SIEMENS

Technical Instructions

Document No. CA2N4713E-P25

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MVL661.25

HED Refrigerant Valve for Safety Refrigerants

Description

Position-controlled magnetic valve for hot-gas expansion and throttling control.

Features

- One valve part number for hot-gas, expansion and suction gas applications.
- Hermetically sealed.
- Standard 0 to 10 Vdc or 4 to 20 mA interface.
- High resolution with precise positioning control and position feedback.
- Closed when de-energized.
- Sturdy and maintenance-free.

Application

With its position-controlled magnetic actuator, the MVL661.25 HED refrigerant valve is designed for modulating capacity control of chillers and heat pumps. It is suitable for evaporator and suction pressure control but must not be used for safety shut-off functions (see *Leakage* under *Specifications*).
The MVL661.25 can be used with organic safety refrigerants such as R22, R134a, R404A, R407C, and R507.

Function

The MVL661.25 has a sturdy, maintenance-free valve body as a self-contained hermetically-sealed unit. The valve has a high resolution and precise position control. The electronic interface is designed for an 24 Vac operating voltage and a control signal of 0 to 10 Vdc or 4 to 20 mA, and provides a 0 to 10 Vdc position feedback signal. The valve is closed when de-energized.

Product Numbers

Table 1. Product Numbers and Operating Data.

Product Number	Line Size [in.]	Cv	Qo [Tons]	PN [VA]	Pmed [VA]	L (ft)		
						16 AWG	14 AWG	12 AWG
MVL661.25	1	2.4	70	16	4	164	279	443

Key:

Cv = Flow rate tolerance ±10%

PN = Nominal power

P_{med} = Mean operating power

Q_o = Nominal refrigeration capacity in expansion applications

L = Max.cable length between controller output and valve for the cable cross-sections shown

Ordering

The MVL661.25 is supplied as a pre-assembled unit, comprising the valve body, magnetic actuator and terminal housing.
When ordering, specify the quantity, product number and product name.

Example: 1 MVL661.25 HED refrigerant valve

Warning/Caution Notations

WARNING:		Personal injury/loss of life may occur if a procedure is not performed as specified.
CAUTION:		Equipment damage may occur if the user does not follow a procedure as specified.

Technical Design

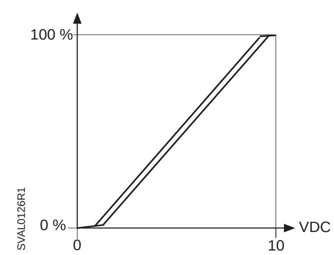
Principle of Operation

The actuator performs modulating control based on the principle of a proportionally-acting magnet. The magnetic core is designed as a floating component within the pressure system, eliminating the need for an external shaft gland. The valve is hermetically sealed. The moving piston has built-in pressure compensation and a return-spring, which is forced against the control disc when the valve is de-energized, providing a tight seal.

The valve holds a position between 0 and 100% stroke corresponding to the 0 to 10 Vdc control signal. The built-in positioning control feature acts quickly and accurately to correct deviations from the control signal.

The valve position is measured inductively. The position feedback signal is available at the connection terminals as a 0 to 10 Vdc signal for other purposes (e.g., indication). The valve has extended female solder unions, making pipe connections easy.

Stroke



Control Signal

Sizing

Refrigeration Capacity

The sizing of the MVL661.25 valve depends on the refrigerant, the evaporating and condensing pressures, and the application (hot-gas bypass, suction gas or expansion). The amount of refrigerant flowing through the fully opened valve varies according to the C v -value, the pressure upstream [p_1] and downstream [p_2] of the valve, and whether the valve is operating with a super-critical or sub-critical pressure ratio.

Pressure ratio: Super-critical 0.42 > $\frac{p1 - p2}{p1}$ >0.42 Sub-critical

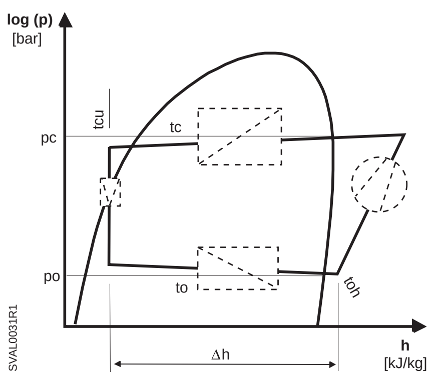
In expansion applications, the effect of the proportion of fluid is a further factor. Calculations for gas-only or liquid-only valves are not possible.

