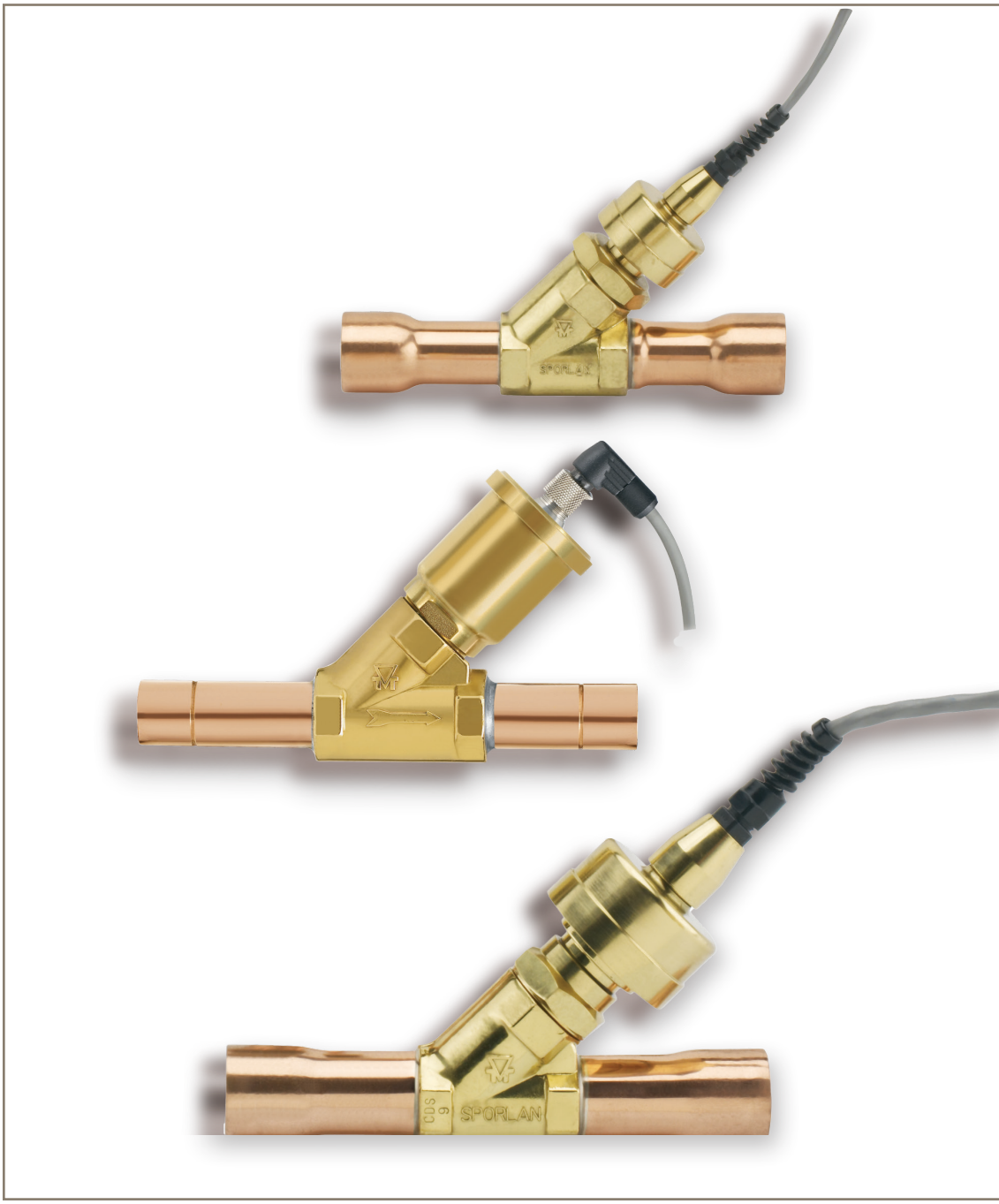
December 2024 / **BULLETIN 100-40**

Electric Pressure Regulating Valves

CDS Series

SPORLAN



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Bulletin 100-40, December 2024 supersedes Bulletin 100-40 April 2018 and all prior publications.

The Sporlan 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. By providing synchronized signals to the step motor, discrete angular movements are translated through a Digital Linear Actuator (DLA) into precise linear positioning of the valve piston. The balanced pistons and ports are uniquely characterized, providing superb flow resolution and performance across a range of applications and operating conditions. The CDS valves interface easily with microprocessor based controllers, including Sporlan supplied controllers.

FEATURES AND BENEFITS

- Step motor operated for precise control
- High resolution drive assembly
- Solenoid tight seating
- Corrosion resistant materials used throughout
- Field proven reliability
- Low power consumption (4 watts or less)
- Balanced port designs
- Compatible with most A1, A2L, and A2 refrigerants and oils, in addition to subcritical CO_2
- Self lubricating materials used for long life
- High linear force output

THE VALVES

Sporlan CDS valves are available in two styles - the CDS-2, CDS-4 and CDS-7 provide 2500 steps of resolution, while the larger CDS-9 and CDS-17 provide 6386 steps of resolution. 12 VDC step motors coupled to an integral gear reduction system give the valves unparalleled accuracy and repeatability over the entire operating range. Capable of tremendous versatility, CDS valves can be used to replace a variety of mechanical and solenoid valves throughout typical refrigeration and air conditioning systems, where low pressure drop and precise refrigerant flow control are desired. And because the valves are powered by an external controller, no pilot lines or high to low side bleeds are required. The tables found at the back of this bulletin show actual capacity at specific conditions representative of several typical applications.

CDS valves have years of proven field performance, but also offer excellent serviceability. A simple cartridge design permits all moving parts to be replaced as a unit, leaving the valve body in the line. The CDS-2, CDS-4 and CDS-7 also offer a removable cable, which reduces damage potential during brazing, and eliminates rewiring when servicing the motor cartridge. Caution: The CDS-9 and CDS-17 feature a hermetic cable, and no attempt should be made to remove the cable.

