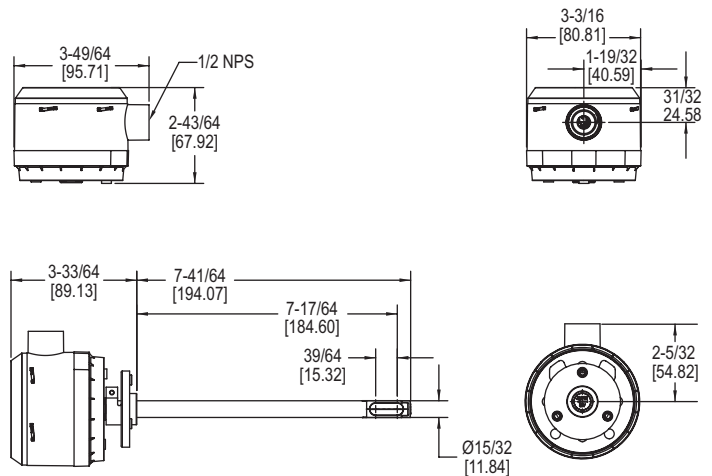# Series AVLV Low Air Velocity Transmitter with Modbus® Communication

Specifications - Installation and Operating Instructions

The **Series AVLV Low Air Velocity Transmitter** quickly and accurately measures air velocity or volumetric flow in imperial or metric units. Simultaneous current and voltage outputs on all models provide universal inputs to monitoring equipment while the output range, units, and 0-5/10 VDC output can be configured via local DIP switches. The optional integral display, or the portable remote display tool, provide a convenient way to locally monitor process values and configure the unit.

Models are available in 1% and 2% accuracy models and low velocity ranges to suit a variety of needs, and the optional BACnet MS/TP or Modbus® RTU/ASCII communication protocol allows units to be daisy-chained while providing access to all of the velocity and flow data, as well as additional information such as air temperature. The lower ranges in these high accuracy units allow for applications in quality intensive environments, such as the pharmaceutical industry.

MODEL CHART

Model	AVLV	-3	D	A1	-LCD	AVLV-3DA1-LCD
Accuracy		5				±(0.2 m/s + 5% of reading) @ standard conditions
		3				±(0.2 m/s + 3% of reading) @ standard conditions
Mounting			D			Duct mount
Output				A1		Analog universal (0-5 VDC, 0 to 10 VDC, 4-20 mA)
				B1		Analog + BACnet MS/TP
				M1		Analog + Modbus® RTU/ASCII
Options					LCD	LCD display
					FC	Factory calibration certificate
					NIST	NIST certificate
					GLD	Electrical cable gland

ACCURACY CHART

Velocity Range	Accuracy Rating*
20 to 100 FPM (0.15 to 0.5 m/s)	± (2% of reading + 0.04 m/s [7.9 FPM])
	± (1% of reading + 0.04 m/s [7.9 FPM])
20 to 200 FPM (0.15 to 1.0 m/s)	± (2% of reading + 0.04 m/s [7.9 FPM])
	± (1% of reading + 0.04 m/s [7.9 FPM])
20 to 300 FPM (0.15 to 1.5 m/s)	± (2% of reading + 0.05 m/s [9.8 FPM])
	± (1% of reading + 0.05 m/s [9.8 FPM])
20 to 400 FPM (0.15 to 2.0 m/s)	± (2% of reading + 0.06 m/s [11.8 FPM])
	± (1% of reading + 0.06 m/s [11.8 FPM])
*Accuracy dependent on model selected when ordering.	

SPECIFICATIONS

Service: Clean air and non-combustible, compatible gases.
Wetted Materials: Consult factory.
Range: 100, 200, 300, 400 FPM (0.5, 1, 1.5, 2.0 m/s; field selectable.
Accuracy: See chart.
Temperature Limits: 32 to 122°F (0 to 50°C).
Power Requirements: 24 VDC ±20% or 24 VAC ±20%.
Humidity Limits: 5 to 95% RH, non-condensing.
Output Signals: 4-20 mA, 0-5 VDC, 0-10 VDC.
Response Time (90%): 4 s, typical; 1 s at constant temperature.
Zero & Span Adjustments: Digital push buttons.
Output Load Resistance: Current output: 0 to 1100 Ω max.; Voltage output: Minimum load resistance 1 kΩ.
Current Consumption: 60 mA max.
Display: 5 digit LCD (optional).
Electrical Connections: Analog: Power and output: four wire removable European style terminal block for 16 to 26 AWG; Communication: Connections: BACnet MS/TP or Modbus® RTU/ASCII: three wire removable European style terminal block for 16 to 26 AWG.
Supported Communication Baud Rates: 9600, 19200, 38400, 57600, 76800, 115200 (optional).
Device Load: 1/8 unit load.
Electrical Entry: 1/2″ NPS thread; Accessory: Cable gland for 5 to 10 mm diameter cable, A-151.
Enclosure Rating: NEMA 4X (IP66).
Mounting Orientation: Flow direction must be parallel to the sensor tip.
Weight: 6.0 oz (160 g).
Agency Approval: BTL, CE.

Do not dispose of as unsorted domestic or municipal waste. Consult retailer or local authorities for recycling information.

Modbus® is a registered trademark of Schneider Automation, Inc.

