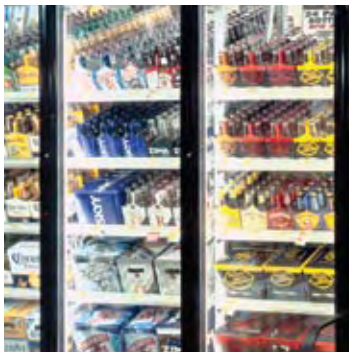


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# Sporlan Electric Expansion Valves

ESX, SER, SEI, SEH

Bulletin 100-20, September 2008



ENGINEERING YOUR SUCCESS.

## 10 FEATURES AND BENEFITS



- Step motor operated for precise control
- High resolution drive assembly
- Tight seating
- Corrosion resistant materials used throughout
- Field proven reliability
- Low power consumption - 4 watts or less
- Unique built-in sightglass available - indicates valve operation, moisture levels and refrigerant quality (SEHI & SERI only)
- Compatibility tested with most CFC, HCFC, and HFC refrigerants and oils
- Self lubricating materials used for long life
- High linear force output

The **ESX**, **SER**, **SEI** and **SEH** 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 translates into precise linear positioning of the valve

piston. Valve pistons and ports are uniquely characterized, providing improved flow resolution and performance. The **ESX**, **SER**, **SEI** and **SEH** valves are easily interfaced with microprocessor based controllers, including Sporlan supplied controllers.

## THE VALVES

Sporlan Electric Expansion Valves (EEVs) are currently available in nominal R-22 capacities from 1/2 to 175 tons (1.5 to 615 kW). Therefore, they are applicable on all the same types of systems found in the air conditioning and refrigeration industry as thermostatic expansion valves.

All Sporlan electric valves are designed for compatibility with all current halocarbon refrigerants, including CFCs, HCFCs and HFCs including R-410A. Specific system conditions will dictate which product is necessary to control the application. Specific details can be reviewed with the Sporlan Sales Engineer.

### FOR USE ON REFRIGERATION and/or AIR CONDITIONING SYSTEMS ONLY

For more information about our products visit us at [www.sporlan.com](http://www.sporlan.com)

Supersedes Bulletin 100-20 July 2000, Bulletin 100-20-1 May 2004, Bulletin 100-20-2 February 2006, and all prior publications

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## ELECTRIC VALVE BASICS

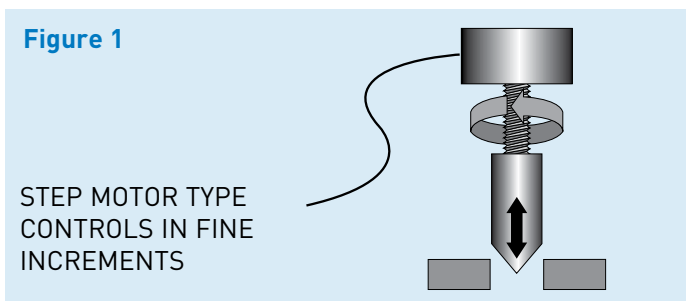
In current designs, the electronics controlling the valve are separate from the valve itself. The correct term to describe the valves is therefore *electronically controlled electric valves*. For convenience, the balance of this discussion will use the term *electric valve*.

Since electric valves are assigned their function in the system by the software in their 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.

## TYPES OF ELECTRONICALLY CONTROLLED VALVES

Four basic types of electric valves have 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” by the controller, 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. The ESX is run at 83 steps per second while larger Sporlan step motors are run at a 200 steps-per-second rate and can be made to return to an exact position. Sporlan electric valves are designed for 500 to 6386 steps, so extraordinary resolution or control of flow is possible.



## STEP MOTORS

Step motors have existed for many years but were limited to very specialized, and usually expensive, applications. When the personal computer industry expanded and automobiles became more electronically controlled, the need for small, reliable and inexpensive stepmotors increased dramatically. Step motors permitted the repeatable precision movement

needed for high speed printers and computerized engine management. In the 1980s Sporlan experimented with 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



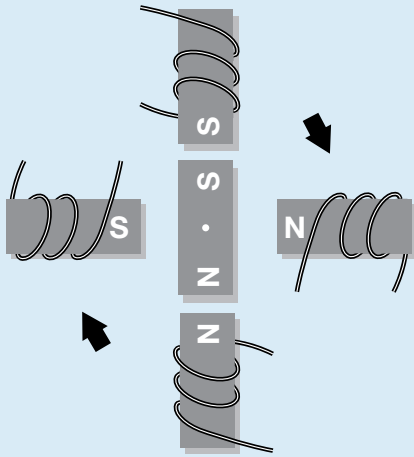
If power is left on, the magnetic poles will align and no further motion will take place.

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



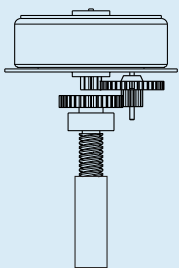
The above is a simple example, in reality step motors may have 24 to 100 virtual electromagnets arranged around the rotor. Simple arithmetic shows these motors have 15° to 3.6° step angles or increments of rotation.

There are two general types of step motors: unipolar and bipolar. In a unipolar style, like the Sporlan ESX motor, current flows in only one direction. In the case of the Sporlan ESX valve motor, the gray lead is always at +12 volts DC and each of the other four colors is, in turn, connected to a ground. Drive circuitry is simpler, but torque and efficiency are lower than bipolar designs. However, unipolar motors are useful in small capacity valves like the Sporlan ESX. A bipolar motor, such as used in all other Sporlan valves, is powered by signals that change polarity. For the first step the black lead may be negative while the white is positive, 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. Bipolar is the style of choice for all larger step motor valves. Table 1 on page 5 reflects bipolar driver circuitry.

## 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. While small tonnage valves like the ESX successfully use direct drive, larger valves may not. The solution to both these needs is a Digital Linear Actuator, or DLA. 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 geartrain and may account for a fivefold increase in mechanical

Figure 6



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.

## 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.

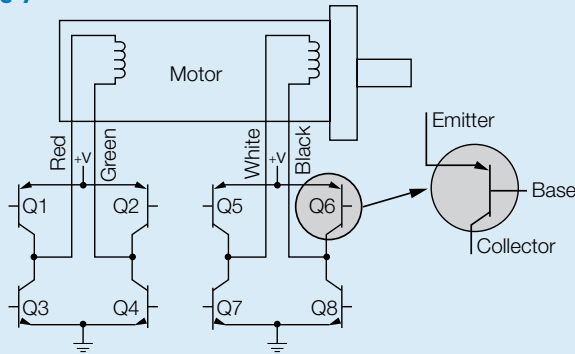
Hysteresis is the internal friction of any system. In a TEV it takes more force or pressure to deform the diaphragm in the opening direction than in the closing direction. This hysteresis has an effect on the resolution of the TEV, and limits its ability to precisely meter refrigerant over widely changing 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 or EEV is governed by the stroke and number of steps in that stroke. Sporlan offers valves in a variety of sizes for a multitude of applications. All valves except the ESX use the same motor/driver assembly, but physical size limits the number of steps used in the different valves. ESX electric expansion valves have 500 nominal steps of stroke, small tonnage SER and SEI electric expansion valves have 1596 nominal steps of stroke, larger SER valves have 2500 steps, SEI-30 has 3193 steps, and large tonnage electric expansion valves have 6386 nominal steps of stroke. The piston or pin of the larger valves moves the same linear distance for each step, .0000783 inches. This extremely small change in the distance the pin moves away from the seat is reflected in the 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.

