SIEMENS

4714

Refrigerant valves MVL661...-...

for safety refrigerants

- **One valve type for expansion, hot-gas and suction throttle applications**
- **Hermetically sealed**
- **Selectable standard DC 0/2...10 V or DC 0/4...20 mA interface**
- **High resolution with precise positioning control and position feedback signal**
- **Closed when deenergized. Robust and maintenance-free**
- **Five valve sizes with k_{vs} values from 0.25 to 12 m³/h**

Use

The MVL661...-... refrigerant valve is designed for modulating control of refrigerant circuits including chillers and heat pumps. It is suitable for use in expansion, hot-gas and suction throttle applications, and for use with organic safety refrigerants (R22, R134a, R404A, R407C, R410A, R507, etc.) and R744 (SO2).

Functions

- Four selectable standard signals for setpoint and measured value
- DIP switch to reduce k_{vs} value to 63 % of nominal value
- Potentiometer for adjustment of minimum stroke for suction throttle applications
- Automatic stroke calibration
- Override input for “Valve closed” or “Valve fully open”
- LED for indicating the operating state

Type summary

Type reference	DN [mm]	k_{vs} [m^3/h]	Qo E [kW]	Qo H [kW]	Qo D [kW]
MVL661.15-0.4 1)	15	0.25	29	5.7	1.0
MVL661.15-0.4	15	0.40	47	9.2	1.7
MVL661.15-1.0 1)	15	0.63	74	14	2.6
MVL661.15-1.0	15	1.0	117	23	4.2
MVL661.20-2.5 1)	20	1.6	187	37	6.6
MVL661.20-2.5	20	2.5	293	57	10
MVL661.25-6.3 1)	25	4.0	468	92	17
MVL661.25-6.3	25	6.3	737	144	26
MVL661.32-12 1)	32	8	2)	2)	33
MVL661.32-12	32	12	2)	2)	50

k_{vs} Flow rate to VDI / VDE 2173, tolerance ±10 %
Qo E Refrigeration capacity in expansion applications
Qo H Refrigeration capacity in hot-gas bypass applications
Qo D Refrigeration capacity in suction throttle applications
Qo with R407C at t_o = 0 °C, t_c = 40 °C and Δp = 0.5 bar
The pressure drop across evaporator and condenser is assumed to be 0.3 bar each, and 1.6 bar upstream of the evaporator (e.g. spider).
The capacities specified are based on superheating by 6 K and subcooling by 2 K.
1) Valve stroke electronically limited to 63 %
2) MVL661.32-12.0 is only approved for suction throttle applications

The refrigeration capacity for various refrigerants and operating conditions can be calculated for the three types of application using the tables at the end of this data sheet.

Ordering

Valve body and magnetic actuator form one integral unit and cannot be separated. When ordering, please give quantity, product name and type reference.

Example: **1 refrigerant valve MVL661.15-0.4**

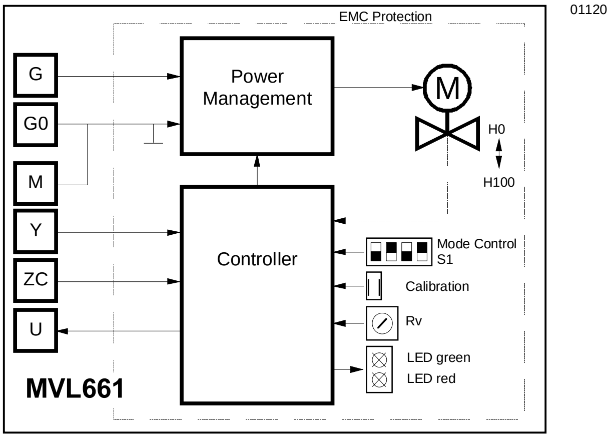
Replacement electronics

Should the valve’s electronics become faulty, the entire electronics housing is to be replaced by spare part ASR61, which is supplied complete with mounting instructions.

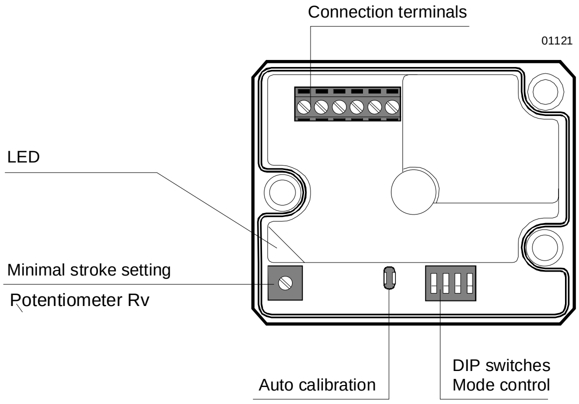
Technical design

The MVL661...-... can be driven by Siemens or third-party controllers that deliver a DC 0/2...10 V or DC 0/4...20 mA output signal.
For optimum control performance, we recommend a 4-wire connection between controller and valve. **When operating on DC voltage, a 4-wire connection is mandatory!**
The valve stroke is proportional to the control signal. Signal GND on the controller must be routed to connection terminal M of the actuator. Connection terminals M and G0 both have the same voltage and are interconnected in the electronics housing.

Schematic diagram



Operator controls and indicators in the electronics housing



Override and minimum stroke limit control

Three modes of operation are possible with override input (ZC):

- **No function**: ZC contact not wired; the valve stroke is determined by control signal Y
- **Valve forced fully open**: ZC connected directly to G (AC 24 V or DC 24)
- **Valve forced closed**: ZC connected directly to M or G0 respectively

See also "Connection terminals" on page 8.

