Data sheet

Electric expansion valve for R744 (CO_2)
Type AKVH

AKVH are electrically operated expansion valves designed for refrigerating plants using R744 refrigerant.
The AKVH valves are normally controlled by a controller from Danfoss' range of ADAP- KOOL® controllers.
The AKVH valves are supplied as a component program, as follows:

- Separate valve.
- Separate coil with junction box or conduit hub.
- Spare parts in the form upper part, orifice and filter.

The orifice assembly is replaceable.
The AKVH 10 valves cover a capacity range from 0.1 TR to 3 TR in refrigeration applications and 0.2 TR to 6.25 TR in freezing applications.

Features

- For R744 refrigerant.
- The valve requires no adjustment.
- Wide regulation range.
- Replaceable orifice assembly.
- Normally closed, solenoid tight expansion valve.
- Wide range of a.c. coils.
- Enables energy saving minimum stable superheat and adaptive defrost algorithms.
- Provides excellent distribution and oil return due to turbulent flow.

Approvals

PED (97/23/EC A3.P3)

c UL us LISTED (Refrigerant valve) 53RO

CE The Low Voltage Directive 73/23/EC
with amendments EN 60730-2-8

Technical data

Valve type	AKVH 10
Working principle (Pulse-width modulation)	PWM
Recommended period of time	6 Seconds
Capacity (R744)	Refrigeration: 0.1 TR – 3 TR Freezing: 0.2 TR – 6.25 TR
Regulation range (Capacity range)	10 – 100%
Connection	Solder
Evaporating temperature	- 76 – 140 °F
Ambient temperature	- 58 – 122 °F
Leak of valve seat	<0.02% of C_v-value
MOPD	435 psi (30 bar)
Filter, replaceable	Internal 100 µm
Max. working pressure	1305 psig / 90 barg[1)]

[1]) 1305 psig / 90 barg under stand still conditions, but under normal operating conditions, there must be liquid to the inlet of the valve.

The individual capacities are indicated with a number forming part of the type designation.
The number represents the size of the orifice of the valve in question. A valve with orifice 3 will for example be designated AKVH 10-3.

Rated capacity and ordering

AKVH 10 R744

Valve type / orifice no.	Rated capacity TR		C_v value	Connection size Solder ODF/ODF		Single pack 1 valve each
	Refrigeration	Freezing	gal/min	[in.]	[mm]	
AKVH 10-0	0.1	0.2	0.132	3/8 × 1/2 in.	–	**068F4078**
AKVH 10-0	0.1	0.2	0.132	–	10 × 12 mm	**068F4088**
AKVH 10-1	0.3	0.6	0.044	3/8 × 1/2 in.	–	**068F4079**
AKVH 10-1	0.3	0.6	0.044	–	10 × 12 mm	**068F4089**
AKVH 10-2	0.5	1.0	0.074	3/8 × 1/2 in.	–	**068F4080**
AKVH 10-2	0.5	1.0	0.074	–	10 × 12 mm	**068F4090**
AKVH 10-3	0.7	1.5	0.110	3/8 × 1/2 in.	–	**068F4081**
AKVH 10-3	0.7	1.5	0.110	–	10 × 12 mm	**068F4091**
AKVH 10-4	1.2	2.5	0.202	3/8 × 1/2 in.	–	**068F4082**
AKVH 10-4	1.2	2.5	0.202	–	10 × 12 mm	**068F4092**
AKVH 10-5	1.9	3.8	0.282	3/8 × 1/2 in.	–	**068F4083**
AKVH 10-5	1.9	3.8	0.282	–	10 × 12 mm	**068F4093**
AKVH 10-6	3.0	6.1	0.502	3/8 × 1/2 in.	–	**068F4084**
AKVH 10-6	3.0	6.1	0.502	–	10 × 12 mm	**068F4094**