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INSTALLATION

Duct Mount:

The transmitter should be mounted away from fans, corners, heating and cooling coils, and other equipment that will effect the measurement of the air velocity. It is recommended that the AVLV is mounted 10 duct diameters downstream of any disturbances and 5 duct diameters upstream of any disturbances, if possible.
1. Mark and drill a 0.750-0.938˝ (20-24 mm) diameter hole into the duct.
2. Insert and center the duct mount flange in the previously drilled hole and mark location of the three mounting screw holes.
3. Remove the mounting flange and drill or punch the mounting holes in the marked locations.
4. Fasten the flange to the duct using three #8 x 1/2 pan head sheet metal screws. Do not over tighten screws.
5. Insert the AVLV probe into the ducts mount flange and set the desired insertion depth.
6. Note the flow direction and unit alignment as shown on sensor tip and product label, tighten probe retention set screw on the duct mount flange screw to affix the probe in place.

Electrical Connection:

The Series AVLV is powered and simultaneously transmits a two-wire 4-20 mA current output and a three-wire 0-5 VDC or 0-10 VDC voltage output via a removable four conductor terminal block. The transmitter power supply common is used to reference the current and voltage outputs so either current, voltage, or current and voltage may be wired according to the application. The range of the voltage output can be selected using the on board DIP switches as described in the Analog DIP Switch Settings section of this manual.

Power Supply

Choose a power supply with a voltage and current rating sufficient to meet the power specifications under all operating conditions. If the power supply is unregulated, make sure the output voltage remains within the required voltage range under all power line conditions. Ripple on the supply should not exceed 100 mV.

CAUTION DO NOT EXCEED SPECIFIED SUPPLY VOLTAGE RATINGS. PERMANENT DAMAGE NOT COVERED BY WARRANTY WILL RESULT.

Current Output Operation

CAUTION DO NOT EXCEED SPECIFIED SUPPLY VOLTAGE RATINGS. PERMANENT DAMAGE NOT COVERED BY WARRANTY WILL RESULT.

The terminal block is removable, and each of the terminals are labeled underneath the terminal block on the circuit board. As the power supply and outputs share the same common signal (GND), the outputs may have separate wires but must effectively join at terminal 2 of the transmitter, as shown in Figure 1. The connections to the transmitter are made to terminals 1, 2, and 3 (PWR, GND, and IOUT respectively) on the terminal block as shown in Figure 4.
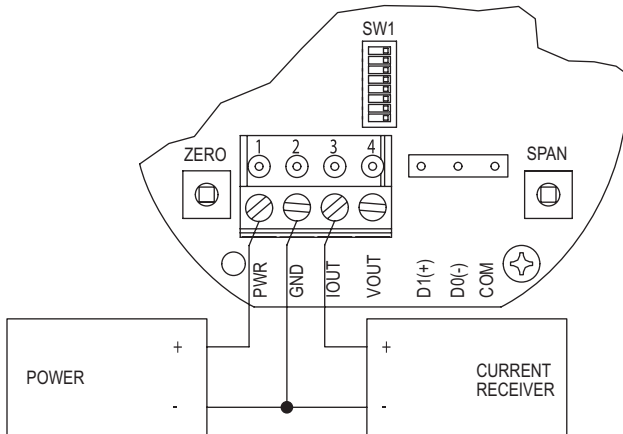

Figure 1: Current output wiring

Although low loop resistances are recommended, the absolute maximum current loop load resistance, R_{MAX}, is defined by the following the equation:

$R_{MAX} = (V_{PS} – 2.0) / 0.02$ where V_{PS} is the power supply voltage

For a 24 VDC nominal power supply, this evaluates to R_{MAX} = 1100 ohms.

Shielded two wire cable is recommended for current output loop wiring. Ground the shield at the power supply end only.

The maximum length of connecting wire between the current transmitter and the receiver is a function of wire size and receiver resistance. That portion of the total current loop resistance represented by the resistance of the connecting wires themselves should not exceed 10% of the receiver resistance. For extremely long runs (over 1,000 ft.), it is desirable to select receivers with higher resistances in order to keep the size and cost of the connecting leads as low as possible. In installations where the connecting run is no more than 100 ft, connecting lead wire as small as No. 22 Ga. can be used.

Voltage Output Operation

CAUTION DO NOT EXCEED SPECIFIED SUPPLY VOLTAGE RATINGS. PERMANENT DAMAGE NOT COVERED BY WARRANTY WILL RESULT.

The terminal block is removable, and each of the terminals are labeled underneath the terminal block on the circuit board. The voltage output and the power supply must have separate wire leads that are only joined at terminal 2 of the transmitter, as shown in Figure 2. Additional error may occur for the voltage output if a single wire is used or if the wires are joined at the power supply or receiver. The connections to the transmitter are made to terminals 1, 2, and 4 (PWR, GND, and VOUT respectively) on the terminal block as shown in Figure 4.
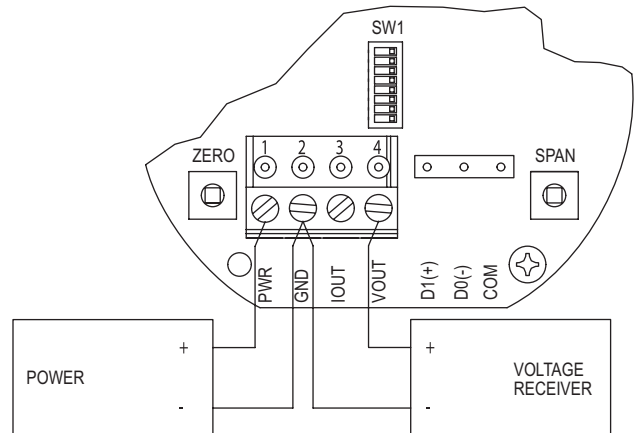

Figure 2: Voltage output wiring

The minimum receiver load is 1 kΩ. The resistance due to the wire should be low compared to the receiver load resistance. While the voltage at the terminal block remains unchanged with a 10 mA current flow, resistive losses in the wiring do cause errors in the voltage delivered to the receiver. For a 1% accurate gauge, the resistance of the wires should be less than 0.1% of the value of the receiver load resistance. This will keep the error caused by the current flow below 0.1%.

