

HANDBOOK
EXPANSION VALVES

Ed. 2017

 **Castel**[®]
Italian technology

CHAPTER 5 ■

SOLENOID EXPANSION VALVES FOR VERY LOW TEMPERATURE

FOR REFRIGERATION PLANTS THAT USE THE R23 REFRIGERANT



APPLICATIONS

The solenoid expansion valves in series 2028R illustrated in this chapter have been designed for installation in very low temperature refrigeration plants that use R23 refrigerant fluid

OPERATION

Please refer to Chapter 3, second paragraph, for the description of the operation of the valves in series 2028R, as it is identical to that of valves in series 2028.

CONSTRUCTION

The valves in series 2028R are supplied complete with orifice. Nine different orifices with nine different maximum potentials that range from orifice O1 to orifice O9 can be assembled. The last two numbers in the part number identify the type of orifice that has been mounted on the valve at the factory. For example, part number 2028R/3S02 identifies a 3/8" valve with solder connections and size O2 orifice. **The orifices are NOT interchangeable because it is strictly prohibited to disassemble this valve for any reason, including for brazing on the system.** Inside the valve body is a ring mesh filter that traps dirt and contaminants at the valve inlet.

Valves in series 2028R are sold exclusively in the model without coil (suffix S).

The main parts of the valves in series 2028R are made from the same materials as the valves in series 2028, with the exception of:

- Copper EN 1625 – Cu-DHP for the outlet gaskets

SELECTION

Please refer to Chapter 3, paragraph 4, for the description of the operation of the valves in series 2028R, as it is identical to that of valves in series 2028.

DIMENSIONING EXAMPLE

- Type of refrigerant: R23
- Evaporator capacity, Q_e : 2.8 kW
- Evaporating temperature, T_e : -40°C
- Minimum condensing temperature, T_c : -5°C
- Liquid refrigerant temperature, T_l : -15°C
- Pressure drop in the liquid line, distributor and evaporator, Δp 2 bar

Step 1 - Determine the pressure drop across the valve.

- Condensing pressure at -5 °C - $P_c = 21.7$ bar
- Evaporating pressure at -40 °C - $P_e = 7.06$ bar

$$\Delta p_{tot} = 21,7 - (7,06 + 2) = 12,6 \cdot \text{bar}$$

Step 2 - Determine required valve capacity

$$\Delta T_{sub} = -5 - (-15) = 10 \cdot ^\circ\text{K}$$

From the subcooling correction factor Table 31B, we find the appropriate correction factor, F_{sub} , equal to 1.05 for $\Delta T_{sub} = 10$ °K. The required valve capacity is

$$Q_{sub} = \frac{2,8}{1,05} = 2,67 \cdot \text{kW}$$

Step 3 - Capacity correction based on the application

According to the above criterion, a correction of + 25% is applied to the calculated capacity:

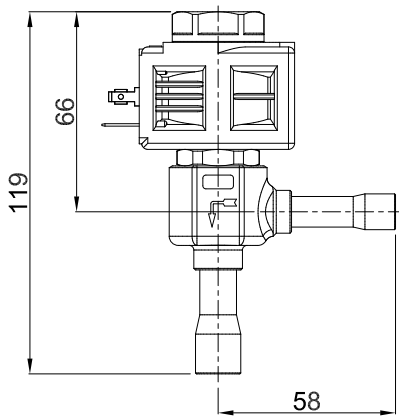
$$Q_{ev} = 1,25 \cdot 2,67 = 3,34 \cdot \text{kW}$$

Step 4 - Determine the orifice size.

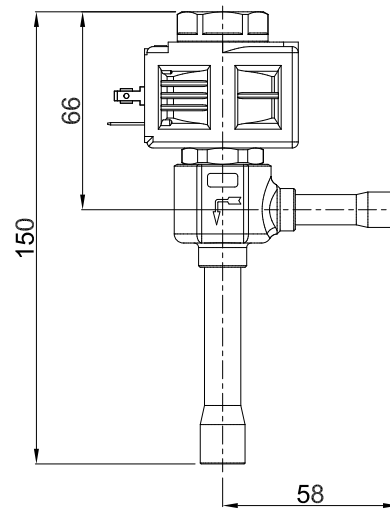
Using the capacity table 31A for R23 refrigerant, enter the data:

- Pressure drop across the valve = 12.6 bar
- Evaporating temperature = -40 °C
- Calculated evaporator capacity = 3.34 kW

Select the corresponding orifice, O3 (Note: the expansion valve capacity must be equal to or slightly greater than the calculated evaporator capacity)