Minimum stroke setting

In the case of the suction throttle valve, it is essential that a minimum stroke limit be maintained to ensure compressor cooling and efficient oil return. This can be achieved with a reinjection valve, a bypass line across the valve, or a guaranteed minimum opening of the valve. The minimum stroke can be defined via the controller and control signal Y, or it can be set directly with potentiometer Rv.
The electronics housing incorporates a potentiometer Rv for this purpose. The factory setting is zero (mechanical stop in counterclockwise direction, CCW). The minimum stroke can be set by turning the potentiometer clockwise to a maximum of 80 % k_{vs} .

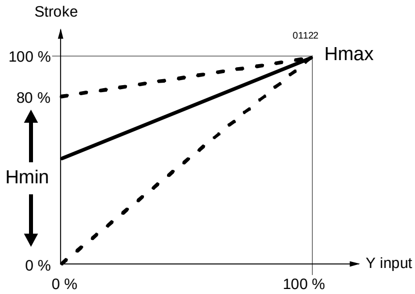
Signal priority

Of the possible input signals, override control signal ZC has the highest priority. If ZC is open, the valve stroke is determined by input Y and the potentiometer setting.
Under no circumstances must potentiometer Rv be used to limit the stroke on expansion applications. It must be possible to close the valve fully.

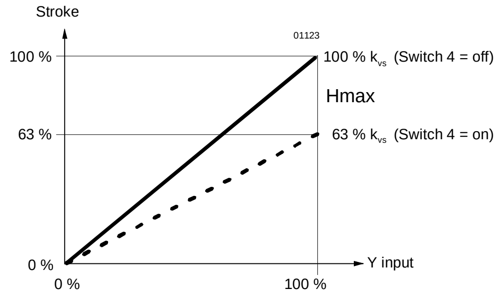
Minimum stroke limitation and k_{vs} reduction

When k_{vs} reduction is enabled, the stroke will be limited to 63 % mechanical stroke. 63 % of full stroke then corresponds to an input / output signal of 10 V.
If, in addition, the stroke is limited to 80 %, for example, the minimum stroke will be 0.63 x 0.8 = 0.50 of full stroke.

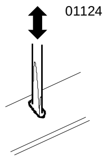
Minimum opening position



k_{vs} reduction



Automatic calibration



The printed circuit board of the MVL661...-... has a slot to facilitate calibration. To make the calibration, insert a screwdriver in the slot so that the contacts inside are connected. As a result, the valve will be fully closed and then fully opened.

DIP switches

Switch	Value	Off	On
1	Input Y	Voltage signal	Current signal
2	Offset (at Y and U)	No offset (0..)	Offset (2 / 4..)
3	Output U	Voltage signal	Current signal
4	k_{vs}	100 % k_{vs}	63 % k_{vs}

	Function of connection terminal			
	Y (setpoint input)		U (measured value output)	
Switch 2	Switch 1		Switch 3	
	Off	On	Off	On
Off	0...10 V	0...20 mA	0...10 V	0...20 mA
On	2...10 V	4...20 mA	2...10 V	4...20 mA

LED

LED	State	Function	Action
LED green	Steady on	• Operation	Automatic mode; everything ok
	Flashing	• Calibration in progress	Wait until calibration is terminated (LED stops flashing)
LED red	Steady on	• No stroke calibration • Internal error	Start stroke calibration again (short-circuit contacts via slot in pcb) Replace electronics
	Flashing	• Mains fault	Check mains power supply (e.g. outside the frequency range)
LED	On	• No power supply • Faulty electronics	Check mains power supply Replace electronics

Depending on the application, it may be necessary to observe additional installation instructions and fit appropriate safety devices (e.g. pressostats, full motor protection, etc.).

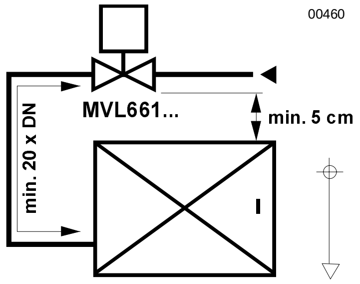
Expansion application

To prevent formation of flashgas on expansion applications, the velocity of the refrigerant in the fluid pipe may not exceed 1 m/s. To assure this, the diameter of the fluid pipe must be greater than the nominal size of the valve, using reducing pieces for making the connections to the valve.
A filter / dryer must be mounted upstream of the expansion valve.

Recommendation

Laboratory measurements reveal that control performance improves when the refrigerant valve is installed so that it is higher than the evaporator (min. 50 mm).
Allow at least 0.5 m of pipework or
20 x DN between valve and distributor.

This is a general recommendation for expansion valves.



The valve is not explosion-proof. It is not approved for use with ammonia, NH3, R717.

Sizing

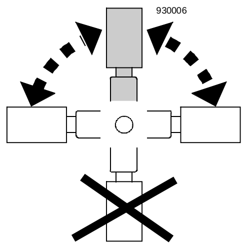
For straightforward valve sizing, refer to the tables for the relevant application (from page 9).
For accurate valve sizing, we recommend to make use of the valve sizing software "Refrigeration VASP“.

Notes

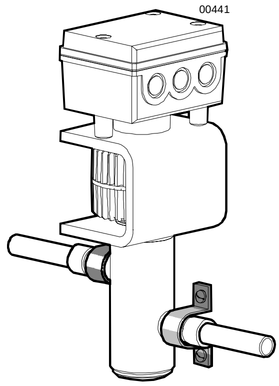
The refrigeration capacity Qo is calculated by multiplying the mass flow by the specific enthalpy differential found in the log(p)-h chart for the relevant refrigerant. To help determine the refrigeration capacity more easily, a selection chart is provided for each application (page 9 and following). With direct or indirect hot-gas bypass applications, the enthalpy differential of Qc (the condenser capacity) must also be taken into account when calculating the refrigeration capacity.
If the evaporating and / or condensing temperatures are between the values shown in the tables, the refrigeration capacity can be determined with reasonable accuracy by linear interpolation (refer to the application examples on page 9 and following).
At the operating conditions given in the tables, the permissible differential pressure Δp_{max} (25 bar) across the valve is within the admissible range for these valves.
If the evaporating temperature is raised by 1 K, the refrigeration capacity increases by about 3 %. If, by contrast, subcooling is increased by 1 K, the refrigeration capacity increases by about 1 to 2 % (this applies only to subcooling down to approximately 8 K).

