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TI-S21-07
CTLS Issue 5

2-Port Self-acting Temperature Control Valve Selection for Heating and Cooling Applications

How to select a system

Valve selection:

1. **Is the application for heating or cooling?**
A **heating application** will require a valve that is normally open and will close with rising temperature.
A **cooling application** will require a valve that is normally closed and will open with rising temperature.

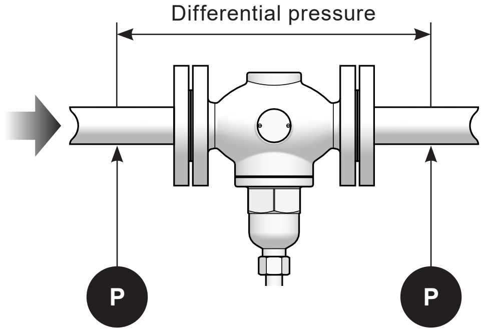
2. **Is the valve to be used on steam or water applications?**
For **steam applications** use the sizing chart in Table 1.
For **water heating applications** use the chart in Table 2.
For **water cooling applications** use the chart in Table 3.

3. **Determine** the pressure upstream of the valve (P_1) for normal running conditions.

4. **Determine** the pressure downstream of the valve (P_2) for normal running conditions.

5. **Determine** the required flowrate of the steam or water.

6. **Determine** the size and basic type of control valve using the sizing charts in Tables 1, 2 and 3. A sizing example is illustrated for each of these charts under each of these Tables.



Please note:
the pressures given on the sizing charts are in bar g only

Please note that at this point only the valve size and basic valve type has been selected. It is now necessary to refer to Tables 4, 5, and 6 to check the following:

7. **What body material is required?**
Pressure temperature limitations for each material (gunmetal, cast iron and cast carbon steel) are shown in Table 4. Economics may also influence the choice of body material.

8. **What end connections are required - screwed or flanged?**
Choices are shown in the valve selection Tables 5 and 6.

9. Normally closed valves may have a bleed which allows a small flow to reach the sensor so that it can react to a temperature rise. This will depend on the application.

10. **What is the maximum differential pressure across the control valve?**
In a heating application with a normally open valve a rise in temperature at the sensor will cause the valve to close. In order to ensure that the valve closes fully the sensor must be able to overcome the force generated on the valve plug by the maximum differential pressure across the control valve (P_1 max - P_2 min). This is often substantially greater than the normal running pressure drop across the control valve. Similarly, for a cooling application using a normally closed valve, the return spring must be able to close the valve against the maximum differential pressure. The maximum differential pressure for each valve is shown in Tables 5 and 6. The maximum differential pressure of a valve may be increased by incorporating a balancing bellows, details of which are also indicated in Tables 5 and 6 under the column titled 'Balanced'.

See page 2 for Table locations

Control system selection and Typical order information are on page 2

Control system selection

The control system consists of the sensor, capillary tube and actuator. Tables 5 and 6 show which control systems are compatible with each valve:

11. From Table 7, **select a temperature range which allows adjustment on both sides of the control point.**

12. From Table 7, **choose the configuration of the control system** to suit the application.

13. From Table 7, **choose the length of capillary tube.**

14. **Choose any ancillaries** (pockets, mounting brackets etc.) from Table 8.

