aerospace
climate control
electromechanical
filtration
fluid & gas handling
hydraulics
pneumatics
process control
sealing & shielding

Electric Expansion Valves

SER, SERI, SEHI

RACE Catalogue 100-20 EEV-2/UK, February 2013

Parker SPORLAN

ENGINEERING YOUR SUCCESS.

FEATURES AND BENEFITS

- Step motor operated for precise control
- High resolution drive assembly
- Solenoid tight seating
- Corrosion resistant materials used throughout
- Field proven reliability
- Low power consumption (less than 4 watts)
- Unique built-in sightglass - indicates valve operation, moisture levels and refrigerant quality (SERI & SEHI only)
- Compatible with HCFC and HFC refrigerants and oils, in addition to subcritical CO2
- Self lubricating materials used for long life
- High linear force output

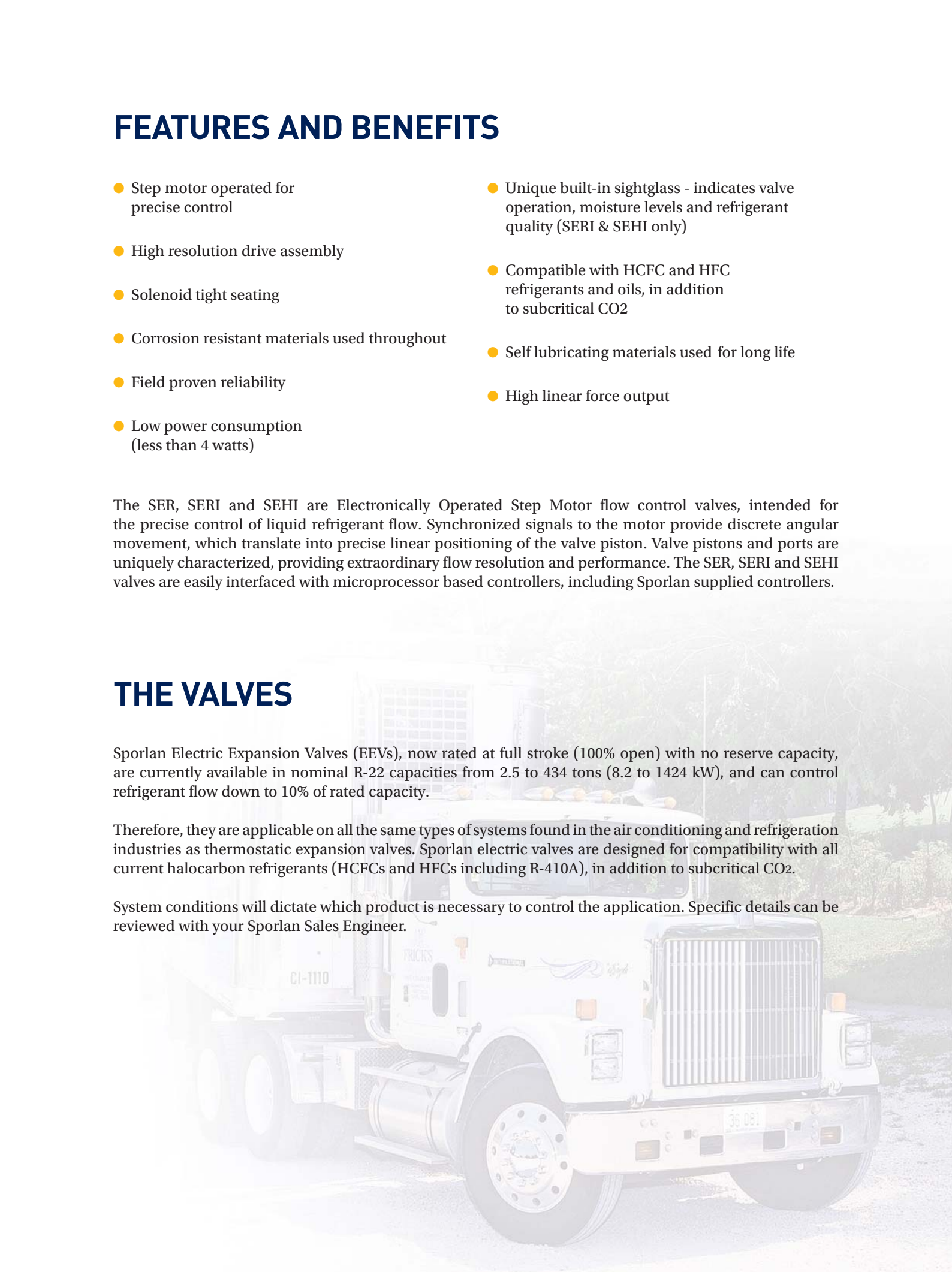
The SER, SERI and SEHI are Electronically Operated Step Motor flow control valves, intended for the precise control of liquid refrigerant flow. Synchronized signals to the motor provide discrete angular movement, which translate into precise linear positioning of the valve piston. Valve pistons and ports are uniquely characterized, providing extraordinary flow resolution and performance. The SER, SERI and SEHI valves are easily interfaced with microprocessor based controllers, including Sporlan supplied controllers.

THE VALVES

Sporlan Electric Expansion Valves (EEVs), now rated at full stroke (100% open) with no reserve capacity, are currently available in nominal R-22 capacities from 2.5 to 434 tons (8.2 to 1424 kW), and can control refrigerant flow down to 10% of rated capacity.

Therefore, they are applicable on all the same types of systems found in the air conditioning and refrigeration industries as thermostatic expansion valves. Sporlan electric valves are designed for compatibility with all current halocarbon refrigerants (HCFCs and HFCs including R-410A), in addition to subcritical CO_2.

System conditions will dictate which product is necessary to control the application. Specific details can be reviewed with your Sporlan Sales Engineer.



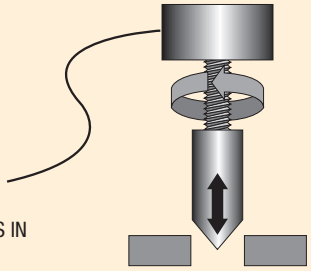
ELECTRIC VALVE BASICS

In current designs, the electronics controlling the valve are separate from the valve itself. The correct term to describe the valves is therefore electronically controlled electric valves. For convenience, the balance of this discussion will use the term electric valve. Since electric valves are assigned their function in the system by the software in the controller, an electric valve can be used anywhere in the system; as an expansion valve, discharge gas bypass valve, evaporator control valve, heat reclaim valve, head pressure control valve or crankcase pressure control valve. Certain design characteristics may indicate or restrict application to certain system conditions, but the fundamental operation of a Sporlan electric valve is consistent. The balance of this bulletin will focus on application as an Electric Expansion Valve (EEV).

TYPES OF ELECTRONICALLY CONTROLLED VALVES

Four basic types of electric valves have historically been offered to the marketplace; solenoid or pulse, analog, heat motor and step motor. Step motor valves, as shown in Figure 1, are the most sophisticated design. In this type of valve a small motor is used to open or close the valve port. The motor that is used does not rotate continuously, but instead, rotates a fraction of a revolution for each signal sent by the controller. These discrete “steps" give the motor its name. The number of step signals sent by the controller is “remembered", and the controller can return the valve to any previous position at any time. This repeatability is almost absolute and extremely fine control can be obtained. The digital circuitry used by step motor controllers can respond quickly and accurately. Sporlan step motors can be run at 200 steps/second using a voltage driver (L/R), or up to 400 steps/second using a current limited “chopper" drive, yet they can be made to return to an exact position. Sporlan Electric Expansion Valves are designed for 2500 or 6386 steps, so extraordinary resolution and control of flow is possible.

Figure 1



STEP MOTOR TYPE CONTROLS IN FINE INCREMENTS

STEP MOTORS

Step motors have existed for many years, but were traditionally limited to very specialized, and often expensive, applications. When the personal computer industry expanded and automobiles became more electronically controlled, the need for small, reliable and inexpensive step motors increased dramatically. Step motors permitted the repeatable precision movement needed for high speed printers and computerized engine management. In the 1980s Sporlan began research into step motor technology, and production step motor valves were offered in the early 1990s.

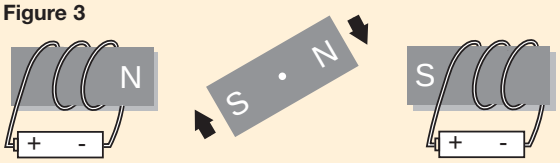
STEP MOTOR THEORY

Unlike traditional motors that will rotate as long as the proper power is supplied, step motors rotate a known amount of arc and then stop. When power is removed and then reapplied the step motor will rotate another fixed amount (or step) and again stop. This cycle may be repeated indefinitely, within mechanical limits, in either direction. While seemingly complex, this start/stop motion is mechanically simpler than induction or commutated motors. Step motors, like almost all motors, are based on the magnetic principal that opposite poles attract and like poles repel. These poles are called North (N) and South (S).

Figure 2

If the center magnet above is free to rotate, then the orientation shown will always occur. If electromagnets are used, then a pivoted magnet or rotor can be made to align with the magnetic fields created when the electromagnets are energized.

Figure 3

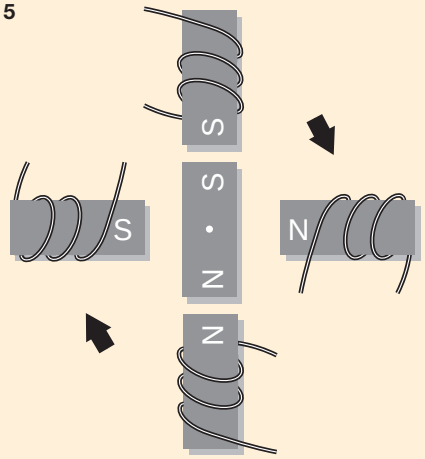


If power is left on, the magnetic poles will align and no further motion will take place.

Figure 4

If multiple groups of electromagnets are placed around a freely rotating permanent magnet rotor, and each is energized in series, then the rotor will step to each alignment position and a step motor is created.

Figure 5



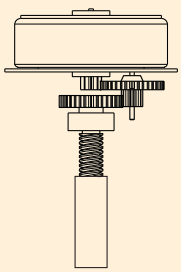
The above is a simple example. In reality, step motors may have 24 to 100 virtual electromagnets arranged around the rotor. Simple arithmetic shows these motors to have 15° to 3.6° step angles, or increments of rotation.

There are two general types of step motors: unipolar and bipolar. In a unipolar style, current flows in only one direction. In a typical example, one lead is always at +12 volts DC, and each of the other four leads is, in turn, connected to a ground. Drive circuitry is simpler, but torque and efficiency are lower than bipolar designs. However, unipolar motors have found acceptance in small capacity systems, within certain application limits. A bipolar motor, such as used in Sporlan electric valves, is powered by signals that change polarity. For the first step the black lead may be negative while the white is positive, but for the second step the black becomes positive while the white becomes negative. This push/pull increases torque and efficiency for motor size and power input, by utilizing the entire motor winding at all times. Bipolar is the predominant style of choice in the industry for larger step motor valves.