Mounting notes

The valve should be mounted and commissioned by qualified staff. The same applies to the replacement electronics and the configuration of the controller (e.g. SAPHIR or PolyCool).

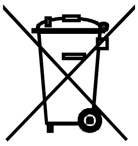


- The refrigerant valve can be mounted at any angle from upright to horizontal, but must not be suspended below the horizontal
- Pipework should be arranged such that the valve is not located at a low point in the plant where oil can collect
- Pipes should be fixed so that there is no pressure on the valve connections (vibration can lead to burst pipes)
- The valve may not be fitted with the help of its bracket
- The valve body and the connected pipework should be lagged
- Before soldering the valve into the pipework, check that the direction of flow is correct
- To avoid dirt and the formation of scale (oxide), inert gas is recommended for soldering
- During soldering, cool the valve with a wet cloth, for example, to ensure that it does not become too hot
- The pipes must be soldered with care. The flame must be large enough to ensure that soldering joints are heated quickly and that the valve itself does not become too hot. The flame should be directed away from the valve
- The refrigerant valve does not require maintenance



The MVL661...-... is supplied complete with mounting instructions.

Disposal



The refrigerant valve contains electrical and electronic components and may not be disposed of together with household waste.
Current local legislation must be observed.

Technical data

Power supply	Electrical interface	extra low-voltage only (SELV, PELV)
	Typical power consumption P_{med}	12 W
	Standby	< 1 W (valve closed)
• AC 24 V	Operating voltage	AC 24 V ± 20 %
	Frequency	45 ... 65 Hz
	Mean apparent power S_{med}	22 VA
	Current draw	0.9 A_{RMS} / 1.5 A_{RMS} (max.)
	Required fuse	1.6 ... 4 A (slow)
• DC 24 V	Operating voltage	DC 20 ... 30 V
	Current draw	0.5 A / 2 A (max.)

Input	Control signal Y	DC 0/2 ... 10 V or DC 0/4 ... 20 mA
	Impedance DC 0/2...10 V	100 kΩ / 5nF
	Impedance DC 0 / 4...20 mA	240 Ω / 5nF
	Override control	
	Input impedance	22 kΩ
	Close valve (ZC connected to M)	< AC 1 V; < DC 0.8 V
	Open valve (ZC connected to G)	> AC 6 V; > DC 5 V
	No function (ZC not wired)	
Output	Position feedback signal Voltage	DC 0/2 ... 10 V; load resistance ≥ 500 Ω
	Current	DC 0/4 ... 20 mA; load resistance ≤ 500 Ω
Product data	Pressure class	PN40
	Permissible pressure p_S	4.0 MPa (40 bar) [1)]
	Max. differential pressure Δp_{max}	2.5 MPa (25 bar) DN32: 200 kPa (2 bar)
	Leakage rate (internally across seat)	max. 0.002 % k_{vs} or max. 1 Nl/h gas at Δp = 4 bar (must not be used for safety shutoff functions)
	External seal	hermetically sealed (fully welded, no static or dynamic seals)
	Valve characteristic (stroke, k_v)	linear (to VDI / VDE 2173)
	Mode of operation	modulating, without hysteresis
	Position when deenergized	closed
	Orientation	upright to horizontal
	Positioning time	< 1 s
	Stroke resolution $^{\Delta H}/_{H100}$	1 : 1000
Materials	Valve body and parts	steel / CrNi steel
	Seat / piston / sealing disk	CrNi steel / brass / PTFE
Pipe connections	Sleeves	internally soldered, CrNi steel
Electrical connections	Cable entry glands	3 x PG11
	Min. cross-sectional area of cable	0.75 mm^2
	Max. cable length between transformator / power supply and valve	65 m with 1.5 mm^2 cable (copper) 110 m with 2.5 mm^2 cable (copper) 160 m with 4.0 mm^2 cable (copper)
Environmental conditions	Max. permissible temperature of medium inside valve T_{med} [2)]	–40 ... 120 °C; max. 140 °C for 10 min
	Operation	as per IEC 721-3-3
	Climatic conditions	Class 3K6
	Temperature T_{amb} [2)]	–25 ... 55 °C
	Humidity	10 ... 100 % r.h.
	Transport	as per IEC 721-3-2
	Climatic conditions	Class 2K3
	Temperature	–25 ... 70 °C
	Humidity	< 95 % r.h.
	Storage	as per IEC 721-3-1
	Climatic conditions	Class 1K3
	Temperature	–5 ... 45 °C
	Humidity	5 ... 95 % r.h.
Dimensions and weight	Dimensions	refer to "Dimensions"
	Weight	refer to "Dimensions"

