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EX4 / EX5 / EX6 / EX7 / EX8
Electrical Control Valves
Technical Data

Emerson **EX4 / EX5 / EX6 / EX7 / EX8** are stepper motor driven valves for precise control of refrigerant mass flow in air conditioning, refrigeration, heat pumps, close and industrial process cooling applications.

The Control Valves can be used as thermo-expansion duty, liquid injection duty, hot gas bypass, evaporator pressure regulator, crankcase pressure regulator, head pressure regulator, or liquid level control.

This data sheet describes only the performance of the valves. Operation of required controllers, driver boards and sensors are part of other documentations.



EX4 / EX5 / EX6 (Uni-flow/Bi-flow)



EX7 (Uni-flow/Bi-flow)



EX8 (Uni-flow)

Features

- Multifunction as expansion valves, hot gas bypass, suction gas throttling, head pressure, liquid level actuator etc.
- Fully hermetic design (no thread joints between valve body and motor compartment)
- Applicable to all common refrigerants (HCFC, HFC) and for subcritical CO_2 applications
- Stepper motor driven
- Short opening and closing time
- Very fast full stroke time
- High resolution and excellent repeatability
- Bi-flow versions for heat pump applications
- Positive shut-off function to eliminate the need for an additional solenoid valve
- Linear flow capacity
- Extremely wide capacity range (10 … 100%)
- Continuous modulation of mass flow, no stress (liquid hammering) in the refrigeration circuit
- Direct coupling of motor and valve for high reliability (no gear mechanism)
- Ceramic slide and port for accurate flow and minimal wear
- Balanced force design
- Corrosion resistant stainless steel body and connections
- Europe patent No. 0743476, USA patent No. 5735501, Japan patent No. 28225789

Selection table

Type	Part No.	Emerson PCN	Flow Pattern	Capacity Range	Inlet Connection	Outlet Connection	Electric Connector
EX4-I21	800 615	097719	Uni-flow	10 … 100%	3/8” ODF	5/8” ODF	M12 plug
EX5-U21	800 618	097720			5/8” ODF	7/8” ODF	
EX6-I21	800 620	097721			7/8” ODF	1-1/8” ODF	
EX7-I21	800 624	097722			1-1/8” ODF	1-3/8” ODF	
EX8-I21	800 631	097723			1-5/8” ODF	1-5/8” ODF	

EX4/5/6/7/8 are delivered without cable/connector assembly (order separately).

Cable and Connector Assembly for EX4 / EX5 / EX6 / EX7 / EX8

Type	Part No.	Temperature Range	Length	Connector Type to Valve	Connector Type to Driver Board or Controller	Illustration
EX5-N60	804 652	-13 … +176°F	20 ft	M12	Loose wires for EXD-S / -U / -C EC3-33x EC3-X3x EC3-D7x	

Introduction

Thermostatic expansion valves and mechanical regulator valves have been used in the refrigeration and air conditioning industry to control superheat and refrigerant mass flow since its very beginning. As today's systems require improved energy efficiency, tighter temperature control, wider range of operating conditions and incorporate new features like remote monitoring and diagnostics, the application of electronically operated valves becomes mandatory. These Valves offer the control performance necessary to meet these needs.

As more new refrigerants appear on the market requiring an ever increasing number of different charges and settings for thermostatic expansion valves, electrical control valves can work with all refrigerants.

Emerson electrical control valves are the solution for the challenges above. The latest technology and more than 80 years of experience in design and production of flow controls including Thermo® expansion valves have been incorporated in the design of the EX4, EX5, EX6, EX7 and EX8.

Construction

EX4/EX5/EX6/EX7/EX8 consist of two main internal assemblies, the valve and the stepper motor. The stepper motor is connected directly to the slide and cage assembly of the valve. Similar to the technology used in compressors, the motor is exposed to refrigerant and lubricant and the materials used are identical. The housing of the motor and valve assembly is fully hermetic, utilizing exclusively brazing and welding technologies and eliminating all gaskets.

This design offers several technical advantages. The motor is direct coupled to the valve assembly for easy and reliable movement of the valve slide, no need for any other seals and eliminating the use of bellows and diaphragms which could be subject to lifetime limitations and leaks.

Four electrical pins connect the motor to the outside. These pins are applied to the housing using melting-glass process technology. The EX4/5/6/7/8 pins require a M12 electrical connector.

The complete housing of the ECVs is made from stainless steel.

Unlike mechanical expansion valves, EX4/5/6/7/8 are equipped with ceramic slide port.

Features:

- Wide range regulation (10 … 100%) with one slide orifice for each valve
- Linear characteristic over entire capacity range
- Positive shut-off

Guidelines for selection of electrical control valves

The following guideline should be taken in to the consideration in order to obtain full advantages of ECV:

- Published capacities are maximum. There is no reserve capacities.
- Larger size of valve leads to shorter pull down period and shorter travel time i.e. faster respond. For example, EX7 has maximum 3.2 seconds travel time. The valve has approximately 1.6 seconds travel time at 50% capacity operation.

Emerson Selection Tool

For easy and quick selection of Electrical Control Valves an Excel based selection tool can be ordered from the Emerson sales offices, or use the quick selection tables mentioned in this datasheet.

Example:

System with R-407C having two different operating conditions:

A) 32 Tons capacity at +40°F/+122°F with two stages compressor at 50%/100% capacity

B) 39 Tons at +40°F/+86°F with two stages compressor at 50%/100% capacity

EX6 with 36 Tons covers condition A, however is not sufficient to cover condition B. It is recommended to select the larger valve EX7 which offers 96 Tons at condition A and 83 Tons at condition B.

Condition A:

$$\text{Full load ratio} = \frac{32}{96} = 33\%$$

$$\text{Partial load ratio} = \frac{(32/2)}{96} = 16\%$$

Condition B:

$$\text{Full load ratio} = \frac{39}{83} = 47\%$$

$$\text{Partial load ratio} = \frac{(39/2)}{83} = 23\%$$

The capacity ratios of system to valve are in all conditions higher than 10%. It is recommended to use EX7 rather EX6.

EX4/EX5/EX6/EX7/EX8 nominal and extended capacities as expansion valves and liquid injection valves

Nominal Capacities (10% … 100%), Tons

Valve Type	R-407C	R-22	R-134a	R-404A	R-410A	R-23	R-124	R-744
EX4	.6 … 5	.6 … 4.7	.3 … 3.6	.3 … 3.3	.6 … 5.5	.6 … 5.1	.3 … 2.6	.9 … 9.5
EX5	1.4 … 15.1	1.4 … 14.2	1.1 … 11.1	1.1 … 10	1.7 … 16.5	1.4 … 15.4	.9 … 8	2.8 … 29
EX6	4.3 … 35.8	4.3 … 34.1	2.8 … 26.4	2.8 … 23.9	4.3 … 39.8	3.7 … 37	2 … 19.1	6.8 … 69.4
EX7	10 … 98.7	10 … 93.8	7.1 … 72.5	7.1 … 65.4	11.4 … 109.5	-	-	19.9 … 190.5
EX8	28.4 … 263	25.6 … 250.2	19.9 … 193.4	17.1 … 174.3	28.4 … 292	-	-	51.2 … 508.7

Note 1: EX Bi-flow versions are not released for use with R-124 and R-23 refrigerants.
Note 2: EX Bi-flow versions have identical capacity in both flow direction.

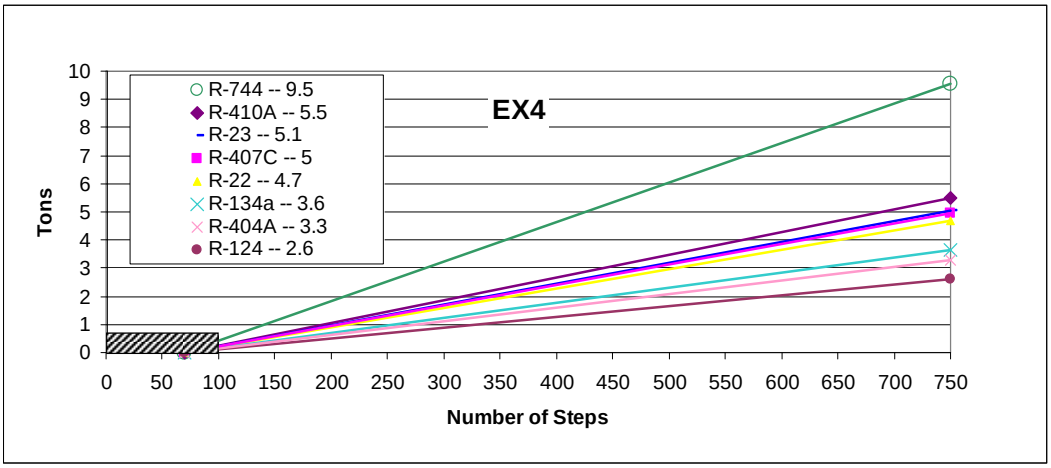
The nominal capacity is based on the following conditions:

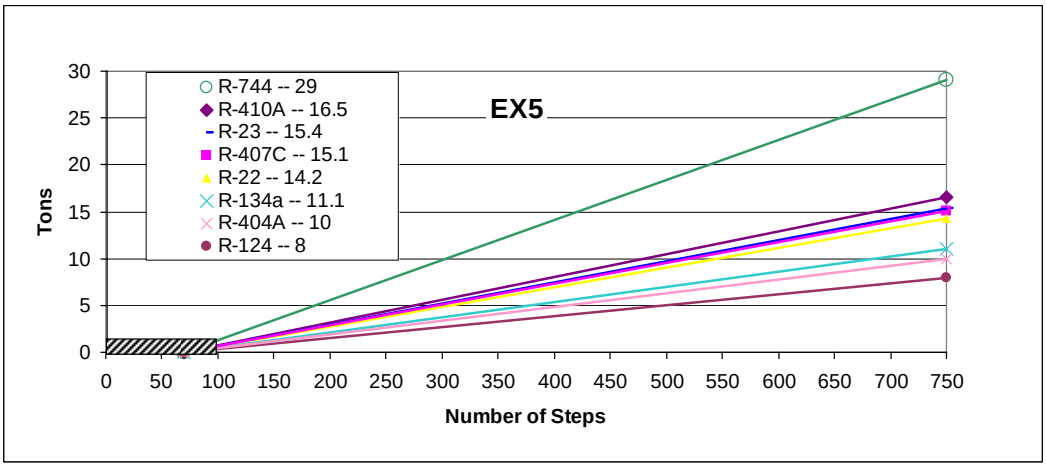
Refrigerant	Evaporating Temperature	Condensing Temperature	Subcooling
R-22, R-134a, R-404A, R-410A	+40 °F	+100°F	2°F
R-407C	+40°F dew point	+100°F bubble	2°F
R-124	+68°F	+176°F	2°F
R-23	-76°F	-13°F	2°F
R-744	-40°F	14°F	2°F

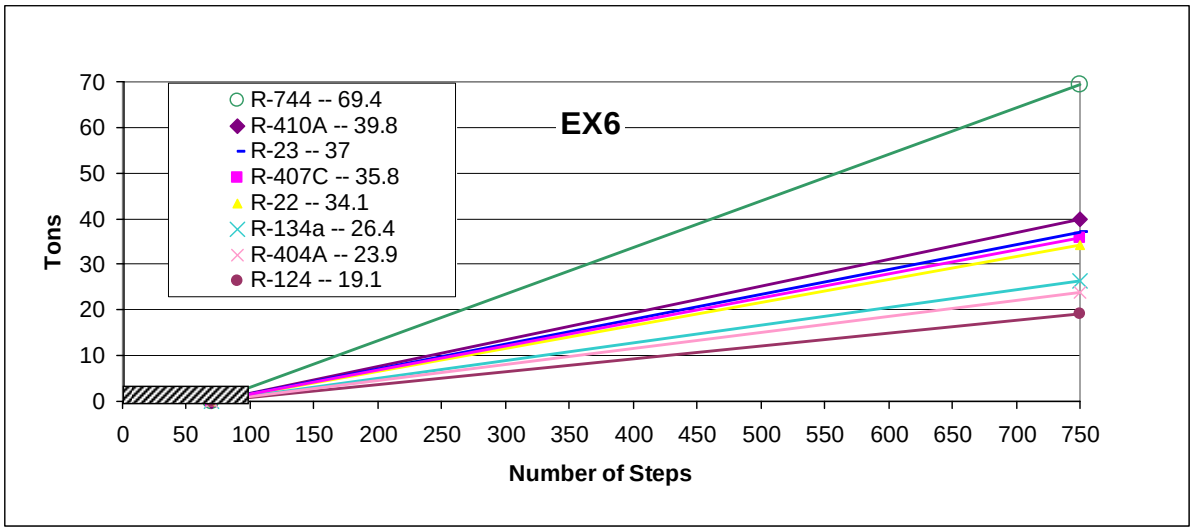
Overview of working pressure regardless of applied refrigerant type