DIGITAL LINEAR ACTUATORS - DLAs

Small increments of rotation may be useful in print head drives or for signaling purposes, but often a linear movement is more desirable. In the case of electric refrigerant control valves, not only is linear motion needed, but significant linear force is also needed to close a port against high pressure. The solution to both these needs is a Digital Linear Actuator, or DLA (Figure 6). DLAs are used to convert rotation to a push/pull, often with a large increase in output force. The force increase is derived from a simple gear train, and may account for a fivefold increase in mechanical advantage. This torque increase is used to turn a drive screw or threaded shaft. A drive nut, or coupling, is threaded onto the shaft but prevented from turning by keyways, or specially shaped guides. Since the drive nut cannot turn, it must move forward or backward, depending on the rotation of the threaded shaft.

Figure 6



RESOLUTION

Resolution is defined as the ability of the valve to meet flow requirements accurately. In a pulse type valve only two stages of resolution are possible, fully open or fully closed. Theoretically, if a valve needs to meet a 50% load then it may remain closed for half the time and be fully open for half the time. The control of temperature and superheat will be “jumpy" as the valve alternately floods and starves the evaporator. If the swings are 6°, we say the resolution is ±3°. An Analog Electric Valve or TEV has better resolution because it opens and closes smoothly. In both valves, however, there is hysteresis.

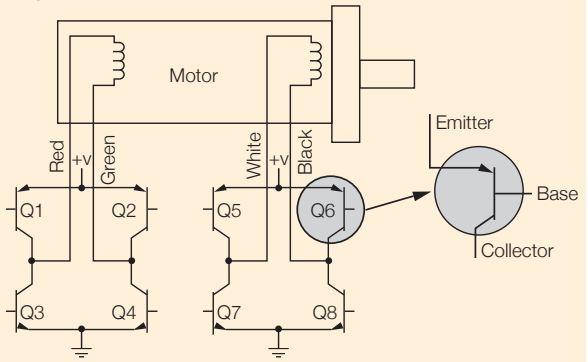
Hysteresis is the internal friction of any system. In a TEV it takes more force or pressure to deform the diaphragm in the opening direction than in the closing direction. This hysteresis has an effect on the resolution of the TEV, and limits its ability to precisely meter refrigerant over widely changing head pressure and evaporator load conditions. Balanced ported TEVs, like Sporlan BF and O series valves, have a much greater ability to follow load than conventional TEVs, but still not to the extent that EEVs can.

The resolution of an Electric Expansion Valve (EEV) is governed by the stroke and number of steps in that stroke. Sporlan offers nine standard Electric Expansion Valves to cover the full nominal capacity range from 2.5 to 434 tons (8.2 to 1424 kW) using R-22. All valves currently offer 2500 steps of stroke, except for the two largest valves, which have 6386 steps. The piston or pin moves the same linear distance for each step. For Sporlan EEVs, this distance ranges from 0.00008" to 0.00012" (0.002mm to 0.003mm). This extremely small change in the distance the pin moves away from the seat is reflected in a minute amount of refrigerant flow increase or decrease. Pulse type valves, with only open and shut capabilities, will have inferior resolution. A simple analogy is comparing an on/off light switch which has only two steps of resolution and a dimmer switch which may have thousands. You may be exposed to the same amount of light by setting the dimmer to 50%, or by flickering the light on and off rapidly, but the impact to the room is very different.

CONTROL HARDWARE

Actual control hardware for the valves may take a variety of forms. The most complex and expensive utilizes discrete or individual transistors for each switching function. This design requires the use of eight transistors, labeled Q1 through Q8, connected as shown in the schematic Figure 7.

Figure 7



Transistors are simply solid state switches. Solid state means they are fabricated from a solid chip of silicon and have no moving parts. They act as switches or relays by using a small electrical signal to turn a large signal off and on. In the symbol above, the small signal enters the “base" lead and allows flow from emitter to collector. The microprocessor, or small computer, used in the controller has the ability to sequence signals to the “base" of each transistor. This sequence of signals turn the transistors on and off in pairs, to step the valve open or shut. Transistors are available as bipolar (not to be confused with motors of the same name) which control current, and MOSFET (Metal Oxide Semiconductor Field Effect Transistor) which control voltage. In each type there are also transistors that are used to turn off the supply voltage or the ground. Full exploration of these differences is beyond the scope of this bulletin, but drive circuitry using each of these types have been used successfully.

The drive sequence for Sporlan valves is shown in Table 1 below.

Table 1

	BIPOLAR DRIVE SEQUENCE				
	STEP	BLACK	WHITE	RED	GREEN
CLOSE	1	12 volts	0 volts	12 volts	0 volts
	2	0 volts	12 volts	12 volts	0 volts
	3	0 volts	12 volts	0 volts	12 volts
	4	12 volts	0 volts	0 volts	12 volts
OPEN	1	12 volts	0 volts	12 volts	0 volts

As each phase is energized in sequence, the shaft of the motor will move one step in the direction indicated. The sequence repeats as many times as is needed to achieve the position calculated by the external electronic controller. Reversing the sequence changes the direction of the motor shaft. Proper sequencing allows the valve to open and close without loss of steps. While properly configured drives may be able to reverse direction without pausing, it is recommended to pause 25 ms prior to reversing direction to prevent loss of steps. Sporlan Digital Linear Actuators will maintain position when power is removed. This “brake" effect allows controllers to be simpler and use less energy. Sporlan suggests that all voltage be removed from the motor when not actively stepping to minimize heat and power consumption. Over 130 pounds of force (578 newtons) are needed to cause the motor to turn when not powered. This is not possible in any proper application of the valve.

SOFTWARE

The valves, with their motors and wiring, and the controllers, with their transistors and microprocessors, are grouped together as “Hardware". To make the hardware perform a function, a set of instructions must be given to the microprocessor. This set of instructions is called “Software" and certain “routines" must be incorporated to make valve control possible.

Most step motor valves are designed without internal intelligence or feedback, that is, they move only in response to controller signals. The valves maintain their position when no signals are received and valve position is stored in controller memory.
When the valve is given a signal to change position the controller keeps track of the change, however, the controller does not directly “know" whether the valve has changed position. To make this form of control effective, two control routines must be implemented: initialization and feedback loops.

INITIALIZATION

Initialization occurs when the valves are powered up for the first time, and sometimes when a large change to the system is made, e.g. closing for defrost. When the controller and valve combination are first powered together, the control does not know the valve position. To initialize, the controller sends out a stream of closing steps greater than the total number of steps in the valve stroke. This will assure that the valve is closed. This closed position becomes the “0" (zero) position of the valve used in all subsequent controller calculations.

This series of extra steps is called “overdriving", and the valves have been designed to accept this without damage. The actual number of overdriving steps required is dependent upon the valve used. The actual number of mechanical travel steps of the valves is larger than the number of flow control steps, to account for design requirements and manufacturing tolerance. To ensure that the valves are completely closed during initialization, valves that have 2500 steps of flow control require 3500 steps of initialization. For the largest valves that have 6386 steps of control, 6500 steps of initialization are specified (reference Table 2).

Table 2

INITIALIZATION	
VALVE TYPE	STEPS
SER-B, -C, -D	3500
SERI-F, -G, -J, -K, -L	3500
SEHI-175, -400	6500

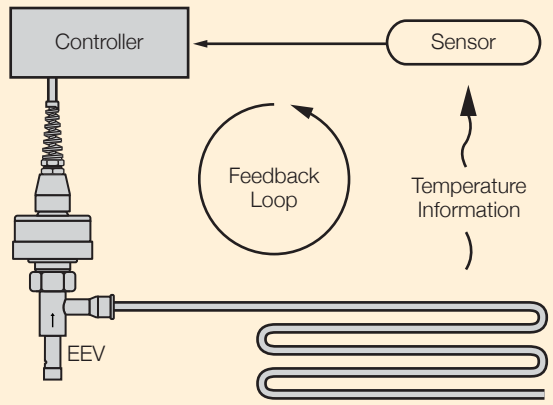
Once the valve is fully closed and the controller knows the “0" valve position, the algorithm may be implemented with the aid of a feedback loop.

When properly controlled, Sporlan valves should not lose steps, and therefore it is not recommended that a full initialization take place every time the valve is closed. It is however reasonable to over-drive a small number of steps to ensure full closure every time the valve is closed, or to perform an initialization at a regular interval when convenient (e.g. during system defrost).

FEEDBACK LOOPS

Feedback occurs when the result of a process is sensed and the sensory information is used to modify the process. In simpler terms, when the controller opens the EEV too much, causing over-cooling, the temperature sensor “feeds back" that information, and the controller closes the valve (Figure 8).

Figure 8



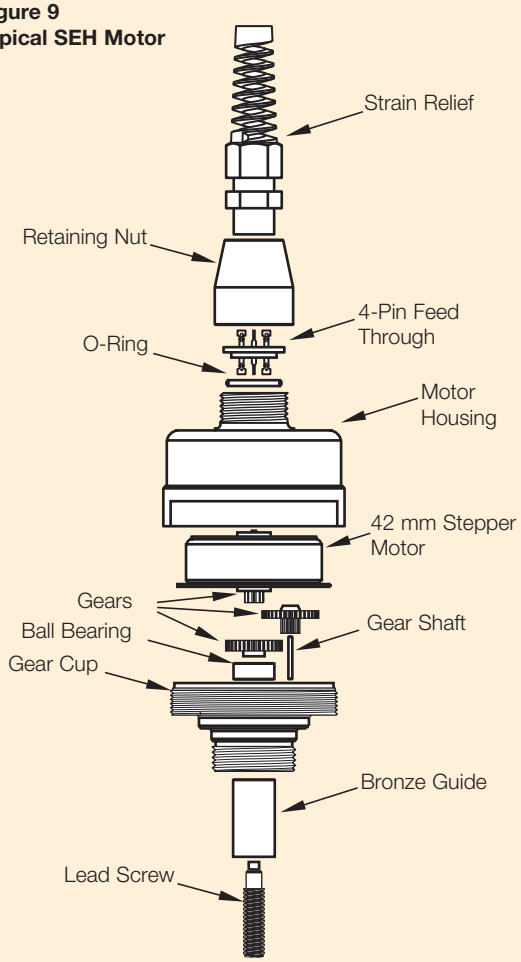
Step motor valves could be designed with internal feedback that would report the actual position of the valve in number of steps open; however, this would be expensive and undesirable in terms of temperature control.

If a control algorithm were written with only references to absolute number of steps open, then changes in head pressure, liquid temperature, etc. would not be taken into account and control would be poor. Instead, sensors are used to ascertain the effect of valve position on temperature and the position is changed to bring the sensed temperature closer to the set point.

