

Technical brochure

Electrically operated valves for CO₂ CCM - Gas bypass & Expansion



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Introduction



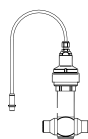
The CCM is an electrically operated valve designed specifically for operation in CO₂ systems. The valve is capable of functioning both as an expansion valve, and as a gas bypass valve with back-pressure regulation in subcritical applications.

The pressure rating allows for operation in environments where system standby capability is required without the need for auxiliary cooling systems during servicing or power outages.

Features

- Up to 90 bar (1305 psi) working pressure to accommodate CO₂ system pressures during standstill conditions.
- Precise positioning for optimal control of intermediate pressures in transcritical CO₂ systems or liquid injection in heat exchangers.
- Possibility of bi-flow operation
- MOPD up to 50 bar (725 psi)
- Combined stainless steel butt weld/solder connections for installation in copper piped systems (K65 alloy or standard) as well as steel piped systems.
- Standard M12 connector for simple and flexible connection to the motor driver.
- For manual operation and service of the CCM an AST-g service driver is available. For further information please contact Danfoss (Commercial Refrigeration and Air Conditioning Controls).

Technical data



Parameter	CCM
Compatibility	R744
MOPD	50 bar (725 psi)
Max. working pressure (PS/MWP)	90 bar (1305 psi)
Refrigerant temperature range	-40°C to 40°C (-40°F to 104°F)
Ambient temperature	-40°C to 60°C (-40°F to 140°F)
Total stroke	13 mm / 16 mm (0.5 in. / 0.6 in.)
Motor enclosure	IP 67

Electrical data

Parameter	CCM
Stepper motor type	Bi-polar - permanent magnet
Step mode	2 phase full step
Phase resistance	52Ω ±10%
Phase inductance	85 mH
Holding current	Depends on application. Full current allowed (100% duty cycle)
Step angle	7.5° (motor), 0.9° (lead screw), Gearing ration 8.5:1. (38/13):1
Nominal voltage	(Constant voltage drive) 12 V dc -4% +15%, 150 steps/sec.
Phase current	(Using chopper drive) 100 mA RMS -4% +15%,
Max. total power	Voltage / current drive: 5.5 / 1.3 W (UL: NEC class 2)
Step rate	150 steps/sec. (constant voltage drive) 0-300 steps/sec. 300 recommended (chopper current drive)
Total steps	CCM 10, 20, 30 2625 [+160 / -0] steps CCM 40 3530 [+160 / -0] steps
Full travel time	CCM 10, 20, 30 17 / 8.5 sec. (voltage / current) CCM 40 23 / 11.5 sec. (voltage / current)
Lifting height	CCM 10, 20, 30 13 mm (0.5 in.) CCM 40 16 mm (0.6 in.)
Reference position	Overdriving against the full close position
Electrical connection	4 wire 0.5 mm ² (0.02 in ²), 0.3 m (1 ft) long cable

Stepper motor switch sequence:

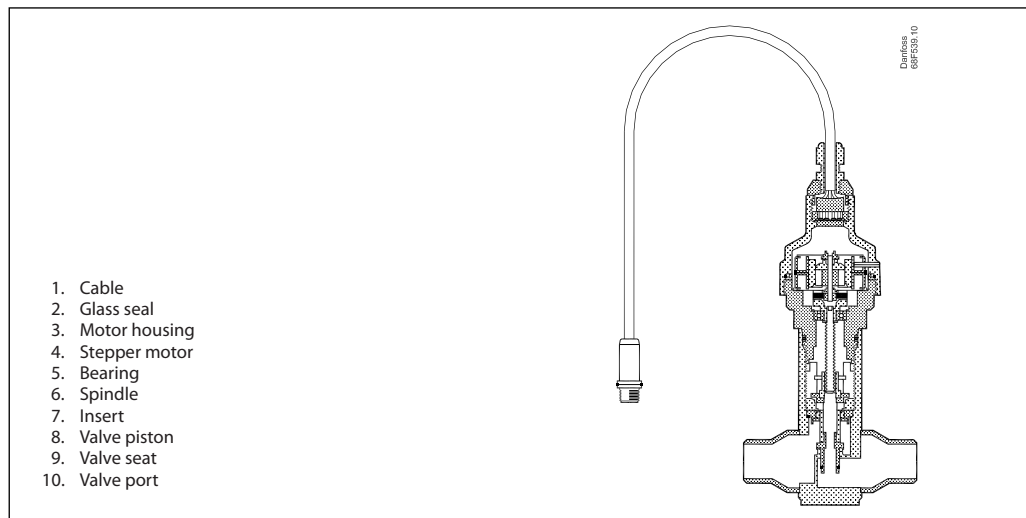
CCM		Wire Color	Connector
	4	Black	4
	3	White	3
	2	Green	2
	1	Red	1
	Connection 1	Wire Color	Connection 2
	Pin Out		