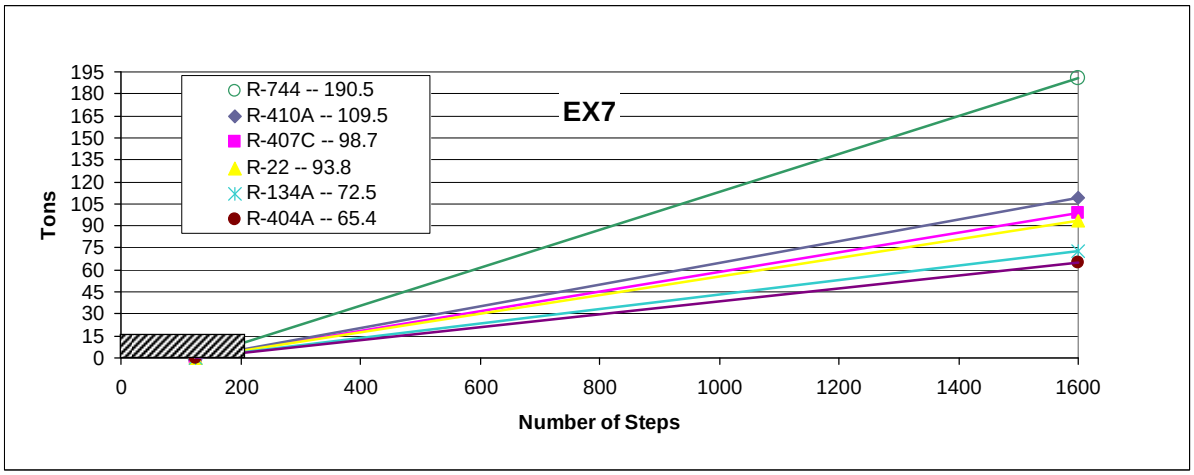
Valve type	Flow Pattern	Maximum Working Pressure (MWP)	Maximum Test Pressure
EX4, EX5, EX6, EX7	Uni-flow/Bi-flow	650 psi	718 psi
EX8	Uni-flow	650 psi	718 psi

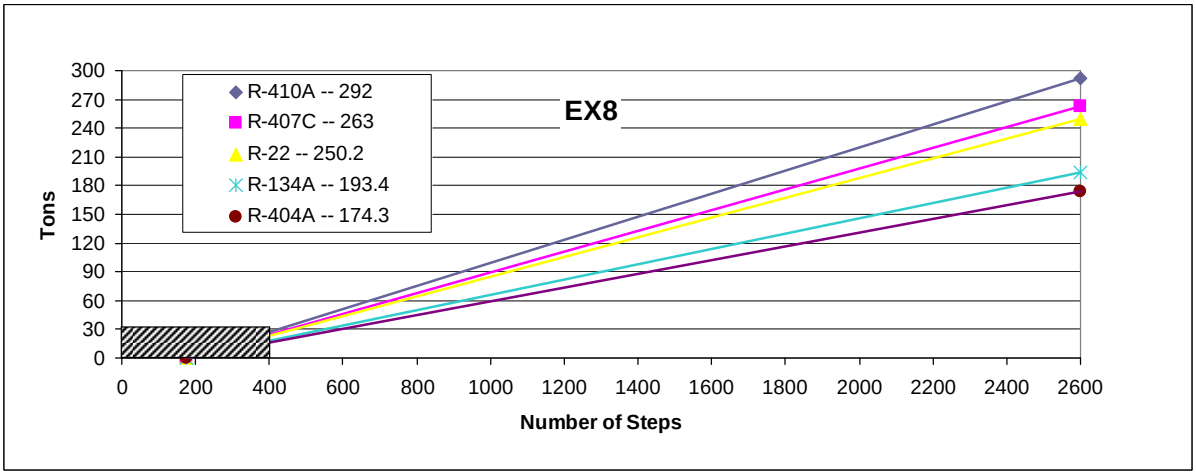
Capacity Diagrams in Tons






EX6
Tons
Number of Steps
R-744 -- 69.4
R-410A -- 39.8
R-23 -- 37
R-407C -- 35.8
R-22 -- 34.1
R-134a -- 26.4
R-404A -- 23.9
R-124 -- 19.1
0
10
20
30
40
50
60
70
0
50
100
150
200
250
300
350
400
450
500
550
600
650
700
750


EX7
Tons
Number of Steps
R-744 -- 190.5
R-410A -- 109.5
R-407C -- 98.7
R-22 -- 93.8
R-134A -- 72.5
R-404A -- 65.4
0
15
30
45
60
75
90
105
120
135
150
165
180
195
0
200
400
600
800
1000
1200
1400
1600


EX8
Tons
Number of Steps
R-410A -- 292
R-407C -- 263
R-22 -- 250.2
R-134A -- 193.4
R-404A -- 174.3
0
30
60
90
120
150
180
210
240
270
300
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600

Extended capacities as expansion and liquid injection valves

The following tables provide the capacity of valves at different conditions considering **20 psi pressure drop** through liquid line:

Condensing Temperature °F	R-410A Extended Capacity Tons Evaporating Temperature °F												Valve Type
	60	50	40	30	20	10	0	-10	-20	-30	-40	-50	
140	5	5	5	5	5	5	5	5	5	5	5	5	EX4
	15	15	16	16	16	16	16	16	15	15	15	15	EX5
	36	37	38	38	38	38	38	38	37	37	36	35	EX6
	99	102	104	105	105	105	105	104	103	101	99	97	EX7
	265	271	277	279	281	281	280	277	274	269	264	258	EX8
130	5	5	5	5	6	6	6	6	5	5	5	5	EX4
	15	16	16	16	17	17	17	17	16	16	16	16	EX5
	37	38	39	40	40	40	40	40	40	39	39	38	EX6
	101	105	107	109	110	110	111	110	109	108	106	104	EX7
	269	279	285	292	293	295	296	294	291	288	283	277	EX8
120	5	5	6	6	6	6	6	6	6	6	6	6	EX4
	15	16	17	17	17	17	17	17	17	17	17	17	EX5
	37	39	40	41	42	42	42	42	42	42	41	40	EX6
	101	106	110	112	114	115	116	116	116	114	113	111	EX7
	270	283	293	299	305	308	309	310	309	305	301	297	EX8
110	5	5	5	6	6	6	6	6	6	6	6	6	EX4
	15	15	16	17	17	17	18	18	18	17	17	17	EX5
	35	37	39	40	42	42	43	43	43	42	42	41	EX6
	96	102	107	111	114	115	117	118	117	116	115	113	EX7
	257	273	286	297	305	308	313	314	313	309	308	303	EX8
100	5	5	5	6	6	6	6	6	6	6	6	6	EX4
	14	15	16	17	17	17	18	18	18	18	18	18	EX5
	33	36	38	40	41	42	43	43	43	43	43	42	EX6
	90	98	105	110	113	116	118	119	119	118	118	116	EX7
	240	261	281	294	301	308	315	316	316	315	316	311	EX8
90	4	4	5	5	5	6	6	6	6	6	6	6	EX4
	12	13	15	16	16	17	17	18	18	18	18	18	EX5
	28	33	36	38	40	41	42	42	43	43	43	43	EX6
	78	89	98	104	109	112	116	116	118	118	118	117	EX7
	207	239	260	277	290	300	308	311	314	314	315	313	EX8
80	3	4	4	5	5	5	6	6	6	6	6	6	EX4
	9	12	13	15	15	16	17	17	17	17	17	17	EX5
	22	28	32	35	37	39	40	41	42	42	42	42	EX6
	61	77	87	97	103	107	111	113	114	116	115	114	EX7
	163	204	233	257	274	286	297	300	305	309	308	305	EX8
70	2	3	4	4	5	5	5	5	6	6	6	6	EX4
	5	9	11	13	14	15	16	16	17	17	17	17	EX5
	11	21	27	31	34	37	39	39	40	41	41	41	EX6
	31	59	75	86	94	101	106	108	111	112	114	113	EX7
	84	157	201	230	251	270	284	289	295	300	303	301	EX8
60	-	1	3	4	4	5	5	5	5	5	5	5	EX4
	-	4	8	11	13	14	15	15	16	16	16	16	EX5
	-	10	20	26	30	33	36	37	38	39	40	39	EX6
	-	27	56	72	84	92	98	102	105	108	109	109	EX7
	-	72	150	192	224	245	262	273	281	287	291	290	EX8
50	-	-	1	3	3	4	4	5	5	5	5	5	EX4
	-	-	3	8	10	12	14	14	15	15	16	16	EX5
	-	-	8	19	25	29	33	35	36	37	38	38	EX6
	-	-	21	53	69	80	90	95	99	102	104	104	EX7
	-	-	57	143	185	214	239	254	265	272	278	277	EX8

Extended capacities as expansion and liquid injection valves

The following tables provide the capacity of valves at different conditions considering **20 psi pressure drop** through liquid line:

Condensing Temperature Bubble Point °F	R-407C Extended Capacity Tons Evaporating Temperature °F 60	50	40	30	20	10	0	-10	Valve Type
140	5	5	5	5	5	5	5	5	**EX4**
	14	15	15	15	15	15	14	14	**EX5**
	34	35	35	35	35	35	34	33	**EX6**
	95	97	97	97	96	95	94	92	**EX7**
	253	257	258	259	256	255	250	244	**EX8**
130	5	5	5	5	5	5	5	5	**EX4**
	15	15	15	15	15	15	15	14	**EX5**
	35	35	36	36	36	35	35	34	**EX6**
	95	96	98	98	98	97	96	94	**EX7**
	253	257	261	261	261	260	256	252	**EX8**
120	5	5	5	5	5	5	5	5	**EX4**
	14	15	15	15	15	15	15	15	**EX5**
	34	35	36	36	36	36	36	36	**EX6**
	93	96	99	99	99	100	99	98	**EX7**
	249	256	264	265	265	266	264	261	**EX8**
110	4	5	5	5	5	5	5	5	**EX4**
	14	14	15	15	15	15	15	15	**EX5**
	33	34	35	35	36	36	36	35	**EX6**
	90	93	96	97	99	99	99	98	**EX7**
	239	248	255	260	263	264	263	260	**EX8**
100	4	4	5	5	5	5	5	5	**EX4**
	13	14	14	15	15	15	15	15	**EX5**
	30	32	34	35	35	36	36	36	**EX6**
	84	89	94	96	98	99	99	98	**EX7**
	224	239	250	256	260	263	264	262	**EX8**
90	4	4	4	5	5	5	5	5	**EX4**
	11	13	13	14	14	15	15	15	**EX5**
	27	30	32	33	34	35	35	35	**EX6**
	75	83	87	92	94	96	97	96	**EX7**
	201	220	233	244	250	256	259	257	**EX8**
80	3	4	4	4	4	5	5	5	**EX4**
	10	11	12	13	13	14	14	14	**EX5**
	23	26	29	31	32	33	34	34	**EX6**
	63	73	80	85	88	91	93	93	**EX7**
	169	193	212	227	235	243	247	248	**EX8**
70	2	3	4	4	4	4	4	4	**EX4**
	7	9	11	12	13	13	14	14	**EX5**
	17	22	26	28	30	31	32	33	**EX6**
	47	61	71	77	83	87	89	90	**EX7**
	125	164	190	206	220	231	236	239	**EX8**
60	0	2	3	3	4	4	4	4	**EX4**
	2	7	9	10	11	12	13	13	**EX5**
	4	16	21	24	27	29	30	31	**EX6**
	10	43	58	67	74	79	82	85	**EX7**
	26	115	154	179	197	211	219	225	**EX8**
50	-	-	2	3	3	4	4	4	**EX4**
	-	-	6	8	10	11	12	12	**EX5**
	-	-	15	20	23	26	27	29	**EX6**
	-	-	40	55	64	70	75	79	**EX7**
	-	-	107	146	170	187	201	210	**EX8**

Extended capacities as expansion and liquid injection valves

The following tables provide the capacity of valves at different conditions considering **20 psi pressure drop** through liquid line:

