Bulletin 100-40 / **APRIL 2008**

CDS

ELECTRIC EVAPORATOR CONTROL VALVES

SPORLAN MECHATRONICS

FOR USE ON REFRIGERATION and/or AIR CONDITIONING SYSTEMS ONLY

Bulletin 100-40, April 2008 supersedes Bulletin 100-40, November 2002, and all prior publications.

The **CDS** valves are electronically operated step motor evaporator pressure regulating valves. 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 superb flow resolution and performance. The CDS valves easily interface with microprocessor based controllers, including Sporlan supplied controllers.

10 FEATURES AND BENEFITS

- **Step motor operated for precise control**
- **High resolution drive assembly**
- **Tight seating valve for suction applications**
- **Corrosion resistant materials used throughout**
- **Field proven reliability**
- **Low power consumption**
- **Balanced port design**
- **Compatibility tested with most CFC, HCFC and HFC refrigerants and oils**
- **Self lubricating materials used for long life**
- **High linear force output**

THE VALVES

The CDS valves are designed for precise and energy efficient control of evaporator temperatures. Proper temperature is obtained by regulating refrigerant flow in the evaporator in response to signals generated by an electronic controller and sensor combination. The valves are built around balanced ports which require input less than one quarter of the power used by older, heat motor and analog designs. When not actively stepping, power to the motor is removed for further energy savings. The 12 VDC step motors coupled to the integral gear reduction system, give the valves unparalleled accuracy and repeatability over the entire operating range.

Because the valves are powered by an external controller, no pilot lines or high to low side bleeds are required. When properly applied the CDS valves and controllers can replace standard mechanical evaporator pressure regulator (EPR) valves, suction stop solenoid valves, and conventional thermostats. Since these valves have a direct acting motor, they can be sized for minimal pressure drop.

The simple cartridge design permits all moving parts to be replaced as a unit, leaving the valve body in the line. This reduces the chance of leaks developing.

The CDS-7 uses the same forging and fittings to provide a drop-in or alternative to the CDS-9 and incorporates the same piston and port size to provide equal system performance. The CDS-7 motor has been updated with a stainless steel housing, similar to the SER family. This new stainless steel housing incorporates the robust design of the SERs motor, with years of proven field performance.

The CDS-7 is engineered to maximize capacity, meeting the requirements of most CDS-9 applications. Features have been added like the newly designed removeable cable, which eliminates the potential of damaging the valve wiring during the brazing process. In addition to simplifying new valve installation, the removable cable eliminates re-wiring if service is required.

Another addition to the CDS line is the CDS-4. The smaller port and forging of the CDS-4 makes it ideal for mounting in the case or at the rack. The design provides tighter control on low load circuits such as single evaporators, dual temp end caps, or seafood cases.

The CDS-4 uses the same motor housing, and has the same precision steps of resolution (2500), as the CDS-7. Careful selection of the piston and port allow both low pressure drop and high control resolution. The desirable features of the CDS-7 valve are also incorporated in the CDS-4 – including the ability to remove the cable for installation and motor replacement. The motor housing is field tested and offers proven reliability.

The Sporlan CDS valves are currently available in nominal R-22 capacities from 1 to 35 tons (3.5 to 123 kW). The capacity tables on pages 9 and 10 show actual capacities at specific conditions.

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 valve's port.

The two-phase motor is driven in the bipolar mode. Two discrete sets of motor stator windings are powered in sequence to rotate the rotor. Polarity of the drive signal reverses for each step. The sequencing is accomplished electronically through the bipolar drive circuit shown in Figure 1. The drive transistors, Q1 through Q8, are electronically biased in pairs by the controller as shown in Table 1.

Table 1

BIPOLAR DRIVE SEQUENCE					
CLOSE ↓	STEP	Q1-Q4	Q2-Q3	Q5-Q8	Q6-Q7	↑ OPEN
	1	ON	OFF	ON	OFF	
	2	ON	OFF	OFF	ON	
	3	OFF	ON	OFF	ON	
	4	OFF	ON	ON	OFF	
	1	ON	OFF	ON	OFF	

CDS-4 and CDS-7 valves have 2500 steps and CDS-9, 16 and 17 have 6386 steps. See specifications for valve stroke and resolution.

Although phase resistance for the CDS-4 and CDS-7 are different (100 ohms) from the larger valves (75 ohms), no controller modification should be necessary.

All external parts of the valve are brass, copper or stainless steel and meet or exceed ASTM standard B-117 for corrosion resistance.