## 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. As shown in Table 1 below, 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 are beyond the scope of this explanation but drive circuitry using each of these types have been used successfully.

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

Table 1

BIPOLAR DRIVE SEQUENCE				
STEP	BLACK	WHITE	RED	GREEN
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
1	12 volts	0 volts	12 volts	0 volts

Used for all Sporlan Step Motor Valves except ESX.

UNIPOLAR DRIVE SEQUENCE				
STEP	BLACK	WHITE	RED	GREEN
1	0 volts	12 volts	12 volts	12 volts
2	0 volts	0 volts	12 volts	12 volts
3	12 volts	0 volts	12 volts	12 volts
4	12 volts	0 volts	0 volts	12 volts
5	12 volts	12 volts	0 volts	12 volts
6	12 volts	12 volts	0 volts	0 volts
7	12 volts	12 volts	12 volts	0 volts
8	0 volts	12 volts	12 volts	0 volts
1	0 volts	12 volts	12 volts	12 volts

Gray is common and connected to 12 volts at all times  
Used for ESX valves only

CLOSE  
↓

CLOSE  
↓

↑  
OPEN

↑  
OPEN

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 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.

Permanent magnet step motors, such as those used by Sporlan, 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 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 is dependent upon the valve used. Sporlan valves, while all using the same motor/driver, are available in a variety of configurations and sizes. The number of nominal or flow steps changes from 500 for the ESX to 3500

for the small SER expansion valve and SDR-3(X) valves and 6500 for all others. The number of flow steps is the range over which the valves can best control flow. The actual number of mechanical travel steps is larger and dependent on manufacturing tolerance. To assure that the valves are completely closed during initialization, the number of steps shown below in Table 2 should be used.

Table 2

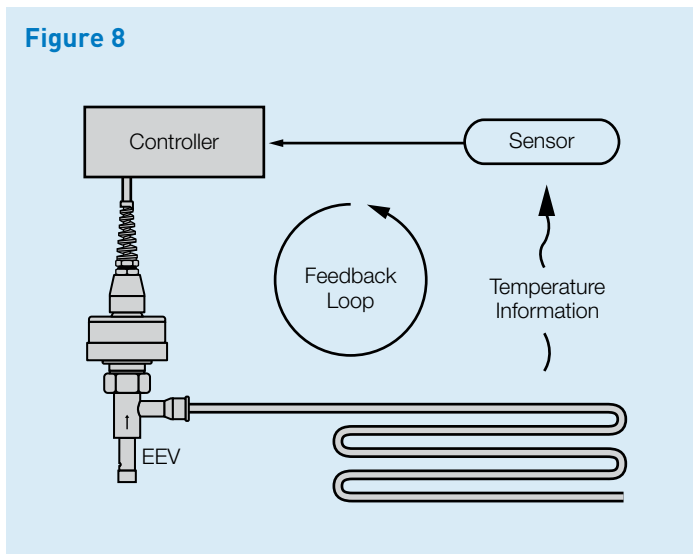
INITIALIZATION	
VALVE TYPE	STEPS
ESX	500
SER 1.5 TO 20, G, J, K	3500
SEI-30 & 50	6500
SEH-100	6500
SEH-175	6500
CDS-9	6500
CDS-16	6500
SDR-3 & SDR-3X	3500
SDR-4	6500

Since the valves have been designed to accept overdriving steps without damage, an initialization of 7500 steps may be used on all valves except the ESX.

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.

### 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 overcooling, the temperature sensor “feeds back” that information, and the controller closes the valve. 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 setpoint.

### VALVE OPERATION — ESX\*

The “dry” stator used in the ESX is constructed with multiple magnetic pole pairs created by energized wire windings. The term “dry” is used because the windings of the stator are outside the refrigerant envelope. In the ESX stator there are 4 phases (windings) energized sequentially by a step motor controller that creates a rotating magnetic field. The stator magnetically couples with the rotor and causes it to turn in unison with the rotating field. The field rotates either clockwise or counter-clockwise depending on the sequence of electrical pulses to each of the 4 phases. The result is a proportional valve actuator with the ability to achieve a precise, repeatable position using an electronic signal.

The “wet” rotor is directly linked to a low-friction threaded “needle” which moves into and out of the valve’s metering orifice. The term “wet” indicates that the permanent magnet rotor is located in the hermetic refrigerant environment. As the rotor rotates step by step, the needle’s distance from the valve orifice changes incrementally, thus opening or closing the expansion valve. Valve “steps” are incremental changes of the rotor position; in the ESX valve, each step is equivalent to a 3.75° rotation of the rotor. An internal torsion spring limits clockwise and counter-clockwise motion to eliminate the potential damage due to driving the valve past its full open or full closed position. The torsion spring absorbs the torque at the extreme rotational positions and causes the rotor to “slip” in the magnetic field created by the stator. The ESX valve incorporates a spring-loaded needle designed to “collapse” as the valve approaches the full closed position. This novel feature limits maximum seating force to reduce seat wear and maximize valve life. The fine pitch thread design of the needle prevents “back travel” when power is removed. This specific feature increases efficiency by requiring power only when a change in valve position is called for, the ESX does not require continuous power to maintain position. The result is a highly reliable step motor expansion valve which is predictable, durable, and energy efficient.

The resolution and linear flow allow the ESX to be used at just a fraction of its capacity. The wide range of control possible with the model ESX allows it to be used down to 10% of its capacity, or up to 110%. Refer to the capacity tables for proper sizing for your application, refrigerant, and operating conditions.

Approximately 48 single-phase steps from full closed are required before the valve orifice begins to open. Beyond 448 steps, the flow rate does not significantly change. The usable flow range of the valve is from 48 to 448 steps and is the recommended design range for flow control. The step motor controller should be configured and scaled to use 48 single phase steps (from step=0 position) as the 0% capacity point, and to use 448 steps (from step=0 position) as the 100% capacity point.

The initial opening steps (step=0 to step=48) position the valve in its fully closed position but with varying levels of seating force. This is due to the spring compression biasing the needle (see Figure 9) against the valve seat. Full seating force is achieved at the home position (step=0), which is the fully overdriven position. It is suggested that in forward flow mode (flow entering side fitting) driving to step 48 will achieve sufficient seating force in most applications. It is not necessary to overdrive the valve to step=0 to achieve full valve closure in forward flow mode, but it is necessary to achieve full closure when the valve is flowed in the reverse direction.

Because the valve needle is spring biased, the MOPD (**M**aximum **O**perating **P**ressure **D**ifferential) of the valve in reverse flow can be significantly lower than in forward flow. The MOPD, in reverse flow only, varies with orifice size and is shown in Table 3. Exceeding the MOPD in reverse flow does not damage the valve; however, it will result in leakage through the valve seat until the pressure difference across the valve decreases below the MOPD. Maximum MOPD will always be achieved in forward flow.