Table 2. Refrigeration Calculation.

Application	Pressure Ratio	Refrigerant Quantity
Suction gas, hot gas (distributed to 2 condensers)	Sub-critical	$m = k_{vs} \times 0{,}143 \times \sqrt{\frac{\rho_N \times (p_1 - p_2) \times p_2}{T_1}}$
Indirect hot gas Direct hot gas	Super-critical [1)]	$m = k_{vs} \times 0{,}06 \times p_1 \times \sqrt{\frac{\rho_N}{T_1}}$
Expansion	Super-critical [1)]	$m = k_{vs} \times f \times \sqrt{p_1 \times \rho}$

Key:
- m: Quantity of refrigerant in kg/sec
- ρ_N: Standard density gas in kg/m^3 (= Mol weight of refrigerant: 22.4)
- ρ: Density of sub-cooled liquid in kg/dm^3
- f: Factor 0.14 to 0.18 (dependent on refrigerant, inlet pressure and valve geometry)
- T_1: Temperature at valve inlet in Kelvin (e.g., 32°F (0°C) → 273K)
- p_1: Absolute pressure at valve inlet [bar]
- p_2: Absolute pressure at valve outlet [bar]
- Cv: Volume of water in m^3/h at a pressure differential of 1 bar
- 1): When the evaporating and condensing temperatures are close to one another, the pressure ratio is sub-critical.

Formula Symbols and Definitions



Key:

pc	:	Condensing pressure	[bar, absolute]
tc	:	Condensing temperature	[°F]
po	:	Evaporating pressure	[bar, absolute]
to	:	Evaporating temperature	[°C]
tcu	:	Sub-cooled liquid temperature	[°C]
toh	:	Superheated suction gas temperature	[°C]
Δtoh	:	Superheating	[°C]
		Δtoh = toh – to	[K]
Δtcu	:	Sub-cooling	[°C]
		Δtcu = tc – tcu	[K]
Δh	:	Special enthalpy differential	[BTU]

Figure 1.

The refrigeration capacity Qo is calculated by multiplying the volume of refrigerant per second by the special enthalpy differential from the log (p) – h chart for the refrigerant concerned. To help determine the refrigeration capacity more easily, a selection chart is provided for each application. 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.

- All selection charts are based on superheating by 4K and sub-cooling by 2K.
- The pressure drop in the condenser/evaporator is based on 0.3 bar in each case.
- The pressure drop upstream of the evaporator (e.g., with distributor) is based on 0.3 bar.

If the evaporation and/or condensing temperatures are between the values shown in the table, the refrigeration capacity can be determined reasonably accurately by linear interpolation.

Formula Symbols and Definitions, Continued

NOTES:

1. If the valve is used within the specified refrigerant and evaporating / condensing temperatures, the admissible differential pressure (Δp_{max} 25 bar) of the MVL661.25 will not be exceeded when the valve is used as an expansion valve or for direct or indirect hot-gas bypass applications.

2. An increase of 1°F (1°C) in the evaporating temperature will produce an increase of approximately 0.5 to 1% in refrigeration capacity. In contrast, improving sub-cooling by 1°F (1°C) gives an increase of 1 to 2% in refrigeration capacity (this applies only down to sub-cooling by approximately 8K). Insufficient sub-cooling, resulting from too great a pressure drop upstream of the expansion valve, can lead to flash gas, and must be avoided.

3. The differential pressure across the open valve is defined as Δp_{v100} and across the closed valve as Δp_{v0}. Note that Δp_{v0} must not exceed the maximum differential pressure Δp_{max}.

Correction factor k

Depending on the type of evaporator (direct expansion, shell-and-tube heat exchanger, plate heat exchanger, etc.) the additional pressure drop between the valve and evaporator must be taken into account. This is particularly relevant with condensing temperatures below 86°F (30°C) (e.g., in the transitional period from autumn to winter). Here, the actual refrigeration capacity will be lower than that shown in the selection charts.

The correction factor k applies only to expansion and direct or indirect hot-gas applications, and depends on the evaporating temperature and the refrigerant used.

