SIEMENS

BACnet Programmable Fume Hood Controller

2-Position Constant Volume with Damper Application 6740

Application Note

140-1341
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Building Technologies

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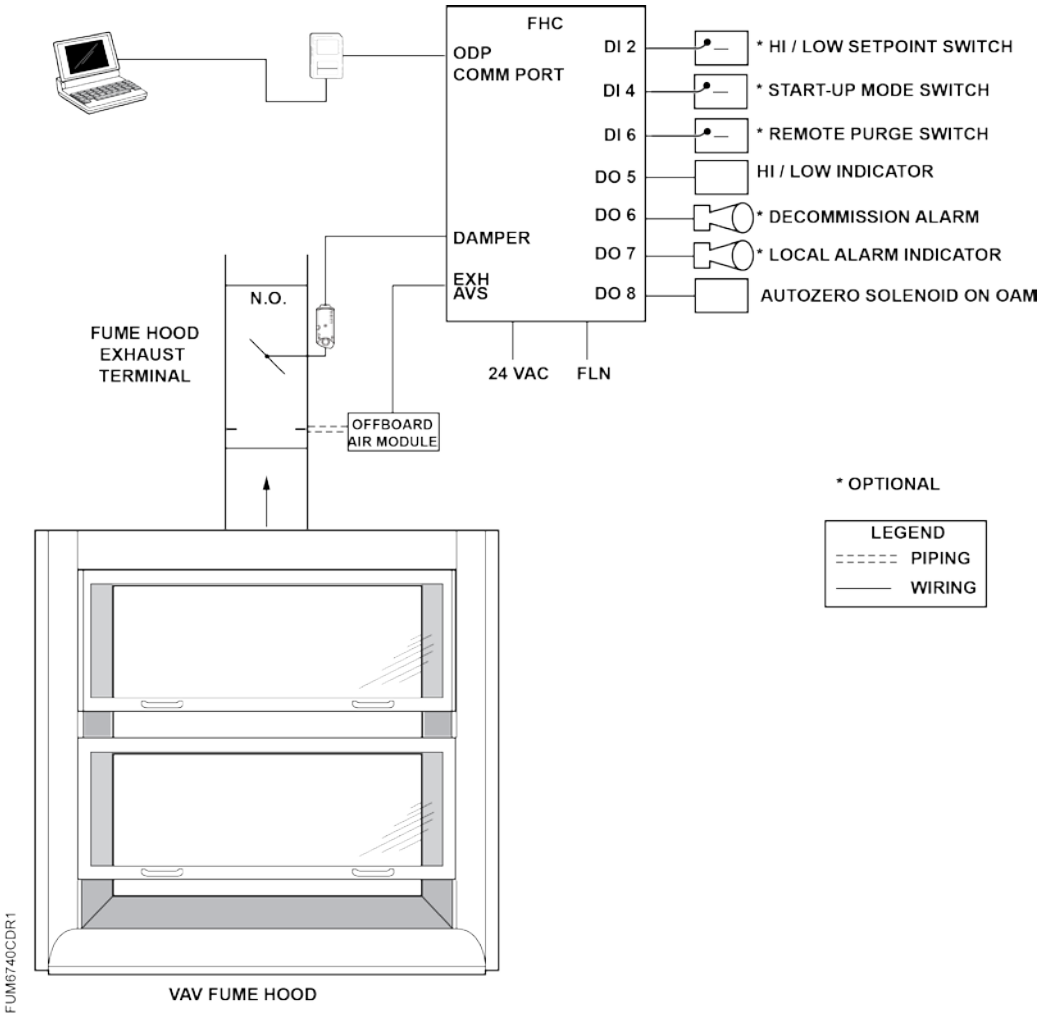
Overview

Application 6740 is designed for use with a constant volume or two position fume hood in a manifold fume hood exhaust system. In this application, two position fume hoods have an individual exhaust damper connected to a central fan. The application modulates the exhaust damper to maintain a high or low flow set point based on inputs from the ODP (Operators Display Panel), digital Input, an exhaust air flow sensor and the controller setpoints.