Stepper motor switch sequence:

	STEP	Coil I		Coil II		↑ CLOSING ↑	↓ OPENING ↓
		Red	Green	White	Black		
	1	+	-	+	-		
	2	+	-	-	+		
	3	-	+	-	+		
	4	-	+	+	-		
	1	+	-	+	-		

Design

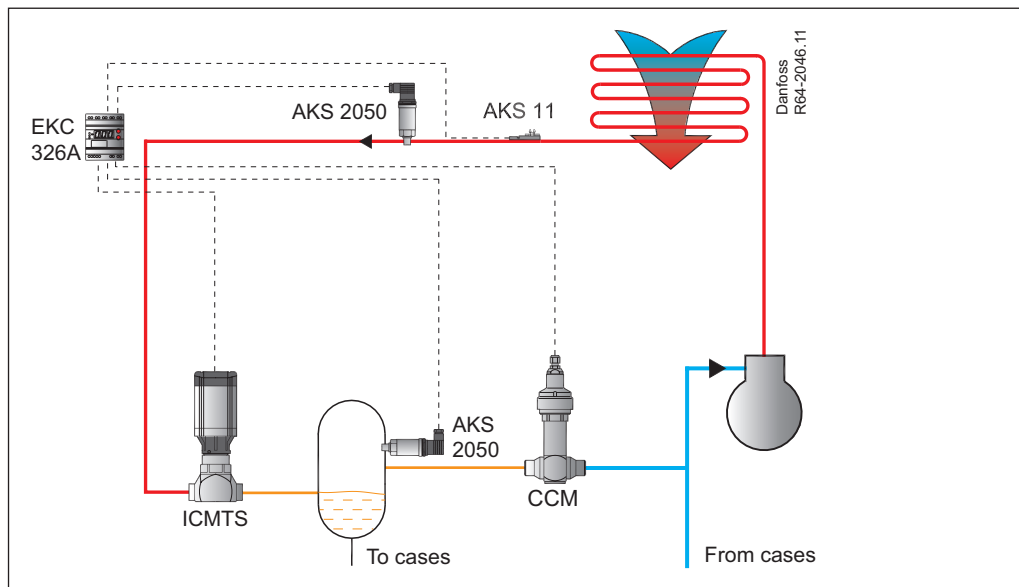
CCM



Valve operation

The CCM can be used in a variety of applications within CO₂ refrigeration systems. Typically it is

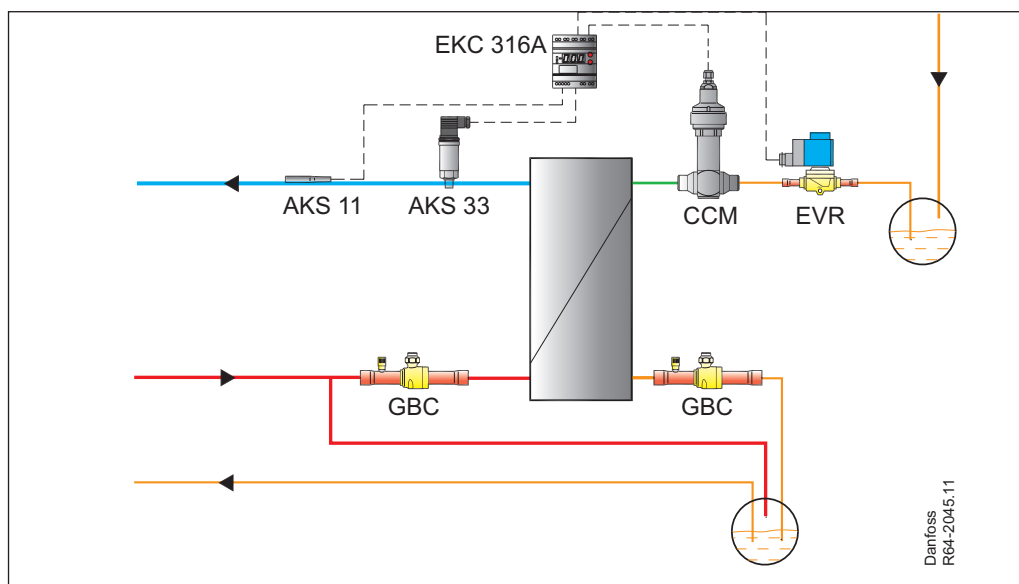
used as a gas bypass valve in a transcritical CO₂ booster system or as an expansion valve.



