

HANDBOOK
EXPANSION VALVES

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 **Castel**[®]
Italian technology

CHAPTER 1

THERMOSTATIC EXPANSION VALVES

FOR REFRIGERATION PLANTS THAT USE HCFC OR HFC REFRIGERANTS



APPLICATIONS

The thermostatic expansion valves in series 221X, 222X, and 223X illustrated in this chapter are designed to work with the interchangeable orifice assembly, for flexible selection of capacity, and can be used in a wide range of applications as listed below:

- Refrigeration systems (display cases in supermarkets, freezers, ice cream and icemaker machines, refrigerated shipping, etc.).
- Air conditioning systems
- Heat pump systems
- Liquid chillers

That use the following refrigerant fluids:

- HCFC (R22)
- HFC (R134a, R404A, R407C, or R507)

belonging to Group 2, as defined in Article 13, Chapter 1(b) of Directive 2014/68/EU, with reference to EC Regulation No. 1272/2008.

OPERATION

Thermostatic expansion valves regulate the flow of liquid refrigerant in evaporators. The superheating of the refrigerant fluid controls liquid injection. Thermostatic expansion valves act as throttle between the high and low-pressure sides of refrigeration systems and ensure that the refrigerant flow rate into the evaporator matches the rate of evaporation of liquid refrigerant in the evaporator. If the actual superheating is greater than the set point, the valve feeds the evaporator more liquid refrigerant. If the actual superheating is lower than the set point, the valve decreases the flow of liquid refrigerant to the evaporator. This ensures that the evaporator is utilized fully and that no liquid refrigerant can reach the compressor.

CONSTRUCTION

The thermostatic expansion valve consists of two parts that must work together. The first is the body, which acts

as the regulating system actuator. The second is the orifice, which contains the real regulator and performs the expansion of the refrigerating fluid.

Body assembly: this consists of two parts: the thermostatic element and the body with its inner components.

The thermostatic element is the valve motor. A sensing bulb is connected to the diaphragm assembly by 1.5 m capillary tubing, which transmits the bulb pressure to the top chamber of the valve's diaphragm. The sensing bulb pressure is directly correlated to the temperature of the thermostatic charge, which is the gas mixture within the bulb.

The body is made from hot forged brass with right-angle connections. The interchangeable orifice assembly can be replaced through the inlet connection. A steel rod slides inside the body and transfers the diaphragm movement to the shutter inside the orifice assembly. When the thermostatic charge pressure increases, the diaphragm will be deflected, transferring this motion to the shutter, which lifts from its seat and allows the liquid to pass through the orifice.

A spring opposes the force underneath the diaphragm and a side set screw can adjust its tension. Static superheating is increased by turning it clockwise and decreased by turning it counter-clockwise.

The thermostatic element is solidly connected by brazing to the forged brass body to avoid any leakage.

The body assembly can be supplied with an internal or external equalizer. Both types can be supplied either with SAE Flare connections or with solder connections (outlet and external equalizer, if present). Both SAE Flare unions, required for threaded connections, and inlet SAE/ODS connection, required for solder connections, must be ordered separately.

Each body assembly is supplied with a strap unit, part no. G9150/R61, that allows the bulb to be fixed to the pipe.

This part can be ordered separately as repair kit, too. The main parts of body assembly are made with the following materials:

- Stainless steel for bulb, capillary tubing, diaphragm casing, diaphragm and rod
- Hot forged brass EN 12420 – CW 617N for the body
- Brass EN 12164 – CW 614N for superheating set screw and spring holder
- Steel DIN 17223-1 for spring
- Copper pipe EN 12735-1 – Cu-DHP for solder connections

Orifice assembly: interchangeable orifice assembly provides a wide capacity range, from 0.5 to 15.5 kW (nominal capacity with R22). The external cartridge contains the following elements: housing, shutter (metering device), seat, spring and filter. The solid construction of the orifice assembly and its internal components ensure that shutter and seat can withstand all types of critical stresses (hammering, cavitation, sudden pressure variations at temperature, or contaminants). The spring holds the shutter firmly in contact with the seat to minimize leakage through the valve. To guarantee complete shut-off, a solenoid valve is required upstream from the thermostatic expansion valve. Orifice assemblies are available in these two solutions:

- With conical flanged filter, for valves with SAE Flare threaded connections.
- With flat flanged filter, for valves with ODS solder connections, to use with adapters in series 2271.

Orifice assembly filters can be cleaned or replaced. In the event of replacement, the following two types of filters are available for separate order:

- Filter 2290, for valves with SAE Flare threaded connections.
- Filter 2290/S, for valves with ODS solder connections.