Condensing Temperature °F	R-22 Extended Capacity Tons, Evaporating temperature °F												Valve Type
	60	50	40	30	20	10	0	-10	-20	-30	-40	-50	
140	5	5	5	5	5	5	5	5	5	5	5	5	**EX4**
	15	15	15	16	16	16	16	15	15	15	15	15	**EX5**
	35	36	37	37	38	38	37	37	37	36	36	35	**EX6**
	97	100	101	102	103	104	103	102	102	100	98	96	**EX7**
	260	266	270	273	275	276	274	272	271	266	262	257	**EX8**
130	5	5	5	5	5	5	5	5	5	5	5	5	**EX4**
	14	15	15	15	16	16	16	15	15	15	15	15	**EX5**
	34	35	36	37	37	37	37	37	37	37	36	36	**EX6**
	94	97	100	101	102	103	102	102	101	101	99	98	**EX7**
	251	258	266	270	273	274	273	273	270	268	264	260	**EX8**
120	4	5	5	5	5	5	5	5	5	5	5	5	**EX4**
	14	14	15	15	15	15	16	15	15	15	15	15	**EX5**
	33	34	35	36	37	37	37	37	37	37	37	36	**EX6**
	90	94	97	99	100	102	103	102	102	101	100	99	**EX7**
	240	250	259	264	268	272	274	272	271	270	268	263	**EX8**
110	4	4	5	5	5	5	5	5	5	5	5	5	**EX4**
	12	13	14	14	15	15	15	15	15	15	15	15	**EX5**
	30	32	34	34	35	36	36	36	37	36	36	36	**EX6**
	82	88	92	95	98	99	100	100	101	99	99	98	**EX7**
	219	234	246	253	260	263	266	266	268	265	263	261	**EX8**
100	4	4	4	5	5	5	5	5	5	5	5	5	**EX4**
	11	12	13	14	14	15	15	15	15	15	15	15	**EX5**
	27	29	31	33	34	35	35	36	36	36	35	35	**EX6**
	74	81	87	91	93	96	97	98	98	98	98	97	**EX7**
	197	216	231	242	249	256	259	263	263	262	260	258	**EX8**
90	3	4	4	4	4	5	5	5	5	5	5	5	**EX4**
	9	11	12	13	13	14	14	14	14	14	14	14	**EX5**
	22	26	29	31	32	33	34	34	35	35	35	34	**EX6**
	61	71	78	84	87	91	93	94	95	95	95	94	**EX7**
	163	190	209	224	233	242	249	251	255	254	253	251	**EX8**
80	2	3	3	4	4	4	4	4	5	5	5	5	**EX4**
	7	9	10	11	12	13	13	14	14	14	14	14	**EX5**
	16	21	25	27	29	30	32	33	33	33	33	33	**EX6**
	44	58	68	75	81	84	87	89	90	91	91	91	**EX7**
	117	156	182	201	215	224	233	239	240	243	243	241	**EX8**
70	-	2	3	3	4	4	4	4	4	4	4	4	**EX4**
	-	6	8	10	11	12	12	13	13	13	13	13	**EX5**
	-	15	20	24	26	28	30	31	31	32	32	32	**EX6**
	-	40	55	65	72	77	81	84	85	87	88	87	**EX7**
	-	108	147	173	191	205	217	224	227	231	234	233	**EX8**
60	-	-	2	3	3	3	4	4	4	4	4	4	**EX4**
	-	-	6	8	9	10	11	12	12	12	12	12	**EX5**
	-	-	13	19	22	25	27	28	29	29	30	30	**EX6**
	-	-	36	51	61	68	74	76	79	81	82	82	**EX7**
	-	-	97	137	163	182	196	204	211	216	219	219	**EX8**
50	-	-	-	2	2	3	3	3	4	4	4	4	**EX4**
	-	-	-	5	7	9	10	11	11	11	12	12	**EX5**
	-	-	-	11	17	21	23	25	26	27	28	28	**EX6**
	-	-	-	31	47	57	65	69	73	74	76	77	**EX7**
	-	-	-	83	126	152	172	185	194	199	203	206	**EX8**

Extended capacities as expansion and liquid injection valves

The following tables provide the capacity of valves at different conditions considering **20 psi pressure drop** through liquid line:

Condensing Temperature °F	R-134a Extended Capacity Tons, Evaporating Temperature °F: 60	50	40	30	20	10	0	-10	-20	Valve Type
140	4	4	4	4	4	4	4	3	3	**EX4**
	11	11	11	11	11	11	11	11	10	**EX5**
	27	27	27	27	27	26	26	25	25	**EX6**
	74	75	75	75	73	73	71	69	68	**EX7**
	197	200	200	199	196	194	190	185	181	**EX8**
130	4	4	4	4	4	4	4	4	3	**EX4**
	11	11	11	11	11	11	11	11	10	**EX5**
	26	26	27	27	27	27	26	26	25	**EX6**
	72	73	74	74	73	73	72	70	69	**EX7**
	191	194	198	197	196	194	192	187	183	**EX8**
120	3	4	4	4	4	4	4	4	4	**EX4**
	10	11	11	11	11	11	11	11	11	**EX5**
	25	26	26	27	27	27	26	26	25	**EX6**
	68	71	73	73	73	73	72	71	70	**EX7**
	182	188	194	196	195	195	193	189	186	**EX8**
110	3	3	3	4	4	4	4	4	3	**EX4**
	10	10	11	11	11	11	11	11	11	**EX5**
	23	24	25	26	26	26	26	26	25	**EX6**
	63	66	69	70	71	71	71	70	69	**EX7**
	168	176	183	187	189	191	189	188	184	**EX8**
100	3	3	3	3	3	3	3	3	3	**EX4**
	9	9	10	10	10	11	11	11	10	**EX5**
	20	22	24	24	25	25	25	25	25	**EX6**
	56	60	65	67	69	69	69	69	68	**EX7**
	149	161	173	178	183	184	185	184	182	**EX8**
90	2	3	3	3	3	3	3	3	3	**EX4**
	7	8	9	9	10	10	10	10	10	**EX5**
	16	19	21	22	23	24	24	24	24	**EX6**
	44	52	58	61	64	66	66	66	66	**EX7**
	118	139	153	163	170	175	177	176	177	**EX8**
80	1	2	2	3	3	3	3	3	3	**EX4**
	4	6	7	8	9	9	9	10	10	**EX5**
	10	15	18	20	21	22	23	23	23	**EX6**
	27	40	49	54	58	60	62	62	63	**EX7**
	72	107	130	144	154	160	165	166	167	**EX8**
70	-	1	2	2	3	3	3	3	3	**EX4**
	-	3	6	7	8	8	9	9	9	**EX5**
	-	8	13	16	18	20	21	21	22	**EX6**
	-	22	37	45	50	54	57	59	59	**EX7**
	-	58	98	120	134	145	152	156	158	**EX8**
60	-	-	1	2	2	2	3	3	3	**EX4**
	-	-	2	5	6	7	8	8	8	**EX5**
	-	-	5	12	15	17	18	19	20	**EX6**
	-	-	14	32	40	46	50	52	53	**EX7**
	-	-	38	84	107	122	133	139	143	**EX8**
50	-	-	-	-	1	2	2	2	2	**EX4**
	-	-	-	-	4	5	6	7	7	**EX5**
	-	-	-	-	9	13	15	16	17	**EX6**
	-	-	-	-	26	36	42	45	48	**EX7**
	-	-	-	-	69	95	111	120	128	**EX8**

Extended capacities as expansion and liquid injection valves

The following tables provide the capacity of valves at different conditions considering **20 psi pressure drop** through liquid line:

Condensing Temperature	R-404A / R-507	Extended Capacity Tons Evaporating Temperature °F											Valve Type
°F	60	50	40	30	20	10	0	-10	-20	-30	-40	-50	
130	3	3	3	3	3	3	3	3	3	2	2	2	**EX4**
	9	9	9	9	9	9	8	8	8	8	7	7	**EX5**
	21	21	22	21	21	21	20	20	19	18	17	16	**EX6**
	58	59	59	58	58	57	56	54	52	50	48	45	**EX7**
	153	156	157	156	154	152	148	143	139	133	127	120	**EX8**
120	3	3	3	3	3	3	3	3	3	3	3	3	**EX4**
	9	9	9	10	9	9	9	9	9	9	8	8	**EX5**
	22	22	23	23	23	23	22	22	21	20	20	19	**EX6**
	59	61	62	63	62	62	61	60	58	56	54	52	**EX7**
	158	162	165	168	166	165	163	159	155	149	144	138	**EX8**
110	3	3	3	3	3	3	3	3	3	3	3	3	**EX4**
	9	9	10	10	10	10	10	9	9	9	9	8	**EX5**
	21	22	23	23	23	23	23	23	22	22	21	20	**EX6**
	58	60	63	63	64	64	63	62	61	59	58	56	**EX7**
	153	161	167	168	170	171	168	165	163	158	154	148	**EX8**
100	3	3	3	3	3	3	3	3	3	3	3	3	**EX4**
	8	9	9	10	10	10	10	10	10	10	9	9	**EX5**
	20	21	23	23	24	24	24	24	23	23	22	22	**EX6**
	54	59	62	64	65	66	66	65	64	63	62	59	**EX7**
	145	156	165	171	174	175	176	173	171	168	164	158	**EX8**
90	2	3	3	3	3	3	3	3	3	3	3	3	**EX4**
	7	8	9	9	10	10	10	10	10	10	10	9	**EX5**
	17	20	21	23	23	24	24	24	24	23	23	23	**EX6**
	48	54	58	62	64	65	66	66	66	64	63	62	**EX7**
	127	144	156	164	170	173	176	176	175	171	169	165	**EX8**
80	2	2	3	3	3	3	3	3	3	3	3	3	**EX4**
	6	7	8	9	9	10	10	10	10	10	10	9	**EX5**
	13	17	19	21	22	23	23	24	24	23	23	23	**EX6**
	37	46	53	58	61	63	64	65	65	64	63	62	**EX7**
	98	124	142	154	162	168	171	173	172	171	169	166	**EX8**
70	1	2	2	3	3	3	3	3	3	3	3	3	**EX4**
	2	5	7	8	9	9	9	10	10	10	10	10	**EX5**
	6	13	17	19	21	22	23	23	24	23	23	23	**EX6**
	16	35	46	52	57	60	62	64	64	64	64	63	**EX7**
	42	94	122	138	152	160	166	170	172	170	170	168	**EX8**
60	-	1	2	2	2	3	3	3	3	3	3	3	**EX4**
	-	2	5	7	8	8	9	9	9	9	9	9	**EX5**
	-	4	12	16	18	20	21	22	22	22	23	22	**EX6**
	-	11	33	43	50	55	58	60	61	62	62	61	**EX7**
	-	30	89	116	133	146	155	159	163	164	165	162	**EX8**
50	-	-	-	2	2	2	3	3	3	3	3	3	**EX4**
	-	-	-	5	6	7	8	9	9	9	9	9	**EX5**
	-	-	-	11	15	18	19	20	21	21	22	22	**EX6**
	-	-	-	31	42	48	53	56	58	59	60	59	**EX7**
	-	-	-	82	111	128	142	149	154	157	160	158	**EX8**
40	-	-	-	-	1	2	2	2	3	3	3	3	**EX4**
	-	-	-	-	4	6	7	8	8	8	8	9	**EX5**
	-	-	-	-	10	14	17	18	19	20	20	21	**EX6**
	-	-	-	-	27	38	46	50	53	55	56	56	**EX7**
	-	-	-	-	72	102	122	133	142	146	149	150	**EX8**

Extended capacities as expansion and liquid injection valves

The following tables provide the capacity of valves at different conditions considering 20 psi pressure drop through liquid line:

Condensing Temperature °F	R-23 Extended Capacity Tons, Evaporating Temperature °F										Valve Type
	-50	-60	-70	-80	-90	-100	-110	-120	-130	-140	
0	5	5	5	5	5	5	5	5	5	5	**EX4**
	14	15	15	16	16	16	16	16	16	16	**EX5**
	33	35	36	38	38	39	39	39	39	38	**EX6**
-10	4	4	5	5	5	5	5	5	5	5	**EX4**
	12	13	14	15	15	15	16	15	16	15	**EX5**
	29	32	34	35	36	37	37	37	37	37	**EX6**
-20	3	4	4	4	5	5	5	5	5	5	**EX4**
	10	12	13	14	14	15	15	15	15	15	**EX5**
	24	28	31	33	34	35	36	36	36	36	**EX6**
-30	2	3	4	4	4	4	5	5	5	5	**EX4**
	7	9	11	12	13	13	14	14	14	14	**EX5**
	17	23	26	29	31	32	33	33	33	34	**EX6**
-40	-	2	3	3	4	4	4	4	4	4	**EX4**
	-	6	9	10	11	12	12	13	13	13	**EX5**
	-	16	21	25	27	29	30	31	31	31	**EX6**
-50	-	-	2	3	3	3	4	4	4	4	**EX4**
	-	-	5	8	9	10	11	11	12	12	**EX5**
	-	-	13	19	23	25	26	27	28	28	**EX6**

Condensing Temperature °F	R-124 Extended Capacity Tons, Evaporating Temperature °F					Valve Type
	80	70	60	50	40	
210	2	2	2	2	2	**EX4**
	6	6	6	5	5	**EX5**
	15	14	13	13	12	**EX6**
200	2	2	2	2	2	**EX4**
	7	6	6	6	6	**EX5**
	16	15	15	14	14	**EX6**
190	2	2	2	2	2	**EX4**
	7	7	7	7	6	**EX5**
	17	17	17	16	15	**EX6**
180	3	2	2	2	2	**EX4**
	8	8	7	7	7	**EX5**
	18	18	18	17	17	**EX6**
170	3	3	2	2	2	**EX4**
	8	8	8	7	7	**EX5**
	18	18	18	18	17	**EX6**
160	3	3	3	3	3	**EX4**
	8	8	8	8	8	**EX5**
	18	19	19	18	18	**EX6**
150	2	2	3	3	3	**EX4**
	7	8	8	8	8	**EX5**
	18	18	18	18	18	**EX6**

Extended capacities as expansion and liquid injection valves

The following tables provide the capacity of valves at different conditions considering 20 psi pressure drop through liquid line:

Condensing Temperature °F	R-744 Extended Capacity Tons — Evaporating Temperature °F							Valve Type
	10	0	-10	-20	-30	-40	-50	
30	6	7	8	9	10	10	10	**EX4**
	18	22	25	27	29	30	31	**EX5**
	43	53	60	65	70	73	75	**EX6**
	117	145	165	179	191	200	206	**EX7**
	312	388	439	479	510	534	549	**EX8**
20	-	6	7	8	9	9	10	**EX4**
	-	18	22	25	27	29	30	**EX5**
	-	43	53	60	65	69	72	**EX6**
	-	119	145	164	178	189	197	**EX7**
	-	319	387	437	476	506	526	**EX8**
10	-	-	6	7	8	9	9	**EX4**
	-	-	18	22	25	27	29	**EX5**
	-	-	43	53	60	65	68	**EX6**
	-	-	119	145	163	178	187	**EX7**
	-	-	318	386	436	474	500	**EX8**
0	-	-	-	6	7	8	9	**EX4**
	-	-	-	17	21	24	26	**EX5**
	-	-	-	41	51	58	63	**EX6**
	-	-	-	114	140	159	172	**EX7**
	-	-	-	303	373	423	458	**EX8**
-10	-	-	-	-	5	7	8	**EX4**
	-	-	-	-	17	20	23	**EX5**
	-	-	-	-	40	49	55	**EX6**
	-	-	-	-	109	134	152	**EX7**
	-	-	-	-	290	359	405	**EX8**
-20	-	-	-	-	3	5	6	**EX4**
	-	-	-	-	9	16	20	**EX5**
	-	-	-	-	22	38	47	**EX6**
	-	-	-	-	61	104	129	**EX7**
	-	-	-	-	163	278	344	**EX8**
-30	-	-	-	-	-	3	5	**EX4**
	-	-	-	-	-	8	15	**EX5**
	-	-	-	-	-	19	35	**EX6**
	-	-	-	-	-	53	96	**EX7**
	-	-	-	-	-	142	257	**EX8**

EX4/EX5/EX6/EX7/EX8 Nominal and extended capacities as hot gas bypass regulator

Nominal Capacities, Tons

Valve Type	R-22/R-407C	R-134a	R-404A/R-507
EX4	1.4	1.0	1.3
EX5	4.5	3.1	4.3
EX6	10.5	7.3	10.1
EX7	37.3	26.0	35.7
EX8	113.0	79.0	108.5

The nominal capacity is based on the following conditions:

Refrigerant	Evaporating Temperature	Condensing Temperature	Subcooling
R-22, R-134a, R-404A, R-507	+40°F	+100°F	2°F
R-407C	+40°F bubble point	+100°F dew point	2°F

Remarks: Note 1: Bi-flow versions are not released for hot gas bypass applications.
Note 2: EX4, EX5, EX6, EX7 and EX8 must be installed with motor downward in hot gas line applications. This insures the valve life expectancy.

Extended Capacities, Tons

Liquid / Condensing Temperature °F	R-22 / R-407C	R-134a	R-404A / R-507	Valve Type
140 bubble point for all refrigerants (147 dew point for R-407C)	2	1	2	EX4
	7	5	6	**EX5**
	15	11	13	**EX6**
	54	38	46	**EX7**
	165	117	139	**EX8**
130 bubble point for all refrigerants (138 dew point for R-407C)	2	1	2	**EX4**
	6	4	5	**EX5**
	14	10	12	**EX6**
	49	35	44	**EX7**
	150	106	132	**EX8**
120 bubble point for all refrigerants (128 dew point for R-407C)	2	1	2	**EX4**
	6	4	5	**EX5**
	13	9	12	**EX6**
	45	32	41	**EX7**
	138	97	126	**EX8**
110 bubble point for all refrigerants (119 dew point for R-407C)	2	1	1	**EX4**
	5	3	5	**EX5**
	12	8	11	**EX6**
	41	29	38	EX7
	124	87	117	**EX8**

EX6/EX7/EX8 Nominal and extended capacities as suction pressure regulator (evaporator or crankcase)

Nominal Capacities, Tons

Valve Type	R-407C	R-22	R-134a	R-404A
EX6	1.1	1.1	0.9	1.0
EX7	3.8	4.0	3.0	3.5
EX8	11.5	12.2	9.2	10.5

The nominal capacity is based on the following conditions:

Refrigerant	Evaporating Temperature	Condensing Temperature	Subcooling	Pressure Drop
R-22, R-134a, R-404A	+40°F	+100°F	2°F	2 psid
R-407C	+40°F bubble point	+100°F dew point	2°F	2 psid

Remarks: Bi-flow versions are not released for use below -40°F.
EX6, EX7 and EX8 must be installed with motor downward in suction line applications.
This insures the valve life expectancy.

Multiply above nominal capacities by following factors to obtain capacities at different pressure drops:

ΔP, psid	1.5	2.0	3.0	4.5
Correction factor	0.82	1.00	1.15	1.41

Example: EX6 provides 1 ton at 2.0 psid pressure drop with R-404A: 4 psi pressure drop.

Extended Capacities in Tons, suction pressure regulator duty

Condensing Temperature °F	R-22 Extended Capacity Tons Evaporating Temperature °F										Valve Type
	50	40	30	20	10	0	-10	-20	-30	-40	
140	1	1	1	1	1	1	1	0	0	0	**EX6**
	4	3	3	3	2	2	2	2	1	1	**EX7**
	11	10	9	8	7	6	5	5	4	3	**EX8**
130	1	1	1	1	1	1	1	0	0	0	**EX6**
	4	3	3	3	3	2	2	2	1	1	**EX7**
	12	11	10	8	8	7	6	5	4	4	**EX8**
120	1	1	1	1	1	1	1	0	0	0	**EX6**
	4	4	3	3	3	2	2	2	1	1	**EX7**
	12	11	10	9	8	7	6	5	4	4	**EX8**
110	1	1	1	1	1	1	1	1	0	0	**EX6**
	4	4	3	3	3	2	2	2	2	1	**EX7**
	13	12	11	9	8	7	6	6	5	4	**EX8**
100	1	1	1	1	1	1	1	1	0	0	**EX6**
	4	4	4	3	3	3	2	2	2	1	**EX7**
	14	12	11	10	9	8	7	6	5	4	**EX8**

Condensing Temperature Bubble Point °F	R-407C Extended Capacity Tons Evaporating Temperature °F					Valve Type
	50	40	30	20	10	
140	1	1	1	1	1	**EX6**
	3	3	3	2	2	**EX7**
	10	9	8	7	6	**EX8**
130	1	1	1	1	1	**EX6**
	4	3	3	2	2	**EX7**
	11	9	8	7	7	**EX8**
120	1	1	1	1	1	**EX6**
	4	3	3	3	2	**EX7**
	12	10	9	8	7	**EX8**
110	1	1	1	1	1	**EX6**
	4	4	3	3	2	**EX7**
	12	11	10	8	8	**EX8**
100	1	1	1	1	1	**EX6**
	4	4	3	3	3	**EX7**
	13	11	10	9	8	**EX8**

Extended capacities in Tons, suction pressure regulator duty

Condensing Temperature °F	R-134a Extended Capacity Tons Evaporating Temperature °F 50	40	30	20	10	Valve Type
140	1	1	1	1	0	**EX6**
	3	2	2	2	2	**EX7**
	8	7	6	5	5	**EX8**
130	1	1	1	1	0	**EX6**
	3	3	2	2	2	**EX7**
	9	8	7	6	5	**EX8**
120	1	1	1	1	1	**EX6**
	3	3	2	2	2	**EX7**
	9	8	7	6	5	**EX8**
110	1	1	1	1	1	**EX6**
	3	3	3	2	2	**EX7**
	10	9	8	7	6	**EX8**
100	1	1	1	1	1	**EX6**
	3	3	3	2	2	**EX7**
	11	9	8	7	6	**EX8**

Condensing Temperature °F	R-404A / R-507 Extended Capacity Tons Evaporating Temperature °F 50	40	30	20	10	0	-10	-20	-30	-40	Valve Type
140	1	1	1	0	0	0	0	0	0	0	**EX6**
	3	2	2	2	2	1	1	1	1	1	**EX7**
	8	7	6	5	5	4	3	3	2	2	**EX8**
130	1	1	1	1	1	0	0	0	0	0	**EX6**
	3	3	2	2	2	2	1	1	1	1	**EX7**
	9	8	7	6	5	5	4	3	3	2	**EX8**
120	1	1	1	1	1	0	0	0	0	0	**EX6**
	3	3	3	2	2	2	1	1	1	1	**EX7**
	10	9	8	7	6	5	4	4	3	3	**EX8**
110	1	1	1	1	1	1	0	0	0	0	**EX6**
	4	3	3	2	2	2	2	1	1	1	**EX7**
	11	10	9	8	7	6	5	4	4	3	**EX8**
100	1	1	1	1	1	1	1	0	0	0	**EX6**
	4	3	3	3	2	2	2	2	1	1	**EX7**
	12	11	9	8	7	6	5	5	4	3	**EX8**

EX5/EX6/EX7/EX8 Nominal and extended capacities as condensing pressure regulator and liquid duty

Nominal Capacities, Tons

Valve Type	R-407C	R-22	R-134a	R-404A
EX5	5	6	5	4
EX6	12	13	12	9
EX7	44	46	43	31
EX8	133	140	131	93

Refrigerant	Evaporating Temperature	Condensing Temperature	Subcooling	Pressure Drop
R-22, R-134a, R-404A	+40°F	+100°F	2°F	5 psid
R-407C	+40°F dew point	+100°F bubble	2°F	5 psid

Multiply above nominal capacities by following factors to obtain capacities at different pressure drops.

ΔP, psid	2.0	3.0	5.0
Correction factor	0.65	0.76	1.00

Extended Capacities, Tons

Condensing Temperature °F	R-22 Extended Capacity Tons Evaporating Temperature °F										Valve Type
	50	40	30	20	10	0	-10	-20	-30	-40	
140	4	4	4	4	4	4	4	4	4	4	**EX5**
	10	10	10	10	10	9	9	9	9	9	**EX6**
	36	36	35	35	34	33	33	32	31	31	**EX7**
	111	109	107	105	104	102	100	98	96	94	**EX8**
130	5	5	5	4	4	4	4	4	4	4	**EX5**
	11	11	11	10	10	10	10	10	10	9	**EX6**
	39	38	38	37	37	36	35	35	34	33	**EX7**
	118	116	115	113	111	109	107	105	103	101	**EX8**
120	5	5	5	5	5	5	5	5	4	4	**EX5**
	12	12	11	11	11	11	11	10	10	10	**EX6**
	42	41	41	40	39	39	38	37	37	36	**EX7**
	126	125	123	121	119	117	115	113	111	109	**EX8**
110	5	5	5	5	5	5	5	5	5	5	**EX5**
	12	12	12	12	12	12	11	11	11	11	**EX6**
	44	43	43	42	42	41	40	40	39	38	**EX7**
	133	132	130	128	126	124	122	120	118	116	**EX8**
100	6	6	6	5	5	5	5	5	5	5	**EX5**
	13	13	13	13	12	12	12	12	12	11	**EX6**
	47	46	46	45	44	44	43	42	41	41	**EX7**
	142	140	138	136	134	132	130	128	126	124	**EX8**

Condensing Temperature °F	R-134a Extended Capacity Tons Evaporating Temperature °F				Valve Type
	50	40	30	20	
140	4	4	4	4	**EX5**
	9	9	9	8	**EX6**
	33	32	31	30	**EX7**
	100	98	95	92	**EX8**
130	4	4	4	4	**EX5**
	10	10	9	9	**EX6**
	36	35	34	33	**EX7**
	108	105	102	99	**EX8**
120	5	5	4	4	**EX5**
	11	11	10	10	**EX6**
	39	38	37	36	**EX7**
	117	115	112	108	**EX8**
110	5	5	5	5	**EX5**
	12	11	11	11	**EX6**
	41	40	39	38	**EX7**
	125	122	119	116	**EX8**
100	5	5	5	5	**EX5**
	12	12	12	12	**EX6**
	44	43	42	41	**EX7**
	134	131	128	125	**EX8**

Extended Capacities in Tons, condensing pressure and liquid regulator

Condensing Temperature °F	Extended Capacity Tons R-404A / R-507 Evaporating Temperature °F										Valve Type
	50	40	30	20	10	0	-10	-20	-30	-40	
140	2	2	2	2	2	2	2	2	2	2	**EX5**
	5	5	5	5	5	4	4	4	4	4	**EX6**
	19	19	18	17	17	16	15	14	13	13	**EX7**
	59	57	55	52	50	48	45	43	41	38	**EX8**
130	3	3	3	2	2	2	2	2	2	2	**EX5**
	6	6	6	6	5	5	5	5	5	4	**EX6**
	22	22	21	20	19	19	18	17	16	15	**EX7**
	68	66	63	61	59	56	54	52	49	47	**EX8**
120	3	3	3	3	3	3	3	2	2	2	**EX5**
	7	7	7	7	6	6	6	6	5	5	**EX6**
	26	25	24	23	23	22	21	20	19	19	**EX7**
	78	76	73	71	69	66	64	61	59	56	**EX8**
110	3	3	3	3	3	3	3	3	3	3	**EX5**
	8	8	8	7	7	7	7	6	6	6	**EX6**
	28	28	27	26	25	24	23	23	22	21	**EX7**
	86	84	81	79	77	74	71	69	66	64	**EX8**
100	4	4	4	4	3	3	3	3	3	3	**EX5**
	9	9	8	8	8	8	7	7	7	7	**EX6**
	31	31	30	29	28	27	26	26	25	24	**EX7**
	95	93	91	88	86	83	80	78	75	73	**EX8**

Condensing Temperature Dew Point °F	Extended Capacity Tons R-407C Evaporating Temperature °F				Valve Type
	50	40	30	20	
140	4	4	4	4	**EX5**
	9	9	9	8	**EX6**
	32	32	31	30	**EX7**
	98	96	94	91	**EX8**
130	4	4	4	4	**EX5**
	10	10	9	9	**EX6**
	35	34	34	33	**EX7**
	106	105	102	100	**EX8**
120	5	5	4	4	**EX5**
	11	11	10	10	**EX6**
	38	38	37	36	**EX7**
	117	115	112	110	**EX8**
110	5	5	5	5	**EX5**
	12	11	11	11	**EX6**
	41	40	40	39	**EX7**
	125	123	120	118	**EX8**
100	5	5	5	5	**EX5**
	12	12	12	12	**EX6**
	44	44	43	42	**EX7**
	135	133	130	128	**EX8**

EX6/EX7/EX8 Nominal and extended capacities for hot gas flow such as heat reclaim application

Nominal Capacities, Tons

Valve Type	R-22 / R-407C	R-404A / R-507
EX6	3.1	2.8
EX7	11.1	10.2
EX8	33.8	30.7

The nominal capacity is based on the following conditions:

Refrigerant	Evaporating temperature	Condensing temperature	Subcooling	Pressure Drop	Isentropic Efficiency
R-22, R-404A, R-507	+40°F	+100°F	2°F	2 psid	80%
R-407C	+40°F bubble point	+100°F dew point	2°F	2 psid	80%

Remarks: Bi-flow versions are not released for hot gas flow applications.
EX6, EX7 and EX8 must be installed with motor downward in suction line applications.
This insures the valve life expectancy.

