

Electrically operated suction modulating control valves, type KVS

Contents**Page**

Introduction.....	3
Features.....	3
Technical data.....	3
Electrical data.....	4
Design.....	4
Valve operation.....	5
Sizing.....	6
Valve selection.....	6
Ordering.....	7
Capacities:	
SI units.....	8
US units.....	9
Dimensions and weights:	
KVS 15-35.....	10
KVS 42-54.....	11

Introduction



KVS is a series of electrically operated suction modulating control valves for AC transport and refrigeration applications.

The balanced design provides bi-flow operation as well as solenoid shut-off function in both flow directions at MOPD 33 bar (478 psi).

Accurate temperature or pressure control is obtained by modulating the refrigerant flow in the evaporator with a current or voltage driver.

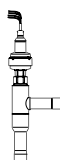
The KVS design is being registered. The pending reference number is 200530003728.1.

With an EKC 368 controller (current driver) and an AKS sensor placed in the media to be controlled, an accuracy better than $\pm 0.5K$ can be obtained.

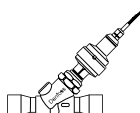
Features

- Balanced port design.
- High resolution for precise control.
- Solenoid tight shut-off.
- Low power consumption.
- Corrosion resistant design external as well as internal.
- For manual operation and service of KVS valves an AST-g service driver is available. For further information please contact Danfoss (Commercial Refrigeration & Air Conditioning Controls).

Technical data



Parameter	KVS 15-35
Compatibility	HFC, HCFC
CE marking	Yes
MOPD	28.5 bar (413 psi)
Max. working pressure	28.5 bar (413 psig)
Refrigerant temperature range	-40 to +10°C (-40 to +50°F)
Ambient temperature	-40 to +60°C (-40 to +140°F)
Total stroke	KVS 15-22: 20 mm (0.79 in.) KVS 28-35: 27 mm (1.06 in.)
Motor enclosure	IP 67



Parameter	KVS 42-54
Compatibility	HFC, HCFC
CE marking	Yes
MOPD	33 bar (478 psi)
Max. working pressure	34 bar (493 psig)
Refrigerant temperature range	-40 to +10°C (-40 to +50°F)
Ambient temperature	-40 to +60°C (-40 to +140°F)
Total stroke	17.2 mm (0.68 in.)
Motor enclosure	IP 67