Application 6740 Control Diagram.

BACnet

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

Product	Supported BIBBs	BIBB Name
BTEC/PTEC	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-DCC-B	Device Management-Device Communication Control-B
	DM-RD-B	Device Management-Reinitialize Device-B
	DM-BR-B	Device Management-Backup and Restore-B
	DM-OCD-B	Device Management-Object Creation and Deletion-B
	CPT	Confirmed Private Transfer (Auto Discovery)
	UPT	Unconfirmed Private Transfer

Auto Discovery

Auto Discovery allows you to automatically discover and identify PTEC/ATEC controllers on the BACnet MS/TP Network. There are two basic configurations:

- Devices not configured with an address. (Devices are discovered by their unique serial number.)
- Devices configured with an address and available for modification.

Auto Addressing

Auto Addressing allows you to automatically assign device addresses to a PTEC/ATEC controller on the BACnet MS/TP Network. If a controller is not configured with a MAC address, you have the option to auto-address or manually address the controller. During this time the baud rate is automatically detected by the controller.

Controller(s) must be connected on the BACnet/IP network in order for automatic addressing to occur.

Hardware Inputs

Analog

- Air velocity sensor(s) – (2nd sensor available for field use)
- *(Optional)* Differential pressure transmitter/Linear Flow input (Vortex Shedder)

Digital

- Operator Display Panel (ODP)
- *(Optional)* High/Low select (through DI 2)
- *(Optional)* Startup Mode (through DI 4)
- *(Optional)* Remote Emergency Purge (through DI 6)

Hardware Outputs

Analog

- Operator Display Panel (ODP)
- AO2 (flow signal, 1 to 10 Vdc)

Digital

- Autozero Solenoid in Offboard Air Module (DO8)
- *(Optional)* Alarm (DO 7)
- *(Optional)* OFF Mode (DO 6)
- Exhaust damper (DO 1 and DO 2, Floating Control Actuation)
- Hi/Low Output indication (DO 5)

Ordering Notes

570-00701	2-Position Constant Volume Fume Hood Controller with Damper – Application 6740 Requires Offboard Air Module – order and ship separately
AQM2200	Power Module
550-819B	Offboard Air Module (OAM) – order and ship separately
575-820A	Operator Display Panel
AQM2200	Power Module

Sequence of Operation

The following paragraphs present the sequence of operation for Fume Hood Controller Application 6740, 2-Position Constant Volume Controller with Damper.

The Fume Hood Controller can operate at two different setpoints, described as HI flow and LOW flow setpoints. The controller can be set to an OFF mode. In this mode the damper is closed and the controller enters into a standby mode of operation.

The Operators Display Panel II (ODP II) can display HI/LOW setpoint or output exhaust flow in CFM. The Fume Hood Controller maintains the duct air flow at the flow setpoint, EXH STPT. This is accomplished as follows:

EXH STPT — The EXH STPT will be equal to EXH LO STPT or EXH HI STPT, both of which are set to field requirements. The LOW or HI set point is determined by the state of DI2 STPT SW (DI 2) and ODP STPT SW (left ODP switch). The priority sequence of operation is shown in the following table.

FLOW STPT Priority Schedule					
IF	**DI2 STPT SW**	**AND**	**ODP STPT SW**	**THEN**	**FLOW STPT**
	LO		LO		LO
	LO		HI		HI
	HI		LO		HI
	HI		HI		HI

DO5 HI/LOW Output Functionality — HI.LO DO5 is ON while the controller is in LOW flow operation and OFF when the controller is in HI flow operation.

DO7 Alarm Output Functionality —ALARM DO7 is turned ON when the ODP displays an alarm condition and OFF during normal operation.

Air Velocity Sensing

Primary sensing of the exhaust air flow is through the OAVS. Optionally, AI3 may be used to input a Differential pressure transmitter or a Linear Flow input signal.

AVS Calibration

Calibration of the air velocity transducer(s) is periodically required to maintain accurate air velocity readings. Depending on the value of CAL SETUP, calibration takes place either at fixed time intervals or whenever the application goes into unoccupied mode. When calibration is in progress, CAL AIR equals YES. After calibration, CAL AIR returns to NO.

