 (temperature sensor (10K thermistor) or percentage (0-10V/4-20ma)) *

Digital

- Night mode override (optional)
- Wall switch (optional) or Spare UI2 *
- Spare UI1 *

* Feature available on the full feature BACnet ATEC only.

Hardware Outputs

Analog

- none

Digital

- Damper actuator
- Spare DO3, DO4, or (DO3/DO4 Spare floating actuator)*
- Spare DO5 *

* Available on the full feature BACnet ATEC only.

Sequence of Operation

The following paragraphs present the sequence of operation for Application 2861, “VAV Cooling or Heating“.

The source for cooling or heating is provided by the supply air from the air handling unit.

Control Temperature Setpoints

Depending on the controller’s current operational mode (day or night), the control temperature setpoint, CTL STPT holds the value of one of the following setpoints:

Day Mode - Room Temperature Setpoint dial disabled (STPT DIAL = NO) In the day mode when a setpoint dial has not been enabled, then CTL STPT holds the value of DAY CLG STPT or DAY HTG STPT.

Day Mode - Room Temperature Setpoint Dial Enabled (STPT DIAL = YES)

Setpoint dial configured with a heating/cooling deadband (default).

To allow the controller to operate with a heating/cooling deadband (functioning the same as provided when the setpoint dial is not present) the following configuration should be used.

Set the DAY HTG STPT less than the DAY CLG STPT by the deadband (or zero energy band) that is desired. (for example, DAY HTG STPT equals 70°F; DAY CLG STPT equals 74°F, providing a deadband of 4 degrees).

As described below, the setpoint(s) for heating/cooling will be 1/2 of the deadband above or below the setpoint dial value.

When HEAT.COOL equals HEAT, then:

CTL STPT will equal RM STPT DIAL – 0.5 * (DAY CLG STPT – DAY HTG STPT) and will be limited by RM STPT MIN and RM STPT MAX.

When HEAT.COOL equals COOL, then:

CTL STPT will equal RM STPT DIAL + 0.5 * (DAY CLG STPT – DAY HTG STPT) and will be limited by RM STPT MIN and RM STPT MAX.

NOTE:

A space where the deadband is used can be more energy efficient than a space where the deadband is not being used.

Setpoint dial configured for zero heating/cooling deadband.

When the job specification requires a common heating and cooling temperature setpoint, the following configuration should be used.

Set DAY HTG STPT equal to DAY CLG STPT. This will configure the setpoint deadband equal to zero.

In addition, with a setpoint deadband equals zero, then:

CTL STPT will equal RM STPT DIAL, and will be limited by RM STPT MIN and RM STPT MAX.

NOTE:

A space where the heating/cooling deadband is zero may be more comfortable than a space where the deadband is being used, but may use more energy.

Night Mode – In night mode, CTL STPT holds the value of NGT CLG STPT or NGT HTG STPT.

Day and Night Modes

The day/night status of the space is determined by the status of DAY.NGT. 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 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, then the controller stays in day 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 DAY.NGT. See *Powers Process Control Language (PPCL) User's Manual* (125-1896) and *Field Panel User's Manual* (125-3019 or 125-3020) for more information.

For controlers with expanded IO (models 2301):

When a wall switch is physically connected to the termination strip on the controller at UI 2 (see the *Control Diagram* in Overview [→ 4]), and WALL SWITCH = YES, the controller monitors the status of UI 2. When the status of UI 2 is ON (the switch is closed), then DAY.NGT will be set to DAY indicating that the controller is in day mode. When the status of UI 2 is OFF (the switch is open), then DAY.NGT will be set to NIGHT indicating that the controller is in night mode

See also

Overview [→ 4]

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, pressing the override switch will reset the controller to day operational mode for the time period that is set in OVRD TIME. The status of NGT OVRD changes to DAY. After the override time elapses, the controller returns to night mode and the status of NGT OVRD changes back to NIGHT.