AKVH 10 R744

Valve type / orifice no.	Rated capacity TR		C_v value	Connection size Solder ODF/ODF		Industrial pack 32 valves each
	Refrigeration	Freezing	gal/min	[in.]	[mm]	
AKVH 10-0	0.1	0.2	0.132	3/8 × 1/2 in.	–	**068F4068**
AKVH 10-0	0.1	0.2	0.132	–	10 × 12 mm	**068F4058**
AKVH 10-1	0.3	0.6	0.044	3/8 × 1/2 in.	–	**068F4069**
AKVH 10-1	0.3	0.6	0.044	–	10 × 12 mm	**068F4059**
AKVH 10-2	0.5	1.0	0.074	3/8 × 1/2 in.	–	**068F4070**
AKVH 10-2	0.5	1.0	0.074	–	10 × 12 mm	**068F4060**
AKVH 10-3	0.7	1.5	0.110	3/8 × 1/2 in.	–	**068F4071**
AKVH 10-3	0.7	1.5	0.110	–	10 × 12 mm	**068F4061**
AKVH 10-4	1.2	2.5	0.202	3/8 × 1/2 in.	–	**068F4072**
AKVH 10-4	1.2	2.5	0.202	–	10 × 12 mm	**068F4062**
AKVH 10-5	1.9	3.8	0.282	3/8 × 1/2 in.	–	**068F4073**
AKVH 10-5	1.9	3.8	0.282	–	10 × 12 mm	**068F4063**
AKVH 10-6	3.0	6.1	0.502	3/8 × 1/2 in.	–	**068F4074**
AKVH 10-6	3.0	6.1	0.502	–	10 × 12 mm	**068F4064**

Spare parts

Orifice no.	Contents	Code no.
0	4 pc. orifice 4 pc. gasket	**068F5283**
1		
2		
3		
4	3 pc. orifice 3 pc. gasket	**068F5284**
5		
6		

Technical data

Design
In accordance with UL 429

Power supply
Alternating current (a.c.)

Permissible voltage variation
Alternating current (a.c.):
50 Hz and 60 Hz: -10% – 15%
50/60 Hz: +/- 10%

Power consumption
Alternating current (a.c.): Inrush: 49 VA;
Holding: 28 VA, 16 W

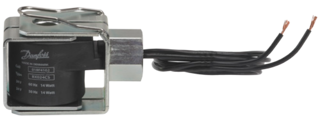
Insulation of coil wire
Class H according to IEC 85

Connection
Junction box or Conduit boss

Enclosure, IEC 60529
Junction box NEMA 2 ~ IP 12–32
Conduit boss NEMA 4 ~ IP 54

Ambient temperature
-40 °F – 122 °F / -40 °C – 50 °C

Ordering



BJ and BX Coils

Valve type	Coil type	Wire length [in.]	Wire length [cm]	Voltage [V a.c.]	Frequency [Hz]	Power consumption [W]	Code no.
Junction box NEMA 2							
AKVH / EVRH	BJ120BS	7	18	120	60	16	**018F4130**
	BJ208BS	7	18	208	60	16	**018F4132**
	BJ240BS	7	18	240	60	16	**018F4134**
Conduit boss NEMA 4							
AKVH / EVRH	BX120BS	98	250	120	60	16	**018F4131**
	BX208BS	98	250	208	60	16	**018F4133**
	BX240BS	98	250	240	60	16	**018F4135**

Capacity

Capacity in TR **R744**

Valve type	Pressure drop across valve Δp psi [1])								
	29	**58**	**87**	**116**	**145**	**174**	**203**	**232**	**261**
AKVH 10-0	0.094	0.125	0.151	0.168	0.185	0.199	0.208	0.216	0.222
AKVH 10-1	0.256	0.341	0.427	0.455	0.512	0.540	0.569	0.597	0.597
AKVH 10-2	0.398	0.569	0.654	0.739	0.796	0.881	0.910	0.938	0.967
AKVH 10-3	0.626	0.881	1.052	1.166	1.251	1.365	1.422	1.479	1.535
AKVH 10-4	1.024	1.393	1.649	1.848	2.019	2.189	2.275	2.360	2.417
AKVH 10-5	1.592	2.189	2.616	2.900	3.156	3.412	3.583	3.696	3.839
AKVH 10-6	2.559	3.497	4.151	4.635	5.004	5.431	5.687	5.914	6.113