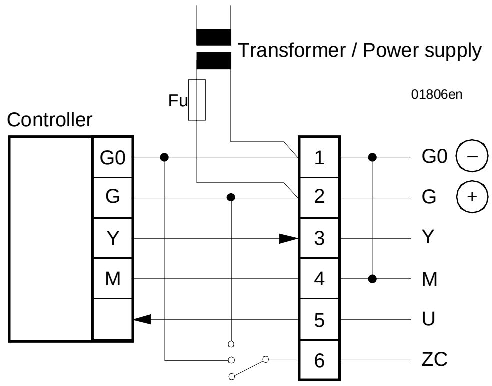
Safety		
	Protection standard	IP65 to IEC529
	Conformity	meets the requirements for **CE** marking **UL** listed for UL 873 C-UL certified to Canadian Standard C22.2 No. 24 **C-Tick** N 474 **PED** 97/23/EC: pressure bearing equipment Article 1, Paragraph 2.1.4 / Article 3, Paragraph 3 DN32: fluid group 2 only
	AC + DC: immunity	Industrial IEC 61000-6-2
	AC: emission	Residential IEC 61000-6-3
	DC: emission	CISPR 22, Klasse B
	HF interference immunity	IEC 1000-4-3; IEC 1000-4-6 (10 V/m)
	HF interference emission	EN 55022, CISPR 22, Klasse B
	Vibration [3]	IEC 68-2-6 (5 g acceleration, 10-150 Hz, 2.5 h)

[1] On the basis of DIN 3230-3, tested with 1.5 x PN (60 bar)

[2] At 45 °C < T_{amb} < 55 °C **and** 80 °C < T_{med} < 120 °C, the valve must be installed on its side (i.e. at an angle of 45° ... 90° to the vertical plane), to avoid shortening the service life of the valve electronics

[3] In conjunction with severely vibrating plant, use only highly flexible stranded conductors

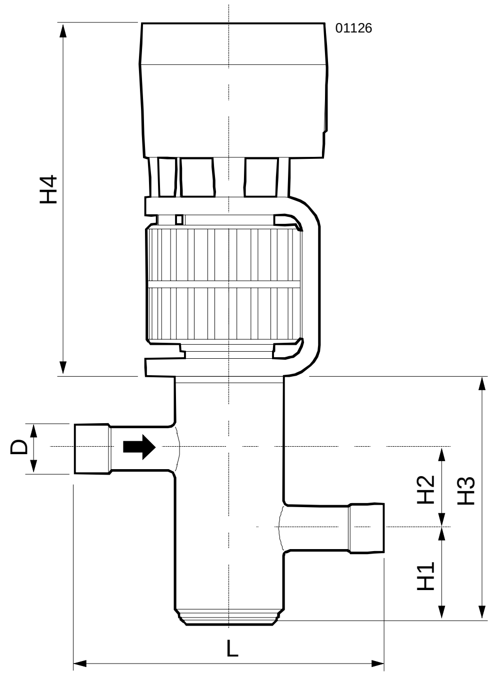
Connection terminals



Power supply AC / DC 24 V:	G0 = neutral (internally connected to M)
Input (setpoint):	DC 0...10 V, 0...20 mA / 2...10 V, 4...20 mA
Meas-GND for signals:	
Stroke position output (actual value):	DC 0...10 V, 0...20 mA / 2...10 V, 4...20 mA
Multifunction:	Override control: Forced fully open / Forced closed / No function

Dimensions

All dimensions in mm



Type reference	DN [mm]	D [inch]	L [mm]	H1 [mm]	H2 [mm]	H3 [mm]	H4 [mm]	T [mm]	M [kg]
MVL661.15-0.4	15	5/8"	140	44	36	113	160	103	4.4
MVL661.15-1.0	15	5/8"	140	44	36	113	160	103	4.4
MVL661.20-2.5	20	7/8"	150	41	41	119	160	103	4.5
MVL661.25-6.3	25	1 1/8"	160	40	47	126	160	103	4.6
MVL661.32-12	32	1 3/8"	190	43	54	142	160	103	6.1

DN Nominal size [mm]
D Pipe connections [inch]
T Depth
M Weight including packaging [kg]

Valve sizing with correction factor

The applications and tables on the following pages are designed for help with selecting the valves. To select the correct valve, the following data is required:

- **Application**
  - Expansion (starting on page 10)
  - Hot-gas (starting on page 13)
  - Suction throttle (starting on page 15)
- **Refrigerant type**
- **Evaporating temperature t_o** [°C]
- **Condensing temperature t_c** [°C]
- **Refrigeration capacity Q_o** [kW]

To calculate the nominal capacity, use the following formula:

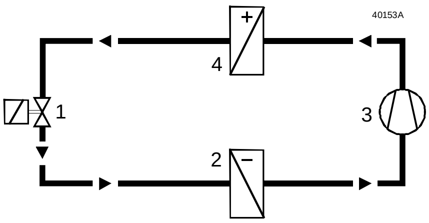
- **k_{vs} [m³/h] = Q_0 [kW] / K...*** * **K...** for expansion = **KE**; for hot-gas = **KH**; for suction throttle = **KS**
- The theoretical k_v value for the nominal refrigeration capacity of the plant should not be less than 50 % of the k_{vs} value of the selected valve
- For accurate valve sizing, the valve selection program "Refrigeration VASP" is recommended

The application examples on the following pages deal with the principles only. They do not include installation-specific details such as safety elements, refrigerant collectors, etc.

Use of the MVL661...-... as an expansion valve

- Typical control range 20...100 %.
- Increased capacity through better use of the evaporator
- The use of two or more compressors or compressor stages significantly increases efficiency with low loads
- Especially suitable for fluctuating condensing and evaporating pressures

Capacity optimization



1 = MVL661...-...
2 = evaporator
3 = compressor
4 = condenser

Electronic superheat control is achieved by using additional control equipment (e.g. PolyCool).

Application example

Refrigerant R407C; Q_o = 205 kW; t_o = –5 °C; t_c = 35 °C
The correct k_{vs} value for the MVL661...-... valve needs to be determined.
The important section of table KE for R407C (see page 12) is the area around the working point. The correction factor KE relevant to the working point should be determined by linear interpolation from the four guide values.

