

Technical brochure

Electrically operated expansion valves, type ETS 6



With many years of experience the current range of Electronic Expansion Valves offers high reliability and precise solutions for expansion and flow control in a wide range of refrigeration and air conditioning systems.

Compact and lightweight, the current range are available with different capacities, and can be used with all common refrigerants (R410A, R407C, R404A, R134a, R22) Bi-flow operation is also possible for heat pump systems.

The valve design uses uni-polar drives, and different control solutions exist that are compatible with uni-polar drives. Please, contact Danfoss for more details.

Features

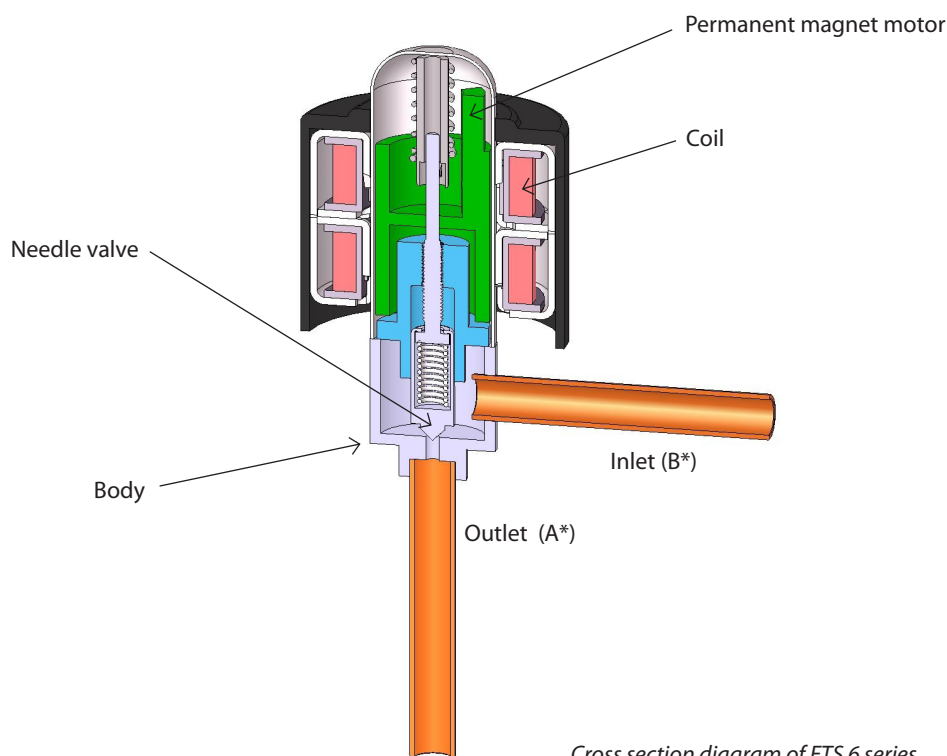
- Enables energy efficiency of the system
- Precision flow control with high resolution
- Compact and lightweight
- Power saving design
- Proven know-how and high reliability
- Wide range for all common refrigerants, HCF, HCFC (i.e. R410A, R407C, R404A, R134a, R22,)
- Bi-flow for heat pump applications

Construction & principles of operation

The ETS 6 electronic expansion valves open and close to regulate refrigerant flow by means of a screw structure which has linear motion. This occurs by the rotation of a magnet-needle valve assembly which moves when electrical signals are applied to the surrounding coil.

Within the coil structure, there are different winding configurations, and the polarities are

changed by the electrical signals applied. By application of the appropriate combination of signals, in the form of pulses, the coil forces the rotor of the valve to move in a stepwise fashion. Application of multiple pulses will make the valve mechanism move through a series of steps in the direction of choice, in order for the valve to adopt the required position.



