



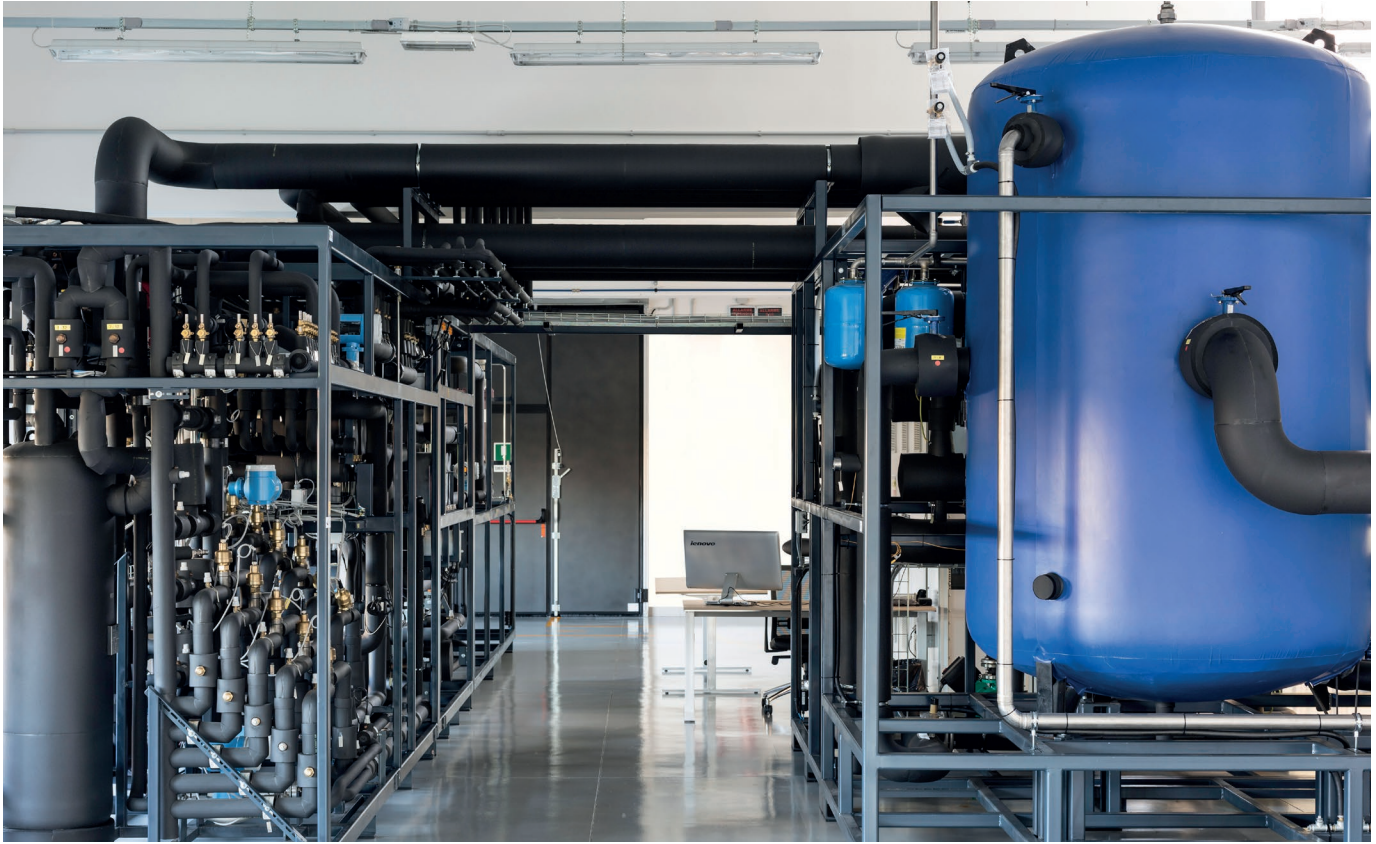
CO₂ Innovations

Energy Conscious Solutions for Supermarkets



ENGINEERING YOUR SUCCESS.

ENERGY CONSCIOUS SOLUTIONS FOR SUPERMARKETS



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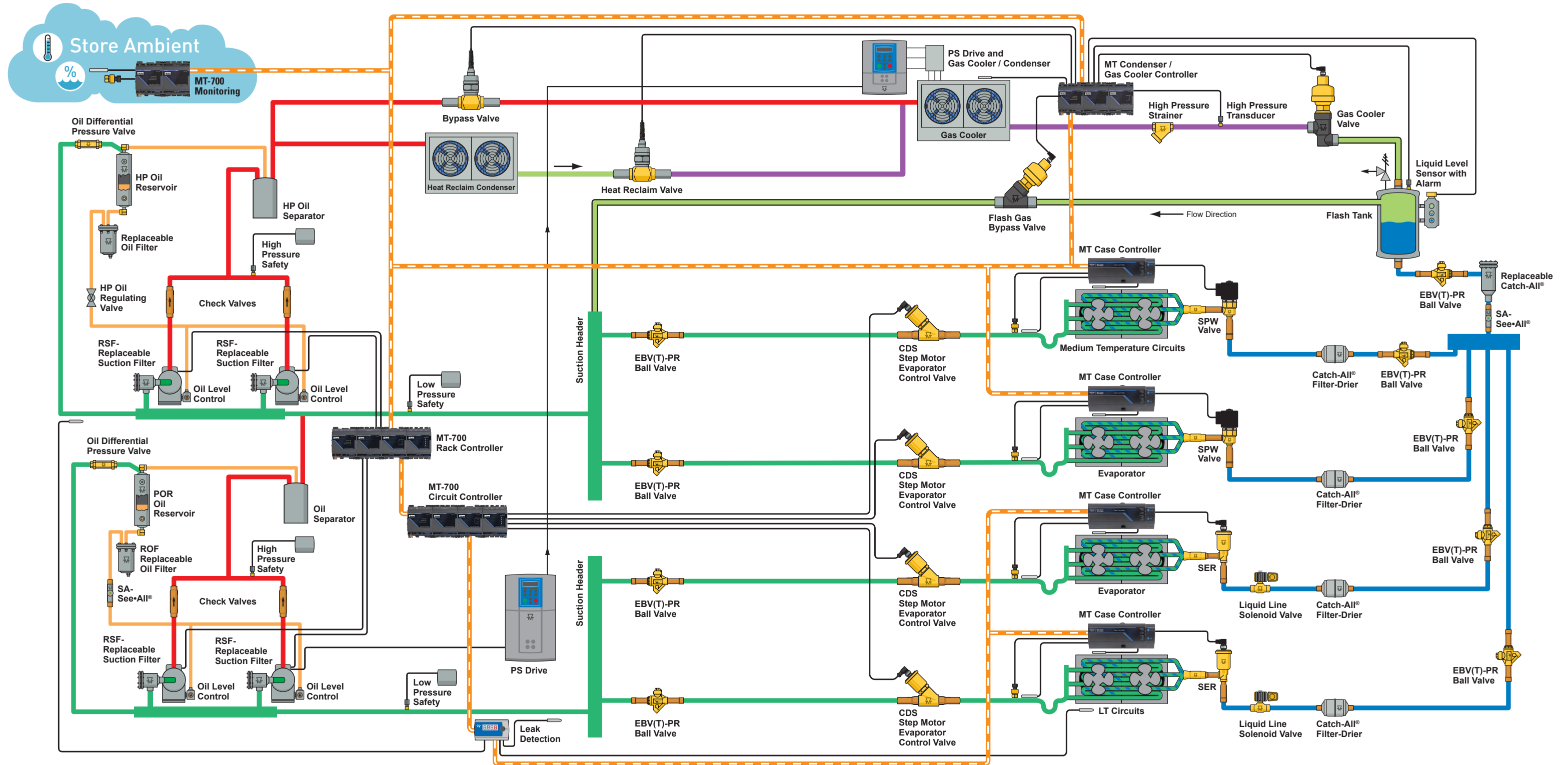
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TYPICAL CO₂ CIRCUITS

R744 TRANSCRITICAL BOOSTER SYSTEM SCHEMATIC

The GC and FGB valves shown in the scheme can be driven with a PSD4 (Valve Positioner) or, as with the SER, SERI, and CDS valves, through the IB-G Board.

NOTE
This is only a theoretical scheme so some components could not be shown.
All components must be properly pressure rated and protected for safe installation.



ELECTRIC VALVES

2030
psig

140
bar

ELECTRIC PRESSURE REGULATING VALVES

TYPE GC and FGB

The Gas Cooler valve (GC) and Flash Gas Bypass valve (FGB) are stepper motor driven pressure regulating valves, designed specifically for transcritical R-744 refrigeration systems.

The GC are applicable as gas cooler / condenser holdback valves and can also be applied as flash tank pressure regulating valves (flash gas bypass). The flash gas bypass valve capacity range is expanded with the use of the FGB valves in this application.

All GC and FGB valves have 2500 steps of movement and synthetic seats to provide great resolution and ensure tight shutoff.

The Sporlan GC and FGB valves can be controlled and driven using the Parker Sporlan PSD4 Interface Board/Positioner. The PSD4 Interface Board accepts a 0-10VDC or 4-20mA signal from the gas cooler/system controller. The PSD4 translates this signal into a suitable stepper motor sequence to position the valve proportionally. The PSS4B Backup Power Module provides reserve power for one full valve closure in the event of a power loss. This serves to isolate the refrigerant charge and minimize CO₂ refrigerant loss if system pressure exceeds the system's pressure relief valve setting.