THERMOSTATIC CHARGES

Liquid charge: the behaviour of valves with liquid charge is exclusively determined by the temperature changes at the bulb and they are not subject to any environmental interference. They feature fast response time, reacting quickly in the control circuit. Castel thermostatic expansion valves with liquid charge cannot incorporate MOP functions.

Gas charge: the behaviour of valves with gas charge will be determined by the lowest temperature at any part of the expansion valve (thermostatic element, capillary tube or bulb). If any parts other than the bulb are subjected to the lowest temperature, the malfunctioning of the expansion valve can occur (charge migration). Castel thermostatic expansion valves with gas charge always feature MOP function and include ballast bulb. The ballast has a damping effect on the valve regulation and leads to slow opening and fast closure of the valve.

MOP (Maximum Operating Pressure): this function limits the evaporator pressure to a maximum value to protect the compressor from the overload condition. MOP

is the evaporating pressure at which the expansion valve will throttle liquid injection into the evaporator, preventing the evaporating pressure from rising. The expansion valve acts as superheating control in the normal working range and acts as a pressure regulator within MOP range.

The MOP point will change if the factory superheating setting of the expansion valve is changed. Superheating adjustments influence the MOP point as follows:

- Increase superheating → Decrease MOP
- Decrease superheating → Increase MOP

Superheating: this is the controlling parameter for the expansion valve. Superheating, measured at the evaporator outlet, is defined as the difference between the actual bulb temperature and the evaporating temperature, deduced from evaporator pressure. In order to prevent liquid refrigerant from entering the compressor, a certain minimum superheating value must be maintained. In expansion valve operation, the following terms are used:

- **Static superheating:** this is the superheating above which the valve begins to open. Castel thermostatic expansion valves are factory pre-set to the following static superheating values:
 - 5 °C for Castel valves without MOP
 - 5 °C for Castel valves with MOPUnder nominal operating conditions (see Table 2)
- **Opening superheating:** this is the superheating, above the static superheating, required to produce a given valve potential
- **Operating superheating:** this is the sum of static and opening superheating

Subcooling: this is defined as the difference between the condensing temperature (deduced from condensing pressure) and the actual temperature at inlet valve. Subcooling generally increases the refrigeration system potential and must be accounted for when dimensioning an expansion valve. Depending on system design, subcooling may be necessary to prevent gas bubbles from forming in the liquid line. If gas bubbles form in the liquid line, the potential of the expansion valve will be reduced significantly. All potential tables, provided in this chapter, are calculated for a subcooling value of 4 °C. If the actual subcooling value is higher than 4 °C, the valve potential is taken from the evaporator demand divided by the correction factor shown in the tables below each potential table.

SELECTION

To dimension a thermostatic expansion valve for a refrigerating system correctly, the following design parameters must be available:

- Type of refrigerant
- Evaporator capacity, Q_e
- Evaporating temperature/pressure, T_e / p_e
- Minimum condensing temperature/pressure, T_c / p_c
- Liquid refrigerant temperature at valve inlet, T_l
- Pressure drop in the liquid line, distributor and evaporator, Δp

The following procedure helps the correct dimensioning of

an expansion valve for a refrigeration plant.

Step 1

Determine the pressure drop across the valve. The pressure drop is calculated using the equation:

$$\Delta p_{\text{tot}} = p_c - (p_e + \Delta p)$$

where:

- P_c = condensing pressure
- P_e = evaporating pressure
- Δp = sum of pressure drops in the liquid line, distributor and evaporator

Step 2

Determine required valve capacity. Use the evaporator capacity, Q_e , to select the required valve capacity at a given evaporating temperature. If necessary, correct the evaporator capacity based on the subcooling value. Subcooling liquid refrigerant entering the evaporator increase the evaporator capacity such that a smaller valve may be required. The subcooling is calculated using the equation:

$$\Delta T_{\text{sub}} = T_c - T_l$$

In the subcooling correction factor table, identify the appropriate correction factor, F_{sub} , corresponding to the ΔT_{sub} calculated, and determine the required valve capacity using the equation:

$$\Delta Q_{\text{sub}} = \frac{Q_e}{F_{\text{sub}}}$$

Step 3

Determine the orifice size required: use the pressure drop across the valve, the evaporating temperature, and the calculated evaporator capacity to select the corresponding orifice size from the capacity table corresponding to the chosen refrigerant fluid.

Step 4

Select a thermostatic charge. Choose the type of charge, with or without MOP, and the operating temperature range, normal temperature or low temperature.

Step 5

Choose the type of equalizer: if a distributor is used, or if there is an appreciable difference in pressure between the valve outlet and the bulb location, an external equalizer is required. Determine the type of connections and their sizes.