The output across VOUT and COM will be either 0-5 VDC, 0-10 VDC, or the inverse depending on the DIP switch setting. See the Analog DIP Switch Settings section for more information.

Simultaneous Current and Voltage Output Operation

The terminal block is removable, and each of the terminals are labeled underneath the terminal block on the circuit board. The voltage output and the power supply must have separate wire leads that are only joined at terminal 2 of the transmitter, as shown in Figure 3. Additional error may occur for the voltage output if a single wire is used or if the wires are joined at the power supply or receiver. The connections to the transmitter are made to terminals 1, 2, 3 and 4 (PWR, GND, IOUT, and VOUT respectively) on the terminal block as shown in Figure 4, which reflects both the 4-20 mA and 0-5/10 VDC outputs in the same circuit. Details of each output are detailed in their electrical connection sections.
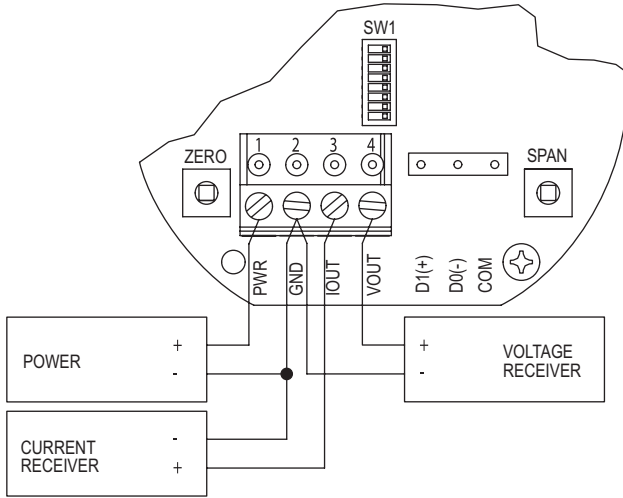

Figure 3: Simultaneous current and voltage output wiring

ANALOG DIP SWITCH SETTINGS

The analog output DIP switches (SW1) are located above the terminal blocks on the left are as shown in Figure 4. A small screw driver or pen can be used to change the position of the switches as required.
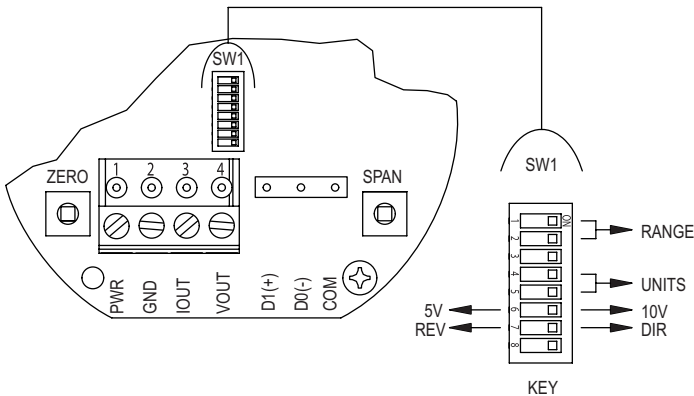
Figure 4: Analog dip switches

Factory Default Settings (DIP SW1 – All Switches ON)
Range = Highest Range Setting (400 FPM)
Units = Imperial (FPM)
Voltage Output Range = 0-10 VDC
Direct / Reverse Output Action = Direct

Setting the Air Velocity Range

The range of the instrument is selected by using DIP switches 1 and 2 on SW1. Table 1 shows the maximum full scale value for the selected range and unit. Refer to Setting the Engineering Units section for information on setting the unit.

DIP Switch SW1		Full Scale Range	
1	2	Imperial (FPM)	Metric (m/s)
ON	ON	400	2
ON	OFF	300	1.5
OFF	ON	200	1
OFF	OFF	100	0.5

Table 1: DIP switch SW1 settings for full scale range

Setting the Engineering Units

The Series AVLV can be configured to indicate velocity in imperial (FPM, CFM) or metric (m/s, m³/h) units using DIP switches 4 and 5 on SW1, and Table 2 shows the values. The units will be displayed on the optional LCD display if connected.

DIP Switch SW1		Units	
4	5	Velocity Mode	Air Flow Mode
ON	ON	FPM	CFM
ON	OFF	m/s	m³/h
OFF	ON	m/s	m³/h
OFF	OFF	m/s	m³/h

Table 2: DIP switch SW1 settings for units

The default operating mode is velocity, but changes can be made, such as flow mode, via the menu system while an optional display or remote display accessory is connected. Please refer to Appendix VI for a full menu flow chart.

Setting the Output Voltage Range

Voltage Output can be either 0-5 VDC or 0-10 VDC depending on the position of DIP Switch 6 ON SW1.

• When the switch is in the ON position, the output will be 0-10 VDC.
• When the switch is in the OFF position, the output will be 0-5 VDC.

Setting the Input / Output Action

The output will either follow the process directly (DIRECT) or inverted (REVERSED) based on the position of DIP Switch 7 on SW1.

• When the switch is in the ON position, the output directly follows the input (i.e. output increases as the input increases).
• When the switch is in the OFF position, the output acts in reverse of the input (i.e. output decreases as the input increases).

CALIBRATION

NOTICE There is a 5 second delay from the time the zero or span calibration buttons are released until the time that the change in calibration takes place. This delay is used to reduce vibration or disturbances of the user related to the button presses.

NOTICE The security level that is set in the Programming Menu section of the manual will determine which calibrations, if any, may be adjusted by the user.