MODEL	GC, FGB
Motor type	Permanent magnet bipolar internal (wet) motor
Phase Resistance	12.8 Ω ± 10%
Phase Inductance	18.5 mH (Reference)
Phase Current	275 mA (using current limited / chopper drive)
Holding Current	0 mA
Cable type	M12 Quad-Position
Step mode	2 Phase, Full Step
Step rate	400/s
Number of steps	2500
Initialization number of steps	3125
Reference Position	Overdrive against fully closed position
Full Stroke Transit Time	7.25s
MRP	2030 psig (140 barg)
MOPD GC	1305 psid (90 bar)
MOPD FGB	725 psid (50 bar)
Max external leakage	0.10 oz/y @ 300 psig (2.8 g/y @ 20 barg)
Ambient temp. range	-40°F to 140°F (-40°C to 60°C)
Fluid temp. range	-40°F to 239°F (-40°C to 115°C)
Certifications and Compliance	UL US (SA5460), CE, RoHS, REACH



FEATURES AND BENEFITS

- High resolution actuators with 2500 steps
- 7.25 second full stroke actuation
- Uniquely characterized pin and port combinations to provide excellent full range flow control
- Cartridge valve designs
- Interchangeable bodies with flexible connections
- Replaceable/serviceable screen (GC Series)



ORDERING INSTRUCTIONS

Description	Family	Model	Connection size	Cable length
Possible values	GC	- 10 20	1/2"	LESS CABLE*
	GC	- 30	3/4" 1"	
	GC	- 40 50	1"	
	FGB	- 60 70	1"	
Example	GC	- 30	1"	LESS CABLE

Cables with length of 10', 20', 30' and 40' are available as separated options.

GAS COOLER VALVE CAPACITY

Full stroke capacity (capacities in Tons)			
Gas Cooler Valve inlet conditions	650 psi(g); 51°F	725 psi(g); 59°F	1450 psi(g); 100°F
Gas Cooler Valve outlet conditions	435 psi(g); 24°F	561 psi(g); 41°F	561 psi(g); 41°F
GC-10	9.5	6.20	6.60
GC-20	21.6	14.1	16.9
GC-30	80.2	52.5	61.9
GC-40	154	101	111
GC-50	226	148	163

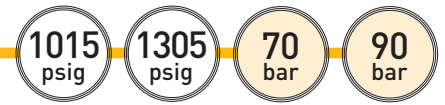
Please refer to Parker Sporlan's [Virtual Engineer](#) sizing and selection software.

FLASH GAS BYPASS VALVE COEFFICIENTS

Full stroke flow coefficients			
	Kv	Cv us	
GC-10	0.16	0.19	
GC-20	0.48	0.55	
GC-30	1.46	1.69	
GC-40	2.80	3.24	
GC-50	4.15	4.80	
FGB-60	7.29	8.43	
FGB-70	11.12	12.86	

Full stroke capacity (capacities in kW)			
Gas Cooler Valve inlet conditions	44 bar(g); 10°C	50 bar(g); 15°C	100 bar(g); 38°C
Gas Cooler Valve outlet conditions	30 bar(g); -4°C	39 bar(g); 5°C	39 bar(g); 5°C
GC-10	35.5	21.9	23.3
GC-20	75.8	49.6	58.4
GC-30	282	185	218
GC-40	542	355	390
GC-50	795	520	572

ELECTRIC VALVES

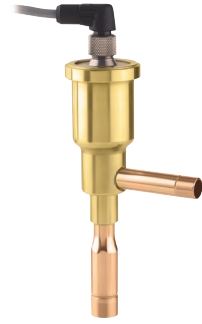


ELECTRIC EXPANSION VALVES

TYPE **SER-AA-HP, SER-A-HP**

The SER valves are suitable for use in subcritical and transcritical CO₂ refrigeration systems as electric expansion valves. The -AA and -A models are available with two distinct pressure ratings. The standard SER valves have a maximum rated pressure (MRP) of 1015 psig (70 bar). The high pressure SER-HP version has a 1305 psig (90 bar) MRP.

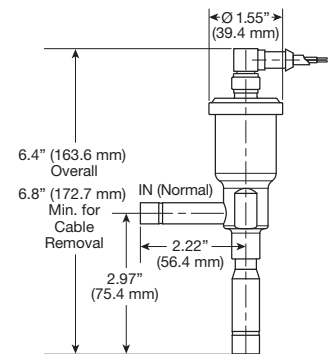
Both the SER and SER-HP models have a maximum operating pressure differential (MOPD) of 580 psid (40 bar). With advanced pin and port geometries and precision machined components, these bi-flow valves provide unmatched resolution under the lightest load conditions. The SER-HP valves utilize the existing SER body design and improves its pressure rating with thick walled copper fittings. The SER-HP has the same robust design, corrosion resistance and mounting flexibility for which the SER valve has become known. The SER and SER-HP valves have a removable M12 style cable that is IP67 rated.



MODEL	SER-AA, -A	SER-AA-HP, -A-HP
Motor type	2 phases, bipolar wet motor	
Compatible oil	All common Mineral, Polyolester and Alkybenzene oils	
Supply voltage	12 V DC, -5%, +10% (L/R)	
Cable type	IP67 Removable M12 Quad-Position	
Phase resistance	100 ohm ± 10%	
Stepping current	120 mA/ winding (L/R)	
Step rate	200/s (L/R), up to 400/s (properly configured current chopper)	
Number of steps	2500	
MOPD	580 psid (40 bar)	
MRP	1015 psig (70 bar)	1305 psig (90 bar)
Max internal leakage	100 cc/min @ 100 psid (6.9 bar), dry air	
Max external leakage	0.10 oz./yr @ 300 psig (2.8 g/y @ 20 bar)	
Operating temp. Range	-50 ÷ 155°F [-45 ÷ 68°C]	
ATEX marking	II 3 G Ex nA IIC T6 Gc -20°C ≤ Ta ≤ +60°C IP64/67	
Certifications and Compliance	ULus (SA5460), CE, PED, RoHS, REACH	

FEATURES AND BENEFITS

- Step motor operated for precise control
- High resolution drive assembly
- High linear force output
- Self lubricating materials used for long life
- Solenoid tight seating
- Corrosion resistant materials used throughout



ORDERING INSTRUCTIONS

Description	Family	Model	High MRP	Inlet fitting	Outlet fitting	Fitting type	Cable length	Stripped and tinned cable ends
Possible values	SER	- AA A	- HP	3/8"	x 3/8" 1/2"	ODF	- LESS CABLE	- S
Example	SER	- AA	- HP	3/8"	x 3/8"	ODF	- LESS CABLE	- S

Cables with length of 10', 20', 30' and 40' are available as separated options.

CAPACITY

Full Stroke Capacity (capacities in Tons)															
Evaporation Temp [°F]	-40°F					-20°F					0°F				
	100	150	200	250	300	100	150	200	250	300	100	150	200	250	300
Δp [psid]	1.24	1.38	1.51	1.63	1.75	1.08	1.24	1.39	1.52	1.64	0.88	1.08	1.24	1.39	1.52
SER-AA	2.67	2.98	3.27	3.53	3.78	2.33	2.69	3.00	3.29	3.55	1.90	2.32	2.68	3.00	3.29
SER-A															

Full stroke capacity (capacities in kW)													
Evaporation Temp [°C]	-40°C				-30°C				-20°C				
	8	12	16	20	8	12	16	20	8	12	16	20	
Δp [bar]	4.70	5.25	5.75	6.22	4.09	4.73	5.28	5.79	3.34	4.09	4.73	5.29	
SER-AA	10.15	11.35	12.44	13.43	8.85	10.21	11.42	12.51	7.22	8.85	10.22	11.42	
SER-A													

Liquid temperature correction factors										
°F	0	10	20	30	40	50	60	70	80	
°C	-18	-12	-7	-1	4	10	16	21	27	
	1.13	1.07	1.00	0.93	0.86	0.79	0.71	0.62	0.51	

ELECTRIC VALVES

ELECTRIC EXPANSION VALVES

TYPE SER-B, SER-C

The SER 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 is easily interfaced with microprocessor based controllers, including Sporlan supplied controllers.