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

Heating/Cooling Switchover

There are three options for the heating/cooling switchover for this application. In order for the controller to function properly, one of the following three options must be used:

1. A temperature sensor is installed in the supply air ductwork. The controller uses the measured temperature point, SUPPLY TEMP, to determine whether it is in heating or cooling mode.
   When SUPPLY TEMP < COOL TEMP, the controller sets HEAT.COOL to COOL, switching the controller to cooling mode.
   When SUPPLY TEMP > HEAT TEMP, the controller sets HEAT.COOL to HEAT, switching the controller to heating mode.
2. If the controller is connected to a field panel, the field panel can command SUPPLY TEMP.
   When SUPPLY TEMP is commanded below the value of COOL TEMP, the controller sets HEAT.COOL to COOL, switching the controller to cooling mode.
   When SUPPLY TEMP is commanded above the value of HEAT TEMP, the controller sets HEAT.COOL to HEAT, switching the controller to heating mode.
3. If the controller is connected to a field panel, the field panel can switch the controller between heating and cooling modes by commanding HEAT.COOL to HEAT or COOL

Damper Operation During Heating or Cooling Mode

When the controler is in the cooling mode (HEAT.COOL = COOL), the supply damper will modulate between CLG FLOW MIN and CLG FLOW MAX to maintain the desired temperature setpoint. In this mode, the damper operates in a direct acting mode (increase in space temperature, increase in damper position).

When the controller is in the heating mode (HEAT.COOL = HEAT) the supply damper will module between HTG FLOW MIN and HTG FLOW MAX to maintain the desired temperature setpoint. In this mode, the damper operates in a reverse acting mode (decrease in space temperature, increase in damper position).

Room Temperature Offset (Optional)

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

CTL TEMP = ROOM TEMP + TEMP OFFSET

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.

Control Loops

The terminal box 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. See Control Temperature Setpoints [→ 6].

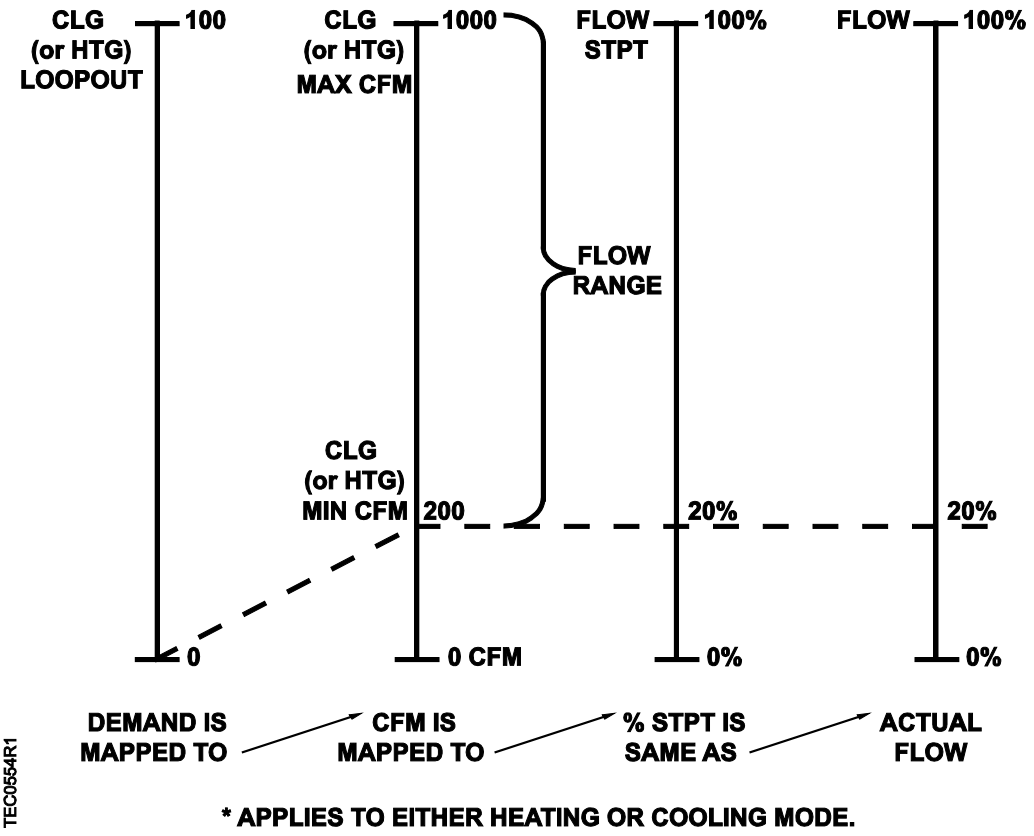
Cooling Loop – Generates cooling loopout which is then used to generate FLOW STPT. FLOW STPT is the result of scaling the cooling loopout to the appropriate range of values determined by CLG FLOW MIN and CLG FLOW MAX.