Zero Calibration
The zero calibration can be set by covering the sensor to ensure no air flow and pressing the zero button for 3 seconds. If either the remote or local LCD is present, the display will read *ZERO* and then sequence back to the home display.

SPAN Calibration
The span calibration can be adjusted only after setting the zero adjustment. It must be completed within 5 minutes of the last zero calibration. The span calibration button will be ignored until the zero calibration is completed. Place the sensor in airflow that matches the maximum selected range of the transmitter. Press and hold the span button for 3 seconds. If either the remote or local LCD is present, the display will read *SPAN* and then sequence back to the home display. If the span calibration is attempted before adjusting the zero calibration, the *FAIL* error message will be displayed briefly before returning to the home display.

LCD Display
The Series AVLV can be ordered with an optional, integral LCD. It comes with a housing cover and overlay to protect the display. The display will plug into the pins as shown in Figure 5. If the display is not needed for normal operation, the transmitter can be ordered without the LCD.
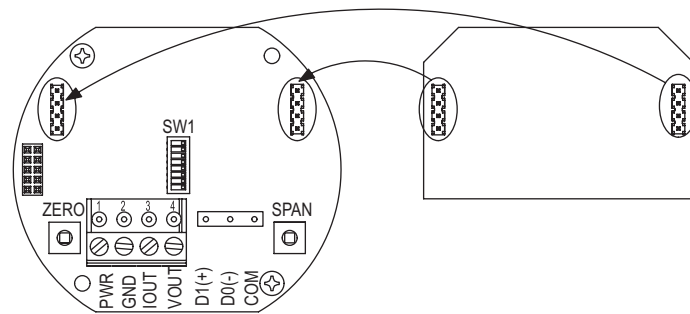

Figure 5: Pluggable display diagram

Another option for models that do not have a display would be to use a Model A-435-A remote display tool which can plug into the connector shown in Figure 6. The remote display tool has two buttons that function identically to the buttons on the PCB.
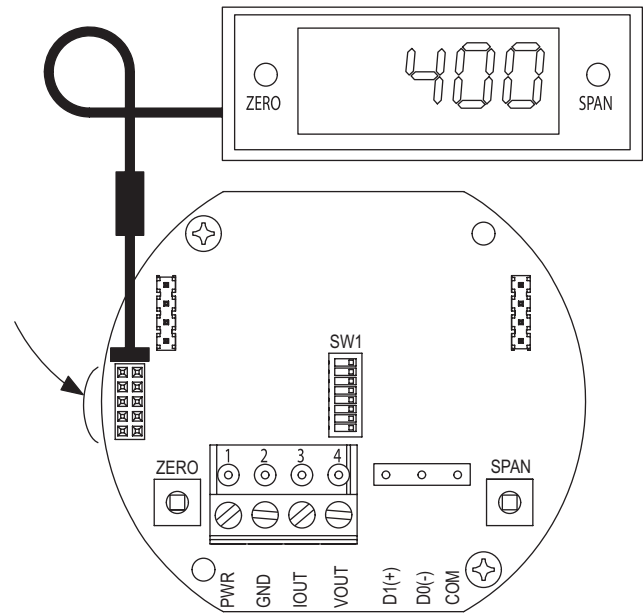

Figure 6: Remote display diagram

Display Error Messages
OVER = The air velocity is greater than the maximum span value causing an Over Range Error
UNDER = The air velocity is less than the minimum span value causing an Under Range Error
FAIL = When the span or zero buttons are pressed, the air velocity value is out of the range to allow a correct setting. This may be due to a sensor failure.
ERR1 = The sensor is damaged.

PROGRAMMING MENUS

Home Menu
During normal operation, the display will be in the Home Menu and will display the current measured pressure and the engineering units.

Menu Access Security
While in the Home Menu, press and hold the Zero and Span buttons simultaneously until *SECUR* appears on the display in order to access the other programming menus. Upon releasing the buttons, the display will indicate the current security level.

If the current security level is the security level desired (i.e. Security Level 0), press and hold the span button for 3 seconds to enter the Velocity or Air Flow Menu.

If the security level is not the desired level, the security level can be changed temporarily to a lower security level or permanently to a higher level of security by pressing the zero button. A security code will appear on the display, and it can be changed to one of the codes listed in Table 3. The span button chooses which digit and the zero button increments the value of that digit. Pressing and holding the span button will store the value.

The level of access to the programming menus and the calibration is limited based on the security level. Table 3 details the level of access for each security level.

Security Level	Setting	Access			
		View Menu	Edit Menu	Span	Zero
0	000	Yes	Yes	Yes	Yes
1	111	Yes	No	No	Yes
2	222	No	No	No	No
3	333	No	No	No	No

Table 3: Security settings

Mode Selection / Digital Dampening Menu

From the home display, pressing the span and zero button simultaneously for 3 seconds will access the Menu Security Level. If the level is set to 0 or 1, pressing and holding the span button for 3 seconds, a second time, will access the Mode Selection Menu. The display will default to air velocity when first powered up. Pressing the zero button will cycle to air flow.

Once the desired mode is displayed, pressing and holding the span button for 3 seconds will save the selected mode and display the digital dampening or averaging parameter. This parameter stabilizes the output and the display by averaging the readings. There are 2.5 readings taken each second and the user can select the number of seconds that they would like to average, up to 240 seconds. The display and the output will continue to update at a rate of 2.5 updates per second, but the moving average is used for these updates.

Velocity Mode
K-Factor Adjustment

If the Velocity Mode was selected, pressing and holding the span after adjusting the digital dampening will enter the Velocity Mode and the transmitter will display the engineering unit that has been selected by the DIP switch. Pressing and holding the span button for 3 seconds will enter the K – Factor adjustment. The K – Factor can be adjusted between 0.001 to 9.999. The K-Factor can be adjusted by pressing the span button to select the digit and pressing the zero button to increment the value of the digit. Pressing and holding the span button for 3 seconds will enter the Maximum Output Adjustment parameter.