Application 1

A gas bypass valve is typically used to regulate the intermediate pressure in a transcritical CO₂ refrigeration system. By venting flashgas generated after the transcritical expansion, the pressure can

be kept at a safe level for all components situated in the liquid lines of a transcritical CO₂ system. For use in the gas bypass application the EKC326A controller is recommended.

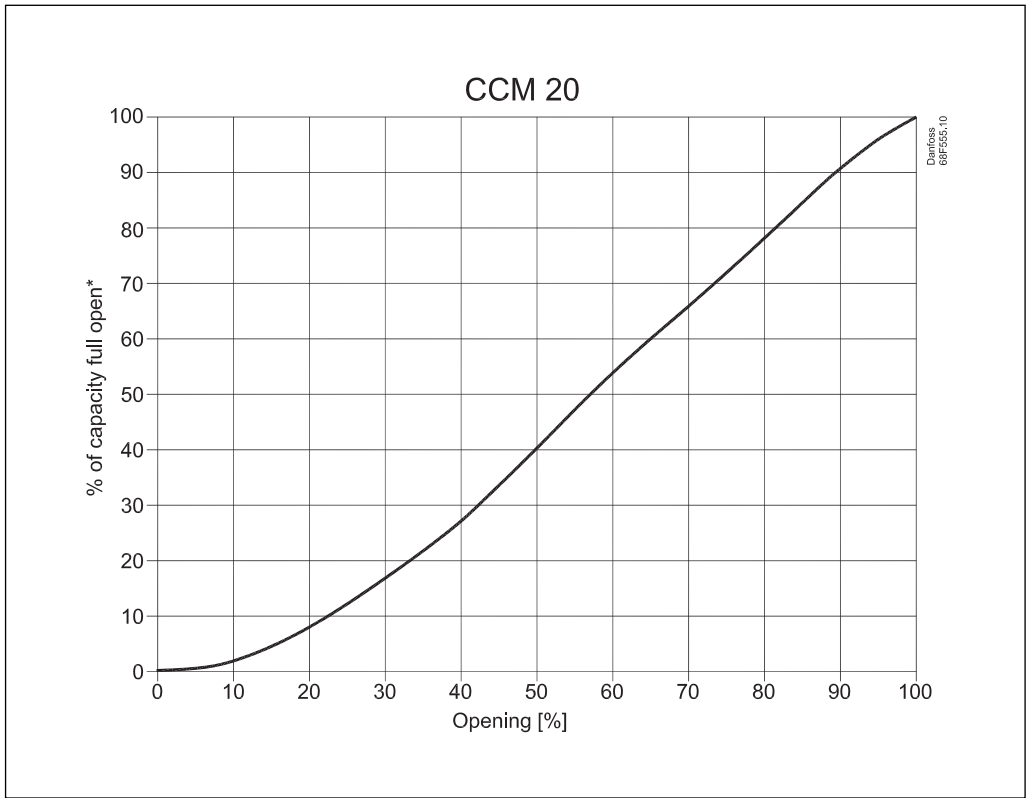
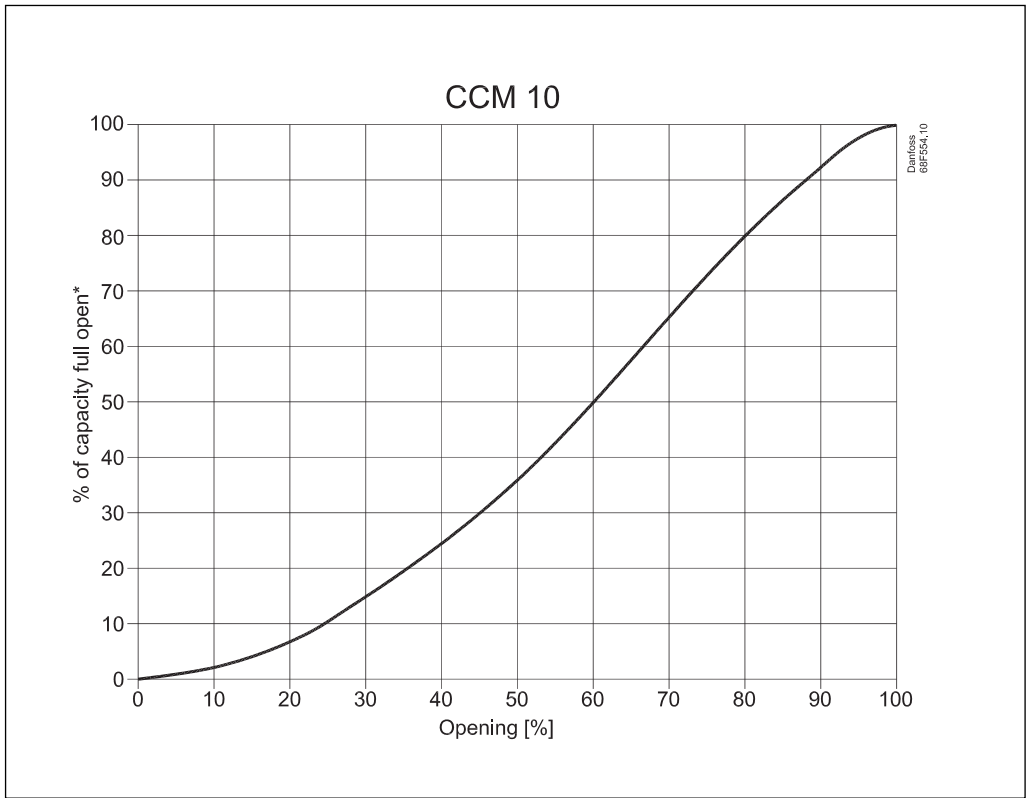