The CDS-9, 16 and 17 are supplied with a hermetic cable connection. The CDS-4 and CDS-7 are supplied with a replacable cable. Although 20 feet is the standard length, the lead can be supplied in a variety of lengths up to 40 feet (12 meters) to suit specific customer requirements. Unless otherwise specified, the terminal end of the wires will be supplied stripped and tinned.

CAUTION: No attempt should be made to remove cable from CDS-9, 16 and 17. The 40-foot limit on the lead wire is because of voltage drop considerations. 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.

Total power consumption is less than 4 watts when operating a rate of 200 steps per second with standard L/R drive circuitry. Refer to the motor specifications shown on pages 4 through 8. Faster step rates may be obtained with proper "current limited chopper" type drives. Please contact Sporlan for more information.

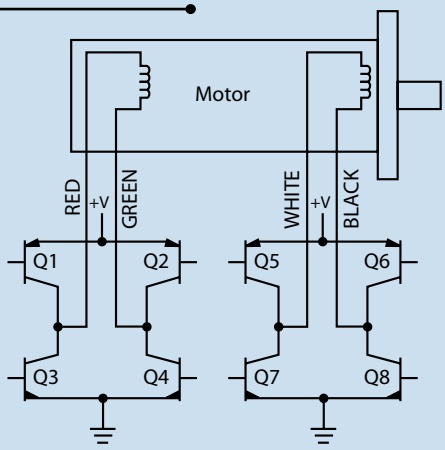
The CDS valves have a maximum rated pressure of at least 680 PSIG, (47 bar). Operating ambient temperature range is -50°F to 140°F (-45°C to 60°C) but temperatures of up to 250°F (120°C) may be used for dehydration.

APPLICATION

Sporlan 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. General drive circuitry is shown in Figure 1. 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 to the valve be disabled when not actively stepping. Conventional initialization routines, which include overdriving the motor to ascertain the zero step position, are acceptable. The valve should be completely closed on initial power up of the controller by inducing 7,500 steps in the closing direction. (Subsequent closing of the valve should include 10% more steps than would be required from the valve's calculated position.)

Figure 1



SELECTION EXAMPLE

REFRIGERANT: R-22
CONDENSING TEMPERATURE: 110°F
LIQUID TEMPERATURE: 60°F
EVAPORATOR TEMPERATURE: 20°F
EVAPORATOR CAPACITY: 6 Tons

To select a valve for the system conditions listed above, look at the capacity tables on page 9. The leftmost set of columns lists the capacities for the valves when used on R-22 systems. To apply a valve with a minimum pressure drop, the 0.5 PSI column should be used. Note that for an evaporator of 20°F, a CDS-16 with a capacity of 6.41 tons would be required for this application. A more economical approach would be to use the CDS-9 with a capacity of 7.43 tons at 2-PSI pressure drop, if the higher pressure drop can be tolerated.

ORDERING INSTRUCTIONS

The CDS-16 is the only angled valve. The CDS-4, CDS-7, CDS-9 and CDS-17 are straight through valves.

CDS	–	T	–	17	–	1-3/8 X 1-3/8 ODF	–	20	–	S	–	ANGLE
Controls Discharge, Stepmotor		Optional Inlet Pressure Tap		Model Number		Fitting Size		Cable Length 20' standard, others available		S = Stripped and tinned cable ends. Custom Connectors available		Used only if angled configuration (CDS-16 ONLY)

CDS-4

SPECIFICATIONS

MOTOR TYPE:
2-phase permanent magnet, 2 coil bipolar
SUPPLY VOLTAGE:
12 VDC, -5% +10%, measured at the valve leads
CONNECTIONS:
4 lead, 18 AWG, PVC insulation jacketed cable
PHASE RESISTANCE:
100 ohms per winding ± 10%
CURRENT RANGE:
.104 to .147 amps per winding (.208 to .294 amps with two windings energized depending on temperature)
MAXIMUM POWER:
3 watts
INDUCTANCE PER WINDING:
43mH ± 20%
REQUIRED STEP RATE:
200 steps per second, other rates must be tested and approved
NUMBER OF STEPS:
2500
RESOLUTION:
.000119 inches/step (.003 mm/step)
TOTAL STROKE:
0.297 inches (7.54 mm)
MAXIMUM ALLOWABLE INTERNAL LEAKAGE:
less than 400 cc/min. at 100 PSIG
MAXIMUM ALLOWABLE EXTERNAL LEAKAGE:
less than .10 oz./year at 300 PSIG (.2 gr./year at 20 bar)
MAXIMUM RATED PRESSURE (MRP):
700 PSIG (48 bar)
OPERATING TEMPERATURE RANGE:
-50 to 140°F. (-45°C to +60°C)
MAXIMUM DEHYDRATION TEMPERATURE:
250°F. (120°C)
COMPATIBILITY:
all common CFC, HCFC and HFC refrigerants and all common mineral, polyolester and alkylbenzene oils
MATERIALS OF CONSTRUCTION:
copper - fittings; brass - valve body, adapters, stainless steel motor housing; synthetic materials - seating and seals