Flow Mode
K-Factor Adjustment

If the Flow Mode was selected, pressing and holding the span after adjusting the digital dampening will enter the Flow Mode and the transmitter will display the engineering unit that has been selected by the DIP switch. Pressing and holding the span button for 3 seconds will enter the K–Factor adjustment. The K–Factor can be adjusted between 0.001 to 9.999. The K-Factor can be adjusted by pressing the span button to select the digit and pressing the zero button to increment the value of the digit. Pressing and holding the span button for 3 seconds will enter the Area Adjustment parameter.

Area Adjustment

For flow applications, the area is multiplied by the velocity to determine the volumetric air flow. The area will be listed in either CFM or m³/h depending on the DIP switch settings. The units will appear on the display at the time of adjustment. The area can be adjusted by pressing the span button to select the digit and pressing the zero button to increment the value of the digit. Pressing and holding the span button for 3 seconds will enter the Maximum Output Adjustment parameter.

Maximum Output Adjustment

The maximum output can be equivalent to air velocity or air flow. After adjusting the K-Factor, the display will indicate if the adjustment is set for velocity or air flow. Pressing the zero button will toggle between the selections. Pressing and holding the span button for 3 seconds will enter the maximum output adjustment. The maximum output can be adjusted by pressing the span button to select the digit and pressing the zero button to increment the value of the digit. Pressing and holding the span button for 3 seconds will save this value and go to the Security Update Menu.

Security Update / Save Changes Menu

The Security Update Menu allows the security level to be set either higher or lower than the current security level setting. This security level will be displayed the next time the Menus are accessed from the home screen. Pressing the zero button cycles through the security levels. Pressing and holding the span button for 3 seconds accepts the new security level and gives the option to save all the menu changes. Pressing the zero button will toggle between yes and no. Yes will save the changes made to all menu items and no will discard all the changes made to all menu items. If the display is set to yes, pressing and holding the span will save the menu items and return the display to the home position.

FACTORY DEFAULT PROCEDURE

In order to reset all of the menu settings back to their factory programmed values, press and hold both the span and zero buttons simultaneously for 10 seconds until *FACT* is displayed on the LCD. Upon releasing the buttons, the unit will be factory defaulted. Since resetting the transmitter will wipe out all changes, it is necessary to zero (and possibly span) the transmitter before taking measurements.

MAINTENANCE/REPAIR

Upon final installation of the Series AVLV Air Velocity Transmitter, no routine maintenance is required besides zeroing the transmitter occasionally. Besides routine calibration and installation of the LCD, the Series AVLV is not field serviceable, and it is not possible to repair the unit. Field repair should not be attempted and may void warranty.

WARRANTY/RETURN

Refer to "Terms and Conditions of Sales" in our catalog and on our website. Contact customer service to receive a Return Goods Authorization number before shipping the product back for repair. Be sure to include a brief description of the problem plus any additional application notes.

APPENDIX I: Air Velocity / Air Flow Calculations

Velocity in m/s is then calculated from the equation:

Velocity (m/s) = Velocity (FPM) x 0.00508

Flow in m³/h is then calculated using the below equation:
Flow (CFM) = Area (ft²) x K-Factor x Velocity (FPM)
Flow (m³/h) = Flow (CFM) x 1.6992

APPENDIX II: Maximum Flow

Max Flow		Max K Factor x Area	
CFM	m³/h	CFM Range	m³/h Range
5885000	9999000	14712.5	1388.75

Table 4: Maximum flow values

APPENDIX III: Modbus® Communication Protocol Operation

NOTICE Wiring should comply with Electrical Characteristics of Generators and Receivers for Use in Balanced Digital Multipoint Systems, TIA/EIA-485-A-1998, Telecommunications Industry Association, 1998.

NOTICE Wiring should comply with Modbus® Communication Protocol over Serial Line Specification and Implementation Guide V1.02, Modbus Organization, Inc., 2006

NOTICE Communications wiring must be in a daisy-chain fashion. Star connections are not permitted.

NOTICE Cable shield must be connected to earth ground at one location only.

Figure 7 shows how to connect the AVLV in a network containing a common power supply. Use a cable containing two twisted pairs. One pair is to be used for D1(+) and D0(-). The other pair is to be used for power and common. This configuration is not suitable for AC supplies. Use a DC supply only. Care should be taken that there are not too many devices powered from the same supply as voltage drops will occur in the wiring. If you have many devices, or have long cable runs, the local supply configuration may be a better choice.

Figure 8 shows how to connect the AVLV in a network containing individual local supplies. Use a cable containing a twisted pair and a single conductor. The pair is to be used for D1(+) and D0(-). The single conductor is to be used for common. Both AC and DC supplies are suitable for this configuration.

In either configuration you must use shielded cable. The AVLV has a shield terminal for a convenient location to make connections. It is not electrically connected to the AVLV. Connect the shield to earth ground at one location only to prevent ground loops.

All devices in the network should be daisy chained. Star connections and T connections are not permitted.

The D1(+) and D0(-) lines must be terminated at both ends with a 120 ohm resistor. If the AVLV is an end device it has an on-board resistor that may be used. See Modbus® Communication Protocol DIP Switch Settings to enable it.

The network must be biased properly. If needed, there are bias resistors on-board the AVLV. No more than two sets of bias resistors should be enabled in the network. See Modbus® Communication Protocol DIP Switch Settings to enable them.