As described in the following figure, the flow setpoint is calculated by:

FLOW STPT = [CLG LOOPOUT × (100% – % minimum setpoint)] + % minimum setpoint.

Where percent minimum setpoint is:

% minimum setpoint = (CLG FLOW MIN / CLG FLOW MAX) x 100 %



FLOW STPT and FLOW % are relative to MIN and MAX STPTS of corresponding heating or cooling mode.

Example

If CLG FLOW MIN = 200 cfm, and CLG FLOW MAX = 1000 cfm, the minimum flow setpoint is (200 cfm /1000 cfm) × 100% flow = 20%.

When CLG LOOPOUT is 0%, FLOW STPT = 20% flow.

[0% × (100% – 20%)] + 20% = 20%

This ensures that the airflow out of the terminal box is no less than CLG FLOW MIN.

When CLG LOOPOUT is 50%, FLOW STPT = 60% flow.

[50% × (100% – 20%)] + 20% = 60%

When CLG LOOPOUT is 100%, FLOW STPT = 100% flow.

[100% × (100% – 20%)] + 20% = 100%

Heating Loop – Generates heating loopout which is then used to generate the FLOW STPT. FLOW STPT is the result of scaling the heating loopout to the appropriate range of values determined by HTG FLOW MIN and HTG FLOW MAX.

As described in the figure, the flow setpoint is calculated by:

FLOW STPT = [HTG LOOPOUT × (100% – % minimum setpoint)] + % minimum setpoint.

Where percent minimum setpoint is:

% minimum setpoint = (HTG FLOW MIN/HTG FLOW MAX) x 100 %

Example

If HTG FLOW MIN = 100 cfm, and HTG FLOW MAX = 1000 cfm, the minimum flow setpoint is (100 cfm / 1000 cfm) × 100% flow = 10%.

When HTG LOOPOUT is 0%, FLOW STPT = 10% flow.

[0% × (100% – 10%)] + 10% = 10%

This ensures that the airflow out of the terminal box is no less than HTG FLOW MIN.

When HTG LOOPOUT is 50%, FLOW STPT = 55% flow.

[50% × (100% – 10%)] + 10% = 55%

When HTG LOOPOUT is 100%, FLOW STPT = 100% flow.

[100% × (100% – 10%)] + 10% = 100%

Flow Loop – Maintains minimum airflow and maximum airflow through CTL FLOW MIN and CTL FLOW MAX.

When the controller is in cooling mode, CTL FLOW MIN = CLG FLOW MIN, and CTL FLOW MAX = CLG FLOW MAX.

When the controller is in heating mode, CTL FLOW MIN = HTG FLOW MIN, and CTL FLOW MAX = HTG FLOW MAX.

In Application 2861, you can set CLG FLOW MIN equal to, but not greater than, CLG FLOW MAX, and set HTG FLOW MIN equal to, but not greater than, HTG FLOW MAX. If the minimum and maximum values are set equal, the flow loop becomes a constant volume loop and loses its ability to control temperature.

The flow loop maintains FLOW STPT by modulating the supply air damper, DMPR COMD. The flow loop maintains the airflow between CTL FLOW MIN and CTL FLOW MAX.

FLOW is the input value for the flow loop. It is calculated as a percentage based on where AIR VOLUME is between 0 cfm and CTL FLOW MAX. This percentage is referred to as % flow.