Electrical data

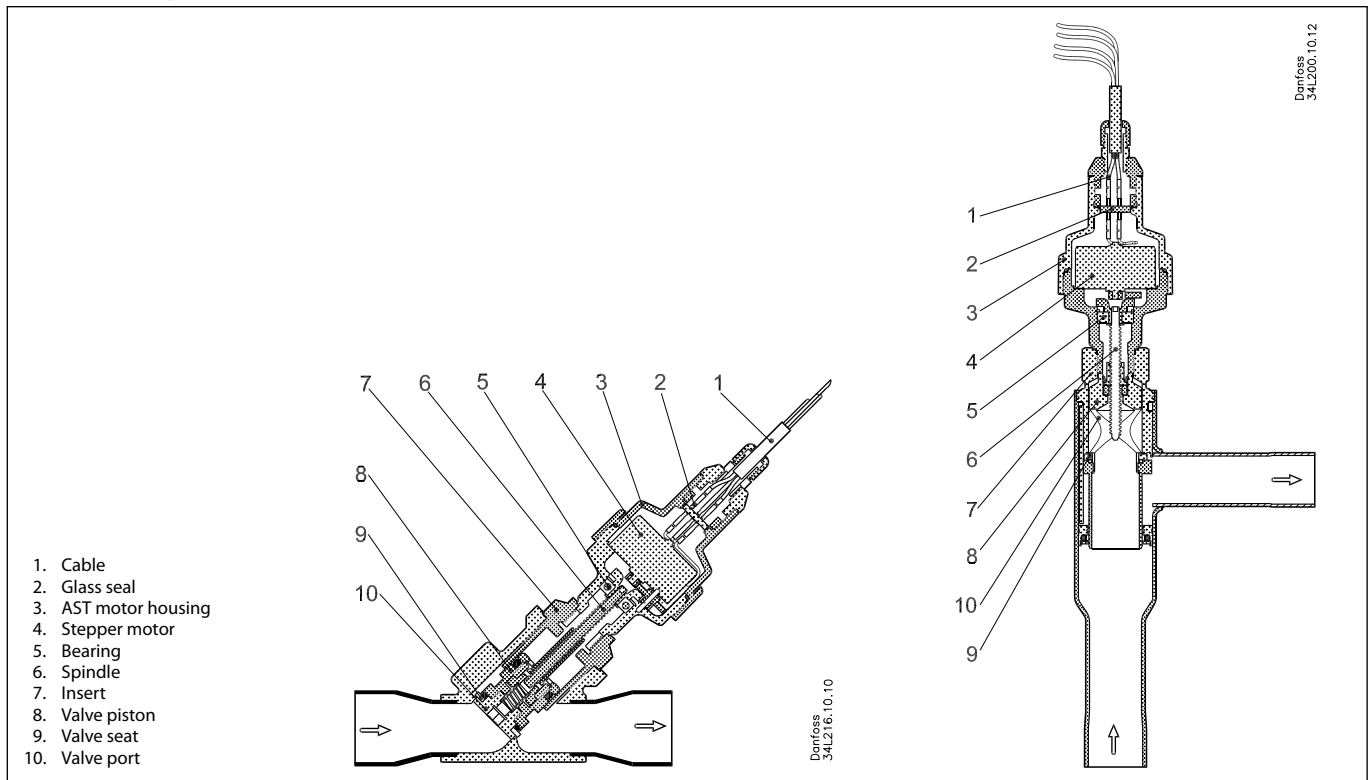
Parameter	KVS 15-54
Stepper motor type	Bi-polar - permanent magnet
Step mode	2 phase full step
Phase resistance	52Ω ±10%
Phase inductance	85 mH
Holding current	Depends on application. Full current allowed (100% duty cycle)
Step angle	7.5° (motor), 0.9° (lead screw), Gearing ration 8.5:1. (38/13)²:1
Nominal voltage	(Constant voltage drive) 12 V dc -4% +15%, 150 steps/sec.
Phase current	(Using chopper drive) 100 mA RMS -4% +15%,
Max. total power	Voltage / current drive: 5.5 / 1.3 W (UL: NEC class 2)
Step rate	150 steps/sec. (constant voltage drive) 0-300 steps/sec. 300 recommended (chopper current drive)
Total steps	KVS 15-22: 4100 [+160 / -0] steps KVS 28-35: 5540 [+160 / -0] steps KVS 42-54: 3810 [+160 / -0] steps
Full travel time	KVS 15-22: 27 / 13.5 sec. (voltage / current) KVS 28-35: 37 / 18.5 sec. (voltage / current) KVS 42-54: 25.4 / 12.7 sec. (voltage / current)
Lifting height	KVS 15-22: 20 mm (0.8 in.) KVS 28-35: 27 mm (1.06 in.) KVS 42-54: 17.2 mm (0.68 in.)
Reference position	Overdriving against the full close position
Electrical connection	4 wire 0.5 mm² (0.02 in²), 2 m (6.5 ft) long cable

Stepper motor switch sequence:

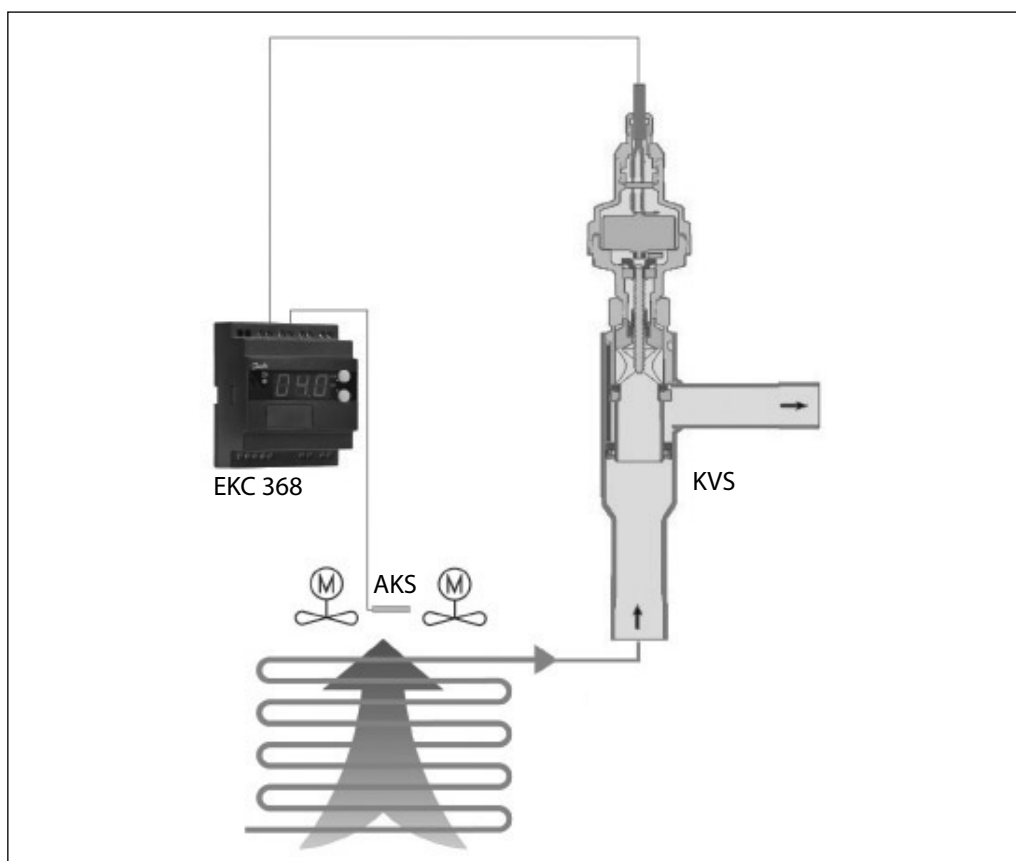
	STEP	Coil I		Coil II		
		Red	Green	White	Black	
↑ OPENING ↑ KVS 15-35	1	+	-	+	-	↓ OPENING ↓ KVS 42-54
	2	+	-	-	+	
	3	-	+	-	+	
	4	-	+	+	-	
	1	+	-	+	-	

Design

Valve / Actuator type KVS / AST



Valve operation



The KVS valves operate modulating by electronically controlled activation of the AST stepper motor. The motor is a type 2-phase bipolar, which stays in position, unless power pulses from a driver initiate the two discrete sets of motor stator windings for rotation in either directions.

The direction depends on the phase relationship of the power pulses, which number again is decisive for the travel.

The motor is operating the spindle, which rotating movements are transformed into linear motion by the transmission in the cage assembly.

The AST motor housing has a glass sealed 2 m (6.5 feet) cable connection as standard, which can be customized in length and plug/socket combinations.

The KVS valves have a fully balanced slide port respectively exponential cone, combining the best performance qualities at part load conditions as well as providing a 0-resistance at maximum capacity.

The cage and orifice design is fully power balanced, giving identical bi-flow performance capabilities and nearby identical maximum capacities.

The port design includes a shut-off function with "solenoid" tightness in both flow directions. Closed position is also the mechanical stop acting as reference point to reset the controller. By overdriving permanently while closed induces that the reference number in steps always is correct.

Operating the KVS series requires a controller with either 12 V dc voltage drive (5.5 W) or using chopper drive (100 mA RMS).

Danfoss EKC 368 is an example of a qualified controller.

Note:
Cable length between driver and actuator exceeding 10m (30 feet) can set off self-induction with reduction in the transmitted power and irregularity in the sequences as consequence.

This may result in loss of steps now and again or more permanent inadequate power supply to the step motor.

The driver circuit as well as the cable specifications are part of this interference.

Please contact Danfoss for further information and possible countermeasures.

Sizing

For optimum performance, it is important to take into consideration all system conditions and requirements. Selection is also dependent on an acceptable pressure drop across the valve. The following information will be needed when sizing a KVS valve:

- Refrigerant - HCFC or HFC
- Evaporator capacity Q_e in kW or TR
- Evaporating temperature t_e in °C or °F
- Liquid temperature ahead of expansion valve t_l in °C or °F
- Max. acceptable pressure drop in the KVS valve in bar or psig
- Connection size

Valve selection Example

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

- *Refrigerant:*
R22
- *Evaporator capacity:*
 $Q_e = 20$ kW (5.7 TR)
- *Evaporating temperature:*
 $t_e = -5^\circ\text{C} \sim 3.3$ bar ($23^\circ\text{F} \sim 47.9$ psig)
- *Liquid temperature ahead of expansion valve:*
 $t_l = 25^\circ\text{C}$ (77°F)
- *Max. pressure drop in the valve*
 $\Delta p = 0.2$ bar (2.9 psig)
- *Connection type:*
Solder
- *Connection size:*
 $1\frac{1}{8}$ in.

Step 1

Determine the correction factor for liquid temperature t_l ahead of expansion valve.