Step 6

Order the required components:

If the connections are SAE Flare, the following two parts must be ordered:

- Body assembly (see Tables 1a and 1b)
- Orifice assembly, including filter (see Table 2)

If ODS connections, you must order the following three parts:

- Body assembly (see Tables 1a and 1b)
- Orifice assembly, including filter (see Table 2)
- Solder connector (see Table 3)

DIMENSIONING EXAMPLE

• Type of refrigerant	R134a
• Evaporator capacity, Q_e	6 kW
• Evaporating temperature, T_e	- 10 °C
• Minimum condensing temperature, T_c	+ 30 °C
• Liquid refrigerant temperature, T_l	+ 20 °C
• Pressure drop in the liquid line, distributor and evaporator, Δp	1.5 bar

Step 1 - Determine the pressure drop across the valve.

- Condensing pressure at + 30 °C - $P_c = 6.71$ bar
- Evaporating pressure at - 10 °C - $P_e = 1.01$ bar

$$\Delta p_{\text{tot}} = 6,71 - (1,01 + 1,5) = 4,2 \cdot \text{bar}$$

Step 2 - Determine required valve capacity

$$\Delta T_{\text{sub}} = 30 - 20 = 10 \cdot \text{°C}$$

From the subcooling correction factor Table 6B, we find the appropriate correction factor, F_{sub} , equal to 1.06 for $\Delta T_{\text{sub}} = 10$ °C. The required valve capacity is

$$\Delta Q_{\text{sub}} = \frac{6}{1,06} = 5,66 \cdot \text{kW}$$

Step 3 - Determine required orifice dimension

Using Table 6A for the capacity for refrigerant fluid R134a, enter the data:

- Pressure drop across the valve = 4.2 bar
- Evaporating temperature = - 10 °C
- Calculated evaporator capacity = 5.66 kW
- Calculated evaporator capacity = 5.66 kW

Select the corresponding orifice, 2205 (Note: the expansion valve capacity must be equal to or slightly greater than the calculated evaporator capacity)

MARKING

Main valve data are indicated on the upper side of the thermostatic element and on the side surface of the orifice assembly cartridge.

On the thermostatic element, you can find the following data:

- Valve part number
- Refrigerant fluid
- Evaporating temperature range
- MOP value, if present
- Maximum allowable pressure, PS
- Date of production

On the orifice assembly cartridge, you can find the following data:

- Orifice size
- Date of production

The orifice size is marked on the plastic cap of the orifice assembly package. This cap can be fastened easily around the valve capillary tube to clearly identify the orifice size assembled in the valve.

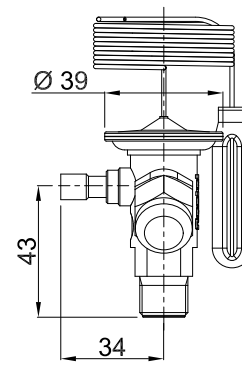
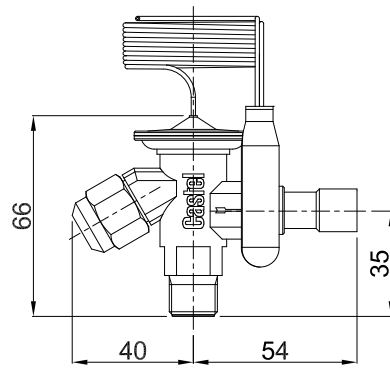
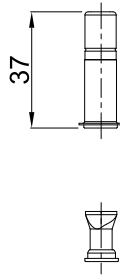
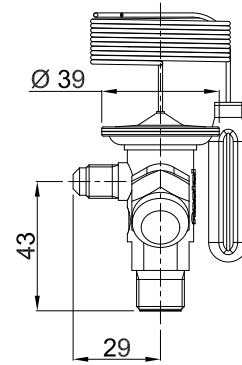
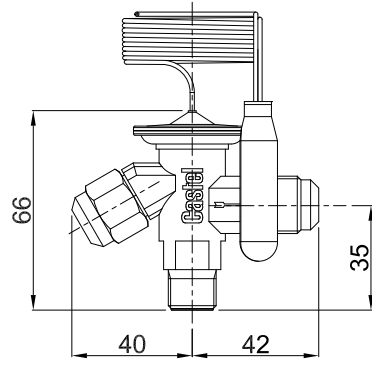
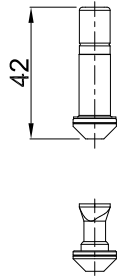


TABLE 1: General characteristics of body assemblies of liquid charge thermostatic expansion valves