The application uses Autozero Modules connected to AUTOZERO DO8. This means that the exhaust flow control device does not close during calibration of the transducers.

NOTE:
The FHC does not monitor Fume Hood flow changes for 3 seconds during AVS calibration.

AO2 Flow Signal

An analog signal of the exhaust flow is available at AO2 of the controller board and is displayed at EXH SIG AO2. To get an output from EXH SIG AO2, you must command AO2 RANGE to the maximum expected flow for the fume hood. Then AO2 is scaled such that 1 Vdc is equal to 0 cfm, and 10 Vdc is equal to AO2 RANGE. If the output drops below 1 Vdc, this indicates a GENERAL FAILURE or loss of power.

EXH SIG AO2 = (EXH VOL/AO2 RANGE x 9 volts) + 1 volt

AO2 V MIN allows the minimum AO2 output voltage to be modified.

NOTE:
If the AO2 V MIN is set to 0, failure detection is lost.

The value of AO2 is determined by the following conditions:

Operating Condition	AO2 FLOW SIG Value
Normal/warning condition inside the range of AO2 DEADBAND	EXH STPT
Normal/warning condition outside the range of AO2 DEADBAND	EXH VOL
Alarm and emergency condition	

AO2 DEADBAND defaults to 5.2%. If EXH STPT is 1000 cfm, AO2 FLOW SIG = EXH STPT if the actual flow is between 948 and 1052 cfm (these values are approximate and will vary based on duct area). If the actual flow is outside these values AO2 FLOW SIG = EXH VOL.

For stable pressure reading, lower the AO2 DEADBAND. For unstable pressure readings, raise the AO2 DEADBAND until the output signal stabilizes.

AO2 DEADBAND can be set from 0 to 102% in 0.4 % increments. 0% will give the actual flow all the time. This signal may be too unstable to give a stable output and will cause short-term room instability during fume hood sash movements. 5.2% removes most of the signal bounce, maintains tighter control of actual flow changes and maintains room stability during fume hood sash movements. A 10% deadband is equal to a ± 5% of the flow. Any value over 100% will turn the feature off and revert to standard control.

The average value of AVE EXH VOL is displayed at the ODP. The following two points help stabilize the displayed face velocity:

- DISPLAY WT assigns a weighted calculated value to the exhaust volume. If DISPLAY WT is set to 100%, the value of exhaust volume displayed at the ODP is the same as the value displayed at EXH VOL and may fluctuate rapidly. When DISPLAY WT is set to a value less than 100%, the displayed value updates less frequently.

NOTE:
If you set DISPLAY WT to zero, the ODP “freezes” at the last read value. Resetting DISPLAY WT to a value other than zero allows the Operator Display Panel to update the displayed value.

- DISPLAY RES is the COV limit for exhaust volume readings.

NOTE:
If you set DISPLAY RES to zero, the ODP continuously displays the value of EXH FLOW. Resetting DISPLAY RES to a value other than zero displays the EXH FLOW incrementally. The factory default is 5, cfm values displayed will be in increments of 5 (for example, 80, 85, 90, 95, 100, etc.). If the actual filtered cfm is 84, 85 will be displayed.

These two points affect the ODP display only; they do not affect the values in the controller or values sent to the network.

Control Loop

The PID loop controls the damper based on the values of EXH VOL and EXH STPT. The loop output, DMPR CMD, controls EXTN DO1 and RETC DO2 through a time modulation scheme. The DMPR CMD ranges of -100 to 100%.

- -100% is the maximum extend which closes the damper at full speed.
- 0% holds the damper at its current position.
- 100% is the maximum retract which opens the damper at full speed.

For example, if you command the point to -50, the damper will still close the drive but not as quickly as if it were commanded to -100.

The controller sends a separate signal to each of the two inputs that reside on the damper actuator. For values of 100% to 0%, the controller sends a decreasing percentage of the full signal length to the retract input. For values of 0% to -100%, the controller sends an increasing percentage of the full signal to the extend input.