1015
psig

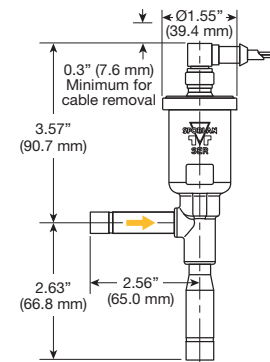
70
bar



MODEL	SER-B, SER-C
Motor type	2 phases, bipolar wet motor
Compatible oil	All common Mineral, Polyolester and Alkybenzene oils
Supply voltage	12 V DC, -5%, +10% measured at the valve leads
Cable type	IP67 Removable M12 Quad-Position
Phase resistance	100 ohm ± 10%
Stepping current	120 mA/ winding
Step rate	200/s (L/R), up to 400/s (properly configured, current chopper)
Number of steps	2500
MOPD	580 psid (40 bar)
MRP	1015 psig (70 bar)
Max internal leakage	100 cc/min @ 100 psid (6.9 bar), dry air
Max external leakage	0.10 oz./yr @ 300 psig (2.8 g/y @ 20 bar)
Operating temp. Range	-50 ÷ 155°F (-45 ÷ 68°C)
ATEX marking	II 3 G Ex nA IIC T6 Gc -20°C ≤ Ta ≤ +60°C IP64/67
Certifications and Compliance	UL US (SA5460), CE, PED, RoHS, REACH

FEATURES AND BENEFITS

- Step motor operated for precise control
- High resolution drive assembly
- High linear force output
- Self lubricating materials used for long life
- Solenoid tight seating
- Corrosion resistant materials used throughout



ORDERING INSTRUCTIONS

Description	Family	Model	Inlet fitting	Outlet fitting	Fitting type	Cable length	Stripped and tinned cable ends	
Possible values	SER	B C	1/4" 3/8"	x x	3/8" 1/2" 5/8"	ODF	LESS CABLE	S
Example	SER	B	3/8"	x	3/8"	ODF	LESS CABLE	S

Cables with length of 10', 20', 30' and 40' are available as separated options

CAPACITY

Full Stroke Capacity (capacities in Tons)															
Evaporation Temp [°F]	-40°F					-20°F					0°F				
	100	150	200	250	300	100	150	200	250	300	100	150	200	250	300
Δp [psid]	5.13	5.74	6.29	6.79	7.26	4.47	5.17	5.78	6.33	6.83	3.65	4.47	5.16	5.77	6.32
SER-B	13.9	15.6	17.0	18.4	19.7	12.1	14.0	15.7	17.2	18.5	9.9	12.1	14.0	15.6	17.1
SER-C															

Full stroke capacity (capacities in kW)													
Evaporation Temp [°C]	-40°C				-30°C				-20°C				
	8	12	16	20	8	12	16	20	8	12	16	20	
Δp [bar]	19.4	21.7	23.8	25.7	16.9	19.6	21.9	24.0	13.8	16.9	19.6	21.9	
SER-B	52.7	59.0	64.6	69.8	45.9	53.0	59.3	65.0	37.5	46.0	53.1	59.3	
SER-C													

Liquid temperature correction factors					
°F	0	10	20	30	40
°C	-18	-12	-7	-1	4
	1.13	1.07	1.00	0.93	0.86

ELECTRIC VALVES

1305 psig 90 bar

PULSE WIDTH MODULATION VALVES

TYPE SPW

The Sporlan SPW line of electric expansion valves uses pulse width modulation (PWM) control to manage refrigerant flow in direct expansion refrigeration systems. The valve's duty cycle is varied based on measured evaporator superheat. Typical controllers monitor superheat and vary the duty cycle across a 6 seconds period. The SPW valve family offers 8 port sizes to cover a wide range of evaporator loads. The serviceable port and strainer design allows the contractor to service and clean the SPW valve or easily replace the port during a refrigerant retrofit.



MODEL	SPW
Actuation type	Pulse Width Modulation
Recommended period	6 seconds
Control range	10 – 100% Duty Cycle
Voltage	24 VAC/60 Hz, 110-120 VAC/50-60 Hz, 220-240 VAC/50-60 Hz
Power input	11W
Inrush power	38 VA
Holding power	22 VA
Coil resistance	4.0 Ω (24 VAC) - 103.1 Ω (110-120 VAC) - 412.9 Ω (220-240 VAC)
Electrical connection style	"½" NPT Conduit W/18" leads DIN 43650A"
Mounting Orientation	Enclosing tube no less than horizontal
Strainer size	100µm
Max Internal Leak	5 @ 100 psid
Max External Leak	0.1 oz/year @ 300 psig
Certifications & Compliance	UL File MH4576, PED, Reach, ROHS, LVD
Maximum Rating Pressure [MRP]	1305 psig / 90 barg
MOPD	507 psid / 35 bar
Ambient temp. range	-40°F to 130°F (-40°C to 54°C)
Fluid temp. range	-40°F to 180°F (-40°C to 82°C)

Refer Bulletin 30-30 for more details.

ORDERING INSTRUCTIONS

Description	VALVE	Port size	Inlet fitting	Outlet fitting	Fitting type	COIL
Possible values	SPW	- 0 thru 7	3	x 4	ODF	LESS COIL
Example	SPW	- 1	3	x 4	ODF	LESS COIL

Description	COIL	Connector	Coil voltage	Coil type	Wire gauge	Cable length
Possible values	PWC	- Blank E = DIN	24/60 110-120/50-60 220-240/50-60	Blank C = Conduit	Blank A = 3/16" insulation	Blank 18 (inches)
Example	PWC	- E	220-240/50-60	C	A	18

CAPACITY

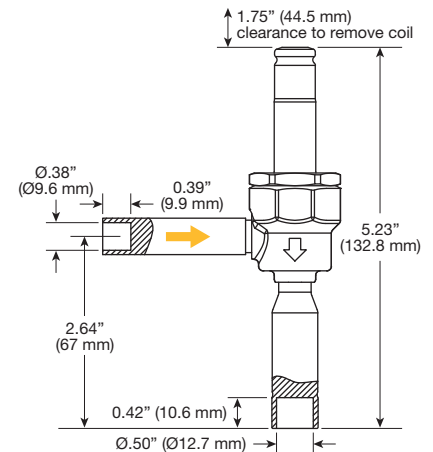
Evaporation Temp	Full stroke capacity (capacities in kW, pressures in bar)											
	-20°C				-30°C				-40°C			
	8	12	16	20	8	12	16	20	8	12	16	20
SPW-0	0.47	0.58	0.67	0.75	0.47	0.58	0.67	0.75	0.47	0.57	0.66	0.74
SPW-1	1.15	1.41	1.63	1.82	1.15	1.41	1.63	1.82	1.14	1.40	1.62	1.81
SPW-2	2.07	2.53	2.92	3.27	2.07	2.53	2.92	3.27	2.05	2.51	2.90	3.25
SPW-3	3.19	3.91	4.51	5.05	3.19	3.91	4.51	5.04	3.17	3.88	4.48	5.01
SPW-4	5.52	6.76	7.81	8.73	5.52	6.76	7.81	8.73	5.48	6.72	7.76	8.67
SPW-5	8.69	10.6	12.3	13.7	8.68	10.6	12.3	13.7	8.63	10.6	12.2	13.6
SPW-6	14.6	17.9	20.6	23.1	14.6	17.9	20.6	23.1	14.5	17.8	20.5	22.9
SPW-7	25.7	31.4	36.3	40.6	25.7	31.4	36.3	40.6	25.5	31.2	36.1	40.3

Evaporation Temp	Full Stroke Capacity (capacities in Tons, pressures in psid)											
	0°F				-20°F				-40°F			
	100	150	200	300	100	150	200	300	100	150	200	300
SPW-0	0.12	0.15	0.17	0.21	0.12	0.15	0.18	0.21	0.12	0.15	0.17	0.21
SPW-1	0.30	0.37	0.43	0.52	0.30	0.37	0.43	0.52	0.30	0.37	0.42	0.52
SPW-2	0.54	0.66	0.77	0.94	0.54	0.66	0.77	0.94	0.54	0.66	0.76	0.93
SPW-3	0.84	1.02	1.18	1.45	0.84	1.03	1.18	1.45	0.83	1.02	1.18	1.44
SPW-4	1.45	1.77	2.05	2.51	1.45	1.77	2.05	2.51	1.44	1.76	2.04	2.49
SPW-5	2.28	2.79	3.22	3.94	2.28	2.79	3.22	3.95	2.26	2.77	3.20	3.92
SPW-6	3.83	4.69	5.41	6.63	3.83	4.69	5.42	6.63	3.80	4.66	5.38	6.59
SPW-7	6.73	8.24	9.52	11.7	6.74	8.25	9.53	11.7	6.69	8.19	9.46	11.6

Liquid temperature correction factors						
°F	0	10	20	30	40	50
°C	-18	-12	-7	-1	4	10
	1.32	1.24	1.17	1.09	1.00	0.91

FEATURES AND BENEFITS

- Low Wattage NEMA-4X Coil, IP65 Rated, Class F
- Robust Design, 50 Million+ Cycle Life
- Interchangeable Coil, Port & Strainer
- Tight seating design
- Solenoid tight seating
- Operates from 10% to 100% of rated capacity