VALVE OPERATION

The SER, SERI and SEHI valves modulate by the electronically controlled rotation of a step motor. The step motor drives a gear train and lead screw to position a piston (refer to Figure 9).
The piston is used to modulate flow through a port.

Figure 9
Typical SEH Motor



NOTE: Exploded view for illustration only, motor housing is hermetic and cannot be disassembled.

The motor is a two phase type driven in the bipolar mode. Two discrete sets of motor stator windings are powered in sequence to rotate the rotor. Polarity of the drive signal reverses for each step.

The sequencing is accomplished electronically through the bipolar drive circuit shown in Figure 7. The drive transistors,

Q1 through Q8, are electronically biased in pairs by the controller as shown in Table 1.

The SER valves have a stroke of 0.23" (5.8mm) and 2500 steps of resolution. Each step yields 0.00009" (0.0023 mm) of travel. SERI valves also have 2500 steps, but with 0.297" (7.5 mm) of travel, yielding 0.00012" (0.003mm) of travel per step. The SEHI valves have an operating stroke of 0.500" (12.7 mm) and 6386 steps of control, therefore each step translates into 0.00008" (0.002 mm) of travel. When used with a Sporlan controller, the valves provide unsurpassed accuracy in resolution of flow and repeatability of position.

External parts of the valve are brass, copper and stainless steel, and meet or exceed 2000 hour salt spray tests per ASTM B-117. The SER valves have an innovative uni-body construction that further improves resistance to extreme environmental conditions, as well as an IP-67 rated removable cable that can be installed in any of four possible orientations for ultimate flexibility. The SERI family also comes standard with a removable cable, rated IP-66, and a detachable motor housing for serviceability. The SEHI valves are also equipped with a removable motor housing, that has a hermetic cable connection to the motor. The leads on all valves can be supplied in a variety of lengths to suit specific customer requirements, both with and without connectors installed.

Total power consumption is less than 4 watts when operating at a rate of 200 steps/second with standard L/R type drive circuitry (refer to the Table of Specifications). Faster step rates (up to 400 steps/second) may be obtained with properly configured current limited “chopper" type drives. Please contact Sporlan for more information.

The SER-B and SER-C are now rated at a safe working pressure of 1015 psig (70 bar). The remainder of the SER and SERI valves are rated 700 psig (48 bar) MRP, while the SEHI-175 and SEHI-400 are rated 620 psig (43 bar) and 500 psig (34 bar), respectively. Operating ambient temperature range is -50°F to 155°F (-45°C to 68°C) but temperatures of up to 250°F (121°C) may be used for dehydration.

APPLICATION

Sporlan is not responsible for system design, for any damage arising from faulty system design, or for misapplication of its products. If these valves are applied in any manner other than as described in this bulletin, the Sporlan warranty is void. Please contact your Sporlan Sales Engineer for assistance with your specific application.

It is the responsibility of the controller manufacturer to provide suitable drive circuitry and power supply. Sporlan will assist where necessary, but accepts no liability for improper control of the valve. Careful consideration should be given to the interaction between the valve controller and system controller (if independent), to ensure proper behavior in all system conditions. Control strategy is a critical factor in determining valve duty cycle and superheat control capability.

It is strongly suggested that power be disabled to the valve when not actively stepping. While properly configured drives may be able to reverse direction without pausing, it is recommended to pause 25 ms prior to reversing direction to prevent loss of steps. Conventional initialization routines, which include overdriving the motor to ascertain the zero step position are acceptable. Contact Sporlan for more information.

SELECTION PROCEDURE

Sporlan Electric Expansion Valves (EEVs) are one part of a system used for refrigerant flow control in air conditioning or refrigeration applications. The other parts of the system are sensors and an electronic controller. The EEV controls the flow of refrigerant entering the direct expansion (DX) evaporator in response to signals sent by the controller. These signals are calculated by the controller from sensor inputs. A set of sensors, either two temperature sensors or a pressure transducer and a temperature sensor, are used to measure superheat. Typical control is based on superheat set point but an additional temperature sensor may be used to measure discharge water or air temperature. This air or water temperature may be controlled directly, as long as superheat remains at a level sufficient to prevent floodback. The ability of the EEV to control the amount of refrigerant in the evaporator to reach discharge set point while preventing floodback makes the EEV the ideal expansion device for most air conditioning, chiller, environmental chamber and refrigeration applications. Some EEV controllers can be programmed to follow unique control algorithms making the EEV especially useful for many diverse applications.

The actual selection of EEV valves should be based on information generally required for any expansion valve. The following procedure should be used when selecting a Sporlan EEV.

1. **Determine refrigerant to be used.** Sporlan electric valves are designed for compatibility with all current halocarbon refrigerants (HCFCs and HFCs including R-410A), in addition to subcritical CO_2.
2. **Determine capacity required for the valve.** This is normally the evaporator capacity at the desired conditions.
3. **Determine pressure drop across valve.** Subtract the evaporating pressure from the condensing pressure. The condensing pressure used in this calculation should be the minimum operating condensing pressure of the system. From this value, subtract all other pressure losses to obtain the net pressure drop across the valve. Be sure to consider all of the following possible sources of pressure drop: (1) friction losses through refrigeration lines including the evaporator and condenser; (2) pressure drop across liquid line accessories such as a solenoid valve and filter-drier; (3) static pressure loss (gain) due to the vertical lift(drop) of the liquid line; and (4) pressure drop across a refrigerant distributor, if used. Refer to Bulletin 20-10 for further information on refrigerant distributors.

4. **Determine the liquid temperature of the refrigerant entering the valve.** The EEV capacity tables in this bulletin are typically based on a liquid temperature of 100°F (38°C). For other liquid temperatures, apply the correction factor shown below the tables for each refrigerant.

5. **Select valve from the capacity tables.** Select a valve based on the design evaporating temperature and the available pressure drop across the valve. Sporlan EEVs are now rated at full stroke (100% open), with no reserve capacity. Due to superior resolution and flow control capability across the entire operating range, Sporlan EEVs can be applied down to 10% of nominal capacity. Be sure to apply the appropriate liquid temperature correction factor to the valve ratings shown in the tables. Once the desired valve capacity has been located, determine the valve model from the first column of the appropriate table. On multiple evaporator systems, select each valve on the basis of individual evaporator capacity.

SELECTION EXAMPLES:

Refrigerant: R-410A
Condensing Temperature: 100°F
Liquid Temperature: 90°F
Evaporator Temperature: 40°F
Liquid Line Loss: 7 psi
ΔP Distributor and Tubes: 35 psi*
Evaporator Load: 5 tons

Condensing Pressure (psig):	320
Liquid Line Loss (Estimate):	- 7
Distributor and Tubes:	-35
Evaporator Pressure (psi):	-118
ΔP across EEV:	160

R-410A, 90°F Liquid Correction Factor: 1.08
SER-B: 2.97 tons x 1.08 = 3.21 tons
SER-C: 8.05 tons x 1.08 = 8.69 tons
Select an SER-C from the capacity table.

Refrigerant: R-134a
Condensing Temperature: 32°C
Liquid Temperature: 27°C
Evaporator Temperature: -10°C
Liquid Line Loss: 0.5 bar
ΔP Distributor and Tubes: 1.7 bar*
Evaporator Load: 900 kW

Condensing Pressure (bar):	7.2
Liquid Line Loss (Estimate):	- 0.5
Distributor and Tubes:	- 1.7
Evaporator Pressure:	- 1.0
ΔP across EEV:	4.0

R-134a, 27°C Liquid Correction Factor: 1.16
SEHI-175: 482 kW x 1.16 = 559 kW
SEHI-400: 1006 kW x 1.16 = 1167 kW
Select an SEHI-400 from the capacity table.

* See Sporlan Bulletin 20-10 for pressure drop data as related to percent loading.

VALVE NOMENCLATURE

Sporlan valves are available in angle and/or straight through offset configurations (reference the Available Connections table for additional details). The SERI and SEHI valves feature a built-in sightglass (not available on the small SER family of valves).

The sightglass indicates the moisture level of the refrigerant, flash gas present upstream of the valve, and provides a visual confirmation of valve piston movement.
This unique feature is useful for system refrigerant charging, service and diagnostics.

SER-B, -C, -D

SER	-	C		3/8"	x	1/2"	ODF
Valve Family		Valve Model		Inlet Fitting Size		Outlet Fitting Size	Fitting Type

SERI-F, -G, -J, -K, -L

SERI	-	J	S	7/8"	x	1-1/8"	ODF
Valve Family		Valve Model	Straight Through Offset Configuration (blank if angle)	Inlet Fitting Size		Outlet Fitting Size	Fitting Type

SEHI-175

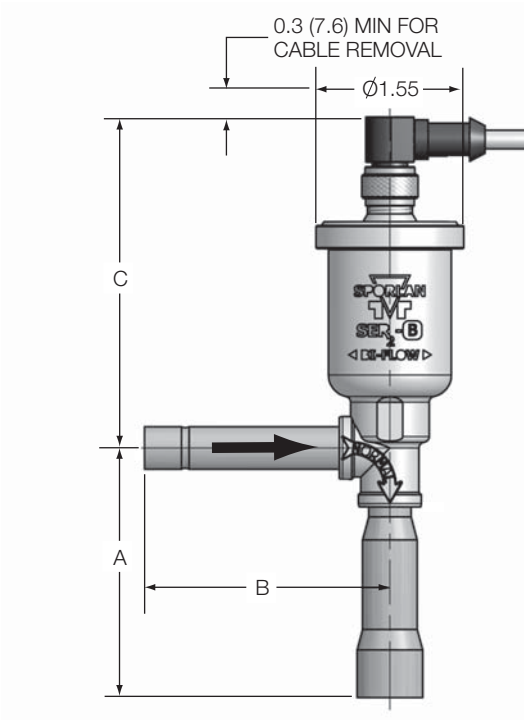
SEHI	-	175	1-5/8"	x	2-1/8"	ODF
Valve Family		Valve Model	Inlet Fitting Size		Outlet Fitting Size	Fitting Type

SEHI-400

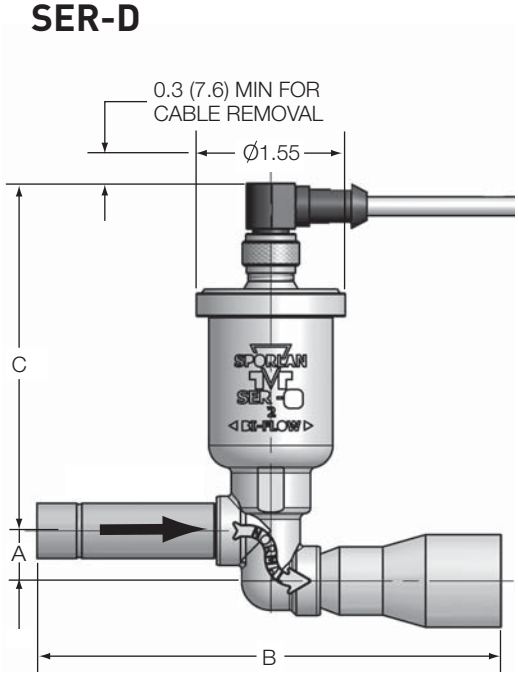
SEHI	-	400	2-1/8"	x	2-1/8	ODF
Valve Family		Valve Model	Inlet Fitting Size		Outlet Fitting Size	Fitting Type