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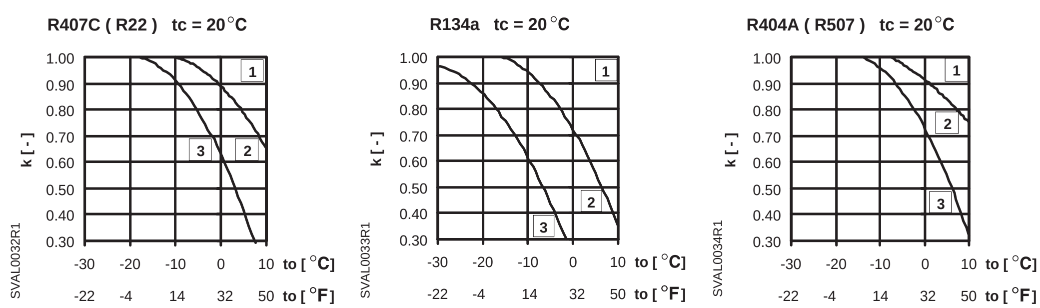


Key:

Curve 1	: Δp = 0,3 bar	e.g., shell-and-tube heat exchanger
Curve 2	: Δp = 1 bar	e.g., plate heat exchanger
Curve 3	: Δp = 2 bar	e.g., direct expansion evaporator

Figure 2. Correction Factor k Calculations.

Use Curve 3 if there is no information on the pressure drop between the valve and evaporator.

Expansion Application

Table 3. Expansion Refrigeration Capacity in Tons of Refrigeration.

E	**Refrigerant**								
	R407C (R22)			**R134a**			**R404A / R507**		
	Condensing Temperature t_c [°F]								
t_o [°F]	68	104	140	68	104	140	68	104	140
– 40	95	98	85	–	–	–	68	59	–
– 4	102	106	96	73	78	74	75	68	44
14	105	111	101	76	82	78	79	72	49
32	103	115	106	69	86	83	79	76	53
50	66	119	111	34.7	89	87	52	79	57

- The minimum refrigeration capacity of the system should not be less than 50% of the values shown in *Table 3*.
- It is important to use the correction factor k in conjunction with low loads (e.g., in autumn and winter).

Hot-gas Bypass Application

Table 4. Refrigeration Capacity in Tons of Refrigeration with Direct/Indirect Hot-gas Bypass Applications.

FB	**Refrigerant**								
	R407C (R22)			**R134a**			**R404A / R507**		
	Condensing Temperature t_c [°F]								
t_o [°F]	68	104	140	68	104	140	68	104	140
– 40	14	23	34	–	–	–	14	21	–
-4	14	22	32	9	14	21	14	20	25
14	14	22	32	9	14	21	14	20	25
32	14	22	31	9	14	21	14	20	24
50	12	22	31	7	14	20	12	20	24

- The minimum refrigeration capacity of the system should not be less than 65% of the values shown in *Table 4*.
- These values vary under low load conditions, depending on the type of evaporating and condensing pressure control. With low loads, if the evaporating and condensing pressure is not maintained constant, the evaporation pressure will rise and the condensation pressure will fall. The correction factor k must be included in calculations.

Suction Gas Application

Table 5. Refrigeration Capacity in Tons of Refrigeration at a Condensing Temperature t_c of 104°F.

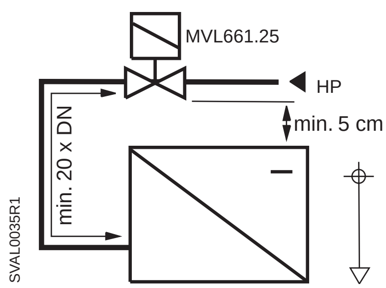
S	Refrigerant								
	R407C (R22)			R134a			R404A /R507		
	Pressure Differential Δp_{v100}								
t_o [°F]	2.2	4.4	7.3	2.2	4.4	7.3	2.2	4.4	7.3
– 40	0.8	1.0	1.0	–	–	–	0.8	1.0	1.1
- 4	1.5	2.1	2.5	1.1	1.5	1.6	1.4	1.8	2.2
14	2.0	2.7	3.3	1.5	2.0	2.4	1.7	2.4	3.0
32	2.4	3.4	4.2	1.9	2.6	3.2	2.1	3.0	3.8
50	3.0	4.2	5.3	2.4	3.2	4.0	2.6	3.7	4.7

Engineering Notes

Depending on the application, additional installation instructions must be observed and the relevant safety elements (e.g., pressostats, full motor protection) must be installed.