**\*NOTE:** ESX valves are suggested for A/C and heat pump only – please contact SVD for refrigeration applications.

## VALVE OPERATION — SER, SER(I), SEI, SEH(I)

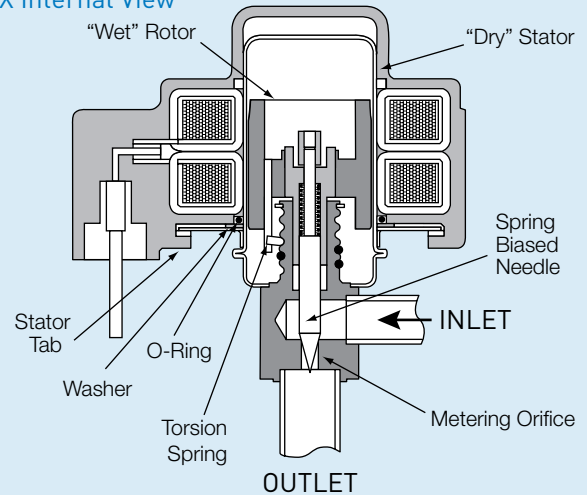
The SER, SEI and SEH valves modulate by the electronically controlled rotation of a step motor. The step motor drives a gear train and lead screw to position a piston. The piston is used to modulate flow through a port, refer to Figure 10.

The motor is a two phase type driven in the bi-polar mode. Two discrete sets of motor stator windings are powered in sequence to rotate the rotor 3.6 degrees per step. Polarity of the drive signal reverses for each step.

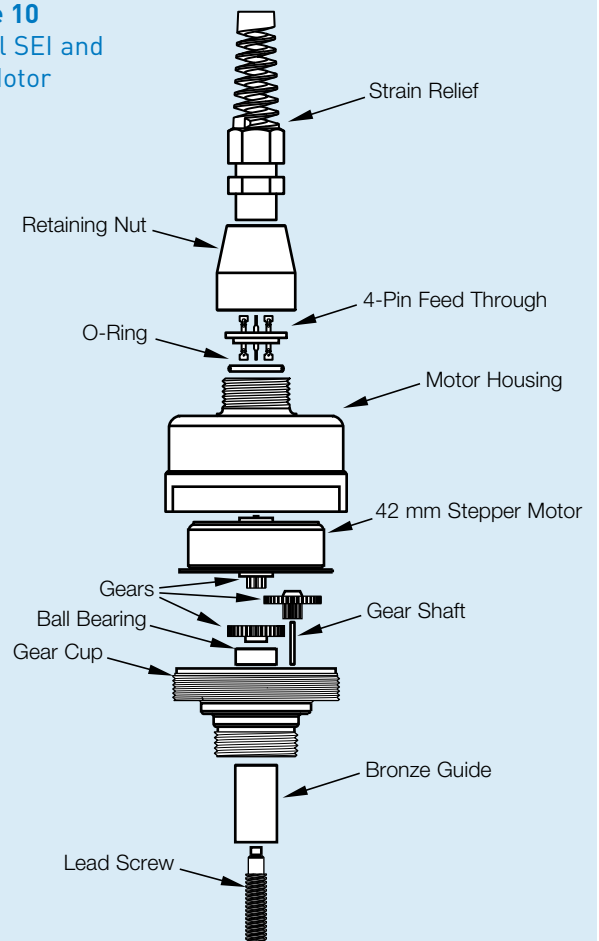
The sequencing is accomplished electronically through the bi-polar drive circuit shown in Figure 7. The drive transistors, Q1 through Q8, are electronically biased in pairs by the controller as shown in Table 1.

The SER valves have a stroke of .189” (4.8mm) and 1596 or 2500 steps of resolution. Each step yields .00012” (.03mm) of travel. Small SEI valves have 1596 with .250 inches of

**Figure 9**  
ESX Internal View



**Figure 10**  
Typical SEI and SEH Motor



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

**Table 3**

ESX MOPD		
VALVE TYPE	FORWARD FLOW SIDE INLET	REVERSE FLOW BOTTOM INLET
ESX-14	500 psi	400 psi
ESX-18	500 psi	300 psi
ESX-24	500 psi	125 psi

and large SEI and SEH valves have an operating stroke of 0.500 inches (12.7 mm) and 6386 steps of control, therefore each step translates into 0.0000783 inches (.02 mm) of travel. When used with one of the Sporlan Valve Company controllers, the valves provide unsurpassed accuracy in resolution of flow and repeatability of position.

External parts of the valve are brass and copper and meet or exceed 2000 hour salt spray tests per ASTM B-117.

The SEI/SEH motor housing is equipped with a hermetic cable connection to the motor and a 10 foot (3 meter) motor lead is supplied as standard length. The lead can be supplied in a variety of lengths to suit specific customer requirements, both with or without connectors installed. The SER is equipped with a removeable cable.

Total power consumption is less than 4 watts when operating a rate of 200 steps per second with standard L/R type drive circuitry. Refer to motor specifications shown in Table 4. Faster step rates may be obtained with proper current limited chopper type drives. Please contact Sporlan Valve Company for more information.

The SER valves are rated at 700 psig (48 bar) MRP while the SEI and SEH valves have a safe working pressure of 620 psig (42 bar). Operating ambient temperature range is -50°F to 140°F (-45°C to 60°C) but temperatures of up to 250°F (120°C) may be used for dehydration.