VALVE OPERATION

The CDS valves are driven by the electronically controlled rotation of a step motor. The step motor drives a gear train and lead screw to position a piston, modulating flow through the port. The two-phase motor is driven in bipolar mode. Two discrete sets of motor 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 a bipolar drive circuit, an example of which is shown in Figure 1. Further exploration of this drive circuit and alternatives is beyond the scope of this bulletin.

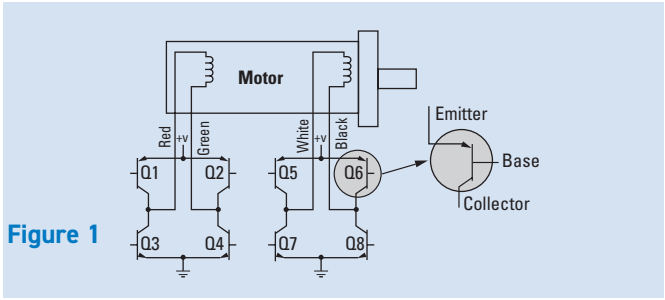


Figure 1

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

OPEN ↓ ↑ CLOSE

CDS-2, -4 and -7 valves have 2500 steps and CDS-9,and -17 have 6386 steps. See specifications for valve stroke and resolution. Phase resistance for the CDS-2, -4 and -7 are different (100 ohms) from the larger valves (75 ohms).

The CDS-9 and -17 are supplied with a hermetic cable connection. CAUTION: No attempt should be made to remove the hermetic cable. The CDS-2, -4 and -7 are supplied with a removable cable. All external parts of the valve are brass, copper or stainless steel, and meet or exceed ASTM standard B-117 for corrosion resistance.

Although 20 feet is the standard cable length, the leads can be supplied from 10 feet (3 meters) up to 40 feet (12 meters) to suit specific customer requirements. If a valve must be installed more than 40 feet from the controller, a short lead wire must be used with an extension of heavier (14-gauge) wire, due to voltage drop considerations. Unless otherwise specified, the terminal end of the wires will be supplied stripped and tinned.

Total power consumption is less than 4 watts when operating a rate of 200 steps per second with standard L/R drive circuitry. Faster step rates up to 400 steps per second may be obtained with properly configured current limited chopper drives. Refer to the motor specifications or contact Sporlan for more information.

The CDS-2 through the CDS-9 valves have a maximum rated pressure of 700 PSIG (48 bar), while the CDS-17 has an MRP of 650 PSIG (44 bar). Allowable ambient temperatures are -50°F to 140°F (-45°C to 60°C), while fluid temperatures up to 240°F (115°C) are acceptable.

APPLICATION

The CDS valves are designed for precise and energy efficient control of evaporator temperatures, in addition to modulating temperature control of reclaim condensers, head pressure or liquid line differential control, and other applications where low pressure drop contribution is desirable. Modulation around a set point is obtained by regulating refrigerant flow in response to signals generated by an electronic controller and sensor combination.

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

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

Power should be removed from the valve when not actively stepping. It is recommended to apply power for 25 ms prior and subsequent to stepping, and to pause 25 ms before reversing direction.

Conventional initialization routines, which include overdriving the motor closed to ascertain the zero step position, are acceptable. Overdriving open is not recommended. When properly controlled, Sporlan CDS valves should not lose steps, and therefore it is not recommended to perform a full initialization every time the valve is closed. It is however, reasonable to reinitialize the valve once per day using 10% of the valve's steps. This reinitialization often occurs during a system defrost or other time when the valve is fully closed.

SELECTION EXAMPLE – SUCTION (TONS)

Refrigerant: R-404A

Liquid Temperature: 80°F
Evaporator Temperature: 20°F
Evaporator Capacity: 4 Tons

To select a valve for these system conditions, look at the suction capacity tables, and locate the set of columns applicable to R-404A. To apply a valve with minimal pressure drop, the 0.5 PSI column should be used. Adjust for the liquid temperature by multiplying the appropriate correction factor (shown at the bottom of the page) to each capacity value. For an evaporator capacity of 4 tons at 20°F, a CDS-17 with a capacity of 6.2* 0.87=5.39 tons would be required. A more economical approach would be to select a CDS-9 at 1 PSI drop, which has a capacity of 4.82 * 0.87 = 4.19 tons. To extend the example, if a 3 PSI drop could be tolerated, the best cost solution would be to select a CDS-7 with a capacity of 5.38 * 0.87 = 4.68 tons.

ORDERING INSTRUCTIONS/NOMENCLATURE

CDS	T	–	9	1-1/8"	ODF	20'	–	S	M-12
Valve Family	Inlet Pressure Tap (Optional)		Valve Model	Fitting Size	Fitting Type	Cable Length		Stripped and Tinned Cable Ends (Custom Connectors Available)	Connection for CDS -2, -4, -7

*CDS-2, CDS-4, CDS-7, CDS-9 and CDS-17 are straight through valves.