Valve type	Pressure drop across valve Δp psi								
	290	**319**	**348**	**377**	**406**	**435**	**464**	**493**	**507**
AKVH 10-0	0.227	0.230	0.233	0.239	0.242	0.242	0.245	0.247	0.247
AKVH 10-1	0.626	0.626	0.654	0.654	0.654	0.682	0.682	0.682	0.682
AKVH 10-2	0.995	1.024	1.052	1.052	1.081	1.081	1.081	1.081	1.081
AKVH 10-3	1.564	1.592	1.621	1.649	1.678	1.678	1.706	1.706	1.706
AKVH 10-4	2.502	2.531	2.588	2.644	2.673	2.701	2.701	2.730	2.730
AKVH 10-5	3.924	4.009	4.095	4.151	4.208	4.237	4.265	4.265	4.265
AKVH 10-6	6.256	6.369	6.512	6.625	6.682	6.739	6.796	6.796	6.824

[1]) *Rated capacitities are based on*
Subcooling $t_{sub} = 7.2\ ^{\circ}F$
Evaporating temperature $t_e = -13\ ^{\circ}F$
Superheating $t_{sup} = 9\ ^{\circ}F$

Valve sizing using calculation software

It is strongly recommended to use Cool Selector to find the correct valve for our application
The software can be downloaded from the Danfoss website. When using the calculation software it is recommended to choose a valve that is between 50 and 75% loaded at the nominal capacity. In addition, the liquid velocity in the line leading to the valve should not exeed 3ft/s (1m/s).

Valve sizing

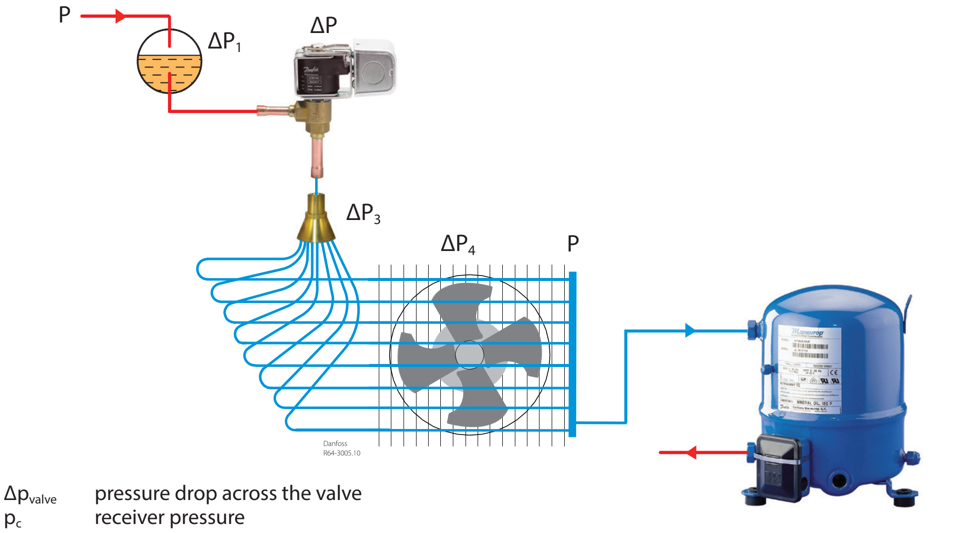
To obtain an expansion valve that will function correctly under different load conditions it is necessary to consider the following points when sizing the valve.
These points must be dealt with in the following sequence:

1) Evaporator capacity
2) Pressure drop across the valve
3) Correction for subcooling
4) Correction for evaporating temperature
5) Determination of valve size
6) Correctly dimensioned liquid line

1) Evaporator capacity
The evaporator capacity is found in the specifications from the evaporator supplier.