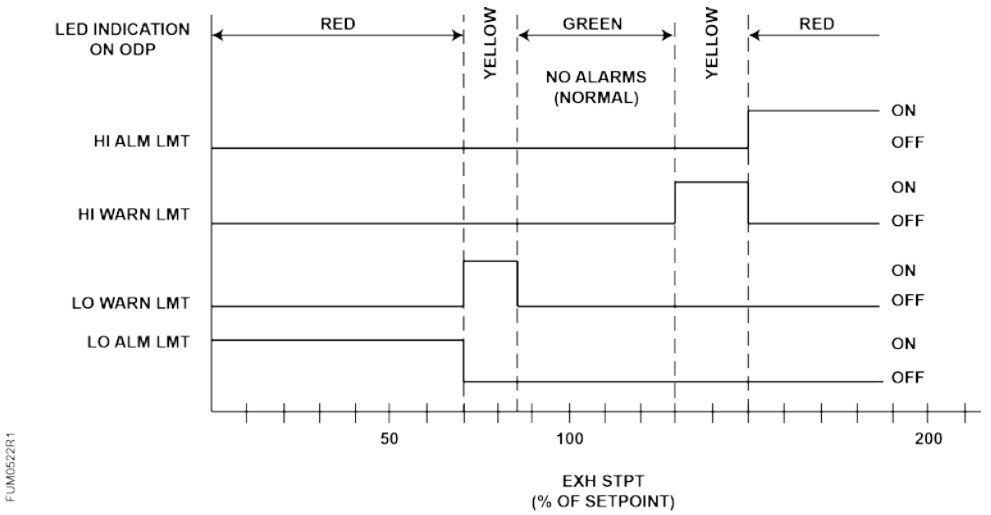
Warning Limits

The Fume Hood Controller contains high and low flow warning limits, HI WARN LMT and LOW WARN LMT, respectively.

The warning limits are defined as a percentage of the controller setpoint; therefore, the warning limits apply to EXH STPT during normal control.

For either of the warnings to become active, the warning condition must be maintained for the time specified in ALARM TIME.

When the actual flow is greater than HI WARN LMT or less than LOW WARN LMT for a time greater than ALARM TIME, the yellow LED illuminates and HIGH WARN or LOW WARN turns ON.



Warning and Alarm Schedule.

Alarm Limits

The Fume Hood Controller contains high and low flow alarm limits, HI ALM LMT and LOW ALM LMT, respectively.

The alarm limits are defined as a percentage of the controller setpoint; therefore, the alarm limits apply to EXH STPT during normal control.

For either of the alarms to become active, the alarm condition must be maintained for the time specified in ALARM TIME.

When the actual flow is greater than HI ALM LMT or less than LOW ALM LMT for a time greater than ALARM TIME, the red LED illuminates, HIGH ALM or LOW ALM turns ON, the audible alarm on the Operator Display Panel sounds, “High Alarm” or “Low Alarm” is displayed. See Figure *Warning and Alarm Schedule*.

Alarm Output

The digital output DO7 can be used for local indication of an alarm condition. The output will be turned ON if EMER ALM, GEN FAILURE, LOW ALM, or HI ALM are ON and the output will be OFF when they are all OFF.