SPECIFICATIONS

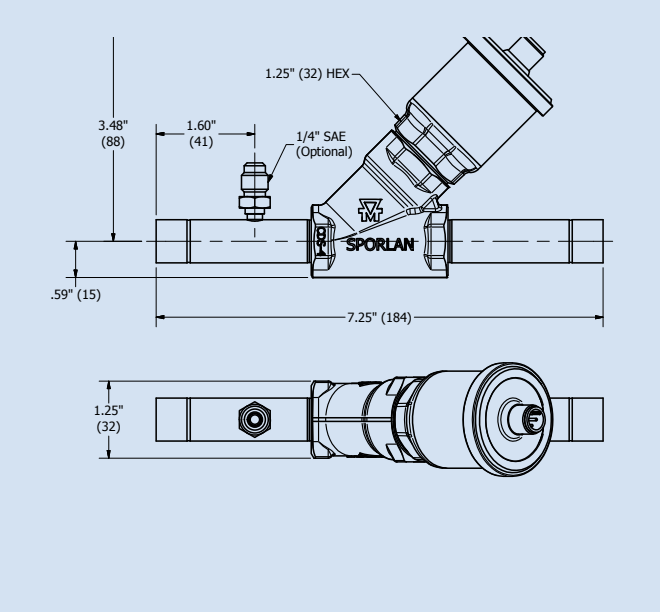
	Valves	Valves	
	CDS -2, -4, -7	CDS -9,	CDS-17
Motor Type	2 phase, bipolar wet motor		
Compatible Refrigerant	All common HCFC and HFC refrigerants including R-410A and subcritical R-744		
Compatible Oils	All common Mineral, Polyolester and Alkybenzene oils		
Supply Voltage*	12 VDC-5% +10% (measured at the valve leads)		
Cable Type	IP67 Removable (M12)	Hermetic	
Phase Resistance	100 ohms ± 10%	75 ohms ± 10%	
Phase Inductance	43 MHz ± 20%	62 MHz ± 20%	
Nominal Current*	120 ma / winding	160 ma / winding	
Holding Current	Evaluate to avoid step loss or damage to the valve**		
Power Input*	2.8 watts	3.8 watts	
Recommended Step Rate	200 / second (L/R), up to 400 / second (properly configured current chopper)		
Number of Steps	2500	6386	
Full Motor Transit Time*	12.5 seconds	32 seconds	
Resolution	.00012 inches (.003 mm) / step	.000078 inches (.002 mm) / step	
Total Stroke	0.297 inches	0.500 inches	
MRP	700 psig (48 bar)	700 psig (48 bar)	650 psig (45 bar)
Max. Internal Leakage	400 cc/min at 100 psid (6.9 bar), dry air		
Max. External Leakage	.10 oz/yr @ 300 psig (2.8 grams/yr @ 20 bar)		
Ambient Temp. Range	-50°F to 140°F (-45°C to 60°C)		
Refrigerant Temp. Range	-50°F to 240°F (-45°C to 116°C)		
Agency Certification	cUR (SA5460), RoHS, REACH		
Materials of Construction	Brass, copper, stainless steel, synthetic seals		

*Specifications based upon L/R driver.
**Contact Sporlan Application Engineering for qualification testing details.

REFERENCE DIMENSIONS – Inches (mm)

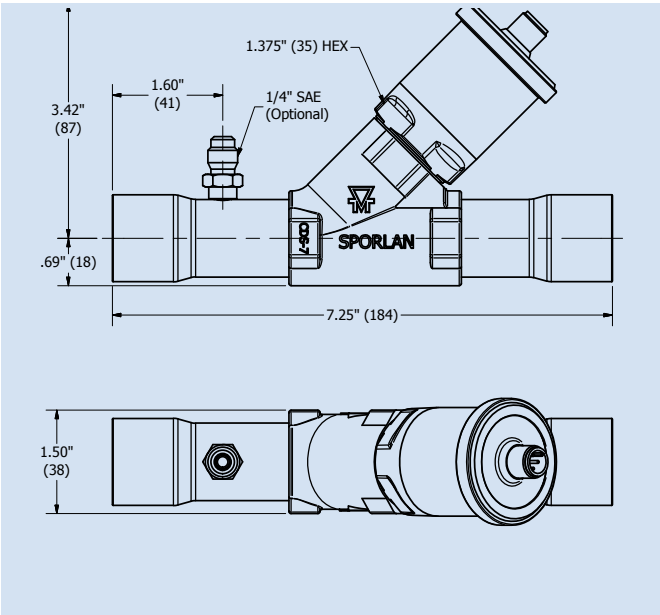
CDS-2, -4

Available Fittings
1/2" ODF
5/8" ODF
7/8" ODF



CDS-7

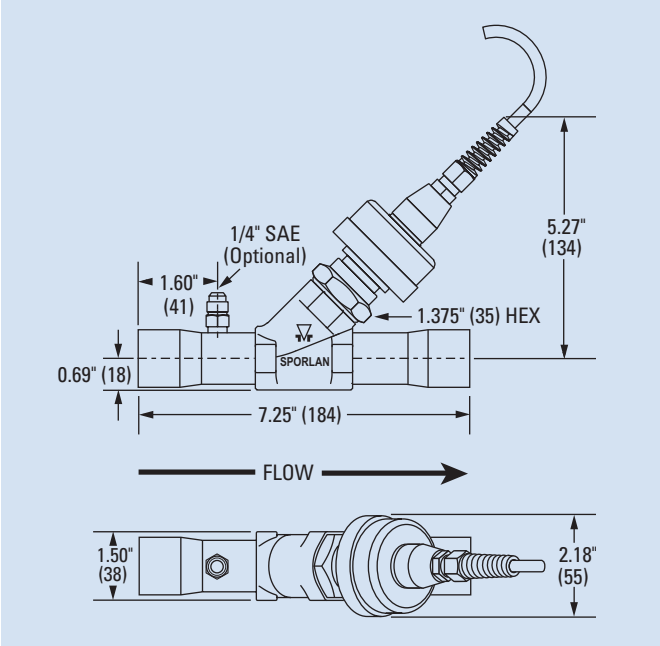
Available Fittings
5/8" ODF
7/8" ODF
1-1/8" ODF
1-3/8" ODF



REFERENCE DIMENSIONS – Inches (mm)