From the correction factors table (see below) a liquid temperature of 25°C (100°F), R22 corresponds to a factor of 1.0.

Correction factors for liquid temperature t_l

t_l °C	10	15	20	25	30	35	40	45	50
R134a	0.88	0.92	0.96	1.0	1.05	1.10	1.16	1.23	1.31
R22	0.90	0.93	0.96	1.0	1.05	1.10	1.13	1.18	1.24
R404A / R507	0.84	0.89	0.94	1.0	1.07	1.16	1.26	1.40	1.57
R407C	0.88	0.91	0.95	1.0	1.05	1.11	1.18	1.26	1.35

t_l °F	50	60	70	80	90	100	110	120
R134a	0.79	0.82	0.86	0.90	0.95	1.0	1.06	1.13
R22	0.82	0.85	0.88	0.92	0.96	1.0	1.05	1.10
R404A / R507	0.71	0.75	0.80	0.85	0.92	1.0	1.10	1.24
R407C	0.78	0.81	0.85	0.89	0.94	1.0	1.07	1.15

Step 2

Corrected evaporator capacity is
 $Q_e = 20 \times 1.0 = 20$ kW ($5.7 \times 1.0 = 5.7$ TR)

Step 3

Now select the appropriate capacity table, R22, and choose the column for an evaporating temperature of $t_e = -5^\circ\text{C}$ (23°F).

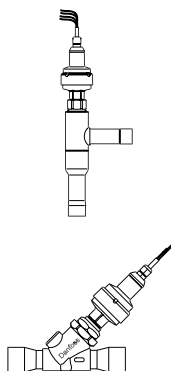
KVS 28/35 delivers 42.93 kW (12.19 TR) at a 0.2 bar (2.9 psig) pressure drop across the valve.

Using the corrected evaporator capacity, select a valve that provides an equivalent or greater capacity at an acceptable pressure drop across the valve of 0.2 bar (2.9 psig).

Based on the required connection size of $1\frac{1}{8}$ in., the KVS 28 is the proper selection for this example.

Step 4

KVS 28, $1\frac{1}{8}$ in. solder connection:
code no. 034L2051

Ordering
Valve / Actuator type KVS / AST-g in single pack


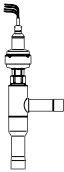
Type	Rated capacity ¹⁾						Valve KVS + Actuator AST		
	R22		R134a		R404A/R507		Connection		Code no. single pack
	kW	TR	kW	TR	kW	TR	mm	in.	
KVS 15	13.6	3.9	9.9	2.8	11.9	3.4	16	5/8	034L2060
KVS 22	13.6	3.9	9.9	2.8	11.9	3.4	22	7/8	034L2061
KVS 28	38.8	11.0	28.0	8.0	33.8	9.6	28	1 1/8	034L2051
KVS 35	38.8	11.0	28.0	8.0	33.8	9.6	35	1 3/8	034L2052
KVS 42	40.4	11.4	29.3	8.3	35.3	10.0	28	1 1/8	034G2050
	40.4	11.4	29.3	8.3	35.3	10.0	35	1 3/8	034G2051
	40.4	11.4	29.3	8.3	35.3	10.0	X	1 5/8	034G2052
KVS 54	55.5	15.7	40.3	11.4	48.5	13.7	X	1 5/8	034G3050
	55.5	15.7	40.3	11.4	48.5	13.7	54	2 1/8	034G3051

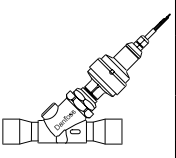
¹⁾ Rated capacity is the valve capacity at evaporating temperature $t_e = -10^\circ\text{C}$ (14°F), condensing temperature $t_c = +25^\circ\text{C}$ (77°F) and pressure drop across valve $\Delta p = 0.2$ bar (2.9 psig).