2) Pressure drop across the valve
The pressure drop across the valve directly determines the capacity and must therefore be considered.

The pressure drop across the valve is normally calculated as the receiver pressure less the evaporating pressure and sundry other pressure drops in the liquid line, distributor, evaporator, etc. It is indicated in the following formula:
$\Delta p_{valve} = p_c - (p_e + \Delta p_1 + \Delta p_3 + \Delta p_4)$



Δp_{valve} pressure drop across the valve
p_c receiver pressure
p_e evaporating pressure
Δp_1 pressure drop across the liquid line
Δp_3 pressure drop across the distributor system
Δp_4 pressure drop across the evaporator

Note! The pressure drop across the liquid line and the distributor system must be calculated on the basis of the valve's max. capacity, as the valve operates with pulse-width modulation.

Example of calculation of pressure drop across a valve:
Refrigerant: R744
p_c = Receiver pressure: 580 psig (at 43 °F)
Evaporating temperature: 23 °F (p_e = 426 psig)
Δp_1 = 2.9 psi
Δp_3 = 12 psi
Δp_4 = 1.5 psi

This will give you the following equation:

$$\begin{aligned}\Delta p_{valve} &= p_c - (p_e + \Delta p_1 + \Delta p_3 + \Delta p_4)\\ &= 40 - (29.4 + 0.2 + 0.8 + 0.1)\\ &= 580 - (426 + 2.9 + 12 + 1.45)\\ &= 138 \text{ psi}\end{aligned}$$

The found value for "pressure drop across the valve" is used later in the section "Determination of valve size".

Valve sizing

3) Correction for subcooling
The evaporator capacity used must be corrected, if the subcooling deviates from -452.47 °F. Use the actual correction factor indicated in the table.

Multiply the evaporator capacity by the correction factor to obtain the corrected capacity.

Correction factors for subcooling Δt_{sub}

Correction factor [°F]	7.2	18	27	36	45	54	63	72	81	90
R744	1.00	0.91	0.86	0.81	0.77	0.73	0.69	0.66	0.63	0.60

Corrected capacity = evaporator capacity x correction factor.

The corrected capacity is used in the section "Determination of valve size".

Example of corection:
Refrigerant: R744
Evaporator capacity Q_e: 1.42 TR
Subcooling: 18 °F

Correction factor according to the table = 0.91
Corrected capacity = 1.42 x 0.91 = 1.29 TR.

Note: Too little subcooling may cause flash gas.

4) Correction for transient conditions and evaporating temperature (t_e)
To obtain a correctly dimensioned valve it is important that the application is considered. Depending on the application, the valve should have an overcapacity enabling it to cope with the extra amount of refrigeration needed during certain periods, e.g. during the defrost recovery process.

The valve's opening degree should therefore be between 50 and 75% when regulating. In this way it is ensured that the valve has a sufficiently wide regulation range, so that it can manage changed loads at or near the normal working point.
The change in capacity as an effect of the deviation in refrigerant density is included in this correction factor.

Correction factor for transient conditions and evaporating temperature (t_e)

Evaporating temperature t_e °F	50 to -58
AKVH 10	1.6

5) Determination of valve size
When the valve size meeting the required capacity is selected it is important to note that the capacity indications are the valve's rated capacity, i.e. when the valve is 100% open.
In this section we tell you how the valve's size is determined.
There are three factors that have an influence on the choice of the valve:
- the pressure drop across the valve
- the corrected evaporator (correction for subcooling)
- the corrected capacity for evaporating temperature

The three factors have been described earlier in this section on dimensioning. When these three factors have been established, the selection of the valve can be made:
- First you multiply the "*corrected capacity*" by a value stated in the table.
- Use the new value in the capacity table in combination with the pressure drop value.
- Now select the valve size.