Extended capacities, Tons

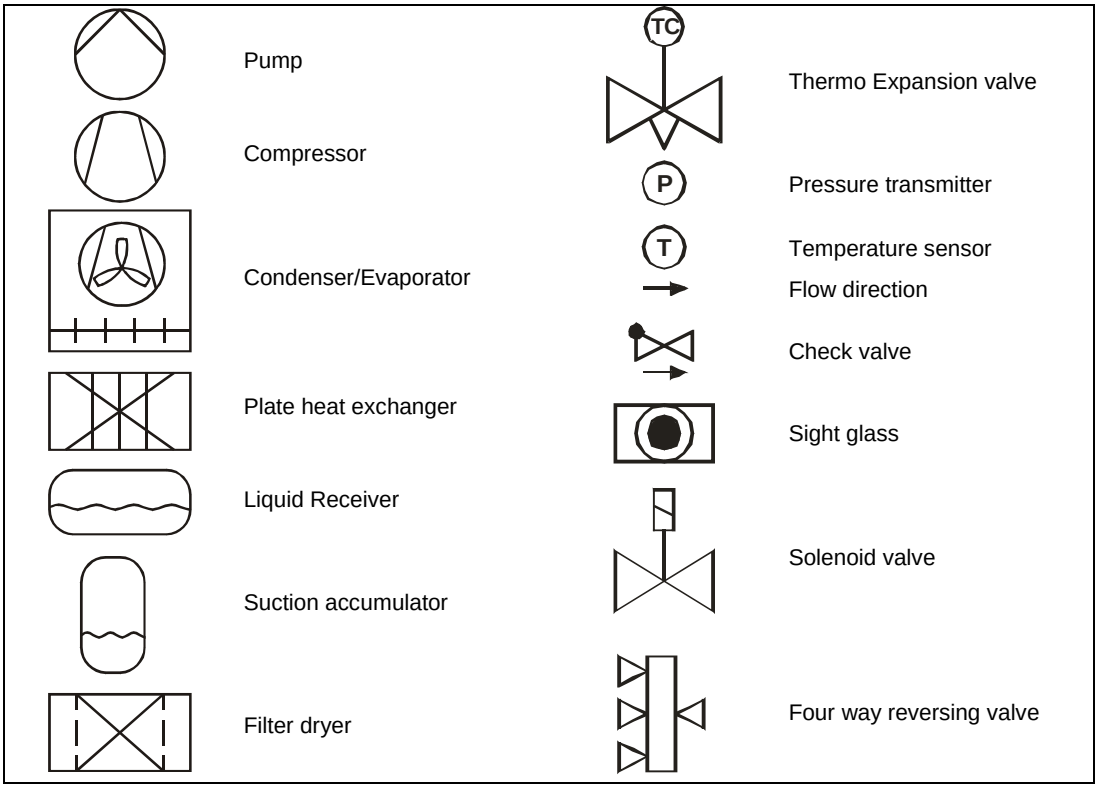
Condensing Temperature °F	Pressure Drop psi	R-22/R-407C Extended Capacity Tons Evaporating Temperature °F												Valve Type
		60	50	40	30	20	10	0	-10	-20	-30	-40	-50	
140	1.5	1.6	1.5	1.5	1.5	1.4	1.4	1.3	1.3	1.2	1.2	1.2	1.1	**EX6**
		5.6	5.5	5.3	5.2	5.0	4.9	4.7	4.6	4.4	4.3	4.1	4.0	**EX7**
		17.0	16.6	16.2	15.7	15.3	14.8	14.4	13.9	13.4	13.0	12.5	12.0	**EX8**
	7	3.4	3.3	3.3	3.2	3.1	3.0	2.9	2.8	2.7	2.6	2.5	2.4	**EX6**
		12.2	11.9	11.6	11.3	10.9	10.6	10.3	10.0	9.6	9.3	9.0	8.6	**EX7**
		37.0	36.1	35.2	34.2	33.3	32.3	31.3	30.3	29.3	28.2	27.2	26.2	**EX8**
	14	4.8	4.7	4.5	4.4	4.3	4.2	4.0	3.9	3.8	3.7	3.5	3.4	**EX6**
		17.3	16.9	16.4	16.0	15.6	15.1	14.6	14.2	13.7	13.2	12.7	12.3	**EX7**
		52.5	51.3	49.9	48.6	47.3	45.9	44.5	43.0	41.6	40.2	38.7	37.3	**EX8**
120	1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.3	1.3	1.2	1.2	1.2	1.1	**EX6**
		5.5	5.3	5.2	5.1	4.9	4.8	4.7	4.5	4.4	4.3	4.1	4.0	**EX7**
		16.6	16.2	15.8	15.4	15.0	14.6	14.2	13.8	13.4	12.9	12.5	12.1	**EX8**
	7	3.3	3.3	3.2	3.1	3.0	2.9	2.9	2.8	2.7	2.6	2.5	2.4	**EX6**
		11.8	11.6	11.3	11.0	10.7	10.4	10.1	9.9	9.6	9.3	8.9	8.6	**EX7**
		35.9	35.1	34.3	33.5	32.6	31.7	30.8	29.9	29.0	28.1	27.2	26.2	**EX8**
	14	4.6	4.5	4.4	4.3	4.2	4.1	4.0	3.9	3.7	3.6	3.5	3.4	**EX6**
		16.8	16.4	16.0	15.6	15.2	14.8	14.4	14.0	13.5	13.1	12.7	12.3	**EX7**
		50.9	49.7	48.6	47.4	46.2	44.9	43.7	42.4	41.1	39.8	38.5	37.2	**EX8**
100	1.5	1.5	1.4	1.4	1.4	1.3	1.3	1.3	1.2	1.2	1.2	1.1	1.1	**EX6**
		5.2	5.1	5.0	4.9	4.7	4.6	4.5	4.4	4.3	4.1	4.0	3.9	**EX7**
		15.8	15.4	15.1	14.7	14.4	14.0	13.7	13.3	12.9	12.5	12.2	11.8	**EX8**
	7	3.2	3.1	3.0	3.0	2.9	2.8	2.7	2.7	2.6	2.5	2.4	2.4	**EX6**
		11.2	11.0	10.7	10.5	10.2	10.0	9.7	9.5	9.2	8.9	8.7	8.4	**EX7**
		34.1	33.4	32.6	31.9	31.1	30.4	29.6	28.8	28.0	27.1	26.3	25.5	**EX8**
	14	4.4	4.3	4.2	4.1	4.0	3.9	3.8	3.7	3.6	3.5	3.4	3.3	**EX6**
		15.8	15.5	15.2	14.8	14.5	14.1	13.7	13.4	13.0	12.6	12.2	11.8	**EX7**
		48.0	47.0	46.0	45.0	43.9	42.8	41.7	40.6	39.5	38.3	37.2	36.0	**EX8**
80	1.5	1.4	1.3	1.3	1.3	1.2	1.2	1.2	1.2	1.1	1.1	1.1	1.0	**EX6**
		4.8	4.7	4.6	4.5	4.4	4.3	4.2	4.1	4.0	3.9	3.8	3.7	**EX7**
		14.7	14.4	14.1	13.8	13.5	13.2	12.8	12.5	12.2	11.9	11.5	11.2	**EX8**
	7	2.9	2.9	2.8	2.8	2.7	2.6	2.6	2.5	2.4	2.4	2.3	2.2	**EX6**
		10.4	10.2	10.0	9.8	9.6	9.3	9.1	8.9	8.6	8.4	8.2	7.9	**EX7**
		31.6	31.0	30.4	29.7	29.0	28.4	27.7	27.0	26.3	25.6	24.8	24.1	**EX8**
	14	4.0	4.0	3.9	3.8	3.7	3.6	3.5	3.4	3.4	3.3	3.2	3.1	**EX6**
		14.6	14.3	14.0	13.7	13.4	13.1	12.8	12.5	12.1	11.8	11.5	11.1	**EX7**
		44.3	43.4	42.6	41.7	40.7	39.8	38.8	37.9	36.9	35.9	34.8	33.8	**EX8**

Extended Capacities Tons, hot gas flow such as heat reclaim applications

Condensing Temperature °F	Pressure Drop psi	R-404A/R-507 Extended Capacity Tons Evaporating Temperature °F												Valve Type
		60	50	40	30	20	10	0	-10	-20	-30	-40	-50	
140	1.5	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	0.7	0.7	0.6	EX6
		4.2	4.1	3.9	3.7	3.5	3.3	3.2	3.0	2.8	2.6	2.4	2.2	EX7
		12.8	12.3	11.8	11.3	10.7	10.1	9.6	9.0	8.4	7.8	7.2	6.6	EX8
	7	2.6	2.5	2.4	2.3	2.2	2.0	1.9	1.8	1.7	1.6	1.4	1.3	EX6
		9.2	8.8	8.4	8.1	7.7	7.3	6.8	6.4	6.0	5.6	5.2	4.7	EX7
		27.8	26.7	25.6	24.5	23.3	22.0	20.8	19.5	18.2	16.9	15.6	14.4	EX8
	14	3.6	3.4	3.3	3.2	3.0	2.8	2.7	2.5	2.4	2.2	2.0	1.9	EX6
		13.0	12.5	12.0	11.4	10.9	10.3	9.7	9.1	8.5	7.9	7.3	6.7	EX7
		39.4	37.9	36.3	34.7	33.0	31.3	29.5	27.7	25.9	24.1	22.2	20.4	EX8
120	1.5	1.3	1.3	1.2	1.2	1.1	1.1	1.0	1.0	0.9	0.9	0.8	0.8	EX6
		4.6	4.5	4.3	4.2	4.0	3.8	3.7	3.5	3.3	3.2	3.0	2.8	EX7
		14.0	13.6	13.1	12.7	12.2	11.7	11.2	10.7	10.1	9.6	9.1	8.5	EX8
	7	2.8	2.7	2.6	2.5	2.4	2.3	2.2	2.1	2.0	1.9	1.8	1.7	EX6
		10.0	9.7	9.4	9.0	8.7	8.3	8.0	7.6	7.2	6.9	6.5	6.1	EX7
		30.4	29.5	28.5	27.5	26.4	25.4	24.3	23.1	22.0	20.9	19.7	18.6	EX8
	14	3.9	3.8	3.7	3.5	3.4	3.3	3.1	3.0	2.8	2.7	2.5	2.4	EX6
		14.1	13.7	13.3	12.8	12.3	11.8	11.3	10.8	10.3	9.7	9.2	8.7	EX7
		43.0	41.7	40.3	38.9	37.4	35.9	34.4	32.8	31.2	29.6	28.0	26.3	EX8
100	1.5	1.3	1.3	1.2	1.2	1.2	1.1	1.1	1.1	1.0	1.0	0.9	0.9	EX6
		4.7	4.6	4.4	4.3	4.2	4.0	3.9	3.7	3.6	3.4	3.3	3.1	EX7
		14.2	13.9	13.5	13.1	12.7	12.2	11.8	11.4	10.9	10.4	10.0	9.5	EX8
	7	2.9	2.8	2.7	2.6	2.5	2.5	2.4	2.3	2.2	2.1	2.0	1.9	EX6
		10.1	9.9	9.6	9.3	9.0	8.7	8.4	8.1	7.8	7.4	7.1	6.8	EX7
		30.8	30.0	29.2	28.3	27.4	26.5	25.5	24.6	23.6	22.6	21.6	20.6	EX8
	14	4.0	3.9	3.7	3.6	3.5	3.4	3.3	3.2	3.0	2.9	2.8	2.6	EX6
		14.3	13.9	13.5	13.1	12.7	12.3	11.9	11.4	11.0	10.5	10.0	9.6	EX7
		43.5	42.3	41.2	39.9	38.7	37.4	36.1	34.7	33.3	31.9	30.5	29.1	EX8
80	1.5	1.3	1.3	1.2	1.2	1.2	1.1	1.1	1.1	1.0	1.0	0.9	0.9	EX6
		4.6	4.5	4.4	4.2	4.1	4.0	3.9	3.8	3.6	3.5	3.4	3.2	EX7
		13.9	13.6	13.3	12.9	12.6	12.2	11.8	11.4	11.0	10.6	10.2	9.8	EX8
	7	2.8	2.7	2.6	2.6	2.5	2.4	2.4	2.3	2.2	2.1	2.0	2.0	EX6
		9.9	9.6	9.4	9.2	8.9	8.7	8.4	8.1	7.8	7.6	7.3	7.0	EX7
		30.0	29.3	28.6	27.8	27.1	26.3	25.5	24.7	23.8	22.9	22.1	21.2	EX8
	14	3.8	3.7	3.7	3.6	3.5	3.4	3.3	3.2	3.0	2.9	2.8	2.7	EX6
		13.9	13.5	13.2	12.9	12.5	12.2	11.8	11.4	11.0	10.6	10.2	9.8	EX7
		42.1	41.1	40.1	39.1	38.0	36.9	35.8	34.7	33.5	32.3	31.1	29.8	EX8

Application of control valves in systems
The following schematics show the arrangement of integrated valves for different applications.