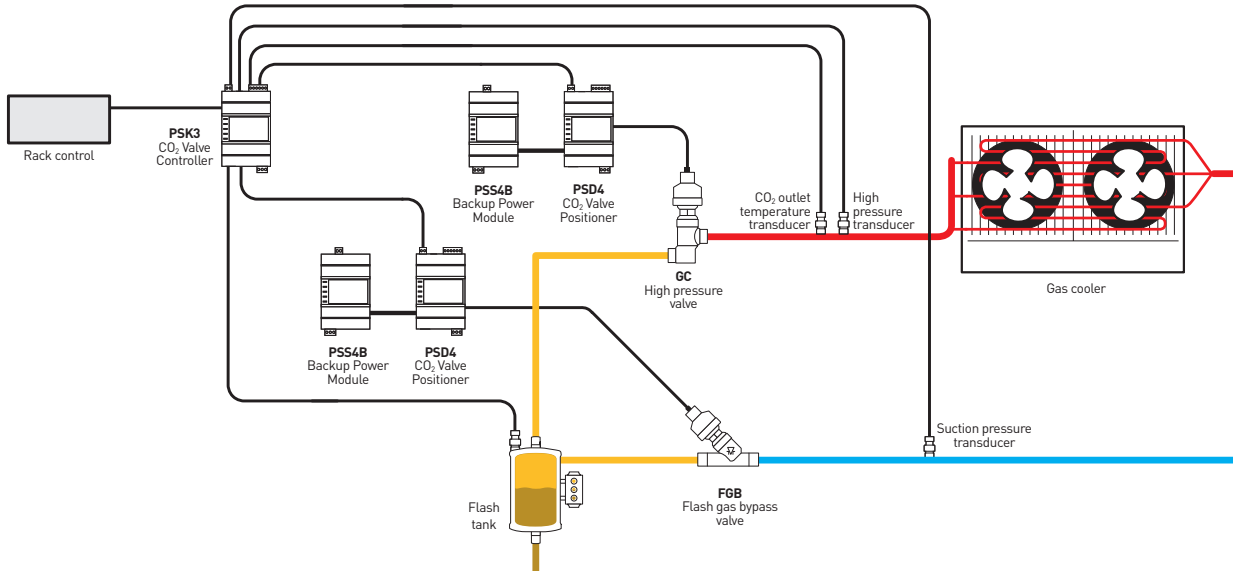
ELECTRONIC CONTROLLERS

CO₂ VALVE POSITIONER

PSD4BX3XXXVP

PSD4BX3XXXVP CO₂ Valve Positioner drives the Parker-Sporlan GC and FGB valves. By providing either a 0-10V or 4-20mA signal from a system controller, the PSD4BX3XXXVP translates this signal in to a suitable stepper motor sequence to position the valve proportionally.

The Backup Power Module PSS4B is available as an option. Upon power loss, the backup module provides reserve power for one full valve closure, to isolate the refrigerant and minimize refrigerant loss due to venting.



IB-G BOARD FOR CO₂ APPLICATIONS

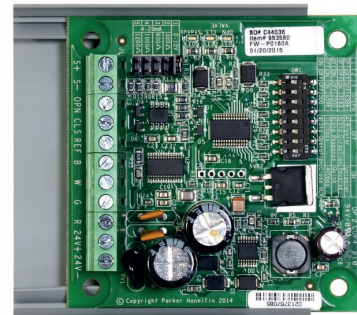
IB-G is a small electronic circuit board that extends the functionality of an external system controller to drive Step Motor Valves. The IB-G board can manage SER family of electric expansion valves and CDS family of electric pressure regulating valves. The IB-G board can power one or two valves. Two bipolar valves may be used and will operate simultaneously and will open and close by the same number of steps.

The controller accepts 4-20mA or 0-10V Analog Input signal from external controller. Enhanced features include LED indicators for power and valve position.

FEATURES AND BENEFITS

- Small dimensions
- 24V power supply
- Easy setup
- Initialization routine
- Valve force close/open
- Visual indicators LED

Refer to Bulletin 100-50-2.1 for more details.



SOLENOID VALVES

1015
psig

70
bar

TECHNICAL SPECIFICATIONS

TYPE **E2-HP** and **E5-HP** SERIES

The E2-HP Series are direct acting hermetic solenoid valves.

The E5-HP Series are hermetic solenoid valves with pilot operated disc construction.

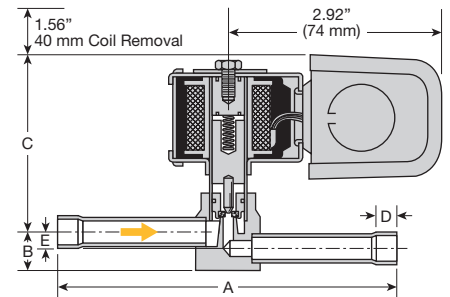
These valves may be mounted horizontally, on their side or in a vertical line.

The E2-HP and E5-HP series solenoid valves feature extended solder type connections as standard. One important benefit to the user is that all valves in the E2-HP and E5-HP series can be installed using either low or no silver content brazing alloy.

The MKC-1 coil is Class "F" temperature rated and is provided as standard, therefore a high temperature coil is not required for discharge service.



E2S120E-HP



FEATURES AND BENEFITS

- Compact, Pilot Operated, Disc Construction
- Mount Horizontally, on Side, or in a Vertical Line
- MKC-1 and OMKC-1 Coils, Class F
- Tight closing through use of synthetic seating material.

ORDERING INSTRUCTIONS

Description	Series	Port size in 1/32"	Connections	Coil size	Connections size in 1/8"	Connection type*	Coil connection	Pressure
Possible values	E	2 5	S=Solder	1	2 3	0 = ODF x ODF 1 = ODF x ODM 2 = ODM x ODF 3 = ODM x ODM	S = Spade E = DIN 43650A	- HP
Example	E	2	S	1	2	0	E	- HP

*Standard connections are ODF inlet x ODF outlet on "E" Series valves. Minimum quantities may be required for other connections.

When ordering complete valves, specify Valve Type, Connections, Voltage and Cycles.

When ordering Body Assembly, specify Valve Type and Connections.

When ordering Coil Assembly ONLY, specify Coil Type, Voltage and Cycles.

Example: MKC-1 120/50-60.

Voltage and cycles available:

24V/50-60Hz, 120V/50-60Hz, 208-240V/50-60Hz, 120-208-240V/50-60Hz.

For Secondary Coolant CO₂ applications, please refer to Bulletin 30-10-10.

TECHNICAL DATA

Series	TYPE	A [inch]	B [inch]	C [inch]	D Fitting depth [ODF] [inch]	E OFFSET [inch]	Connections ODF [inch]	Cv	Port size [inch]	MRP [psi]	MOPD (AC) [psi]	MOPD (DC) [psi]
E2	E2S120-HP	4.63	0.55	1.96	0.31	0.29	1/4	0.15	0.075	1.015	450	400
E5	E5S130-HP	4.56	0.53	2.48	0.31	0.23	3/8	0.53	0.150	1.015	450	400

Series	TYPE	A [mm]	B [mm]	C [mm]	D Fitting depth [ODF] [mm]	E OFFSET [mm]	Connections ODF [inch]	Kv	Port size [mm]	MRP [bar]	MOPD (AC) [bar]	MOPD (DC) [bar]
E2	E2S120-HP	118	14	50	8	7.4	1/4	0.13	1.9	70	31	27.6
E5	E5S130-HP	116	13	63	8	5.8	3/8	0.46	3.8	70	31	27.6

SOLENOID VALVES

1015
psig

70
bar

TECHNICAL SPECIFICATIONS

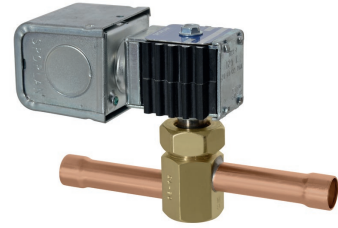
TYPE **E6-HP** and **E8-HP** SERIES

The E6-HP and E8-HP Series are compact solenoid valves with pilot operated disc construction for refrigeration and air conditioning.

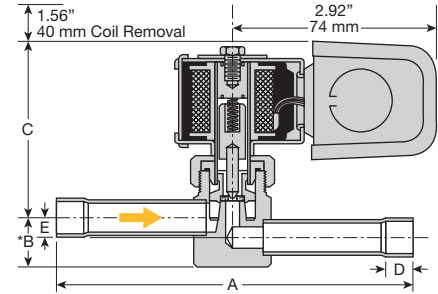
These valves may be mounted horizontally, on their side or in a vertical line. They are suitable for suction line service because very low pressure differential, 1 psi, is required for full operation.

The Type E6-HP and E8-HP series solenoid valves feature extended solder type connections as standard. One important benefit to the user is that all valves in the E6-HP and E8-HP series can be installed without disassembly using either low or no silver content brazing alloy.

The MKC-1 coil is Class "F" temperature rated and is provided as standard, therefore a high temperature coil is not required for discharge service.



E8S140E-HP



FEATURES AND BENEFITS

- Compact, Pilot Operated, Disc Construction
- Mount Horizontally, on Side, or in a Vertical Line
- MKC-1 and OMKC-1 Coils, Class F
- Tight closing through use of synthetic seating material.

ORDERING INSTRUCTIONS

Description	Series	Port size in 1/32"	Connections	Coil size	Connections size in 1/8"	Connection type*	Coil connection	Pressure
Possible values	E ME	6 8	S=Solder	1	3 4	0 = ODF x ODF 1 = ODF x ODM 2 = ODM x ODF 3 = ODM x ODM	S = Spade E = DIN 43650A	- HP
Example	ME	8	S	1	4	0	E	- HP

*Standard connections are ODF inlet x ODF outlet on "E" Series valves. Minimum quantities may be required for other connections.

When ordering complete valves, specify Valve Type, Connections, Voltage and Cycles.

When ordering Body Assembly, specify Valve Type and Connections.

When ordering Coil Assembly ONLY, specify Coil Type, Voltage and Cycles.

Example: MKC-1 120/50-60.

