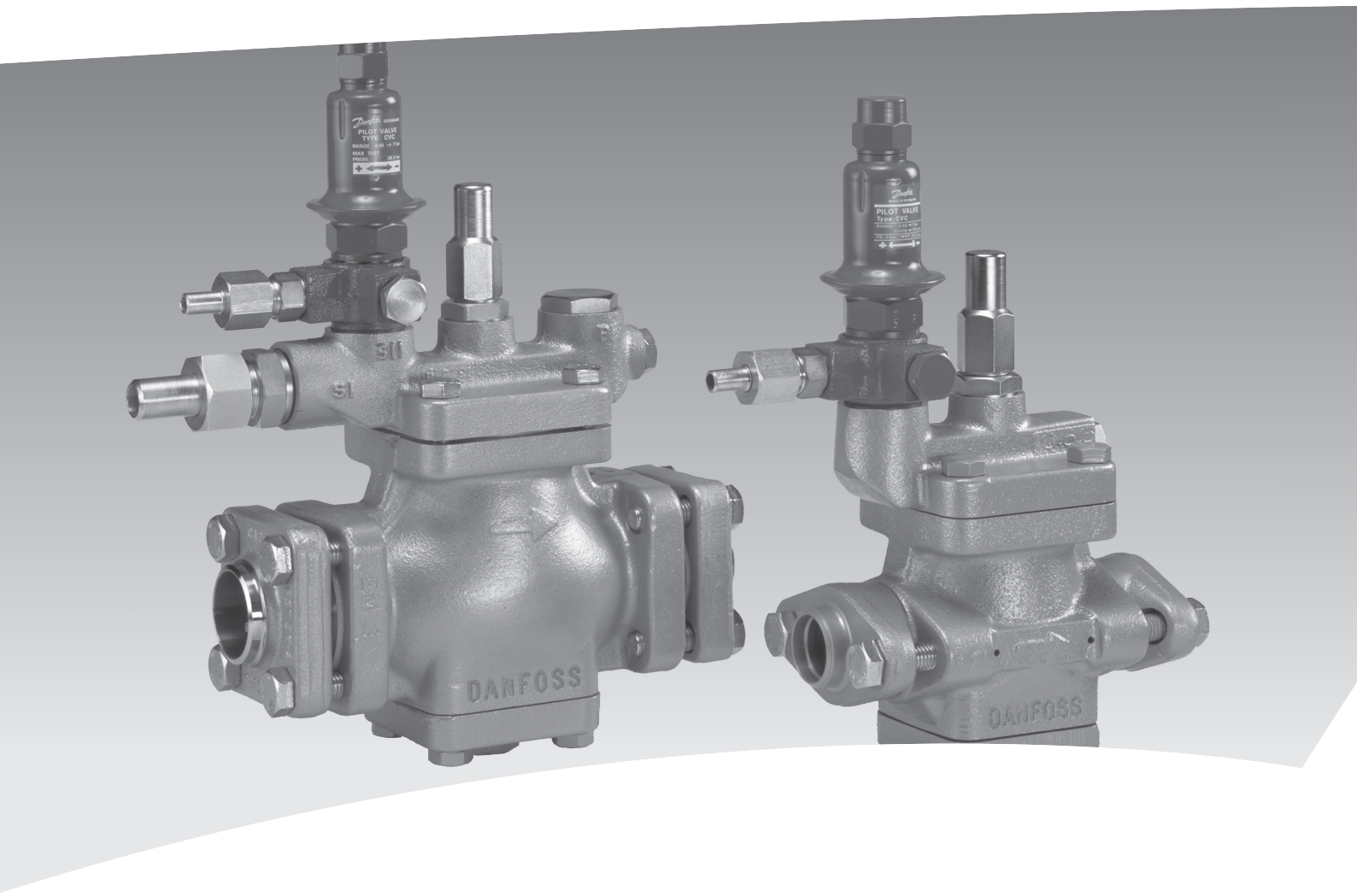


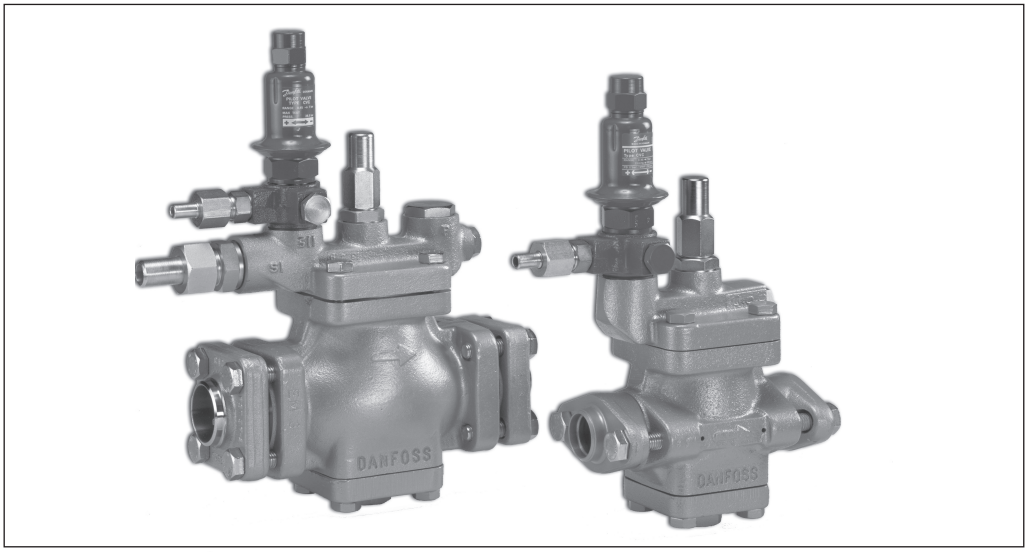
Capacity regulators (hot gas bypass)
Type PMC and CVC

REFRIGERATION AND
AIR CONDITIONING

Technical leaflet

Contents

Introduction



The PMC and CVC is used for capacity regulation in refrigeration, freezing and air conditioning plant for ammonia and fluorinated refrigerants. The PMC is a servo-operated regulator with screwed-on pilot valves.

PMC and CVC can be used in all types of refrigeration plant:

- With direct expansion
- With pump recirculation
- With natural circulation

The function of the capacity regulator is to match the fixed output of the compressor and the varying load on the system. This function is obtained when the PMC and CVC is installed in a bypass line between the discharge and suction sides of the compressor.
If the load on the evaporator, and with it the load on the compressor, falls, an "artificial" load in the form of hot gas from the high pressure side of the compressor is applied to the evaporator or compressor.

Features

- Accurate regulation
- High capacity and operating range
- Independent of condensing pressure variations
- High flexibility
- Screw in pilot
- Simple adjustment and build-up

