TI-P133-46
CMGT Issue 2

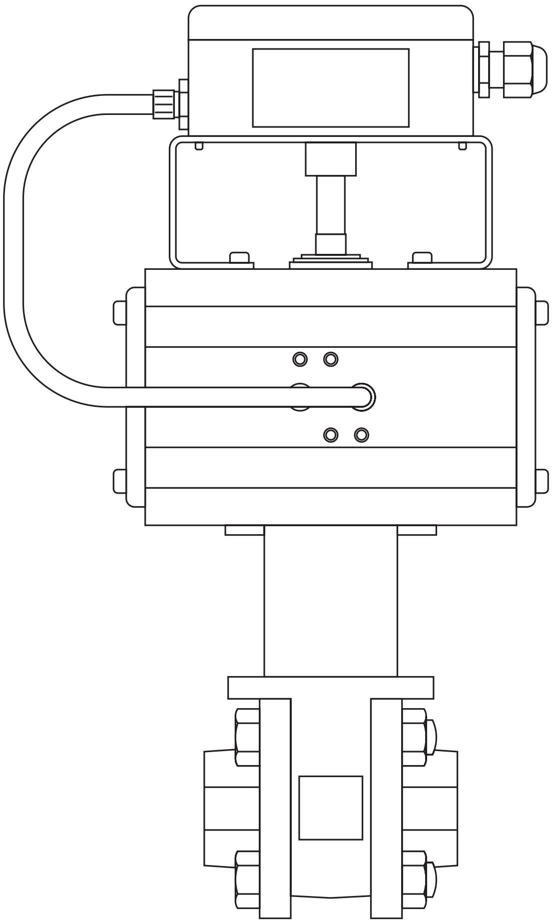
M15 ISO
Ball Valve for Control of Fluids
Sizing Sheet

Description

The M15 ISO ball valve is ideal for control applications. Both ball and seat are manufactured in chrome plated metal which ensures a long life, even with applications that constantly modulate the flow of the fluid. The valve is actuated by a double or single acting pneumatic actuator. The actuator is regulated by an electropneumatic positioner that receives a 4 - 20 mA signal from the process.

Advantages:

- Inherent equal percentage flow characteristic with high rangeability (32:1).
- Suitable for fluids that contain solids in suspension.
- Capacity is much higher than a same size globe valve.
- Less maintenance than spindle regulating valves.
- Small, compact and easily maintained.



Sizing

1. Determine the required C_v for the ball valve using the appropriate equation detailed below. With the first approximation for this calculation it is suggested to use a factor FL = 0.68, that corresponds to an opening of the valve of 72°.
2. Calculate the diameter of the pipe for maximum flow within the limits of velocity and pressure drop for the fluid.
3. With the C_v and pipe diameter, use the table overleaf starting with the column that corresponds to the rotation of 72°, that gives FL = 0.68.
4. In this column, choose the combination of ball valve diameter and pipe diameter that gives a C_v result the same or superior to the one calculated in step 1.
5. It is recommended not to use a ball valve with a diameter less than half the pipe diameter, because of excessive tension that can produce vibrations.

Simplified equations for sizing (K$_v$ values = C$_v$ x 0.86)

For liquids		
Where:	**Sub-critical flow**	**Critical flow**
ΔPm = Maximum ΔP for sizing, When $P_2 > P_v$ use $\Delta Pm = F_L^2(P_1 - P_v)$ When $P_2 > P_v$ use $\Delta Pm = P_1 - \left[0.96 - 0.28\sqrt{\frac{P_V}{P_C}}\right] P_V$	**When:** $\Delta P < \Delta Pm$	**When:** $\Delta P \geq \Delta Pm$
C_v = Flow coeffecient of the valve F_L = Pressure recovery factor pr = Density at inlet temperature (water = 1.0 at STP) P_1 = Upstream pressure (bar a) P_2 = Downstream presure (bar a) P_V = Vapour pressure of the liquid at inlet temperature (bar a)	**Volumetric flowrate** $C_V = 1.16\dot{V}\sqrt{\frac{pr}{\Delta P}}$	**Volumetric flowrate** $C_V = \frac{1.16\dot{V}}{F_L}\sqrt{\frac{pr}{\Delta Pm}}$
P_C = Thermodynamic critical pressure (bar a) $\dot{V}$ = Flowrate in m³/h $\dot{m}$ = Flowrate in in kg/h	**Mass flowrate** $C_V = \frac{\dot{m}}{865\sqrt{\Delta P pr}}$	**Mass flowrate** $C_V = \frac{\dot{m}}{865 F_L\sqrt{pr\Delta Pm}}$

Simplified equations for sizing (K$_v$ values = C$_v$ x 0.86)

For steam and gases

Where:

- C_V = Flow coeffecient of the valve
- F_L = Pressure recovery factor
- pr = Specific density of gas (air = 1)
- P_1 = Upstream pressure (bar a)
- P_2 = Downstream presure (bar a)
- T = Inlet temperature in °K (°C + 273)
- $\dot{V}$ = Flowrate of gas in Nm³/h (at 15°C and 1 bar a)
- $\dot{m}$ = Flowrate of gas in in kg/h
- T_{SO} = Superheating of steam in °C (Temperature of superheated steam - Temperature of saturated steam)
- $\dot{m}_S$ = Flowrate of steam in kg/h

Note: These equations are only a simplified version of the original sizing equations of the ISA and IEC regulations. The results are sufficiently close for practical use. There could be a maximum error of 8% in the transition of non-choked flowrate to choked flowrate.