Catalogue Number		Connections							Refrigerant	Evaporating Temperature Range [°C]	MOP	Max bulb temperature [°C]	PS [bar]	TS [°C]		TA [°C]		Risk Category according to PED Recast											
internal equalizer	external equalizer	SAE Flare			ODS [mm]		ODS [in]							min	max	min	max												
		IN	OUT	Equal.	OUT	Equal.	OUT	Equal.																					
2210/4	-	3/8"	1/2"	-	-	-	-	-	R22 R407C	-40 → +10	without	100 (1)	34	-60	+120	-40	+50	Art. 4.3											
2210/M12S			-	-	12	-	-	-											-										
2210/4S			-	-	-	-	1/2"	-											-										
-	2210/4E	1/2"	1/4"	-	-	-	-																						
	2210/M12SE	-	-	12	6	-	-																						
	2210/4SE	-	-	-	-	1/2"	1/4"																						
2220/4	-	3/8"	1/2"	-	-	-	-	R134a											-40 → +10	without	100 (1)	34	-60	+120	-40	+50	Art. 4.3		
2220/M12S			-	-	12	-	-																					-	-
2220/4S			-	-	-	-	1/2"																					-	-
-	2220/4E	1/2"	1/4"	-	-	-	-																						
	2220/M12SE	-	-	12	6	-	-																						
	2220/4SE	-	-	-	-	1/2"	1/4"																						
2230/4	-	3/8"	1/2"	-	-	-	-		R404A R507A	-60 → -25	without	100 (1)	34	-60	+120	-40	+50	Art. 4.3											
2230/M12S			-	-	12	-	-																					-	-
2230/4S			-	-	-	-	1/2"																					-	-
-	2230/4E	1/2"	1/4"	-	-	-	-																						
	2230/M12SE	-	-	12	6	-	-																						
	2230/4SE	-	-	-	-	1/2"	1/4"																						
2239/4	-	3/8"	1/2"	-	-	-	-	R404A R507A											-60 → -25	without	100 (1)	34	-60	+120	-40	+50	Art. 4.3		
2239/M12S			-	-	12	-	-																					-	-
2239/4S			-	-	-	-	1/2"																					-	-
-	2239/4E	1/2"	1/4"	-	-	-	-																						
	2239/M12SE	-	-	12	6	-	-																						
	2239/4SE	-	-	-	-	1/2"	1/4"																						

(1) : when valve is installed. 60 °C with element not mounted

TABLE 2: General characteristics of body assemblies of MOP charge thermostatic expansion valves

Catalogue Number		Connections							Refrigerant	Evaporating Temperature Range [°C]	MOP	Max bulb temperature [°C]	PS [bar]	TS [°C]		TA [°C]		Risk Category according to PED Recast											
internal equalizer	external equalizer	SAE Flare			ODS [mm]		ODS [in]							min	max	min	max												
		IN	OUT	Equal.	OUT	Equal.	OUT	Equal.																					
2211/4	-	3/8"	1/2"	-	-	-	-	-	R22 R407C	+15 °C (95 psi)	100 (1)	34	-60	+120	-40	+50	Art. 4.3												
2211/M12S			-	-	12	-	-	-										-											
2211/4S			-	-	-	-	1/2"	-										-											
-	2211/4E	1/2"	1/4"	-	-	-	-																						
	2211/M12SE	-	-	12	6	-	-																						
	2211/4SE	-	-	-	-	1/2"	1/4"																						
2221/4	-	3/8"	1/2"	-	-	-	-	R134a										-40 → +10	+15 °C (55 psi)	100 (1)	34	-60	+120	-40	+50	Art. 4.3			
2221/M12S			-	-	12	-	-																				-	-	
2221/4S			-	-	-	-	1/2"																				-	-	
-	2221/4E	1/2"	1/4"	-	-	-	-																						
	2221/M12SE	-	-	12	6	-	-																						
	2221/4SE	-	-	-	-	1/2"	1/4"																						
2231/4	-	3/8"	1/2"	-	-	-	-		R404A R507A	-60 → -25	+15 °C (120 psi)	100 (1)	34	-60	+120	-40	+50										Art. 4.3		
2231/M12S			-	-	12	-	-																					-	-
2231/4S			-	-	-	-	1/2"																					-	-
-	2231/4E	1/2"	1/4"	-	-	-	-																						
	2231/M12SE	-	-	12	6	-	-																						
	2231/4SE	-	-	-	-	1/2"	1/4"																						
2234/4	-	3/8"	1/2"	-	-	-	-	R404A R507A										-60 → -25	-20 °C (30 psi)	100 (1)	34	-60	+120	-40	+50	Art. 4.3			
2234/M12S			-	-	12	-	-																					-	-
2234/4S			-	-	-	-	1/2"																					-	-
-	2234/4E	1/2"	1/4"	-	-	-	-																						
	2234/M12SE	-	-	12	6	-	-																						
	2234/4SE	-	-	-	-	1/2"	1/4"																						