2028R/3
2028R/M10



2028R/4
2028R/M12

TABLE 30: General characteristics of PWM expansion valves, suitable for R23

Catalogue number	Ori- fice Type	ODS Connections				Orifice Size [mm]	Kv Factor [m³/h]	Rated capac- ities R23 [kW]	Opening Pressure Differential [bar]				Operating principles	Mini- mum Working Time [s]	PS [bar]	TS [°C]		TA [°C]		Risk Cat- egory accord- ing to PED Recast	
		[in]		[mm]					MinOPD	MOPD						min.	max.	min.	max.		
		IN	OUT	IN	OUT					9160 (AC)	9160 (DC)	9320 (AC)									9320 (DC)
2028R/3S01	01	3/8"	1/2"	-	-	0,500	0,010	1,50	0	PWM (Pulse Width Modulating)	1	45	-80	+60	-40	+50	Art.4.3				
2028R/M10S01		-	-	10	12																
2028R/3S02	02	3/8"	1/2"	-	-	0,7	0,017	3,00										37	37	37	37
2028R/M10S02		-	-	10	12																
2028R/3S03	03	3/8"	1/2"	-	-	0,8	0,023	3,52										37	37	37	37
2028R/M10S03		-	-	10	12																
2028R/3S04	04	3/8"	1/2"	-	-	1,1	0,043	5,74										27	18	32	32
2028R/M10S04		-	-	10	12																
2028R/3S05	05	3/8"	1/2"	-	-	1,3	0,065	9,77										18	14	32	32
2028R/M10S05		-	-	10	12																
2028R/3S06	06	3/8"	1/2"	-	-	1,7	0,113	13,54	10	22	22	22									
2028R/M10S06		-	-	10	12																
2028R/4S07	07	1/2"	5/8"	-	-	2,300	0,200	21,45	18	14	32	32									
2028R/M12S07		-	-	12	16																
2028R/4S08	08	1/2"	5/8"	-	-	2,500	0,230	25,78	27	27	27	27									
2028R/M12S08		-	-	12	16																
2028R/4S09	09	1/2"	5/8"	-	-	2,700	0,250	28,57	10	22	22	22									
2028R/M12S09		-	-	12	16																

Rated capacities are based on:

- Evaporating temperature $T_{\text{evap}} = -30 \text{ }^\circ\text{C}$
- Condensing temperature $T_{\text{cond}} = -4 \text{ }^\circ\text{C}$
- Refrigerant liquid temperature ahead of valve $T_{\text{liq}} = -8 \text{ }^\circ\text{C}$