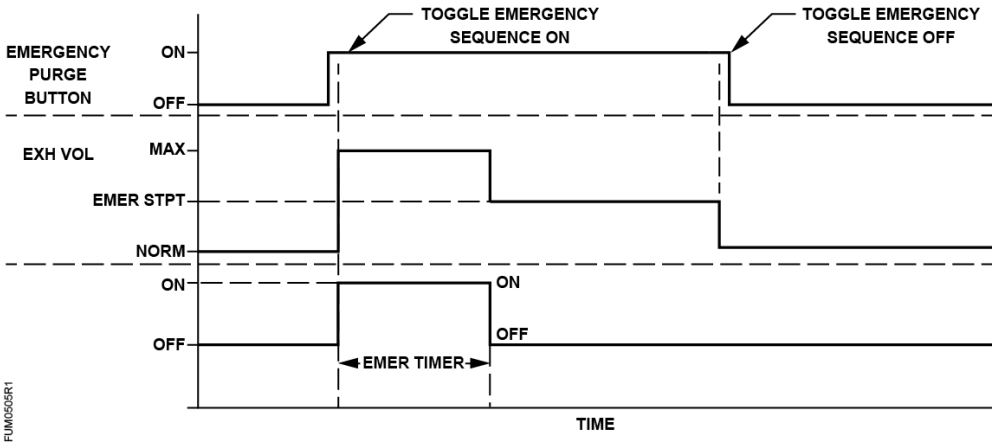
Horn Disable

When the alarm silence button is pressed, ALM AKNLG turns ON, the audible alarm turns OFF, and the red LED stays ON. The alarm descriptor remains until the flow returns to the normal range and ALM AKNLG turns OFF. Alarm limits always override any current warning limits.

Emergency Mode

The emergency mode operation overrides any other control mode in the Fume Hood Controller. When the Emergency Purge button on the ODP is pressed, the following sequence of events occurs.

1. EMER ALM turns ON at BACnet priority level 1, the horn sounds, and the red LED on the ODP illuminates. The ODP displays “EMERGENCY” mode and indicates to close the hood.
2. The Fume Hood Controller commands the damper/Venturi valve to fully open for the time (in seconds) specified in EMER TIMER.
3. After EMER TIMER has timed out, the Fume Hood Controller controls the flow at the flow setpoint, EXH STPT, multiplied by the emergency set point percentage, EMER STPT.
4. When the Emergency Purge button is pressed a second time, the Fume Hood Controller returns to normal operation for the current conditions.



Emergency Purge Schedule.

NOTE:
Norm = Normal operation in which control is at the EXH STPT.
EMER STPT = EXH STPT increased by the value (%) of EMER STPT.
MAX = Maximum flow, where the damper is controlled to fully opened.

Start-up/Decommission Mode

The Fume Hood Controller contains different modes controlled by STARTUP MODE (default is 3). These modes of operation allow the controller to be started up without the sound of nuisance alarms at the hood. These modes are useful at different stages of construction and after decommissioning.

The FHC also contains decommission modes and allow some or all of the functionality of the controller to be turned off.

The modes are described as an enumerated point:

STARTUP MODE	Mode	Description
0	Normal	The controller is fully functional.
2	Non-functional Decommission, closed	The controller is fully functional, except the flow setpoint is set to 0, alarming is limited and the ODP displays “Out of service” and “OFF”. If the sash is opened, nothing changes.
3 (default)	Non-functional Startup	The controller is fully functional, except alarming does not work and the ODP displays “Controller – Startup” and “OFF”.

The digital output DO6 can be used for local indication that the sash was opened after the hood entered Out of Service mode. The output will remain ON until STARTUP MODE is changed.

Fail Mode

If the Fume Hood Controller or one of its accessories fails, then a failure mode sequence is initiated.

Fume Hood Controller – If the Fume Hood Controller power fails, the exhaust damper goes to the fully opened position. Since there is no power to the controller, no LEDs or displays are available on the ODP. If the power fails to both the exhaust fan and the controller, there is no indication except for the absence of the noise that the air makes during normal operation.

Operator Display Panel – If the ODP fails, then the Fume Hood Controller continues to control the flow. However, displays and audible alarms are not available.

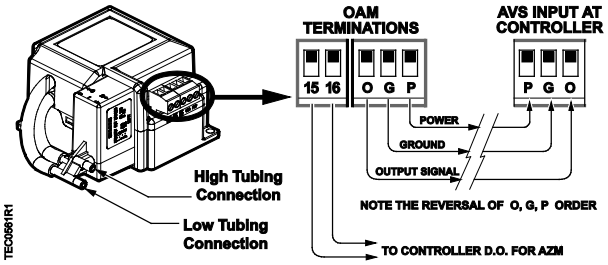
OAVS Sensor – If the OAVS sensor fails or is disconnected, then GEN FAILURE turns ON, AO2 goes to zero Vdc, and the Fume Hood Controller controls the exhaust damper to the condition described in AVS FAILMODE. This will be either fully open or holding the current position. The ODP displays the failure.