(1) : when valve is installed. 60 °C with element not mounted

TABLE 3: Orifice Assemblies - Rated Capacities in kW

Catalogue Number		Evaporating Temperature Range [°C]			
Valves with SAE Flare connections	Valves with ODS connections	- 40 → + 10			- 60 → - 25
		R22 R407C	R134a	R404A R507A	R404A R507
220X	220X/S	0,5	0,4	0,38	0,38
2200	2200/S	1,0	0,9	0,7	0,7
2201	2201/S	2,5	1,8	1,6	1,6
2202	2202/S	3,5	2,6	2,1	2,1
2203	2203/S	5,2	4,6	4,2	3,5
2204	2204/S	8,0	6,7	6,0	4,9
2205	2205/S	10,5	8,6	7,7	6,0
2206	2206/S	15,5	10,5	9,1	6,6

Rated capacities, for temperature range - 40 → + 10, are based on:

- Evaporating temperature $T_{\text{evap}} = + 5 \text{ °C}$
- Condensing temperature $T_{\text{cond}} = + 32 \text{ °C}$
- Refrigerant liquid temperature ahead of valve $T_{\text{liq}} = + 28 \text{ °C}$

Rated capacities, for temperature range - 60 → - 25, are based on:

- Evaporating temperature $T_{\text{evap}} = - 30 \text{ °C}$
- Condensing temperature $T_{\text{cond}} = + 32 \text{ °C}$
- Refrigerant liquid temperature ahead of valve $T_{\text{liq}} = + 28 \text{ °C}$

TABLE 4: Solder adapters

Catalogue Number	ODS Connections	
	[in]	[mm]
2271/M6S	-	6
2271/2S	1/4"	-
2271/3S	3/8"	-
2271/M10S	-	10

TABLE 5A: Refrigerant R22/R407C - Capacities in kW for temperature range - 40°C → + 10°C

Orifice code	Pressure drop across valve [bar]								Orifice code	Pressure drop across valve [bar]							
	2	4	6	8	10	12	14	16		2	4	6	8	10	12	14	16
Evaporating temperature = + 10 °C									Evaporating temperature = 0 °C								
220X	0,37	0,48	0,55	0,60	0,63	0,65	0,65	0,67	220X	0,37	0,48	0,55	0,59	0,63	0,65	0,66	0,66
2200	0,87	1,1	1,2	1,3	1,4	1,4	1,4	1,5	2200	0,84	1,0	1,2	1,3	1,3	1,4	1,4	1,4
2201	2,2	2,8	3,2	3,4	3,6	3,7	3,8	3,8	2201	1,9	2,4	2,7	3,0	3,1	3,2	3,3	3,3
2202	3,0	4,0	4,7	5,1	5,4	5,6	5,8	5,8	2202	2,6	3,4	4,0	4,3	4,6	4,8	4,9	5,0
2203	5,4	7,2	8,3	9,1	9,7	10,0	10,2	10,3	2203	4,6	6,1	7,1	7,8	8,2	8,5	8,7	8,8
2204	8,1	10,8	12,5	13,8	14,5	15,0	15,5	15,5	2204	6,9	9,1	10,5	11,5	12,2	12,7	13,0	13,2
2205	10,2	13,6	15,7	17,2	18,3	18,9	19,3	19,5	2205	8,8	11,6	13,3	14,6	15,5	16,1	16,4	16,6
2206	12,6	16,7	19,3	21,0	22,3	23,1	23,5	23,7	2206	10,8	14,2	16,3	17,8	18,9	19,6	20,0	20,2
Evaporating temperature = - 10 °C									Evaporating temperature = - 20 °C								
220X	0,37	0,47	0,53	0,57	0,60	0,63	0,64	0,64	220X		0,44	0,50	0,54	0,57	0,59	0,61	0,61
2200	0,79	0,96	1,1	1,2	1,2	1,3	1,3	1,3	2200		0,88	1,0	1,1	1,1	1,2	1,2	1,2
2201	1,6	2,0	2,3	2,5	2,6	2,7	2,8	2,8	2201		1,7	1,9	2,0	2,2	2,3	2,3	2,3
2202	2,2	2,9	3,3	3,6	3,8	4,0	4,1	4,1	2202		2,4	2,7	2,9	3,1	3,2	3,3	3,3
2203	3,9	5,1	5,9	6,4	6,8	7,1	7,3	7,3	2203		4,2	4,8	5,2	5,5	5,8	5,9	6,0
2204	5,8	7,6	8,7	9,5	10,1	10,5	10,8	10,9	2204		6,2	7,1	7,7	8,2	8,5	8,7	8,8
2205	7,4	9,6	11,0	12,0	12,8	13,3	13,6	13,8	2205		7,9	9,0	9,8	10,3	10,8	11,0	11,2
2206	9,1	11,6	13,5	14,7	15,6	16,2	16,6	16,8	2206		9,6	11,0	11,9	12,6	13,1	13,5	13,7
Evaporating temperature = - 30 °C									Evaporating temperature = - 40 °C								
220X		0,40	0,45	0,49	0,52	0,55	0,56	0,57	220X			0,42	0,45	0,48	0,50	0,52	0,53
2200		0,79	0,9	0,96	1,0	1,1	1,1	1,1	2200			0,8	0,86	0,92	0,95	0,98	0,99
2201		1,4	1,5	1,7	1,8	1,8	1,9	1,9	2201			1,3	1,4	1,4	1,5	1,5	1,6
2202		1,9	2,2	2,7	2,5	2,6	2,6	2,7	2202			1,7	1,9	2,0	2,0	2,1	2,1
2203		3,4	3,9	4,2	4,4	4,6	4,7	4,8	2203			3,1	3,4	3,5	3,7	3,8	3,8
2204		5,0	5,7	6,2	6,6	6,8	7,0	7,1	2204			4,6	4,9	5,2	5,4	5,6	5,7
2205		6,4	7,2	7,8	8,3	8,6	8,8	9,0	2205			5,8	6,3	6,6	6,9	7,1	7,2
2206		7,8	8,8	9,6	10,1	10,5	10,8	11,0	2206			7,1	7,7	8,1	8,4	8,7	8,8