SPECIFICATIONS					
VALVE	**SER-B,-C**	**SER-D**	**SERI-F, -G, -J, -K, -L**	**SEHI-175**	**SEHI-400**
Motor type	2 phase, bipolar wet motor				
Compatible refrigerant	All common HCFC and HFC refrigerants including R-410A and subcritical R-744				All common HCFC and HFC refrigerants
Compatible oils	All common Mineral, Polyolester and Alkybenzene oils				
Supply voltage (L/R)	12 volt DC, -5%, +10% measured at the valve leads				
Cable type	IP67 Removable Quad-Position		IP66 Removable	Hermetic	Hermetic
Phase resistance	100 ohms ±10%			75 ohms ±10%	
Current range (L/R)	120 ma/ winding			160 ma/ winding	
Maximum power input (L/R)	2.8 watts			3.8 watts	
Recommended step rate	200/second (L/R), up to 400/second (current limited)				
Number of steps	2500			6386	
Resolution	.00009" (.0023 mm) / step		.00012" (.003 mm) / step	.00008" (.002 mm) / step	
Stroke	0.23" (5.8 mm)		.297" (7.5 mm)	.500" (12.7mm)	
MOPD	580 psid (40 bar)		500 psid (34 bar)		300 psid (21 bar)
MWP (PS)	1015 psig (70 barg)	700 psig (48 barg)		620 psig (43 barg)	500 psig (34 barg)
Max. internal leakage	100 cc/min @ 100 psid (6.9 bar), dry air				
Max. external leakage	.10 oz./yr at 300 psig (2.8 gram/yr @ 20 bar)				
Operating temp range TS	-50°F to 155°F (-45°C to 68°C)				
Materials of construction	Brass, copper, synthetic seals, stainless steel				

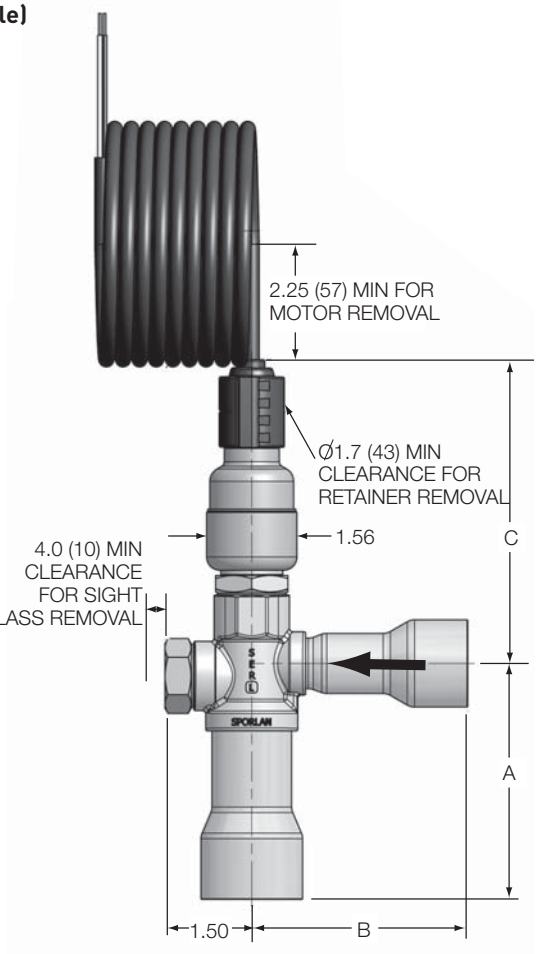
SER-B, -C



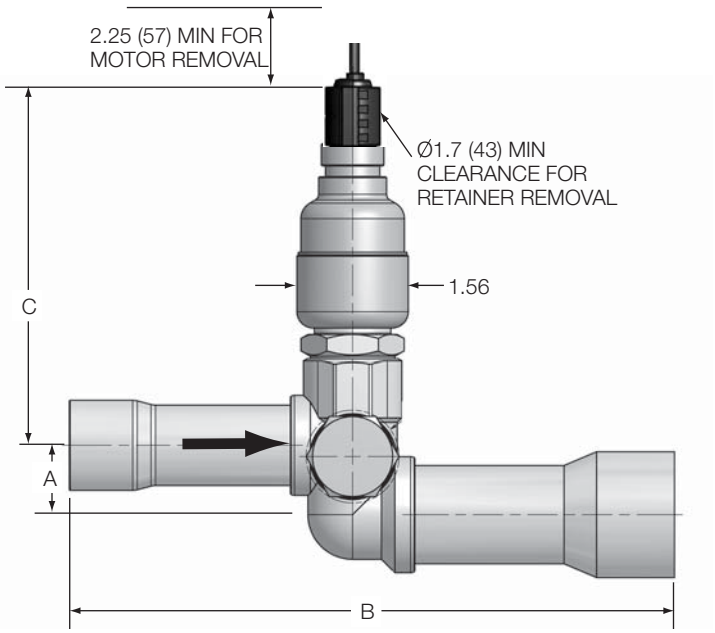
SER-D



SERI-F, -G, -J, -K, -L
(Angle)



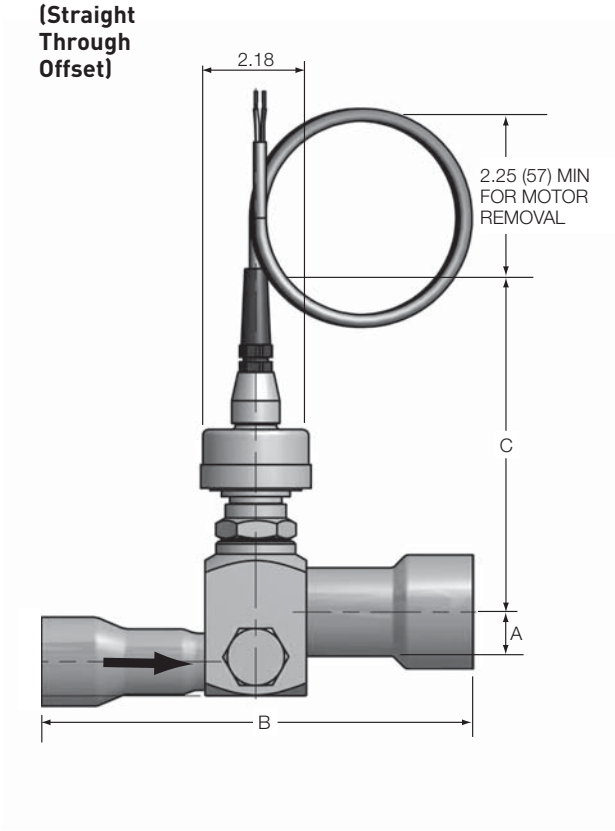
SERI-G, -J, -K, -L
(Straight Through Offset)



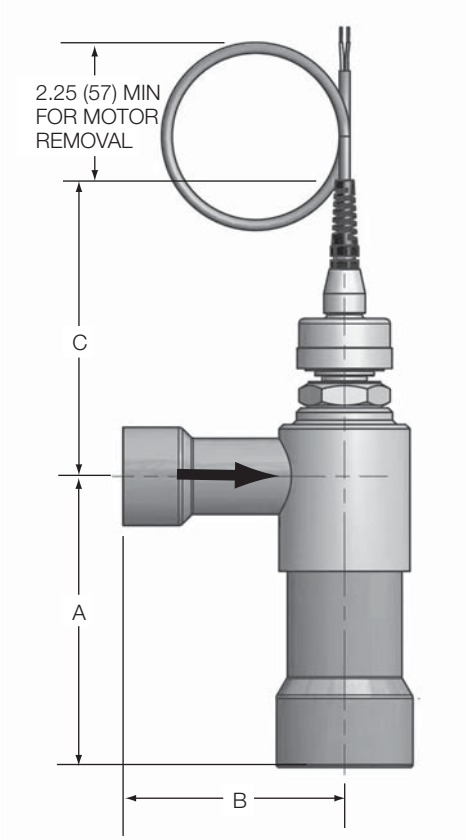
Reference Dimensions - Inches (mm)

SEHI-175

(Straight Through Offset)



SEHI-400



REFERENCE DIMENSIONS / Inches (mm) *				
VALVE	**CONFIGURATION**	**A**	**B**	**C**
SER-B	Angle	2.63 (66.8)	2.56 (65.0)	3.57 (90.7)
SER-C	Angle	2.63 (66.8)	2.56 (65.0)	3.57 (90.7)
SER-D	Straight Through Offset	0.52 (13.2)	4.83 (122.7)	3.57 (90.7)
SERI-F	Angle	3.65 (92.7)	3.11 (79.0)	4.91 (124.7)
SERI-G		3.65 (92.7)	3.11 (79.0)	4.91 (124.7)
SERI-J		3.86 (98.0)	3.31 (84.1)	4.91 (124.7)
SERI-K		3.92 (99.6)	3.39 (86.1)	5.27 (133.9)
SERI-L		4.00 (101.6)	3.70 (94.0)	5.27 (133.9)
SERI-G	Straight Through Offset	0.73 (18.5)	6.84 (173.7)	4.91 (124.7)
SERI-J		0.73 (18.5)	7.09 (180.1)	4.91 (124.7)
SERI-K		0.97 (24.6)	7.66 (194.6)	5.27 (133.9)
SERI-L		0.97 (24.6)	7.69 (195.3)	5.27 (133.9)
SEHI-175	Straight Through Offset	0.98 (24.9)	8.50 (215.9)	6.85 (174.0)
SEHI-400	Angle	6.28 (159.5)	5.08 (129.0)	6.71 (170.4)

* Dimensions may vary slightly based upon connection sizes selected.