Materials

- Gaskets are non-asbestos
- Valve body
  EN-GJS-400-18-LT or cast iron GG 25

CE

Pressure Equipment Directive (PED)
The PMC and CVC valves are approved in accordance with the European standard specified in the Pressure Equipment Directive and are CE marked. For further details / restrictions - see Installation Instruction.

PMC and CVC valves	
Nominal bore	DN ≤ 25 (1 in.)
Classified for	Fluid group I
Category	Article 3, paragraph 3

Technical data

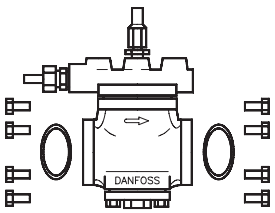
Type		Refrigerants [1]	Opening diff. pressure Δp bar	P-band	Temperature of medium °C	Max. working pressure PS [2] bar	Max. test pressure p' bar
PMC 1 and PMC 3		R22 R134a R404A R717 (NH_3) R12 R502 ect.		With built-on CVC: Approx. 0.2 bar	−50 → +120	28	42.0
CVC					−50 → +120	17/28	26.5/42.0
EVM	a.c.: 10W d.c.: 20W		a.c.: 0 → 21 d.c.: 0 → 14		−50 → +120	35	46.0

[1] In addition to the refrigerants specified, other fluorinated refrigerants can be used within the pressure or temperature range of the valves.

[2] Max. working and test pressures refers to the high pressure side connection (PS: 28 and p': 42 bar) and reference pressure (PS: 17 and p': 26.5 bar) which must be connected to the low pressure side of the system.