Note on interpolation

In practice, the KE, KH or KS value can be estimated because the theoretical k_{vs}-value ascertained will be rounded off by up to 30 % to one of the ten available k_{vs}-values. So you can proceed directly with Step 4.

Step 1: For t_c = 35, calculate the value for t_o = –10 between values 20 and 40 in the table; result: **112**

Step 2: For t_c = 35, calculate the value for t_o = 0 between values 20 and 40 in the table; result: **109**

Step 3: For t_o = –5, calculate the value for t_c = 35 between correction factors 112 and 109; calculated in steps 1 and 2; result: **111**

Step 4: Calculate the theoretical k_{vs} value; result: **1.85 m³/h**

Step 5: Select the valve; the valve closest to the theoretical k_{vs} value is the **MVL661.20-2.5**

Step 6: Check that the theoretical k_{vs} value is not less than 50 % of the nominal k_{vs} value

KE-R407C	t_o = –10 °C	t_o = 0 °C
t_c = 20 °C	**108**	**85**
t_c = 35 °C	*112*	*109*
t_c = 40 °C	**113**	**117**

Interpolation at	t_c = 35 °C
108 + [(113 – 108) x (35- 20) / (40 - 20)]	112
85 + [(117 - 85) x (35 - 20) / (40 - 20)]	109

Interpolation at	t_o = -5 °C
112 +[(109 - 112) x (-5 - 0) / (-10 - 0)]	111

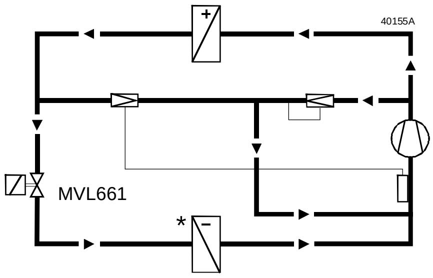
k_v theoretical = 205 kW / 111 = 1.85 m³/h

Valve MVL661.20-2.5 is suitable, since: 1.85 m³/h / 2.5 m³/h x 100 % = 74 % (> 50 %)

Capacity control

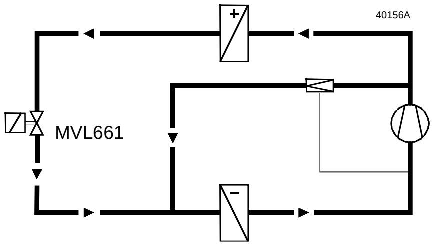
a) Refrigerant valve MVL661...-... for capacity control of a dry expansion evaporator. Suction pressure and temperature are monitored with a mechanical capacity controller and reinjection valve.

- Typical control range 0...100 %
- Energy-efficient operation with low loads
- Ideal control of temperature and dehumidification



b) Refrigerant valve MVL661...-... for capacity control of a chiller.

- Typical control range 10...100 %
- Energy-efficient operation with low loads
- Allows wide adjustment of condensing and evaporating temperatures
- Ideal for use with plate heat exchangers
- Very high degree of frost protection



Note

A larger valve may be required for low load operation than is needed for full load conditions. To ensure that the selected valve will not be too small for low loads, sizing should take account of both possibilities.

Correction table KE
Expansion valve

t_c \ t_o	R22 -40	-30	-20	-10	0	10
00	82	68	37			
20	101	104	107	105	81	18
40	108	111	114	118	120	123
60	104	108	112	116	119	122

t_c \ t_o	R134a -40	-30	-20	-10	0	10
00	27					
20	71	74	77	66	43	
40	74	78	81	85	89	92
60	67	72	76	81	85	89

t_c \ t_o	R744 -40	-30	-20	-10	0	10
-20	226	149				
00	262	264	241	166		
20	245	247	247	246	213	

t_c \ t_o	R290 -40	-30	-20	-10	0	10
00	83	67	22			
20	104	109	113	107	80	
40	105	110	115	120	125	130
60	93	99	105	111	116	122

t_c \ t_o	R401A -40	-30	-20	-10	0	10
00	31					
20	80	83	85	72	46	
40	87	90	94	97	101	102
60	85	89	94	98	102	106

t_c \ t_o	R402A -40	-30	-20	-10	0	10
00	73	69	50			
20	77	81	85	88	74	35
40	71	75	80	84	88	91
60	50	55	60	65	69	74

t_c \ t_o	R404A -40	-30	-20	-10	0	10
00	69	63	44			
20	70	74	78	81	68	30
40	61	65	70	74	78	81
60	36	41	46	51	55	59

t_c \ t_o	R407A -40	-30	-20	-10	0	10
00	79	67	40			
20	91	95	98	102	82	30
40	89	94	98	102	106	110
60	72	77	82	87	92	96

t_c \ t_o	R407B -40	-30	-20	-10	0	10
00	72	66	45			
20	77	80	84	88	75	34
40	69	74	78	83	87	91
60	46	51	56	61	66	70

t_c \ t_o	R407C -40	-30	-20	-10	0	10
00	79	65	31			
20	98	101	105	108	85	21
40	100	104	109	113	117	121
60	87	93	98	103	108	113

t_c \ t_o	R410A -40	-30	-20	-10	0	10
00	116	117	91	12		
20	125	130	133	137	120	69
40	119	124	129	133	137	140
60	90	96	101	106	110	114

t_c \ t_o	R410B -40	-30	-20	-10	0	10
00	112	112	87	11		
20	122	126	129	132	115	66
40	119	124	128	131	134	137
60	98	103	108	112	115	118

t_c \ t_o	R507 -40	-30	-20	-10	0	10
00	72	66	47			
20	78	81	83	86	71	33
40	74	78	81	84	87	90
60	53	57	61	64	68	71