Reference Dimensions - Inches (mm)

Order Selection Guide

Type	Connections	Body Configuration	Part Number
SER-B	3/8" x 3/8" ODF	Angle - Less Cable	805254
	3/8" x 1/2" ODF		805210
	10mm x12mm ODF		805264
SER-C	3/8" x 1/2" ODF	Angle - Less Cable	805159
	3/8" x 5/8" ODF		805212
	10mm x12mm ODF		805265
	Inlet 10mm ODF Outlet 16mm ODF		Special order valve
SER-D	5/8" x 7/8"	Straight Through Offset Less Cable	805206
	Inlet 5/8" or 16mm ODF Outlet 1-1/8", 22mm, 28mm ODF		Special order valve
***SERI-F**	5/8'' x 7/8'' ODF	Angle - Less Cable	805274
	7/8'' x 1- 1/8'' ODF		805251
	Inlet 5/8' , 7/8'' ODF Outlet 5/8'', 7/8'', 1-1/8'' ODF		Special order valve
***SERI-G**	7/8" x 1-1/8" ODF	Angle - Less Cable	805207
	5/8" x 7/8" ODF		805076
	7/8" x 1-1/8" ODF	Straight Through Offset - Less Cable	805138
	Inlet 5/8", 7/8" ODF Outlet 7/8" ODF	Angle or Straight Through Offset Less Cable	Special order valve
***SERI-J**	7/8" x 1-1/8" ODF	Sraight Through Offset - Less Cable	805157
	1-1/8" x 1-3/8" ODF	Angle - Less Cable	805208
	7/8" x 7/8" ODF		805078
	Inlet 7/8", 1-1/8" ODF Outlet 7/8", 1-1/8", 1-3/8" ODF	Angle or Straight Through Offset Less Cable	Special order valve
***SERI-K**	1-1/8" x 1-5/8" ODF	Angle - Less Cable	805209
	1-1/8" x 1-1/8" ODF		805088
	1-1/8" x 1-5/8" ODF	Straight Through Offset - Less Cable	805154
	1-1/8" x 1-3/8" ODF		805137
	Inlet 1-1/8" ODF Outlet 1-3/8" ODF	Angle or Straight Through Offset Less Cable	Special order valve
***SERI-L**	1-1/8" x 1-3/8" ODF	Straight Through Offset - Less Cable	805144
	1-3/8" x 1-5/8" ODF		805167
	Inlet 1-1/8", 1-3/8" ODF Outlet 1-3/8", 1-5/8" ODF	Angle or Straight Through Offset Less Cable	Special order valve
***SEHI-175**	1-5/8" x 2-1/8"	Straight Through Offset - With Cable (6 meter)	953012
	Inlet 1-3/8" ODF Outlet 2-1/8" ODF		Special order valve
***SEHI-400**	2-5/8" x 2-5/8"	Angle - With Cable (6 meter)	953251
	Inlet 2-1/8", 2-5/8" ODF Outlet 2-5/8" ODF, 3-1/8 ODM		Special order valve

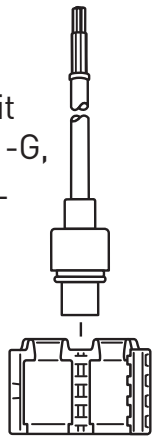
* With built-in sight glass
Special order valves might be available upon request.

Cable Assembly Kit
for Electric Expansion Valves

Valve Type	Cable Length	Part Number
SER-B, -C, -D	3 meter	805194
	6 meter	805195
SERI-F,-G,-J,-K,-L	3 meter	805081
	6 meter	805082
	9 meter	805083
	12 meter	805084

Cable Kit
SER-B,-C,-D

Cable Kit
SERI-F, -G, -J, -K,-L

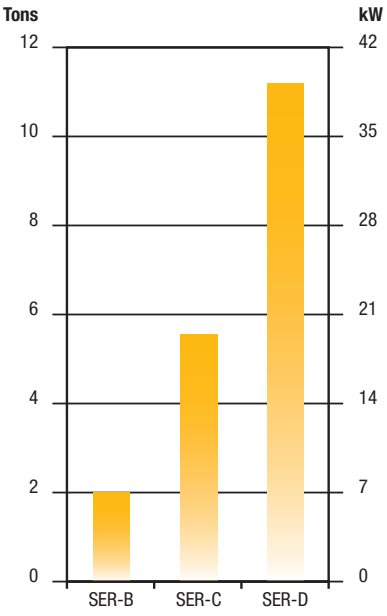


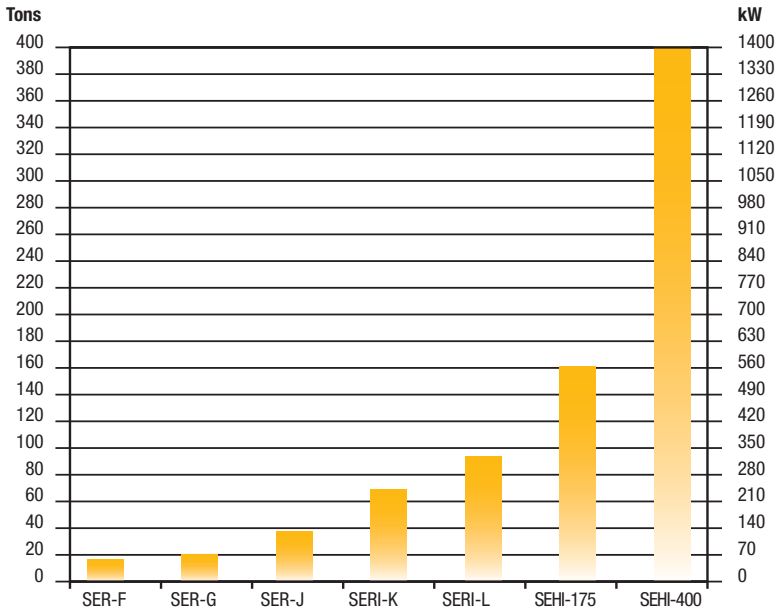
Available Connections

Valve Type	Inlet Inches/mm*** (ODF)	Outlet Inches/mm*** (ODF)	Configuration	Cable Length		Cable Ends
				Feet	Meters	
SER-B*	3/8" or 10mm	3/8", 1/2", 10mm, 12mm	Angle	10, 20	3, 6	S Stripped and Tinned
SER-C*	3/8" or 10mm	1/2", 5/8", 12mm, 16mm	Angle			
SER-D*	5/8" or 16mm	7/8", 1-1/8" 22mm, 28mm	Straight Through Offset			
SERI-F*	5/8, 7/8	5/8, 7/8, 1-1/8	Angle			
SERI-G*	5/8, 7/8	7/8, 1-1/8	Angle or Straight Through Offset	10, 20, 30, 40	3, 6, 9, 12	
SERI-J*	7/8, 1-1/8	7/8, 1-1/8, 1-3/8				
SERI-K **	1-1/8	1-1/8, 1-3/8, 1-5/8				
SERI-L**	1-1/8, 1-3/8	1-1/8, 1-3/8, 1-5/8				
SEHI-175	1-1/8, 1-3/8, 1-5/8	2-1/8	Straight Through Offset	10, 20, 30, 40	3, 6, 9, 12	
SEHI-400	1-5/8, 2-1/8, 2-5/8	1-5/8, 2-1/8, 2-5/8, 3-1/8 (ODM)	Angle			

* Suitable for bi-directional applications.
** Bi-sealing, reduced flow in reverse direction.
*** Some fitting Combinations may not be available.

Capacity





R-407C at 100°F (38°C) liquid, 100 psi (7bar) pressure drop, and 40°F (5°C) evaporator temperature.

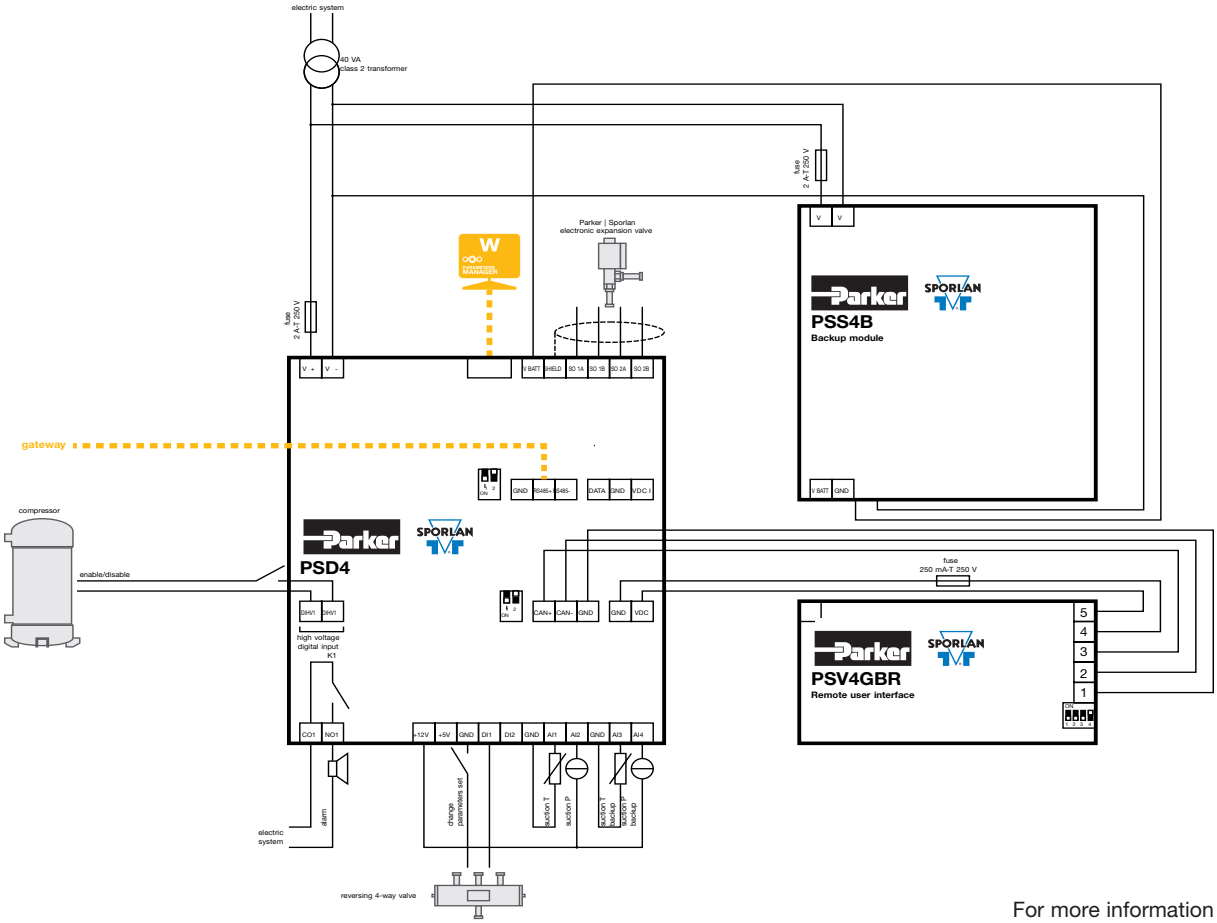
Order Selection Guide PSD4

PSD4 Superheat Controller for SER,SERI and SEHI Electric Expansion Valves

Please note that full warranty and support will be provided only by using a Parker PSD4 driver or a driver which has been tested and approved by Parker Sporlan Division.