Sub-critical flow	Critical flow
When: $\Delta P < 0.5\ F_L^2\ P_1$	**When:** $\Delta P > 0.5\ F_L^2\ P_1$
For gases (volumetric flowrate) $C_V = \frac{\dot{V}}{295}\sqrt{\frac{pr\,T}{P_1^2 - P_2^2}}$	**For gases (volumetric flowrate)** $C_V = \frac{\dot{V}}{257}\,\frac{\sqrt{pr\,T}}{F_L P_1}$
For gases (mass flowrate) $C_V = \frac{\dot{m}\sqrt{T}}{360\sqrt{(P_1^2 - P_2^2)pr}}$	**For gases (mass flowrate)** $C_V = \frac{\dot{m}\sqrt{T}}{311 F_L P_1 \sqrt{pr}}$
For saturated steam $C_V = \frac{\dot{m}_S}{13.81\sqrt{P_1^2 - P_2^2}}$	**For saturated steam** $C_V = \frac{\dot{m}_S}{11.95\ F_L P_1}$
For superheated steam $C_V = \frac{\dot{m}_S\ (1 + 0.00126\ T_{SO})}{13.81\sqrt{P_1^2 - P_2^2}}$	**For superheated steam** $C_V = \frac{\dot{m}_S\ (1 + 0.00126\ T_{SO})}{11.95\ F_L P_1}$

C_V values for reduced bore (RB) valves (K_V values = C_V x 0.86)

Valve size	Pipe size	Rotation 0°	9°	18°	27°	36°	45°	54°	63°	72°	81°	90°
½"	½"	0.00	0.00	0.22	0.36	0.58	0.88	1.47	2.17	**3.50**	5.53	7.00
	¾"	0.00	0.00	0.22	0.36	0.58	0.88	1.45	2.12	**3.29**	4.80	5.66
	1"	0.00	0.00	0.22	0.36	0.58	0.87	1.44	2.09	**3.20**	4.53	5.23
¾"	¾"	0.00	0.00	0.37	0.62	0.99	1.50	2.52	3.72	**6.00**	9.48	12.00
	1"	0.00	0.00	0.37	0.62	0.99	1.50	2.50	3.69	**5.87**	8.98	11.03
	1¼"	0.00	0.00	0.37	0.62	0.99	1.50	2.49	3.65	**5.73**	8.52	10.21
	1½"	0.00	0.00	0.37	0.62	0.99	1.49	2.48	3.64	**5.68**	8.35	9.91
1"	1"	0.00	0.00	0.98	1.64	2.61	3.95	6.64	9.80	**15.80**	24.96	31.60
	1¼"	0.00	0.00	0.98	1.64	2.61	3.94	6.59	9.63	**15.10**	22.45	26.91
	1½"	0.00	0.00	0.98	1.64	2.60	3.93	6.55	6.52	**14.70**	21.20	24.83
	2"	0.00	0.00	0.98	1.64	2.60	3.92	6.50	9.36	**14.15**	19.63	22.41
1¼"	1¼"	0.00	0.00	1.47	2.46	3.90	5.91	9.93	14.66	**23.65**	37.37	47.30
	1½"	0.00	0.00	1.47	2.46	3.90	5.90	9.88	14.50	**23.00**	34.95	42.66
	2"	0.00	0.00	1.47	2.46	3.89	5.88	9.80	14.24	**22.00**	31.72	37.14
	2½"	0.00	0.00	1.47	2.46	3.89	5.87	9.75	14.09	**21.47**	30.18	34.74
1½"	1½"	0.00	0.00	2.54	4.26	6.77	10.25	17.22	25.42	**41.00**	64.78	82.00
	2"	0.00	0.00	2.54	4.26	6.76	10.21	17.03	24.83	**38.65**	56.53	66.91
	2½"	0.00	0.00	2.54	4.25	6.75	10.18	16.89	24.40	**37.08**	51.94	59.65
	3"	0.00	0.00	2.54	4.25	6.74	10.15	16.75	23.97	**35.63**	48.16	54.12
2"	1½"	0.00	0.00	3.72	6.24	9.90	15.00	25.20	37.20	**60.00**	94.80	120.00
	2½"	0.00	0.00	3.72	6.24	9.89	14.98	25.10	36.88	**58.70**	89.92	110.53
	3"	0.00	0.00	3.72	6.24	9.88	14.94	24.93	36.33	**56.56**	82.73	97.93
	4"	0.00	0.00	3.72	6.23	9.87	14.90	24.73	35.75	**54.43**	76.46	87.97
2½"	2½"	0.00	0.00	6.08	10.19	16.17	24.50	41.16	60.76	**98.00**	154.84	196.00
	3"	0.00	0.00	6.08	10.19	16.16	24.46	40.99	60.22	**95.79**	146.53	179.90
	4"	0.00	0.00	6.08	10.18	16.14	24.38	40.60	59.01	**91.13**	131.31	153.72
	6"	0.00	0.00	6.08	10.17	16.11	24.28	40.16	57.67	**86.43**	118.31	133.91

FL	-	-	0.96	0.94	0.92	0.88	0.82	0.75	**0.68**	0.62	0.50