Application 2

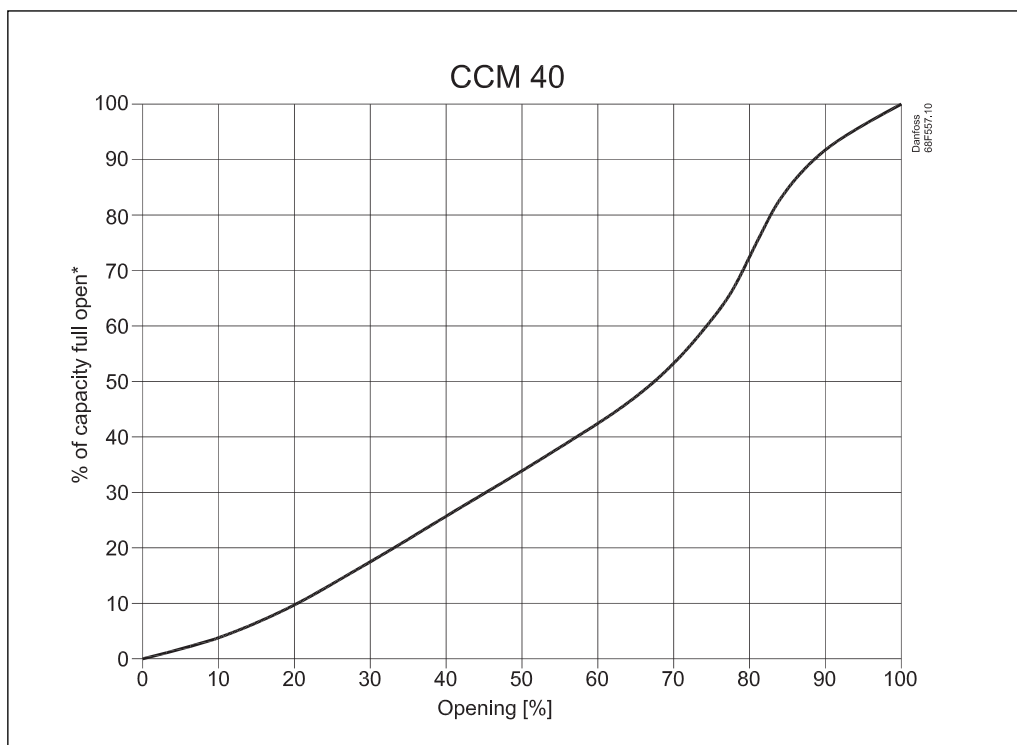
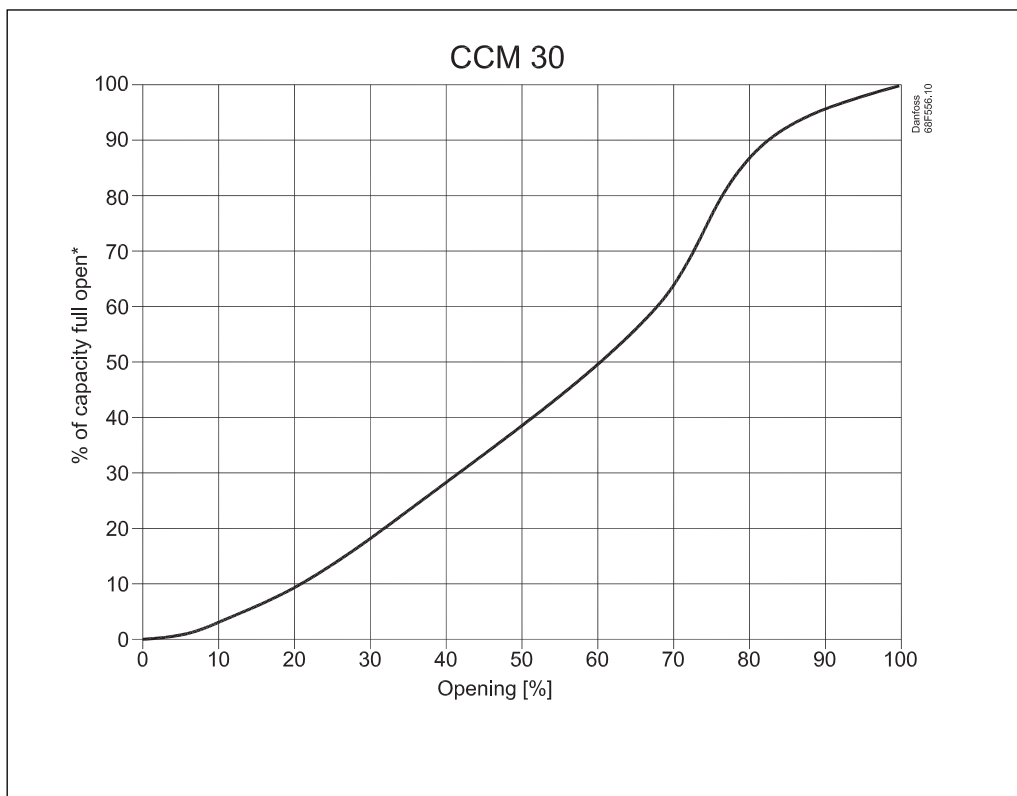
A liquid expansion valve is typically used for injection in plate heat exchangers of CO₂/CO₂ cascades, or as an expansion valve for CO₂ evaporators. For the

liquid injection applications CCM is used with EKC 316A controller.

Valve operation (Cont.)



Valve operation (Cont.)



Sizing and capacities

The following tables indicate nominal capacities of the valve in the gas bypass application and in the liquid expansion application with R744 (CO₂) as refrigerant. Capacities are given for varying operating conditions within the normal range

of the valve. If the capacity shown in the table is less than 75% of the required capacity, then it is recommended to use a valve one size larger, or as an alternative, to use an additional valve in parallel.

Gas Bypass Application

The capacities shown are based on the amount of flash gas produced when expanding from supercritical CO₂ before the transcritical expansion valve (ICMTS) at 35°C and the corresponding

optimal high pressure setting (89 bar) as set by the Danfoss EKC326A controller. The capacities shown are the total system evaporating capacity at the given evaporating temperature.

