Overview

The Air Valve Interface (AVI) connects long-running jack-screw style Variable Air Volume (VAV) floating point actuators with mechanical end switches to DDC controllers. The unit has two input signal modes;

PULSE

The DDC controller's 24 VAC actuator drive power pulses are timed, the timing is multiplied by the AVI's Gain Filter potentiometer setting and appropriately long 24 VAC power pulses are sent from the AVI to the air valve actuator.

ANALOG

A 0 to 10 VDC proportional control voltage is turned into 24 VAC power pulses to position the actuator accordingly, fully closed (0 VDC) to fully open(10 VDC). The Gain Filter potentiometer sets a hysteresis dead band for the input voltage to prevent hunting.

Additionally, the AVI provides;

- Self resetting 3-Ampere fuse

- Fused 24 VAC output to power auxiliary equipment (VAV Box Controller).

- Terminals to make wiring reheat control relays or actuators easier.

- 0 to 10 VDC proportional output that indicates damper position.

- Manual air valve actuator stroke time training switch used to calibrate the damper position proportional output voltage.

- Duty cycle protection to prevent actuator motor failure.
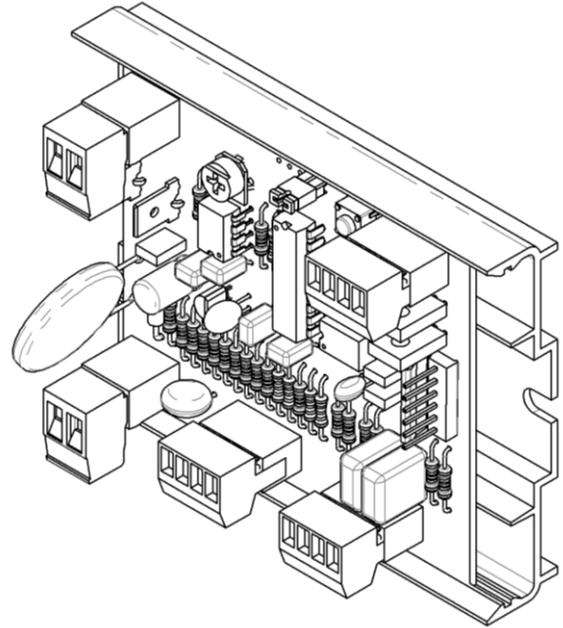
Figure 1: AVI in 2.75 inch Snap Track

Specifications

ELECTRICAL		MIN	TYP	MAX
Input Voltage	(J3, S1, J7)	18.0VAC	24VAC	32VAC **Note:** AC voltage ONLY
Input Voltage	(J5-IN 0-10V)	0VDC	-	10VDC
Output Voltage	(J4, J5-24)	Input voltage fused at 3 Amps		
Output Voltage	(J7 OUT DMPPOS)	0VDC	-	10VDC
Output Current	(J7 OUT DMPPOS)	0VDC	-	±10mA (short circuit limited)
Current Draw		Dependent on load – Maximum current 3A @ 24VAC		
Triac Current	(J1-open, J1-close)	250mA	350mA	500mA
Power		Dependent on loads – Maximum 96VA		

ENVIRONMENTAL	MIN	MAX	UNITs
Temperature -operating	-20	70	Degrees C
Temperature –storage	-40	85	Degrees C
Humidity	0	95%	Relative Humidity, Non-condensing
Pressure	NA	NA	
Altitude	NA	NA	

MECHANICAL

Screw Terminals	J3, J4, J5, J6, J7 28-16 AWG / 0.5-1.5mm	
Enclosure	None	
Mounting	2.75" or 3.25" Snaptrack – not included	
PCB	FR4 94V0 2.75" x 3.25" x 1.25"	