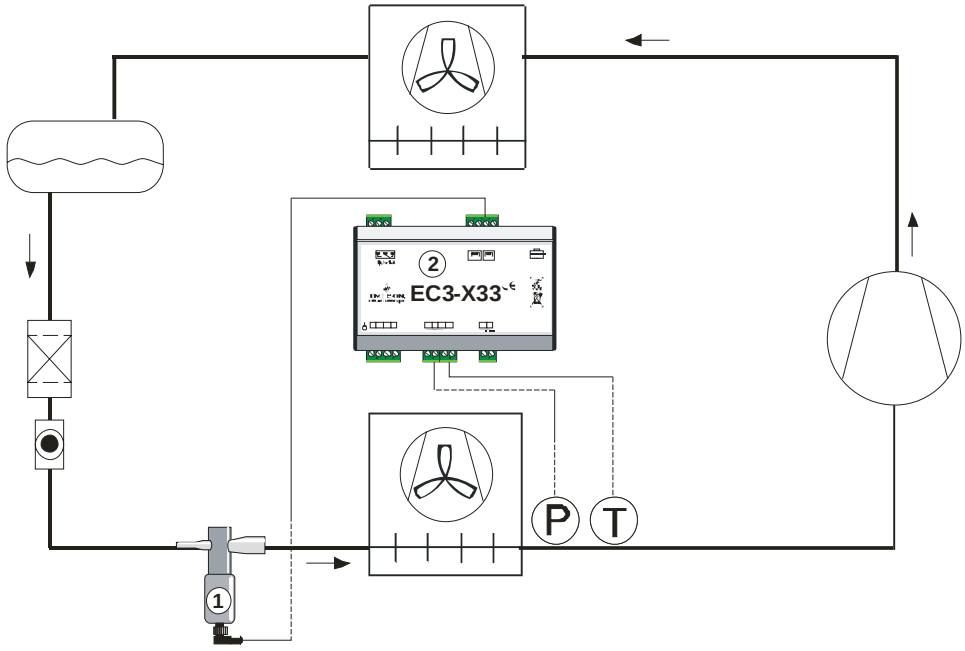
Legends:



Overview applications: **page**

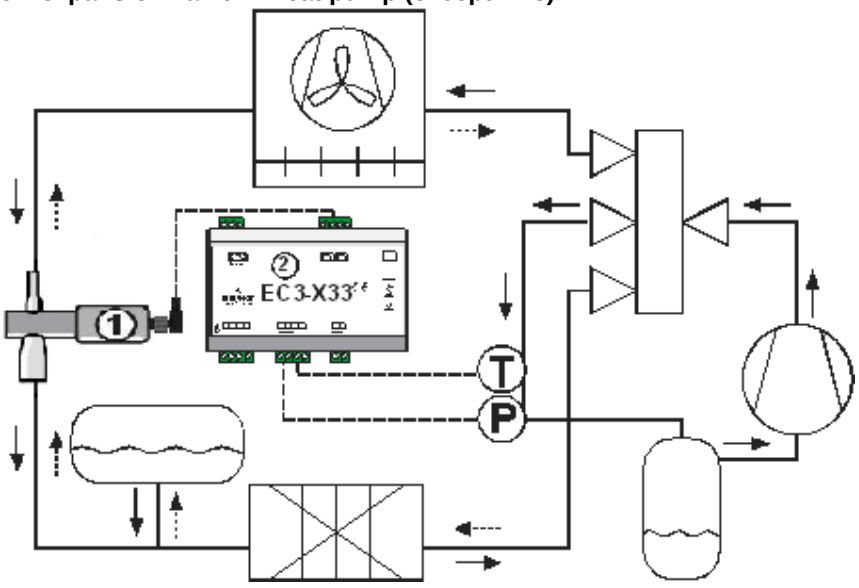
Application 1: Expansion valve in cooling system 20
Application 2: Bi-Flow expansion valve in heat pump (except EX8) 20
Application 3: Expansion valve in heat pump (only EX8) 21
Application 4: Expansion valve in heat pump (two valves) 21
Application 5: Expansion valve as liquid injection valve for desuperheating 22
Application 6: Expansion valve as liquid injection valve for subcooling 22
Application 7: Capacity control by means of hot gas bypass 23
Application 8: Capacity control by means of suction pressure throttling 23
Application 9: Crankcase pressure control 24
Application 10: Head pressure control 24
Application 11: Liquid level control 25

Application 1: Expansion valve in cooling system



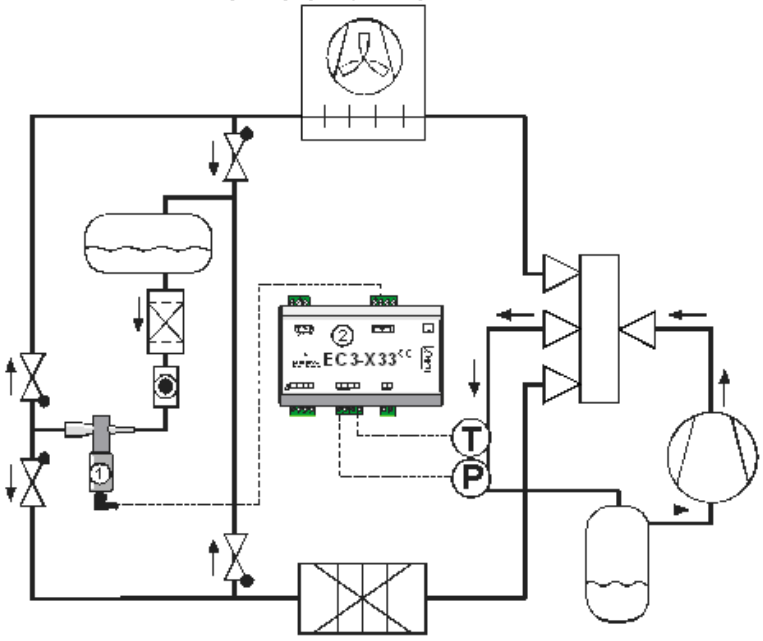
(1) = Expansion Valve
(2) = Superheat controller EC3-X33

Application 2: Bi-Flow expansion valve in heat pump (except EX8)



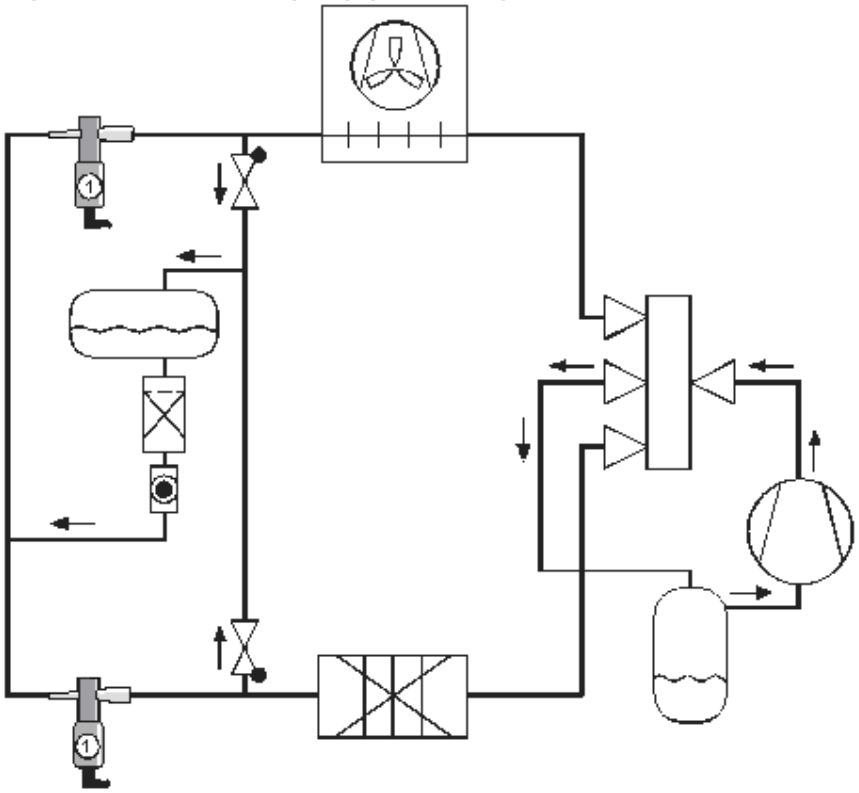
(1) = Bi-Flow Expansion Valve
(2) = Superheat controller EC3-X33

Application 3: Expansion valve in heat pump (only EX8)



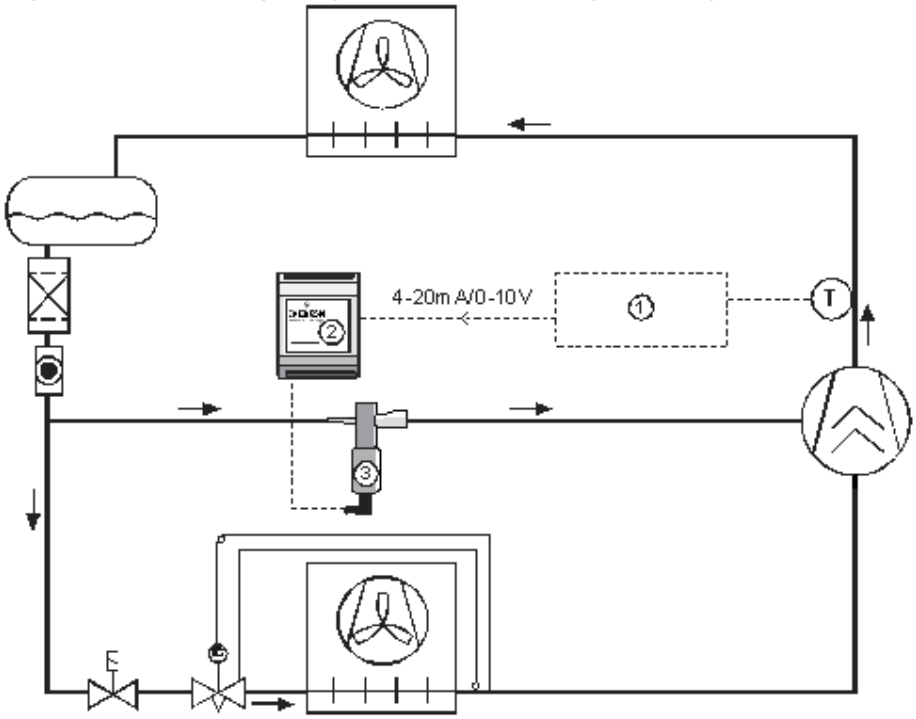
(1) = Expansion Valve
(2) = Superheat controller EC3-X33

Application 4: Expansion valve in heat pump (two valves)



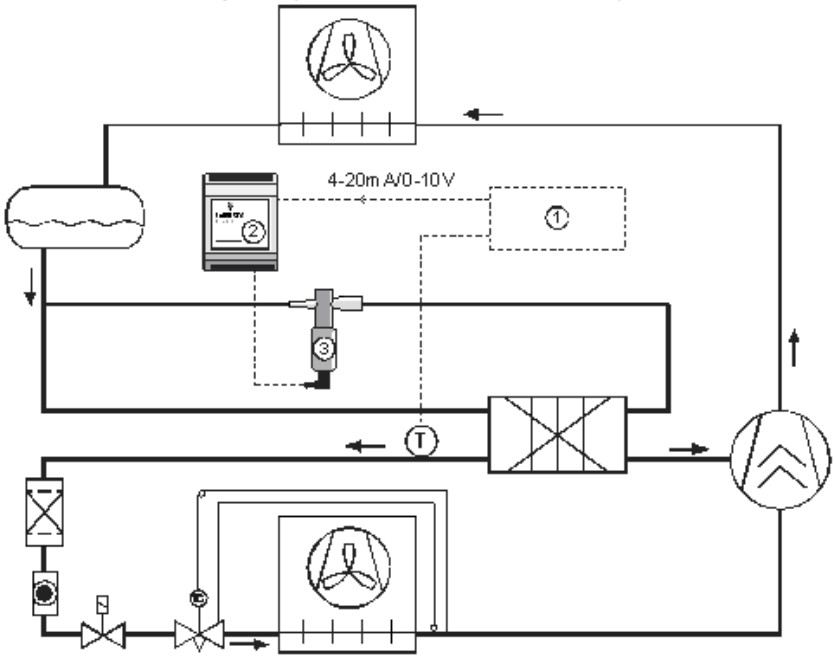
(1) = Expansion Valve, heating mode
(2) = Expansion Valve, cooling mode