*Cross section diagram of ETS 6 series
* Refers to refrigerant flow in cooling mode*

Technical data

Maximum working pressure	45 bar (653 psig)
Compatible refrigerants	HCF, HCFC (i.e. R22, R134a, R404A, R407C, R410A)
Refrigerant oil	All mineral oils and ester oils (to lubricate ETS 6 valve)
Ambient temperature	-30°C to 60°C (-22 °F to 140° F)
Fluid Temperature	-30°C to 70°C (-22 °F to 158° F)
Durability	Tested for 60 Million total pulses supplies to the valve during partially open valve, which is comparable to 150,000 cycles if the valve is operated between 100 to 300 pulses open. Tested for 30,000 full stroke cycles including 20 pulse overdrive at each closing.
Ambient humidity	95% RH or less
Modulation	Permanent magnet type direct operating stepper motor
Excitation method	1-2 phase
Electrical connection	JST XHP-6 and JST XHP-5
Excitation speed	min. 30 pps (pulses per second) to max. 90 pps, recommended 31.3 pps
Operating range	0 to 480 pulses, no holding power required (NOTE: do not apply more than 520 pulses)
Full motion transit time	e.g. 16 sec @ 30 pps, 6 sec @ 80 pps
Installation position	With coil on the upper side and the valve/coil assembly within ±15° of the vertical axis
Liquid line solenoid valve	If using a liquid line solenoid valve, it must be installed in such a way that it does not create liquid hammering in ETS 6 valve
Max. coil winding temperature	115°C (239° F)



Valve Specifications

Model No.	Single pack Code No.	I-pack Code No. (100 units per box)	Orifice [mm]	Nominal Capacity [kW]					Connection (solder)		Valve tube configuration	MWP [bar]	MOPD [bar]	Max. Reverse Pressure [bar]	Flow direction characteristic
				R22	R134a	R404A	R407C	R410A	A [mm]	B [mm]					
ETS 6 - 10	034G5005	034G5000	1	2.6	2	1.8	2.7	3.1	7.94	7.94	90°	45	35	35	bi-flow
ETS 6 - 14	034G5015	034G5010	1.4	5.8	4.5	4.1	5.9	6.8	7.94	7.94	90°	45	35	20	bi-flow
ETS 6 - 18	034G5026	034G5024	1.8	10.3	8.1	7.3	10.6	12.1	6.35	6.35	90°	45	35	28	bi-flow
ETS 6 - 25	034G5035	034G5030	2.5	19.6	15.3	13.8	20.1	23	7.94	7.94	90°	45	35	22	bi-flow
ETS 6 - 32	034G5055	034G5050	3.2	28.8	22.5	20.3	29.6	33.9	7.94	7.94	90°	45	28	12*	bi-flow

Nominal Capacity based on:

R410A: CT=38°C, ET=5°C, SC=0°C, SH=0°C

*Please contact Danfoss if higher maximum reverse pressure valve is required.



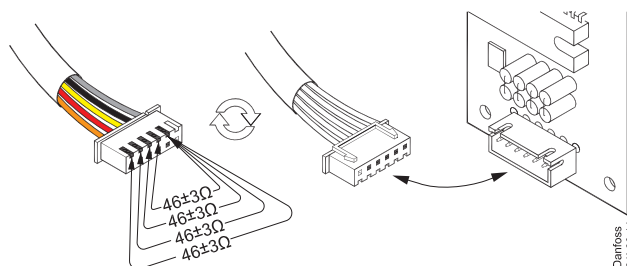
Coil Specifications

Model No.	Single pack Code No.	I-pack Code No. (100 units per box)	Relevant valve model	Voltage (current)	Cable length [m]	Protective cable tube length [m]	Enclosure	Insulation	Connector
								class	
ETS 6 Coil	034G5105	034G5100	Coil for ETS 6 valves	12 VDC (0,26A/phase)	0.7	0.6	IP 66	Class "E" (UL Class 105 (A))	JST XHP-6
ETS 6 Coil	034G5115	034G5110	Coil for ETS 6 valves	12 VDC (0,26A/phase)	0.7	0.6	IP 66	Class "E" (UL Class 105 (A))	JST XHP-5

