Calculating Control Valve Wiring Size

Method of Wire Sizing from controller to solenoid valve

Data Needed

- Inrush current of the solenoid valve (I)
- Distance in metres (one way) between controller and solenoid valve (D)
- The allowable voltage drop in the wire without affecting the operation of the solenoid valve (V_d)

Steps

1. Calculate the maximum allowable wire resistance per 1000 metres with the following formula:

$$R = \frac{500^* \times V_d}{D \times I}$$

where R = allowable wire resistance per 1000 metres

* This assumes that the active and common wires are the same size

Example: A valve with a minimum operating voltage of 20 volts and an inrush current of 0.34 amps is to be located 650 metres from the controller. The controller minimum output voltage is 24 VAC.

The allowable voltage drop V_d = 24-20 = 4 volts

The distance to the valve (D) = 650 metres

The current draw (I) = 0.34 amps

$$R = \frac{500 \times 4}{650 \times 0.34} = 9.05 \text{ ohms/1000m}$$

From Table 2, 1.5 mm² wire has too much resistance, therefore select 2.5 mm²

Table 3 provides maximum wire runs given a solenoid valve with a minimum operating voltage of 20 volts AC, an inrush current of 0.34 amps and a controller minimum output voltage of 24 VAC.

For example, such a solenoid that was 810 metres away from the controller, could have a 2.5 mm² active with a 4 mm² common wire.

Table 4 provides multiplying factors should the minimum output voltage of the controller vary from the 24 VAC used in table 3.

For example, if the controller output is 26 VAC, the multiplying factor is 1.5. From table 3 the maximum distance for 1.5 mm² active and common is 433 metres. If the controller minimum output is 26Vac the maximum distance is 433 × 1.5 = 649 metres.

Table 1
Minimum Operating Voltages at Various Mainline Pressures

Minimum Pressure (kPa)	Minimum Voltage (Internal Bleed)	Minimum Voltage (External Bleed)
1350	21.1	
1200	20.2	
1000	19.1	20.0
850	18.2	19.1
700	17.1	18.2
500	16.1	17.3
350	16.0	16.4

Table 2
Copper Wire Resistance

Nominal Area of Conductor (mm²)	Resistance at 20°C ohms / 1000 m
0.5	38.4
1.0	21.2
1.5	13.6
2.5	7.4
4.0	4.6
6.0	3.1
10.0	1.8
16.0	1.1

Table 3
Maximum one-way distance between controller and valve

Common Wire (mm²)	Active Wire (mm²)					
	0.50	1.00	1.50	2.50	4.00	6.00
0.50	153	197	226	257	274	283
1.00	197	277	338	411	456	484
1.50	226	338	433	560	646	704
2.50	257	411	560	795	980	1120
4.00	274	456	646	980	1279	1528
6.00	283	484	704	1120	1528	1898

This table has been calculated based on the following factors. Solenoid voltage: 24VAC, Maximum Pressure: 1000 kPa, Voltage drop: 4 volts, Solenoid inrush current: 0.34 Amps.

Table 4
Multiplier Factor for Minimum Output Voltages from Controllers

Controller Output Voltage	24 VAC Solenoid
28	2.00
27	1.75
26	1.50
25	1.25
24	1.00
23	0.75
22	0.50

Table 5
American Wire Cross Sectional Area

AWG Gauge	Area (mm²)	AWG Gauge	Area (mm²)
26	0.128	12	3.302
25	0.162	11	4.156
24	0.205	10	5.271
23	0.255	9	6.629
22	0.322	8	8.350
21	0.411	7	10.544
20	0.516	6	13.292
19	0.653	5	16.755
18	0.823	4	21.137
17	1.039	3	26.653
16	1.308	2	33.606
15	1.652	1	42.384
14	2.088	0	53.454
13	2.629	00	67.399