Figure 7: Common power supply

Figure 8: Local power supply

Modbus® Communication Protocol DIP Switch Settings

Use the middle DIP Switch SW2 to configure the Modbus® Communication Protocol address of the device. The LCD will show the address when the transmitter is powered on. Valid addresses range from 1 to 247. By default, the device is shipped with the address 127 (as shown in Figure 10). A valid and unused address should be set before connecting to an existing network. However, the address can be changed while the device is operational. If the address is changed, the device will stop responding to the currently configured address immediately. The device waits 15 seconds after the last switch change before applying the new address. The device will not function properly if an invalid address is set. The red LED will periodically blink once indicating an invalid address. The LCD will display *A ERR* when the transmitter is powered on if the address is invalid. See Appendix V for setting the Modbus® Communication Protocol address of the device. Use the right DIP Switch SW3 to configure other hardware and software options.
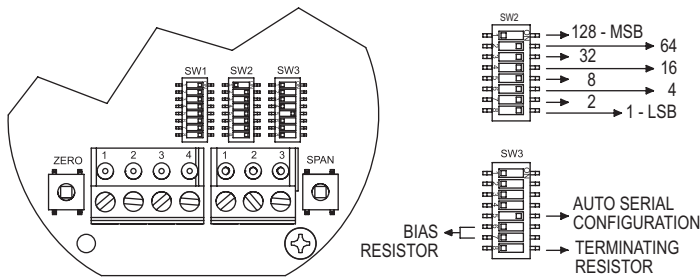
Figure 9

Switch	On	Off
1-2 – Display Units Selection		
3-4 – Reserved		
5 - Intelligent Serial Configuration	Enabled	Disabled
6 – D1(+) Network resistor	511Ω Pull-up to 5V	Pull-up not connected
7 – D0(-) Network resistor	511Ω Pull-down to GND	Pull-down not connected
8 – Terminating resistor	120Ω between D0(-) and D1(+)	Open

Table 5: DIP switch SW3 functions

Modbus® Mode	Supported Baud Rates	Data Size	Parity	Stop Bits
RTU	9600 19200 38400 57600	8	Even Odd None[1]	1
			None	2
ASCII	76800 115200	7	Even Odd	1
			None	2

Table 6: Supported Modbus® communication protocol configurations

Intelligent Serial Configuration

Intelligent serial configuration enables the device to determine the baud rate, data size, party, stop bits and even the Modbus® Communication Protocol mode directly from the serial traffic. This allows the Series AVLV to be quickly and easily deployed after a valid Modbus® Communication Protocol address is chosen.

To activate intelligent serial configuration, set a valid Modbus® Communication Protocol address using the left DIP switch SW2, connect the serial bus and power wires, and then apply power. The device will power up and begin examining the serial bus for communication. The Red LED will repeatedly flash twice, indicating that intelligent serial configuration is in progress.

If the device is setup offline or away from the main network, it is necessary to generate Modbus® Communication Protocol traffic in order to configure the serial communication. Attempting to read input registers is a good method to generate Modbus® Communication Protocol traffic. Note that while serial configuration is in progress, the device may not respond to requests. The device may require multiple read requests to complete the serial configuration process.

The intelligent serial configuration process will complete once a message addressed to the device is received and processed successfully. The serial configuration parameters are then saved to non-volatile storage and loaded by default each time the device starts. If the serial configuration of the bus changes, a power cycle of the device is required to restart the Intelligent Serial Configuration process.

Function Name	Function Code
Read Coils	01
Read Holding Registers	03
Read Input Registers	04
Write Single Coil	05
Write Single Register	06
Write Multiple Registers	16

Table 7: Supported Modbus® communication protocol functions

The String data type is read as a stream of ASCII characters, with the first character sent in the MSB of the first register, and the second character sent in the LSB of the first register and so on. If the string is shorter than the allotted size, the remaining bytes will be zero padded.

Register	Description	Data Type	Value	Range	Multi-Address Supported
0001 – 0002	Velocity Flow Area (ft2)	Float	0.01…999.99	0.01…999.99	Yes
0003 – 0004	Velocity Flow Area (m2)	Float	0.00093…92.9	0.00093…92.9	Yes
Register	Description	Data Type	Value	Range	Multi-Address Supported

Table 8: Holding registers

1 - The serial configuration, no parity with one stop bit is not officially supported by the Modbus® Communication Protocol standard. However, if this configuration is desired, set switch 5 on DIP switch SW3 to off. The device will configure itself in Modbus® RTU Communication Protocol mode with a data size of 8, no parity, and 1 stop bit. The baud rate will still be determined automatically.
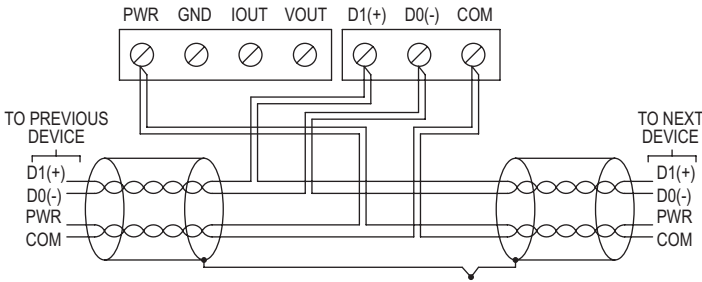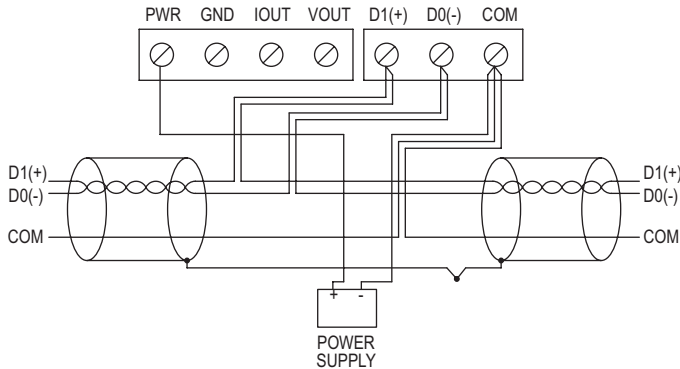
Coils