Example of selection of valve
Use as starting point the two earlier mentioned examples, where the following two values have been obtained:
Δp_{valve} = 138 psi
$Q_{e\ corrected}$ = 1.29 TR
The valve should be used in a coldroom.
1.6 is the"correction factor for the evaporating temperature".

The dimensioned capacity will then be:
1.6 x 1.29 TR = 2.07 TR.

Now select a valve size from one of the capacity tables.
With the given values Δp_{valve} = 138 psi and a capacity of 2.07 TR, select the valve size for AKVH 10-5.
This valve has a capacity of approx. 2.90 TR

Valve sizing

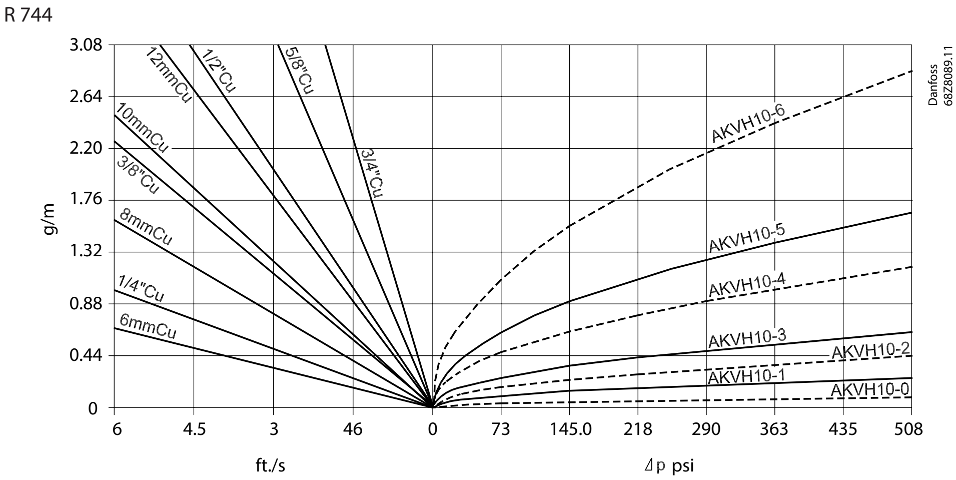
6) Correctly dimensioned liquid line

To obtain a correct supply of liquid to the AKVH valve, the liquid line to the individual AKVH valve must be correctly dimensioned.

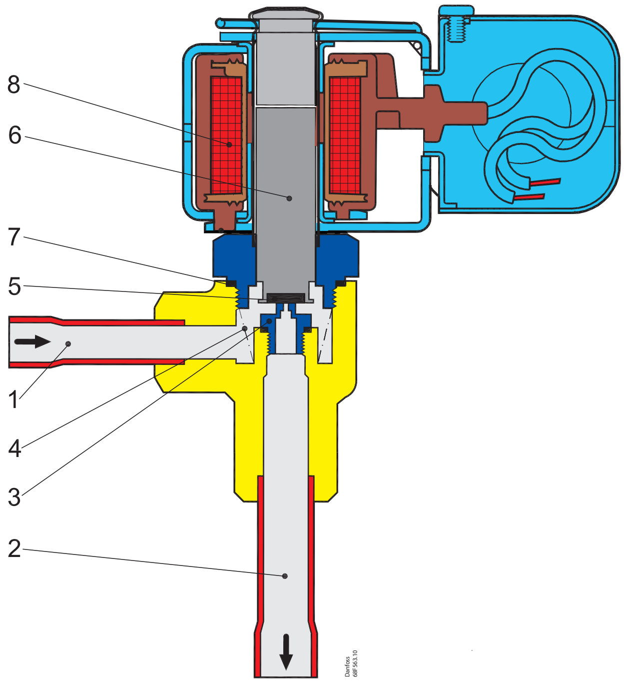
The liquid flow rate should not exceed 3 ft/s

This must be observed on account of the pressure drop in the liquid line (lack of subcooling) and pulsations in the liquid line.