AGENCIES

Lead Free RoHs

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Terminations

Note: Notch on pot indicates position; see Technician Setup Options for details
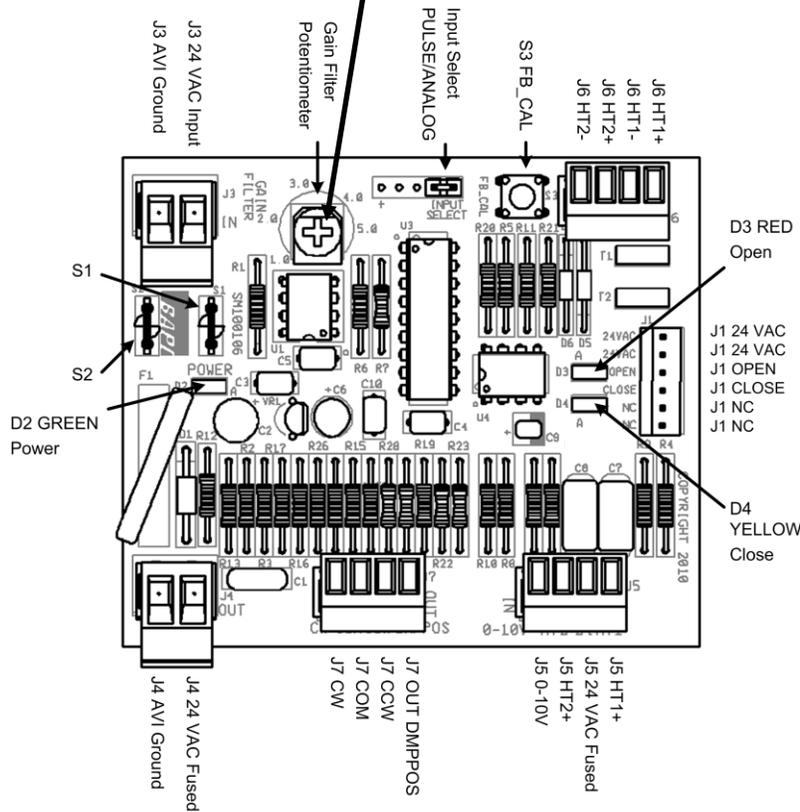
Figure 2: Front view AVI

Connector	Function
J1	Floating point actuator drive, open and close along with 24VAC. Triac sinks current to AVI Ground through OPEN and CLOSE. Connector type Tyco 640456-6 or compatible. See PCB labeling for detailed pin-out
J3	'+' 24 VAC Input, National Electrical Code Class 2, 100 VA Maximum '-' AVI Ground
J4	AC output (hot) voltage, fused to 3A with a resettable fuse
J5	'HT1' is common with J6-'HT1+' (1st stage reheat) Connect to controller '24' is common with J4- 24VAC (i.e. fused) Connect to controller power 'HT2' is common with J6- 'HT2+' (2nd stage reheat) Connect to controller '0-10V' is the analog input voltage terminal when used in the ANALOG mode. N/C in the Pulse mode
J6	'HT1+' is common with J5 'HT1' Connect to stage 1 heat relay (+24 VAC) or "Close" on floating point reheat water valve actuator 'HT1-' is common with 'J3-' (AVI Ground) Connect to stage 1 heat relay or "Common" on floating point reheat water valve actuator 'HT2+' is common with J5 'HT2' Connect to stage 2 heat relay (+24 VAC) or "Open" on floating point reheat water valve actuator 'HT2-' is common with 'J3-' (AVI Ground) Connect to stage 2 heat relay
J7	'OUT DMPPOS' - Damper position, 0 to 10 Volts – Connect to damper position input on controller 'CCW' - Counter-Clockwise pulse input from DDC controller – see electrical specifications for voltage limits 'COM' - common with 'J3-' (AVI Ground) Connect to "Common" terminal on controller, reference ground for the DMPPOS signal 'CW' - Clockwise pulse input from DDC controller – see electrical specifications for voltage limits
S1 and S2	S1 – common with 'J3+' (24VAC not fused) ¼ inch quick connect [Alternate 24 VAC input] S2 – common with 'J3-' (AVI Ground) ¼ inch quick connect [Alternate 24 VAC input]

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Functional Behavior

Pulse Input Option – The DDC controller has standard floating-point tri-state outputs to command the position of the air valve actuator. The controller's CW terminal is connected to the AVI's J7-CW terminal and the controller's CCW terminal is connected to the AVI's J7-CCW terminal. The AVI times the CW and CCW pulses from the controller. The duration of the AVI's output pulses to the air vale actuator are multiplied by the GAIN FILTER setting. For a gain setting of 1, the AVI output pulse to the air valve would be as long as the controller's input pulse. A gain of 5 would drive the AVI's output pulse 5 times as long as the input pulse. The AVI's drive pulses to the air valve actuator are connected through J1.