Capacities

Range -40°C to +10°C

SI units

	t _e [°C]	Rated capacity [kW]											
		KVS 15-22						KVS 28-35					
		Pressure drop Δp [bar]											
		0.05	0.1	0.2	0.3	0.5	0.7	0.05	0.1	0.2	0.3	0.5	0.7
R134a	-40	2.30	3.01	3.52	3.52	3.52	3.52	6.55	8.57	10.00	10.02	10.02	10.02
	-30	3.12	4.21	5.38	5.85	5.89	5.89	8.87	11.98	15.31	16.63	16.77	16.77
	-20	4.08	5.62	7.49	8.61	9.55	9.59	11.62	15.98	21.32	24.48	27.17	27.27
	-10	5.21	7.23	9.85	11.60	13.71	14.67	14.81	20.58	28.03	32.99	39.01	41.73
	-5	5.83	8.13	11.14	13.21	15.91	17.41	16.59	23.12	31.70	37.59	45.26	49.54
	10	7.99	11.20	15.56	18.71	23.24	26.40	22.74	31.87	44.27	53.23	66.12	75.10
R404A/R507	-40	2.92	4.01	5.36	6.15	6.83	6.86	8.30	11.42	15.24	17.50	19.44	19.51
	-30	3.82	5.30	7.23	8.52	10.10	10.84	10.86	15.08	20.57	24.23	28.73	30.83
	-20	4.87	6.81	9.39	11.22	13.72	15.31	13.86	19.36	26.72	31.91	39.03	43.56
	-10	6.09	8.55	11.88	14.30	17.79	20.26	17.34	24.31	33.80	40.67	50.62	57.63
	-5	6.77	9.51	13.26	15.99	20.02	22.94	19.27	27.05	37.71	45.50	56.96	65.27
	10	9.11	12.84	18.03	21.91	27.86	32.45	25.93	36.53	51.29	62.34	79.26	92.32
R22	-40	3.58	4.90	6.46	7.30	7.73	7.73	10.19	13.94	18.37	20.76	22.00	22.00
	-30	4.58	6.34	8.57	9.99	11.56	11.97	13.03	18.03	24.37	28.43	32.88	34.06
	-20	5.72	7.96	10.91	12.92	15.52	16.95	16.27	22.65	31.03	36.76	44.15	48.21
	-10	7.02	9.83	13.63	16.35	20.22	22.84	19.97	27.97	38.78	46.52	57.52	64.96
	-5	7.73	10.85	15.09	18.18	22.67	25.87	21.99	30.85	42.93	51.72	64.50	73.58
	10	10.09	14.19	19.86	24.07	30.41	35.18	28.70	40.38	56.51	68.48	86.51	100.09

	t _e [°C]	Rated capacity [kW]											
		KVS 42						KVS 54					
		Pressure drop Δp [bar]											
		0.05	0.1	0.2	0.3	0.5	0.7	0.05	0.1	0.2	0.3	0.5	0.7
R134a	-40	6.79	8.84	10.24	10.25	10.25	10.25	9.33	12.16	14.08	14.09	14.09	14.09
	-30	9.25	12.52	16.04	17.49	17.67	17.67	12.72	17.21	22.06	24.05	24.30	24.30
	-20	12.12	16.68	22.24	25.54	28.32	28.42	16.67	22.93	30.58	35.11	38.94	39.08
	-10	15.48	21.5	29.29	34.47	40.79	43.65	21.28	29.56	40.27	47.40	56.08	60.01
	-5	17.34	24.16	33.13	39.28	47.28	51.73	23.85	33.22	45.55	54.01	65.00	71.13
	10	23.79	33.35	46.32	55.69	69.18	78.58	32.71	45.85	63.69	76.57	95.12	108.04
R404A/R507	-40	8.66	11.92	15.90	18.27	20.29	20.37	11.91	16.39	21.87	25.12	27.89	28.00
	-30	11.33	15.74	21.47	25.29	29.98	32.18	15.58	21.65	29.52	34.77	41.23	44.24
	-20	14.46	20.21	27.89	33.30	40.74	45.46	19.88	27.79	38.35	45.79	56.01	62.51
	-10	18.09	25.37	35.27	42.45	52.83	60.14	24.88	34.89	48.50	58.37	72.65	82.70
	-5	20.11	28.24	39.36	47.49	59.45	68.12	27.65	38.83	54.12	65.30	81.75	93.66
	10	27.06	38.13	53.53	65.07	82.73	96.36	37.21	52.43	73.60	89.47	113.75	132.49
R22	-40	10.58	14.45	18.95	21.30	22.37	22.37	14.54	19.87	26.05	29.29	30.76	30.76
	-30	13.56	18.77	25.36	29.58	34.19	35.42	18.64	25.80	34.87	40.67	47.02	48.70
	-20	16.96	23.65	32.48	38.58	46.63	51.26	23.32	32.52	44.66	53.05	64.11	70.48
	-10	20.80	29.13	40.39	48.46	59.92	67.69	28.60	40.06	55.54	66.63	82.39	93.07
	-5	22.90	32.12	44.67	53.77	66.98	76.31	31.48	44.16	61.42	73.94	92.10	104.93
	10	29.90	42.07	58.88	71.36	90.15	104.30	41.12	57.85	80.97	98.12	123.95	143.41

Correction factors

t _i [°C]	+25	+30	+35	+40
R134a, R22	1.0	1.04	1.09	1.14
R404a/R507	1.0	1.06	1.12	1.20

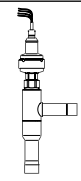
The values in the capacity table refer to the evaporator capacity and are based on liquid temperature t_i = +25°C ahead of the thermostatic expansion valve.

