PENTAIR

SAPAG

MONOVAR® is the energy dissipating valve.

Features
- Extremely simple design (patented)
- Excellent cavitation characteristics
- Very accurate flow or pressure control
- Manual or automatic control
- Suitable for flow measurement
- Small sizes are available
- Minimum flow disturbance
- The flow is divided equally over a larger number of jets. This ensures an accurate and stable performance
- These unique features, together with the wide range of construction materials make MONOVAR® valves an automatic choice in all severe industrial and water-supply situations requiring fluid flow control or of some associated characteristic, e.g. pressure, temperature and level
- The design suppresses vibration, cavitation, pressure fluctuations and excess noise
- Suitable for high velocity applications
- Suitable for high pressure drop applications

Valve shown: MONOVAR® DN2000 (80")

Example shown is a large dam in California, USA.

Applications

Application of MONOVAR®:
- Water supply systems (reliability, pressure, cavitation),
- Industrial flow, cooling and mixing systems (cavitation, sensitivity, pressure, reliability),
- Head works of water treatment plant (reduced civil works, cavitation, reliability),
- Laboratory test-rigs (sensitivity, absence of disturbances),
- Turbine bypass (dams),
- End of line, free discharge,
- Replace variable speed pumps with constant flow or constant pressure pumps in combination with MONOVAR®,
- Seawater applications on request.

Technical features

Size range	: DN100 - DN2000 (4" - 80")
Pressure range	: 50 bar (725 psi)
Temperature range	: -50° to +200°C (-60°F to +390°F)
Flange accommodation	: EN 1092-1 PN10/16/20/25 ANSI B16.5 class 150 MSS SP 44 class 150 AWWA C207 Others on request

Operating principle

The simplicity of the MONOVAR® design is explained in Figure 1.

Components are simply two circular perforated plates, and an annular body (1) mounted between pipe flanges. Plate (2) is fixed. Plate (3) on the upstream side is free to slide up and down. In the fully open position the orifices in the plates are in line. The fully closed position is obtained by displacing the mobile plate (3) by one full orifice diameter.

Under specified flow conditions, the position is intermediate, with the orifices in the fixed plate partly blocked off by those of the mobile plate.
The valve can be operated both manually or by using pneumatic, hydraulic or preferably electric modulating actuators.

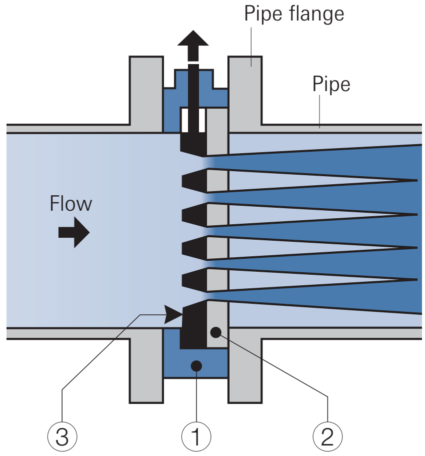


Figure 1
1 = Annular body
2 = Downstream, fixed plate
3 = Upstream, mobile plate

Advantages

The energy released by a fluid when it flows through a valve often causes disturbance in the flow.

Examples are: flow and pressure fluctuations liable cause vibration in the pipework, cavitation bubbles (i.e. fluid vapor bubbles), and noise. Noise is caused by sudden implosion of cavitation bubbles.

In MONOVAR® valves, energy dissipation is controlled by multiple distributed jets which divide the flow. This means that disturbing effects are considerably reduced, as described below:

- Flow fluctuations are reduced by the jet design and the quick flow stabilization. Consequently, devices such as flow meters may be placed much closer to the control valve than usual, so the system can be constructed more compact.

- MONOVAR® control valves have better cavitation indexes which are more favorable than those of conventional valves. Due to its design MONOVAR® copes better with cavitation than traditional control valves.