TABLE 31A: Refrigerant R23 - Capacities in kW

Evaporating Temperature -30 °C										Evaporating Temperature -40 °C									
Orifice Type	Pressure drop across valve [bar]									Orifice Type	Pressure drop across valve [bar]								
	2	4	6	8	10	12	14	16	18		2	4	6	8	10	12	14	16	18
01	0,72	0,90	1,07	1,22	1,37	1,50	1,62	1,73	1,83	01	0,76	0,95	1,12	1,28	1,42	1,56	1,69	1,80	1,91
02	1,44	1,80	2,14	2,44	2,73	3,00	3,24	3,46	3,67	02	1,52	1,89	2,24	2,56	2,85	3,12	3,37	3,60	3,82
03	1,71	2,13	2,52	2,88	3,21	3,52	3,81	4,07	4,30	03	1,81	2,24	2,64	3,01	3,35	3,67	3,96	4,23	4,48
04	2,76	3,45	4,09	4,68	5,23	5,74	6,21	6,64	7,03	04	2,91	3,62	4,28	4,89	5,46	5,98	6,46	6,90	7,31
05	4,72	5,89	6,97	7,98	8,91	9,77	10,56	11,29	11,95	05	4,99	6,19	7,31	8,34	9,29	10,18	10,99	11,74	12,43
06	6,56	8,18	9,67	11,06	12,35	13,54	14,64	15,65	16,57	06	6,93	8,60	10,14	11,57	12,89	14,11	15,24	16,27	17,23
07	10,31	12,89	15,28	17,50	19,56	21,45	23,21	24,81	26,28	07	10,89	13,55	16,01	18,29	20,40	22,35	24,16	25,81	27,33
08	12,45	15,55	18,40	21,05	23,51	25,78	27,88	29,80	31,55	08	13,16	16,33	19,28	22,00	24,53	26,86	29,02	30,99	32,82
09	13,82	17,24	20,40	23,33	26,06	28,57	30,89	33,01	34,95	09	14,60	18,12	21,38	24,39	27,18	29,77	32,15	34,33	36,35
Evaporating Temperature -50 °C										Evaporating Temperature -60 °C									
Orifice Type	Pressure drop across valve [bar]									Orifice Type	Pressure drop across valve [bar]								
	2	4	6	8	10	12	14	16	18		2	4	6	8	10	12	14	16	18
01	0,84	1,03	1,21	1,37	1,52	1,66	1,79	1,91	2,02	01	0,82	1,01	1,18	1,34	1,49	1,62	1,75	1,86	1,97
02	1,68	2,06	2,42	2,74	3,04	3,32	3,58	3,82	4,04	02	1,64	2,01	2,36	2,68	2,97	3,24	3,49	3,72	3,94
03	2,00	2,44	2,85	3,23	3,58	3,91	4,21	4,48	4,74	03	1,95	2,38	2,78	3,15	3,49	3,81	4,10	4,37	4,62
04	3,22	3,95	4,62	5,25	5,83	6,37	6,86	7,32	7,74	04	3,14	3,85	4,52	5,12	5,69	6,21	6,69	7,13	7,54
05	5,51	6,75	7,89	8,95	9,93	10,84	11,68	12,45	13,17	05	5,38	6,59	7,70	8,73	9,69	10,58	11,39	12,14	12,82
06	7,65	9,36	10,94	12,41	13,77	15,02	16,19	17,26	18,25	06	7,47	9,14	10,69	12,12	13,44	14,66	15,79	16,82	17,77
07	12,03	14,76	17,28	19,63	21,80	23,80	25,66	27,37	28,95	07	11,74	14,41	16,88	19,16	21,27	23,23	25,02	26,68	28,19
08	14,53	17,80	20,81	23,61	26,21	28,60	30,83	32,87	34,76	08	14,18	17,37	20,33	23,05	25,57	27,91	30,06	32,04	33,85
09	16,13	19,74	23,08	26,18	29,05	31,69	34,16	36,41	38,50	09	15,74	19,27	22,54	25,55	28,34	30,93	33,31	35,49	37,49
Evaporating Temperature -70 °C										Evaporating Temperature -80 °C									
Orifice Type	Pressure drop across valve [bar]									Orifice Type	Pressure drop across valve [bar]								
	2	4	6	8	10	12	14	16	18		2	4	6	8	10	12	14	16	18
01	0,92	1,09	1,26	1,42	1,56	1,70	1,82	1,94	2,04	01	1,08	1,11	1,26	1,42	1,55	1,69	1,81	1,92	2,02
02	1,84	2,19	2,52	2,83	3,12	3,39	3,64	3,87	4,08	02	2,15	2,21	2,53	2,83	3,11	3,37	3,61	3,83	4,04
03	2,18	2,58	2,97	3,33	3,67	3,98	4,27	4,54	4,79	03	2,55	2,62	2,98	3,33	3,66	3,96	4,24	4,50	4,73
04	3,52	4,18	4,82	5,42	5,98	6,49	6,97	7,41	7,82	04	4,11	4,23	4,84	5,42	5,95	6,45	6,92	7,34	7,73
05	6,02	7,14	8,22	9,24	10,18	11,05	11,86	12,61	13,29	05	7,04	7,24	8,26	9,24	10,14	10,99	11,77	12,49	13,15
06	8,36	9,92	11,41	12,81	14,11	15,32	16,45	17,48	18,42	06	9,78	10,04	11,46	12,81	14,07	15,23	16,31	17,32	18,22
07	13,14	15,63	18,02	20,26	22,34	24,27	26,07	27,72	29,22	07	15,38	15,83	18,10	20,26	22,26	24,13	25,86	27,46	28,91
08	15,88	18,85	21,70	24,37	26,86	29,17	31,31	33,30	35,09	08	18,57	19,09	21,80	24,37	26,77	29,00	31,06	32,98	34,71
09	17,63	20,90	24,06	27,02	29,77	32,32	34,69	36,89	38,87	09	20,62	21,17	24,17	27,02	29,67	32,13	34,42	36,53	38,45

TABLE: 31B - Correction factor for subcooling $\Delta t_{sub} \neq 4^\circ K$

$\Delta t_{sub} [^\circ K]$	4	10	15	20	25	30	35	40	45
F_{sub}	1,00	1,05	1,10	1,15	1,20	1,25	1,29	1,40	1,45

When subcooling ahead of the expansion valve is other than 4 °K , adjust the evaporator capacity by dividing by the appropriate correction factor found in Table 31B

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