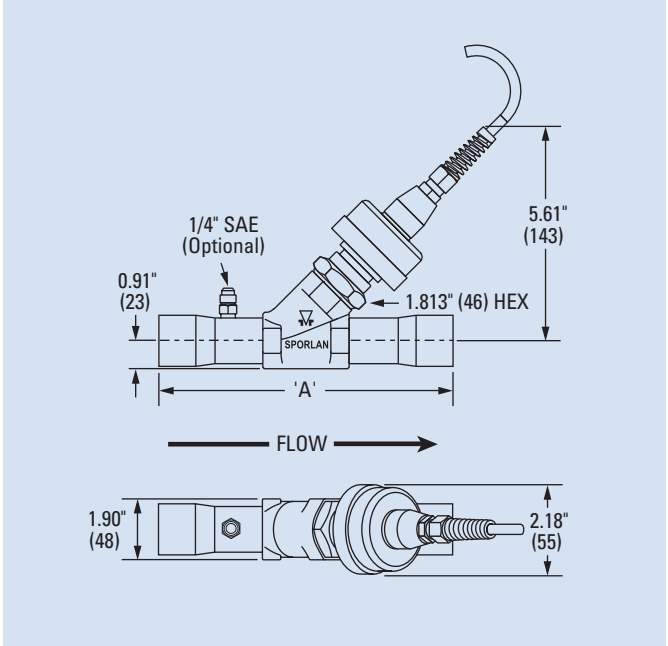
CDS-9

Available Fittings
5/8″ ODF
7/8″ ODF
1-1/8″ ODF
1-3/8″ ODF



CDS-17

Available Fittings	'A'
1-3/8″ ODF	9.88″ (251)
1-5/8″ ODF	9.88″ (251)
2-1/8″ ODF	10.62″ (270)



CORRECTION FACTORS - SUCTION & DISCHARGE

REFRIGERANT	Liquid Temperature Entering Expansion Valve °F										
	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°
	Correction Factor, CF Liquid Temperature										
R-22	1.22	1.18	1.15	1.11	1.07	1.04	1.0	0.96	0.92	0.88	0.84
R-134a	1.27	1.22	1.18	1.14	1.09	1.05	1.0	0.95	0.91	0.86	0.81
R-404A	1.34	1.29	1.23	1.17	1.12	1.06	1.0	0.94	0.88	0.81	0.74
R-407A	1.28	1.23	1.19	1.14	1.10	1.05	1.0	0.95	0.90	0.85	0.79
R-407C	1.26	1.22	1.18	1.13	1.09	1.05	1.0	0.95	0.91	0.86	0.81
R-410A	1.26	1.22	1.18	1.13	1.09	1.05	1.0	0.95	0.90	0.85	0.80
R-422D	1.34	1.29	1.23	1.17	1.12	1.06	1.0	0.94	0.88	0.81	0.75
R-507A	1.35	1.29	1.24	1.18	1.12	1.06	1.0	0.94	0.87	0.81	0.74
R-744	1.09	1.05	1.0	0.95	0.90	–	–	–	–	–	–

CORRECTION FACTORS - LIQUID

REFRIGERANT	Liquid Temperature Entering Expansion Valve °F										
	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°
	Correction Factor, CF Liquid Temperature										
R-22	1.27	1.22	1.18	1.14	1.09	1.05	1.0	0.95	0.91	0.86	0.81
R-134a	1.32	1.27	1.21	1.16	1.11	1.05	1.0	0.95	0.89	0.84	0.78
R-404A	1.41	1.35	1.28	1.21	1.14	1.07	1.0	0.93	0.86	0.78	0.70
R-407A	1.34	1.29	1.23	1.17	1.12	1.06	1.0	0.94	0.88	0.82	0.76
R-407C	1.32	1.27	1.22	1.16	1.11	1.05	1.0	0.94	0.89	0.83	0.77
R-410A	1.33	1.28	1.22	1.17	1.11	1.06	1.0	0.94	0.88	0.82	0.76
R-422D	1.41	1.34	1.27	1.21	1.14	1.07	1.0	0.93	0.86	0.79	0.71
R-507A	1.42	1.35	1.28	1.21	1.14	1.07	1.0	0.93	0.85	0.78	0.70
R-744	1.12	1.06	1.0	0.94	0.88	–	–	–	–	–	–

Capacity based upon 60°F liquid. Reference page 14 for liquid temperature correction factors.
* R-744 capacity based upon 20°F liquid.

FLOW CAPACITY - LIQUID (TONS)