- Fully developed cavitation does not damage MONOVAR® valves since the implosions occur in the fluid and not in the valve its vital parts. This unique design outperforms the design of conventional valves where cavitation is frequently observed on the obturator and seat. Vapor bubbles are not formed when MONOVAR® valves are properly selected.

A final point for operational reliability: MONOVAR® valves do not have a natural tendency to open or close while controlling flow or pressure.

This section gives a brief overview of the hydraulic design data and selection criteria for MONOVAR® control valves. The data come from measurements made on the Sapag test rigs, from experience gained on Sapag turbine test installations, and from feedback from MONOVAR® users in the industry and in the water resources field.

Cavitation

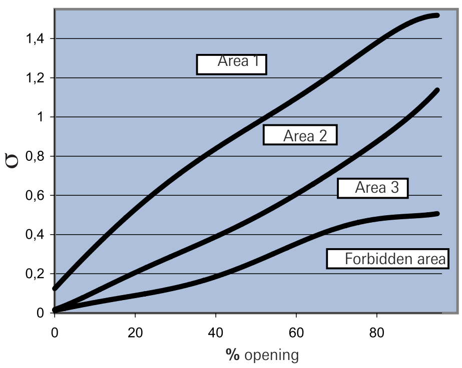
The flow-path contractions, sudden expansions and changes of direction encountered by a fluid as it passes through a valve tend to create -locally- a reduction of pressure. If the local pressure drops below the vapor pressure of the liquid, then the liquid boils. Vapor bubbles and their implosions appear in the liquid. This phenomenon is called cavitation.

The tendency of a valve to cavitate is usually characterized by a cavitation number defined as:

$$\sigma = \frac{P_2 - P_v}{P_1 - P_2}$$

P_1 : absolute upstream pressure measured in practice one pipe diameter above the valve,
P_2 : absolute pressure measured 10 pipe diameters below the valve and corrected for friction losses between points 1 and 2,
P_V : vapor pressure of the liquid at the operating temperature.

MONOVAR® index cavitation



These pressure values are generally expressed as meters head of liquid.
Some valve manufacturers utilize a cavitation number defined as:

$$K = \frac{P_1 - P_2}{P_1 - P_v}$$

with the same notations. Simple algebra shows that the two numbers are related by

$$K = \frac{1}{1 + \sigma} \quad \text{and} \quad \sigma = \frac{1 - K}{K}$$

For a given valve opening various values of σ are established by the manufacturer corresponding to various degrees of cavitation. Also defined for a given valve is how the σ values vary with opening. These values may be plotted in the form of so-called "required sigma" curves which indicate the degree of cavitation risk which will be encountered by users of the manufacturer's valve.

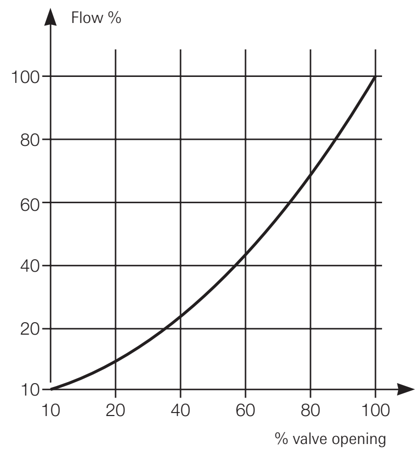
Specific flow

Specific flow is defined as the flow passing through a one meter diameter MONOVAR®, which causes a head loss equal to one meter head of water. Specific flow q_{11} may be written in terms of head loss as:

$$q_{11} = \frac{Q}{D^2 \sqrt{\Delta H}}$$

q_{11} : specific flow in m³/s at a given valve opening,
Q : the total flow passing through the valve in m³/s,
ΔH : the head loss in water column meters liquid at the same valve opening,
D : is the nominal MONOVAR® diameter in meters.

Typical flow characteristics



The graph shows how q_{11} varies with valve opening at constant headloss.