TABLE 5B: Correction factor for subcooling $\Delta t_{sub} \neq 4^\circ\text{K}$

Δt_{sub} [°K]	4	10	15	20	25	30	35	40	45
Fsub	1,00	1,05	1,10	1,15	1,20	1,25	1,29	1,40	1,45

When subcooling ahead of the expansion valve is other than 4 °K , adjust the evaporator capacity by dividing by the appropriate correction factor found in Table 5B

TABLE 6A: Refrigerant R134a - Capacities in kW for temperature range - 40°C → + 10°C

Orifice code	Pressure drop across valve [bar]					Orifice code	Pressure drop across valve [bar]				
	2	4	6	8	10		2	4	6	8	10
Evaporating temperature = + 10 °C						Evaporating temperature = 0 °C					
220X	0,34	0,43	0,47	0,50	0,51	220X	0,33	0,42	0,46	0,47	0,49
2200	0,71	0,86	0,93	0,97	0,98	2200	0,65	0,78	0,86	0,89	0,91
2201	1,5	1,9	2,1	2,2	2,2	2201	1,3	1,6	1,7	1,8	1,8
2202	2,0	2,6	3,0	3,1	3,2	2202	1,7	2,2	2,4	2,6	2,6
2203	3,6	4,7	5,3	5,6	5,8	2203	3,0	3,9	4,4	4,6	4,7
2204	5,4	7,0	7,8	8,3	8,6	2204	4,5	5,7	6,4	6,8	7,0
2205	6,9	8,9	9,9	10,8	10,9	2205	5,7	7,3	8,1	8,6	8,8
2206	8,4	10,8	12,1	12,8	13,2	2206	7,0	8,9	1,0	10,5	10,8
Evaporating temperature = - 10 °C						Evaporating temperature = - 20 °C					
220X	0,30	0,36	0,43	0,44	0,44	220X	0,28	0,35	0,39	0,41	0,42
2200	0,59	0,70	0,77	0,81	0,82	2200	0,53	0,62	0,69	0,72	0,73
2201	1,0	1,3	1,4	1,5	1,5	2201	0,81	1,0	1,1	1,2	1,2
2202	1,4	1,8	2,0	2,1	2,1	2202	1,1	1,4	1,5	1,6	1,7
2203	2,5	3,1	3,5	3,7	3,8	2203	2,0	2,5	2,8	2,9	3,0
2204	3,6	4,6	5,1	5,4	5,6	2204	2,9	3,6	4,0	4,3	4,4
2205	4,6	5,8	6,5	6,9	7,1	2205	3,7	4,6	5,1	5,4	5,5
2206	5,7	7,1	8,0	8,4	8,6	2206	4,5	5,6	6,2	6,6	6,8
Evaporating temperature = - 30 °C						Evaporating temperature = - 40 °C					
220X	0,25	0,32	0,35	0,37	0,38	220X	0,23	0,28	0,32	0,33	0,34
2200	0,48	0,55	0,61	0,64	0,64	2200	0,44	0,50	0,54	0,56	0,57
2201	0,66	0,80	0,88	0,93	0,95	2201	0,54	0,65	0,72	0,78	0,77
2202	0,9	1,1	1,2	1,3	1,3	2202	0,7	0,9	1,0	1,0	1,0
2203	1,6	2,0	2,2	2,3	2,3	2203	1,3	1,6	1,8	1,9	1,9
2204	2,3	2,9	3,2	3,3	3,4	2204	1,9	2,3	2,6	2,7	2,7
2205	3,0	3,6	4,0	4,2	4,3	2205	2,4	2,9	3,2	3,5	3,5
2206	3,6	4,4	4,9	5,2	5,3	2206	3,0	3,6	4,0	4,2	4,3