Stepper motor switch sequence

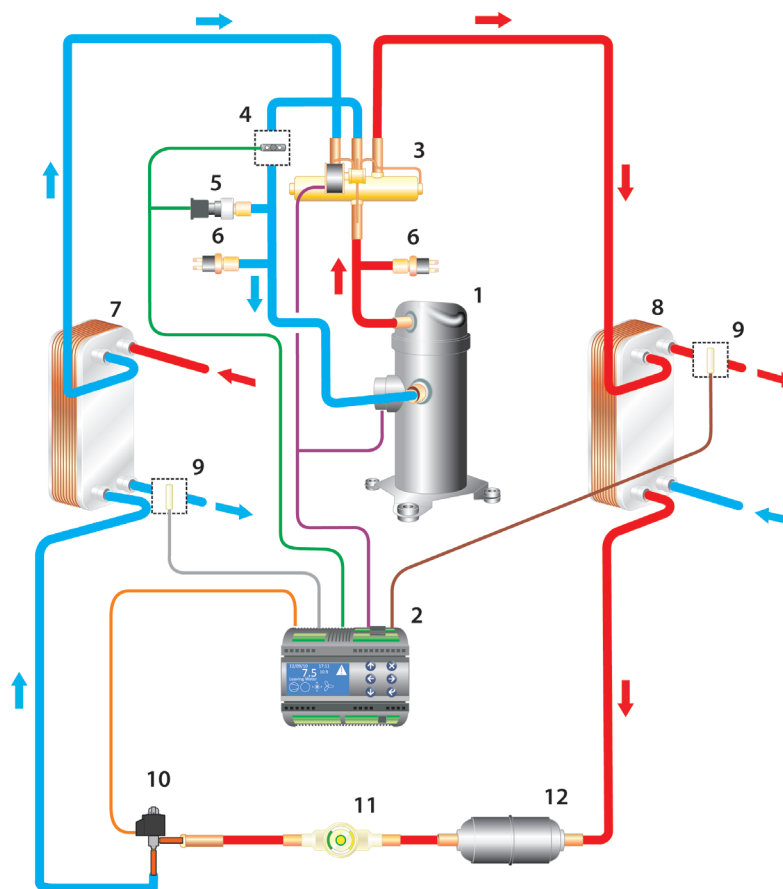
	Coil I		Coil II		Common	↓ OPENING ↓	↑ CLOSING ↑
	Orange	Red	Yellow	Black	Gray		
	on	off	off	off	0		
on	on	off	off	0			
off	on	off	off	0			
off	on	on	off	0			
off	off	on	off	0			
off	off	on	on	0			
off	off	off	on	0			
on	off	off	on	0			

Electrical wiring



The illustration shows the JST XHP-6 connector. The coil with JST XHP-5 is identical except that the unused pin has been removed

Application example



Heat pump components in typical system. 1. Compressor. 2. Controller. 3. Four-way valve. 4. Temperature sensor. 5. Pressure sensor. 6. Cartridge pressure control. 7. Evaporator. 8. Condenser. 9. Temperature sensor. 10. Expansion device. 11. Sight glass. 12. Liquid line filter drier.

Valve Selection

For optimum performance, it is important to correct the evaporator capacity. In order to select the correct size of ETS 6 you will need the following information:

- Refrigerant: HCFC or HFC
- Evaporator capacity Q_e in kW or TR
- Evaporating temperature t_e in °C or °F
- Condenser temperature t_c in °C or °F
- Subcooling Δt_{sub} in K or °F

Example

When selecting the valve it may be necessary to apply a correction factor to the actual evaporator capacity. This correction factor is required when system conditions are different than table conditions. Selection also depends on having an acceptable pressure drop across the valve. In the selection table, the pressure drop in the liquid line is assumed to be zero. The following example illustrates correct selection of the valve.

- Refrigerant: R407C
- Evaporator capacity: $Q_e = 10$ kW (2.84TR)
- Condensing temperature: $t_c = 40^\circ\text{C}$ (104 °F)
- Evaporating temperature: $t_e = +10^\circ\text{C}$ (50°F)
- Subcooling $\Delta T_{sc} = 10$ K

Valve Selection
(continued)

Step 1

Determine the correction factor for subcooling ΔT_{sc} . From the correction factor table (see below) a subcooling of 10 K, R407C corresponds to a factor of 1.14.

Correction factors for subcooling ΔT_{sc} .