Expansion Application

The velocity of the refrigerant at the valve inlet in expansion valve applications must not exceed 3.3 feet per second. To achieve this, the pipe bore must be greater than one-inch diameter or, for copper pipes greater than one inch.



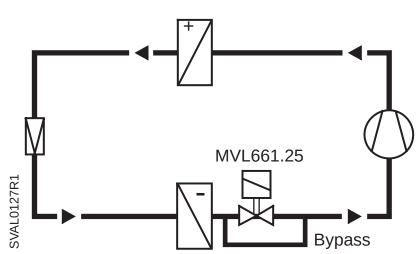
To achieve the best control, the refrigerant valve must be installed so that it is higher than the evaporator. Allow at least 1.5 feet of pipework between the expansion valve and the distributor.

Figure 3. Refrigerant Valve Installation.

CAUTION:

The direction of flow in the MVL661.25 refrigerant valve is NOT the same as in the M2FE...L... expansion valve.

Suction Gas Application



For optimum compressor cooling, a capacity controller is required for the compressor. Alternatively, a bypass line must be installed across the refrigerant valve. The bypass dimensions should be such that at zero load, the minimum velocity of the gas in the suction line is greater than 2.3 feet per second.

Figure 4.

Mounting

Mounting instructions are enclosed with the refrigerant valve.

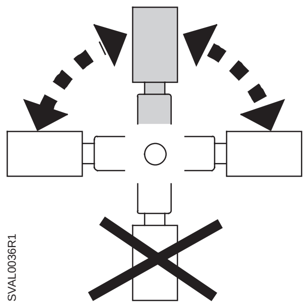


Figure 5. Acceptable Mounting Positions.

- The refrigerant valve may be mounted at any angle from upright to horizontal, but must not be suspended below the horizontal.
- Pipes should be fixed so that there is no pressure on the valve connections (vibration can lead to burst pipes).
- The valve body and the pipes leading from it must be insulated.
- Before soldering the pipes, check that the direction of flow through the valve is correct.

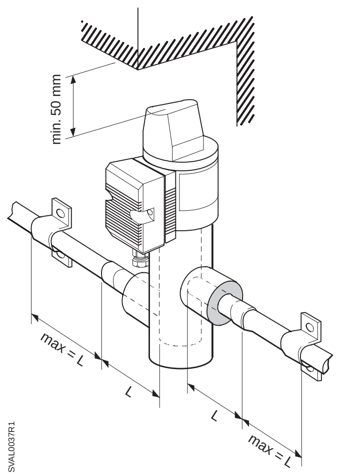


Figure 6.

- Remove the terminal housing and rotate the actuator so that the terminal base is facing away from the connection to be soldered.
- Cool the valve body with a wet cloth while soldering.
- The pipes must be soldered with care. The flame should be large enough to ensure that the connection heats up quickly and that the valve itself does not become too hot. The flame should be directed away from the valve.

CAUTION:

1. Disconnect the power before removing or replacing the signal transducer (terminal housing)
   Ensure that the ZM152 / ZM153 terminal housings are those supplied with the valve; the housings are NOT interchangeable.

2. The terminal housing is calibrated for the valve and must not be replaced.

Specifications

Power Supply	Electrical interface:	With Class 2 only
	Operating voltage	24 Vac +15/–10%
	Frequency	50/60 Hz
Input	Control signal	0 to 10 Vdc or 4 to 20 mA
	- Impedance (0 to 10 Vdc control signal)	50K ohm
	- Resistance (4 to 20 mA control signal)	330K ohm
Output	Position feedback signal	0 to 10 Vdc
	– Current	Maximum 2 mA load