Ordering

PMC main valves

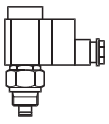
	PMC 1 		*PMC 3* 	
Size	GG-25	EN-GJS-400-18-LT	GG-25	EN-GJS-400-18-LT
PMC 5	**027F0140**	**027F3045**	**027F0150**	**027F3049**
PMC 8	**027F0141**	**027F3046**	**027F0151**	**027F3050**
PMC 12	**027F0142**	**027F3047**	**027F0152**	**027F3051**
PMC 20	**027F0143**	**027F3048**	**027F0153**	**027F3052**

Valve size	Rated replacement capacity in kW						k_v value
	R22	R134a	R404A	R12	R502	R717	m^3/h [1]
PMC 5	36	19	36	20	34	96	1.7
PMC 8	67	35	65	37	61	179	3.2
PMC 12	82	47	88	51	83	244	4.2
PMC 20	140	74	136	78	130	367	6.5

[1]) The k_v value is the water flow in m^3/h at a pressure drop across the valve of 1 bar (ρ = 1000 kg/m^3).

The code nos. stated apply to main valve type PMC incl. flange gaskets and bolts.

The rated capacity is given for an evaporating temperature of t_e = –10°C, a condensing temperature of t_c = +32°C and an offset (= suction temperature reduction Δt_s) of 4 K.

Pilot valves

Description	Range	**Code no.**
Pilot valve type CVC with ∅ 6.5/10 mm weld signal connection	–0.45 → +7 bar	**027B1070** [1])
Pilot valve type EVM	a.c.	**027B1122** [2])
	d.c.	**027B1124** [2])

[1]) The code no. stated apply to pilot valve type CVC incl. pilot signal connector.
[2]) When ordering, please state code no., voltage and frequency.

Flange sets

Valve type	Flange type	Weld flange set		Solder flange set			
		in.	**Code no.** [1])	in.	**Code no.** [1])	mm	**Code no.** [1])
PMC 1 and 3	12	$^3/_4$	**027N1220**	$^7/_8$	**027L1223**	22	**027L1222**
		1	**027N1225**	$1^1/_8$	**027L1229**	28	**027L1228**
		$1^1/_4$	**027N1230**				

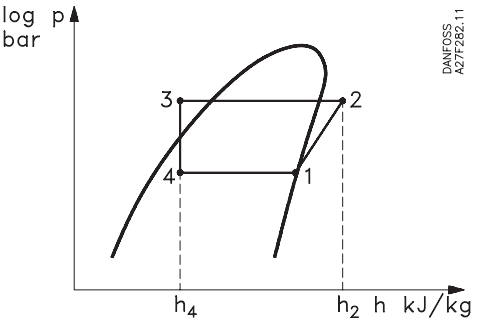
[1]) Code no. applies to a flange set consisting of one inlet flange and one outlet flange.

Example
PMC 3 size 12, code no. **027F0152**
+ 1 in. flange set, code no. **027N1225**
+ CVC, code no. **027B1070**
+ EVM, code no. **027B1122**, 220 V, 50 Hz
+ ∅ 6.5 / 10 mm pressure gauge connection, code no. **027B2035**.

Accessories

Description		**Code no.**
Pressure gauge connector Ø 6.5 / Ø 10 mm weld / solder		**027B2035**
Pressure gauge connector ¼ in. flare (self-closing) Must not be used for ammonia		**027B2041**
Pressure gauge connector, cutting ring connection	6 mm	**027B2063**
	10 mm	**027B2064**
Pressure gauge connector	¼ NPT	**027B2062**
External pilot connection		**027F1048**

Sizing



Q_h = $\dot{m}_b(h_2-h_4)$ (kW) where
Q_h = hot gas capacity or replacement capacity given in table in kW
$\dot{m}_b$ = flow through PMC in kg/s
h_2-h_4 = enthalpy difference in kJ/kg

The stated PMC hot gas capacities assume that the hot gas is injected ahead of the evaporator. The thermostatic expansion valve compensates for the heat the hot gas transfers to the evaporator by increasing liquid injection. In this way the superheat at the evaporator outlet is kept more or less constant.
Capacities are thus made up of the PMC regulator capacity + expansion valve compensation.
Capacities are given for an offset (= suction temperature reduction Δt_s) of 4 K.

Suction pressures in the table relates to suction pressure / suction temperature after the reduction.
If a smaller offset than 4 K is required, multiply the capacity found at $\Delta t_s = 4$ K by a correction factor k.
If the correction factors are not changed as a function of the suction temperature reduction Δt_s, the proportional band of the regulator is fully utilized.
The proportional band of the regulator is approx. 0.2 bar.