ΔT_{sc}	0K	4K	10K	15K	20K	25K	30K	35K	40K	45K	50K
	0°F	7.2°F	18°F	27°F	36°F	45°F	54°F	63°F	72°F	81°F	90°F
R22	1.00	1.04	1.10	1.16	1.20	1.25	1.30	1.35	1.41	1.45	1.50
R410A	1.00	1.06	1.14	1.21	1.28	1.34	1.40	1.47	1.53	1.58	1.65
R407C	1.00	1.06	1.14	1.20	1.28	1.34	1.40	1.47	1.53	1.60	1.66
R134a	1.00	1.06	1.14	1.19	1.26	1.32	1.38	1.45	1.50	1.56	1.63
R404A/R507	1.00	1.07	1.18	1.29	1.38	1.47	1.56	1.65	1.75	1.82	1.91

Step 2

Corrected evaporator capacity is

$$Q_e \text{ (Corrected)} = 10 \text{ kW} / 1.14 = 8.8 \text{ kW (2.5 TR)}$$

Step 3

Now select the appropriate capacity table, R407C, and choose the column for condensing temperature of $t_c = 40^\circ\text{C}$ (104°F) and evaporating temperature of $t_e = +10^\circ\text{C}$ (50°F) which will provide an equivalent or greater capacity of 8.8 kW (2.5 TR). ETS 6-18 provides 10.35 kW (2.94 TR), which is the proper selection for this example.

Step 4

Choose ETS 6-18:

- Single pack code no. 034G5026
- I-pack code no. 034G5024

Rated Capacity (kW)

	Condensing temperature (°C)	ETS 6-18						
		Evaporation temperature (°C)						
		10	5	0	-5	-10	-20	-30
R410A	30	10.35	11.21	11.88	12.41	12.81	13.31	13.52
	35	11.15	11.84	12.38	12.79	13.10	13.47	13.58
	38	11.51	12.11	12.58	12.94	13.20	13.50	13.55
	40	11.70	12.25	12.67	13.00	13.23	13.48	13.50
	45	12.00	12.44	12.77	13.02	13.19	13.33	13.27
R407C	30	8.95	9.61	10.11	10.48	10.74	11.02	11.06
	35	9.75	10.26	10.65	10.92	11.11	11.27	11.22
	38	10.13	10.57	10.90	11.13	11.28	11.38	11.28
	40	10.35	10.75	11.04	11.24	11.36	11.42	11.30
	45	10.79	11.09	11.30	11.43	11.50	11.47	11.27
R22	30	8.59	9.27	9.80	10.22	10.53	10.92	11.07
	35	9.41	9.96	10.38	10.71	10.96	11.24	11.33

Correction factors for subcooling ΔT_{sc}

The evaporator capacities used must be corrected if subcooling deviates from 4 K (7.2°F). The corrected capacity can be obtained by

dividing the required evaporator capacity by the correction factor below. Selections can then be made from the tables above.

ΔT_{sc}	0K	4K	10K	15K	20K	25K	30K	35K	40K	45K	50K
	0°F	7.2°F	18°F	27°F	36°F	45°F	54°F	63°F	72°F	81°F	90°F
R22	1.00	1.04	1.10	1.16	1.20	1.25	1.30	1.35	1.41	1.45	1.50
R410A	1.00	1.06	1.14	1.21	1.28	1.34	1.40	1.47	1.53	1.58	1.65
R407C	1.00	1.06	1.14	1.20	1.28	1.34	1.40	1.47	1.53	1.60	1.66
R134a	1.00	1.06	1.14	1.19	1.26	1.32	1.38	1.45	1.50	1.56	1.63
R404A/R507	1.00	1.07	1.18	1.29	1.38	1.47	1.56	1.65	1.75	1.82	1.91

Rated Capacity (kW)