Refrigerant	Pressure Drop (psi)	Valve Model														
		CDS-2			CDS-4			CDS-7			CDS-9			CDS-17		
		Evap Temp (F°)			Evap Temp (F°)			Evap Temp (F°)			Evap Temp (F°)			Evap Temp (F°)		
		40	0	-40	40	0	-40	40	0	-40	40	0	-40	40	0	-40
R22	0.5	3.37	3.21	3.04	7.24	6.91	6.53	19.0	18.1	17.1	28.9	27.6	26.1	52.2	49.8	47.1
	1	4.71	4.49	4.24	10.2	9.70	9.17	26.2	25.0	23.6	40.2	38.3	36.2	72.7	69.3	65.5
	3	8.41	8.02	7.58	18.3	25.7	33.8	46.1	44.0	41.5	71.2	67.9	64.1	129	123	116
	5	11.7	11.2	10.6	25.7	24.6	23.2	63.7	60.8	57.5	98.9	94.3	89.1	180	171	162
	10	15.4	14.7	13.9	33.8	32.3	30.5	82.8	79.0	74.7	129	123	116	235	224	211
R32	0.5	5.01	4.92	-	10.77	10.57	-	28.21	27.69	-	43.4	42.25	-	77.79	76.26	-
	1	7.00	6.87	-	15.12	14.84	-	39.03	38.61	-	59.80	58.70	-	108.13	106.14	-
	3	11.9	11.7	-	25.9	-	-	65.3	64.1	-	100.7	98.90	-	182.6	179.2	-
	5	15.2	14.9	-	33.2	32.6-	-	82.9	81.4	-	128.3	126.0	-	233.0	228.7	-
	10	21.2	20.8	-	46.6	45.8	-	114.7	112.6	-	178.3	175.0	-	324.3	318.3	-
R134a	0.5	3.24	3.00	2.75	6.97	6.46	5.92	18.2	16.9	15.5	27.8	25.8	23.6	50.2	46.5	42.6
	1	4.53	4.19	3.84	9.78	9.06	8.31	25.2	23.4	21.4	38.7	35.8	32.8	69.9	64.8	59.4
	3	8.09	7.49	6.87	17.6	16.3	15.0	44.3	41.0	37.6	68.4	63.4	58.1	124	115	105
	5	11.3	10.5	9.59	24.8	22.9	21.0	61.3	56.8	52.0	95.1	88.1	80.7	173	160	147
	10	14.8	13.7	12.6	32.6	30.2	27.6	79.7	73.8	67.6	124	115	105	226	209	192
R404A	0.5	2.46	2.27	2.05	5.30	4.87	4.40	13.9	12.8	11.6	21.2	19.5	17.6	38.2	35.2	31.8
	1	3.44	3.17	2.86	7.4	6.84	6.18	19.2	17.7	16.0	29.4	27.1	24.5	53.2	49.0	44.3
	3	6.15	5.66	5.12	13.4	12.3	11.1	33.8	31.1	28.1	52.1	47.9	43.3	94.5	87.0	78.6
	5	8.59	7.91	7.15	18.8	17.3	15.6	46.7	43.0	38.8	72.4	66.6	60.2	132	121	109
	10	11.3	10.4	9.36	24.7	22.8	20.6	60.7	55.9	50.5	94.4	86.9	78.5	172	158	143
R407A	0.5	3.10	2.90	2.68	6.66	6.24	5.76	17.4	16.3	15.1	26.6	24.4	23.0	48.0	45.0	41.6
	1	4.33	4.05	3.74	9.35	8.76	8.09	24.1	22.6	20.9	37.0	34.6	32.0	66.9	62.6	57.8
	3	7.73	7.24	6.69	16.9	15.8	14.6	42.4	39.7	56.6	65.5	61.3	56.6	119	111	103
	5	10.8	10.1	9.34	23.7	22.2	20.5	58.7	54.9	78.7	91.0	85.2	78.7	165	155	143
	10	14.1	13.2	12.2	31.1	29.1	26.9	76.2	71.4	103	119	111	103	216	202	187
R454A	0.5	3.3	3.1	-	7.2	6.7	-	18.8	17.6	-	28.6	26.9	-	51.7	48.5	-
	1	4.7	4.4	-	10.1	9.5	-	26.0	24.4	-	39.8	37.4	-	72.0	67.6	-
	3	7.9	7.4	-	17.2	16.2	-	43.4	40.8	-	67.0	62.9	-	121.5	114.1	-
	5	10.1	9.5	-	22.1	20.8	-	55.2	51.8	-	85.4	80.2	-	155.0	145.6	-
	10	14.1	13.3	-	31.1	29.2	-	76.3	71.6	-	118.6	111.4	-	215.8	202.6	-
R454B	0.5	4.16	4.02	-	8.94	8.64	-	23.41	22.62	-	35.72	34.51	-	64.48	62.30	-
	1	5.81	5.61	-	12.55	12.13	-	32.39	31.29	-	49.63	47.95	-	89.74	86.71	-
	3	9.86	9.53	-	21.48	20.76	-	54.17	52.34	-	83.58	80.75	-	151.55	146.43	-
	5	12.6	12.2	-	27.6	26.7	-	68.8	66.5	-	106.5	102.9	-	193.4	186.8	-
	10	17.6	17.0	-	38.7	37.4	-	95.2	92.0	-	148.0	143.0	-	269.1	260.0	-
R454C	0.5	3.1	2.8	-	6.6	6.1	-	17.2	15.9	-	26.2	24.2	-	47.3	43.7	-
	1	4.3	3.9	-	9.2	8.5	-	23.7	21.9	-	36.4	33.6	-	65.8	60.8	-
	3	7.2	6.7	-	15.8	14.6	-	39.7	36.7	-	61.3	56.6	-	111.2	102.7	-
	5	9.3	8.6	-	20.2	18.7	-	50.4	46.6	-	78.1	72.2	-	141.8	131.1	-
	10	12.9	12.0	-	28.4	26.3	-	69.8	64.5	-	108.5	100.3	-	197.4	182.4	-
R455A	0.5	3.1	2.9	-	6.7	6.2	-	17.4	16.1	-	26.6	24.6	-	48.0	44.5	-
	1	4.3	4.0	-	9.4	8.7	-	24.1	22.3	-	37.0	34.2	-	66.8	61.9	-
	3	7.3	6.8	-	16.0	14.8	-	40.3	37.4	-	62.2	57.6	-	112.9	104.5	-
	5	9.4	8.7	-	20.6	19.0	-	51.2	47.4	-	79.3	73.5	-	144.0	133.4	-
	10	13.1	12.2	-	28.9	26.7	-	70.8	65.6	-	110.2	102.1	-	200.4	185.7	-

Capacities based upon 60°F liquid and 25°F superheated vapor. Reference page 14 for liquid temperature correction factors.
* R-744 capacities based upon 20°F liquid and 25°F superheat.

FLOW CAPACITY - SUCTION (TONS)