Selection example
An R134a unit for compressed air drying must be capacity regulated from 100% to 0% using hot gas injection direct into the evaporator after the expansion valve. The compressor has no internal capacity regulation.
Compressor capacity, $Q_c = 12$ kW at $t_e = 0°C$ and $t_c = +30°C$.
Min. suction temperature, t_s min. = 0°C.
Max. off-set, Δt_s max. = 2 K.
Min. evaporator load, Q_e min. = 0 kW.
Necessary PMC replacement capacity, $Q_h = 12 - 0 = 12$ kW.
From the capacity table, it can be seen that PMC size 5 produces 19 kW at $t_s = 0°C$, $t_c = +30°C$ and $\Delta t_s = 4$ K.
Correction factor k for off-set $\Delta t_s = 2$ K is given as 0.7.
The final replacement capacity Q_h for PMC size 5 thus become $19 \times 0.7 = 13.3$.
A PMC size 5 will therefore produce the same as the compressor, i.e. 12 kW at an off-set a little lower than 2 K.

Hot gas capacity

Hot gas / replacement capacity for suction temperature reduction, off-set $\Delta t_s = 4$ K.

Type PMC 1 and PMC 3

Size	Suction temp. t_s after temperature reduction °C	kg/s				kW			
		Condensing temperature t_c °C							
		20	30	40	50	20	30	40	50
R22									
5	+10	0.111	0.184	0.232	0.29	23	36	45	55
	0	0.14	0.182	0.231	0.289	29	36	45	55
	-10	0.14	0.181	0.231	0.289	29	36	45	55
	-20	0.138	0.181	0.231	0.289	29	36	45	54
	-30	0.137	0.17	0.229	0.289	29	36	45	54
	-40	0.137	0.18	0.229	0.289	29	36	45	54
8	+10	0.192	0.337	0.425	0.534	38	67	83	101
	0	0.257	0.333	0.424	0.532	54	67	83	101
	-10	0.257	0.333	0.424	0.532	54	67	82	101
	-20	0.253	0.333	0.424	0.532	54	67	82	101
	-30	0.253	0.33	0.424	0.532	54	67	82	101
	-40	0.251	0.33	0.397	0.397	54	67	77	76
12	+10	0.239	0.455	0.574	0.722	49	89	111	139
	0	0.348	0.45	0.573	0.72	72	89	111	139
	-10	0.348	0.45	0.573	0.72	72	89	111	139
	-20	0.343	0.45	0.573	0.72	72	89	111	139
	-30	0.339	0.447	0.538	0.541	73	90	104	102
	-40	0.339	0.364	0.393	0.4	73	73	77	75
20	+10	0.335	0.688	0.885	1.112	67	130	173	216
	0	0.53	0.694	0.885	1.112	108	140	173	216
	-10	0.537	0.694	0.885	0.922	108	140	173	173
	-20	0.53	0.694	0.733	0.715	108	140	140	140
	-30	0.464	0.53	0.568	0.567	99	107	108	108
	-40	0.369	0.399	0.41	0.414	79	80	78	79

Correction factor k for different off-set (suction temperature reductions)

Refrige-rant	Suction temp. t_s after temperature reduction °C	t_c = 20°C and 30°C				t_c = 40°C and 50°C			
		Suction temperature reduction Δt_s k							
		1	2	3	4	1	2	3	4
R22	+10	0.4	0.7	0.9	1.0	0.6	0.9	1.0	1.0
	0	0.5	0.9	1.0	1.0	0.5	0.7	0.9	1.0
	-10	0.5	0.9	1.0	1.0	0.5	0.7	0.9	1.0
	-20	0.4	0.7	0.9	1.0	0.5	0.7	0.9	1.0
	-30	0.4	0.7	0.9	1.0	0.4	0.6	0.8	1.0
	-40	0.3	0.6	0.8	1.0	0.4	0.7	0.8	1.0