The coil registers represent functions of the device. The value returned when reading a coil register indicates the status of the last function execution. If the value is 1, then the last time the function executed was a success. If the value is 0, then the function has either not been executed since power on or failed during the last execution. To execute a function, write 1 to the corresponding register. A response will be returned immediately and the value of the coil will be set to 0. Once the function completes, the value of the coil will be set to 1 if the operation was a success. An application should poll the value of the coil periodically during this time to determine if the function succeeded. If the coil value does not transition to 1 after at most 10 seconds, then the operation failed.

Register	Description	Data Type	Value	Range	Multi-Address Supported
0001	Perform Zero Function	Boolean	0…1	False – True	No
0002	Perform Span Function	Boolean	0…1	False – True	No
0003	Reset Factory Defaults	Boolean	0…1	False – True	No
0004	Reset Device	Boolean	0…1	False – True	No

Table 9: Coils

Coil 1 – Zero Function

The zero function will attempt to recalibrate the zero point. This may be needed if the sensor has drifted over time. Note that the zero function will only re-zero the sensor if the current air velocity is within ±2% of span air velocity of the previous zero. If the current air velocity is outside the valid band, the zero function will fail and the coil value will remain 0. If the sensor has drifted far enough that the zero function fails, then the unit will have to be placed in flow to bring the current air velocity closer to the current zero, and the zero function will have to be executed multiple times until the actual zero is reached.

Coil 2 – Span Function

The span function will attempt to recalibrate the maximum air velocity. Note that accurate span air velocity depends on an accurate zero air velocity. The span function will fail if the zero function has not been executed within the last 5 minutes.

Coil 3 – Reset factory Defaults Function

The reset factory defaults function resets the zero, span, Velocity K value, Area, and Use Default K Value variables back to their factory default values.

Coil 4 – Reset Device Function

The reset device function allows this device to be reset remotely from the Modbus® Communication Protocol. When the reset device function coil is written with a value of 1, the device will immediately respond with success. The reset will take place approximately 5 seconds after the command was received. Writing the value 0 to this coil has no effect.

Multi-address Support

Multi-Address support allows a register to be read or written to using different byte orientations specified by the address range. For example, input register 0003 can also be read at 2003, 4003 and 6003 with different byte orientations as listed in Table 10. Registers that do not have multi-address support are only available in Big-Endian byte orientation (Modbus® Communication Protocol standard).

Byte Order	Address Range	Float/32 Bit Values				16 Bit Values	
		Register 1		Register 2		Register 1	
		MSB			LSB	MSB	LSB
Big-Endian	1 – 2000	A	B	C	D	A	B
Byte Swap	2001 – 4000	B	A	D	C	B	A
Word Sway	4001 – 6000	C	D	A	B	A	B
Little-Endian	6001 - 8000	D	C	B	A	B	A

Table 10: Multi-address support

APPENDIX V: Setting Modbus® Communication Protocol MAC Address of Unit

Switch Position	1	2	3	4	5	6	7	8
Address Value	128	64	32	16	8	4	2	1

Table 11: Device objects

The address assignment is determined by adding the values for each of the switches that are in the ON position. The transmitter comes from the factory with all of the DIP switches, except position 1, in the ON position as shown in Figure 10. The address of the transmitter would be 127 as it would be 64+32+16+8+4+2+1 = 127. Another example would be if the address desired was 008, the only DIP switch position in the ON position would be position 5 as shown in Figure 11.
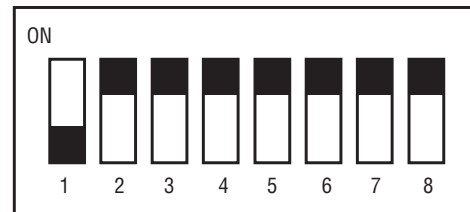

Figure 10
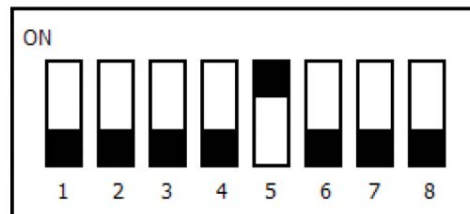
Figure 11

NOTICE Though the minimum possible address would be address 0 when all the DIP switch positions were set to OFF, and the maximum possible address would be address 255 when all of the DIP switches were set to ON, but the transmitter only has valid address from 1 to 247. Any address outside of this range will give an error code.

APPENDIX VI: Modbus® Communication Protocol Registers

Register	Description	Data Type	Value	Range	Multi-Address Supported
0001	Velocity (FPM)	Signed 16bit integer			Yes
0002	Velocity (0.001 MPS)	Signed 16bit integer			Yes
0003	Flow (CFM)	Signed 16bit integer			Yes
0004	Flow (CMH)	Signed 16bit integer			Yes
0005	Temperature (0.1 °F)	Signed 16bit integer			Yes
0006	Temperature (0.1 °C)	Signed 16bit integer			Yes
0007 – 0008	Velocity (FPM)	Float			Yes
0009 – 0010	Velocity (MPS)	Float			Yes
0011 – 0012	Flow (CFM)	Float			Yes
0013 – 0014	Flow (CMH)	Float			Yes
0015 – 0016	Temperature (°F)	Float			Yes
0017 – 0018	Temperature (°C)	Float			Yes
0019	Sensor Operational	Unsigned 16bit integer	0…1	False – True	Yes
0020 – 0021	Sensor Communication Errors	Unsigned 32bit integer	0…2^{32}-1	0…2^{32}-1	Yes
8001 – 8006	Modbus® Application Firmware Version	String			No
8007 – 8012	Sensor Application Firmware Version	String			No
8013 – 8018	Modbus® Application Serial Number	String			No
8019 – 8024	Sensor Application Serial Number	String			No