Voltage and cycles available:

24V/50-60Hz, 120V/50-60Hz, 208-240V/50-60Hz, 120-208-240V/50-60Hz.

For Secondary Coolant CO₂ applications, please refer to Bulletin 30-10-10.

TECHNICAL DATA

Series	TYPE	A [inch]	B [inch]	C [inch]	D Fitting depth (ODF) [inch]	E OFFSET [inch]	Connections ODF [inch]	Cv	Port size [inch]	MRP [psi]	MOPD [AC] [psi]	MOPD [DC] [psi]
E6	E6S130-HP	4.66	0.73	2.59	0.31	0.31	3/8	0.93	0.188	1.015	450	400
	E6S140-HP	5.00	0.73	2.59	0.38	0.31	1/2	0.93	0.188	1.015	450	400
E8	E8S140-HP	5.00	0.73	2.59	0.38	0.31	1/2	0.93	0.250	1.015	450	400

Series	TYPE	A [mm]	B [mm]	C [mm]	D Fitting depth (ODF) [mm]	E OFFSET [mm]	Connections ODF [mm]	Kv	Port size [mm]	MRP [bar]	MOPD [AC] [bar]	MOPD [DC] [bar]
E6	E6S130-HP	118	19	66	7.9	7.9	3/8	0.81	4.8	70	31	27.6
	E6S140-HP	127	19	66	9.7	7.9	1/2	0.81	4.8	70	31	27.6
E8	E8S140-HP	127	19	66	9.7	7.9	1/2	1.02	6.3	70	31	27.6

SOLENOID VALVES

1015
psig

70
bar

TECHNICAL SPECIFICATIONS

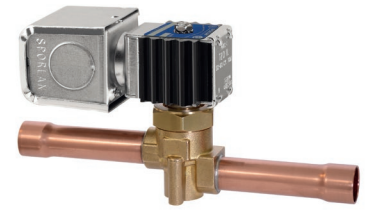
TYPE E10S1-HP SERIES

Type E10S1-HP Series are compact solenoid valves with pilot operated disc construction for refrigeration and air conditioning.

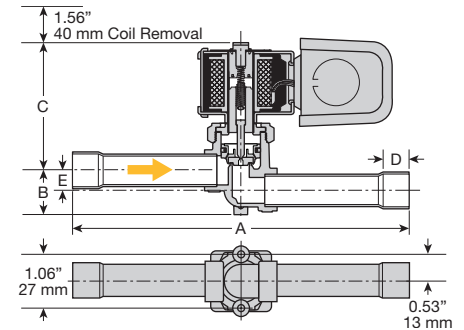
These valves may be mounted horizontally, on their side or in a vertical line. They are suitable for suction line service because very low pressure differential, 1 psi, is required for full operation.

The Type E10S1-HP Series solenoid valves features extended solder type connections as standard and the MKC-1 coil. One important benefit to the user is that all valves in the E10S1-HP series can be installed without disassembly using either low or no silver content brazing alloy.

The MKC-1 and OMKC-1 coils are Class "F" temperature rated and are provided as standard, therefore a high temperature coil is not required for discharge service.



E10S140E-HP



FEATURES AND BENEFITS

- Compact, Pilot Operated, Disc Construction
- Mount Horizontally, on Side, or in a Vertical Line
- MKC-1 and OMKC-1 Coils, Class F
- Tight closing through use of synthetic seating material.

ORDERING INSTRUCTIONS

Description	Series	Port size in 1/32"	Connections	Coil size	Connections size in 1/8"	Connection type*	Coil connection	Pressure	
Possible values	E ME	10	S=Solder	1	4 5	0 = ODF x ODF 1 = ODF x ODM 2 = ODM x ODF 3 = ODM x ODM	S = Spade E = DIN 43650A	- -	HP
Example	E	10	S	1	4	0	E	-	HP

*Standard connections are ODF inlet x ODF outlet on "E" Series valves. Minimum quantities may be required for other connections.

When ordering complete valves, specify Valve Type, Connections, Voltage and Cycles.

When ordering Body Assembly, specify Valve Type and Connections.

When ordering Coil Assembly ONLY, specify Coil Type, Voltage and Cycles.

Example: MKC-1 120/50-60.

Voltage and cycles available:

24V/50-60Hz, 120V/50-60Hz, 208-240V/50-60Hz, 120-208-240V/50-60Hz.

For Secondary Coolant CO₂ applications, please refer to Bulletin 30-10-10.

TECHNICAL DATA

Series	TYPE	A [inch]	B [inch]	C [inch]	D Fitting depth [ODF] [inch]	E OFFSET [inch]	Connections ODF [inch]	Cv	Port size [inch]	MRP [psi]	MOPD [AC] [psi]	MOPD [DC] [psi]
E10S1-HP	E10S140-HP	5.00	0.86	2.52	0.38	0.39	1/2	2.10	5/16	1.015	450	400
	E10S150-HP	6.49	0.86	2.52	0.50	0.39	5/8	2.10	5/16	1.015	450	400

Series	TYPE	A [mm]	B [mm]	C [mm]	D Fitting depth [ODF] [mm]	E OFFSET [mm]	Connections ODF [mm]	Kv	Port size [mm]	MRP [bar]	MOPD [AC] [bar]	MOPD [DC] [bar]
E10S1-HP	E10S140-HP	127	22	64	10.0	10.0	1/2	1.81	7.9	70	31	27.6
	E10S150-HP	165	22	64	13.0	10.0	5/8	1.81	7.9	70	31	27.6

SOLENOID VALVES



SELECTION – CAPACITY RATIO

LIQUID CAPACITY SELECTION TABLE												
Series	TYPE		Tons of refrigeration					kW of refrigeration				
	Without manual lift stem	With manual lift stem	Pressure drop *									
			[psi]					[bar]				
			1	2	3	4	5	0.07	0.1	0.2	0.3	0.4
	Normally closed	Normally closed										
E2-HP	E2S120-HP	-	0.66	0.95	1.16	1.34	1.51	2.3	2.8	3.9	4.8	5.6
E5-HP	E5S130-HP	-	2.34	3.33	4.09	4.73	5.30	8.1	9.7	13.9	17.0	19.7
E6-HP	E6S130-HP	ME6S130-HP	4.20	5.90	7.21	8.30	9.26	14.6	17.4	24.4	29.8	34.3
	E6S140-HP	ME6S140-HP										
E8-HP	E8S140-HP	ME8S140-HP	5.38	7.60	9.31	10.75	12.02	18.9	22.7	32.2	39.2	45.5
E10S1-HP	E10S140-HP	-	9.11	12.90	15.90	18.40	20.60	32.0	38.6	54.6	67.0	77.0
	E10S150-HP	-										

* Do not use below 1 psi (0.07 bar) pressure drop.

Ratings based on 20°F (-5°C) liquid, -20°F (-30°C) evaporator temperature.
All solenoid valves are tested and rated in accordance with A.R.I. Standard No. 760-2001.
For the selection capacity, MOPD and electrical specifications are required.

CORRECTION FACTOR, LIQUID CAPACITY RATING										
Liquid temperature										
0°F	10°F	20°F	30°F	40°F	-20°C	-15°C	-10°C	-5°C	0°C	5°C
1.13	1.07	1.00	0.93	0.86	1.18	1.12	1.06	1.00	0.94	0.87

These factors include corrections for liquid refrigerant density and net refrigerating effect and are based on an average evaporator temperature of 40°F (5°C). For each 10°F (10°C) reduction in evaporating temperature, capacities are reduced by approximately 1-1/2%.

For Secondary Coolant CO₂ applications, please refer to Bulletin 30-10-10.

Some CO₂ systems do not use oil or lubrication in their systems. If so, the lack of lubrication in the system may cause the internal components of the valve to wear prematurely resulting in eventual failure of the valve. This disclaimer is for solenoid valves only.

SUCTION CAPACITY SELECTION TABLE												
Series	TYPE		Tons of refrigeration					kW of refrigeration				
	Without manual lift stem	With manual lift stem	Evaporation temperature									
			[°F]					[°C]				
			-40°	-30°	-20°	-10°	0°	-40°	-35°	-30°	-25°	-20°
	Normally closed	Normally closed										
E2-HP	E2S120-HP	-	0.10	0.11	0.12	0.13	0.15	2.3	2.8	3.9	4.8	5.6
E5-HP	E5S130-HP	-	0.35	0.39	0.43	0.47	0.52	1.23	1.37	1.51	1.65	1.83
E6-HP	E6S130-HP	ME6S130-HP	0.68	0.75	0.82	0.90	0.98	2.39	2.64	2.88	3.16	3.45
	E6S140-HP	ME6S140-HP										
E8-HP	E8S140-HP	ME8S140-HP	0.82	0.92	1.02	1.14	1.27	2.88	3.23	3.59	4.00	4.46
E10S1-HP	E10S140-HP	-	1.35	1.52	1.70	1.90	2.12	4.75	5.34	5.98	6.68	7.46
	E10S150-HP	-										

Ratings based on 20°F (-5°C) liquid, 25°F (14°C) superheat, 1psi (0.07bar) Δp.