	Condensing temperature (°C)	ETS 6-10						
		Evaporation temperature (°C)						
		10	5	0	-5	-10	-20	-30
R410A	30	2.59	2.80	2.97	3.10	3.20	3.33	3.38
	35	2.79	2.96	3.09	3.20	3.28	3.37	3.39
	38	2.88	3.03	3.14	3.23	3.30	3.37	3.39
	40	2.92	3.06	3.17	3.25	3.31	3.37	3.37
	45	3.00	3.11	3.19	3.25	3.30	3.33	3.32
	50	3.02	3.10	3.17	3.21	3.24	3.25	3.21
R407C	30	2.24	2.40	2.53	2.62	2.69	2.76	2.76
	35	2.44	2.57	2.66	2.73	2.78	2.82	2.81
	38	2.53	2.64	2.72	2.78	2.82	2.84	2.82
	40	2.59	2.69	2.76	2.81	2.84	2.86	2.82
	45	2.70	2.77	2.82	2.86	2.87	2.87	2.82
	50	2.77	2.82	2.85	2.85	2.88	2.85	2.78
R22	30	2.15	2.32	2.45	2.55	2.63	2.73	2.77
	35	2.35	2.49	2.60	2.68	2.74	2.81	2.83
	38	2.45	2.58	2.67	2.74	2.79	2.85	2.86
	40	2.52	2.63	2.71	2.78	2.82	2.87	2.88
	45	2.64	2.73	2.80	2.85	2.88	2.91	2.90
	50	2.74	2.81	2.86	2.90	2.92	2.93	2.90
R134a	30	1.71	1.82	1.91	1.97	2.01	2.04	2.02
	35	1.86	1.95	2.01	2.05	2.08	2.09	2.05
	38	1.94	2.01	2.06	2.09	2.11	2.11	2.07
	40	1.98	2.05	2.09	2.12	2.13	2.12	2.07
	45	2.08	2.12	2.15	2.16	2.16	2.13	2.07
	50	2.14	2.17	2.18	2.18	2.17	2.12	2.05
R404A	30	1.60	1.71	1.80	1.85	1.89	1.92	1.90
	35	1.71	1.79	1.85	1.89	1.91	1.91	1.88
	38	1.75	1.82	1.86	1.89	1.90	1.89	1.84
	40	1.76	1.82	1.86	1.88	1.89	1.87	1.81
	45	1.78	1.82	1.84	1.85	1.84	1.80	1.73
	50	1.75	1.77	1.78	1.77	1.76	1.70	1.61

Rated Capacity (kW)

	Condensing temperature (°C)	ETS 6-14						
		Evaporation temperature (°C)						
		10	5	0	-5	-10	-20	-30
R410A	30	5.80	6.28	6.66	6.95	7.17	7.46	7.57
	35	6.25	6.63	6.93	7.16	7.34	7.55	7.60
	38	6.44	6.78	7.04	7.24	7.39	7.56	7.59
	40	6.55	6.86	7.10	7.28	7.41	7.55	7.56
	45	6.72	6.97	7.15	7.29	7.39	7.47	7.43
	50	6.76	6.95	7.09	7.19	7.25	7.28	7.20
R407C	30	5.01	5.38	5.66	5.87	6.02	6.17	6.19
	35	5.46	5.75	5.96	6.12	6.22	6.31	6.29
	38	5.67	5.92	6.10	6.23	6.31	6.37	6.32
	40	5.80	6.02	6.18	6.29	6.36	6.40	6.33
	45	6.04	6.21	6.33	6.40	6.44	6.42	6.31
	50	6.19	6.32	6.39	6.43	6.44	6.38	6.23
R22	30	4.81	5.19	5.49	5.72	5.89	6.11	6.20
	35	5.27	5.58	5.82	6.00	6.14	6.30	6.34
	38	5.50	5.77	5.98	6.14	6.26	6.39	6.41
	40	5.63	5.88	6.07	6.22	6.32	6.43	6.44
	45	5.92	6.12	6.27	6.38	6.46	6.52	6.50
	50	6.14	6.29	6.41	6.49	6.54	6.56	6.51
R134a	30	3.82	4.08	4.27	4.40	4.49	4.56	4.53
	35	4.17	4.37	4.51	4.60	4.65	4.67	4.60
	38	4.35	4.51	4.62	4.69	4.73	4.72	4.63
	40	4.45	4.59	4.69	4.74	4.77	4.74	4.64
	45	4.65	4.75	4.81	4.84	4.84	4.77	4.63
	50	4.79	4.85	4.88	4.88	4.86	4.75	4.59
R404A	30	3.58	3.84	4.02	4.15	4.24	4.30	4.25
	35	3.83	4.01	4.15	4.23	4.28	4.29	4.20
	38	3.91	4.07	4.17	4.23	4.26	4.24	4.13
	40	3.94	4.08	4.16	4.21	4.23	4.19	4.06
	45	3.98	4.07	4.12	4.13	4.12	4.04	3.88
	50	3.92	3.97	3.98	3.97	3.93	3.81	3.61