- If AIR VOLUME = 0 cfm, FLOW is 0% flow.
- If AIR VOLUME = CTL FLOW MAX, FLOW is 100% flow.

The low limit of FLOW STPT will be the percentage that corresponds to the volume given in CTL FLOW MIN. This percentage can be calculated as:

(CTL FLOW MIN/CTL FLOW MAX) × 100% flow

The flow loop ensures that the supply air will not be less than CTL FLOW MIN.

Example

If CTL FLOW MIN = 250 cfm, and CTL FLOW MAX = 1000 cfm,
the low limit of FLOW STPT = (250 cfm / 1000 cfm) × 100% flow
= 0.25 × 100% flow
= 25% flow.
Since 25% of 1000 cfm = 250 cfm, the minimum airflow out of the terminal box will be 250 cfm.

See also

Control Temperature Setpoints [→ 6]

Calibration

Calibration of the controller's internal air velocity transducers is periodically required to maintain accurate air velocity readings. CAL SETUP is set with the desired calibration option during controller startup.

Depending on the value of CAL SETUP, calibration may be set to take place automatically or manually. If CAL AIR = YES, calibration is in progress.

The damper is commanded closed to get a zero airflow reading during calibration.

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

During normal operation: To ensure that the damper closes fully, the controller will provide additional closing time when the DMPR POS = 0%.

Fail Mode Operation

If the air velocity sensor fails, the controller uses pressure dependent control. The temperature loop controls the operation of the damper.

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

Application Notes

- If temperature swings in the room are excessive or there is trouble maintaining the setpoint, the cooling loop needs to be tuned. If FLOW is oscillating while FLOW STPT is constant, the flow loop requires tuning. See *iKnow Troubleshooting Tool* for more information.
- Siemens BACnet Actuator, as shipped from the factory, keeps all associated equipment OFF. See the *BACnet Actuator Start-up Procedures* for information on how to release the controller and its equipment to application control.

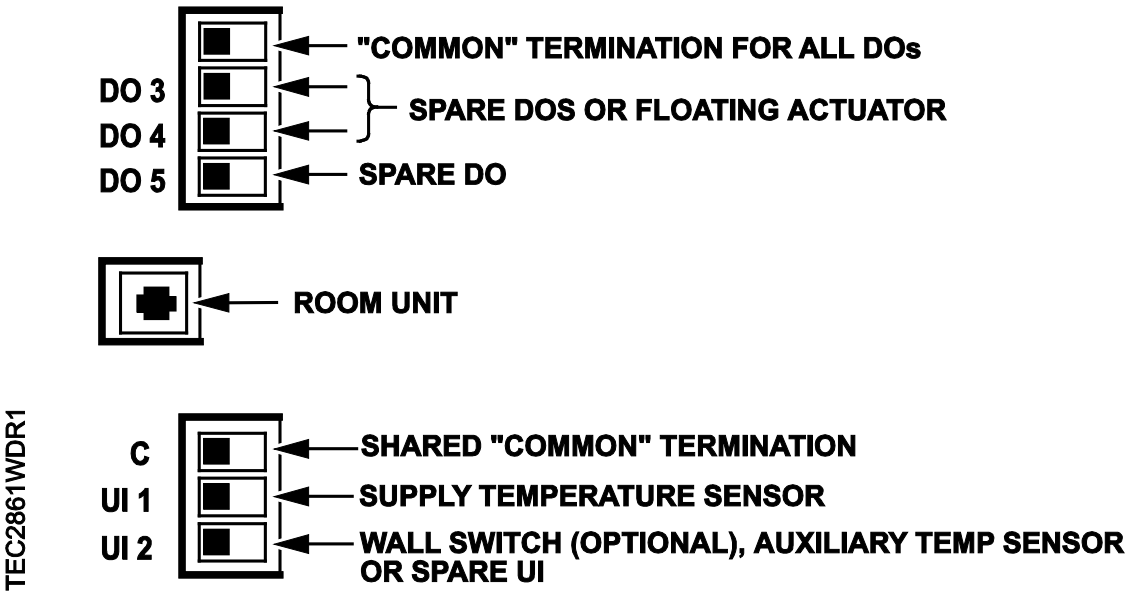
For controllers with expanded IO (model 2301):

- 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 3 and DO 4 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.
- Spare UIs can be used as temperature inputs, percentage inputs (for example, humidity) or digital inputs. See the *BACnet Actuator Start-up Procedures* for information on how to setup these inputs for analog or digital use.