Note that q_{11} may be expressed in terms of the head loss coefficient for example in the fully open position, the specific q_{11} of a MONOVAR® valve with maximum perforated area installed in a pipe whose diameter is equal to the nominal diameter of the valve is 1,3 m³/s.
The specific flow value drops to 0,95 m³/s for an end-mounted valve.

$$q_{11} = \sqrt{\frac{\pi^2 g}{8k}}$$

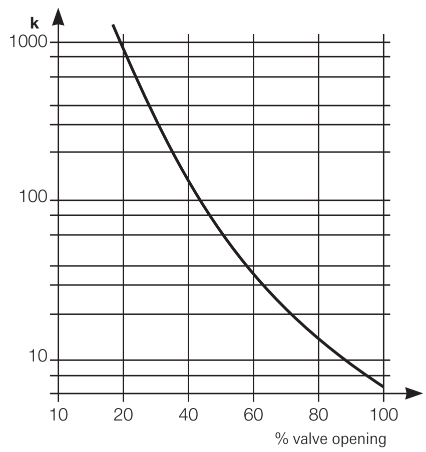
Head loss

The pressure drop caused by flow through MONOVAR® valves is written as:

$$\Delta H = k \frac{V^2}{2g}$$

ΔH : the pressure drop in meters water column at a given valve opening,
k : the (dimensionless) head loss coefficient at the same valve opening,
V : the velocity of the liquid in meters per second computed on the basis of the nominal flow-section of the valve,
g : gravitational acceleration in meters per square second.

Headloss coefficient / % valve opening



The graph shows an example curve of k values for maximum perforated area of the MONOVAR® plates.

Graphic method of determining available sigma

The available cavitation figures may be calculated quite simply by graphic means. The example calculation shown in the Figure below is based on flow between tanks at different levels. The figure depicts the connecting pipe and included control valve and, to the right, a head versus flow chart. Pressures are expressed here as heads of flowing liquid because this is the usual procedure. However, variables H_1, H_2, H_v have the same basic meanings as P_1, P_2, P_v cited above, e.g., Hv is the vapor pressure of the flowing liquid expressed in meters head of that liquid.

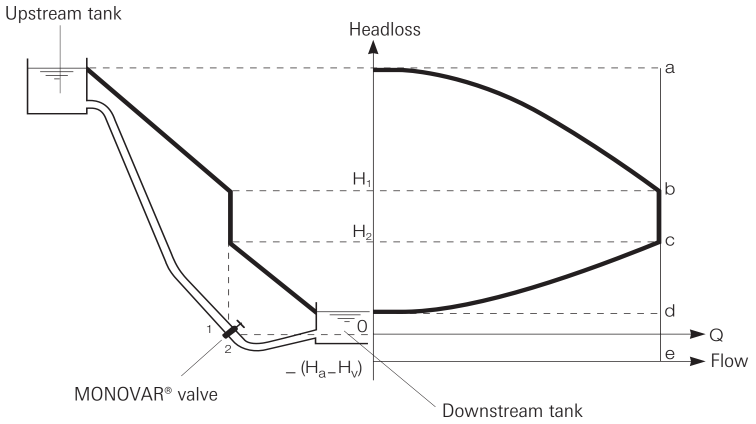
Vertical a b c d conveniently depicts the head loss components at the maximum value of discharge Q.

The head losses above and below the valve are ab and cd respectively. The intermediate distance bc, i.e. (H_1 - H_2) represents the head loss which may be throttled out by the valve. The (quadratic) curves leading down to b and up to c show how head is lost by friction effects along the two lengths of pipe.

H_a, the head at point a, corresponds to the pressure at the surface of the upper tank, I.e. atmospheric. Having drawn out the essentials of the figure thus far, it only remains to add a further horizontal line labeled e. This should be drawn at a distance equal to (H_a - H_v) below the zero head axis.

The numerator (P_2 - P_v) of the sigma expression is represented by the length ce, which is evidently equivalent to H_2 + H_a - H_v, the denominator being bc. The desired sigma cavitation number is therefore ce/bc.