TABLE 6B: Correction factor for subcooling $\Delta t_{sub} \neq 4^\circ K$

$\Delta t_{sub} [^\circ K]$	4	10	15	20	25	30	35	40	45
Fsub	1,00	1,06	1,12	1,17	1,23	1,29	1,35	1,44	1,49

When subcooling ahead of the expansion valve is other than 4 °K , adjust the evaporator capacity by dividing by the appropriate correction factor found in Table 6B

TABLE 7A: Refrigerant R404A/R507A - Capacities in kW for temperature range - 40°C → + 10°C

Orifice code	Pressure drop across valve [bar]								Orifice code	Pressure drop across valve [bar]							
	2	4	6	8	10	12	14	16		2	4	6	8	10	12	14	16
Evaporating temperature = + 10 °C									Evaporating temperature = 0 °C								
220X	0,28	0,35	0,40	0,42	0,43	0,43	0,42	0,41	220X	0,30	0,37	0,41	0,42	0,43	0,43	0,43	0,41
2200	0,67	0,82	0,90	0,94	0,96	0,96	0,93	0,90	2200	0,68	0,80	0,87	0,90	0,92	0,93	0,91	0,87
2201	1,70	2,10	2,30	2,42	2,48	2,46	2,41	2,34	2201	1,53	1,86	2,04	2,13	2,18	2,18	2,15	2,08
2202	2,32	3,00	3,39	3,61	3,73	3,74	3,68	3,59	2202	2,06	2,64	2,95	3,13	3,22	3,25	3,21	3,11
2203	4,15	5,36	6,03	6,43	6,63	6,66	6,55	6,39	2203	3,68	4,72	5,27	5,59	5,75	5,80	5,73	5,55
2204	6,24	8,06	9,06	9,66	9,95	9,98	9,81	9,57	2204	5,49	7,15	7,86	8,33	8,58	8,64	8,53	8,27
2205	7,91	10,17	11,43	12,16	12,53	12,56	12,34	12,03	2205	6,97	8,92	9,95	10,52	10,83	10,90	10,76	10,43
2206	9,71	12,47	13,98	14,86	15,29	15,31	15,05	14,66	2206	8,57	10,93	12,16	12,85	13,21	13,30	13,12	12,72
Evaporating temperature = - 10 °C									Evaporating temperature = - 20 °C								
220X	0,30	0,37	0,40	0,42	0,42	0,42	0,41	0,41	220X		0,35	0,38	0,40	0,39	0,40	0,39	0,38
2200	0,65	0,76	0,82	0,84	0,87	0,87	0,85	0,83	2200		0,70	0,75	0,77	0,79	0,79	0,79	0,76
2201	1,31	1,61	1,74	1,81	1,84	1,85	1,84	1,78	2201		1,34	1,45	1,50	1,52	1,52	1,51	1,47
2202	1,76	2,24	2,50	2,62	2,69	2,71	2,68	2,60	2202		1,85	2,04	2,14	2,17	2,18	2,16	2,09
2203	3,14	4,02	4,47	4,69	4,81	4,84	4,79	4,65	2203		3,32	3,66	3,83	3,89	3,90	3,86	3,75
2204	4,66	5,97	6,61	6,95	7,13	7,18	7,11	6,91	2204		4,88	5,40	5,64	5,75	5,77	5,71	5,56
2205	5,93	7,57	8,39	8,81	9,02	9,08	8,99	8,73	2205		6,20	6,86	7,17	7,29	7,31	7,23	7,05
2206	7,28	9,27	10,26	10,76	11,00	11,08	10,97	10,65	2206		7,60	8,39	8,75	8,91	8,93	8,84	8,61
Evaporating temperature = - 30 °C									Evaporating temperature = - 40 °C								
220X			0,35	0,37	0,36	0,37	0,36	0,35	220X			0,32	0,33	0,33	0,33	0,32	0,32
2200			0,67	0,70	0,70	0,70	0,69	0,67	2200			0,60	0,61	0,62	0,61	0,60	0,59
2201			1,18	1,21	1,23	1,21	1,20	1,17	2201			0,92	0,96	0,97	0,96	0,94	0,91
2202			1,63	1,69	1,71	1,70	1,68	1,64	2202			1,27	1,32	1,33	1,31	1,28	1,24
2203			2,93	3,04	3,07	3,06	3,02	2,93	2203			2,28	2,36	2,38	2,36	2,31	2,24
2204			4,28	4,47	4,52	4,51	4,46	4,35	2204			3,34	3,47	3,50	3,48	3,42	3,33
2205			5,45	5,68	5,74	5,74	5,67	5,52	2205			4,25	4,41	4,45	4,43	4,36	4,24
2206			6,66	6,94	7,02	7,01	6,93	6,75	2206			5,19	5,39	5,45	5,42	5,33	5,19