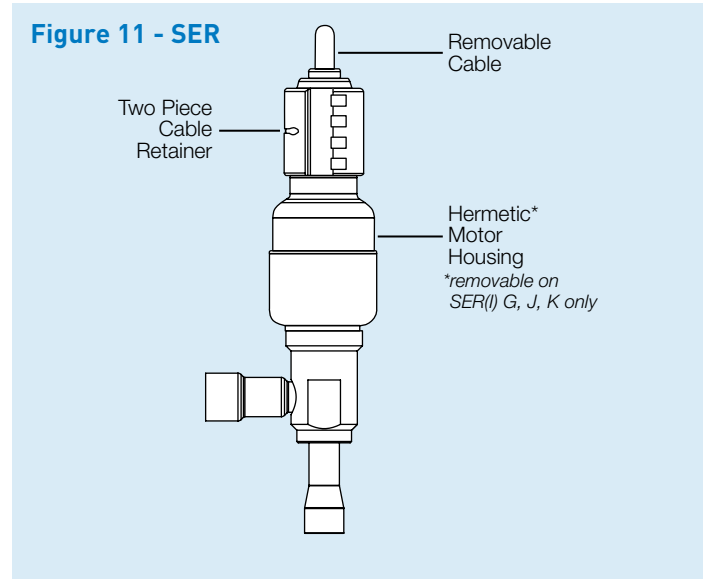


Table 4

SPECIFICATIONS						
	ESX	SEI 5 TO 11	SER 1.5 TO 20	SEI 30	SER(I) G, J, K	SEI 50, SEH(I) 100, 175
<b>Motor type</b>	4 phase, unipolar dry stator	2 phase, bipolar wet motor				
<b>Compatible refrigerant</b>	All common CFC, HCFC and HFC refrigerants including R-410A					
<b>Compatible oils</b>	All common Mineral, Polyolester and Alkybenzene oils					
<b>Supply voltage</b>	12 volt DC, -5%, +10% measured at the valve leads					
<b>Cable type</b>	Removable stator	Hermetic 4 lead, 18 AWG, PVC insulation	Removable	Hermetic 4 lead, 18 AWG, PVC insulation	Removable	Hermetic 4 lead, 18 AWG, PVC insulation
<b>Phase resistance</b>	46ohms +- 10%	75 ohms +-10%	100 ohms +-10%	75 ohms +-10%	100 ohms +-10%	75 ohms +-10%
<b>Current range</b>	260 ma/phase	160 ma/ winding	120 ma/ winding	160 ma/ winding	120 ma/ winding	160 ma/ winding
<b>Maximum power input</b>	5.8 watts	3.8 watts	2.8 watts	3.8 watts	2.8 watts	3.8 watts
<b>Recommended step rate</b>	30 - 83.5/second	200/ second	200/ second	200/ second	200/ second	200/ second
<b>Number of steps</b>	500 +-20	1596	1596	3193	2500	6386
<b>Full motion transit time</b>	16.7sec @ 30 pps 6 sec. @83.5 pps	7.5 seconds	7.5 seconds	16 seconds	12.5 seconds	30 seconds
<b>Resolution</b>	.0002" (.005mm) / step	.00008" (.002 mm) / step	.00012" (.003mm) / step	.00008" (.002mm) / step	.00012" (.003mm) / step	.00008" (.002mm) / step
<b>Stroke</b>	.104" (2.64 mm)	.125" (3.2 mm)	.189" (4.8mm)	.250" (6.4mm)	.297" (7.5mm)	.500" (12.7mm)
<b>Max. internal leakage</b>	140 cc/min @ 150 psid (10.3 bar), dry air	50 cc/min @ 100 psig (6.9 bar), dry air	50 cc/min @ 100 psig (6.9 bar), dry air	100 cc/min @ 100 psig (6.9 bar), dry air	100 cc/min @ 100 psig (6.9 bar), dry air	100 cc/min @ 100 psig (6.9 bar), dry air
<b>Max. external leakage</b>	.10 oz./yr at 300 psig (.2 gram/yr @ 20 bar)	.10 oz./yr at 300 psig (.2 gram/yr @ 20 bar)	.10 oz./yr at 300 psig (.2 gram/yr @ 20 bar)	.10 oz./yr at 300 psig (.2 gram/yr @ 20 bar)	.10 oz./yr at 300 psig (.2 gram/yr @ 20 bar)	.10 oz./yr at 300 psig (.2 gram/yr @ 20 bar)
<b>MOPD</b>	500 psig (34 bar) forward flow	500 psig (34 bar)	500 psig (34 bar)	500 psig (34 bar)	500 psig (34 bar)	500 psig (34 bar)
<b>MRP</b>	650 psig (45 bar)	620 psig (49 bar)	700 psig (49 bar)	620 psig (49 bar)	700 psig (49 bar)	620 psig (49 bar)
<b>Operating temp range</b>	-40°F to 155°F (-40°C to 70°C)	-50°F to 155°F (-45°C to 60°C)	-50°F to 155°F (-45°C to 60°C)	-50°F to 155°F (-45°C to 60°C)	-50°F to 155°F (-45°C to 60°C)	-50°F to 155°F (-45°C to 60°C)
<b>Materials of construction</b>	Brass, copper, synthetic seals, stainless steel					



## APPLICATION

Sporlan Valve Division is not responsible for system design, 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. It is strongly suggested that power be disabled to the valve when not actively stepping. Conventional initialization routines, which include overdriving the motor to ascertain the zero step position are acceptable. Contact Sporlan for more information.

## SELECTION PROCEDURE

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 setpoint but an additional temperature sensor may be used to measure discharge water or air temperature. This air or water temperature is controlled directly, as long as superheat remains at a level to prevent floodback.

The ability of the EEV to control the amount of refrigerant in the evaporator to reach discharge setpoint 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.** The EEV valves may be used on most common refrigerants. See selection tables.
- 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 are based on a liquid temperature of 100°F (38°C) for R-22, R-134a, R-404A/R-507 and R-407C. For other liquid temperatures, apply the correction factor given in 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. Due to improved ability to follow load, Sporlan EEVs provide 10% to 110% of nominal capacity listed in the capacity tables. 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 tables. On multiple evaporator systems, select each valve on the basis of individual evaporator capacity.

## SELECTION EXAMPLE:

Refrigerant: R-134a

Condensing Temperature: 133°F

Liquid Temperature: 80°F

Evaporator Temperature: 40°F

Liquid Line Loss: 7 psi

ΔP Distributor and Tubes: 35 psi\*

Evaporator Load: 2.5 tons

Condensing Pressure (psig):	211
-----------------------------	-----

Liquid Line Loss (Estimates):	- 7
-------------------------------	-----

Distributor and Tubes:	-35
------------------------	-----

Evaporator Pressure (psi):	<u>-69</u>
----------------------------	------------

ΔP across EEV:	100
----------------	-----

R-134a, 80°F Liquid Correction Factor  
from Table: 1.19

ESX-18 2.1 tons x 1.19 = 2.5 tons

ESX-24 4.3 tons x 1.19 = 5.1 tons

**Select an ESX 18 from capacity table.**

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

## ORDERING INSTRUCTIONS / NOMENCLATURE

The ESX, SER, and SEI up to SEI 30 are available in angle configurations. The SEI 50, SEH 100 and 175 are available in straight through configurations as shown below. The SEH and larger SER valves are also available with an optional sightglass

built-in. The sightglass indicates the moisture levels of the refrigerant, flash gas present at the valve, and provides a visual confirmation of valve piston movement. This unique feature is useful for system refrigerant charging and service.

<b>SEH</b>	<b>(I)</b>	<b>175</b>	<b>1-1/8</b>	<b>x</b>	<b>2-1/8</b>	<b>ODF</b>	<b>10</b>	<b>S</b>
Valve Model	Indicating Sightglass optional	Valve Nominal Capacity	Inlet Fitting 7/8", 1-3/8", and 1-5/8" available*		Outlet Fitting 1-3/8", 1-5/8" and 2-1/8" available*	Fitting type ODF only	Cable Length 10' standard, 20', 30', and 40' available	Stripped and Tinned cable ends, Packard WeatherPak™ also available

\* Not all fitting sizes are available on all valves - see table below and on page 23.