		CCM 10- Gas Bypass Application - System Evaporator Capacity [kW]													
		Evaporating temperature [°C]													
		-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25
Inlet Pressure [bar]	15	20	17	9											
	20	30	29	26	21	7									
	25	39	40	38	36	31	20								
	30	49	49	49	47	45	40	29							
	35	60	60	60	60	57	55	49	37	7					
	40	71	72	72	72	72	68	65	58	44	11				
	45	85	85	85	86	85	85	80	76	66	49				
	50	101	102	102	102	102	102	101	94	87	75	53			
	55	122	123	123	123	123	123	122	116	111	101	83	53		
	60	154	155	155	156	156	155	154	152	143	134	118	93	49	
	65				221	221	220	218	216	213	195	179	152	109	29
70						610	605	597	587	546	510	450	357	217	

		CCM 20 - Gas Bypass Application - System Evaporator Capacity [kW]													
		Evaporating temperature [°C]													
		-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25
Inlet Pressure [bar]	15	40	33	17											
	20	61	57	53	42	13									
	25	79	79	76	72	62	40								
	30	98	99	99	95	90	80	59							
	35	119	120	120	120	115	110	98	75	14					
	40	143	143	143	144	144	137	130	115	88	22				
	45	170	170	170	171	171	170	161	151	133	98				
	50	202	203	203	204	204	203	202	188	174	150	105			
	55	244	246	246	247	247	246	244	232	221	201	167	107		
	60	308	310	311	311	311	310	308	305	285	268	237	186	98	
	65				442	442	440	437	432	425	390	357	303	219	58
70						1219	1209	1195	1173	1092	1019	899	715	435	

		CCM 30 - Gas Bypass Application - System Evaporator Capacity [kW]													
		Evaporating temperature [°C]													
		-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25
Inlet Pressure [bar]	15	59	50	26											
	20	91	86	79	63	20									
	25	118	119	113	107	93	61								
	30	147	148	148	142	135	120	88							
	35	179	180	180	180	172	164	147	112	20					
	40	214	215	216	216	216	205	195	173	132	32				
	45	255	256	256	257	256	256	241	227	199	148				
	50	303	305	305	306	306	305	303	282	262	224	158			
	55	367	368	370	370	370	369	366	348	332	302	250	160		
	60	462	465	466	467	466	465	462	457	428	402	355	279	147	
	65				663	662	660	655	648	638	585	536	455	328	87
70						1829	1814	1792	1760	1639	1529	1349	1072	652	

Gas Bypass Application (continued)

		CCM 40 - Gas Bypass Application - System Evaporator Capacity [kW]													
		Evaporating temperature [°C]													
		-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25
Inlet Pressure [bar]	15	104	87	45											
	20	159	151	139	111	35									
	25	207	208	198	188	162	106								
	30	258	259	259	248	237	210	155							
	35	313	314	315	316	301	288	257	196	36					
	40	375	376	377	378	377	359	341	303	231	56				
	45	445	447	449	449	449	447	422	397	348	258				
	50	531	533	535	535	535	533	530	494	458	392	277			
	55	642	645	647	648	647	645	641	608	581	528	437	280		
	60	809	813	816	817	816	813	808	800	749	703	622	488	257	
	65				1160	1159	1155	1146	1134	1116	1024	938	797	574	153
	70						3200	3175	3136	3080	2868	2675	2361	1876	1142

Liquid Expansion Application

Valve capacities when operating as an expansion valve are given in the following table for different evaporating temperatures (t_e) and varying pressure differences over the valve. The values shown are based on 0.1 K liquid subcooling at the inlet to

the valve and no useful superheat. Capacities can be adjusted for different levels of subcooling by multiplying the capacity found in the table below, by the capacity correction factor found in the subsequent table.