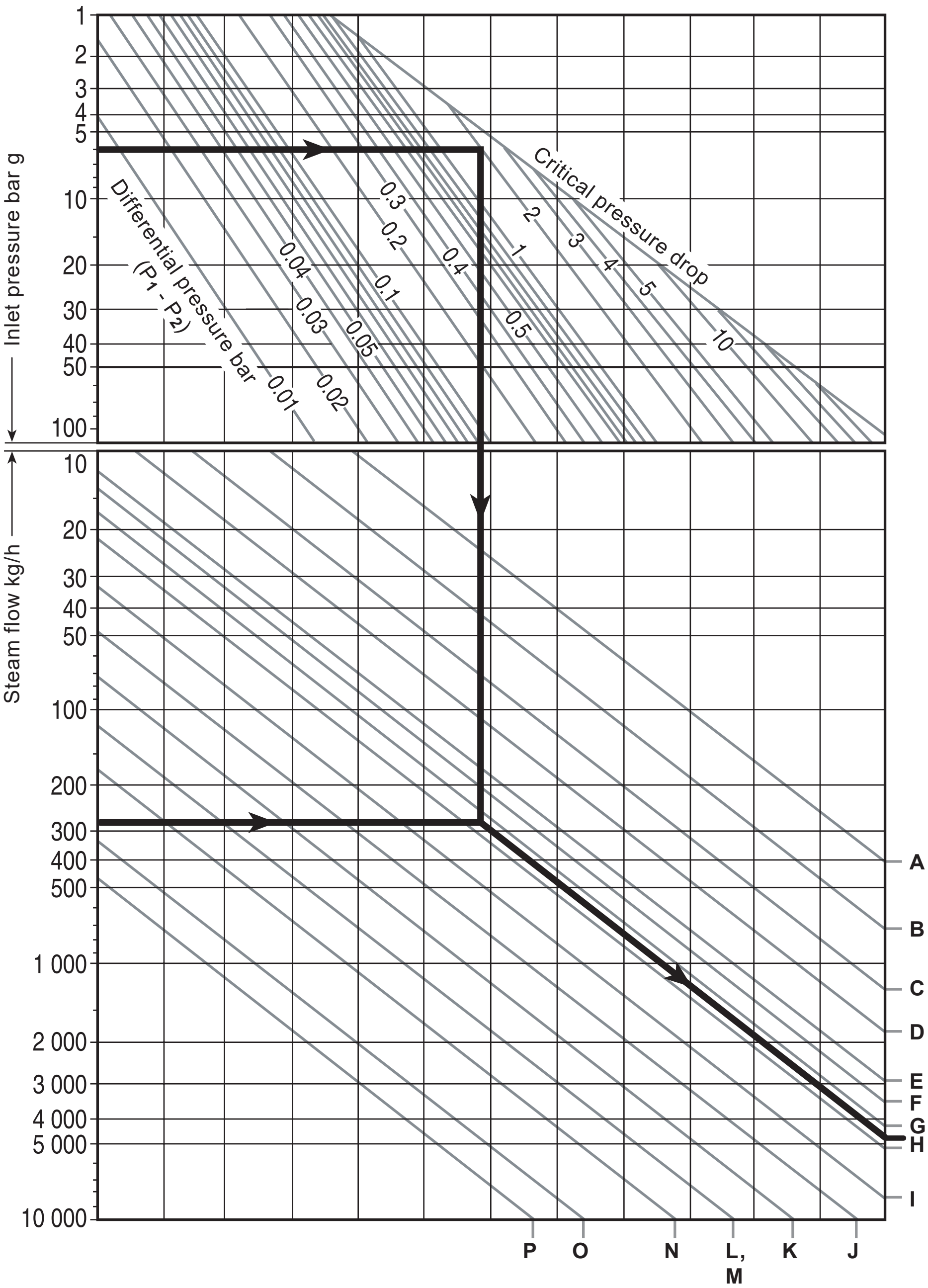
Typical order information

1 off Spirax Sarco self-acting temperature control comprising:

- DN20 KA43 control valve flanged to EN 1092 PN40,
- SA121 control system, range 2,
- 2 m capillary tube length,
- Stainless steel pocket.

Table locations

Table 1 Valve sizing for heating applications using steam

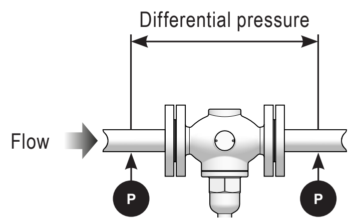


	Kvs value	Size DN	Type
A	0.38	15	BX2/ BMF2/ BM2
B	0.64	15	BX3/ BMF3/ BM3
C	1.03	15	BX4/ BMF4/ BM4
D	1.65	15	BX6/ BMF6/ BM6
E	2.58	15	SB
F	2.9	15	KA
G	3.86	20	SB
H	4.64	20	KA
I	6.8	25	SB
J	9.8	25	KA/KB
K	16.48	32	KA/ KB/KC
L	16.48	40	KC
M	23.7	40	KA/KB
N	34	50	KA/ KB/KC
O	65	65	NS
P	94	80	NS

Sizing example

Given:

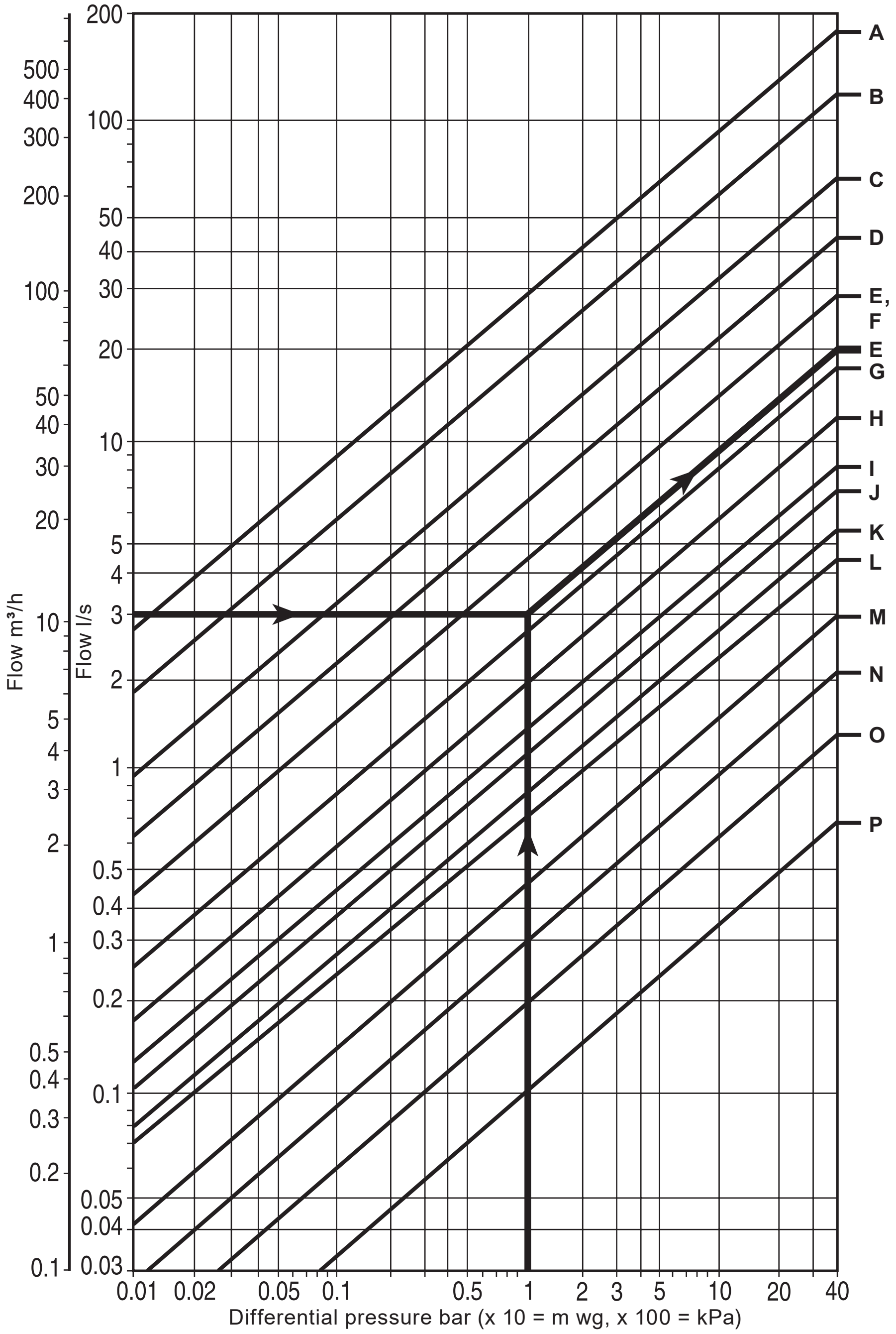
- Pressure at valve inlet P_1 = 6 bar g
- Pressure at valve outlet P_2 = 4 bar g
- The required steam flowrate = 280 kg / h