Refrigerant	Pressure Drop (psi)	Valve Model														
		CDS-2					CDS-4					CDS-7				
		Evap Temp (F°)					Evap Temp (F°)					Evap Temp (F°)				
		40	20	0	-20	-40	40	20	0	-20	-40	40	20	0	-20	-40
R22	0.5	0.53	0.43	0.35	0.28	0.22	1.10	0.91	0.73	0.58	0.45	3.12	2.59	2.11	1.69	1.33
	1	0.73	0.61	0.49	0.39	0.31	1.54	1.27	1.03	0.82	0.63	4.31	3.58	2.93	2.34	1.84
	3	1.25	1.03	0.84	0.65	0.49	2.64	2.18	1.76	1.37	1.02	7.22	5.99	4.89	3.72	2.69
	5	1.59	1.32	1.07	0.82	0.61	3.39	2.79	2.23	1.70	1.22	9.17	7.61	6.04	4.48	3.07
	10	2.28	1.84	1.45	1.09	0.76	4.78	3.82	2.95	2.15	1.41	13.0	10.2	7.62	5.21	3.15
R32	0.5	0.82	0.68	0.56	0.45	-	1.71	1.42	1.17	0.94	-	4.84	4.07	3.37	2.74	-
	1	1.14	0.95	0.79	0.63	-	2.39	2.00	1.64	1.32	-	6.70	5.63	4.67	3.79	-
	3	1.93	1.62	1.33	1.08	-	4.10	3.42	2.81	2.27	-	11.20	9.42	7.80	6.34	-
	5	2.47	2.07	1.71	1.37	-	5.26	4.40	3.61	2.87	-	14.23	11.97	9.91	7.84	-
	10	3.46	2.97	2.39	1.87	-	7.39	6.24	4.99	3.84	-	19.68	17.13	13.46	10.07	-
R134a	0.5	0.42	0.34	0.26	0.20	0.15	0.88	0.70	0.55	0.42	0.31	2.51	2.02	1.59	1.22	0.92
	1	0.59	0.47	0.37	0.28	0.20	1.23	0.98	0.77	0.58	0.41	3.47	2.79	2.20	1.69	1.10
	3	1.00	0.79	0.61	0.45	0.31	2.11	1.67	1.26	0.91	0.61	5.81	4.57	3.40	2.36	1.44
	5	1.29	1.01	0.76	0.54	0.36	2.70	2.09	1.55	1.07	0.65	7.38	5.60	4.01	2.58	1.44
	10	1.76	1.35	0.98	0.66	0.38	3.62	2.71	1.89	1.16	0.65	9.53	6.82	4.36	2.58	1.44
R404A	0.5	0.48	0.39	0.31	0.24	0.19	1.01	0.82	0.65	0.51	0.39	2.85	2.33	1.87	1.47	1.13
	1	0.67	0.55	0.44	0.34	0.26	1.42	1.15	0.92	0.71	0.54	3.94	3.22	2.58	2.03	1.56
	3	1.14	0.93	0.74	0.58	0.43	2.43	1.97	1.57	1.21	0.89	6.60	5.38	4.32	3.31	2.37
	5	1.46	1.19	0.96	0.73	0.53	3.12	2.53	2.00	1.51	1.08	8.38	6.84	5.47	4.03	2.77
	10	2.12	1.68	1.30	0.97	0.68	4.45	3.51	2.68	1.95	1.30	12.2	9.5	7.03	4.86	2.95
R407A	0.5	0.51	0.41	0.32	0.25	0.19	1.06	0.85	0.67	0.52	0.39	3.00	2.44	1.94	1.52	1.16
	1	0.71	0.57	0.45	0.35	0.27	1.48	1.20	0.95	0.73	0.55	4.15	3.37	2.69	2.10	1.60
	3	1.20	0.97	0.77	0.58	0.42	2.54	2.05	1.62	1.22	0.87	6.93	5.64	4.50	3.29	2.27
	5	1.53	1.26	0.98	0.73	0.52	3.26	1.65	2.04	1.50	1.03	8.81	7.27	5.50	3.93	2.53
	10	2.19	1.73	1.32	0.96	0.64	4.59	3.58	2.68	1.87	1.14	12.5	9.5	6.87	4.43	2.55
R454A	0.5	0.53	0.43	0.35	0.27	-	1.11	0.91	0.72	0.57	-	3.16	2.59	2.09	1.65	-
	1	0.74	0.61	0.49	0.38	-	1.56	1.27	1.02	0.80	-	4.37	3.58	2.89	2.28	-
	3	1.26	1.03	0.82	0.64	-	2.68	2.18	1.74	1.33	-	7.32	6.00	4.83	3.64	-
	5	1.62	1.32	1.05	0.80	-	3.44	2.80	2.21	1.66	-	9.29	7.62	5.99	4.39	-
	10	3.32	1.85	1.43	1.06	-	4.87	3.84	2.93	2.11	-	13.29	10.31	7.62	5.16	-
R454B	0.5	0.69	0.58	0.47	0.38	-	1.45	1.20	0.98	0.78	-	4.11	3.43	2.82	2.27	-
	1	0.97	0.80	0.66	0.53	-	2.04	1.69	1.38	1.10	-	5.68	4.75	3.90	3.15	-
	3	1.64	1.37	1.12	0.90	-	3.49	2.89	2.35	1.88	-	9.51	7.94	6.52	5.26	-
	5	2.10	1.75	1.43	1.13	-	4.48	3.71	3.02	2.37	-	12.08	10.08	8.29	6.42	-
	10	2.94	2.50	1.99	1.54	-	6.28	5.23	4.13	3.13	-	16.71	14.26	11.05	8.08	-
R454C	0.5	0.47	0.38	0.30	0.23	-	0.97	0.78	0.62	0.48	-	2.77	2.25	1.79	1.40	-
	1	0.65	0.53	0.42	0.32	-	1.37	1.10	0.87	0.67	-	3.83	3.11	2.48	1.94	-
	3	1.10	0.89	0.71	0.54	-	2.34	1.89	1.48	1.11	-	6.40	5.20	4.08	3.01	-
	5	1.41	1.15	0.89	0.67	-	3.01	2.42	1.86	1.37	-	8.13	6.63	5.00	3.56	-
	10	2.01	1.58	1.20	0.87	-	4.20	3.26	2.43	1.69	-	11.35	8.62	6.16	3.93	-
R455A	0.5	0.48	0.39	0.31	0.24	-	1.01	0.81	0.64	0.50	-	2.85	2.32	1.85	1.45	-
	1	0.67	0.54	0.43	0.34	-	1.41	1.14	0.90	0.70	-	3.95	3.21	2.56	2.01	-
	3	1.14	0.92	0.73	0.56	-	2.42	1.95	1.54	1.16	-	6.60	5.37	4.29	3.14	-
	5	1.46	1.20	0.93	0.70	-	3.10	2.51	1.94	1.43	-	8.39	6.90	5.23	3.75	-
	10	2.08	1.64	1.25	0.91	-	4.35	3.39	2.54	1.79	-	11.81	9.02	6.51	4.22	-

Capacities based upon 60°F liquid and 25°F superheated vapor. Reference page 14 for liquid temperature correction factors.
* R-744 capacities based upon 20°F liquid and 25°F superheat.