		CCM 10 - Liquid Expansion Application - Evaporator Capacity [kW]															
		Pressure drop Δp [bar]															
		2	4	6	8	10	12	14	16	20	24	28	32	36	40	44	48
Evaporating temperature t _e [°C]	-40	53	73	86	96	103	110	115	119	126	130	132	133	133	131	128	125
	-35	51	70	83	93	101	107	112	116	122	126	129	130	129	127	125	120
	-30	50	68	80	90	97	103	108	113	119	123	125	125	125	123	120	115
	-25	47	65	77	86	94	100	105	109	114	118	120	121	120	118	114	109
	-20	45	62	74	83	90	96	100	104	110	113	115	115	114	111	107	100
	-15	43	59	70	79	85	91	95	99	104	107	109	108	107	103	98	89
	-10	41	56	66	74	81	86	90	93	98	101	102	101	98	94	86	
	-5	38	52	62	70	75	80	84	87	91	93	93	92	88	81		
	0	35	48	57	64	70	74	77	80	83	85	84	81	75			
	5	32	44	52	59	63	67	70	72	74	74	72	66				
	10	29	40	47	52	56	59	61	63	64	62	54					
	15	25	34	40	45	48	50	51	52	50							
20	21	28	33	36	38	38	38	35									
25	16	20	23	23													

		CCM 20 - Liquid Expansion Application - Evaporator Capacity [kW]															
		Pressure drop Δp [bar]															
		2	4	6	8	10	12	14	16	20	24	28	32	36	40	44	48
Evaporating temperature t _e [°C]	-40	104	142	167	187	202	215	225	233	245	253	258	260	259	256	251	243
	-35	101	137	162	181	197	209	219	227	239	247	251	253	252	249	243	235
	-30	97	132	157	175	190	202	212	220	232	240	244	245	244	240	234	225
	-25	93	127	151	169	183	195	204	212	224	231	235	236	234	230	223	212
	-20	89	121	144	162	175	187	196	203	214	221	224	225	222	217	209	196
	-15	84	115	137	154	167	178	186	193	204	210	212	212	208	202	191	175
	-10	79	109	129	145	158	168	176	182	192	197	198	197	192	183	169	
	-5	74	102	121	136	147	157	164	170	178	182	182	179	172	159		
	0	69	94	112	126	136	144	151	156	163	165	164	158	146			
	5	63	86	102	114	124	131	136	141	145	145	141	129				
	10	56	77	91	102	110	116	120	123	124	121	106					
	15	49	67	79	87	93	98	100	101	97							
20	41	55	64	70	74	75	74	68									
25	30	40	45	45													

CCM 30 - Liquid Expansion Application - Evaporator Capacity [kW]																	
Evaporating temperature t_e [°C]	Pressure drop Δp [bar]																
		2	4	6	8	10	12	14	16	20	24	28	32	36	40	44	48
	-40	161	219	259	289	312	331	347	360	379	391	398	401	400	396	388	376
	-35	155	212	251	280	304	322	338	350	369	381	388	391	390	384	376	363
	-30	150	204	242	271	294	312	327	340	358	370	377	379	377	371	361	348
	-25	143	196	233	261	283	301	316	328	345	357	363	364	361	355	344	328
	-20	137	188	223	250	271	288	302	314	331	341	346	347	343	335	322	303
	-15	130	178	212	237	258	274	288	299	314	324	328	327	322	312	296	270
	-10	123	168	200	224	243	259	271	282	296	304	306	304	297	283	261	
	-5	115	157	187	210	228	242	253	263	275	281	282	277	266	246		
0	106	146	173	194	210	223	233	241	251	255	253	244	225				
5	97	133	158	177	191	202	211	217	224	224	217	199					
10	87	119	141	157	169	178	185	189	192	186	164						
15	76	104	122	135	144	151	155	156	150								
20	63	85	99	108	114	116	114	104									
25	47	62	69	70													

CCM 40 - Liquid Expansion Application - Evaporator Capacity [kW]																	
Evaporating temperature t_e [°C]	Pressure drop Δp [bar]																
		2	4	6	8	10	12	14	16	20	24	28	32	36	40	44	48
	-40	276	377	445	496	537	569	596	618	651	672	685	689	688	680	666	646
	-35	267	364	431	482	522	554	580	602	635	656	667	672	669	661	646	624
	-30	257	351	416	466	505	537	562	584	616	636	647	651	647	637	621	597
	-25	246	337	400	448	486	517	542	563	594	613	623	626	621	609	591	564
	-20	235	322	383	429	466	495	520	539	569	587	595	596	590	576	554	521
	-15	223	306	364	408	443	471	494	513	540	556	563	562	553	536	508	463
	-10	211	289	344	385	418	445	466	484	509	522	527	523	510	486	448	
	-5	197	271	322	361	391	416	435	451	473	483	484	476	457	422		
0	183	251	298	334	361	384	401	415	432	438	434	419	287				
5	167	229	272	304	328	348	262	373	385	386	373	341					
10	150	205	243	270	291	307	318	326	330	320	281						
15	131	178	209	232	248	259	266	268	258								
20	108	146	170	186	195	199	196	180									
25	81	106	119	121													