DISCHARGE CAPACITY SELECTION TABLE												
Series	TYPE		Tons of refrigeration					kW of refrigeration				
	Without manual lift stem	With manual lift stem	Pressure drop									
			[psi]					[bar]				
			2	5	10	25	50	0,15	0,3	0,7	1,5	4,0
	Normally closed	Normally closed										
E2-HP	E2S120-HP	-	0.21	0.34	0.48	0.77	1.25	0.78	1.11	1.71	2.52	4.67
E5-HP	E5S130-HP	-	0.75	1.20	1.70	2.72	4.39	2.75	3.91	6.02	8.87	16.5
E6-HP	E6S130-HP	ME6S130-HP	1.40	2.20	3.09	4.85	7.46	5.11	7.19	10.9	15.9	27.9
	E6S140-HP	ME6S140-HP										
E8-HP	E8S140-HP	ME8S140-HP	1.81	2.89	4.05	6.41	8.78	6.61	9.36	14.2	20.9	32.8
E10S1-HP	E10S140-HP	-	2.90	4.63	6.60	10.5	15.5	10.6	15.2	23.4	34.5	58.1
	E10S150-HP	-										

Ratings based on 20°F (-5°C) condensing, isentropic compression plus 50°F (28°C), -20°F (-30°C) evaporator, 5°F (-15°C) suction gas at the compressor.

BALL VALVES

1305
psig

90
bar

BALL VALVE WITH INTEGRATED PRESSURE RELIEF

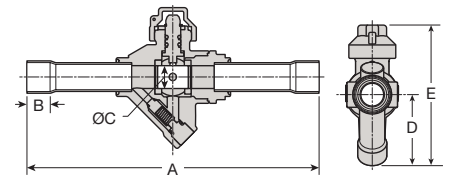
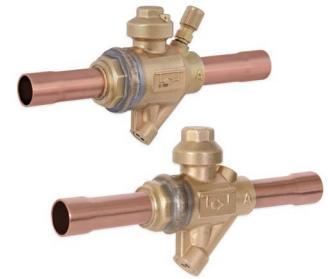
TYPE EBV(T)-PR

For greater system design flexibility and increased productivity, specify the EBV(T)-PR Ball Valve with Integrated Pressure Relief. This compact solution eliminates the check valve and associated brazing involved when piping a ball valve and check valve in parallel to protect a system from over pressurization.

EBV(T)-PR allows for positive shut-off in one direction and flow in the other direction whenever pressure differential is present. The integrated pressure relief feature is in one direction only.

FEATURES AND BENEFITS

- All EBV-PR ball valves may be installed in any position.
- Protects system from pressure spikes when servicing equipment.
- Stainless steel stop plate ensures fully open to fully closed with a 1/4 turn.
- Full size ports for unrestricted flow on most sizes, 3/8" (10 mm) through 1-1/8" (28 mm).
- Dual Teflon seals surround the polished, brass ball to prevent leakage.
- Stem seal and stem washer provide the primary stem seal.
- Bottom load stem for safety.
- Maximum Rating Pressure (MRP) of 1,305 psig (90 bar)
- Operating temperature range: -40°F to +225°F (-40°C to +107°C)



ORDERING INSTRUCTIONS

Description	Family	Access fitting	Pressure relief	Series	Fitting size	Fitting configuration	
Possible values	EBV	T	-	PR	1 = full port 2 = reduced port	XX (ODF connection in eighths of an inch) -xxMM (ODF connection in mm)	0 = ODF x ODF
Example	EBV	T	-	PR	1	03	0

DIMENSIONS AND TECHNICAL DATA

	Connection (ODF)	A Overall length [inch]	B Socket depth [inch]	C Port size [inch]	D [inch]	E Overall height [inch]	Cv
EBV-PR1030	3/8"	6.5	0.3	0.50	1.6	3.1	4.30
EBV-PR1040	1/2"	6.5	0.4	0.50	1.6	3.1	7.00
EBV-PR1050	5/8"	6.5	0.5	0.50	1.6	3.1	13.9
EBV-PR1060	3/4"	7.3	0.6	0.75	1.8	3.6	21.0
EBV-PR1070	7/8"	7.3	0.8	0.75	1.8	3.6	30.3
EBV-PR1090	1-1/8"	8.5	0.9	1.00	2.1	4.1	61.3
EBVT-PR1030*	3/8"	6.5	0.3	0.50	1.6	3.1	4.30
EBVT-PR1040*	1/2"	6.5	0.4	0.50	1.6	3.1	7.00
EBVT-PR1050*	5/8"	6.5	0.5	0.50	1.6	3.1	13.9
EBVT-PR1060*	3/4"	7.3	0.6	0.75	1.8	3.6	21.0
EBVT-PR1070*	7/8"	7.3	0.8	0.75	1.8	3.6	30.3
EBVT-PR1090*	1-1/8"	8.5	0.9	1.00	2.1	4.1	61.3

	Connection (ODF)	A Overall length [mm]	B Socket depth [mm]	C Port size [mm]	D [mm]	E Overall height [mm]	Kv
EBV-PR-10MM	10 mm	165	8	12.7	40	78	3.67
EBV-PR-12MM	12 mm	165	10	12.7	40	78	6.0
EBV-PR-16MM	16 mm	165	13	12.7	40	78	11.9
EBV-PR-18MM	18 mm	184	16	19.1	45	91	17.9
EBV-PR-22MM	22 mm	184	19	19.1	45	91	25.9
EBV-PR-28MM	28 mm	216	24	25.4	54	104	52.3
EBVT-PR 10MM*	10 mm	165	8	12.7	40	78	3.67
EBVT-PR 12MM*	12 mm	165	10	12.7	40	78	6.0
EBVT-PR 16MM*	16 mm	165	13	12.7	40	78	11.9
EBVT-PR 18MM*	18 mm	184	16	19.1	45	91	17.9
EBVT-PR 22MM*	22 mm	184	19	19.1	45	91	25.9
EBVT-PR 28MM*	28 mm	216	24	25.4	54	104	52.3

* With access fitting.

Refer to Bulletin 50-10-1 for more details.

OTHER COMPONENTS

ELECTRIC PRESSURE REGULATING VALVE

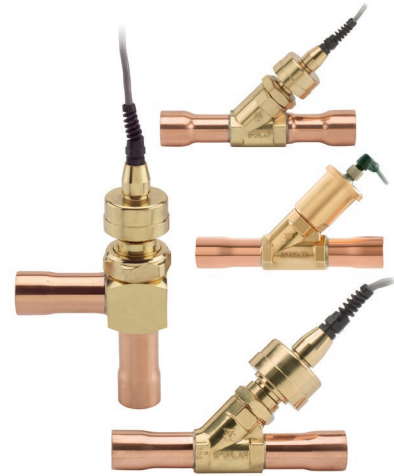


TYPE CDS SERIES

The CDS family represents a line of electronically controlled step motor valves, designed to contribute minimal pressure drop to the system. In addition to their traditional application as Electric Evaporator Pressure Regulators, CDS valves can also be applied as Heat Reclaim, Head Pressure Control or Liquid Line Differential valves. CDS valves can be used to replace a variety of mechanical and solenoid valves throughout typical refrigeration systems, where low pressure drop and precise refrigerant flow control are desired.

Maximum rated pressure of 680 or 700 psig (47 or 48 bar) in according with the model.

Refer to Bulletin 100-40 for more details.



Catch-All®



FILTER-DRIERS

CATCH-ALL® SERIES

The Catch-All® filter-drier removes moisture from the refrigerant by absorbing and retaining it deep within the desiccant granules. Large filtering area of the filter-drier core permits it to collect a large amount of dirt without plug up. Refrigerant flow capacity from 2 tons up to 46.3 tons (7 kW up to 163 kW) at $\Delta P=1$ psi (0.07 bar), 23°F (-5°C) liquid temperature, and -22°F (-30°C) evaporator temperature.

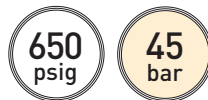
In according with model and size, Catch-All® are available as sealed type or with replaceable core type.

Maximum rated pressure up to 650 psig (44.8 bar) in according with the model.

Refer to Bulletin 40-10 for more details.



See-All®



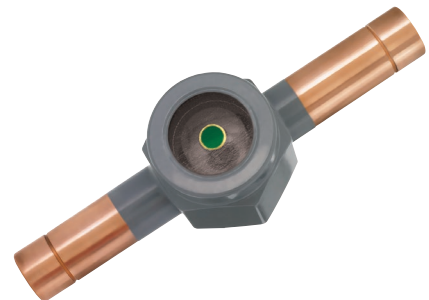
MOISTURE & LIQUID INDICATORS

TYPE SEE-ALL® SERIES

See-All® Moisture and Liquid Indicator combines the two functions of moisture and liquid indication into a single economical product. It takes the guess work out of servicing refrigeration and air conditioning equipment. The See-All® assists the technician in determining the state of the circulating refrigerant at a particular location and if a safe moisture level exists in the system. Reliable and accurately calibrated color change points, replaceable indicator element and unnecessary disassembly for installation are the three bigger benefits on use of See-All®.

Maximum rated pressure of 650 psig (44.8 bar).

Refer to Bulletin 70-10 for more details.



SUPPORT

SIZING AND SELECTION TOOL

VIRTUAL ENGINEER

Parker Sporlan's web-based product selection program, Virtual Engineer, allows the user to size, select, and fully configure products for Air Conditioning and Refrigeration applications, including subcritical and transcritical cycles. An innovative dashboard and project system make saving, editing, and sharing projects easy.