FLOW CAPACITY - SUCTION (TONS) continued

Refrigerant	Pressure Drop (psi)	CDS-9 Evap Temp (F°)					CDS-17 Evap Temp (F°)				
		40	20	0	-20	-40	40	20	0	-20	-40
R22	0.5	4.65	3.85	3.14	2.51	1.96	8.31	6.88	5.6	4.47	3.49
	1	6.46	5.35	4.36	3.48	2.72	11.6	9.57	7.79	6.22	4.85
	3	10.9	9.01	7.34	5.64	4.17	19.5	16.2	13.2	10.2	7.50
	5	13.9	11.5	9.17	6.96	4.98	24.9	20.6	16.6	12.5	8.88
	10	19.7	15.7	12.1	8.71	5.60	35.6	28.3	21.6	15.5	9.77
R32	0.5	7.21	6.06	5.00	4.06	-	12.90	10.82	8.93	7.23	-
	1	10.02	8.42	6.95	5.64	-	17.95	15.06	12.43	10.06	-
	3	16.88	14.17	11.71	9.49	-	30.31	25.43	20.98	16.99	-
	5	21.51	18.06	14.92	11.85	-	38.68	32.44	26.77	21.41	-
	10	29.68	25.78	20.54	15.75	-	53.83	46.61	37.05	28.28	-
R134a	0.5	3.73	2.99	2.35	1.81	1.35	6.67	5.34	4.19	3.22	2.40
	1	5.19	4.16	3.27	2.51	1.69	9.28	7.43	5.83	4.48	3.04
	3	8.74	6.89	5.20	3.73	2.45	15.7	12.5	9.37	6.68	4.34
	5	11.2	8.9	6.33	4.33	2.56	20.1	15.5	11.3	7.69	4.47
	10	14.9	11.0	7.60	4.58	2.56	26.7	19.7	13.4	7.99	2.97
R404A	0.5	4.26	3.47	2.77	2.17	1.67	7.62	6.20	4.95	3.88	2.97
	1	5.91	4.82	3.85	3.02	2.31	10.6	8.62	6.89	5.40	4.13
	3	9.96	8.11	6.49	4.99	3.64	17.9	14.6	11.6	9.02	6.57
	5	12.7	10.3	8.27	6.20	4.41	22.8	18.6	14.9	11.2	7.90
	10	18.4	14.5	11.0	7.93	5.20	33.2	26.1	19.7	14.1	9.13
R407A	0.5	4.47	3.62	2.89	2.25	1.71	7.99	6.47	5.15	4.01	3.04
	1	6.21	5.03	4.01	3.12	2.37	11.1	9.01	7.17	5.57	4.23
	3	10.5	8.48	6.75	5.01	3.56	18.8	15.2	12.1	9.05	6.40
	5	13.3	10.9	8.39	6.15	4.19	24.0	19.8	15.1	11.0	7.45
	10	18.9	14.7	10.9	7.56	4.52	34.2	26.5	19.6	13.4	7.9
R454A	0.5	4.71	2.59	2.09	1.65	-	8.43	6.88	5.53	4.35	-
	1	6.55	3.58	2.89	2.28	-	11.73	9.58	7.69	6.05	-
	3	11.03	6.00	4.83	3.64	-	19.83	16.18	12.99	9.94	-
	5	14.03	7.62	5.99	4.39	-	25.27	20.64	16.42	12.25	-
	10	20.09	10.31	7.62	5.16	-	36.30	28.51	21.52	15.23	-
R454B	0.5	6.13	5.11	4.19	3.37	-	10.96	9.12	7.47	6.00	-
	1	8.51	7.09	5.81	4.68	-	15.25	12.69	10.40	8.36	-
	3	14.34	11.94	9.79	7.88	-	25.75	21.44	17.56	14.11	-
	5	18.27	15.22	12.48	9.76	-	32.85	27.35	22.40	17.61	-
	10	25.38	21.57	16.98	12.80	-	45.78	38.97	30.58	22.94	-
R454C	0.5	4.12	3.34	2.66	2.07	-	7.37	5.96	4.74	3.69	-
	1	5.73	4.64	3.69	2.88	-	10.26	8.30	6.60	5.14	-
	3	9.64	7.81	6.13	4.59	-	17.32	14.02	11.09	8.28	-
	5	12.29	10.00	7.65	5.61	-	22.10	18.08	13.80	10.06	-
	10	17.29	13.38	9.90	6.80	-	31.19	24.05	17.70	12.00	-
R455A	0.5	4.25	3.45	2.75	2.15	-	7.60	6.16	4.91	3.83	-
	1	5.91	4.79	3.82	2.98	-	10.58	8.58	6.83	5.33	-
	3	9.95	8.07	6.43	4.79	-	17.87	14.48	11.53	8.64	-
	5	12.68	10.38	7.97	5.87	-	22.80	11.53	14.38	10.54	-
	10	17.94	13.94	10.39	7.21	-	32.38	8.64	18.59	12.77	-

Capacities based upon 60°F liquid and 25°F superheated vapor. Reference page 14 for liquid temperature correction factors.
* R-744 capacities based upon 20°F liquid and 25°F superheat.

FLOW CAPACITY - DISCHARGE (TONS)