Application 5: Expansion valve as liquid injection valve for desuperheating



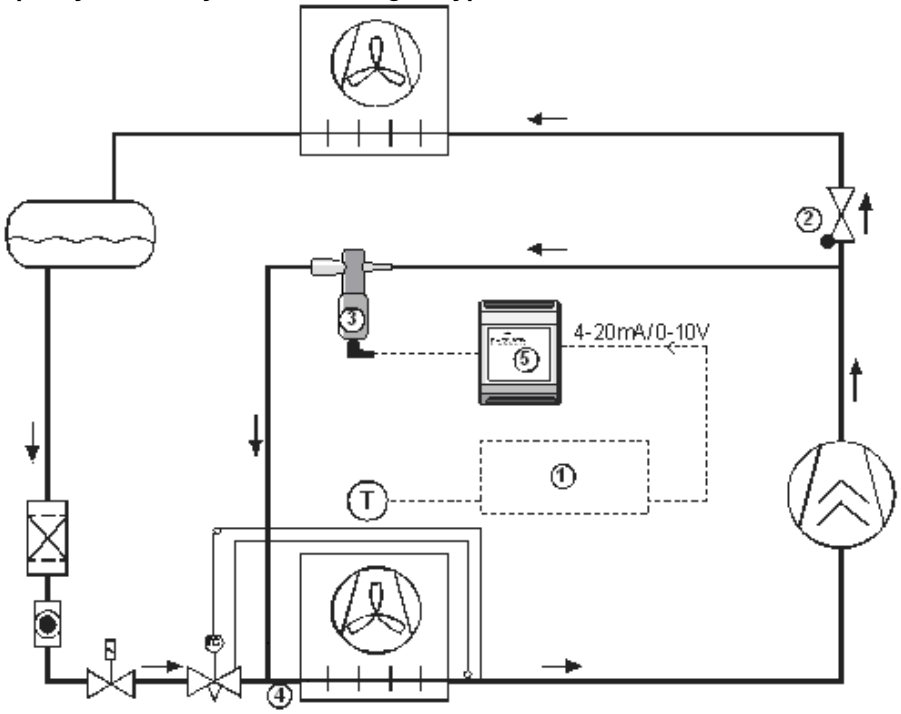
(1) = Temperature Controller
(2) = Stepper motor driver EXD-U00
(3) = Electrical Control Valve

Application 6: Expansion valve as liquid injection valve for subcooling



(1) = Temperature Controller
(2) = Stepper motor driver EXD-U00
(3) = Electrical Control Valve

Application 7: Capacity control by means of hot gas bypass



Remarks:

(1) = Temperature Controller

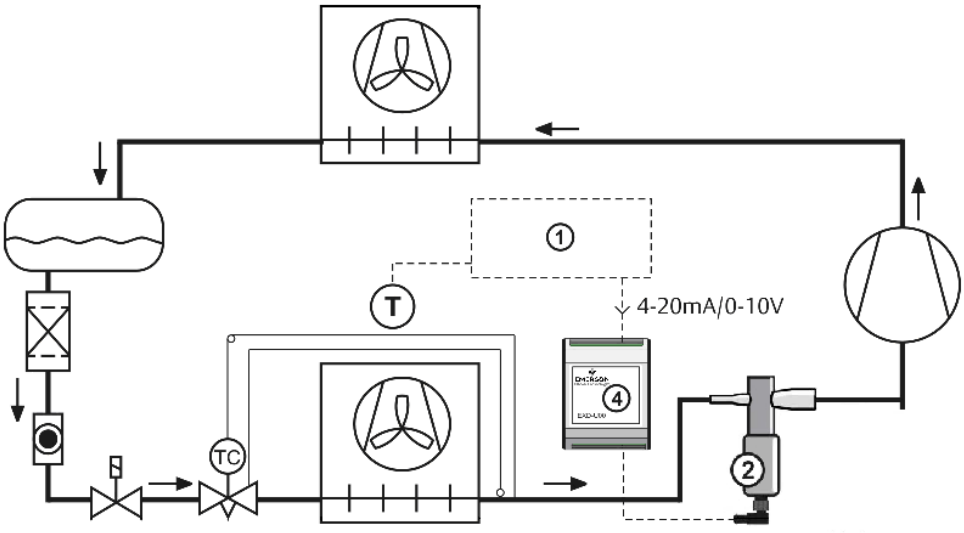
(2) = Check Valve: It is important to install a check valve just after T-connection as shown. Check valve will not allow return of liquid refrigerant from condenser through electrical control valve in to the evaporator during power interruption to system.

(3) = Hot gas bypass valve must be installed with motor downward. This insures the valve life expectancy.

(4) = Liquid Distributor must be selected properly for hot gas mass flow.

(5) = Stepper motor driver EXD-U00

Application 8: Capacity control by means of suction pressure throttling



Remarks:

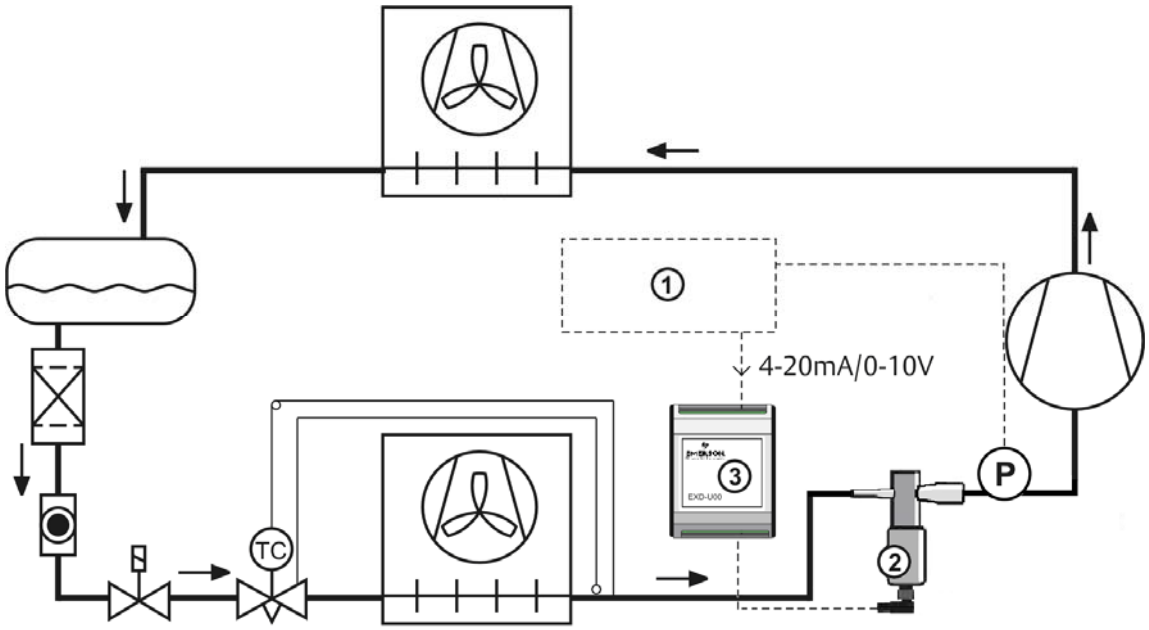
(1) = Temperature Controller

(2) = Evaporator temperature regulator. EX6, EX7 and EX8 must be installed with motor downward in suction line applications. This insures the valve life expectancy.

(3) This application may require additional liquid injection to suction line for desuperheating of compressor by means of suction line superheat control or discharge line temperature control. Please consult Emerson Flow Controls for more details.

(4) = Stepper motor driver EXD-U00

Application 9: Crankcase pressure control



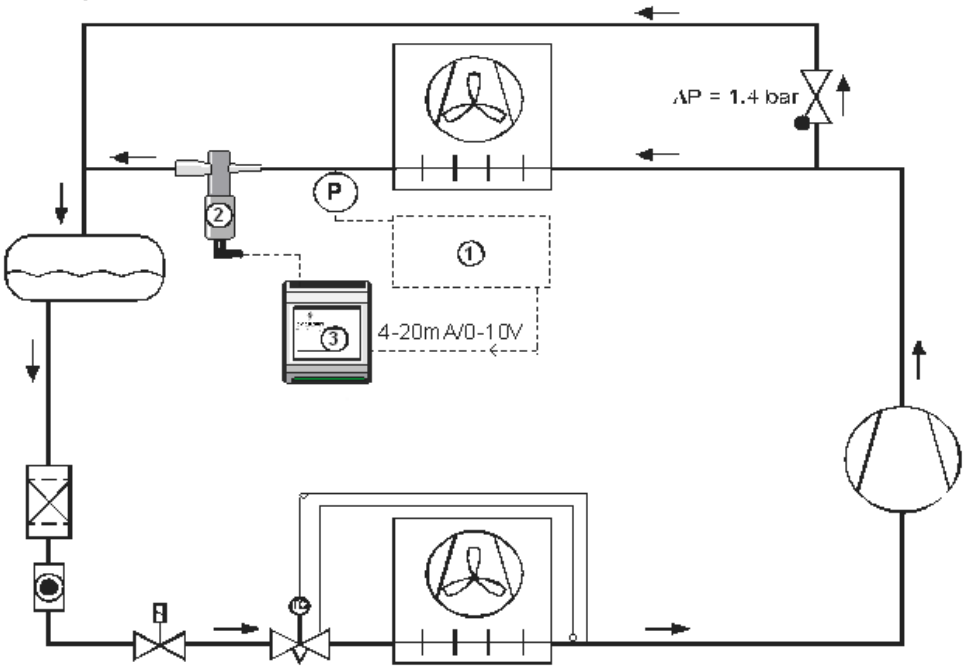
Remarks:

(1) = Pressure Controller

(2) = Crankcase pressure regulator. ECVs must be installed with motor downward in suction line applications. This insures the valve life expectancy.

(3) = Stepper motor driver EXD-U00

Application 10: Head pressure control

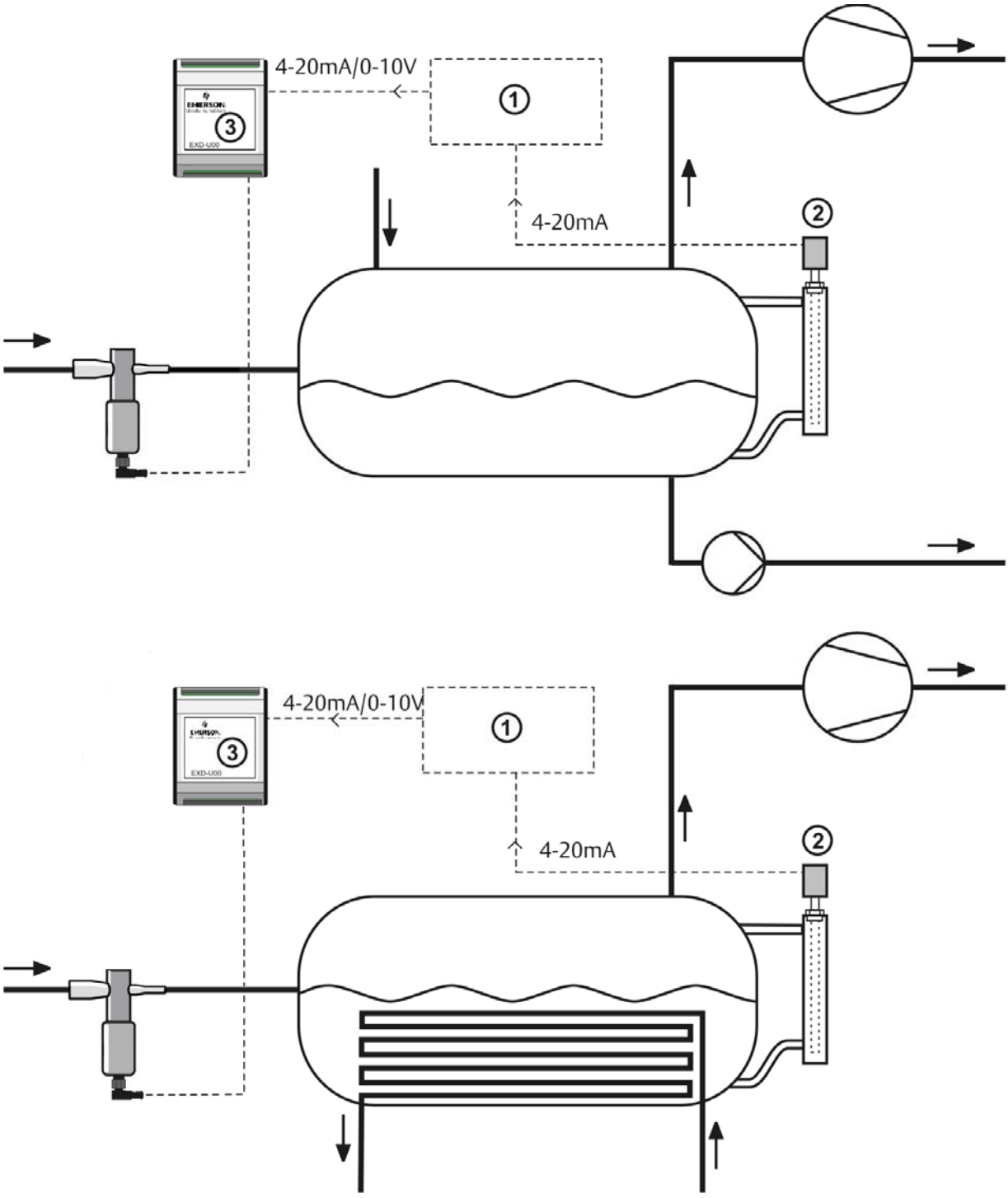


(1) = Pressure Controller

(2) = Condensing pressure regulator

(3) = Stepper motor driver EXD-U00

Application 11: Liquid level control



(1) = Level Controller
(2) = Liquid level sensor
(3) = Stepper motor driver EXD-U00
Note: ECVs are not released for use with ammonia.