By using Virtual Engineer, OEMs, Wholesalers, and Contractors can select the latest Parker Sporlan products with the most up-to-date refrigerants available on the market today. Users can select and size easily while out on the job site, in the equipment room, or from their office.

Save design engineering time with these simple steps:

- Step 1: Click to access [Parker Sporlan's Virtual Engineer](#).
- Step 2: Choose your product category using the interactive interface.
- Step 3: Size, select and compare products that meet the requirements of your application.
- Step 4: Find a wholesaler, create your personal account, share your project, and/or download files.



Virtual Engineer is a web-based tool that allows the sizing and selection of Sporlan products.

**To Get Started
CLICK HERE:**
[http://solutions.parker.com/
SporlanVirtualEngineer](http://solutions.parker.com/SporlanVirtualEngineer)

A screenshot of the Virtual Engineer web interface. The title is 'Virtual Engineer : Simple CO2 System'. Below the title is a 'Metric' toggle switch set to 'Imperial'. The interface is divided into three main sections: 'SYSTEM CONDITIONS', 'GAS COOLER', and 'FLASH GAS BYPASS'. Each section contains input fields for various parameters. In the 'SYSTEM CONDITIONS' section, 'Evaporator Temperature' is -20 °F, 'Cooling Capacity' is 5 tons, and 'Liquid Temperature' is 35 °F. In the 'GAS COOLER' section, 'Gas Cooler Outlet Temperature' is 80 °F and 'Gas Cooler Outlet Pressure' is 969.57 psi. In the 'FLASH GAS BYPASS' section, 'Receiver Pressure' is 550 psi and 'Flash Tank Temperature' is 37.8 °F. Some values are highlighted in red, indicating they are critical or require special instructions.

Special instructions, critical information, and required parameters are noted in red text.

Another screenshot of the Virtual Engineer web interface, showing a different configuration for a 'Simple CO2 System'. The layout is identical to the first screenshot, but with different values. In the 'SYSTEM CONDITIONS' section, 'Evaporator Temperature' is -20 °F, 'Cooling Capacity' is 5 tons, and 'Liquid Temperature' is 35 °F. In the 'GAS COOLER' section, 'Gas Cooler Outlet Temperature' is 100 °F and 'Gas Cooler Outlet Pressure' is 1400.00 psi. In the 'FLASH GAS BYPASS' section, 'Receiver Pressure' is 550 psi and 'Flash Tank Temperature' is 37.8 °F. Again, some values are highlighted in red.

TERMS OF SALE WITH WARRANTY LIMITATIONS

PARKER-HANNIFIN CORPORATION OFFER OF SALE

1. Definitions. As used herein, the following terms have the meanings indicated.

Buyer: means any customer receiving a Quote for Products.

Goods: means any tangible part, system or component to be supplied by Seller.

Products: means the Goods, Services and/or Software as described in a Quote.

Quote: means the offer or proposal made by Seller to Buyer for the supply of Products.

Seller: means Parker-Hannifin Corporation, including all divisions and businesses thereof.

Services: means any services to be provided by Seller.

Software: means any software related to the Goods, whether embedded or separately downloaded.

Terms: means the terms and conditions of this Offer of Sale.

2. Terms. All sales of Products by Seller are expressly conditioned upon, and will be governed by the acceptance of, these Terms. These Terms are incorporated into any Quote provided by Seller to Buyer. Buyer's order for any Products whether communicated to Seller verbally, in writing, by electronic data interface or other electronic commerce, shall constitute acceptance of these Terms. Seller objects to any contrary or additional terms or conditions of Buyer. Reference in Seller's order acknowledgement to Buyer's purchase order or purchase order number shall in no way constitute an acceptance of any of Buyer's terms or conditions of purchase. No modification to these Terms will be binding on Seller unless agreed to in writing and signed by an authorized representative of Seller.

3. Price; Payment. The Products set forth in the Quote are offered for sale at the prices indicated in the Quote. Unless otherwise specifically stated in the Quote, prices are valid for thirty (30) days and do not include any sales, use, or other taxes or duties. Seller reserves the right to modify prices at any time to adjust for any raw material price fluctuations. Unless otherwise specified by Seller, all prices are F.C.A. Seller's facility (INCOTERMS 2020). All sales are contingent upon credit approval and full payment for all purchases is due thirty (30) days from the date of invoice (or such date as may be specified in the Quote). Unpaid invoices beyond the specified payment date incur interest at the rate of 1.5% per month or the maximum allowable rate under applicable law.

4. Shipment; Delivery; Title and Risk of Loss. All delivery dates are approximate, and Seller is not responsible for damages resulting from any delay. Regardless of the manner of shipment, delivery occurs and title and risk of loss or damage pass to Buyer, upon placement of the Products with the carrier at Seller's facility. Unless otherwise agreed prior to shipment and for domestic delivery locations only, Seller will select and arrange, at Buyer's sole expense, the carrier and means of delivery. When Seller selects and arranges the carrier and means of delivery, freight and insurance costs for shipment to the designated delivery location will be prepaid by Seller and added as a separate line item to the invoice. Buyer shall be responsible for any additional shipping charges incurred by Seller due to Buyer's acts or omissions. Buyer shall not return or repackage any Products without the prior written authorization from Seller, and any return shall be at the sole cost and expense of Buyer.

5. Warranty. The warranty for the Products is as follows: (i) Goods are warranted against defects in material or workmanship for a period of twelve (12) months from the date of delivery or 2,000 hours of use, whichever occurs first; (ii) Services shall be performed in accordance with generally accepted practices and using the degree of care and skill that is ordinarily exercised and customary in the field to which the Services pertain and are warranted for a period of six (6) months from the date of completion of the Services; and (iii) Software is only warranted to perform in accordance with applicable specifications provided by Seller to Buyer for ninety (90) days from the date of delivery or, when downloaded by a Buyer or end-user, from the date of the initial download. All prices are based upon the exclusive limited warranty stated above, and upon the following disclaimer: **EXEMPTION CLAUSE; DISCLAIMER OF WARRANTY, CONDITIONS, REPRESENTATIONS: THIS WARRANTY IS THE SOLE AND ENTIRE WARRANTY, CONDITION, AND REPRESENTATION, PERTAINING TO PRODUCTS. SELLER DISCLAIMS ALL OTHER WARRANTIES, CONDITIONS, AND REPRESENTATIONS, WHETHER STATUTORY, EXPRESS OR IMPLIED, INCLUDING BUT NOT**

LIMITED TO THOSE RELATING TO DESIGN, NONINFRINGEMENT, MERCHANTABILITY, AND FITNESS FOR A PARTICULAR PURPOSE. SELLER DOES NOT WARRANT THAT THE SOFTWARE IS ERROR-FREE OR FAULT-TOLERANT, OR THAT BUYER'S USE THEREOF WILL BE SECURE OR UNINTERRUPTED. UNLESS OTHERWISE AUTHORIZED IN WRITING BY SELLER, THE SOFTWARE SHALL NOT BE USED IN CONNECTION WITH HAZARDOUS OR HIGH RISK ACTIVITIES OR ENVIRONMENTS. EXCEPT AS EXPRESSLY STATED HEREIN, ALL PRODUCTS ARE PROVIDED "AS IS".

6. Claims; Commencement of Actions. Buyer shall promptly inspect all Products upon receipt. No claims for shortages will be allowed unless reported to Seller within ten (10) days of delivery. Buyer shall notify Seller of any alleged breach of warranty within thirty (30) days after the date the non-conformance is or should have been discovered by Buyer. Any claim or action against Seller based upon breach of contract or any other theory, including tort, negligence, or otherwise must be commenced within twelve (12) months from the date of the alleged breach or other alleged event, without regard to the date of discovery.

7. LIMITATION OF LIABILITY. IN THE EVENT OF A BREACH OF WARRANTY, SELLER WILL, AT ITS OPTION, REPAIR OR REPLACE THE NON-CONFORMING PRODUCT, RE-PERFORM THE SERVICES, OR REFUND THE PURCHASE PRICE PAID WITHIN A REASONABLE PERIOD OF TIME. **IN NO EVENT IS SELLER LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES INCLUDING ANY LOSS OF REVENUE OR PROFITS, WHETHER BASED IN CONTRACT, TORT OR OTHER LEGAL THEORY. IN NO EVENT SHALL SELLER'S LIABILITY UNDER ANY CLAIM MADE BY BUYER EXCEED THE PURCHASE PRICE PAID FOR THE PRODUCTS.**

8. Confidential Information. Buyer acknowledges and agrees that any technical, commercial, or other confidential information of Seller, including, without limitation, pricing, technical drawings or prints and/or part lists, which has been or will be disclosed, delivered or made available, whether directly or indirectly, to Buyer ("Confidential Information"), has been and will be received in confidence and will remain the property of Seller. Buyer further agrees that it will not use Seller's Confidential Information for any purpose other than for the benefit of Seller.

9. Loss to Buyer's Property. Any tools, patterns, materials, equipment or information furnished by Buyer or which are or become Buyer's property ("Buyer's Property"), will be considered obsolete and may be destroyed by Seller after two (2) consecutive years have elapsed without Buyer ordering the Products manufactured using Buyer's Property. Furthermore, Seller shall not be responsible for any loss or damage to Buyer's Property while it is in Seller's possession or control.