Dimensioning of the liquid line must be based on the capacity of the valve at the pressure drop with which it is operating (cf. capacity table), and not on the evaporator's capacity.



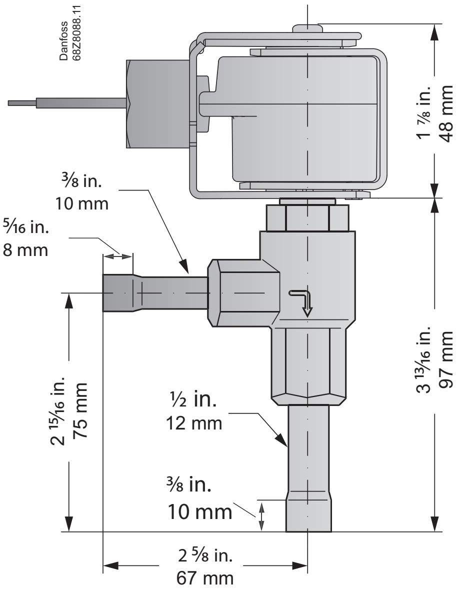
Design and function



1. Inlet
2. Outlet
3. Orifice
4. Filter
5. Valve seat
6. Armature
7. Copper gasket
8. Coil

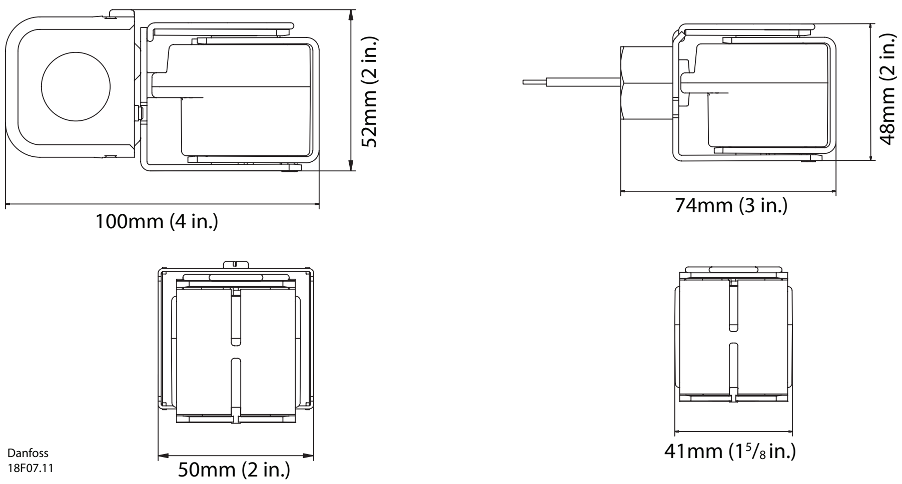
The valve capacity is regulated by means of pulse-width modulation. Within a period of six seconds a voltage signal from the controller will be transmitted to and removed from the valve coil. This makes the valve open and close for the flow of refrigerant.
The relation between this opening and closing time indicates the actual capacity. If there is an intense need for refrigeration, the valve will remain open for almost all six seconds of the period. If the required amount of refrigeration is modest, the valve will only stay open during a fraction of the period. The amount of refrigeration needed is determined by the controller.
When no refrigeration is required, the valve will remain closed and thus function as a solenoid valve.

Dimensions and weight AKVH valve



Weight excluding coil
0.84lbs = 0.38 kg

Dimensions and weight Coils



Junction box	Conduit boss
Weight: 0.86 lbs / 0.39 kg	Weight: 0.72 lbs / 0.33 kg