(Optional) Differential Pressure Transmitter – If A I3 is used and the differential pressure transmitter fails by losing the 4 to 20 mA signal, then GEN FAILURE turns ON, AO2 goes to 0 Vdc, and the Fume Hood Controller controls the exhaust damper to the condition described in AVS FAILMODE. This will be either fully open or holding the current position. The ODP displays the failure.

Electronic Actuator – If the actuator fails and flow control is lost, the ODP displays alarms indicating unsafe operating conditions.

Upon loss of power the actuator will fail based on the related DIP switch settings.

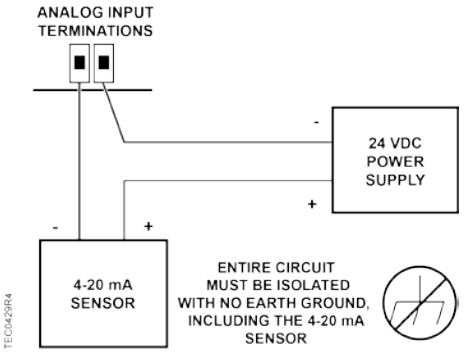
Wiring Diagram



Offboard Air Module Wiring.

	⚠ CAUTION
	The FHC-OAVS has two terminal blocks with terminations numbered identically (terminations 1 through 16). DO NOT mix these up with each other. If the FHC-OAVS is not connected as shown, it is not resistant to electrical surges. It is also susceptible to interference from other equipment.

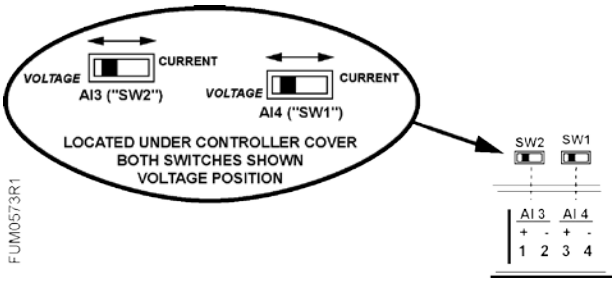
	⚠ CAUTION
	A separate power supply is required if a 4-20 mA sensor is used. Failure to follow wiring precautions will result in equipment damage.



Wiring for AI with a 4 to 20 mA Sensor.

	⚠ CAUTION
	Each 4-20 mA sensor requires a SEPARATE dedicated power limited 24 Vdc power supply. DO NOT use the same transformer to power both the sensor and the controller.

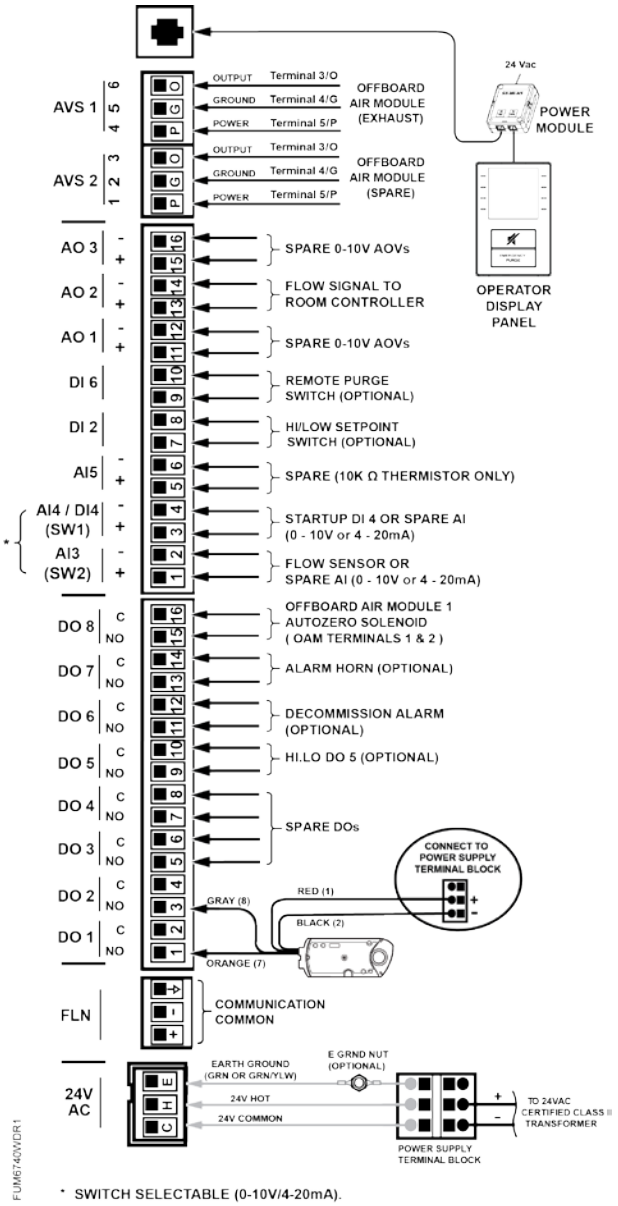
NOTE:
If the voltage/current switch is set to current and a 4 to 20 mA sensor is connected to an AI, then special wiring requirements must be followed.