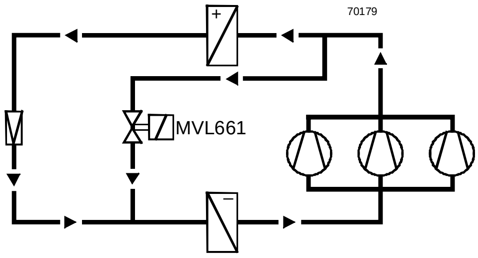
t_c \ t_o	R1270 -40	-30	-20	-10	0	10
00	109	93	59			
20	122	126	130	129	101	31
40	122	127	133	138	142	147
60	108	115	121	127	132	138

- With superheat = 6 K With subcooling = 2 K Δp upstream of evaporator = 1.6 bar
- Δp condenser = 0.3 bar Δp evaporator = 0.3 bar

Use of the MVL661...-... as a hot-gas valve

The control valve throttles the capacity of a compressor stage. The hot gas passes directly to the evaporator, thus permitting capacity control in the range from 100 % down to approximately 0 %.

Indirect hot-gas bypass application



Suitable for use in large refrigeration systems in air conditioning plant, to prevent unacceptable temperature fluctuations between the compressor stages.

Application example

With low loads, the evaporating and condensing pressures can fluctuate depending on the type of pressure control. In such cases, evaporating pressure increases and condensing pressure decreases. Due to the reduction in differential pressure across the fully open valve, the volumetric flow rate will drop – the valve is undersized. This is why the effective pressures must be taken into account when sizing the valve for low loads.

Refrigerant R507; 3 compressor stages; Q_o = 75 kW; t_o = 4 °C; t_c = 40 °C
Part load Q_o per stage = 28 kW; t_o = 4 °C; t_c = 23 °C

KH-R507	t_o = 0 °C	t_o = 10 °C
t_c = 2 °C	**14.4**	**9.0**
t_c = 23 °C	*15.6*	*11.0*
t_c = 40 °C	**22.4**	**22.0**

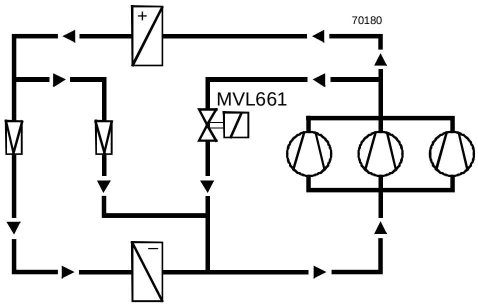
Interpolation at	t_c = 23 °C
14.4 + [(22.4 – 14.4) x (23 - 20) / (40 - 20)]	15.6
9.0 + [(22.0 – 9.0) x (23 - 20) / (40 - 20)]	11.0

Interpolation at	t_o = 4 °C
15.6 + [(11.0 – 15.6) x (4 - 0) / (10 - 0)]	13.8

k_{vs} theoretical = 28 kW / 13.8 = 2.03 m^3/h
Valve MVL661.20-2.5 is suitable, since: 2.03 m^3/h / 2.5 m^3/h x 100 % = 81 % (> 50 %)

Direct hot-gas bypass application

The control valve throttles the capacity of one compressor stage. The gas is fed to the suction side of the compressor and then cooled using a reinjection valve. Capacity control ranges from 100 % down to approximately 10 %.



Suitable for large refrigeration systems in air conditioning applications with several compressors or compressor stages, and where the evaporator and compressor are some distance apart (attention must be paid to the oil return).

Correction table KH

Hot-gas valve

	R22					
$t_c \setminus t_o$	-40	-30	-20	-10	0	10
00	8.9	8.4	6.3			
20	15.3	15.1	14.8	14.6	13.2	6.5
40	24.2	23.7	23.2	22.8	22.4	22.1
60	35.7	34.7	33.8	33.0	32.3	31.7

	R134a					
$t_c \setminus t_o$	-40	-30	-20	-10	0	10
00	4.5					
20	9.8	9.6	9.5	9.2	7.4	
40	15.9	15.6	15.3	15.1	14.9	14.7
60	23.8	23.2	22.7	22.3	21.9	21.6

	R744					
$t_c \setminus t_o$	-40	-30	-20	-10	0	10
-20	38.1	30.5				
00	60.9	59.8	58.1	47.1		
20	87.3	84.9	82.5	80.2	76.1	

	R290					
$t_c \setminus t_o$	-40	-30	-20	-10	0	10
00	10.9	10.0	6.5			
20	18.0	17.7	17.4	17.1	15.0	
40	27.3	26.7	26.2	25.8	25.4	25.1
60	38.2	37.2	36.4	35.7	35.1	34.5

	R401A					
$t_c \setminus t_o$	-40	-30	-20	-10	0	10
00	4.7					
20	10.2	10.0	9.9	9.5	7.6	
40	16.9	16.6	16.2	16.0	15.8	15.6
60	25.9	25.2	24.6	24.1	23.7	23.3

	R402A					
$t_c \setminus t_o$	-40	-30	-20	-10	0	10
00	9.7	9.5	8.3			
20	15.9	15.7	15.4	15.2	14.5	9.3
40	23.7	23.2	22.7	22.4	22.0	21.7
60	31.5	30.7	29.9	29.2	28.7	28.1

	R404A					
$t_c \setminus t_o$	-40	-30	-20	-10	0	10
00	9.4	9.2	7.8			
20	15.2	15.0	14.8	14.6	13.9	8.6
40	22.3	21.8	21.5	21.1	20.9	20.6
60	28.8	28.0	27.4	26.8	26.4	25.9