Product Data	Admissible pressure p_s	507 psi (35 bar)
	Maximum differential pressure Δp_{max}	365 psi (25 bar)
	Leakage	Maximum 0.001 C_V
	Temperature of medium	-40 to 248°F (– 40 to 120°C)
	Valve characteristic (stroke, k_v)	Linear
	Type of operation	Modulating
	Position when de-energized	Closed
	Orientation	From upright to horizontal; do not suspend below horizontal
	Positioning time	<0.5 second
Materials	Housing components	Steel, copper, CrNi steel
	Seat/inner valve	CrNi steel/PTFE
	Connections	Extended female solder unions
Electrical Connections	Connection terminals	Screw terminals for max. 12 AWG wire
General Ambient Conditions	Ambient temperature	-4 to 122°F (– 20 to 50°C)
	Ambient atmosphere	Avoid use in saline atmosphere except with prior consultation
Dimensions and Weight	Dimensions	See *Dimensions*
	Weight	10.5 lbs. (including packaging)
Agency Certification		Conforms to CE requirements.

Connection Terminals

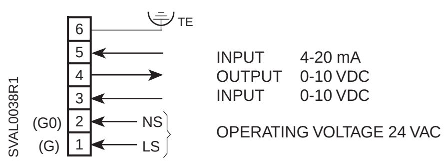


Figure 7. Terminal Layout.

CAUTION:

The input voltage may be either 0 to 10 Vdc or 4 to 20 mA, but not simultaneously.

Application Examples

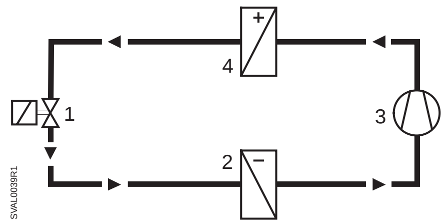
The following examples illustrate the principles only. Installation–specific details (safety elements, refrigerant collectors, etc.) are not shown.

Use as Expansion Valve for Capacity Optimization

Use as an electronic expansion valve:

- Control range 50 to 100%
- Increased capacity through better use of 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

Use as Expansion Valve for Capacity Optimization, Continued.



Key:
1 = MVL661.25
2 = Evaporator
3 = Compressor
4 = Condenser

Figure 8.

Example 1

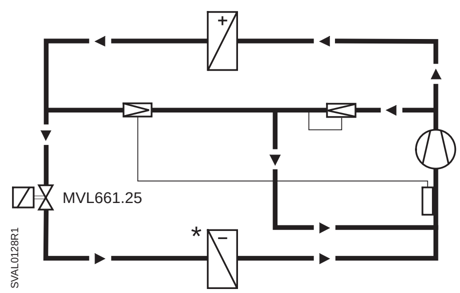
Electronic superheating control is achieved by using additional control equipment (e.g., *SolutionPack* or *PolyCool).*

:

Refrigerant R407C; Qo = 58.3 tons (205 kW); to = 23°F (– 5°C); tc = 95°F (+ 35°C)
Refrigeration capacity of MVL661.25 (interpolated) => 111 tons (390 kW).

Capacity Control

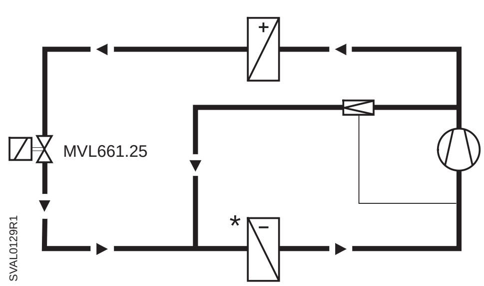
1. The MVL661.25 refrigerant valve for capacity control of a direct expansion evaporator. Monitoring of suction pressure and temperature with mechanical capacity controller and re-injection valve.
   - Control range 10 to 100%
   - Economical low-load operation
   - Ideal control of temperature and humidity



* In the absence of electronic superheating control, a thermostatic expansion valve capable of adequate sub-cooling must be installed between the MVL661.25 valve and the evaporator.

Figure 9.

2. MVL661.25 refrigerant valve for capacity control of a chilled water unit.
   - Control range 0 to 100%
   - Economical low-load operation
   - Allows wide adjustment of condensing and evaporating temperatures
   - Ideal for plate heat exchangers
   - Highly reliable protection against freezing



* In the absence of electronic superheating control, a thermostatic expansion valve capable of adequate sub-cooling must be installed between the MVL661.25 valve and the evaporator.

Figure 10.