Type PMC 1 and PMC 3

Size	Suction temp. t_s after temperature reduction °C	kg/s				kW			
		Condensing temperature t_c °C							
		20	30	40	50	20	30	40	50
R134a									
5	+10	0.019	0.122	0.156	0.194	3	19	24	29
	0	0.072	0.12	0.154	0.192	15	19	24	29
	-10	0.092	0.118	0.152	0.192	15	19	24	29
	-20	0.092	0.118	0.151	0.192	15	19	24	29
	-30	0.092	0.118	0.151	0.192	15	19	24	29
8	+10	0.035	0.224	0.285	0.358	5	34	43	52
	0	0.161	0.22	0.281	0.354	26	35	44	54
	-10	0.169	0.218	0.28	0.353	28	35	44	54
	-20	0.169	0.218	0.28	0.353	28	35	44	54
	-30	0.169	0.218	0.278	0.353	28	35	44	54
12	+10	0.047	0.302	0.385	0.484	7	46	58	72
	0	0.203	0.299	0.38	0.478	33	47	58	73
	-10	0.228	0.294	0.378	0.478	37	47	60	73
	-20	0.228	0.294	0.378	0.478	37	47	60	73
	-30	0.228	0.294	0.332	0.359	37	47	52	54
20	+10	0.076	0.421	0.594	0.747	12	65	89	113
	0	0.264	0.46	0.587	0.739	42	73	90	113
	-10	0.332	0.455	0.584	0.636	55	74	91	96
	-20	0.332	0.403	0.466	0.505	55	66	73	77
	-30	0.278	0.32	0.358	0.374	45	52	56	57

Correction factor k for different off-set (suction temperature reductions)

Refrige-rant	Suction temp. t_s after temperature reduction °C	t_c = 20°C and 30°C				t_c = 40°C and 50°C			
		Suction temperature reduction Δt_s k							
		1	2	3	4	1	2	3	4
R 134a	+10	0.1	0.4	0.8	1.0	0.4	0.8	1.0	1.0
	0	0.3	0.7	0.9	1.0	0.4	0.7	0.9	1.0
	-10	0.3	0.6	0.8	1.0	0.3	0.6	0.8	1.0
	-20	0.3	0.6	0.8	1.0	0.3	0.6	0.8	1.0
	-30	0.2	0.6	0.8	1.0	0.2	0.5	0.8	1.0

Hot gas capacity
(continued)

Hot gas / replacement capacity for suction temperature reduction, off-set Δt_s = 4 K.

Type PMC 1 and PMC 3

Size	Suction temp. t_s after temperature reduction °C	kg/s				kW			
		Condensing temperature t_c °C							
		20	30	40	50	20	30	40	50
R404A									
5	+10	0.151	0.235	0.295	0.373	23	34	43	50
	0	0.184	0.234	0.294	0.37	28	36	43	51
	−10	0.182	0.233	0.292	0.368	28	36	44	51
	−20	0.179	0.231	0.291	0.367	28	36	43	51
	−30	0.178	0.23	0.291	0.367	28	36	43	51
	−40	0.178	0.23	0.291	0.367	28	36	43	51
8	+10	0.266	0.43	0.543	0.685	39	63	78	93
	0	0.337	0.427	0.539	0.68	51	65	79	93
	−10	0.333	0.425	0.536	0.676	52	65	79	94
	−20	0.328	0.425	0.535	0.676	52	65	79	94
	−30	0.328	0.425	0.535	0.676	52	65	79	94
	−40	0.328	0.425	0.535	0.59	52	65	79	82
12	+10	0.333	0.577	0.734	0.927	49	85	106	122
	0	0.454	0.579	0.73	0.921	69	86	107	122
	−10	0.449	0.575	0.725	0.915	71	88	107	122
	−20	0.443	0.575	0.725	0.915	72	88	107	122
	−30	0.443	0.574	0.725	0.744	72	88	107	104
	−40	0.443	0.53	0.544	0.569	72	79	105	79
20	+10	0.435	0.871	1.132	1.429	65	125	159	193
	0	0.688	0.892	1.125	1.418	104	136	170	193
	−10	0.694	0.886	1.118	1.191	109	136	170	170
	−20	0.685	0.886	0.928	0.941	110	136	136	136
	−30	0.659	0.713	0.73	0.875	107	113	105	125
	−40	0.511	0.557	0.556	0.569	82	84	82	79

Correction factor k for different off-set (suction temperature reductions)

Refrige-rant	Suction temp. t_s after temperature reduction °C	t_c = 20°C and 30°C				t_c = 40°C and 50°C			
		Suction temperature reduction Δt_s K							
		1	2	3	4	1	2	3	4
R404A	+10	0.4	0.7	0.9	1.0	0.6	0.9	1.0	1.0
	0	0.5	0.9	1.0	1.0	0.5	0.7	0.9	1.0
	−10	0.5	0.9	1.0	1.0	0.5	0.7	0.9	1.0
	−20	0.4	0.7	0.9	1.0	0.5	0.7	0.9	1.0
	−30	0.4	0.7	0.9	1.0	0.4	0.6	0.8	1.0
	−40	0.3	0.6	0.8	1.0	0.4	0.7	0.8	1.0