	R407A					
$t_c \setminus t_o$	-40	-30	-20	-10	0	10
00	8.9	8.6	6.7			
20	15.7	15.4	15.2	15.0	14.1	8.0
40	24.9	24.4	23.9	23.5	23.1	22.8
60	35.9	34.9	34.0	33.2	32.6	32.0

	R407B					
$t_c \setminus t_o$	-40	-30	-20	-10	0	10
00	9.0	8.8	7.4			
20	15.3	15.1	14.8	14.7	14.0	8.8
40	23.3	22.8	22.4	22.0	21.7	21.5
60	31.6	30.7	30.0	29.3	28.8	28.3

	R407C					
$t_c \setminus t_o$	-40	-30	-20	-10	0	10
00	8.6	8.1	5.9			
20	15.3	15.0	14.8	14.6	13.6	7.0
40	24.7	24.2	23.7	23.3	22.9	22.6
60	36.3	35.3	34.4	33.6	33.0	32.4

	R410A					
$t_c \setminus t_o$	-40	-30	-20	-10	0	10
00	14.5	14.3	13.2	6.2		
20	24.2	23.7	23.3	23.0	22.1	15.9
40	36.8	35.9	35.1	34.4	33.7	33.1
60	50.0	48.5	47.2	46.0	44.9	43.8

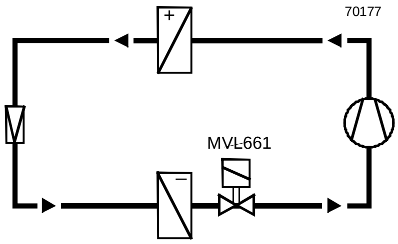
	R410B					
$t_c \setminus t_o$	-40	-30	-20	-10	0	10
00	14.3	14.1	12.9	6.1		
20	23.8	23.3	22.9	22.5	21.6	15.5
40	36.5	35.6	34.7	33.9	33.2	32.5
60	50.7	49.1	47.7	46.4	45.2	44.0

	R507					
$t_c \setminus t_o$	-40	-30	-20	-10	0	10
00	9.8	9.5	8.1			
20	16.1	15.8	15.5	15.3	14.4	9.0
40	24.5	23.8	23.3	22.8	22.4	22.0
60	33.1	31.8	30.7	29.8	29.0	28.3

	R1270					
$t_c \setminus t_o$	-40	-30	-20	-10	0	10
00	13.5	13.0	10.3			
20	22.0	21.6	21.2	20.9	19.0	9.9
40	33.0	32.2	31.6	31.1	30.6	30.1
60	46.1	44.8	43.8	42.8	41.9	41.2

- With superheat = 6 K   With subcooling = 2 K   Δp upstream of evaporator = 1.6 bar
- Δp condenser = 0.3 bar   Δp evaporator = 0.3 bar

Use of the MVL661...-... as a suction throttle valve



Typical control range 50 ... 100 %.
Minimum stroke limit control:
To ensure optimum cooling of the compressor, either a capacity controller must be provided for the compressor, or a minimum stroke must be set via the valve electronics.
The minimum stroke can be limited to a maximum of 80 %. At zero load, the minimum stroke must be sufficient to ensure that the minimum gas velocity in the suction line is > 0.7 m/s and that the compressor is adequately cooled.
As the control valve closes, the evaporating temperature rises and the air cooling effect decreases continuously. The electronic control system provides demand-based cooling without unwanted dehumidification and costly retreatment of the air.
The pressure at the compressor inlet falls and the power consumption of the compressor is reduced. The energy savings to be anticipated with low loads can be determined from the compressor selection chart (power consumption at minimum permissible suction pressure). Compressor energy savings of up to 40 % can be achieved.
The recommended differential pressure Δp_{v100} across the fully open control valve is between 0.15 < Δp_{v100} < 0.5 bar.

Application example

Refrigerant R134A; Q_o = 9.5 kW; t_o = 4 °C; t_c = 40 °C;
Differential pressure across MVL661: Δp_{v100} = 0.25 bar

In this application example, t_o, t_c and Δp_{v100} are to be interpolated.

KS-R134a	t_o = 0 °C	t_o = 10 °C
0.15 / 20	**2.2**	**2.7**
0.15 / 50	**1.7**	**2.1**
0.45 / 20	**3.6**	**4.5**
0.45 / 50	**2.7**	**3.4**

Interpolation at	t_o = 4 °C
2.2 + [(2.7 – 2.2) x (4 - 0) / (10 - 0)]	2.4
1.7 + [(2.1 – 1.7) x (4 - 0) / (10 - 0)]	1.9
3.6 + [(4.5 – 3.6) x (4 - 0) / (10 - 0)]	4.0
2.7 + [(3.4 – 2.7) x (4 - 0) / (10 - 0)]	3.0

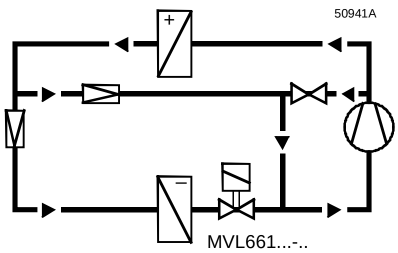
t_o = 4 °C	t_c = 20 °C	t_c = 50 °C
Δp_{v100} 0.15	**2.4**	**1.9**
Δp_{v100} 0.45	**4.0**	**3.0**

Interpolation at	t_c = 40 °C
2.4 + [(1.9 – 2.4) x (40 - 20) / (50 - 20)]	2.1
4.0 + [(3.0 – 4.0) x (40 - 20) / (50 - 20)]	3.3

t_c = 40 °C	Δp_{v100} 0.15	Δp_{v100} 0.45
	2.1	**3.3**

Interpolation at	Δp_{v100} 0.25
2.1 + [(3.3 – 2.1) x (0.25 – 0.15) / (0.45 – 0.15)]	2.5

k_{vs} theoretical = 9.5 kW / 2.5 = 3.8 m^3/h
Valve MVL661.25-6.3 is suitable, since 3.8 m^3/h / 6.3 m^3/h x 100 % = 60 % (> 50 %)
It is recommended that the k_{vs} value be set to 63 % = 4 m^3/h



Typical control range 10 ... 100 %.
The capacity controller ensures that the compressor is adequately cooled, making it unnecessary to set a minimum stroke in the refrigerant valve.