Head H in meters versus flow rate Q



Operating limits

• **Temperature**

MONOVAR® valves made from the standard materials should not be operated outside the temperature range 0 to 80°C. Seal effectiveness may be maintained up to 200°C by using special seal material.
Elastomer and plastomer seals cater to low temperatures down to -50°C.
The temperature limits above are only approximate and depend on fluid and operating pressure.

• **Pressure**

PN64 : DN100
PN40 : DN150
PN25 : DN200 to DN600
PN16 : DN700 to DN800
PN10 : DN900 to DN2000

• **Tightness**

Valve is not bubble tight as it is recommended to install the MONOVAR® between two isolation valves.

• The MONOVAR® is unidirectional. In case of backflow, please contact factory.

Characteristics

MONOVAR® flow and cavitation characteristics are shown in Figure 2 in terms of specific flow q_{11} in m³/s.

$$q_{11} = \frac{Q}{D^2 \sqrt{\Delta H}}$$

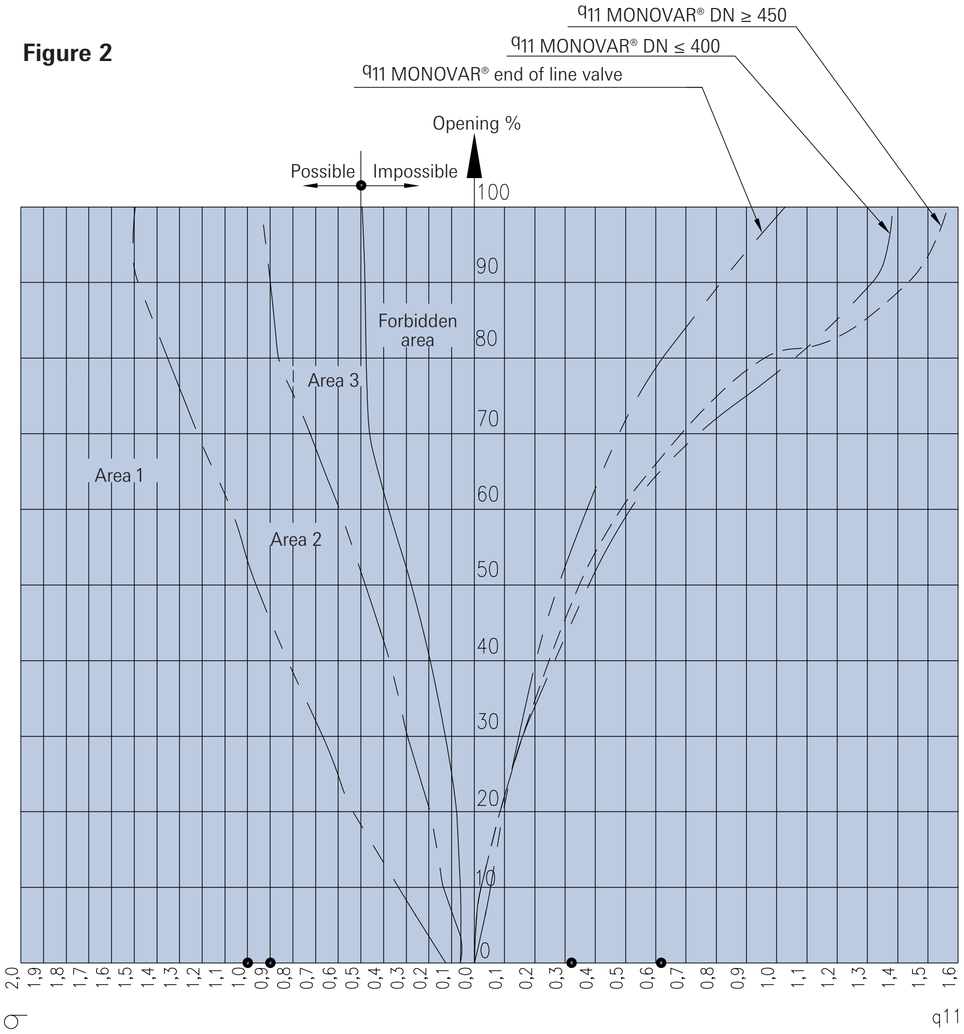
Q : m³/s
D : m
ΔH : headloss in m

$$\sigma = \frac{P_2 - P_v}{P_1 - P_2}$$

$$K = \frac{P_1 - P_2}{P_1 - P_v}$$

Area 1: Excellent operation
Area 2: Acceptable operation
Area 3: Possible operation
Area 4: Forbidden area
Please contact factory for applications in area 3 and 4.