NOTE:
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 6740 Wiring Diagram.

Point Database Application 6740

Object Type	Object Instance (Point Number) [a] [b]	Object Name (Descriptor)	Factory Default (SI Units) [c]	Eng Units (SI Units) [c]	Range	Active Text	Inactive Text
AO	1	CTLR ADDRESS	99	--	0-255	--	--
AO	2	APPLICATION	6700	--	0-32767	--	--
BO	{05}	LOW ALM	OFF	--	Binary	ON	OFF
BO	{06}	HIGH ALM	OFF	--	Binary	ON	OFF
BO	{07}	EMER ALM	OFF	--	Binary	ON	OFF
BO	{08}	GEN FAILURE	OFF	--	Binary	ON	OFF
AO	{10}	HI ALM LMT	150	PCT	0-255	--	--
AO	{11}	HI WARN LMT	135	PCT	0-255	--	--
AO	{12}	LOW WARN LMT	85	PCT	0-255	--	--
AO	{13}	LOW ALM LMT	70	PCT	0-255	--	--
AO	{14}	EMER TIMER	300	SEC	0-1023	--	--
AO	{15}	EMER STPT	150	PCT	0-255	--	--
BO	{16}	LOW WARN	OFF	--	Binary	ON	OFF
BO	{17}	HIGH WARN	OFF	--	Binary	ON	OFF
AO	{18}	ALARM TIME	5	SEC	0-255	--	--
BO	{19}	ALM AKNLG	OFF	--	Binary	ON	OFF
BO	{20}	OCC.UNOCC	OCC	--	Binary	UNOCC	OCC
AO	{21}	STARTUP MODE	3	--	0-255	--	--
BO	{22}	ODP STPT SW	HI	--	Binary	LO	HI
BO	{23}	RIGHT SWITCH	OFF	--	Binary	ON	OFF
AI	{31}	EXH VOL	0 (0.0)	CFM (LPS)	0-32764	--	--
AO	{32}	FLOW COEF	0.73	--	0-2.55	--	--
AO	{33}	DUCT AREA	0.55 (0.051106)	SQ. FT (SQ M)	0-6.375	--	--
AO	{34}	TRANS RANGE	0.0 (0.0)	IN H2O (K PA)	0-3.2767	--	--
AO	{35}	LINEAR FL RG	0 (0.0)	CFM (LPS)	0-32764	--	--
AI	{36}	AVS2 PRESS	0.0 (0.0)	IN H2O (K PA)	0-3.2767	--	--
BI	{37}	DI2 STPT SW	HI	--	Binary	LO	HI
BI	{38}	DI 6	OFF	--	Binary	ON	OFF
AO	{39}	AO 1	0	VOLTS	0-10.23	--	--
AO	{40}	AO 3	0	VOLTS	0-10.23	--	--
BO	{41}	EXTN DO1	HOLD	--	Binary	EXTN	HOLD