10. Special Tooling. "Special Tooling" includes but is not limited to tools, jigs, fixtures and associated manufacturing equipment acquired or necessary to manufacture Goods. Seller may impose a tooling charge for any Special Tooling. Such Special Tooling shall be and remain Seller's property notwithstanding payment of any charges by Buyer. In no event will Buyer acquire any interest in the Special Tooling, even if such Special Tooling has been specially converted or adapted for manufacture of Goods for Buyer and notwithstanding any charges paid by Buyer. Unless otherwise agreed, Seller has the right to alter, discard or otherwise dispose of any Special Tooling or other property owned by Seller in its sole discretion at any time.

11. Security Interest. To secure payment of all sums due from Buyer, Seller retains a security interest in all Products delivered to Buyer and, Buyer's acceptance of these Terms is deemed to be a Security Agreement under the Uniform Commercial Code. Buyer authorizes Seller as its attorney to execute and file on Buyer's behalf all documents Seller deems necessary to perfect Seller's security interest.

12. User Responsibility. Buyer, through its own analysis and testing, is solely responsible for making the final selection of the Products and warning requirements of the application of the Products are met. Buyer must analyze all aspects of the application and follow applicable industry standards, specifications, and any technical information provided with the Quote or the Products, such as Seller's instructions, guides and specifications. If Seller provides options of or for Products based upon data or specifications provided by Buyer, Buyer is responsible for determining that such data and specifications are suitable and sufficient for all applications and reasonably foreseeable uses of the Products. In the event Buyer is not the end-user of the Products, Buyer will ensure such end-user complies with this paragraph.

TERMS OF SALE WITH WARRANTY LIMITATIONS

13. Use of Products, Indemnity by Buyer. Buyer shall comply with all instructions, guides and specifications provided by Seller with the Quote or the Products. **Unauthorized Uses.** If Buyer uses or resells the Products in any way prohibited by Seller's instructions, guides or specifications, or Buyer otherwise fails to comply with Seller's instructions, guides and specifications, Buyer acknowledges that any such use, resale, or non-compliance is at Buyer's sole risk. Further, Buyer shall indemnify, defend, and hold Seller harmless from any losses, claims, liabilities, damages, lawsuits, judgments and costs (including attorney fees and defense costs), whether for personal injury, property damage, intellectual property infringement or any other claim, arising out of or in connection with: (a) improper selection, design, specification, application, or any misuse of Products; (b) any act or omission, negligent or otherwise, of Buyer; (c) Seller's use of patterns, tools, equipment, plans, drawings, designs, specifications or other information or things furnished by Buyer; (d) damage to the Products from an external cause, repair or attempted repair by anyone other than Seller, failure to follow instructions, guides and specifications provided by Seller, use with goods not provided by Seller, or opening, modifying, deconstructing, tampering with or repackaging the Products; or (e) Buyer's failure to comply with these Terms. Seller shall not indemnify Buyer under any circumstance except as otherwise provided in these Terms.

14. Cancellations and Changes. Buyer may not cancel or modify, including but not limited to movement of delivery dates for the Products, any order for any reason except with Seller's written consent and upon terms that will indemnify, defend and hold Seller harmless against all direct, incidental and consequential loss or damage and any additional expense. Seller, at any time, may change features, specifications, designs and availability of Products.

15. Limitation on Assignment. Buyer may not assign its rights or obligations without the prior written consent of Seller.

16. Force Majeure. Seller is not liable for delay or failure to perform any of its obligations by reason of events or circumstances beyond its reasonable control. Such circumstances include without limitation: accidents, labor disputes or stoppages, government acts or orders, acts of nature, pandemics, epidemics, other widespread illness, or public health emergency, delays or failures in delivery from carriers or suppliers, shortages of materials, war (whether declared or not) or the serious threat of same, riots, rebellions, acts of terrorism, fire or any reason whether similar to the foregoing or otherwise. Seller will resume performance as soon as practicable after the event of force majeure has been removed. All delivery dates affected by force majeure shall be tolled for the duration of such force majeure and rescheduled for mutually agreed dates as soon as practicable after the force majeure condition ceases to exist. Force majeure shall not include financial distress, insolvency, bankruptcy, or other similar conditions affecting one of the parties, affiliates and/or sub-contractors.

17. Waiver and Severability. Failure to enforce any provision of these Terms will not invalidate that provision; nor will any such failure prejudice either party's right to enforce that provision in the future. Invalidation of any provision of these Terms shall not invalidate any other provision herein and, the remaining provisions will remain in full force and effect.

18. Termination. Seller may terminate any agreement governed by or arising from these Terms for any reason and at any time by giving Buyer thirty (30) days prior written notice. Seller may immediately terminate, in writing, if Buyer: (a) breaches any provision of these Terms, (b) becomes or is deemed insolvent, (c) appoints or has appointed a trustee, receiver or custodian for all or any part of Buyer's property, (d) files a petition for relief in bankruptcy on its own behalf, or one is filed against Buyer by a third party, (e) makes an assignment for the benefit of creditors; or (f) dissolves its business or liquidates all or a majority of its assets.

19. Ownership of Software. Seller retains ownership of all Software supplied to Buyer hereunder. In no event shall Buyer obtain any greater right in and to the Software than a right in the nature of a license limited to the use thereof and subject to compliance with any other terms provided with the Software.

20. Indemnity for Infringement of Intellectual Property Rights. Seller is not liable for infringement of any patents, trademarks, copyrights, trade dress, trade secrets or similar rights ("Intellectual Property Rights") except as provided in this Section. Seller will defend at its expense and will pay the cost of any settlement or damages awarded in an action brought against Buyer based on a third party claim that one or more of the Products sold hereunder infringes the Intellectual Property Rights of a third party in the country of delivery of the Products by Seller to Buyer. Seller's obligation to defend and indemnify Buyer is contingent on Buyer notifying Seller within ten (10) days after Buyer becomes aware of any such claim, and Seller having sole control over the defense of the claim including all negotiations for settlement or compromise. If one or more Products sold hereunder is subject to such a claim,

Seller may, at its sole expense and option, procure for Buyer the right to continue using the Products, replace or modify the Products so as to render them non-infringing, or offer to accept return of the Products and refund the purchase price less a reasonable allowance for depreciation. Seller has no obligation or liability for any claim of infringement: (i) arising from information provided by Buyer; or (ii) directed to any Products provided hereunder for which the designs are specified in whole or part by Buyer; or (iii) resulting from the modification, combination or use in a system of any Products provided hereunder. The foregoing provisions of this Section constitute Seller's sole and exclusive liability and Buyer's sole and exclusive remedy for claims of infringement of Intellectual Property Rights.

21. Governing Law. These Terms and the sale and delivery of all Products are deemed to have taken place in, and shall be governed and construed in accordance with, the laws of the State of Ohio, as applicable to contracts executed and wholly performed therein and without regard to conflicts of laws principles. Buyer irrevocably agrees and consents to the exclusive jurisdiction and venue of the courts of Cuyahoga County, Ohio with respect to any dispute, controversy or claim arising out of or relating to the sale and delivery of the Products.

22. Entire Agreement. These Terms, along with the terms set forth in the main body of any Quote, forms the entire agreement between the Buyer and Seller and constitutes the final, complete and exclusive expression of the terms of sale and purchase. In the event of a conflict between any term set forth in the main body of a Quote and these Terms, the terms set forth in the main body of the Quote shall prevail. All prior or contemporaneous written or oral agreements or negotiations with respect to the subject matter shall have no effect. These Terms may not be modified unless in writing and signed by an authorized representative of Seller.

23. Compliance with Laws. Buyer agrees to comply with all applicable laws, regulations, and industry and professional standards, including those of the United States of America, and the country or countries in which Buyer may operate, including without limitation the U.S. Foreign Corrupt Practices Act ("FCPA"), the U.S. Anti-Kickback Act ("Anti-Kickback Act"), U.S. and E.U. export control and sanctions laws ("Export Laws"), the U.S. Food Drug and Cosmetic Act ("FDCA"), and the rules and regulations promulgated by the U.S. Food and Drug Administration ("FDA"), each as currently amended. Buyer agrees to indemnify, defend, and hold harmless Seller from the consequences of any violation of such laws, regulations and standards by Buyer, its employees or agents. Buyer acknowledges that it is familiar with all applicable provisions of the FCPA, the Anti-Kickback Act, Export Laws, the FDCA and the FDA and certifies that Buyer will adhere to the requirements thereof and not take any action that would make Seller violate such requirements. Buyer represents and agrees that Buyer will not make any payment or give anything of value, directly or indirectly, to any governmental official, foreign political party or official thereof, candidate for foreign political office, or commercial entity or person, for any improper purpose, including the purpose of influencing such person to purchase Products or otherwise benefit the business of Seller. Buyer further represents and agrees that it will not receive, use, service, transfer or ship any Products from Seller in a manner or for a purpose that violates Export Laws or would cause Seller to be in violation of Export Laws. Buyer agrees to promptly and reliably provide Seller all requested information or documents, including end-user statements and other written assurances, concerning Buyer's ongoing compliance with Export Laws.



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