Figure 2



1. Input data liquid

• Flow rate adjustable between	Q and Q'
• Range of absolute upstream pressure	P_1 and P'_1
• Range of absolute downstream pressure	P_2 and P'_2
• Available MONOVAR® throttling range	ΔH and ΔH'
• Vapor pressure of liquid at operating temperature	P_V
• Nominal diameter of pipe	D

Example (water)

Q = 0.150 m³/s	Q' = 0.250 m³/s
P_1 = 50 mWC	P'_1 = 48 mWC
P_2 = 25 mWC	P'_2 = 28 mWC
ΔH = 25 mWC	ΔH' = 20 mWC
P_V = 0.2 mWC	D = 0.3 m

2. First computation stage

calculate

$$q_{11} = \frac{Q}{D^2 \sqrt{\Delta H}} \quad \text{and} \quad q'_{11} = \frac{Q'}{D^2 \sqrt{\Delta H'}}$$

- if $q'_{11} < 1.3$, the MONOVAR® diameter will be less than or equal to D
- if $q'_{11} > 1.3$ the MONOVAR® diameter will be greater than D, and the new valve should be chosen so that $q'_{11} \leq 1.3$

Example (water)

$$q_{11} = \frac{0,15}{0,3^2 \sqrt{25}} = 0,33 \qquad q'_{11} = \frac{0,25}{0,3^2 \sqrt{20}} = 0,62$$

- 0.62 < 1.3: the MONOVAR® will therefore have a diameter ≤ 0.3

Note: Pipe fittings such as bends, cones or any other mechanical equipment will alter the MONOVAR®'s specifications. In that case, please contact factory.

3. Second computation stage

$$\sigma = \frac{P_2 - P_v}{P_1 - P_2} \qquad \sigma' = \frac{P'_2 - P_v}{P_1 - P'_2}$$

If points (q_{11}, σ) are situated in cavitation area 1 (excellent) in Figure 2, then there is no risk of cavitation and the MONOVAR® diameter initially assumed may be selected - or even reduced.
If points (q_{11}, σ) are situated in areas 2 or 3 (acceptable or possible), the effective cavitation risk will depend on operating life and it may be necessary to choose a larger MONOVAR®.