Inlet pressure [bar]	Capacity correction factor for liquid subcooling									
	Subcooling [K]									
	4	10	15	20	25	30	35	40	45	50
20	1.04	1.1	1.15	1.2	1.24	1.29	1.34			
40	1.06	1.15	1.22	1.29	1.36	1.42	1.49	1.55	1.62	1.68
60	1.11	1.26	1.37	1.48	1.58	1.67	1.78	1.86	1.96	2.05

Ordering

Valve incl. actuator

Single pack

Type	Connections (Combi)		Code nos single pack
	Weld ¹⁾ [in]	Solder ODF x ODF [in]	
CCM 10	1/2 x 1/2	5/8 x 5/8	027H7188
CCM 20	3/4 x 3/4	7/8 x 7/8	027H7187
CCM 30	1 x 1	1 1/8 x 1 1/8	027H7186
CCM 40	1 x 1	1 1/8 x 1 1/8	027H7185

¹⁾ OD according to EN 10220

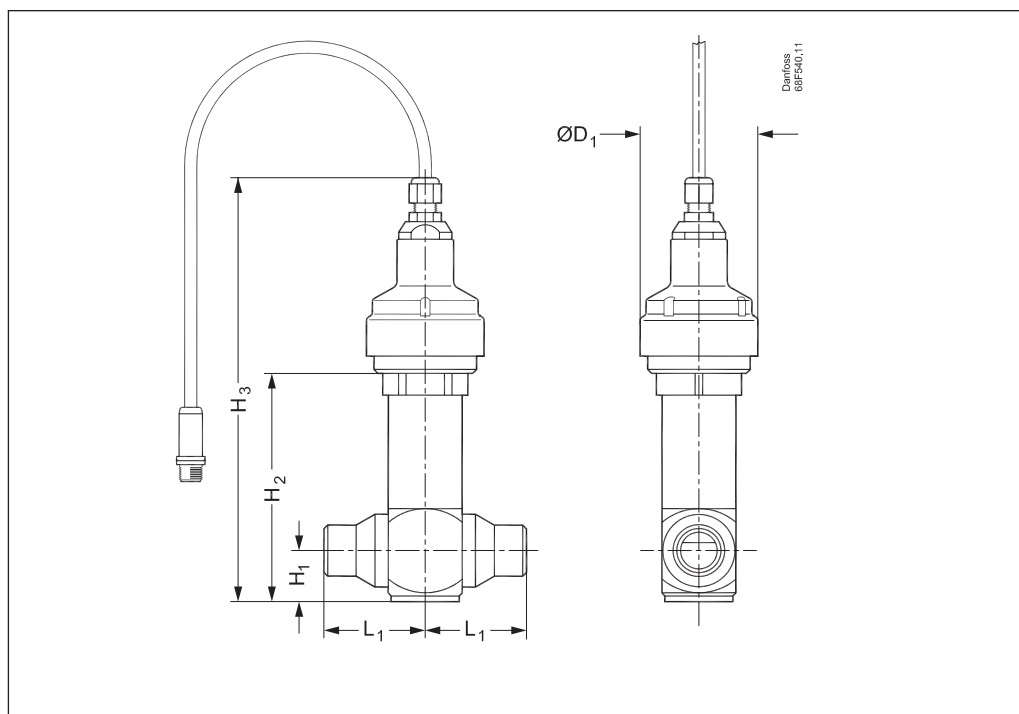
Spare parts

Actuator CCM CO₂ valve, code no. **027H7184**

Wire 4 x 0.5 x 8000 with M12 female, code no. **034G2323**

AST-G driver manual box for operating the valve, code no. **034G0013**

Dimension and weight for CCM



Type	H ₁		H ₂		H ₃		L ₁		ØD ₁		Weight	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	kg	lb.
CCM	26.2	1.0	120.0	4.7	225.0	8.9	53.0	2.1	62.0	2.4	1.8	4.0

For further information please contact Danfoss