To size the valve:

1. Determine the differential pressure across the valve $P_1 - P_2 = 6 - 4 = 2$ bar.
2. Enter the upper section of the chart with the inlet pressure (P_1) at 6 bar g and draw a horizontal line to intersect the differential pressure ($P_1 - P_2$) line at 2 bar. From this intersection draw a vertical line downwards.
3. Enter the lower section of the chart with the steam flowrate at 280 kg / h and draw a horizontal line to intersect the vertical line produced in step 2. From this intersection draw a line parallel to the diagonal lines in the direction of the valve selection box.
4 From the valve selection boxes choose the valve with the higher Kvs value i.e. size DN20 'KA' type valve with a Kvs of 4.64

Table 2 Valve sizing for heating applications using water

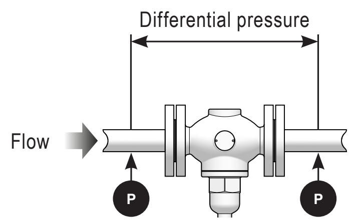


	Kvs value	Size DN	Type
A	94	80	NS
B	65	65	NS
C	34	50	KA/ KB/ KC
D	23.7	40	KA/KB
E	16.48	32	KA/KB
F	16.48	40	KC
G	9.8	25	KA/KB
H	6.8	25	SB
I	4.64	20	KA
J	3.86	20	SB
K	2.9	15	KA
L	2.58	15	SB
M	1.65	15	BX6/ BMF6/ BM6
N	1.03	15	BX4/ BMF4/ BM4
O	0.64	15	BX3/ BMF3/ BM3
P	0.38	15	BX2/ BMF2/ BM2

Sizing example

Given:

- Pressure at valve inlet P_1 = 14 bar g
- Pressure at valve outlet P_2 = 13 bar g
- The required steam flowrate = 3 litres/second



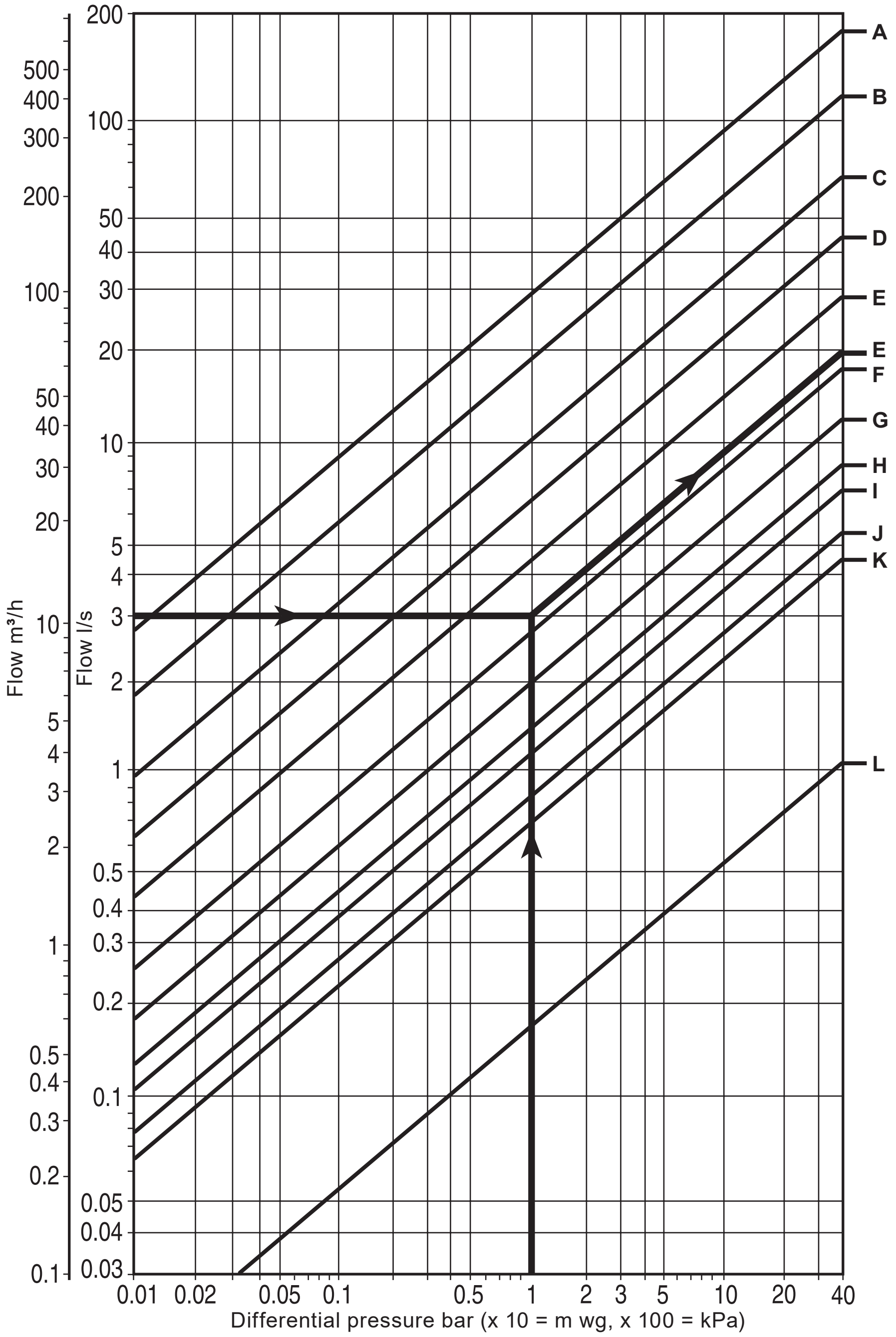
To size the valve:

1. Determine the differential pressure across the valve $P_1 - P_2 = 14 - 13 = 1$ bar

2. Enter the chart with a flowrate of 3 litres/second and draw a horizontal line to intersect the differential pressure line at 1 bar. From this intersection draw a line parallel to the diagonal lines in the direction of the valve selection boxes.

3. From the valve selection boxes choose the valve with the higher Kvs value i.e. size DN32 'KA' or 'KB' type valve with a Kvs of 16.48

Table 3 Valve sizing for cooling applications using water

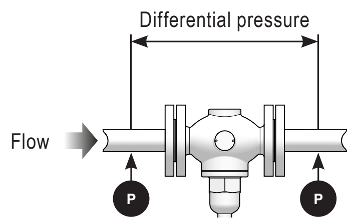


	Kvs value	Size DN	Type
A	94	80	NSRA
B	65	65	NSRA
C	34	50	KX/KY
D	23.7	40	KX/KY
E	16.48	32	KX/KY
F	9.8	25	KX
G	6.8	25	SBRA
H	4.64	20	KX
I	3.86	20	SBRA
J	2.9	15	KX
K	2.58	15	SBRA
L	0.59	15	BXRA/ BMFRA/ BMRA

Sizing example

Given:

- Pressure at valve inlet P_1 = 14 bar g
- Pressure at valve outlet P_2 = 13 bar g
- The required steam flowrate = 3 litres/second



To size the valve:

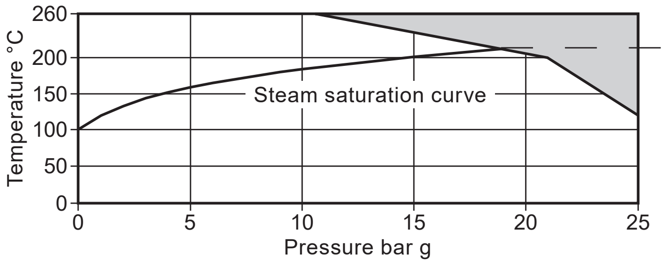
1. Determine the differential pressure across the valve $P_1 - P_2 = 14 - 13 = 1$ bar
2. Enter the chart with a flowrate of 3 litres/second and draw a horizontal line to intersect the differential pressure line at 1 bar. From this intersection draw a line parallel to the diagonal lines in the direction of the valve selection boxes.
3. From the valve selection boxes choose the valve with the higher Kvs value i.e. size DN32 'KX' or 'KY' type valve with a Kvs of 16.48

Table 4 Pressure/temperature limits for different valve materials

Note: Materials for the various valve types are shown in Tables 5 and 6 on the following pages.

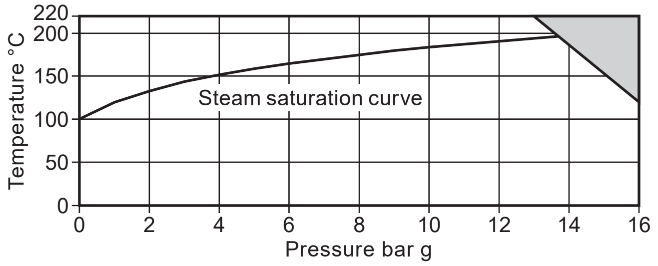
Control valve body material	Gunmetal	Cast iron	Cast carbon steel	
Body design conditions	PN25	PN16	PN25	PN40
Maximum design temperature	260 °C	220 °C	300 °C	300 °C
Maximum cold hydraulic test	38 bar g	24 bar g	38 bar g	60 bar g

Gunmetal

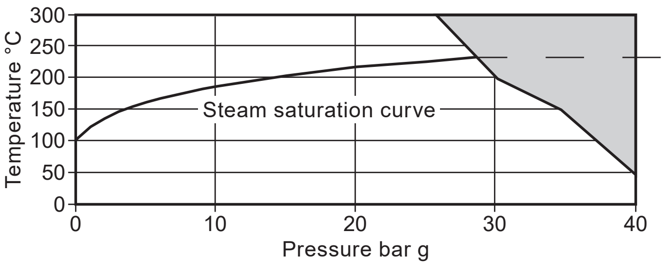


Note: The KB51 and KY51 control valves have a maximum design temperature limit of 232 °C.