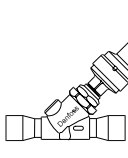
Dry, saturated vapour ahead of the KVS valve is assumed.

Capacities

Range -40°F to +50°F

US units

	t _e	Rated capacity [TR]											
		KVS 15-22						KVS 28-35					
		Pressure drop Δp [psig]											
[°F]	0.7	1.5	2.9	4.4	7.3	10.0	0.7	1.5	2.9	4.4	7.3	10.0	
R134a	-40	0.65	0.85	1.00	1.00	1.00	1.00	1.86	2.43	2.84	2.85	2.85	2.85
	-22	0.89	1.19	1.53	1.66	1.67	1.67	2.52	3.40	4.35	4.72	4.76	4.76
	-4	1.16	1.60	2.13	2.44	2.71	2.72	3.30	4.54	6.05	6.95	7.72	7.72
	14	1.48	2.05	2.79	3.29	3.89	4.17	4.21	5.84	7.96	9.37	11.08	11.85
	23	1.65	2.31	3.16	3.75	4.52	4.94	4.71	6.57	9.00	10.67	12.85	14.07
R404A/R507	-40	0.83	1.14	1.52	1.75	1.94	1.95	2.36	3.24	4.33	4.97	5.52	5.54
	-22	1.08	1.50	2.05	2.42	2.87	3.08	3.08	4.28	5.84	6.88	8.16	8.75
	-4	1.38	1.93	2.67	3.19	3.90	4.35	3.94	5.50	7.59	9.06	11.08	12.37
	14	1.73	2.43	3.37	4.06	5.05	5.75	4.92	6.90	9.60	11.55	14.38	16.37
	23	1.92	2.70	3.76	4.54	5.68	6.51	5.47	7.68	10.71	12.92	16.18	18.54
R22	-40	1.02	1.39	1.84	2.07	2.19	2.19	2.89	3.96	5.50	5.89	6.25	6.25
	-22	1.30	1.80	2.43	2.84	3.28	3.40	3.70	5.12	6.92	8.07	9.34	9.67
	-4	1.62	2.26	3.10	3.67	4.41	4.81	4.62	6.43	8.81	10.44	12.54	13.69
	14	1.99	2.79	3.87	4.64	5.74	6.49	5.67	7.94	11.01	13.21	16.33	18.45
	23	2.19	3.08	4.28	5.16	6.44	7.35	6.24	8.76	12.19	14.69	18.32	20.90
50	2.86	4.03	5.64	6.83	8.64	9.99	8.15	11.47	16.05	19.45	24.57	28.43	

	t _e	Rated capacity [TR]											
		KVS 42						KVS 54					
		Pressure drop Δp [psig]											
[°F]	0.7	1.5	2.9	4.4	7.3	10.0	0.7	1.5	2.9	4.4	7.3	10.0	
R134a	-40	1.66	2.21	2.54	2.54	2.54	2.54	2.28	3.04	3.49	3.49	3.49	3.49
	-22	2.27	3.16	4.00	4.37	4.41	4.41	3.12	4.35	5.50	6.00	6.06	6.06
	-4	2.99	4.25	5.58	6.43	7.11	7.13	4.11	5.84	7.67	8.84	9.77	9.80
	14	3.84	5.51	7.38	8.73	10.30	10.98	5.28	7.57	10.15	12.00	14.17	15.10
	23	4.31	6.20	8.37	9.97	11.98	13.03	5.93	8.53	11.51	13.71	16.47	17.92
R404A/R507	-40	1.97	2.80	3.68	4.25	4.70	4.72	2.71	3.85	5.07	5.84	6.47	6.49
	-22	2.61	3.75	5.03	5.96	7.04	7.53	3.59	5.16	6.92	8.19	9.69	10.35
	-4	3.37	4.87	6.61	7.93	9.68	10.73	4.63	6.69	9.09	10.90	13.31	14.75
	14	4.25	6.17	8.44	10.21	12.67	14.31	5.85	8.48	11.60	14.03	17.42	19.67
	23	4.75	6.89	9.45	11.47	14.32	16.27	6.53	9.48	13.00	15.76	19.69	22.37
R22	-40	2.66	3.75	4.85	5.46	5.72	5.72	3.66	5.16	6.67	7.51	7.87	7.87
	-22	3.42	4.89	6.51	7.62	8.79	9.09	4.71	6.73	8.95	10.48	12.09	12.50
	-4	4.29	6.19	8.36	9.98	12.03	13.15	5.90	8.51	11.50	13.72	16.54	18.08
	14	5.28	7.64	10.43	12.57	15.51	17.39	7.26	10.51	14.34	17.29	21.32	23.91
	23	5.82	8.44	11.54	13.97	17.36	19.62	8.00	11.60	15.87	19.21	23.87	26.97
50	7.62	11.09	15.27	18.60	23.45	26.87	10.48	15.25	20.99	25.58	32.24	36.95	