<b>ESX</b>	<b>14</b>	<b>B</b>	<b>5</b>	<b>S</b>
Valve Model Electric Step Motor eXpansion Valve	Orifice Diameter 14 = 1.4 mm 18 = 1.8 mm 24 = 2.4 mm	Connections 5/16 x 5/16 ODF A 3/8 x 3/8 ODF B 3/8 x 1/2 ODF	Cable Length 5' & 10' available	Stripped and Tinned ends

## MAXIMUM DIMENSIONS\*

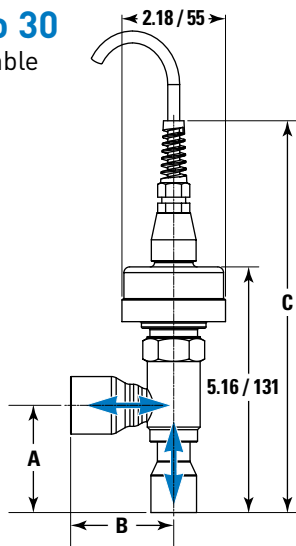
VALVE TYPE	A (Inches / mm)	B (Inches / mm)	C (Inches / mm)
SER 1.5	2.0 / 51	1.7 / 43	7.21 / 183
SER 6	2.0 / 51	2.3 / 58	7.21 / 183
SER 11	2.5 / 64	2.3 / 58	7.21 / 183
SER 20	2.6 / 66	2.4 / 61	7.21 / 183
SERI G	3.78 / 96	3.26 / 76	9.22 / 234
SERI J	3.78 / 96	3.39 / 86	9.22 / 234
SERI K	4.09 / 101	3.39 / 86	9.97 / 253
SEI .5 to 11	2.14 / 54	2.21 / 56	7.97 / 202
SEI 30	2.2 / 56	2.8 / 71	8.23 / 209
SEI 50	8.08 / 205	.68 / 17	8.23 / 209
SEH 100	9.32 / 237	5.15 / 131	8.46 / 215
SEH 175	8.46 / 215	5.24 / 133	8.51 / 216

\* Dimensions may be up to .5" / 12mm less based on connection size.

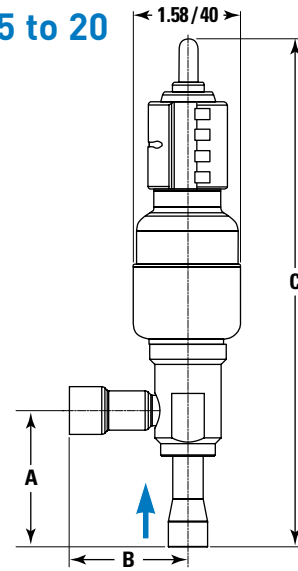
For specific dimensions contact Sporlan Division.