Cast iron



Cast carbon steel



Note: The KB43 and KY43 control valves have a maximum design temperature limit of 232 °C.

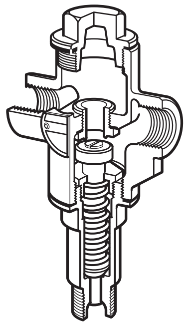
The product **must not** be used in this region.

Valve selection data
Table 5 Normally open valves for heating applications

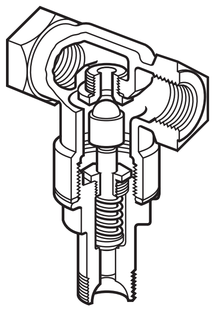
For pressure temperature relationships please refer to the pressure/temperature charts in Table 4.

*Please note:

The **KB31**, **KB33**, **KB43**, and **KB51** control valves can also be used on water applications where high ΔP conditions exist.

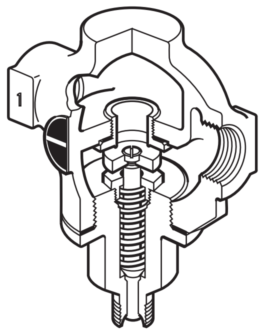


SB (DN15 - DN25 screwed)

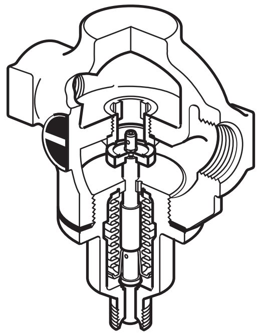


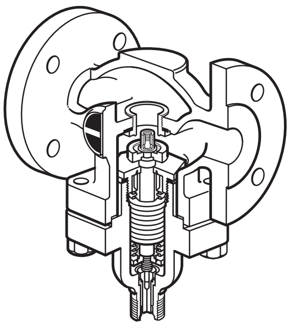
BM (DN15 flanged)
BMF (DN15 flanged)
BX (DN15 screwed)

KA31 (DN15 - DN25 screwed)
KA33 (DN15 - DN25 flanged)
KA51 (DN25 screwed)

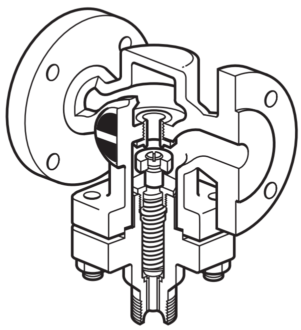


KB31 (DN25 screwed)*
KB33 (DN25 flanged)
KB51 (DN25 screwed)*



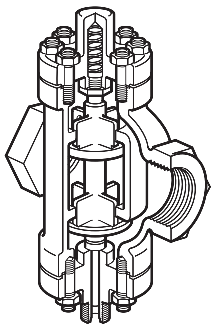


KB33 (DN32 - DN50 flanged)*
KB43 (DN32 - DN50 flanged)*
KC43 (DN32 - DN50 flanged)

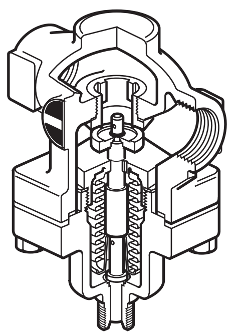


KA31 (DN32 - DN50 screwed)
KA33 (DN32 - DN50 flanged)
KA43 (DN15 - DN50 flanged)
KA51 (DN32 - DN50 screwed)

NS (DN65 - DN80 flanged)
NS (DN65 - DN80 screwed)



KB31 (DN32 - DN50 screwed)*
KB51 (DN32 - DN50 screwed)*
KC31 (DN40 - DN50 screwed)
KC51 (DN40 - DN50 screwed)



Gunmetal

Valve model	Size and pipe connections		Body design rating	Balanced	Kvs	Maximum ΔP (bar)	Stroke mm	Control system options		
	Screwed BSP/NPT	Flanged PN25/ANSI 150						SA121	SA122	SA128
BX2	½"		PN25		0.38	17.2	2.2	•	•	•
BX3	½"		PN25		0.64	17.2	3.2	•	•	•
BX4	½"		PN25		1.03	17.2	3.2	•	•	•
BX6	½"		PN25		1.65	17.2	3.2	•	•	•
SB	½"		PN25		2.58	17.2	3.2	•	•	•
	¾"		PN25		3.86	10.3	4.0	•	•	•
	1"		PN25		6.80	6.8	5.0	•	•	•
KA51	1"		PN25		9.80	4.5	5.6	•	•	•
	1¼"		PN25		16.48	3.0	8.0	•		
	1½"		PN25		23.70	2.0	9.0	•		
	2"		PN25		34.00	1.5	9.5	•		
KB51* Balanced by phosphor bronze bellows	1"		PN25	•	9.80	10.0	5.6	•	•	•
	1¼"		PN25	•	16.48	9.0	8.0	•		
	1½"		PN25	•	23.70	8.2	9.0	•		
	2"		PN25	•	34.00	6.9	9.5	•		
KC51 Balanced by stainless steel bellows	1½"		PN25	•	16.48	16.0	9.0	•		
	2"		PN25	•	34.00	13.8	9.5	•		
NS double sealed valve	2½"	DN65	PN25		65.00	10.0	9.5	•		
	3"	DN80	PN25		94.00	10.0	9.5	•		

