SIEMENS

Siemens BACnet Actuator

Application Notes

VAV Cooling and Heating — Application 2561

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Overview

In Application 2561, 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 (Figure 1).

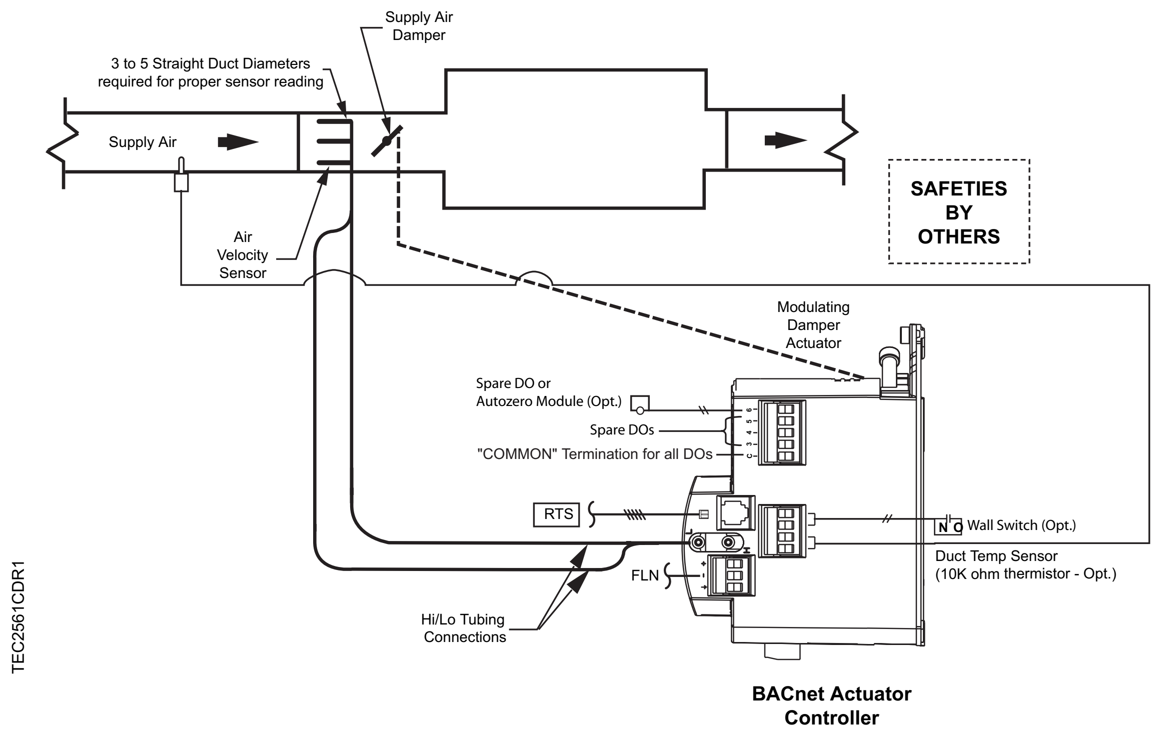

Figure 1. Application 2561 Control Diagram.

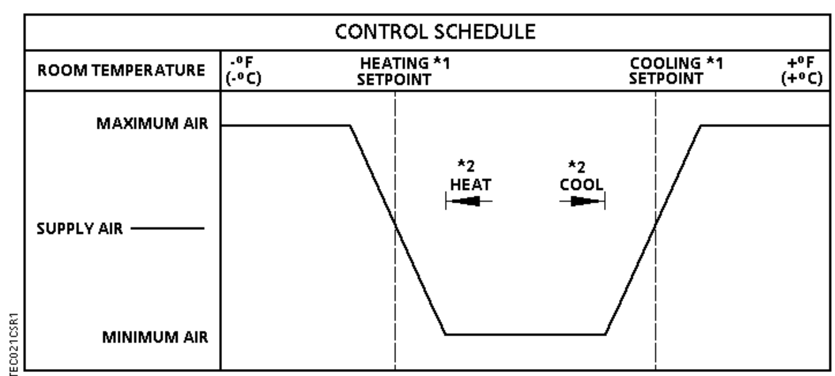

Figure 2. Application 2561 Control Schedule.

See *Sequence of Operation*, *Control Temperature Setpoints*.

BACnet

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

Table 1. Supported BIBBS.