TABLE 7B: Correction factor for subcooling $\Delta t_{sub} \neq 4^\circ\text{K}$

Δt_{sub} [°K]	4	10	15	20	25	30	35	40	45
Fsub	1,00	1,09	1,17	1,26	1,34	1,42	1,50	1,56	1,63

When subcooling ahead of the expansion valve is other than 4 °K , adjust the evaporator capacity by dividing by the appropriate correction factor found in Table 7B

TABLE 8A: Refrigerant R404A/R507A - Capacities in kW for temperature range - 60°C → - 25°C

Orifice code	Pressure drop across valve [bar]								Orifice code	Pressure drop across valve [bar]							
	2	4	6	8	10	12	14	16		2	4	6	8	10	12	14	16
Evaporating temperature = - 25 °C									Evaporating temperature = - 30 °C								
2200	0,57	0,67	0,72	0,73	0,74	0,85	0,74	0,71	2200	0,53	0,64	0,67	0,70	0,70	0,70	0,69	0,67
2201	0,98	1,20	1,31	1,36	1,37	1,37	1,35	1,31	2201	0,88	1,07	1,18	1,21	1,23	1,21	1,20	1,17
2202	1,31	1,65	1,83	1,91	1,93	1,93	1,90	1,85	2202	1,18	1,47	1,63	1,69	1,71	1,70	1,68	1,64
2203	2,35	2,97	3,28	3,42	3,47	3,46	3,42	3,32	2203	2,12	2,65	2,93	3,04	3,07	3,05	3,02	2,93
2204	3,45	4,37	4,82	5,04	5,11	5,12	5,06	4,93	2204	3,09	3,88	4,28	4,47	4,52	4,51	4,46	4,35
2205	4,40	5,56	6,14	6,40	6,49	6,49	6,42	6,26	2205	3,94	4,94	5,45	5,68	5,74	5,74	5,67	5,52
2206	5,40	6,30	7,49	7,81	7,93	7,93	7,85	7,64	2206	4,83	6,06	6,66	6,94	7,02	7,01	6,93	6,75
Evaporating temperature = - 40 °C									Evaporating temperature = - 50 °C								
2200		0,56	0,60	0,61	0,62	0,61	0,60	0,59	2200		0,49	0,53	0,54	0,54	0,53	0,52	0,50
2201		0,65	0,72	0,75	0,77	0,77	0,77	0,75	2201		0,51	0,57	0,60	0,60	0,60	0,60	0,59
2202		1,17	1,27	1,32	1,33	1,31	1,28	1,24	2202		0,91	0,99	1,02	1,02	1,01	0,98	0,95
2203		2,09	2,28	2,36	2,38	2,36	2,31	2,24	2203		1,63	1,73	1,84	1,84	1,81	1,78	1,72
2204		3,03	3,34	3,47	3,50	3,48	3,42	3,33	2204		2,36	2,60	2,69	2,71	2,68	2,63	2,56
2205		3,87	4,25	4,41	4,45	4,43	4,36	4,24	2205		3,02	3,30	3,43	3,45	3,42	3,35	3,26
2206		4,73	5,19	5,39	5,45	5,47	5,33	5,19	2206		3,69	4,04	4,20	4,22	4,18	4,12	4,00
Evaporating temperature = - 60 °C																	
2200			0,46	0,48	0,47	0,45	0,45	0,43									
2201			0,58	0,60	0,60	0,58	0,56	0,54									
2202			0,78	0,80	0,80	0,78	0,75	0,72									
2203			1,40	1,44	1,43	1,40	1,36	1,30									
2204			2,04	2,11	2,11	2,07	2,03	1,96									
2205			2,59	2,69	2,66	2,65	2,59	2,50									
2206			3,16	3,28	3,30	3,25	3,18	3,07									

TABLE 8B: Correction factor for subcooling $\Delta t_{sub} \neq 4^\circ\text{K}$

Δt_{sub} [°K]	4	10	15	20	25	30	35	40	45
Fsub	1,00	1,09	1,17	1,26	1,34	1,42	1,50	1,56	1,63

When subcooling ahead of the expansion valve is other than 4 °K , adjust the evaporator capacity by dividing by the appropriate correction factor found in Table 8B

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