Rated Capacity (kW)

	Condensing temperature (°C)	ETS 6-18						
		Evaporation temperature (°C)						
		10	5	0	-5	-10	-20	-30
R410A	30	10.35	11.21	11.88	12.41	12.81	13.31	13.52
	35	11.15	11.84	12.38	12.79	13.10	13.47	13.58
	38	11.51	12.11	12.58	12.94	13.20	13.50	13.55
	40	11.70	12.25	12.67	13.00	13.23	13.48	13.50
	45	12.00	12.44	12.77	13.02	13.19	13.33	13.27
	50	12.07	12.41	12.66	12.84	12.95	13.00	12.86
R407C	30	8.95	9.61	10.11	10.48	10.74	11.02	11.06
	35	9.75	10.26	10.65	10.92	11.11	11.27	11.22
	38	10.13	10.57	10.90	11.13	11.28	11.38	11.28
	40	10.35	10.75	11.04	11.24	11.36	11.42	11.30
	45	10.79	11.09	11.30	11.43	11.50	11.47	11.27
	50	11.06	11.28	11.42	11.49	11.50	11.39	11.13
R22	30	8.59	9.27	9.80	10.22	10.53	10.92	11.07
	35	9.41	9.96	10.38	10.71	10.96	11.24	11.33
	38	9.82	10.30	10.68	10.96	11.17	11.40	11.44
	40	10.06	10.50	10.85	11.11	11.29	11.49	11.50
	45	10.57	10.93	11.20	11.40	11.53	11.65	11.60
	50	10.96	11.24	11.45	11.59	11.68	11.72	11.62
R134a	30	6.83	7.29	7.63	7.87	8.02	8.14	8.08
	35	7.45	7.80	8.05	8.21	8.31	8.34	8.21
	38	7.76	8.05	8.25	8.38	8.44	8.42	8.26
	40	7.94	8.20	8.37	8.47	8.52	8.46	8.28
	45	8.31	8.49	8.59	8.64	8.64	8.52	8.27
	50	8.56	8.67	8.72	8.72	8.68	8.49	8.19
R404A	30	6.40	6.85	7.18	7.41	7.56	7.67	7.60
	35	6.83	7.17	7.41	7.56	7.65	7.66	7.51
	38	6.99	7.26	7.45	7.56	7.61	7.57	7.38
	40	7.04	7.28	7.43	7.52	7.55	7.47	7.25
	45	7.11	7.27	7.35	7.38	7.36	7.21	6.92
	50	7.00	7.08	7.11	7.09	7.03	6.80	6.45