Product	Supported BIBBs	BIBB Name
	DS-RP-B	Data Sharing-ReadProperty-B
	DS-RPM-B	Data Sharing-ReadPropertyMultiple-B
	DS-WP-B	Data Sharing-WriteProperty-B
	DM-DDB-B	Device Management-Dynamic Device Binding-B
	DM-DOB-B	Device Management-Dynamic Object Binding-B
BTEC	DM-DDC-B	Device Management-Device Communication Control-B

Hardware Inputs

Analog

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

Digital

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

Hardware Outputs

Analog

- None

Digital

- Autozero Module (optional)
- Damper actuator

Ordering Notes

Siemens BACnet Actuator	550-430

Related Equipment:

Autozero Module (optional)
Terminal Equipment Controller Room Temperature Sensor

Point Database

Table 2 presents the point database information for Application 2561.

Sequence of Operation

The following paragraphs present the sequence of operation for Application 2561, “VAV Cooling and Heating”.

Control Temperature Setpoints

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

Day Mode – CTL STPT holds the value of DAY CLG STPT. If the room temperature sensor has a setpoint dial and STPT DIAL = YES, CTL STPT holds the value of RM STPT DIAL.

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

Night Mode – CTL STPT holds the value of NGT CLG STPT.

Room Temperature Offset

Room Temperature Offset, RMTMP 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 TMP + RMTMP OFFSET.

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 a wall switch is physically connected to the termination strip on the controller at DI 2 (see Figure 1 and Figure 3), and WALL SWITCH = YES, the controller monitors the status of DI 2. When DI 2 is ON (the switch is closed), DAY.NGT will be set to DAY indicating that the controller is in day mode. When DI 2 is OFF (the switch is open), DAY.NGT will be set to NIGHT indicating that the controller is in night 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, the controller is operating stand-alone, it stays in day mode all the time. If the controller is operating with centralized control, connected to a field panel, the field panel can send an operator or PPCL command to override the status of DAY.NGT.

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 mode for the time period set in OVRD TIME. The status of NGT OVRD changes to DAY. After the override time elapses, the controller returns to night mode and 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.

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* .

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. In order to scale it, the loopout is multiplied by the range (MAX – MIN) and then added to the minimum setpoint.

When CLG FLOW MIN ≠ 0 CFM, FLOW STPT ≠ CLG LOOPOUT. The minimum flow setpoint is (CLG FLOW MIN / CLG FLOW MAX) × 100% flow. And FLOW STPT is [CLG LOOPOUT × (100% * minimum setpoint)] + minimum setpoint.

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. In order to scale it, the loopout is multiplied by the range (MAX – MIN) and then added to the minimum setpoint.

When HTG FLOW MIN ≠ 0 CFM, FLOW STPT ≠ HTG LOOPOUT. The minimum flow setpoint is (HTG FLOW MIN / HTG FLOW MAX) × 100% flow. And FLOW STPT is [HTG LOOPOUT × (100% – minimum setpoint)] + minimum setpoint.

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 2561, CLG FLOW MIN can be set equal to, but not greater than, CLG FLOW MAX and HTG FLOW MIN can be set 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 its ability to control temperature is lost.

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

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.

- For a controller used without an Autozero Module (CAL MODULE, = 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.

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.

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

Damper Status Operation

Under normal operation DMPR STATUS reads CAL. However, if using an Autozero Module, it is possible after a period of operation for the calculated damper position, DMPR POS, 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 VOLUME > 0 CFM
- FLOW < FLOW STPT

OR

- DMPR POS = 0%
- AIR VOLUME > 0 CFM
- FLOW > FLOW STPT

To change DMPR STATUS from RECAL back to CAL, set DMPR STATUS to CAL and then release it.

Fail-safe 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

1. If temperature swings in the room are excessive or there is trouble maintaining the setpoint, the cooling/heating 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.

2. Siemens BACnet Actuator, as shipped from the factory, keeps all associated equipment OFF. See the *BACnet Terminal Box Controller — Electronic Output Start-up Procedures* 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 3 and DO 4 or 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 Diagram

The point wiring for Application 2561 is shown in Figure 3.

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.

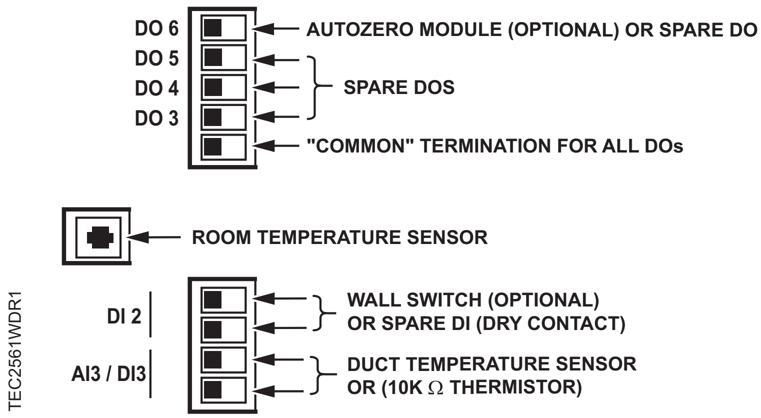

Figure 3. Application 2561 Wiring Diagram.