Type PMC 1 and PMC 3

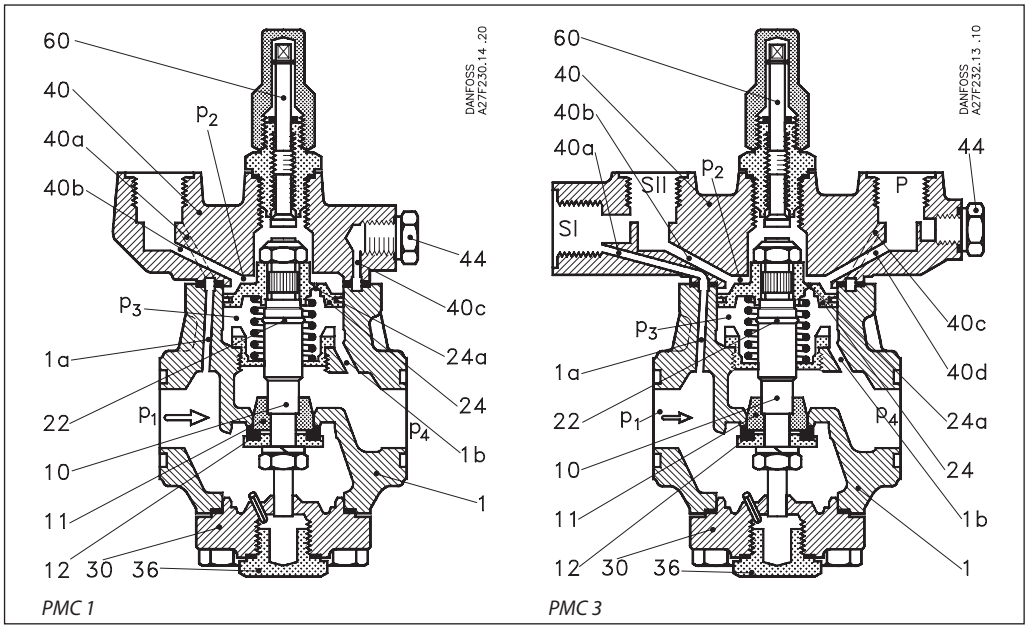
Size	Suction temp. t_s after temperature reduction °C	kg/s				kW			
		Condensing temperature t_c °C							
		20	30	40	50	20	30	40	50
R717 (NH_3)									
5	+10	0.05	0.077	0.098	0.125	63	96	124	158
	0	0.057	0.073	0.097	0.123	73	96	124	158
	−10	0.055	0.072	0.094	0.121	73	96	124	158
	−20	0.054	0.071	0.094	0.121	73	96	124	158
	−30	0.054	0.071	0.094	0.121	73	96	124	158
	−40	0.054	0.071	0.094	0.121	73	96	124	158
8	+10	0.087	0.14	0.18	0.23	111	179	230	282
	0	0.102	0.136	0.178	0.227	141	179	230	282
	−10	0.101	0.133	0.173	0.224	141	179	230	282
	−20	0.1	0.132	0.173	0.224	141	179	230	282
	−30	0.1	0.132	0.173	0.195	141	179	230	243
	−40	0.1	0.115	0.129	0.137	141	154	166	179
12	+10	0.109	0.189	0.245	0.312	139	244	313	383
	0	0.139	0.183	0.241	0.306	186	244	313	383
	−10	0.137	0.181	0.234	0.303	186	244	313	383
	−20	0.135	0.179	0.234	0.266	186	244	313	336
	−30	0.135	0.177	0.19	0.196	186	244	255	244
	−40	0.11	0.122	0.13	0.139	151	162	174	174
20	+10	0.144	0.287	0.377	0.48	184	356	475	583
	0	0.213	0.283	0.372	0.473	281	367	475	583
	−10	0.211	0.279	0.362	0.359	281	367	475	454
	−20	0.207	0.244	0.27	0.27	281	324	356	346
	−30	0.172	0.189	0.197	0.185	238	248	259	238
	−40	0.12	0.121	0.126	0.099	162	162	173	130

Correction factor k for different off-set (suction temperature reductions)