Cast iron

Valve model	Size and pipe connections		Body design rating	Balanced	Kvs	Maximum ΔP (bar)	Stroke mm	Control system options		
	Screwed BSP/NPT	Flanged PN16						SA121	SA122	SA128
BMF2		DN15	PN16		0.38	16.0	2.2	•	•	•
BMF3		DN15	PN16		0.64	16.0	3.2	•	•	•
BMF4		DN15	PN16		1.03	16.0	3.2	•	•	•
BMF6		DN15	PN16		1.65	16.0	3.2	•	•	•
KA31 screwed and **KA33** flanged	½"	DN15	PN16		2.90	13.0	3.2	•	•	•
	¾"	DN20	PN16		4.64	10.3	4.0	•	•	•
	1"	DN25	PN16		9.80	4.5	5.6	•	•	•
	1¼"	DN32	PN16		16.48	3.0	8.0	•		
	1½"	DN40	PN16		23.70	2.0	9.0	•		
	2"	DN50	PN16		34.00	1.5	9.5	•		
KB31* screwed and **KB33*** flanged balanced by phosphor bronze bellows	1"	DN25	PN16	•	9.80	10.3	5.6	•	•	•
	1¼"	DN32	PN16	•	16.48	9.0	8.0	•		
	1½"	DN40	PN16	•	23.70	8.2	9.0	•		
	2"	DN50	PN16	•	34.00	6.9	9.5	•		
KC31 Balanced by stainless steel bellows		DN40	PN16	•	16.48	13.0	9.0	•		
		DN50	PN16	•	34.00	13.0	9.5	•		

Cast carbon steel

Valve model	Size and pipe connections Flanged			Body design rating	Balanced	Kvs	Maximum ΔP (bar)	Stroke mm	Control system options SA121	SA122	SA128
	PN25	PN40	ANSI 300								
BM2	DN15		DN15	PN25		0.32	17.2	2.2	•	•	•
BM3	DN15		DN15	PN40		0.64	17.2	3.2	•	•	•
BM4	DN15		DN15	PN40		1.03	17.2	3.2	•	•	•
BM6	DN15		DN15	PN40		1.65	17.2	3.2	•	•	•
KA43		DN15	DN15	PN40		2.90	17.0	3.2	•	•	•
		DN20	DN20	PN40		4.64	10.0	4.0	•	•	•
		DN25	DN25	PN40		9.80	4.5	5.6	•	•	•
		DN32	DN32	PN40		16.48	3.0	8.0	•		
		DN40	DN40	PN40		23.70	2.0	9.0	•		
		DN50	DN50	PN40		34.00	1.5	9.5	•		
KB43* Balanced by phosphor bronze bellows		DN25	DN25	PN40	•	9.80	10.0	5.6	•	•	•
		DN32	DN32	PN40	•	16.48	9.0	8.0	•		
		DN40	DN40	PN40	•	23.70	8.2	9.0	•		
		DN50	DN50	PN40	•	34.00	6.9	9.5	•		
KC43 Balanced by stainless steel bellows		DN32	DN32	PN40	•	16.48	16.0	8.0	•		
		DN40	DN40	PN40	•	16.48	16.0	9.0	•		
		DN50	DN50	PN40	•	34.00	13.8	9.5	•		

Valve selection data
Table 6 Normally closed valves for cooling applications

For pressure temperature relationships please refer to the pressure/temperature charts in Table 4, page 6.

Gunmetal

Valve model	Size and pipe connections		Body design rating	Balanced	Kvs	Maximum ΔP (bar)	Stroke mm	Control system options		
	Screwed BSP/NPT	Flanged PN25/ANSI 150						SA121	SA122	SA128
BMF2	½"		PN25		0.59	10.3	3.2	•	•	•
SBRA Optional bleed available	½"		PN25		2.58	12.0	3.2	•	•	•
	¾"		PN25		3.86	7.0	4.0	•	•	•
	1"		PN25		6.80	4.7	5.0	•	•	•
NRSA Double seated valve	2½"	DN65	PN25		65.00	2.7	9.5	•		
	3"	DN80	PN25		94.00	2.0	9.5	•		
KX51 Optional bleed available	1"		PN25		9.80	3.5	5.6	•	•	•
	1¼"		PN25		16.48	2.3	8.0	•		
	1½"		PN25		23.70	1.7	9.0	•		
	2"		PN25		34.00	1.1	9.5	•		
KY51* Balanced by phosphor bronze bellows. Optional bleed available	1¼"		PN25	•	16.48	9.0	8.0	•		
	1½"		PN25	•	23.70	8.2	9.0	•		
	2"		PN25	•	34.00	6.9	9.5	•		