Example 2

Refrigerant R404A; Qo = 67.7 tons (238 kW); 2-stage; to = + 37°F (3°C);
tc = 90°F (32°C)
Plate heat exchanger (pressure drop 1 bar for even distribution of refrigerant)
Refrigeration capacity of MVL661.25 (interpolated) => 75 tons (262 kW)

Example 2a

Method of interpolation:
Full load as in Example 2. Low load Qo = 37.3 tons (131 kW);
stage 1: to = + 37.4°F (3°C; tc = + 71.6°F (22°C).

From Table E	**tc = 68°F (20°C)**	**tc = 104°F (40°C)**	**Interpolation at**	**tc = 71.6°F (22°C)**
to = 50°F (10°C)	52.4 tons (184 kW)	79.7 tons (280 kW)	(kW) 184 + (280 – 184) x (22 – 20) / (40 – 20) (tons) 52.4 + &79.7 – 52.4) x (6.3 – 5.7) / (11.4 – 5.7)	193 kW (55.3 tons)
to = 32°F (0°F)	79.1 tons (278 kW)	76.0 tons (267 kW)	(kW) 278 + (267 – 278) x (22 – 20) / (40 – 20) (tons) 79.1 + 76.0 – 79.1) x (6.3 – 5.7) / (11.4 – 5.7)	276 kW (78.8 tons)

	Interpolation At	**to = + 3 °C**
	276 + (193 – 276) x (3 – 0) / (10 – 0)	251 kW
	78.5 + (54.9 – 78.5) x (0.9 – 0) / (2.8 – 0)	(70.9 tons)
Correction factor (Curve No. 2) k = 0.89	0.89 + (1 – 0.89) x (22 – 20) / (30 – 20)	0.91
	0.89 + (1 – 0.89) x (6.3 – 5.7) / (8.5 – 5.7)	(0.91 tons)
Correction factor at tc = 71.6°F (22 °C)	0.91 x 251 kW	228 kW
	(0.91 x 70.9 tons)	(64.5 tons)
The MVL661.25 is suitable, since 131 kW (37.3 tons) / 228 kW (64.5 tons) x 100 % = 57%		>50%

Use in Hot-gas Application

The control valve throttles the capacity of a compressor state. The hot gas passes directly to the evaporator, allowing for capacity control ranging from 100% to approximately 0%.

Indirect Hot-gas Bypass

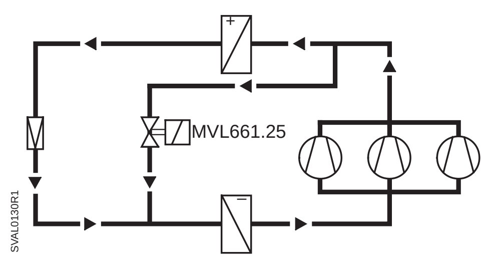


Figure 11.

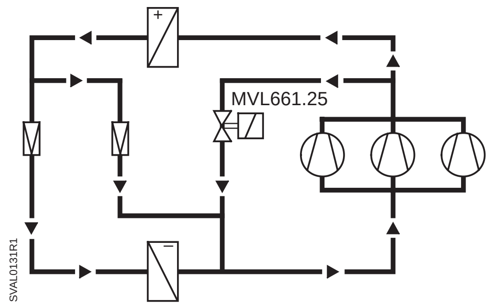
Suitable for use in large refrigeration systems in air conditioning applications to prevent unacceptable fluctuations in temperature between compressor stages.

Example 3

Refrigerant R507 ; 3-stage; Qo = 21.3 tons (75 kW); to = + 39.2°F (4 °C);
tc = + 104°F (40°C)
Low load, Qo per stage = 8.0 tons (28 kW); to = + 39.2°F (4°C); tc = 73.4°F (23°C)
Pressure drop across DX evaporator and distributor: 29 psi (2 bar)
Refrigeration capacity of MVL661.25 (interpolated) => 10.2 tons (36 kW)

Direct Hot-gasBypass

The control valve throttles the capacity of a compressor stage. The gas is fed to the suction side of the compressor and cooled using a re-injection valve. Capacity control range 100% 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 oil return).

Figure 12.