Driver and controller

In contrast to thermo-expansion and regulator valves, stepper motor driven valves are not self operated actuators and require:

- a stepper motor driver which generates the digital pulse sequence needed to move the stepper motor in clockwise or counter clockwise direction
- an algorithm which determines the opening of the valve as a function of system parameters and conditions.

Emerson offers several solutions for this task:

EC3-X33 Superheat controller as stand alone for all applications and **EC3-X32 Superheat controller** for use in TCP/IP networks. The modules contain all required algorithms for full operation of Emerson ECVs. For further details please refer to EC3-X33 or EC3-X32 technical data sheet.

EXD-U Universal driver is a stepper motor driver which uses an analogue input signal to define the valve opening. It enables the operation of EX4/EX5/EX6/EX7/EX8 as:

- Electronic expansion valve
- Capacity control by means of hot gas bypass or evaporating pressure regulator
- Crankcase pressure regulator
- Condenser pressure regulator
- Liquid level actuator
- Liquid injection valve

The input signal for the driver module can be 4…20mA or 0…10V. The output pulses provide the proportional opening/closing of EX4/EX5/EX6/EX7/EX8 and consequently the control of liquid or vapor refrigerant mass flow. The universal driver module can be connected to any controller which provides the analogue signal. This gives system manufacturers the extreme flexibility to use any desired controller in conjunction with the universal driver module to achieve different functionality. For further details please refer to EXD-U technical data sheet.

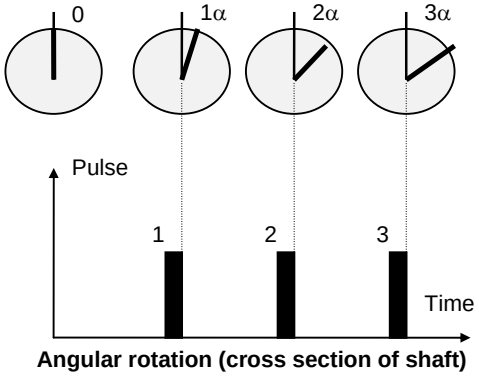
The following information is for those customers who want to develop their own driver/controller/algorithms:

Function

1) Motor

A 2-phase bipolar stepper motor drives the EX4/5/6/7/8. This motor follows the basic operating characteristics of any stepper motor i.e. the motor will be held in position unless current pulses from a driver board initiate rotation in either direction. The direction of the rotation depends on the phase relationship of the current pulses, the amount of rotation is dependent on the number of pulses. One pulse will drive the motor one step i.e. the rotor will move by α=1.8°. Successive pulses will lead to continuous rotation.

The drive shaft of the rotor is connected to a spindle which transforms the rotation into linear motion of the valve slide.



Angular rotation (cross section of shaft)

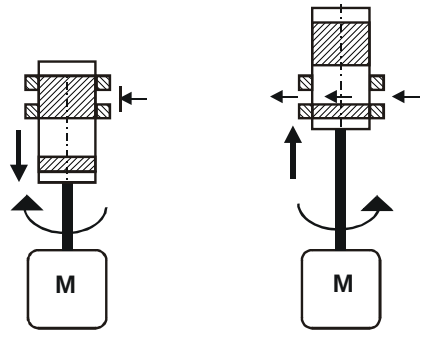
2) Valve

The gate type valve is optimized to provide a wide range of capacity with a linear relation between flow and positioning of the valve (capacity vs. number of steps). Slide and ports are made from ceramic for precise flow characteristics, high resolution and infinite life.

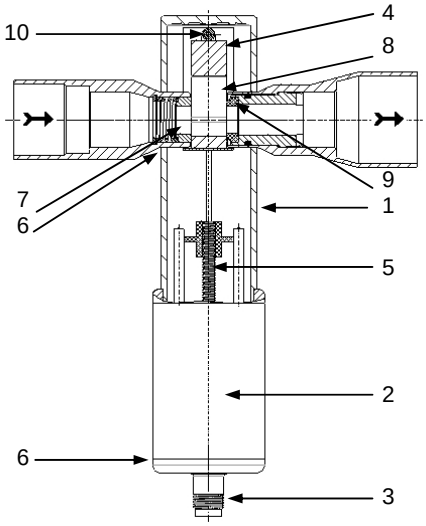
The compliant slide eliminates undesirable horizontal forces caused by differential pressure (across the valve) to the cage assembly and shaft of stepper motor. The internal design of the EX4/5/6/7/8 is patented.

Total valve travel is 750 full steps for EX4/5/6, 1600 steps for EX7 and 2600 steps for EX8.

A mechanical stop in the fully closed position of the valve acts as reference point. The controller is reset by driving the valve towards the fully closed position against the mechanical stop. By overdriving the valve i.e. applying more than the full number of steps, it can be assured that the reference point is correct.



closed **open**



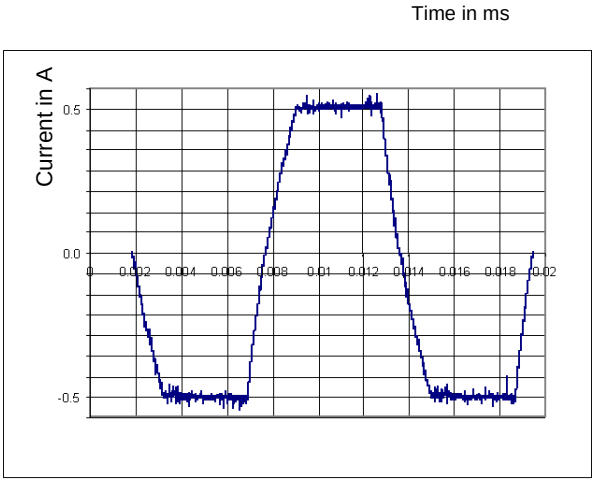
1 Stainless steel body
2 Stepper motor
3 Electrical connector
4 Cage assembly
5 Shaft
6 Welding and/or brazing
7 Ceramic inlet port
8 Ceramic slide
9 Ceramic outlet port
10 Brass ball

3) Driving of stepper motor

There are many different options to drive stepper motors like the one used in the EX4/5/6/7/8. Emerson stepper motors need a driver board with chopper drive function (constant current), an interface and a controller.

Chopper drive (constant current)

The stepper motor of EX4/5/6/7/8 is a bipolar, 2-phase permanent-magnet motor and operates with constant DC current in each phase. A driver board with chopper drive function feeds a DC current as indicated below to the windings of the stepper motor.



4) Design of customized driver board

A suitable driver board must be selected according to the electrical data of the stepper motor and based on the following requirements:

- Electrical output (four-stage switching sequence, see next page)
- The EX4/5/6/7/8 should be operated in full step mode.
- Stepping rate: 500Hz for EX4/5/6/7/8
- Chopper function, current:

Current	EX4/5/6	EX7	EX8
Operating	500 mA	750 mA	800 mA
Holding	100 mA	250 mA	500 mA

Sequence for driving of stepper motor and valve

Direction	Reverse direction	Number of steps	Identification code of pins for electrical connections to third party drivers/controllers			
			A	B	C	D
			Current direction			
Valve is opening ↓	Valve is closing ↑	Step 1	+	-	+	-
		Step 2	-	+	+	-
		Step 3	-	+	-	+
		Step 4	+	-	-	+
		Remark	The sequence is repeated from step 5 to 8 similar to step 1 to 4			
		Step 5	+	-	+	-
		Step 6	-	+	+	-
		Step 7	-	+	-	+
		Step 8	+	-	-	+
		Remark	The sequence is repeated from step 9 to 12 similar to step 1 to 4			
↓	↓	↓	↓			

EX4/EX5/EX6/EX7/EX8 identification code of pins for electrical connection to third party drivers/controllers	**M12 plug and cable assembly (EX5-N60) for EX4/EX5/EX6/EX7/EX8** 
	Cable, wire colour
A	White
B	Black
C	Blue
D	Brown

Technical data

CE marking EX4/EX5: EX6/EX7/EX8:	 not required required, Cat I, Module A
Compatibility (not released for use with inflammable refrigerants)	HCFCs, HFCs, CO_2 Mineral and POE lubricants
MOPD (maximum operating pressure differential)	EX4/EX5/EX6/EX7: 505 psi EX8: 435 psi
Max. working pressure (MWP)	650 psi
Ambient temperature	-40 to +130°F
Medium temperature range Bi-flow version: Uni-flow version	 TS: -40 to +175°F TS: -55 to +212°F
Salt spray test	non-corrosion stainless steel body
Humidity	5 to 95% r.H.
Connections	ODF stainless steel fittings

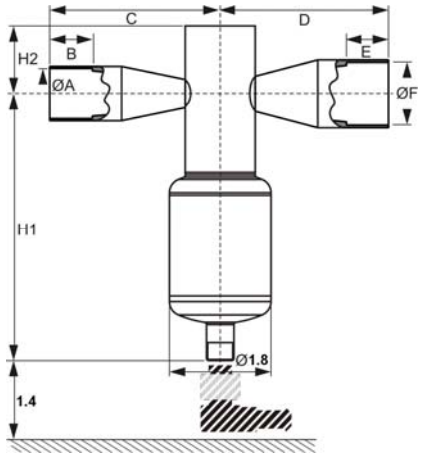
Protection accordance to IEC 529, DIN 40050	IP68 with Emerson supplied cable connector assembly
Vibration for non-connected and fastened valve	4g (0 to 1000 Hz, 1 octave /min.)
Shock	20g at 11 ms 80g at 1 ms
Net weight (kg)	1.1lbs (EX4), 1.2 lbs (EX5), 1.3 lbs (EX6), 2.4 lbs (EX7), 3.3 lbs (EX8)
External leakage	≤ 0.1 oz/yr (R-22)
Seat leakage	Positive shut-off better than solenoid valves
Accessories	See table on page 2
Package and delivery (individual)	without electrical connector

Electrical data

Stepper motor type	Bi-polar, phase current by chopper control (constant current)
Electrical connection	4 pin terminal via plug
Reccom. driver supply voltg.	24 VDC (nominal)
Driver supply voltage range	18 … 36 VDC
Phase current, operating	EX4/EX5/EX6: 500mA max, -10% EX7: 750mA ±10% EX8: 800mA ±10%
Holding current	EX4/EX5/EX6: 100mA EX7: 250mA EX8: 500mA
Nominal input power per phase	EX4/EX5/EX6: 3.5W EX7/EX8: 5W

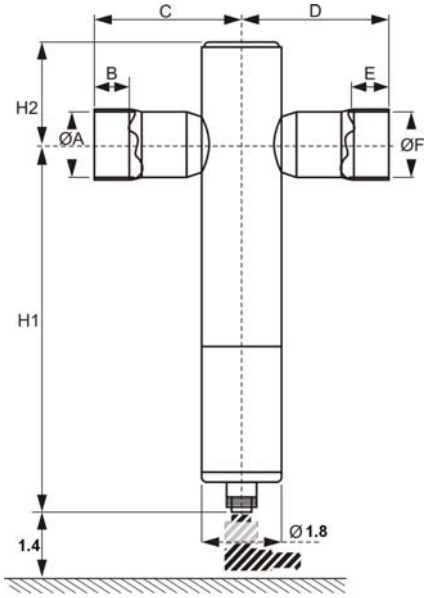
Phase inductance	EX4/EX5/EX6: 30 mH ± 25% EX7: 20 mH ± 25% EX8: 22 mH ± 25%
Step mode	2 phase full step
Step angle	1.8° per step ± 8%
Total number of steps	EX4/EX5/EX6: 750 full steps EX7: 1600 full steps EX8: 2600 full steps
Stepping rate	500Hz
Winding resistance per phase	EX4/EX5/EX6: 13Ohm ±10% EX7: 8Ohm ±10% EX8: 6Ohm ±10%
Full travel time	EX4/EX5/EX6: 1.5 seconds EX7: 3.2 seconds EX8: 5.2 seconds
Reference position	Mechanical stop at fully close position

Dimensions EX4 / EX5 / EX6 / EX7



Valve Type	Ø A x Ø F (ODF)	B	C	D	E	H1	H2
EX4-I21	3/8" x 5/8"	0.3	1.8	2.2	0.4	4.4	1.0
EX5-U21	5/8" x 7/8"	0.4	2.2	2.6	0.6	4.4	1.0
EX6-I21	7/8" x 1-1/8"	0.6	2.6	3.0	0.7	4.4	1.0
EX7-I21	1-1/8" x 1-3/8"	0.8	3.1	3.2	0.9	6.2	1.7
EX8-I21	1-3/8" x 1-3/8"	0.8	3.1	3.1	0.8	7.9	2.2

Dimensions EX8



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