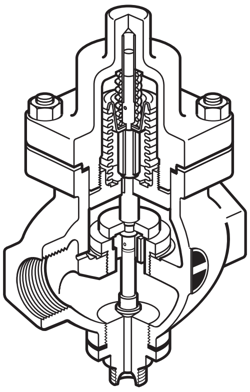
Cast iron

Valve model	Size and pipe connections		Body design rating	Balanced	Kvs	Maximum ΔP (bar)	Stroke mm	Control system options		
	Screwed BSP/NPT	Flanged PN16						SA121	SA122	SA128
BMFRA	½"		PN16		0.59	10.3	3.2	•	•	•
KX31 Screwed and **KX33** flanged. Optional bleed available	½"	DN15	PN16		2.90	12.0	3.2	•	•	•
	¾"	DN20	PN16		4.64	7.0	4.0	•	•	•
	1"	DN25	PN16		9.80	3.5	5.6	•	•	•
	1¼"	DN32	PN16		16.48	2.3	8.0	•	•	•
	1½"	DN40	PN16		23.70	1.7	9.0	•	•	•
	2"	DN50	PN16		34.00	1.1	9.5	•	•	•
KY31* Screwed and **KY33*** flanged by phosphor bronze bellows. Optional bleed available	1¼"		PN16	•	16.48	9.0	8.0	•		
	1½"		PN16	•	23.70	8.2	9.0	•		
	2"		DN16	•	34.00	6.9	9.5	•		

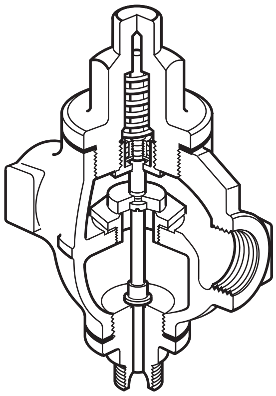
*** Please note:** The **KY31**, **KY33**, and **KY51** can also be used on water applications where high ΔP conditions exist.

Cast carbon steel

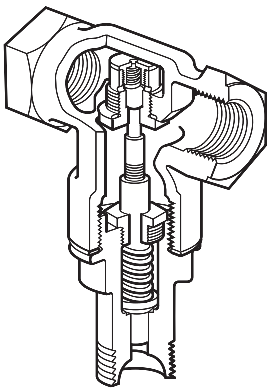
Valve model	Size and pipe connections		Body design rating	Balanced	Kvs	Maximum ΔP (bar)	Stroke mm	Control system options		
	Flanged									
	PN25	PN40						SA121	SA122	SA128
BMRA	DN15		PN25		0.59	10.3	3.2	•	•	•
KX43 Optional bleed available		DN15	PN40		2.90	12.0	3.2	•	•	•
		DN20	PN40		4.64	7.0	4.0	•	•	•
		DN25	PN40		9.80	3.5	5.6	•	•	•
		DN32	PN40		16.48	2.3	8.0	•		
		DN20	PN40		23.70	1.7	9.0	•		
		DN50	PN40		34.00	1.1	9.5	•		
KY43 Balanced by phosphor bronze bellows. Optional bleed available.		DN32	PN40	•	16.48	9.0	8.0	•		
		DN40	PN40	•	23.70	8.2	9.0	•		
		DN50	PN40	•	34.00	6.9	9.5	•		



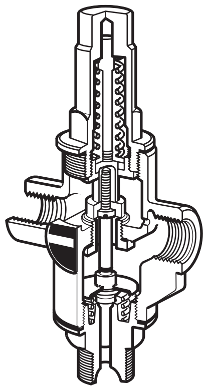
KY51 (DN32 - DN50 screwed)
KY31 (DN32 - DN50 screwed)
KY33 (DN32 - DN50 flanged)
KY43 (DN32 - DN50 flanged)



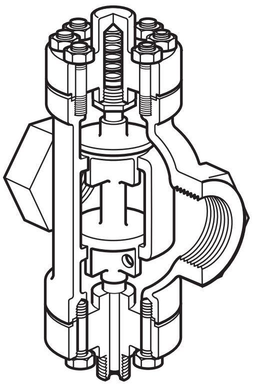
KX31 (DN15 - DN25 screwed)
KX33 (DN15 - DN25 flanged)
KX51 (DN25 screwed)



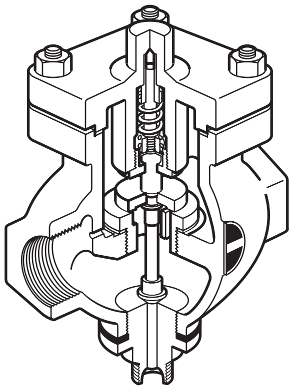
BXRA (DN15 screwed)
BMFRA (DN15 flanged)
BMRA (DN15 screwed)



SBRA (DN15 - DN25 screwed)



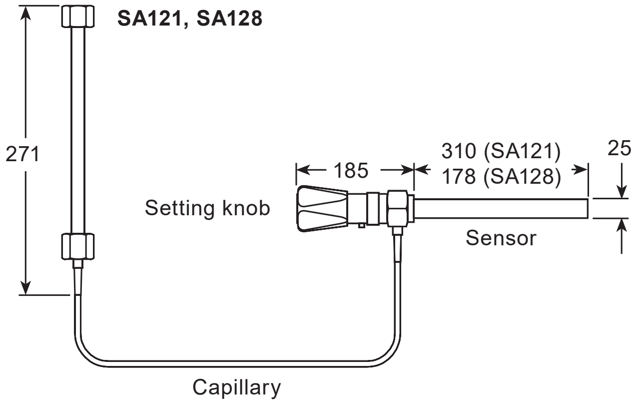
NSRA (DN65 - DN80 screwed)
NSRA (DN65 - DN80 flanged)