Table 2. Point Database for Application 2561.

Object Type[a]	Object Instance (Point Number)[b]	Object Name (Point Descriptor)	Factory Default (SI Units)[c]	Engr Units (SI Units)[c]	Range	Active Text	Inactive Text
AO	1	CTLR ADDRESS	99	–	0-255	–	–
AO	2	APPLICATION	2597	–	2560-2567 and 2597	–	–
AO	3	RMTMP OFFSET	0.0 (0.0)	DEG F (DEG C)	-31.75-32	–	–
AI	{04}[d]	ROOM TEMP	74.0 (23.44888)	DEG F (DEG C)	48-111.75	–	–
BO	{05}	HEAT.COOL	COOL	–	Binary	HEAT	COOL

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Table 2. Point Database for Application 2561. ***(continued)***

Object Type[a]	Object Instance (Point Number)[b]	Object Name (Point Descriptor)	Factory Default (SI Units)[c]	Engr Units (SI Units)[c]	Range	Active Text	Inactive Text
AO	6	DAY CLG STPT	74.0 (23.44888)	DEG F (DEG C)	48-111.75	–	–
AO	7	DAY HTG STPT	70.0 (21.20888)	DEG F (DEG C)	48- 111.75	–	–
AO	8	NGT CLG STPT	82.0 (27.92888)	DEG F (DEG C)	48- 111.75	–	–
AO	9	NGT HTG STPT	65.0 (18.40888)	DEG F (DEG C)	48- 111.75	–	–
AO	11	RM STPT MIN	55.0 (12.80888)	DEG F (DEG C)	48- 111.75	–	–
AO	12	RM STPT MAX	90.0 (32.40888)	DEG F (DEG C)	48- 111.75	–	–
AI	{13}	RM STPT DIAL	74.0 (23.44888)	DEG F (DEG C)	48- 111.75	–	–
BO	14	STPT DIAL	NO	–	Binary	YES	NO
AI	{15}	SUPPLY TEMP	74.0 (23.495556)	DEG F (DEG C)	37.5- 165	–	–
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}	DI 2	OFF	–	Binary	ON	OFF
BI	{25}	DI 3	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	2200 (1038.18)	CFM (LPS)	0- 131068	–	–
AI	{35}	AIR VOLUME	0 (0.0)	CFM (LPS)	0- 131068	–	–
AO	36	FLOW COEFF	1	–	0- 2.55	–	–

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Table 2. Point Database for Application 2561. ***(continued)***

Object Type[a]	Object Instance (Point Number)[b]	Object Name (Point Descriptor)	Factory Default (SI Units)[c]	Engr Units (SI Units)[c]	Range	Active Text	Inactive Text
AO	{37}	MTR3 COMD	0	PCT	0- 102	–	–
AO	{38}	MTR3 POS	0	PCT	0- 102	–	–
AO	39	MTR3 TIMING	130	SEC	0- 511	–	–
BO	{41}	DO 1	OFF	–	Binary	ON	OFF
BO	{42}	DO 2	OFF	–	Binary	ON	OFF
BO	{43}	DO 3	OFF	–	Binary	ON	OFF
BO	{44}	DO 4	OFF	–	Binary	ON	OFF
BO	{45}	DO 5	OFF	–	Binary	ON	OFF
BO	{46}	DO 6	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	0	–	0- 255	–	–
AO	59	DO DIR. REV	0	–	0- 255	–	–
AO	61	COOL TEMP	65.0 (18.455556)	DEG F (DEG C)	37.5- 165	–	–
AO	62	HEAT TEMP	80.0 (26.855556)	DEG F (DEG C)	37.5- 165	–	–
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	–	–

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Table 2. Point Database for Application 2561. ***(continued)***

Object Type[a]	Object Instance (Point Number)[b]	Object Name (Point Descriptor)	Factory Default (SI Units)[c]	Engr Units (SI Units)[c]	Range	Active Text	Inactive Text
AO	{70}	CHK STATUS	-1	–	-1- 32766	–	–
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 (23.44888)	DEG F (DEG C)	48- 111.75	–	–
AO	{79}	CLG LOOPOUT	0	PCT	0- 102	–	–
AO	{80}	HTG LOOPOUT	0	PCT	0- 102	–	–
BO	{84}	DMPR STATUS	CAL	–	Binary	RECAL	CAL
BO	87	CAL MODULE	NO	–	Binary	YES	NO
AO	{92}	CTL STPT	74.0 (23.44888)	DEG F (DEG C)	48- 111.75	–	–
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	–	–

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

[b] Points not listed are not used in this application.

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

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