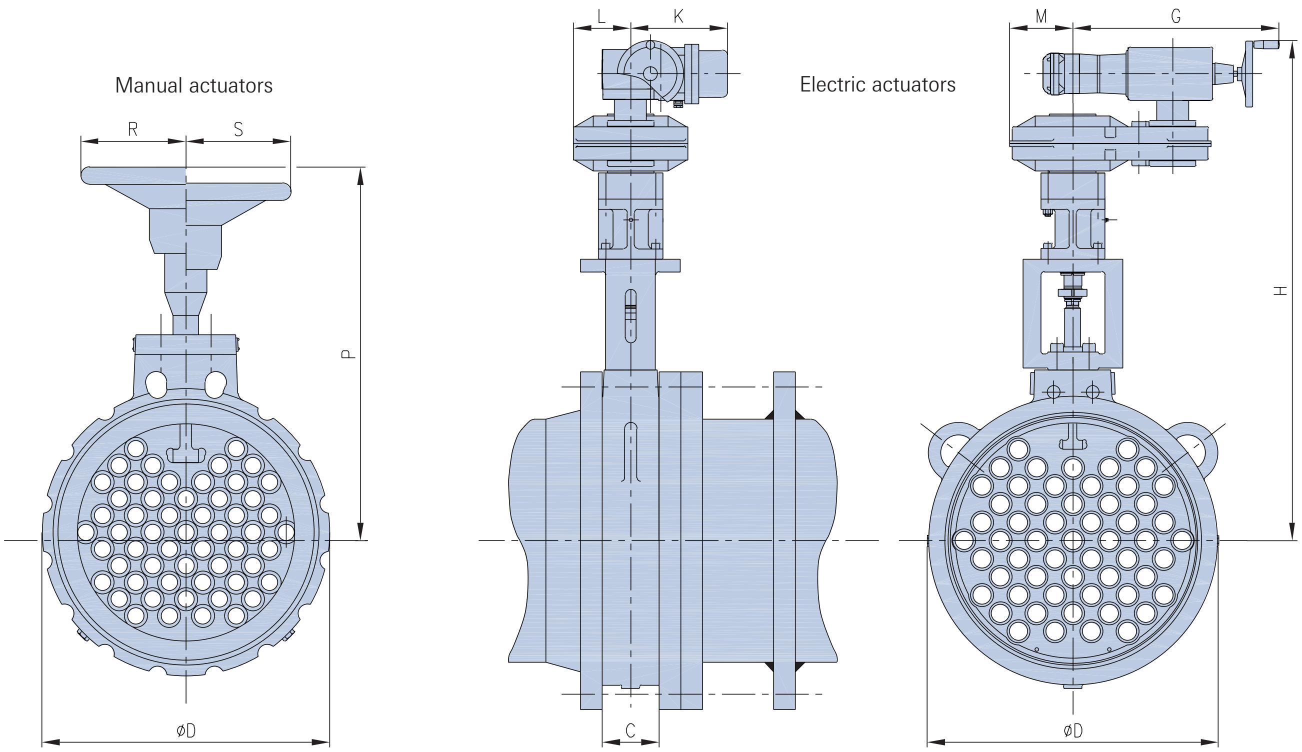
Example (water)

$$\sigma = \frac{25 - 0,2}{50 - 25} = 0,99 \qquad \sigma' = \frac{28 - 0,2}{48 - 28} = 1,39$$

As both points lie in area 1, a 0.3 m diameter MONOVAR® may be chosen. If D were reduced to 0.25 m, then

$q_{11} = 0.48$ $q'_{11} = 0.89$

and the valve would be subject to cavitation in certain cases.



Valve dimensions (mm)

DN												Weights	
(mm)	(inch)	C	øD	G	H	K	L	M	P	R	S	manual	electric
100	4"	60	162	313	446	404	309	64	296	125	125	11	30
150	6"	80	220	348	516	428	309	110	558	148	374	73	67
200	8"	80	290	348	541	428	309	110	583	148	374	86	79
250	10"	84	350	348	576	428	309	110	618	148	374	105	80
300	12"	95	400	348	636	428	309	110	678	148	374	127	115
350	14"	110	438	589	1266	428	309	178	1210	178	530	258	286
400	16"	110	516	589	1271	428	309	178	1215	178	530	290	318
450	18"	140	560	589	1276	428	309	178	1220	178	530	320	350
500	20"	150	594	589	1296	428	309	178	1240	178	530	351	390
600	24"	160	696	589	1366	428	309	178	1310	178	530	432	470
700	28"	160	806	589	1396	428	309	178	1340	178	530	494	510
800	32"	160	914	589	1456	428	309	178	1400	178	530	614	610
900	36"	160	1017	589	1519	428	309	178	1460	178	530	662	690
1000	40"	160	1124	589	1596	428	309	178	1540	178	530	778	806
1200	48"	160	1342	589	1666	283	160	178	1610	178	530	1015	1043
1400	56"	160	1580	589	1816	283	160	178	1760	178	530	1336	1364
1500	60"	250	1660	589	1866	283	160	178	-	-	-	-	2100
1600	64"	330	2032	331	2510	994	254	384	-	-	-	-	5500
2000	80"	450	2345	352	3767	368	437	913	-	-	-	-	8500

Materials of construction

Standard materials are as follows:
- Body: EN GJS 500-7 nodular cast iron
- Fixed plate: EN GJS 700-2 nodular cast iron or 13% Cr stainless steel (X20 C13)
- Moving plate: EN GJS 500-7 nodular cast iron or 13% Cr stainless steel (X20 C13)
- Support: EN GJS 500-7 nodular cast iron
- Stem: 13% Cr stainless steel
- Flange and stem seals: 70 Shore-hardness Perbunan

Other construction materials are available on request to suit particular operating conditions.