A gain setting of 1 is useful for VAV controllers which ignore pulse timing and use the AVI's DMPPOS 0-10 VDC analog output to determine damper position. Gain settings greater than 1 are used with controllers which calculate the damper position based on the total stroke time and accumulated drive pulse times. Divide the air valve's end-to-end stroke time by the controller's end-to-end pulse time to determine the gain setting.

A change in input direction will immediately reset any remaining travel due to gain. For instance a 10-second pulse on J7-CW with gain set to 3 would drive the J1-CLOSE output for 30-seconds. If the J7-CCW input becomes active after 20-seconds of operation, the CLOSE output will stop, an off period of is observed for both J1-OPEN & J1-CLOSED and the J1-OPEN output becomes active. The damper will end up in the correct position.

The AVI's output drive is stopped when either of the air valve actuator's fully mechanical open or fully mechanically closed limit switches are reached. If a limit switch is reached while drive pulses in that direction continue, a runtime error occurs and the LEDs perform as noted. The AVI's DMPPOS output is also reset to either the full closed or full open position (0 or 10 volts). Drive current is monitored to determine a limit switch opening.

When there is any change in direction, minimum off periods of 30 line cycles (0.5 seconds) are observed for both J1-OPEN and J1-CLOSED. The AVI software accounts for these minimum off periods so that the damper will end up in the correct position.

The AVI's DMPPOS output (0 to 10V) is scaled through the use of the FB_CAL cycle's close stroke time. The 0 to 10 volts corresponds to damper position full closed to full open. J7-COM is the reference ground for the DMPPOS signal.

Automatic damper position calibrations are performed after the AVI has been powered up for a month and then approximately monthly thereafter. When the AVI calculates the damper position to be within 10% of either minimum or maximum stroke position, the AVI will drive to the limit switch and then return to where it was. **Note:** DMPPOS will remain fixed during calibration so the controller won't try to correct for the movement. Any input received by the AVI will be accounted for when calibration is complete.

A random number generator is used to determine the monthly calibration cycle start to prevent multiple dampers from calibrating at the same time.

Analog Input Option – The DDC controller has a standard proportion analog output of 0 to 10 VDC to command the position of the air valve actuator. The AVI converts the proportional voltage to timed pulse floating-point tri-state outputs to drive the VAV actuator position.

The analog voltage applied to J5-IN 0-10V terminal scales directly to the damper position (**Note:** Signal ground is J7-COM). The pulse outputs, CLOSE and OPEN, are energized to position the damper to the desired position. In ANALOG Mode, the GAIN FILTER is a pseudo hysteresis value, a percentage (1 to 5%) of the 10 volt span. The hysteresis value protects the motor from overheating due to continuous minor movements caused by controller hunting. The AVI will not drive the actuator until the position commanded by the controller is greater than the hysteresis percent from the current position. If the damper is at 50% open and the gain setting is "2" then the damper will not move until the commanded position is <48% or >52%. The damper will end up in the correct position.

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LED Function

Normal Operation	Error Operation
D2 (Green) lights when power is applied D3 (Red) lights when the open output is active D4 (Yellow) lights when the close output is active	*D3 fast flash* – Calibration cycle error, the AVI drives the open till a time out occurs (12 minutes). The AVI assumes the limit switch has failed and continues on with the calibration cycle by starting a close event. LED flashes until the power is removed. (~2Hz)

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Air Valve Interface
Installation and Operation Instructions

Functional Behavior Continued

D4 fast flash – calibration cycle error, a time out occurs during a close cycle. The AVI assumes that the close limit switch is bad and does not update the calibration time. Fast flash the CLOSE (D4) LED untill power down, no new calibration time is saved. (~2Hz)