Refrige-rant	Suction temp. t_s after temperature reduction °C	t_c = 20°C and 30°C				t_c = 40°C and 50°C			
		Suction temperature reduction Δt_s K							
		1	2	3	4	1	2	3	4
R717 (NH_3)	+10	0.4	0.8	0.9	1.0	0.5	0.8	1.0	1.0
	0	0.5	0.8	1.0	1.0	0.4	0.7	0.9	1.0
	−10	0.5	0.8	1.0	1.0	0.4	0.6	0.8	1.0
	−20	0.4	0.6	0.8	1.0	0.4	0.6	0.8	1.0
	−30	0.3	0.6	0.8	1.0	0.4	0.6	0.8	1.0
	−40	0.2	0.6	0.8	1.0	0.2	0.6	0.8	1.0

Design/Function

1. Valve body
1a and 1b. Channels in valve body
10. Regulating spindle
11. Throttling cone
12. Valve seat
22. Locking ring
24. Servo piston
24 a. Equalizing hole in servo piston
30. Bottom cover
36. Plug
40. Cover
40 a, b, c and d. Channels in cover
44. Blanking plug for pressure gauge connection
60. Manual operating spindle



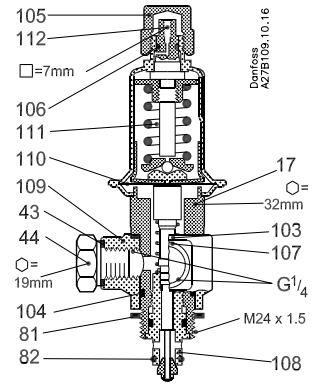
PMC 1 *PMC 3*

The PMC regulator is a servo-operated main valve whose function is determined by the pilot valve. The main valve with pilot valve controls refrigerant flow by modulation in accordance with the pilot valve impulse.
The degree of opening of the PMC is determined by the pressure difference (differential pressure) between pressure p_2, which acts on the top of the servo piston (24), and pressure p_3, which acts on the underside of the servo piston.
Because of the channel (1b) in the valve body, pressure p_3 acting on the underside of the servo piston (24) is equal to the regulator discharge pressure, p_4.
If this pressure difference is 0, the regulator will be fully closed.
If the pressure difference is approximately 0.7 bar or more, the regulator will be fully open.
At pressure differences (p_2 - p_4) between approximately 0.3 bar and 0.7 bar the opening degree of the regulator will be correspondingly proportional. The shape of the throttling hole (11) gives an ideal regulation characteristic to servo-operated regulators.

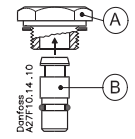
The degree of opening of the regulator is thus controlled by applying a pressure, p_2, on the top of the servo piston which is equal to or greater than the discharge pressure, p_4.
$p_2 = p_4$ ~ closed position.
$p_2 = p_4 + 0.7$ bar ~ completely open position.
$p_4 \leq p_2 \leq p_4 + 0.7$ bar ~ proportional degree of opening.
The maximum pressure, p_2, that can be built up on the top of the servo piston (24) normally corresponds to the pressure, p_1, acting on the regulator inlet side. Inlet pressure p_1 is led, via the drilled channels (1a, 40a, 40b, 40c, 40d) in the valve body (1) and cover (40) through the individual pilot valves and on the top of the servo piston (24).
The degree of opening of the individual pilot valves determines the size of pressure p_2 and thus the degree of opening of the regulator, i.e. the equalisation hole (24a) in the servo piston (24) ensures that pressure p_2 is balanced in accordance with the degree of opening of the pilot valve.

Design
Function
(continued)

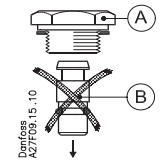
43. Gasket
44. Blanking plug for pressure gauge connection
81. Gasket
82. O-ring
103. Banjo fitting
104. O-ring
105. Protective cap
106. O-ring
107. Signal connection
108. Pilot orifice
109. Banjo fitting connector
110. Diaphragm
111. Spring
112. Setting spindle