## DIMENSIONS (Inches/mm)

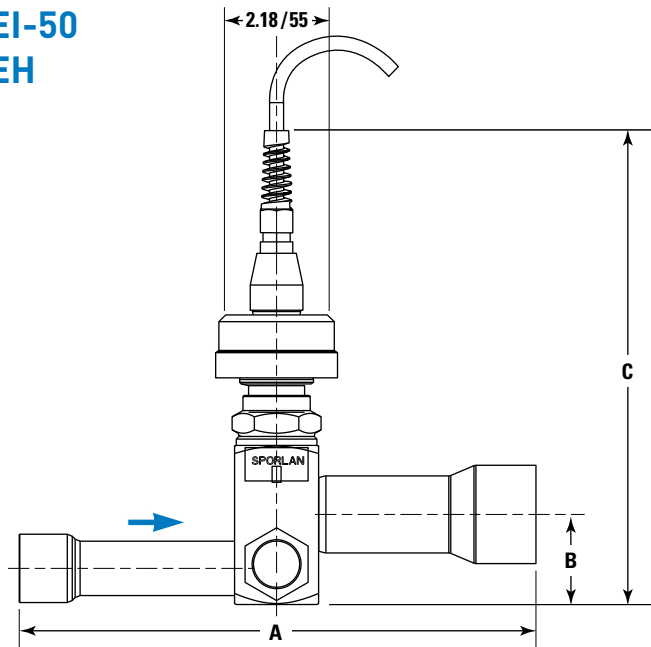
**SEI-.5 to 30**  
Biflow Capable



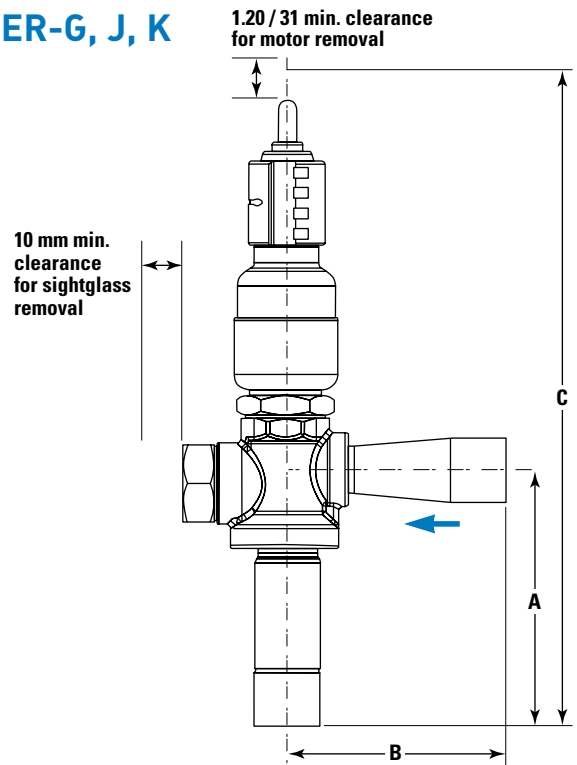
**SER-1.5 to 20**



**SEI-50**  
**SEH**



**SER-G, J, K**



**ESX**

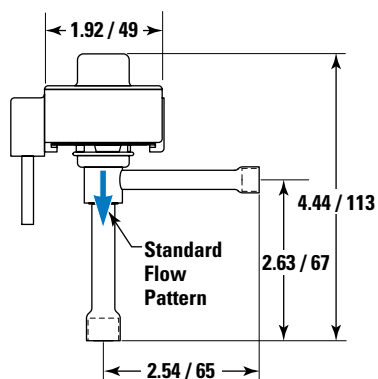


Figure 12

### SUPERHEAT CONTROLLER WIRING SCHEMATIC

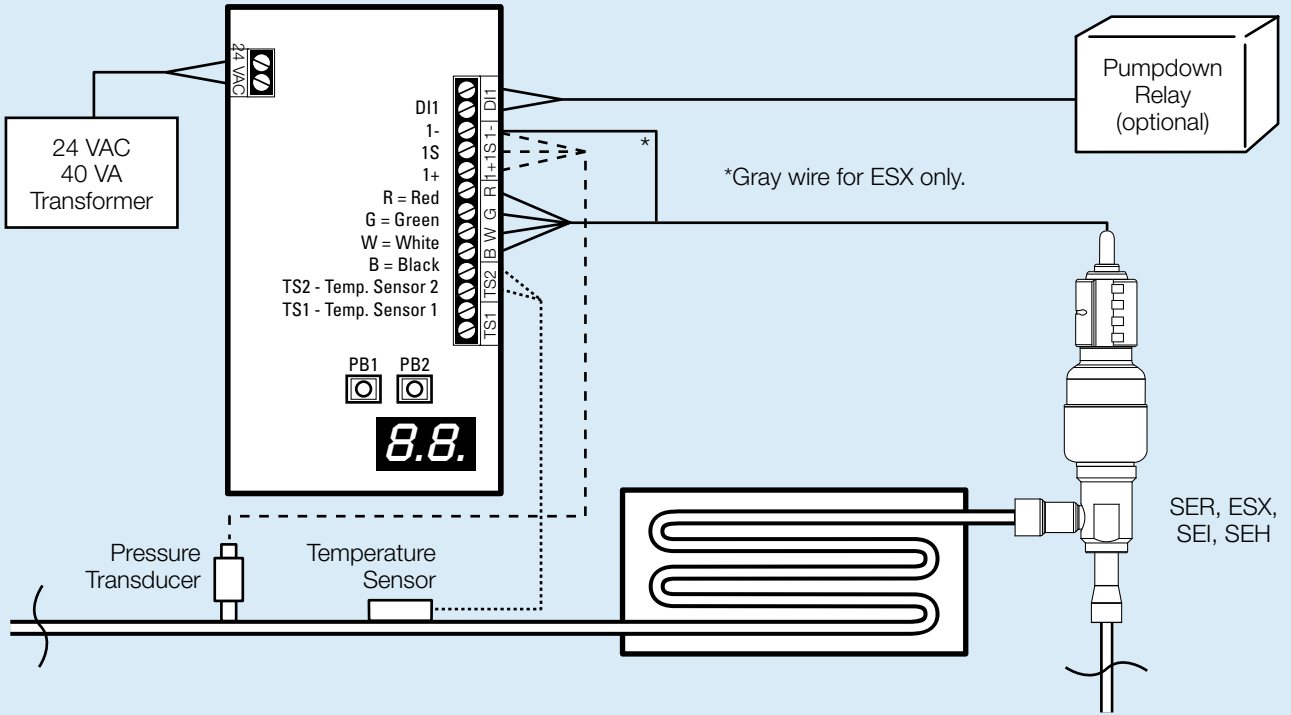


Figure 13

### REFRIGERATION P/T OR SUBCOOLER CONTROLLER WIRING SCHEMATIC

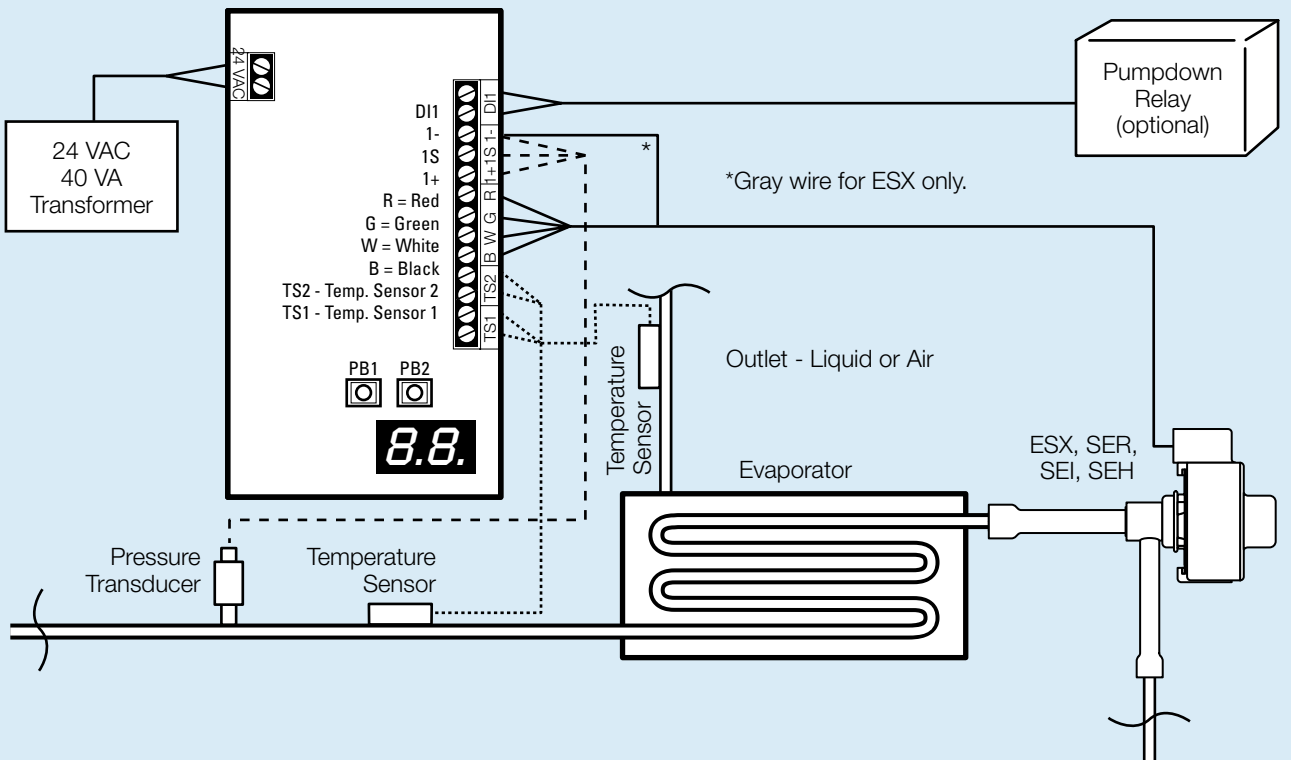
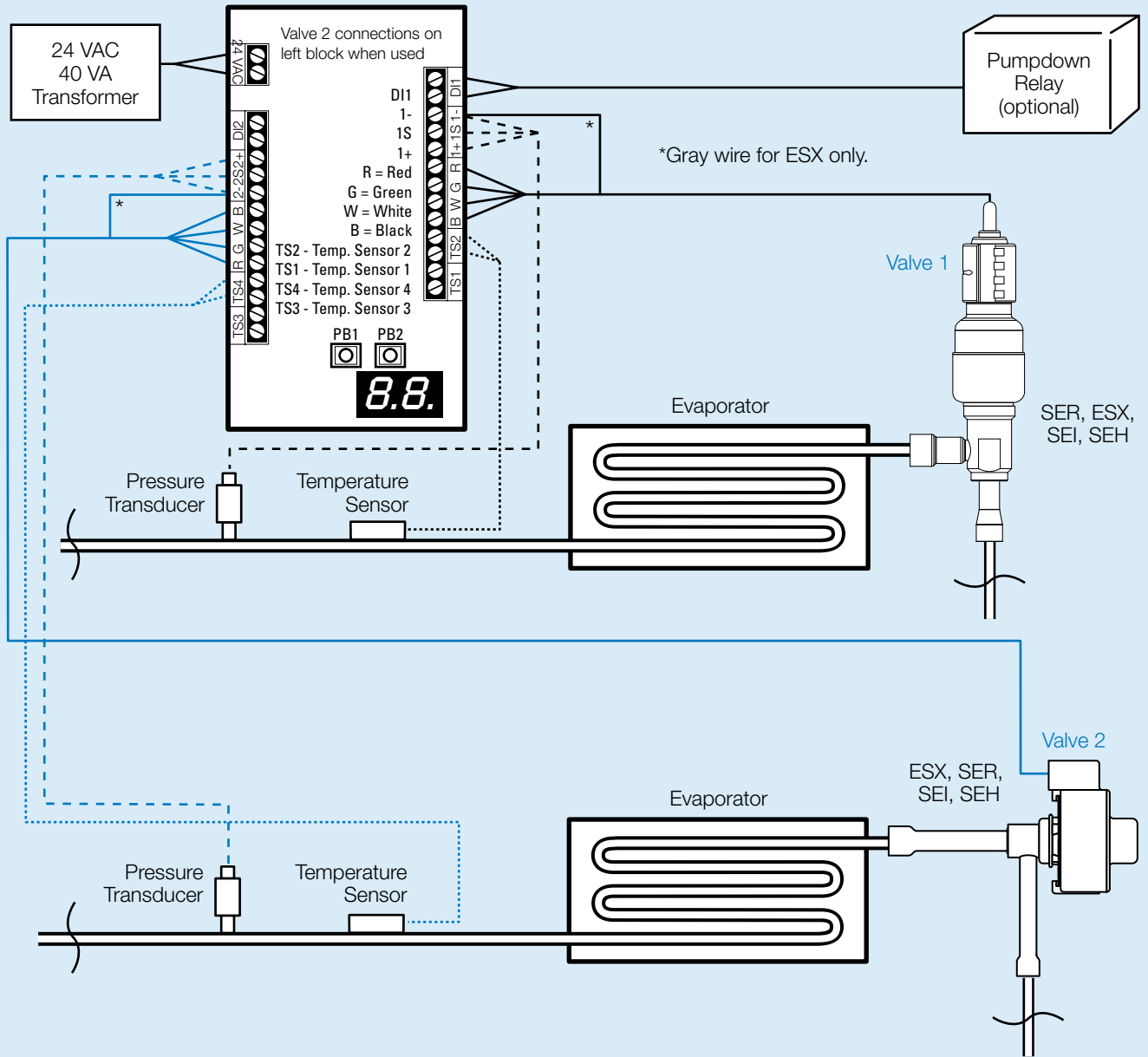