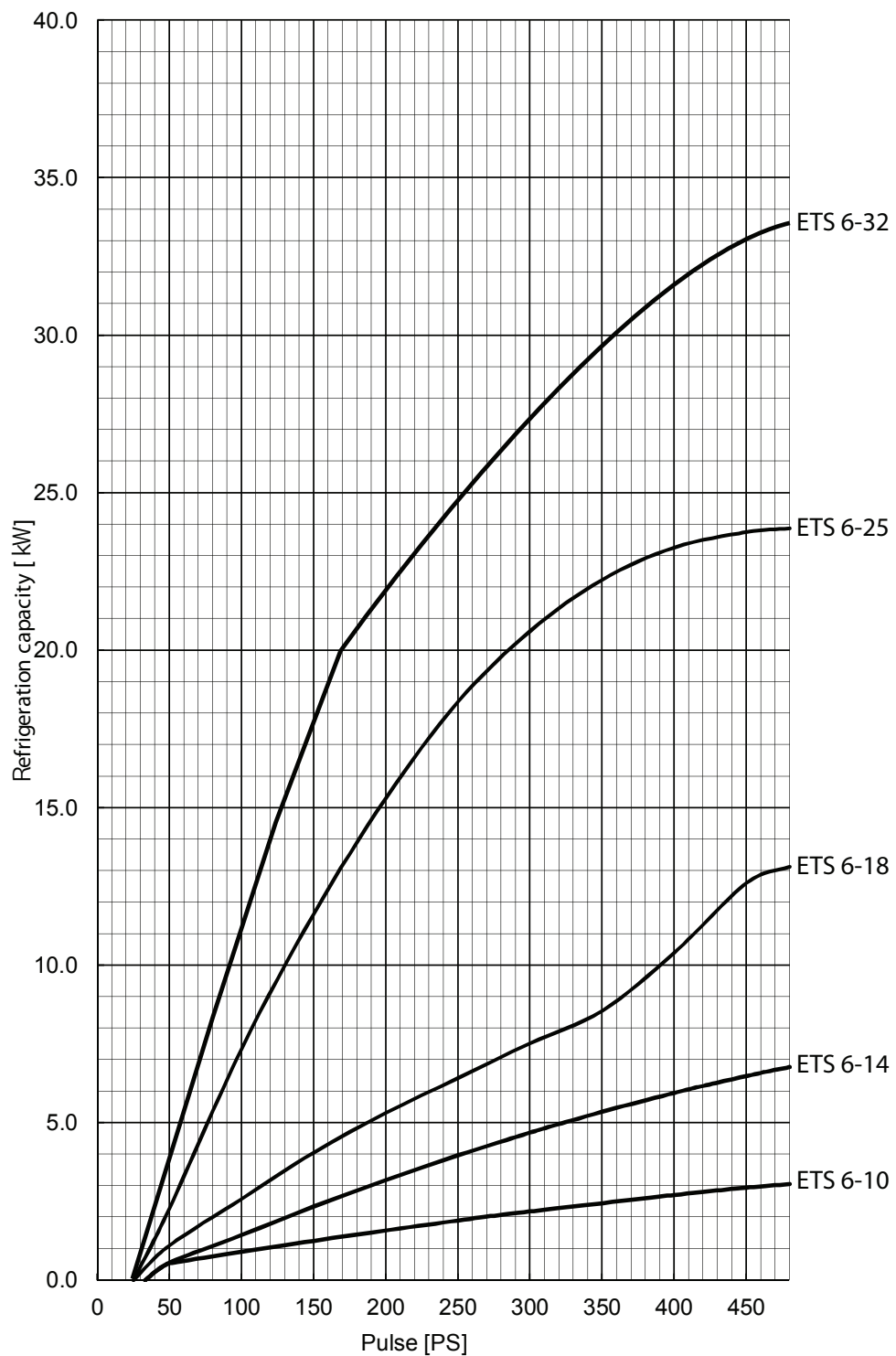
Rated Capacity (kW)

	Condensing temperature (°C)	ETS 6-25						
		Evaporation temperature (°C)						
		10	5	0	-5	-10	-20	-30
R410A	30	19.73	21.37	22.65	23.64	24.41	25.37	25.76
	35	21.26	22.56	23.59	24.38	24.97	25.68	25.88
	38	21.93	23.08	23.97	24.65	25.16	25.72	25.82
	40	22.29	23.34	24.15	24.77	25.22	25.70	25.73
	45	22.88	23.71	24.35	24.81	25.13	25.41	25.28
	50	23.00	23.65	24.13	24.47	24.68	24.77	24.50
R407C	30	17.05	18.32	19.28	19.98	20.48	21.01	21.07
	35	18.58	19.56	20.29	20.82	21.18	21.49	21.39
	38	19.31	20.15	20.77	21.21	21.49	21.69	21.50
	40	19.73	20.49	21.04	21.42	21.66	21.78	21.54
	45	20.57	21.14	21.54	21.79	21.91	21.86	21.48
	50	21.08	21.50	21.76	21.90	21.93	21.71	21.21
R22	30	16.36	17.67	18.69	19.47	20.06	20.81	21.11
	35	17.93	18.98	19.79	20.42	20.88	21.43	21.59
	38	18.71	19.63	20.35	20.89	21.29	21.73	21.81
	40	19.17	20.02	20.67	21.17	21.52	21.89	21.92
	45	20.15	20.83	21.35	21.72	21.98	22.20	22.11
	50	20.88	21.42	21.81	22.09	22.26	22.34	22.14
R134a	30	13.01	13.90	14.55	14.99	15.29	15.52	15.40
	35	14.21	14.87	15.35	15.66	15.84	15.90	15.65
	38	14.79	15.35	15.73	15.97	16.09	16.05	15.74
	40	15.13	15.62	15.95	16.14	16.23	16.13	15.78
	45	15.83	16.17	16.38	16.47	16.47	16.23	15.77
	50	16.31	16.52	16.62	16.62	16.54	16.18	15.61
R404A	30	12.20	13.06	13.69	14.13	14.42	14.63	14.48
	35	13.03	13.66	14.11	14.41	14.57	14.59	14.30
	38	13.32	13.84	14.20	14.41	14.51	14.43	14.06
	40	13.42	13.87	14.17	14.33	14.39	14.24	13.82
	45	13.55	13.85	14.01	14.07	14.04	13.74	13.19
	50	13.33	13.50	13.55	13.51	13.39	12.95	12.30