Correction table KS

Suction throttle valve

t_c	R22					
Δp_{v100} \ t_o	-40	-30	-20	-10	0	10
0.15 / 20	1.2	1.5	1.9	2.4	2.9	3.4
0.15 / 50	0.9	1.2	1.5	1.9	2.3	2.7
0.45 / 20	1.5	2.3	3.0	3.9	4.8	5.7
0.45 / 50	1.2	1.8	2.4	3.0	3.8	4.6

t_c	R134a					
Δp_{v100} \ t_o	-40	-30	-20	-10	0	10
0.15 / 20	0.7	1.0	1.4	1.8	2.2	2.7
0.15 / 50	0.5	0.7	1.0	1.3	1.7	2.1
0.45 / 20	0.7	1.2	1.9	2.7	3.6	4.5
0.45 / 50	0.5	0.9	1.4	2.0	2.7	3.4

t_c	R152A					
Δp_{v100} \ t_o	-40	-30	-20	-10	0	10
0.15 / 20	0.9	1.3	1.7	2.2	2.7	3.3
0.15 / 50	0.7	1.0	1.4	1.7	2.2	2.7
0.45 / 20	1.0	1.5	2.4	3.3	4.3	5.3
0.45 / 50	0.7	1.2	1.9	2.6	3.5	4.4

t_c	R290					
Δp_{v100} \ t_o	-40	-30	-20	-10	0	10
0.15 / 20	1.5	1.9	2.4	3.0	3.6	4.3
0.15 / 50	1.0	1.4	1.8	2.2	2.7	3.3
0.45 / 20	2.0	2.8	3.8	4.8	6.0	7.2
0.45 / 50	1.4	2.1	2.8	3.6	4.5	5.5

t_c	R401A					
Δp_{v100} \ t_o	-40	-30	-20	-10	0	10
0.15 / 20	0.8	1.1	1.5	1.9	2.3	2.9
0.15 / 50	0.6	0.8	1.1	1.5	1.8	2.3
0.45 / 20	0.8	1.3	2.1	2.9	3.7	4.7
0.45 / 50	0.6	1.0	1.6	2.3	3.0	3.7

t_c	R402A					
Δp_{v100} \ t_o	-40	-30	-20	-10	0	10
0.15 / 20	1.1	1.4	1.8	2.2	2.7	3.3
0.15 / 50	0.7	0.9	1.2	1.5	1.8	2.3
0.45 / 20	1.5	2.2	2.9	3.7	4.6	5.6
0.45 / 50	0.9	1.4	1.9	2.4	3.1	3.8

t_c	R404A					
Δp_{v100} \ t_o	-40	-30	-20	-10	0	10
0.15 / 20	1.0	1.3	1.7	2.2	2.7	3.3
0.15 / 50	0.6	0.8	1.1	1.4	1.7	2.1
0.45 / 20	1.4	2.1	2.8	3.6	4.5	5.5
0.45 / 50	0.8	1.2	1.7	2.3	2.9	3.6

t_c	R407A					
Δp_{v100} \ t_o	-40	-30	-20	-10	0	10
0.15 / 20	1.0	1.4	1.8	2.3	2.9	3.5
0.15 / 50	0.7	1.0	1.3	1.6	2.1	2.6
0.45 / 20	1.3	2.0	2.9	3.8	4.7	5.9
0.45 / 50	0.9	1.4	2.0	2.7	3.4	4.3

t_c	R407B					
Δp_{v100} \ t_o	-40	-30	-20	-10	0	10
0.15 / 20	1.0	1.3	1.7	2.2	2.7	3.3
0.15 / 50	0.6	0.8	1.1	1.4	1.8	2.2
0.45 / 20	1.3	2.0	2.7	3.5	4.5	5.5
0.45 / 50	0.8	1.2	1.7	2.3	3.0	3.8

t_c	R407C					
Δp_{v100} \ t_o	-40	-30	-20	-10	0	10
0.15 / 20	1.0	1.4	1.8	2.3	2.9	3.5
0.15 / 50	0.7	1.0	1.3	1.7	2.1	2.6
0.45 / 20	1.3	2.0	2.8	3.8	4.8	5.9
0.45 / 50	0.9	1.4	2.1	2.8	3.5	4.4

t_c	R410A					
Δp_{v100} \ t_o	-40	-30	-20	-10	0	10
0.15 / 20	1.5	2.0	2.5	3.0	3.6	4.4
0.15 / 50	1.0	1.3	1.7	2.1	2.6	3.1
0.45 / 20	2.3	3.1	4.0	5.0	6.1	7.4
0.45 / 50	1.6	2.1	2.8	3.5	4.4	5.3

t_c	R410B					
Δp_{v100} \ t_o	-40	-30	-20	-10	0	10
0.15 / 20	1.5	1.9	2.4	2.9	3.6	4.2
0.15 / 50	1.0	1.3	1.7	2.1	2.6	3.1
0.45 / 20	2.3	3.1	3.9	4.9	6.0	7.2
0.45 / 50	1.6	2.1	2.8	3.5	4.3	5.2

- With superheat = 6 K With subcooling = 2 K Δp upstream of evaporator = 1.6 bar
- Δp condenser = 0.3 bar Δp evaporator = 0.3 bar