	Vac. c.	Hz	A/I	D/I	D/O	SO	BS	PP	SP	CB	RS	DP
PSD4 Super Heat Controllers NO DISPLAY												
PSD4BX3	24	50/60	4	3	1-5 A	1	✔	1	1	-	-	-
PSD4BM3	24	50/60	4	3	1-5 A	1	✔	1	2	-	✔	-
PSD4BF3	24	50/61	4	3	1-5 A	1	✔	1	3	✔	✔	-
PSD4 Super Heat Controllers DISPLAY												
PSD4DF3	24	50/60	4	3	1-5 A	1	✔	1	3	✔	✔	✔

Key:
A/I = Analogue input - **D/I** = Digital Input - **D/O** = Digital Output - **SO** = Stepper Output - **BS** = Battery Back Up - **PP** = Programming Port **SP** = Serial Port - **CB** = CANBus - **IN** = INTRABUS - **RS** = Modbus RS-485 - **DP**= Display Fitted (LED)* LED.



For more information
please refer to ''Race Catalogue PSD4-2/UK''

R-404A Capacities in kW (at Evaporator Temperature °C)

R-404A	Valve Type	5°C								-5°C								-10°C							
		Pressure Drop Across Valve (bar)																							
		4	6	8	10	12	14	16	18	4	6	8	10	12	14	16	18	4	6	8	10	12	14	16	18
	SER-B	4.34	5.32	6.14	6.87	7.52	8.12	8.68	9.21	4.15	5.08	5.87	6.56	7.19	7.76	8.3	8.8	4.05	4.96	5.72	6.4	7.01	7.57	8.09	8.58
	SER-C	11.8	14.4	16.6	18.6	20.4	22	23.5	24.9	11.2	13.8	15.9	17.8	19.5	21	22.5	23.8	11	13.4	15.5	17.3	19	20.5	21.9	23.2
	SER-D	23.9	29.2	33.7	37.7	41.3	44.6	47.7	50.6	22.8	27.9	32.2	36	39.5	42.6	45.6	48.4	22.2	27.2	31.4	35.2	38.5	41.6	44.5	47.2
	SERI-F	35.2	43.1	49.8	55.7	61	65.9	70.5	74.7	33.7	41.2	47.6	53.2	58.3	63	67.3	71.4	32.8	40.2	46.4	51.9	56.8	61.4	65.6	69.6
	SERI-G	46	56.3	65	72.7	79.7	86.1	92	97.6	43.9	53.8	62.1	69.5	76.1	82.2	87.9	93.2	42.9	52.5	60.6	67.8	74.2	80.2	85.7	90.9
	SERI-J	82.7	101	117	131	143	155	165	175	79	96.7	112	125	137	148	158	168	77	94.3	109	122	133	144	154	163
	SERI-K	150	184	212	237	260	280	300	318	143	175	203	226	248	268	286	304	140	171	198	221	242	261	279	296
	SERI-L	204	250	289	323	353	382	408	433	195	239	276	308	338	365	390	414	190	233	269	301	329	356	380	403
	SEHI-175	354	434	501	560	614	663	709	752	339	415	479	535	587	634	677	718	330	405	467	522	572	618	661	701
	SEHI-400	734	899	1039	1161	1272	1374	1469	1558	702	859	992	1109	1215	1313	1403	1488	684	838	968	1082	1185	1280	1369	1452

R-404A	Valve Type	-20°C								-30°C								-40°C							
		Pressure Drop Across Valve (bar)																							
		4	6	8	10	12	14	16	18	4	6	8	10	12	14	16	18	4	6	8	10	12	14	16	18
	SER-B	3.83	4.69	5.42	6.06	6.64	7.17	7.66	8.13	3.61	4.42	5.1	5.71	6.25	6.75	7.22	7.66	3.38	4.14	4.78	5.34	5.85	6.32	6.76	7.17
	SER-C	10.4	12.7	14.7	16.4	18	19.4	20.7	22	9.77	12	13.8	15.4	16.9	18.3	19.5	20.7	9.15	11.2	12.9	14.5	15.8	17.1	18.3	19.4
	SER-D	21.1	25.8	29.8	33.3	36.5	39.4	42.1	44.7	19.8	24.3	28	31.4	34.4	37.1	39.7	42.1	18.6	22.7	26.3	29.4	32.2	34.7	37.1	39.4
	SERI-F	31.1	38.1	44	49.2	53.8	58.2	62.2	65.9	29.3	35.9	41.4	46.3	50.7	54.8	58.6	62.1	27.4	33.6	38.8	43.3	47.5	51.3	54.8	58.1
	SERI-G	40.6	49.7	57.4	64.2	70.3	75.9	81.2	86.1	38.2	46.8	54.1	60.4	66.2	71.5	76.5	81.1	35.8	43.8	50.6	56.6	62	67	71.6	75.9
	SERI-J	72.9	89.3	103	115	126	136	146	155	68.7	84.1	97.1	109	119	129	137	146	64.3	78.8	91	102	111	120	129	136
	SERI-K	132	162	187	209	229	248	265	281	125	153	176	197	216	233	249	264	117	143	165	184	202	218	233	247
	SERI-L	180	221	255	285	312	337	360	382	170	208	240	268	294	317	339	360	159	194	225	251	275	297	318	337
	SEHI-175	313	383	442	495	542	585	626	664	295	361	417	466	510	551	589	625	276	338	390	436	478	516	552	585
	SEHI-400	648	794	917	1025	1123	1213	1296	1375	610	748	863	965	1057	1142	1221	1295	571	700	808	904	990	1069	1143	1212

R-134a Capacities in kW (at Evaporator Temperature °C)

R-134a	Valve Type	10°C								5°C								0°C							
		Pressure Drop Across Valve (bar)																							
		2.5	4	5.5	7	8.5	10	11.5	13	2.5	4	5.5	7	8.5	10	11.5	13	2.5	4	5.5	7	8.5	10	11.5	13
	SER-B	5.06	6.4	7.5	8.46	9.33	10.1	10.8	11.5	4.96	6.28	7.36	8.31	9.15	9.93	10.6	11.3	4.87	6.16	7.22	8.14	8.97	9.73	10.4	11.1
	SER-C	13.7	17.3	20.3	22.9	25.2	27.4	29.4	31.2	13.4	17	19.9	22.5	24.8	26.9	28.8	30.6	13.2	16.7	19.5	22	24.3	26.3	28.3	30
	SER-D	27.8	35.2	41.2	46.5	51.3	55.6	59.6	63.4	27.3	34.5	40.5	45.6	50.3	54.5	58.5	62.2	26.7	33.8	39.7	44.7	49.3	53.5	57.4	61
	SERI-F	41	51.9	60.9	68.7	75.7	82.1	88	93.6	40.3	50.9	59.7	67.4	74.2	80.5	86.4	91.8	39.5	49.9	58.6	66.1	72.8	79	84.7	90
	SERI-G	53.6	67.8	79.5	89.7	98.8	107	115	122	52.6	66.5	78	88	96.9	105	113	120	51.5	65.2	76.5	86.3	95	103	111	118
	SERI-J	96.3	122	143	161	178	193	206	220	94.5	119	140	158	174	189	203	215	92.6	117	137	155	171	185	199	211
	SERI-K	175	221	259	292	322	349	375	398	171	217	254	287	316	343	368	391	168	213	249	281	310	336	360	383
	SERI-L	238	301	353	398	438	475	510	542	233	295	346	390	430	466	500	532	229	289	339	383	422	457	490	521
	SEHI-175	413	522	612	691	761	826	886	942	405	512	601	678	747	810	869	924	397	502	589	665	733	795	852	906
	SEHI-400	855	1082	1269	1431	1577	1711	1835	1951	839	1062	1245	1405	1548	1679	1800	1914	823	1041	1221	1377	1518	1646	1765	1877

R-134a	Valve Type	-5°C								-10°C								-20°C							
		Pressure Drop Across Valve (bar)																							
		2.5	4	5.5	7	8.5	10	11.5	13	2.5	4	5.5	7	8.5	10	11.5	13	2.5	4	5.5	7	8.5	10	11.5	13
	SER-B	4.77	6.03	7.07	7.98	8.79	9.54	10.2	10.9	4.67	5.9	6.92	7.81	8.61	9.33	10	10.6	4.46	5.64	6.62	7.47	8.23	8.93	9.57	10.2
	SER-C	12.9	16.3	19.1	21.6	23.8	25.8	27.7	29.4	12.6	16	18.7	21.1	23.3	25.3	27.1	28.8	12.1	15.3	17.9	20.2	22.3	24.2	25.9	27.5
	SER-D	26.2	33.1	38.9	43.8	48.3	52.4	56.2	59.7	25.6	32.4	38	42.9	47.3	51.3	55	58.5	24.5	31	36.4	41	45.2	49	52.6	55.9
	SERI-F	38.7	48.9	57.4	64.7	71.3	77.4	83	88.2	37.9	47.9	56.2	63.4	69.8	75.7	81.2	86.3	36.2	45.8	53.7	60.6	66.8	72.4	77.6	82.6
	SERI-G	50.5	63.9	74.9	84.5	93.1	101	108	115	49.4	62.5	73.3	82.7	91.2	98.9	106	113	47.3	59.8	70.1	79.1	87.2	94.5	101	108
	SERI-J	90.8	115	135	152	167	182	195	207	88.8	112	132	149	164	178	191	203	84.9	107	126	142	157	170	182	194
	SERI-K	165	208	244	275	304	329	353	375	161	204	239	270	297	322	346	367	154	195	229	258	284	308	330	351
	SERI-L	224	283	332	375	413	448	480	511	219	277	325	367	404	439	470	500	210	265	311	351	387	419	450	478
	SEHI-175	389	492	577	651	718	778	835	888	381	482	565	638	703	762	817	869	364	461	540	610	672	729	781	831
	SEHI-400	806	1020	1196	1349	1487	1613	1729	1839	789	998	1171	1321	1456	1579	1693	1800	755	955	1119	1263	1392	1509	1619	1721

Liquid Temperature Correction Factors

°C	-18	-12	-7	-1	4	10	16	21	27	32	38	43	49	54	60
R-404A	2.04	1.94	1.84	1.74	1.64	1.54	1.43	1.33	1.22	1.11	1.00	0.89	0.77	0.65	0.53
R-134a	1.70	1.63	1.56	1.49	1.42	1.36	1.29	1.21	1.14	1.07	1.00	0.93	0.85	0.78	0.71

R-407C Capacities in kW (at Evaporator Temperature °C)