Figure 14

### CHILLER CONTROLLER WIRING SCHEMATIC



R-22 CAPACITIES IN TONS (AT EVAPORATOR TEMPERATURE °F)

Table with columns for Valve Type, 40°F, 20°F, and 0°F. Sub-headers include Pressure Drop Across the Valve- PSI. Rows list various valve types like ESX 14, SEI 1, etc.

R-134a CAPACITIES IN TONS (AT EVAPORATOR TEMPERATURE °F)

Table with columns for Valve Type, 40°F, 20°F, and 0°F. Sub-headers include Pressure Drop Across the Valve- PSI. Rows list various valve types like ESX 14, SEI 1, etc.

LIQUID TEMPERATURE CORRECTION FACTORS

Table with columns for °F and °C. Rows list refrigerant types: R-22, R-134a, R-404A/507, R-407C, R-410A.

NOTE: Correction factor closest to actual system liquid temperatures may be used, e.g. 5°C actual liquid use 4°C factor. Based on 0°F evaporator, variation across evaporating range of -40°F to 40°F (-40°C to 5°C) is insignificant.













**R-407C 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
<b>ESX 14</b>	3.19	3.91	4.52	5.05	5.53	5.97	6.39	6.77	3.02	3.69	4.27	4.77	5.22	5.64	6.03	6.40	2.89	3.54	4.09	4.57	5.01	5.41	5.78	6.13
<b>ESX 18</b>	5.65	6.92	7.99	8.93	9.78	10.6	11.3	12.0	5.34	6.54	7.55	8.44	9.24	9.98	10.7	11.3	5.12	6.27	7.23	8.09	8.86	9.57	10.2	10.9
<b>ESX 24</b>	11.3	13.8	16.0	17.9	19.6	21.1	22.6	24.0	10.7	13.1	15.1	16.9	18.5	20.0	21.3	22.6	10.2	12.5	14.5	16.2	17.7	19.1	20.5	21.7
<b>SEI 5</b>	1.11	1.35	1.56	1.75	1.91	2.07	2.21	2.34	1.04	1.28	1.48	1.65	1.81	1.95	2.09	2.21	1.00	1.23	1.42	1.58	1.73	1.87	2.00	2.12
<b>SEI 1</b>	2.41	2.95	3.40	3.81	4.17	4.50	4.81	5.11	2.27	2.78	3.22	3.60	3.94	4.25	4.55	4.82	2.18	2.67	3.08	3.45	3.78	4.08	4.36	4.62
<b>SEI 2</b>	4.91	6.02	6.95	7.77	8.51	9.19	9.82	10.4	4.64	5.68	6.56	7.34	8.04	8.68	9.28	9.84	4.45	5.45	6.29	7.03	7.70	8.32	8.90	9.44
<b>SEI 3.5</b>	8.03	9.84	11.4	12.7	13.9	15.0	16.1	17.0	7.59	9.29	10.7	12.0	13.1	14.2	15.2	16.1	7.27	8.91	10.3	11.5	12.6	13.6	14.5	15.4
<b>SEI 6</b>	15.2	18.6	21.5	24.0	26.3	28.4	30.4	32.2	14.3	17.6	20.3	22.7	24.8	26.8	28.7	30.4	13.7	16.8	19.4	21.7	23.8	25.7	27.5	29.2
<b>SEI 8.5</b>	21.5	26.3	30.4	34.0	37.2	40.2	43.0	45.6	20.3	24.9	28.7	32.1	35.2	38.0	40.6	43.1	19.5	23.8	27.5	30.8	33.7	36.4	38.9	41.3
<b>SEI 11</b>	23.0	28.1	32.5	36.3	39.8	43.0	45.9	48.7	21.7	26.6	30.7	34.3	37.6	40.6	43.4	46.0	20.8	25.5	29.4	32.9	36.0	38.9	41.6	44.1
<b>SEI 30</b>	73.7	90.2	104	116	128	138	147	156	69.6	85.3	98.4	110	121	130	139	148	66.7	81.7	94.4	106	116	125	133	142
<b>SEI 50</b>	123	150	174	194	213	230	246	260	116	142	164	183	201	217	232	246	111	136	157	176	193	208	222	236
<b>SER 1.5</b>	3.68	4.51	5.21	5.82	6.38	6.89	7.37	7.81	3.48	4.26	4.92	5.50	6.03	6.51	6.96	7.38	3.34	4.09	4.72	5.28	5.78	6.24	6.67	7.08
<b>SER 6</b>	14.7	18.0	20.8	23.3	25.5	27.6	29.5	31.3	13.9	17.0	19.7	22.0	24.1	26.0	27.8	29.5	13.3	16.3	18.9	21.1	23.1	25.0	26.7	28.3
<b>SER 11</b>	27.0	33.1	38.2	42.7	46.8	50.5	54.0	57.3	25.5	31.3	36.1	40.4	44.2	47.7	51.0	54.1	24.5	30.0	34.6	38.7	42.4	45.8	48.9	51.9
<b>SER 20</b>	49.1	60.2	69.5	77.7	85.1	91.9	98.2	104	46.4	56.8	65.6	73.4	80.4	86.8	92.8	98.4	44.5	54.5	62.9	70.3	77.0	83.2	89.0	94.4
<b>SER(I) G</b>	55.5	67.9	78.5	87.6	96.1	104	111	117	52.4	64.2	74.1	82.9	91.0	97.8	105	111	50.2	61.5	71.1	79.5	86.7	94.4	100	106
<b>SER(I) J</b>	99.5	122	141	158	173	187	200	212	94.4	116	133	149	163	177	189	200	90.1	111	128	143	156	169	181	192
<b>SER(I) K</b>	181	222	256	286	314	338	362	384	171	209	241	270	296	320	342	363	164	201	232	259	284	307	328	348
<b>SEH(I) 100</b>	246	301	347	388	425	459	491	521	232	284	328	367	402	434	464	492	222	272	315	352	385	416	445	472
<b>SEH(I) 175</b>	430	526	608	680	744	804	860	912	406	497	574	642	703	760	812	861	389	477	550	615	674	728	778	826