Refrigerant	Pressure Drop (psi)	Valve Model														
		CDS-2			CDS-4			CDS-7			CDS-9			CDS-17		
		Evap Temp (F°)			Evap Temp (F°)			Evap Temp (F°)			Evap Temp (F°)			Evap Temp (F°)		
		40	0	-40	40	0	-40	40	0	-40	40	0	-40	40	0	-40
R22	0.5	0.74	0.69	0.63	1.56	1.45	1.32	4.36	4.05	3.71	6.52	6.07	5.55	11.7	10.9	9.94
	1	1.04	0.96	0.88	2.19	2.04	1.86	6.03	5.61	5.14	9.07	8.44	7.72	16.3	15.1	13.8
	3	1.77	1.64	1.50	3.76	3.5	3.20	10.1	9.43	8.63	15.3	14.3	13.1	27.6	25.7	23.5
	5	2.27	2.11	1.93	4.85	4.51	4.12	12.9	12.0	11.0	19.6	18.3	16.7	35.3	32.9	30.1
	10	3.20	2.98	2.72	6.88	6.40	5.85	18.0	16.8	15.4	27.5	25.6	23.4	49.7	46.2	42.3
R32	0.5	1.11	1.05	-	2.34	2.20	-	6.55	6.16	-	9.80	9.21	-	17.55	16.49	-
	1	1.56	1.46	-	3.29	3.08	-	9.07	8.52	-	13.63	12.80	-	24.44	22.96	-
	3	2.65	2.49	-	5.64	5.29	-	15.20	14.29	-	23.00	21.61	-	41.38	38.87	-
	5	3.40	3.19	-	7.26	6.81	-	19.35	18.19	-	29.38	27.60	-	52.92	49.71	-
	10	4.77	4.48	-	10.26	9.62	-	26.93	25.32	-	41.06	38.58	-	74.09	69.59	-
R134a	0.5	0.64	0.59	0.53	1.34	1.23	1.11	3.76	3.46	3.12	5.62	5.16	4.66	10.1	9.24	8.34
	1	0.89	0.82	0.74	1.88	1.73	1.56	5.21	4.79	4.32	7.83	7.19	6.49	14.0	12.9	11.6
	3	1.53	1.40	1.26	3.25	2.98	2.69	8.78	8.06	7.28	13.3	12.2	11.0	23.9	21.9	19.8
	5	1.97	1.80	1.63	4.19	3.85	3.47	11.2	10.3	9.30	17.0	15.6	14.1	30.6	28.1	25.4
	10	2.79	2.56	2.31	5.99	5.49	4.96	15.8	14.5	13.1	24.0	22.0	19.9	43.3	39.8	35.9
R404A	0.5	0.69	0.63	0.57	1.46	1.34	1.19	4.06	3.71	3.31	6.08	5.56	4.97	10.9	9.97	8.91
	1	0.97	0.89	0.79	2.05	1.88	1.68	5.62	5.13	4.59	8.46	7.74	6.91	15.2	13.9	12.4
	3	1.65	1.51	1.35	3.53	3.23	2.88	9.43	8.62	7.70	14.3	13.1	11.7	25.8	23.5	21.0
	5	2.12	1.94	1.73	4.55	4.16	3.71	12.0	11.0	9.82	18.3	16.7	14.9	33.0	30.2	26.9
	10	2.99	2.74	2.44	6.45	5.90	5.26	16.8	15.3	13.7	25.7	23.5	20.9	46.3	42.4	37.8
R407A	0.5	0.74	0.69	0.62	1.56	1.44	1.30	4.36	4.02	3.64	6.54	6.03	5.45	11.7	10.8	9.76
	1	1.04	0.96	0.87	2.20	2.03	1.83	6.04	5.57	5.04	9.09	8.38	7.58	16.3	15.0	13.6
	3	1.77	1.63	1.48	3.78	3.48	3.15	10.1	9.36	8.46	15.4	14.2	12.8	27.7	25.5	23.1
	5	2.28	2.10	1.90	4.87	4.49	4.06	12.9	11.9	10.8	19.7	18.1	16.4	35.4	32.7	29.5
	10	3.21	2.96	2.68	6.91	6.37	5.75	18.1	16.7	15.1	27.6	25.4	23.0	49.8	45.9	41.5
R454A	0.5	0.82	0.75	-	1.72	1.58	-	4.78	4.42	-	7.16	6.62	-	12.84	11.85	-
	1	1.14	1.05	-	2.41	2.23	-	6.62	6.11	-	9.96	9.20	-	17.88	16.51	-
	3	1.94	1.79	-	4.14	3.83	-	11.11	10.26	-	16.83	15.54	-	30.30	27.98	-
	5	2.49	2.30	-	5.34	4.93	-	14.15	13.07	-	21.52	19.87	-	38.79	35.82	-
	10	3.51	3.24	-	7.56	6.98	-	19.74	18.23	-	30.15	27.84	-	54.44	50.27	-
R454B	0.5	0.98	0.92	-	2.06	1.93	-	5.74	5.38	-	8.60	8.06	-	15.41	14.43	-
	1	1.37	1.28	-	2.89	2.71	-	7.95	7.45	-	11.96	11.20	-	21.46	20.10	-
	3	2.33	2.18	-	4.96	4.64	-	13.33	12.49	-	20.19	18.92	-	36.34	34.04	-
	5	2.99	2.80	-	6.39	5.98	-	16.98	15.91	-	25.80	24.17	-	46.49	43.54	-
	10	4.20	3.93	-	9.03	8.45	-	23.64	22.16	-	36.08	33.80	-	65.13	61.01	-
R454C	0.5	0.74	0.68	-	1.56	1.43	-	4.35	3.98	-	6.52	5.96	-	11.68	10.68	-
	1	1.04	0.95	-	2.19	2.01	-	6.02	5.51	-	9.06	8.29	-	16.27	14.88	-
	3	1.77	1.62	-	3.77	3.45	-	10.11	9.25	-	15.32	14.02	-	27.58	25.23	-
	5	2.27	2.08	-	4.86	4.45	-	12.89	11.79	-	19.60	17.93	-	35.32	32.32	-
	10	3.20	2.93	-	6.89	6.31	-	18.00	16.47	-	27.48	25.15	-	49.63	45.41	-
R455A	0.5	0.79	0.72	-	1.66	1.52	-	4.62	4.23	-	6.92	6.34	-	12.41	11.36	-
	1	1.10	1.01	-	2.33	2.14	-	6.39	5.85	-	9.62	8.81	-	17.28	15.82	-
	3	1.88	1.72	-	4.01	3.67	-	10.72	26.81	-	16.26	14.89	-	29.28	26.81	-
	5	2.41	2.21	-	5.17	4.73	-	13.67	34.32	-	20.79	19.04	-	37.49	34.32	-
	10	3.40	3.11	-	7.32	6.69	-	19.06	48.16	-	29.13	26.67		52.61	48.16	-

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