	Valve Type	10°C								5°C								0°C							
		Pressure Drop Across Valve (bar)																							
		4	6	8	10	12	14	16	18	4	6	8	10	12	14	16	18	4	6	8	10	12	14	16	18
R-407C	SER-B	6.43	7.87	9.09	10.2	11.1	12	12.9	13.6	6.34	7.76	8.96	10	11	11.9	12.7	13.4	6.24	7.64	8.82	9.87	10.8	11.7	12.5	13.2
	SER-C	17.4	21.3	24.6	27.5	30.1	32.6	34.8	36.9	17.2	21	24.3	27.1	29.7	32.1	34.3	36.4	16.9	20.7	23.9	26.7	29.3	31.6	33.8	35.8
	SER-D	35.3	43.3	50	55.9	61.2	66.1	70.7	74.9	34.8	42.6	49.2	55.1	60.3	65.1	69.6	73.9	34.3	42	48.5	54.2	59.4	64.1	68.6	72.7
	SERI-F	52.2	63.9	73.8	82.5	90.3	97.6	104	111	51.4	63	72.7	81.3	89	96.2	103	109	50.6	62	71.6	80	87.7	94.7	101	107
	SERI-G	68.1	83.4	96.3	108	118	127	136	144	67.1	82.2	94.9	106	116	126	134	142	66.1	80.9	93.5	105	114	124	132	140
	SERI-J	122	150	173	193	212	229	245	260	121	148	171	191	209	226	241	256	119	145	168	188	206	222	238	252
	SERI-K	222	272	314	351	384	415	444	471	219	268	309	346	379	409	438	464	215	264	305	341	373	403	431	457
	SERI-L	302	370	427	478	523	565	604	641	298	365	421	471	516	557	595	632	293	359	415	464	508	548	586	622
	SEHI-175	525	643	742	830	909	982	1050	1113	517	634	732	818	896	968	1035	1097	509	624	720	805	882	953	1019	1081
	SEHI-400	1087	1332	1538	1719	1883	2034	2175	2307	1072	1313	1516	1695	1856	2005	2143	2273	1055	1292	1492	1669	1828	1974	2111	2239

	Valve Type	-5°C								-10°C								-20°C							
		Pressure Drop Across Valve (bar)																							
		4	6	8	10	12	14	16	18	4	6	8	10	12	14	16	18	4	6	8	10	12	14	16	18
R-407C	SER-B	6.14	7.52	8.68	9.71	10.6	11.5	12.3	13	6.03	7.39	8.53	9.54	10.5	11.3	12.1	12.8	5.82	7.12	8.22	9.2	10.1	10.9	11.6	12.3
	SER-C	16.6	20.4	23.5	26.3	28.8	31.1	33.2	35.3	16.3	20	23.1	25.8	28.3	30.6	32.7	34.7	15.7	19.3	22.3	24.9	27.3	29.5	31.5	33.4
	SER-D	33.7	41.3	47.7	53.3	58.4	63.1	67.5	71.6	33.2	40.6	46.9	52.4	57.4	62	66.3	70.3	32	39.1	45.2	50.5	55.4	59.8	63.9	67.8
	SERI-F	49.8	61	70.4	78.7	86.3	93.2	99.6	106	48.9	59.9	69.2	77.4	84.8	91.6	97.9	104	47.2	57.8	66.7	74.6	81.7	88.3	94.4	100
	SERI-G	65	79.6	92	103	113	122	130	138	63.9	78.3	90.4	101	111	120	128	136	61.6	75.4	87.1	97.4	107	115	123	131
	SERI-J	117	143	165	185	202	219	234	248	115	141	162	182	199	215	230	244	111	136	157	175	192	207	221	235
	SERI-K	212	260	300	335	367	396	424	450	208	255	295	329	361	390	417	442	201	246	284	317	348	376	402	426
	SERI-L	288	353	408	456	500	540	577	612	284	347	401	448	491	530	567	601	273	335	386	432	473	511	547	580
	SEHI-175	501	614	709	792	868	937	1002	1063	493	603	697	779	853	922	985	1045	475	581	671	751	822	888	949	1007
	SEHI-400	1038	1272	1468	1642	1798	1942	2076	2202	1021	1250	1443	1614	1768	1909	2041	2165	984	1205	1391	1555	1704	1840	1967	2086

R-407A/F Capacities in kW (at Evaporator Temperature °C)

	Valve Type	5°C								-10°C								-20°C							
		Pressure Drop Across Valve (bar)																							
		4	6	8	10	12	14	16	18	4	6	8	10	12	14	16	18	4	6	8	10	12	14	16	18
R-407A	SER-B	5.83	7.14	8.24	9.21	10.1	10.9	11.7	12.4	5.53	6.77	7.82	8.74	9.58	10.3	11.1	11.7	5.31	6.51	7.51	8.4	9.2	9.94	10.6	11.3
	SER-C	15.8	19.3	22.3	24.9	27.3	29.5	31.5	33.5	15	18.3	21.2	23.7	25.9	28	29.9	31.7	14.4	17.6	20.3	22.7	24.9	26.9	28.8	30.5
	SER-D	32	39.2	45.3	50.6	55.5	59.9	64	67.9	30.4	37.2	43	48	52.6	56.8	60.8	64.4	29.2	35.8	41.3	46.2	50.6	54.6	58.4	61.9
	SERI-F	47.3	57.9	66.8	74.7	81.9	88.4	94.5	100	44.8	54.9	63.4	70.9	77.7	83.9	89.7	95.1	43.1	52.8	61	68.1	74.6	80.6	86.2	91.4
	SERI-G	61.7	75.6	87.3	97.6	107	115	123	131	58.6	71.7	82.8	92.6	101	110	117	124	56.3	68.9	79.6	89	97.5	105	113	119
	SERI-J	111	136	157	175	192	207	222	235	105	129	149	166	182	197	210	223	101	124	143	160	175	189	202	215
	SERI-K	201	246	284	318	348	376	402	427	191	234	270	302	331	357	382	405	183	225	259	290	318	343	367	389
	SERI-L	274	335	387	433	474	512	548	581	260	318	367	411	450	486	520	551	250	306	353	395	432	467	499	530
	SEHI-175	476	583	673	752	824	890	951	1009	451	553	638	714	782	844	903	957	434	531	613	686	751	811	867	920
	SEHI-400	985	1207	1394	1558	1707	1844	1971	2090	935	1145	1322	1478	1619	1749	1870	1983	899	1100	1271	1421	1556	1681	1797	1906

	Valve Type	5°C								-10°C								-20°C							
		Pressure Drop Across Valve (bar)																							
		4	6	8	10	12	14	16	18	4	6	8	10	12	14	16	18	4	6	8	10	12	14	16	18
R-407F	SER-B	6.4	7.83	9.05	10.1	11.1	12	12.8	13.6	6.12	7.49	8.65	9.67	10.6	11.4	12.2	13	5.91	7.24	8.36	9.35	10.2	11.1	11.8	12.5
	SER-C	17.3	21.2	24.5	27.4	30	32.4	34.6	36.7	16.6	20.3	23.4	26.2	28.7	31	33.1	35.1	16	19.6	22.6	25.3	27.7	30	32	34
	SER-D	35.1	43	49.7	55.6	60.9	65.8	70.3	74.6	33.6	41.2	47.5	53.2	58.2	62.9	67.2	71.3	32.5	39.8	46	51.4	56.3	60.8	65	68.9
	SERI-F	51.9	63.6	73.4	82	89.9	97.1	104	110	49.6	60.8	70.2	78.5	86	92.9	99.3	105	48	58.8	67.8	75.9	83.1	89.8	96	102
	SERI-G	67.8	83	95.8	107	117	127	136	144	64.8	79.4	91.7	102	112	121	130	137	62.6	76.7	88.6	99	109	117	125	133
	SERI-J	122	149	172	193	211	228	244	258	116	143	165	184	202	218	233	247	113	138	159	178	195	211	225	239
	SERI-K	221	270	312	349	382	413	442	468	211	259	299	334	366	395	422	448	204	250	289	323	354	382	408	433
	SERI-L	301	368	425	475	521	562	601	638	287	352	407	455	498	538	575	610	278	340	393	439	481	520	556	589
	SEHI-175	522	640	738	826	904	977	1044	1108	499	612	706	790	865	934	999	1060	483	591	683	763	836	903	966	1024
	SEHI-400	1082	1325	1530	1711	1874	2024	2164	2295	1035	1267	1463	1636	1792	1936	2070	2195	1000	1225	1415	1581	1732	1871	2000	2122

Liquid Temperature Correction Factors

°C	-18	-12	-7	-1	4	10	16	21	27	32	38	43	49	54	60
R-407A	1.76	1.68	1.61	1.53	1.46	1.39	1.31	1.24	1.16	1.08	1.00	0.92	0.83	0.74	0.64
R-407C	1.69	1.62	1.55	1.49	1.42	1.35	1.28	1.21	1.14	1.07	1.00	0.93	0.85	0.77	0.69
R-407F	1.74	1.66	1.6	1.52	1.45	1.37	1.3	1.23	1.15	1.08	1.00	0.93	0.84	0.77	0.68

R-410A Capacities in kW (at Evaporator Temperature °C)

	Valve Type	10°C								5°C								0°C							
		Pressure Drop Across Valve (bar)																							
		5	8	11	14	17	20	23	26	5	8	11	14	17	20	23	26	5	8	11	14	17	20	23	26
R-410A	SER-B	7.07	8.94	10.5	11.8	13	14.1	15.2	16.1	7.02	8.88	10.4	11.7	12.9	14	15	16	6.95	8.8	10.3	11.6	12.8	13.9	14.9	15.9
	SER-C	19.1	24.2	28.4	32	35.3	38.3	41.1	43.7	19	24	28.2	31.8	35	38	40.7	43.3	18.8	23.8	27.9	31.5	34.7	37.7	40.4	42.9
	SER-D	38.9	49.1	57.6	65	71.6	77.7	83.3	88.6	38.6	48.8	57.2	64.5	71.1	77.1	82.7	87.9	38.2	48.3	56.7	63.9	70.5	76.4	82	87.1
	SERI-F	57.4	72.6	85.1	96	106	115	123	131	56.9	72	84.4	95.3	105	114	122	130	56.4	71.4	83.7	94.4	104	113	121	129
	SERI-G	74.9	94.7	111	125	138	150	161	171	74.3	94	110	124	137	149	159	169	73.7	93.2	109	123	136	147	158	168
	SERI-J	135	170	200	225	248	269	289	307	134	169	198	223	246	267	286	305	132	167	196	222	244	265	284	302
	SERI-K	244	309	362	408	450	488	524	557	242	306	359	405	447	485	520	552	240	304	356	402	443	480	515	548
	SERI-L	332	420	493	556	613	664	713	758	330	417	489	552	608	659	707	752	327	413	485	547	603	654	701	745
	SEHI-175	577	730	856	966	1064	1154	1238	1316	573	725	850	958	1056	1146	1229	1306	568	718	842	950	1047	1135	1218	1295
	SEHI-400	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