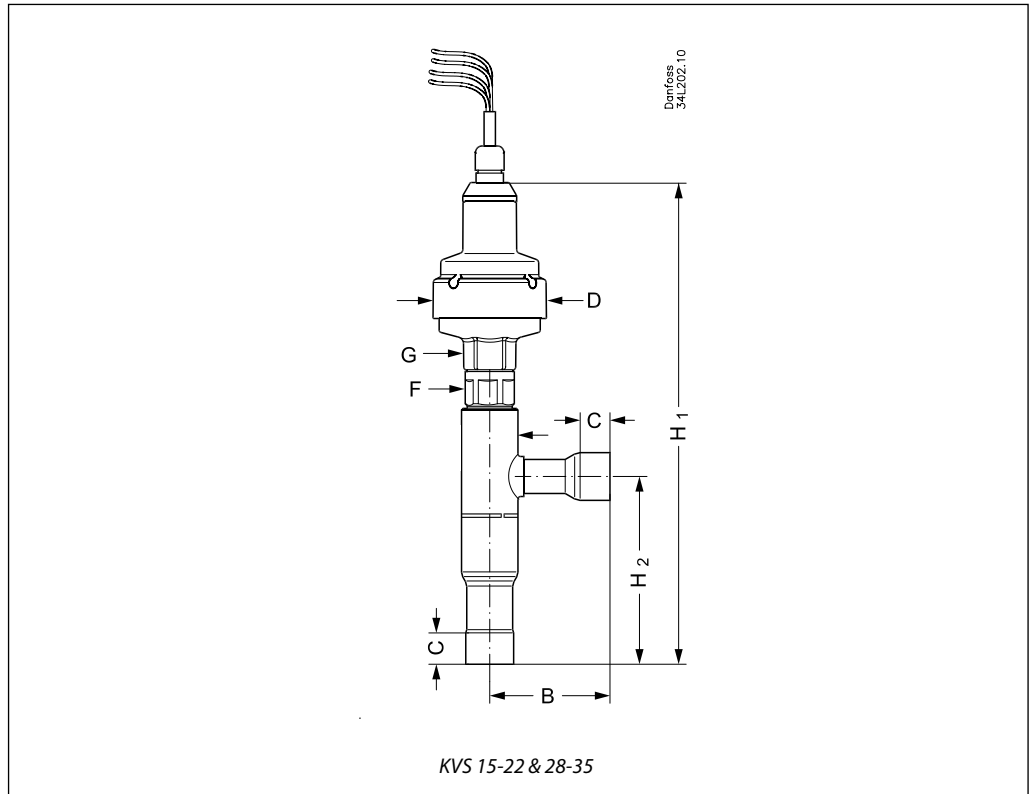
Correction factors

t _i [°F]	+90	+100	+110	+120
R134a, R22	0.95	1.0	1.05	1.10
R404a/R507	0.92	1.0	1.10	1.24

The values in the capacity table refer to the evaporator capacity and are based on liquid temperature t_i = +100°F ahead of the thermostatic expansion valve.