Wiring Diagram

Application 2861 point wiring.

	⚠ CAUTION
	The controller's DOs control 24 Vac loads only. The maximum rating is 12 VA for each DO. An external interposing relay is required 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. (for example part number 540-147, Terminal Equipment Controller Relay Module)



Application 2861- Heating or Cooling.

NOTE:

Spare DOs and UIs are only available on the full feature controller.

Application 2861 Point Database

Object Type [a]	Object Instance (Point Number)	Object Name (Descriptor)	Factory Default (SI Units) [b]	Eng Units (SI Units)	Range	Active Text	Inactive Text
AO	1	CTLR ADDRESS	99	--	0-255	--	--
AO	2	APPLICATION	2897	--	0-32767	--	--
AO	3	RMTMP OFFSET	0.0 (0.0)	DEG F (DEG C)	-255.75	--	--
AI	{04}[c]	ROOM TEMP	74.0 (23.32)	DEG F (DEG C)	-255.75	--	--
BO	{05}	HEAT.COOL	COOL	--	Binary	HEAT	COOL
AO	6	DAY CLG STPT	74.0 (23.32)	DEG F (DEG C)	-255.75	--	--
AO	7	DAY HTG STPT	70.0 (21.08)	DEG F (DEG C)	-255.75	--	--
AO	8	NGT CLG STPT	82.0 (27.8)	DEG F (DEG C)	-255.75	--	--
AO	9	NGT HTG STPT	65.0 (18.28)	DEG F (DEG C)	-255.75	--	--
AO	11	RM STPT MIN	55.0 (12.68)	DEG F (DEG C)	-255.75	--	--
AO	12	RM STPT MAX	90.0 (32.28)	DEG F (DEG C)	-255.75	--	--
AI	{13}	RM STPT DIAL	74.0 (23.32)	DEG F (DEG C)	-255.75	--	--
BO	{14}	STPT DIAL	NO	--	Binary	YES	NO
AI	{15}	SUPPLY TEMP	74.0 (23.32)	DEG F (DEG C)	-255.75	--	--
BO	{18}	WALL SWITCH	NO	--	Binary	YES	NO
BI	{19}	DI OVRD SW	OFF	--	Binary	ON	OFF
AO	20	OVRD TIME	0	HRS	0-255	--	--
BO	{21}	NGT OVRD	NIGHT	--	Binary	NIGHT	DAY
BI	{24}	DIGITAL UI2	OFF	--	Binary	ON	OFF
BI	{25}	DIGITAL UI1	OFF	--	Binary	ON	OFF
BO	{29}	DAY.NGT	DAY	--	Binary	NIGHT	DAY
AO	31	CLG FLOW MIN	220 (103.818)	CFM (LPS)	0-131068	--	--
AO	32	CLG FLOW MAX	2200 (1038.18)	CFM (LPS)	0-131068	--	--
AO	33	HTG FLOW MIN	220 (103.818)	CFM (LPS)	0-131068	--	--
AO	34	HTG FLOW MAX	1100	CFM (LPS)	0-131068	--	--