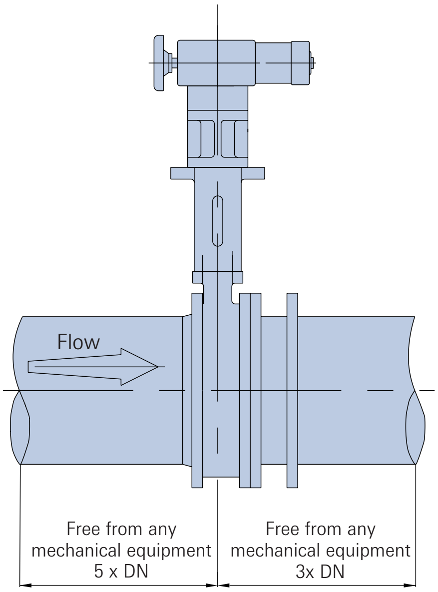
Notes

Dimensions in mm, weights in kg
Dimensions and weights are given as a guide

Valve actuators

MONOVAR® control valves may be controlled manually (handwheel with micrometer position indicator) or by electric, pneumatic or hydraulic powered actuators. Information on the large range of actuator possibilities is available on request.

Recommended installation standard position



Straight lengths of pipe

General installation instructions

- Allow the MONOVAR® to be removed at a later stage (observe clearances, use sliding joints and unions, etc.).
- Install the pipeline, or use the appropriate fittings, so that the MONOVAR® does not have to withstand any abnormal loads, resulting from mechanical pipe stresses or from thermal expansions.
- Check that the pipe sections are in line, that the flanges are parallel, that any sliding flanges are working correctly and that the holes in mating flanges coincide.
- Depending on the kind of water carried, provide a screen, a filter or sludge trap upstream of the valve in order to prevent it from jamming or suffering any mechanical damage.
- Check that the valve is installed correctly with respect to the direction of fluid flow. An arrow on the body of the MONOVAR® shows the correct direction; this direction must be followed, in order to prevent failure.
- Before installing the MONOVAR®, clean it with a jet of compressed air. Ensure that the pipes are perfectly clean and especially that there is no material inside them likely to cause serious damage (lumps of rust, welding pearls, slag, etc.).
- Bear in mind that proper installation of the MONOVAR® is a precondition for satisfactory working of the valve.
- MONOVAR® valves may be mounted between pipe flanges with the help of tie-rods, which ensure correct alignment. They may also be mounted at the end of a pipe. To facilitate mounting and disassembly, the use of sliding flanges or sleeves are recommended.
- The valves may be installed in both vertical and horizontal pipes. In vertical pipes the flow should preferably be downwards. Valves mounted horizontally should be placed with the actuator upwards to make proper use of the drain orifice, which will then be situated on the lower side.