D3 and D4 flash – Runtime error, both controller pulse inputs are active at the same time which shouldn't be possible under normal circumstances. Action is to flash both LEDs while error persists and no output sent to the damper. (~1Hz)

D4 slow flash – Runtime error, the closed limit switch or time limit has been reached, DMPPOS = 0VDC and the pulse input J7-CW is still active. Action is to Slow Flash the CLOSE LED until J7-CW is de-energized and J7-CCW is energized. (~1Hz)

D3 slow flash – Runtime error, the limit switch or time limit has been reached. DMPPOS =10VDC and the pulse input J7-CCW is still active. Action is to Slow Flash the OPEN LED until J7-CCW is de-energized and J7-CW is energized. (~1Hz)

Technician Setup Options

Hardware select (INPUT SELECT) – Placing jumpers as shown in Figures 3 and 4 will change the AVI from Pulse Mode input to Analog Mode input.

FB_cal switch (S3) – Calibrates the air valve damper stroke time. This procedure may take up to 15 minutes.

1. Attach air valve actuator wires to connector J1
2. Disconnect connector J7
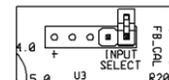3. Apply power
4. Press and release FB_cal switch S3
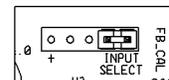

Figure 3: Pulse Mode

Figure 4: Analog Mode

After the FB_cal button is pressed, the AVI will first open the damper until the OPEN limit switch is detected. The AVI will then drive the damper closed until the CLOSED limit switch is detected. The time difference between the OPEN and CLOSED limit switch detection is stored as the stroke time calibration. Finally, the damper returns to its original position.

Gain Filter POT (R24) – In the Pulse mode of operation the Gain Filter POT R24 multiplies the input pulses by the integer setting. In theory, a 1 second CW input with a gain of 3 will make the AVI drive the CLOSED output for 3 seconds. In the Analog mode the Gain Filter POT R24 becomes a hysteresis setting. The hysteresis is defined in terms of an integer percentage of the voltage input (or output). A POT setting of 5 would yield a 5% dead zone around the present position. (±0.5 volts) The potentiometer has a notch on it to indicate its position. In Figure 2, the potentiometer is pointing to approximately 3.25.

Diagnostics

Possible Problems	Possible Solutions
Power LED D2 not lit	• Be sure that the AVI is connected to a source of 24 VAC • Check polarity, be sure that the 24 VAC wire is not grounded • Disconnect connector J4, if D2 lights then there is a problem with the equipment connected to J4 • Disconnect connector J1, if D2 lights then there is a problem with the air valve actuator or the AVI
Air Valve does not move	• Check wiring on header plugged into connector J1, BLUE wire is not ground and should be connected to 24 VAC, BLACK wire should be connected to OPEN and RED wire should be connected to CLOSE • Check Input Select jumper for proper position • Check input wiring on connector J7 or connector J5 • Disconnect DDC controller and check its outputs for proper signals • Apply 24 VAC across air valve actuator to see if it moves • Remove the connector on J1 and check the motor for the correct resistance, approximately 40Ω from BLUE to BLACK and BLUE to RED, approximately 80Ω from BLACK to RED. **Note:** There is a capacitor in the circuit that may cause initial wild swings of the resistance measurement. Be sure to hold the test leads on the wires for a minimum of 10 seconds.
Air valve moves, but not in the correct position	• Check the value of the Gain Filter potentiometer, perform the FB_cal switch procedure in the Technician Setup Options section • Verify J1 is terminated with BLUE on 24 VAC, BLACK on OPEN and RED on CLOSE
Incorrect Voltage on DMPPOS	• Perform the FB_cal switch procedure in the Technician Setup Options section
Input pulse from controller is steady, BUT AVI output is 1 second ON 3 seconds OFF	• Typically happens just after calibration, the AVI has determined that the motor has reached its 15 minute run limit. The AVI output is limiting the motor drive to 1 second ON and 3 seconds OFF to avoid overheating the motor. This action will reset automatically when the damper reaches its correct position.

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