Example 4

Refrigerant R407C; 3 compressors, Qo = 24.2 tons (85 kW); to = + 35.6°F (2°C);
tc = + 104°F (40°C)
Low load, Qo per stage = 8.8 tons (31 kW), to = +35.6°F (2°C); tc = 73.4°F (23°C)
Pressure drop across plate heat exchanger: 1 bar
Refrigeration capacity of MVL661.25 (interpolated) => 13.1 tons (46 kW)

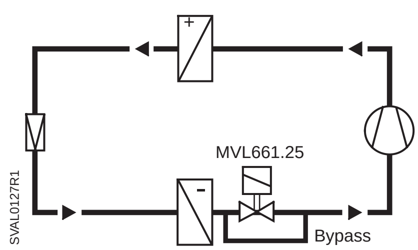
Suction Gas Application

As the control valve closes, the evaporating temperature rises. The air cooling effect decreases continuously. The electronic control system provides demand-based cooling without unwanted dehumidification and costly re-treatment of the air.

The pressure on the suction side of the compressor falls and the power consumption of the compressor is reduced. The anticipated energy savings with low loads can be determined from the compressor selection chart (power consumption at minimum admissible suction pressure). Compressor energy savings of up to 40% can be achieved.

The recommended differential pressure $\Delta pv100$ across the fully open valve should be between 0.15 and 0.5 bar

Suction Throttle Control Range 50 to 100%



To maintain the cooling of the compressor, a bypass line must be installed across the refrigerant valve.

With the MVL661.25 fully closed, the minimum velocity of the gas upstream of the compressor must be at least 2.3 ft/sec (0.7 m/s).

Figure 13.

Example 5

Refrigerant R134a; Qo = 2.7 tons (9.5 kW); to = + 39.2°F (4°C); tc = + 140°F (40°C); minimum refrigeration load 5 kW.

Differential pressure across MVL661.25 (interpolated) Δp_{V100}, approx. 3.6 psi (25 kPa)

Suction Throttle Control Range 10 to 100%

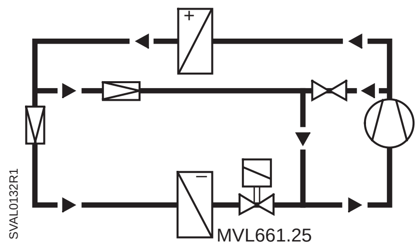
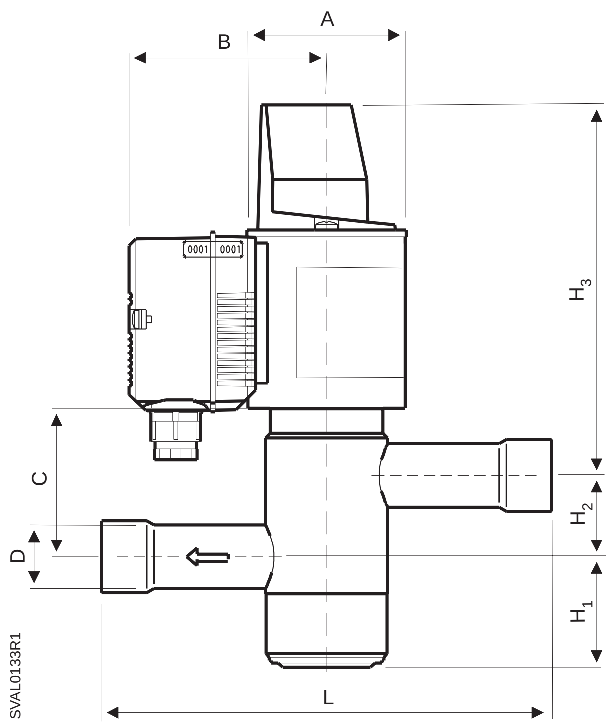


Figure 14.

The compressor is sufficiently cooled by the capacity controller across the compressor, making a bypass line across the valve unnecessary.

Dimensions



DN : Nominal size [inches]
D : Pipe connections [inches]
W : Weight in lbs. (including packaging)

Product Number	Line Size	D [in]	L	H_1	H_2	H_3	A	B	C	W lbs. (kg)
MVL661.25	DN25	1	7.87 (200)	1.93 (49)	1.42 (36)	6.46 (164)	2.76 (70)	3.42 (87)	2.60 (66)	10.5 (4.8)

W = Weight, including packaging

Figure 15. Dimensions in Inches (Millimeters).