Table 12: Modbus® communication protocol registers

APPENDIX III: Menu Flow Chart

BUTTON PRESS LEGEND

[ZERO] = PRESS ZERO BUTTON

[SPAN] = PRESS SPAN BUTTON

[ZERO] = PRESS AND HOLD ZERO BUTTON

[SPAN] = PRESS AND HOLD SPAN BUTTON

[ZERO]
[SPAN] = PRESS AND HOLD ZERO AND SPAN BUTTONS

MENU CONVENTIONS

IN HOME POSITION:

[ZERO] CALIBRATE UNIT TO ZERO PRESSURE.

[SPAN] CALIBRATE UNIT TO SPAN PRESSURE.

[ZERO]
[SPAN] ENTER MENU DISPLAY

DISPLAY IS NOT NECESSARY

IN MENU DISPLAY:

[SPAN] SEQUENCES TO NEXT MAIN MENU ITEM, AND IF A MENU ITEM IS CHANGED TEMPORARILY SAVES THE SELECTION

[ZERO] SEQUENCES THROUGH SUB MENU SELECTIONS OR INCREMENTS DIGITS

[SPAN] SEQUENCE TO NEXT DIGIT. ACTIVE DIGIT WILL BLINK.   = BLINKING DIGIT

Averaging Menu

HOME POSITION

[ZERO]
[SPAN]

WHILE BUTTONS ARE PRESSED

SECURITY LEVEL SELECTION — SECUr

HOLD 7 SECONDS

[ZERO]
[SPAN]

FACTORY SETTINGS RESTORED, THEN RETURNS TO HOME POSITION — FACt

WHEN BUTTONS ARE RELEASED DISPLAYS CURRENT SECURITY LEVEL

SEC 0

[ZERO] TO CHANGE SECURITY LEVEL

S 345

[ZERO] INCREMENT DIGIT

[SPAN] SELECT DIGIT

SECURITY LEVEL	SETTING
0	000
1	111
2	222
3	333

[SPAN]

IF SECURITY IS SET TO 0, 1, OR 2

[SPAN]

IF SECURITY IS SET TO 3

LoCK

PRESS ANY KEY OR WAIT 5 SECONDS

HOME POSITION — 0000

USE DEFAULT DIP SWITCH SETTINGS — diP n

[ZERO] → diP Y

[SPAN]

[SPAN]

[ZERO]

MODE SELECTION VELOCITY OR FLOW — uEL

[ZERO] → FLo

[SPAN]

[ZERO]

BLINKING UNITS AS SELECTED BY DIP SWITCHES

[SPAN]

ADJUST AVERAGING — 000 AVG

[ZERO] INCREMENT DIGIT

[SPAN] SELECT DIGIT

[SPAN]

TO "VELOCITY OR FLOW" MENUS

Velocity Mode Menu

FROM AVERAGING MENU

[SPAN]

ADJUST DISPLAY
K FACTOR

`d iSPK` → [SPAN] UPON RELEASE → `d 1.000`

[SPAN]

SELECT MAXIMUM OUTPUT
SET BY PRESSURE OR
VELOCITY

`o AdJ` → [SPAN] UPON RELEASE → `AdJ u`

[SPAN]

ADJUST VELOCITY
OUTPUT HIGH

`uoH` → [SPAN] UPON RELEASE → `023.3K` FPM

[ZERO] INCREMENT DIGIT
[SPAN] SELECT DIGIT

FPM OR M/S BASED
ON DIP SWITCH SETTING

`023.3K` M/S

[ZERO] INCREMENT DIGIT
[SPAN] SELECT DIGIT

[SPAN]

TO "UPDATE SECURITY
AND SAVE" MENU

Flow Mode Menu

FROM AVERAGING MENU

SPAN

ADJUST DISPLAY
K FACTOR

d iSPK → SPAN UPON RELEASE → d 1.000

SPAN

ArEA → SPAN UPON RELEASE → 10.00 AREA F

ZERO — INCREMENT DIGIT

SPAN — SELECT DIGIT

SQ. FEET OR SQ. METERS BASED
ON DIP SWITCH SETTING

10.00 AREA M

SPAN

SELECT MAXIMUM OUTPUT
SET BY PRESSURE OR
FLOW

o Adj → SPAN UPON RELEASE → Adj F

SPAN

ADJUST FLOW
OUTPUT HIGH

FoH → SPAN UPON RELEASE → 0233K CFM

ZERO — INCREMENT DIGIT

SPAN — SELECT DIGIT

FPM OR M/S BASED
ON DIP SWITCH SETTING

0233K M³/H

ZERO — INCREMENT DIGIT

SPAN — SELECT DIGIT

SPAN

TO "UPDATE SECURITY
AND SAVE" MENU

Security Menu

FROM "UPDATE SECURITY
AND SAVE" MENU

UPDATE SECURITY
LEVEL

SEC 0 → ZERO → SEC 1 → ZERO → SEC 2 → ZERO → SEC 3

SEC 3 → ZERO

SPAN   SPAN   SPAN   SPAN

SAVE CHANGES

SAuE → SPAN   UPON RELEASE →   no → ZERO → YES

YES → ZERO

SPAN   SPAN

0000   HOME POSITION

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