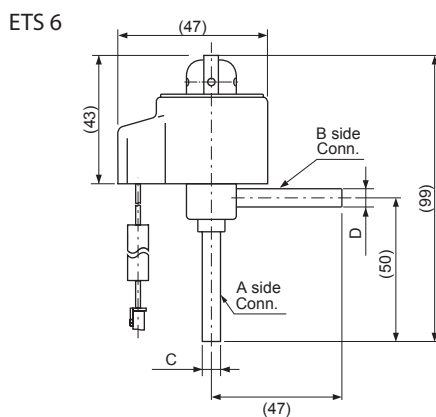
Rated Capacity (kW)

	Condensing temperature (°C)	ETS 6-32						
		Evaporation temperature (°C)						
		10	5	0	-5	-10	-20	-30
R410A	30	29.0	31.4	33.3	34.7	35.9	37.3	37.8
	35	31.2	33.1	34.7	35.8	36.7	37.7	38.0
	38	32.2	33.9	35.2	36.2	37.0	37.8	37.9
	40	32.8	34.3	35.5	36.4	37.1	37.8	37.8
	45	33.6	34.8	35.8	36.5	36.9	37.3	37.1
	50	33.8	34.7	35.5	35.9	36.3	36.4	36.0
R407C	30	25.0	26.9	28.3	29.3	30.0	30.8	30.9
	35	27.3	28.7	29.8	30.5	31.1	31.5	31.4
	38	28.3	29.6	30.5	31.1	31.5	31.8	31.5
	40	28.9	30.1	30.9	31.4	31.8	31.9	31.6
	45	30.2	31.0	31.6	32.0	32.1	32.1	31.5
	50	30.9	31.5	31.9	32.1	32.2	31.8	31.1
R22	30	24.0	26.0	27.5	28.6	29.5	30.6	31.0
	35	26.3	27.9	29.1	30.0	30.7	31.5	31.7
	38	27.5	28.8	29.9	30.7	31.3	31.9	32.0
	40	28.2	29.4	30.4	31.1	31.6	32.2	32.2
	45	29.6	30.6	31.4	31.9	32.3	32.6	32.5
	50	30.7	31.5	32.0	32.5	32.7	32.8	32.5
R134a	30	19.1	20.4	21.4	22.0	22.5	22.8	22.6
	35	20.9	21.9	22.5	23.0	23.3	23.4	23.0
	38	21.7	22.5	23.1	23.5	23.6	23.6	23.1
	40	22.2	22.9	23.4	23.7	23.8	23.7	23.2
	45	23.3	23.8	24.1	24.2	24.2	23.8	23.2
	50	24.0	24.3	24.4	24.4	24.3	23.8	22.9
R404A	30	17.9	19.2	20.1	20.8	21.2	21.5	21.3
	35	19.1	20.1	20.7	21.2	21.4	21.4	21.0
	38	19.6	20.3	20.9	21.2	21.3	21.2	20.7
	40	19.7	20.4	20.8	21.1	21.1	20.9	20.3
	45	19.9	20.3	20.6	20.7	20.6	20.2	19.4
	50	19.6	19.8	19.9	19.8	19.7	19.0	18.1

Capacities, *continued*



Dimensions



Model No.	C	D
ETS 6-10		Ø7.94
ETS 6-14		
ETS 6-18		Ø6.35
ETS 6-25		Ø7.94
ETS 6-32		

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