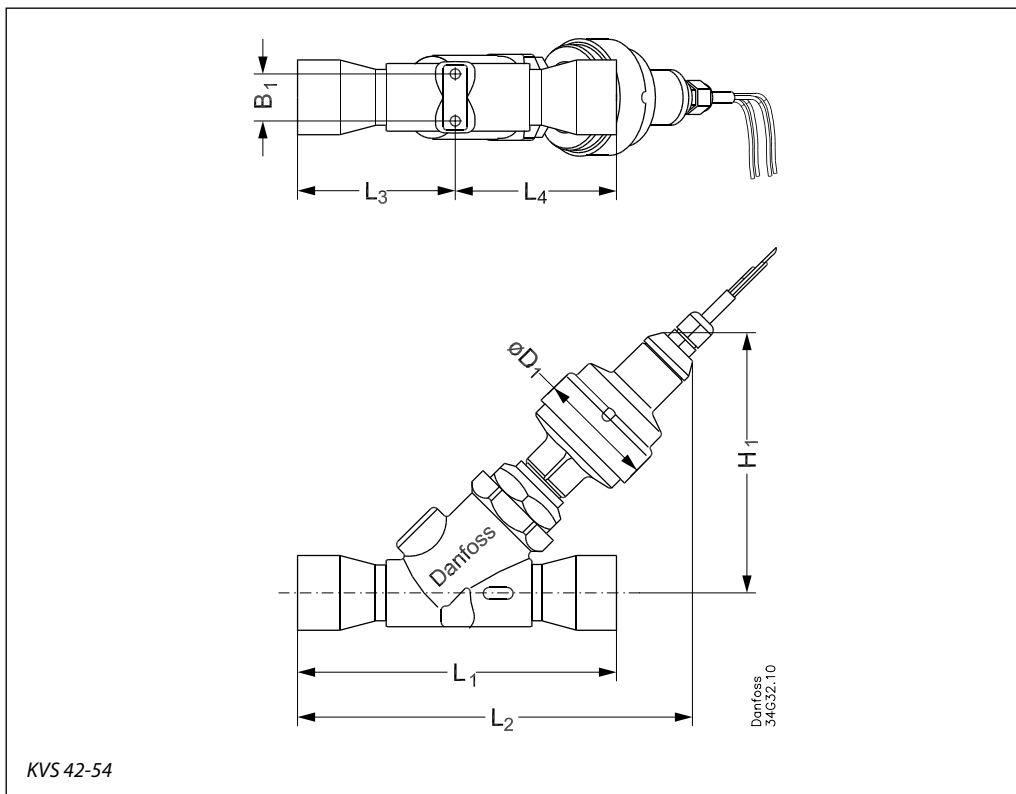
Dry, saturated vapour ahead of the KVS valve is assumed.

Dimensions and weights for KVS 15-35



Type	Connection		B		C		D		F		G		H ₁		H ₂		Weight	
	Input × output	Input × output	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	kg	lb.
KVS 15	5/8 × 5/8	16 × 16	64	2.5	12	0.5	60	2.4	24	0.9	27	1.1	276	10.8	99	3.9	1.1	2.4
KVS 22	7/8 × 7/8	22 × 22	64	2.5	17	0.7	60	2.4	24	0.9	27	1.1	276	10.8	99	3.9	1.1	2.4
KVS 28	1 1/8 × 1 1/8	28 × 28	105	4.1	20	0.8	60	2.4	32	1.3	27	1.1	341	13.4	155	6.1	1.6	3.5
KVS 35	1 3/8 × 1 3/8	35 × 35	105	4.1	25	1.0	60	2.4	32	1.3	27	1.1	341	13.4	155	6.1	1.6	3.5

Dimensions and weights for KVS 42-54



Type	Connection		H ₁		L ₁		L ₂		L ₃		L ₄		øD ₁		B ₁		Weight	
	Input × output	Input × output	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	kg	lb.
KVS 42	1 ¹ / ₈ × 1 ¹ / ₈	28 × 28	133.5	5.3	168.5	6.7	203.0	8.0	83.0	3.3	85.5	3.4	60.0	2.4	24.0	0.95	1.9	4.2
	1 ³ / ₈ × 1 ³ / ₈	35 × 35			178.5	7.0	208.0	8.2	88.0	3.5	90.5	3.6						
	1 ⁵ / ₈ × 1 ⁵ / ₈	42 × 42			188.5	7.4	213.0	8.4	93.0	3.7	95.5	3.8						
KVS 54	1 ⁵ / ₈ × 1 ⁵ / ₈	42 × 42	133.5	5.3	203.0	8.0	214.0	8.4	99.0	3.9	104.0	4.1	60.0	2.4	24.0	0.95	2.2	4.9
	2 ¹ / ₈ × 2 ¹ / ₈	54 × 54			243.0	9.6	234.0	9.2	119.0	4.7	124.0	4.9						