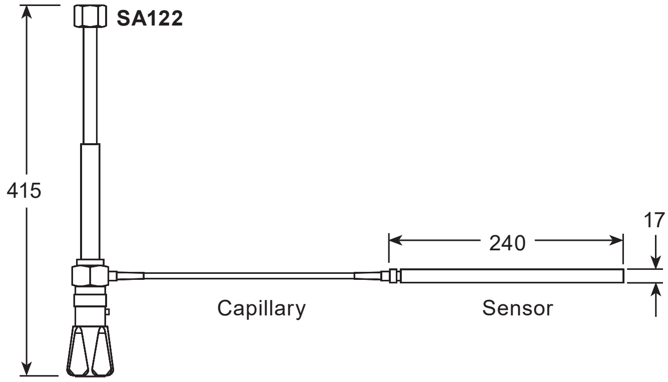


KX31 (DN32 - DN50 screwed)
KX33 (DN32 - DN50 flanged)
KX43 (DN15 - DN50 flanged)
KX51 (DN32 - DN50 screwed)

Table 7 Control system selection

The control systems are available in four configurations as shown below.
Each type is available with either a dial or knob type temperature adjustment except the Type 422 (dial only).
Dimensions are approximate in mm



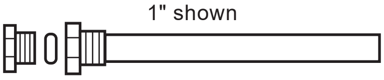
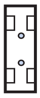
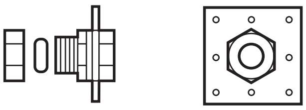
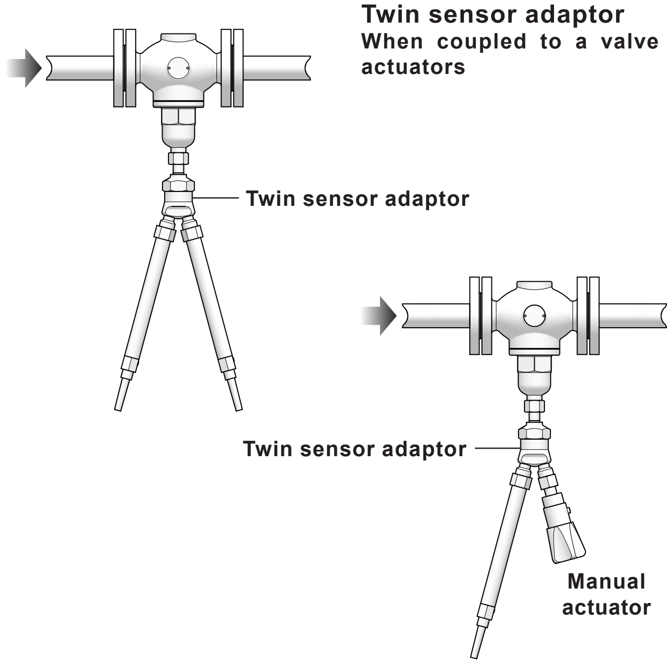


Specifications

Type	Range	Temperature	Maximum sensor temperature	Material	Weight kg	Standard capillary tube (m)
SA121	1	- 15 to 50 °C	55 °C over set value to max. 190 °C	Brass	2.0	2, 4, 8 and 20
	2	40 to 105 °C				
	3	95 to 160 °C				
SA122	1	- 20 to 120 °C	55 °C over set value	Brass	1.8	2, 4, 8 and 20
	2	40 to 170 °C				
SA128	1	- 20 to 120 °C	55 °C over set value to max. 190 °C	Brass	1.8	2, 4, 8 and 20
	2	40 to 170 °C				

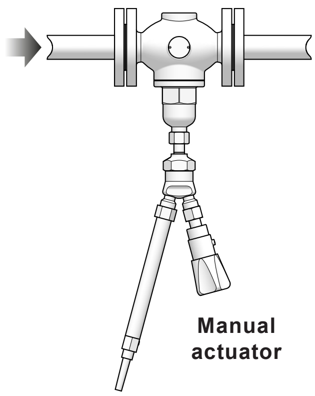
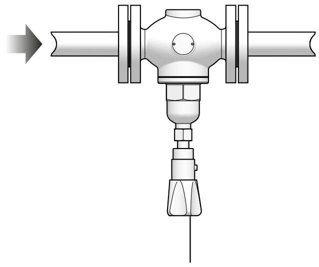
* Longer lengths up to 9.6 m are available to special order

Table 8 Control system ancillaries

Mounting options and ancillaries			Control system type		
			SA121	SA122	SA128
	Standard pocket immersion length (mm)		315	258	258
	Size (BSP or NPT)		1"	¾"	1"
	Wall mounting bracket		•	•	•
	Union kit for sensor immersion without pocket		•	•	•
	Mild steel pocket longer pocket option		•	•	•
		*		•	
	Stainless steel pocket longer pocket option		•	•	•
		*		•	
	Copper pocket longer pocket option		•	•	•
		*		•	
	Brass pocket longer pocket option		•	•	•
		*		•	
	Duct fixing kit		•		
	**Twin sensor adaptor** When coupled to a valve allows operation by two actuators		•	•	•

* Special long pockets are available in lengths from 0.5 m to 1 m.

Table 8 Control system ancillaries (continued)

Mounting options and ancillaries	Control system type		
	SA121	SA122	SA128
 **Manual actuator** When coupled to a valve, it enables the valve to be manually operated. 	•	•	•