	Valve Type	-5°C								-10°C								-20°C							
		Pressure Drop Across Valve (bar)																							
		5	8	11	14	17	20	23	26	5	8	11	14	17	20	23	26	5	8	11	14	17	20	23	26
R-410A	SER-B	6.88	8.71	10.2	11.5	12.7	13.8	14.8	15.7	6.81	8.61	10.1	11.4	12.6	13.6	14.6	15.5	6.64	8.4	9.85	11.1	12.2	13.3	14.2	15.1
	SER-C	18.6	23.6	27.6	31.2	34.4	37.3	40	42.5	18.4	23.3	27.3	30.8	34	36.9	39.5	42	18	22.7	26.7	30.1	33.1	35.9	38.5	41
	SER-D	37.8	47.9	56.1	63.3	69.8	75.7	81.1	86.3	37.4	47.3	55.5	62.6	69	74.8	80.2	85.3	36.5	46.1	54.1	61	67.3	73	78.2	83.2
	SERI-F	55.9	70.6	82.8	93.5	103	112	120	127	55.2	69.9	81.9	92.4	102	110	118	126	53.8	68.1	79.9	90.1	99.3	108	115	123
	SERI-G	72.9	92.2	108	122	134	146	156	166	72.1	91.2	107	121	133	144	155	164	70.3	88.9	104	118	130	141	151	160
	SERI-J	131	166	194	219	242	262	281	299	130	164	192	217	239	259	278	296	126	160	187	211	233	253	271	288
	SERI-K	238	301	353	398	438	475	510	542	235	297	349	393	433	470	504	536	229	290	340	383	423	458	492	523
	SERI-L	323	409	480	541	597	647	694	738	320	405	474	535	590	640	686	729	312	395	463	522	575	624	669	711
	SEHI-175	562	711	834	940	1036	1124	1205	1282	556	703	824	930	1025	1112	1192	1267	542	685	804	907	999	1084	1162	1236
	SEHI-400	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Liquid Temperature Correction Factors

°C	-18	-12	-7	-1	4	10	16	21	27	32	38	43	49	54	60
R-410A	1.61	1.55	1.49	1.43	1.39	1.31	1.23	1.17	1.12	1.06	1.00	0.94	0.88	0.81	0.76

R-744 Capacities in kW (at Evaporator Temperature °C)

R-744	Valve Type	10°C								5°C								0°C							
		Pressure Drop Across Valve (bar)																							
		5	8	11	14	17	20	23	26	5	8	11	14	17	20	23	26	5	8	11	14	17	20	23	26
	SER-B	10.4	13.1	15.4	17.4	19.2	20.8	22.3	-	10.6	13.4	15.7	17.7	19.5	21.2	22.7	24.1	10.7	13.6	15.9	18	19.8	21.5	23	24.5
	SER-C	28.1	35.6	41.7	47.1	51.9	56.3	60.3	-	28.7	36.3	42.5	48	52.9	57.3	61.5	65.4	29.1	36.8	43.1	48.6	53.6	58.1	62.3	66.3
	SER-D	-	-	-	-	-	-	-	-	58.2	73.6	-	-	-	-	-	-	59	74.6	87.5	98.7	-	-	-	-
	SERI-F	-	-	-	-	-	-	-	-	85.9	109	-	-	-	-	-	-	87.1	110	129	146	-	-	-	-
	SERI-G	-	-	-	-	-	-	-	-	112	142	-	-	-	-	-	-	114	144	169	190	-	-	-	-
	SERI-J	-	-	-	-	-	-	-	-	202	255	-	-	-	-	-	-	204	258	303	342	-	-	-	-
	SERI-K	-	-	-	-	-	-	-	-	366	462	-	-	-	-	-	-	371	469	550	620	-	-	-	-
	SERI-L	-	-	-	-	-	-	-	-	498	629	-	-	-	-	-	-	504	638	748	844	-	-	-	-
	SEHI-175	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SEHI-400	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

R-744	Valve Type	-5°C								-10°C								-20°C							
		Pressure Drop Across Valve (bar)																							
		5	8	11	14	17	20	23	26	5	8	11	14	17	20	23	26	5	8	11	14	17	20	23	26
	SER-B	10.8	13.7	16.1	18.1	20	21.7	23.3	24.7	10.9	13.8	16.2	18.3	20.1	21.8	23.4	24.9	11	13.9	16.3	18.4	20.3	22	23.6	25.1
	SER-C	29.4	37.1	43.5	49.1	54.1	58.7	63	66.9	29.6	37.4	43.9	49.5	54.5	59.1	63.4	67.4	29.8	37.7	44.2	49.8	54.9	59.5	63.8	67.9
	SER-D	59.6	75.4	88.4	99.7	110	-	-	-	60	75.9	89	100	111	120	-	-	60.4	76.4	89.6	101	111	121	130	-
	SERI-F	88	111	130	147	162	-	-	-	88.6	112	131	148	163	177	-	-	89.2	113	132	149	164	178	191	-
	SERI-G	115	145	170	192	212	-	-	-	116	146	172	194	213	231	-	-	116	147	173	195	215	233	250	-
	SERI-J	206	261	306	345	381	-	-	-	208	263	308	348	383	416	-	-	209	265	310	350	386	419	449	-
	SERI-K	374	474	555	626	690	-	-	-	377	477	559	631	695	754	-	-	380	480	563	635	700	759	814	-
	SERI-L	510	645	756	853	940	-	-	-	513	649	761	859	946	1026	-	-	517	654	766	865	953	1033	1108	-
	SEHI-175	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SEHI-400	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

R-744	Valve Type	-30°C								-40°C								-20°C							
		Pressure Drop Across Valve (bar)																							
		5	8	11	14	17	20	23	26	5	8	11	14	17	20	23	26	5	8	11	14	17	20	23	26
	SER-B	11	13.9	16.3	18.4	20.3	22	23.6	25.1	10.9	13.8	16.2	18.3	20.2	21.9	23.4	24.9	11	13.9	16.3	18.4	20.3	22	23.6	25.1
	SER-C	29.8	37.6	44.1	49.8	54.9	59.5	63.8	67.9	29.6	37.4	43.9	49.5	54.6	59.2	63.5	67.5	29.8	37.7	44.2	49.8	54.9	59.5	63.8	67.9
	SER-D	60.4	76.4	89.6	101	111	121	130	138	60.1	76	89.1	100	111	120	129	137	60.4	76.4	89.6	101	111	121	130	-
	SERI-F	89.2	113	132	149	164	178	191	203	88.7	112	131	148	163	177	190	202	89.2	113	132	149	164	178	191	-
	SERI-G	116	147	173	195	215	233	250	266	116	146	172	194	213	232	248	264	116	147	173	195	215	233	250	-
	SERI-J	209	265	310	350	386	418	449	477	208	263	309	348	384	416	446	474	209	265	310	350	386	419	449	-
	SERI-K	380	480	563	635	700	759	814	865	377	477	560	631	696	755	809	860	380	480	563	635	700	759	814	-
	SERI-L	517	653	766	864	952	1033	1108	1178	513	650	762	859	947	1027	1101	1171	517	654	766	865	953	1033	1108	-
	SEHI-175	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	SEHI-400	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Liquid Temperature Correction Factors

°C	-18	-12	-7	-1	4	10	16	21	27	32	38	43	49	54	60
R-744	1.13	1.07	1.00	0.93	0.86	-	-	-	-	-	-	-	-	-	-

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Transportation
Water Purification

Key Products

Analytical gas generators
Compressed air filters & dryers
Engine air, coolant, fuel & oil filtration systems
Fluid condition monitoring systems
Hydraulic & lubrication filters
Hydrogen, nitrogen & zero air generators
Instrumentation filters
Membrane & fiber filters
Microfiltration
Sterile air filtration
Water desalination & purification filters & system

Fluid & Gas Handling

Key Markets

Aerial lift
Agriculture
Bulk chemical handling
Construction machinery
Food & beverage
Fuel & gas delivery
Industrial machinery
Life sciences
Marine
Mining
Mobile
Oil & gas
Renewable energy
Transportation

Key Products

Check valves
Connectors for low pressure fluid conveyance
Deep sea umbilicals
Diagnostic equipment
Hose couplings
Industrial hose
Mooring systems & power cables
PTFE hose & tubing
Quick couplings
Rubber & thermoplastic hose
Tube fittings & adapters
Tubing & plastic fittings

Hydraulics

Key Markets

Aerial lift
Agriculture
Alternative energy
Construction machinery
Forestry
Industrial machinery
Machine tools
Marine
Material handling
Mining
Oil & gas
Power generation
Refuse vehicles
Renewable energy
Truck hydraulics
Turf equipment

Key Products

Accumulators
Cartridge valves
Electrohydraulic actuators
Human machine interfaces
Hybrid drives
Hydraulic cylinders
Hydraulic motors & pumps
Hydraulic systems
Hydraulic valves & controls
Hydrostatic steering
Integrated hydraulic circuits
Power take-offs
Power units
Rotary actuators
Sensors

Pneumatics

Key Markets

Aerospace
Conveyor & material handling
Factory automation
Life science & medical
Machine tools
Packaging machinery
Transportation & automotive

Key Products

Air preparation
Brass fittings & valves
Manifolds
Pneumatic accessories
Pneumatic actuators & grippers
Pneumatic valves & controls
Quick disconnects
Rotary actuators
Rubber & thermoplastic hose & couplings
Structural extrusions
Thermoplastic tubing & fittings
Vacuum generators, cups & sensors

Process Control

Key Markets

Alternative fuels
Biopharmaceuticals
Chemical & refining
Food & beverage
Marine & shipbuilding
Medical & dental
Microelectronics
Nuclear Power
Offshore oil exploration
Oil & gas
Pharmaceuticals
Power generation
Pulp & paper
Steel
Water/wastewater

Key Products

Analytical Instruments
Analytical sample conditioning products & systems
Chemical injection fittings & valves
Fluoropolymer chemical delivery fittings, valves & pumps
High purity gas delivery fittings, valves, regulators & digital flow controllers
Industrial mass flow meters/ controllers
Permanent no-weld tube fittings
Precision industrial regulators & flow controllers
Process control double block & bleeds
Process control fittings, valves, regulators & manifold valves

Sealing & Shielding

Key Markets

Aerospace
Chemical processing
Consumer
Fluid power
General industrial
Information technology
Life sciences
Microelectronics
Military
Oil & gas
Power generation
Renewable energy
Telecommunications
Transportation

Key Products

Dynamic seals
Elastomeric o-rings
Electro-medical instrument design & assembly
EMI shielding
Extruded & precision-cut, fabricated elastomeric seals
High temperature metal seals
Homogeneous & inserted elastomeric shapes
Medical device fabrication & assembly
Metal & plastic retained composite seals
Shielded optical windows
Silicone tubing & extrusions
Thermal management
Vibration dampening

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