LIQUID TEMPERATURE CORRECTION FACTORS																
°F	0	10	20	30	40	50	60	70	80	90	100	110	120	130	140	
°C	-18	-12	-7	-1	4	10	16	21	27	32	38	43	49	54	60	
<b>R-22</b>	1.56	1.51	1.45	1.40	1.34	1.29	1.23	1.17	1.12	1.06	1.00	0.94	0.88	0.82	0.76	
<b>R-134a</b>	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	
<b>R-404A/507</b>	1.99	1.89	1.79	1.69	1.59	1.50	1.40	1.30	1.20	1.10	1.00	0.89	0.78	0.66	0.51	
<b>R-407C</b>	1.33	1.30	1.28	1.25	1.22	1.19	1.16	1.12	1.09	1.04	1.00	0.95	0.90	0.84	0.77	
<b>R-410A</b>	1.79	1.71	1.63	1.55	1.47	1.40	1.32	1.24	1.16	1.08	1.00	0.92	0.83	0.73	0.62	

NOTE: Correction factor closest to actual system liquid temperatures may be used, e.g. 5°C actual liquid use 4°C factor. Based on 0°F evaporator, variation across evaporating range of -40°F to 40°F (-40°C to 5°C) is insignificant.





## AVAILABLE CONNECTIONS

TYPE	INLET – Inches STANDARD CONNECTIONS In BOLD	OUTLET – Inches STANDARD CONNECTIONS In BOLD	CONFIGURATION	CABLE LENGTH STANDARD CONNECTIONS In BOLD	
				Feet	Meters
ESX 14	5/16 ODF, 3/8 ODF	5/16 ODF, 3/8 ODF, 1/2 ODF	Angle	5, 10	1.5, 3
ESX 18	5/16 ODF, 3/8 ODF	5/16 ODF, 3/8 ODF, 1/2 ODF	Angle	5, 10	1.5, 3
ESX 24	5/16 ODF, 3/8 ODF	5/16 ODF, 3/8 ODF, 1/2 ODF	Angle	5, 10	1.5, 3
SER 1.5*	3/8, 1/2, 5/8 ODF	3/8, 1/2, 5/8	Angle	10, 40	3, 12
SER 6*	3/8, 1/2, 5/8 ODF	3/8, 1/2, 5/8, 7/8	Angle	10, 40	3, 12
SER 11*	3/8, 1/2, 5/8 ODF	1/2, 5/8, 7/8, 1-1/8 ODF	Angle	10, 40	3, 12
SER 20*	1/2, 5/8, 7/8, 1-1/8 ODF	5/8, 7/8, 1-1/8, 1-3/8 ODF	Angle	10, 40	3, 12
SEI 30	5/8, 7/8, 1-1/8 ODF	5/8, 7/8, 1-1/8, 1-3/8 ODF	Angle	10, 20, 30, 40	3, 6, 9, 12
SEI 50	7/8, 1-1/8, 1-3/8 ODF	7/8, 1-1/8, 1-3/8, 1-5/8 ODF	Straight Through	10, 20, 30, 40	3, 6, 9, 12
SEH 100	1-1/8, 1-3/8 ODF	1-3/8, 1-5/8 ODF	Straight Through	10, 20, 30, 40	3, 6, 9, 12
SEH 175	1-1/8, 1-3/8, 1-5/8 ODF	2-1/8 ODF	Straight Through	10, 20, 30, 40	3, 6, 9, 12
SER G*	5/8, 7/8	1/2, 5/8, 7/8, 1-1/8	Angle	10, 40	3, 12
SER J*	7/8, 1-1/8	7/8, 1-1/8, 1-3/8	Angle	10, 40	3, 12
SER K	1-1/8	7/8, 1-1/8, 1-3/8, 1-5/8	Angle	10, 40	3, 12
SEI .5 to 11	1/4, 3/8, 1/2, ODF 1/4, 3/8, 1/2 SAE	3/8, 1/2, 5/8 ODF 1/2 SAE	Angle	10, 20, 30, 40	3, 6, 9, 12

\*Suitable for bi-directional applications.



## CLIMATE CONTROL

- Accumulators
- CO<sub>2</sub> controls
- Electronic controllers
- Filter-driers
- Hand shut-off valves
- Heat exchangers
- Hose & fittings
- Pressure regulating valves
- Refrigerant distributors
- Safety relief valves
- Solenoid valves
- Thermostatic expansion valves



### AEROSPACE

- Flight control systems & components
- Fluid conveyance systems
- Fluid metering delivery & atomization devices
- Fuel systems & components
- Hydraulic systems & components
- Inert nitrogen generating systems
- Pneumatic systems & components
- Wheels & brakes



### ELECTROMECHANICAL

- AC/DC drives & systems
- Electric actuators, gantry robots & slides
- Electrohydrostatic actuation systems
- Electromechanical actuation systems
- Human machine interfaces
- Linear motors
- Stepper motors, servo motors, drives & controls
- Structural extrusions



### FILTRATION

- Analytical gas generators
- Compressed air & gas filters
- Condition monitoring
- Engine air, fuel & oil filtration & systems
- Hydraulic, lubrication & coolant filters
- Process, chemical, water & microfiltration filters
- Nitrogen, hydrogen & zero air generators



### FLUID & GAS HANDLING

- Brass fittings & valves
- Diagnostic equipment
- Fluid conveyance systems
- Industrial hose
- PTFE & PFA hose, tubing & plastic fittings
- Quick disconnects
- Rubber & thermoplastic hose & couplings
- Tube fittings & adapters



### HYDRAULICS

- Diagnostic equipment
- Hydraulic cylinders & accumulators
- Hydraulic motors & pumps
- Hydraulic systems
- Hydraulic valves & controls
- Power take-offs
- Quick disconnects
- Rubber & thermoplastic hose & couplings
- Tube fittings & adapters



### PNEUMATICS

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



### PROCESS CONTROL

- Analytical sample conditioning products & systems
- Fluoropolymer chemical delivery fittings, valves & pumps
- High purity gas delivery fittings, valves & regulators
- Instrumentation fittings, valves & regulators
- Medium pressure fittings & valves
- Process control manifolds



### SEALING & SHIELDING

- Dynamic seals
- Elastomeric o-rings
- EMI shielding
- Extruded & precision-cut, fabricated elastomeric seals
- Homogeneous & inserted elastomeric shapes
- High temperature metal seals
- Metal & plastic retained composite seals
- Thermal management