Object Type	Object Instance (Point Number) [a] [b]	Object Name (Descriptor)	Factory Default (SI Units) [c]	Eng Units (SI Units) [c]	Range	Active Text	Inactive Text
BO	{42}	RETC DO2	RETC	--	Binary	HOLD	RETC
BO	{43}	DO 3	OFF	--	Binary	ON	OFF
BO	{44}	DO 4	OFF	--	Binary	ON	OFF
BO	{45}	HI.LOW DO5	HI	--	Binary	LO	HI
BO	{46}	DECOM DO6	OFF	--	Binary	ON	OFF
BO	{47}	ALARM DO7	OFF	--	Binary	ON	OFF
BO	{48}	AUTOZERO DO8	OFF	--	Binary	ON	OFF
AI	{49}	AI 3	0	VOLTS	0-10.23	--	--
AI	{50}	AI 4	0	VOLTS	0-32.767	--	--
AI	{51}	AI 5	0	KOHM	0-327.67	--	--
BO	{56}	DI 4	OFF	--	Binary	ON	OFF
AO	{58}	DMPR CMD	-100	PCT	-100-155	--	--
BO	{59}	INVERT DO2	YES	--	Binary	YES	NO
BO	{60}	AVS FAILMODE	OPEN	--	Binary	OPEN	HOLD
AO	{61}	EXH P GAIN	0.04	--	0-4.095	--	--
AO	{62}	EXH I GAIN	0	--	0-4.095	--	--
AO	{63}	EXH D GAIN	0	--	0-4.095	--	--
BO	{78}	STARTUP DI4	NO	--	Binary	YES	NO
AO	{80}	EXH HI STPT	3500 (1651.65)	CFM (LPS)	0-16380	--	--
AO	{81}	EXH LO STPT	192 (90.6048)	CFM (LPS)	0-16380	--	--
AO	{82}	EXH STPT	0 (0.0)	CFM (LPS)	0-16380	--	--
AO	{89}	EXH SIG AO2	0	VOLTS	0-10.23	--	--
AO	{90}	AO2 RANGE	0 (0.0)	CFM (LPS)	0-16380	--	--
AO	{91}	AO2 DEADBAND	5.2	PCT	0-102	--	--
AO	{92}	AO2 V MIN	1	VOLTS	0-10.23	--	--
BO	{94}	CAL AIR	NO	--	Binary	YES	NO
AO	{95}	CAL SETUP	4	--	0-255	--	--
AO	{96}	CAL TIMER	12	HRS	0-255	--	--
AI	{97}	AVS1 PRESS	0.0 (0.0)	IN H2O (K PA)	0-3.2767	--	--
AO	{98}	LOOP TIME	0.1	SEC	0-25.5	--	--
AO	{99}	ERROR STATUS	0	--	0-255	--	--
AO	{106}	DISPLAY WT	100	PCT	0-102	--	--
AO	{107}	DISPLAY RES	20 (9.438)	CFM (LPS)	0-16380	--	--
BO	{108}	BLANK DSPLY	OFF	--	Binary	ON	OFF
BO	{109}	LAMP TEST	OFF	--	Binary	ON	OFF

Object Type	Object Instance (Point Number) [a] [b]	Object Name (Descriptor)	Factory Default (SI Units) [c]	Eng Units (SI Units) [c]	Range	Active Text	Inactive Text
BO	{110}	ENG UNITS	ENG	--	Binary	SI	ENG
AO	{121}	HI LIMIT	1	--	0-2.55	--	--
AO	{122}	LO LIMIT	1	--	0-2.55	--	--
BO	{123}	EMER DI6	OFF	--	Binary	ON	OFF
BO	{125}	ODP DISPLAY	MODE	--	Binary	CFM	MODE
AO	{126}	AVE EXH VOL	0 (0.0)	CFM (LPS)	0-16380	--	--
BO	{127}	PPCL STATE	EMPTY	--	Binary	LOADED	EMPTY

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

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

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

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