Object Type [a]	Object Instance (Point Number)	Object Name (Descriptor)	Factory Default (SI Units) [b]	Eng Units (SI Units)	Range	Active Text	Inactive Text
			(519.09)				
AI	{35}	AIR VOLUME	0 (0.0)	CFM (LPS)	0-131068	--	--
AO	36	FLOW COEFF	1	--	0-2.55	--	--
BO	{43}	DO 3	OFF	--	Binary	ON	OFF
BO	{44}	DO 4	OFF	--	Binary	ON	OFF
BO	{45}	DO 5	OFF	--	Binary	ON	OFF
AO	48	DMPR COMD	0	PCT	0-102	--	--
AO	49	DMPR POS	0	PCT	0-102	--	--
AO	51	MTR1 TIMING	95	SEC	0-511	--	--
AO	52	MTR2 COMD	0	PCT	0-102	--	--
AO	53	MTR2 POS	0	PCT	0-102	--	--
AO	55	MTR2 TIMING	130	SEC	0-511	--	--
AO	56	DMPR ROT ANG	90	--	0-255	--	--
AO	58	MTR SETUP	1	--	0-255	--	--
AO	59	DO DIR. REV	0	--	0-255	--	--
AO	61	COOL TEMP	65.0 (18.28)	DEG F (DEG C)	-255.75	--	--
AO	62	HEAT TEMP	80.0 (26.68)	DEG F (DEG C)	-255.75	--	--
AO	63	CLG P GAIN	20.0 (36.0)	--	0-63.75	--	--
AO	64	CLG I GAIN	0.01 (0.018)	--	0-1.023	--	--
AO	65	CLG D GAIN	0 (0.0)	--	0-510	--	--
BO	{66}	CHK OUT	NO	--	Binary	YES	NO
AO	67	HTG P GAIN	10.0 (18.0)	--	0-63.75	--	--
AO	68	HTG I GAIN	0.01 (0.018)	--	0-1.023	--	--
AO	69	HTG D GAIN	0 (0.0)	--	0-510	--	--
AO	70	CHK STATUS	-1	--	-32767	--	--
AO	71	FLOW P GAIN	0	--	0-51.15	--	--
AO	72	FLOW I GAIN	0.01	--	0-1.023	--	--
AO	73	FLOW D GAIN	0	--	0-510	--	--
AO	74	FLOW BIAS	50	PCT	0-102	--	--
AO	75	FLOW	0	PCT	0-1023.75	--	--
AO	76	CTL FLOW MIN	220 (103.818)	CFM (LPS)	0-131068	--	--
AO	77	CTL FLOW MAX	2200 (1038.18)	CFM (LPS)	0-131068	--	--
AO	78	CTL TEMP	74.0 (23.32)	DEG F (DEG C)	-255.75	--	--
AO	79	CLG LOOPOUT	0	PCT	0-102	--	--

Object Type [a]	Object Instance (Point Number)	Object Name (Descriptor)	Factory Default (SI Units) [b]	Eng Units (SI Units)	Range	Active Text	Inactive Text
AO	80	HTG LOOPOUT	0	PCT	0-102	--	--
AO	92	CTL STPT	74.0 (23.32)	DEG F (DEG C)	-255.75	--	--
AO	93	FLOW STPT	0	PCT	0-255.75	--	--
BO	{94}	CAL AIR	NO	--	Binary	YES	NO
AO	95	CAL SETUP	4	--	0-255	--	--
AO	96	CAL TIMER	12	HRS	0-255	--	--
AO	97	DUCT AREA	1.0 (0.09292)	SQ. FT (SQ M)	0-6.375	--	--
AO	98	LOOP TIME	5	SEC	0-255	--	--
AO	99	ERROR STATUS	0	--	0-255	--	--
AO	102	UI1 CFG	1	--	0-255	--	--
AI	{103}	PERCENT UI1	0	PCT	0-6.375	--	--
AO	104	UI2 CFG	1	--	0-255	--	--
AI	{105}	PERCENT UI2	0	PCT	0-6.375	--	--
AO	106	AIR ALTITUDE	700 (213.36)	FEET (METERS)	0-16383	--	--
AO	107	TUBE LEN	6.0 (1.8288)	FEET (METERS)	0-102.3	--	--
AO	108	TUBE DIAMETE	0.187 (0.47498)	INCH (CM)	0-0.255	--	--
AI	{109}	AUX TEMP UI2	74.0 (23.32)	DEG F (DEG C)	-255.75	--	--
AO	126	STAT SUPV	0	--	0-255	--	--
AO	127	RM RH	50	PCT	0-102	--	--

[a] Object Types are; Analog Input (AI), Analog Output (AO), Binary Input (BI) and Binary Output (BO).

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

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

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