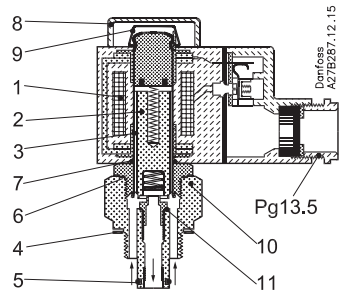
CVC



Blanking plug A + B



Blanking plug A



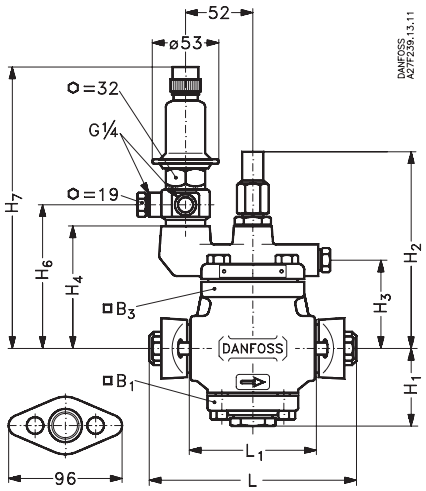
EVM

1. Coil
2. Armature
3. Armature tube
4. Gasket
5. O-ring
6. Seal ring
7. Spacing ring
8. Nut
9. Locking knob
10. Union nut
11. Valve seat

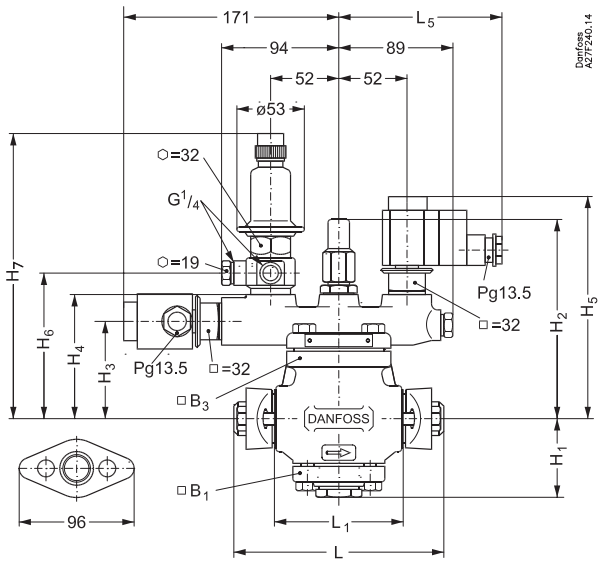
PMC opens when the pressure p_s in the signal connection (107) is below set point.
The PMC 3 has three connections for pilot valves, two in series (marked "SI" and "SII") and one in parallel (marked "P").

If only two pilot valves are necessary for the required function, the third pilot port must be blanked with the blanking plug provided. Fitting instructions accompany the blanking plug.

Dimensions and weights

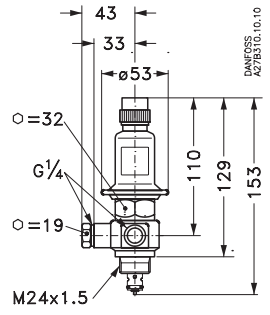


PMC 1 and CVC

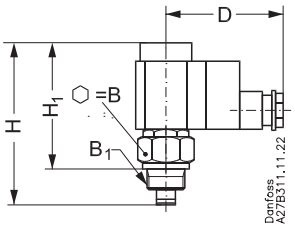


PMC 3, CVC and EVM

Type	Size	H_1	H_2	H_3	H_4	H_5	H_6	H_7	L	L_1	L_5 max.		B_1	B_3	Weight with flanges but without pilot valves		
											10 W	20 W			PMC 1	PMC 3	Flangeset
PMC 1	5 - 20	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	kg	kg	kg
PMC 3		66	162	79	101	178	117	228	177	106	122	132	75	87	6.5	7.0	1.1

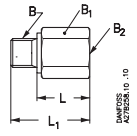


CVC

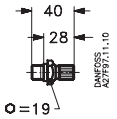


EVM

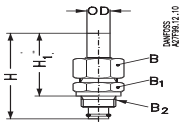
Pilot valve type	Weight kg
CVC	0.7
EVM	0.5



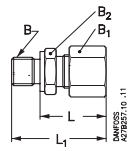
Pressure gauge connector, ¼ NPT



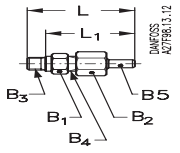
Pressure gauge connector, flare



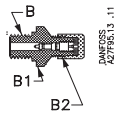
External pilot connection



Pressure gauge connector, cutting ring connection



Pressure gauge connector



Pressure gauge connector, self-closing

Size	A	B	L	M
6 mm	19	14	39	27
10 mm	19	19	40	29