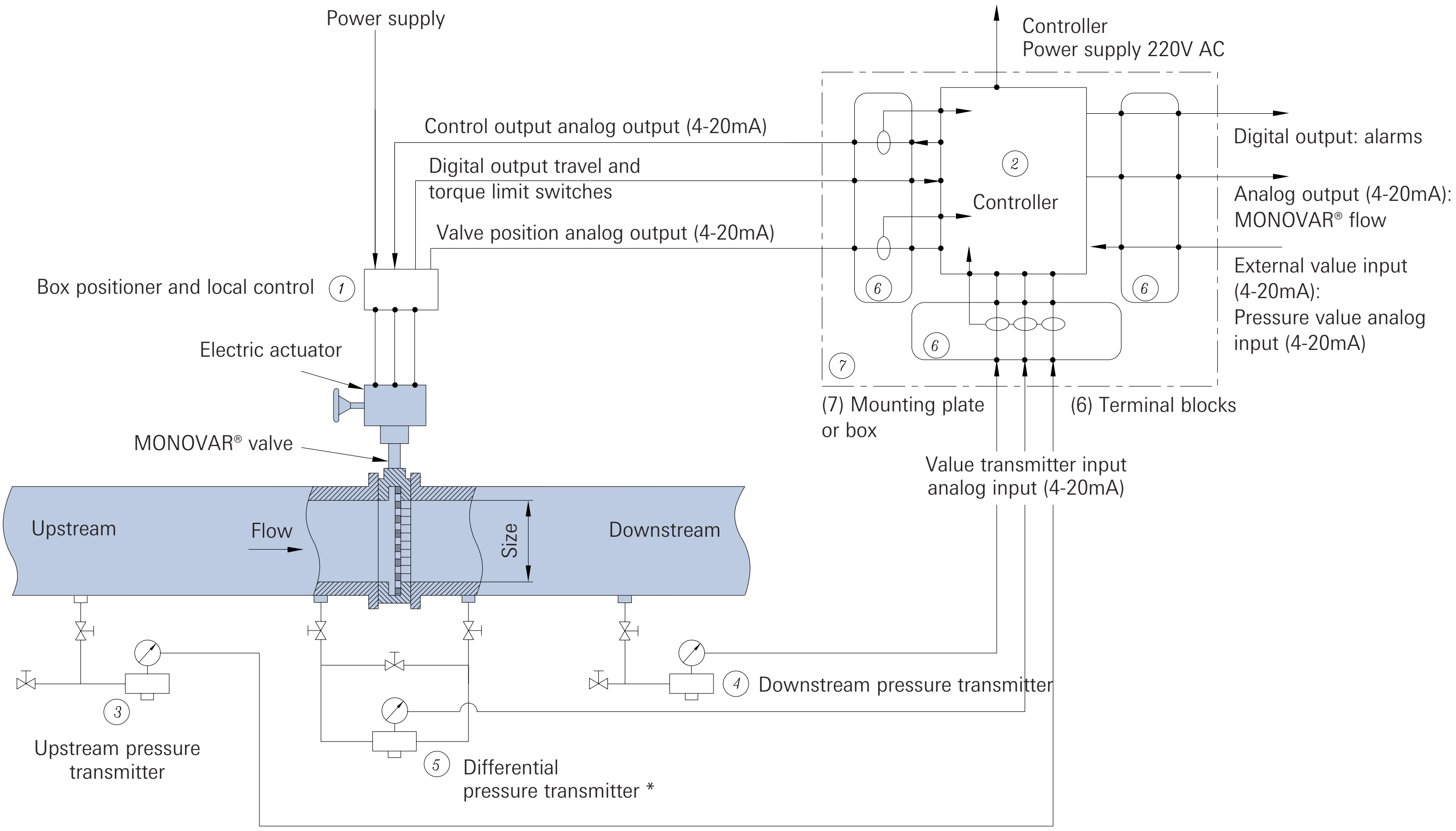
Control details

A controller is designed to control a valve that will regulate the flow or the pressure in an installation. The controller is a PID type (Proportional, Integral, Derivative). In addition to regulation, the controller can accept input data, relevant to the process, from various sources (pressure sensors, etc.). The controller can analyze them (alarm etc.) The controller can be installed on its own (self managing) or be part of a centralized system.

Example of regulation

- Upstream pressure
- Upstream level
- Downstream pressure
- Downstream level
- Flow (with head loss measurement)
- Flow (with flow meter)
- Upstream pressure and flow totals
- Downstream pressure and flow totals
- Upstream level and flow totals
- Downstream level and flow totals

Operating diagram:



* For proper pressure transmitter installation details, please contact factory.