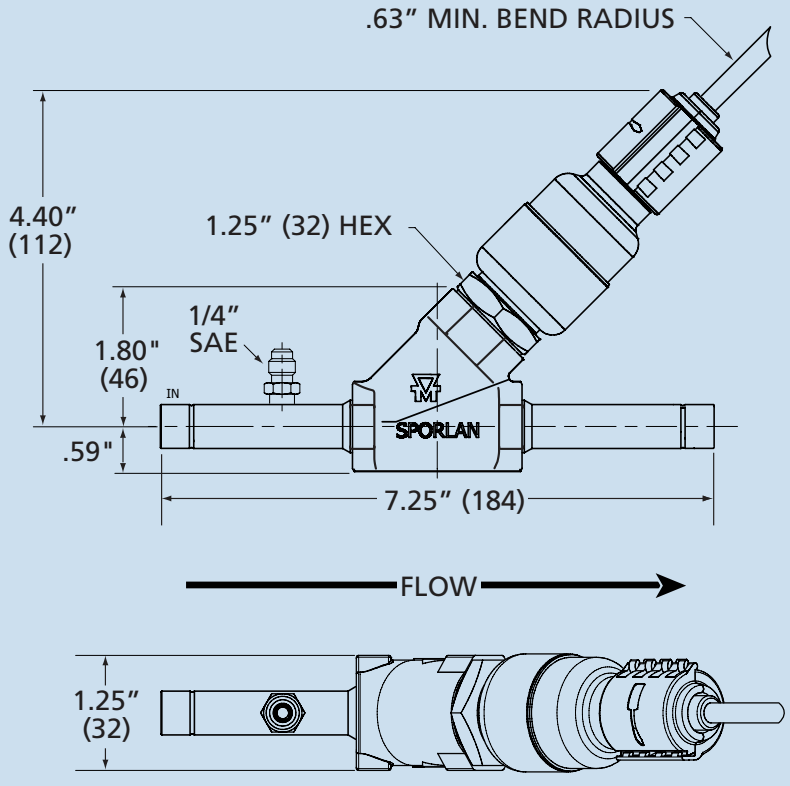
DIMENSIONS

CDST-4

2500 STEPS

Dimensions in inches (mm)

FITTINGS
1/2" ODF
5/8" ODF
7/8" ODF



CDS-7

SPECIFICATIONS

MOTOR TYPE:
2-phase permanent magnet, 2 coil bipolar
SUPPLY VOLTAGE:
12 VDC, -5% +10%, measured at the valve leads
CONNECTIONS:
4 lead, 18 AWG, PVC insulation jacketed cable
PHASE RESISTANCE:
100 ohms per winding ± 10%
CURRENT RANGE:
.104 to .147 amps per winding (.208 to .294 amps with two windings energized depending on temperature)
MAXIMUM POWER:
3 watts
INDUCTANCE PER WINDING:
43mH ± 20%
REQUIRED STEP RATE:
200 steps per second, other rates must be tested and approved
NUMBER OF STEPS:
2500
RESOLUTION:
.000119 inches/step (.003 mm/step)
TOTAL STROKE:
0.297 inches (7.54 mm)
MAXIMUM ALLOWABLE INTERNAL LEAKAGE:
less than 400 cc/min. at 100 PSIG
MAXIMUM ALLOWABLE EXTERNAL LEAKAGE:
less than .10 oz./year at 300 PSIG (.2 gr./year at 20 bar)
MAXIMUM RATED PRESSURE (MRP):
700 PSIG (48 bar)
OPERATING TEMPERATURE RANGE:
-50 to 140°F. (-45°C to +60°C)
MAXIMUM DEHYDRATION TEMPERATURE:
250°F. (120°C)
COMPATIBILITY:
all common CFC, HCFC and HFC refrigerants and all common mineral, polyolester and alkylbenzene oils
MATERIALS OF CONSTRUCTION:
copper - fittings; brass - valve body, adapters, stainless steel motor housing; synthetic materials - seating and seals

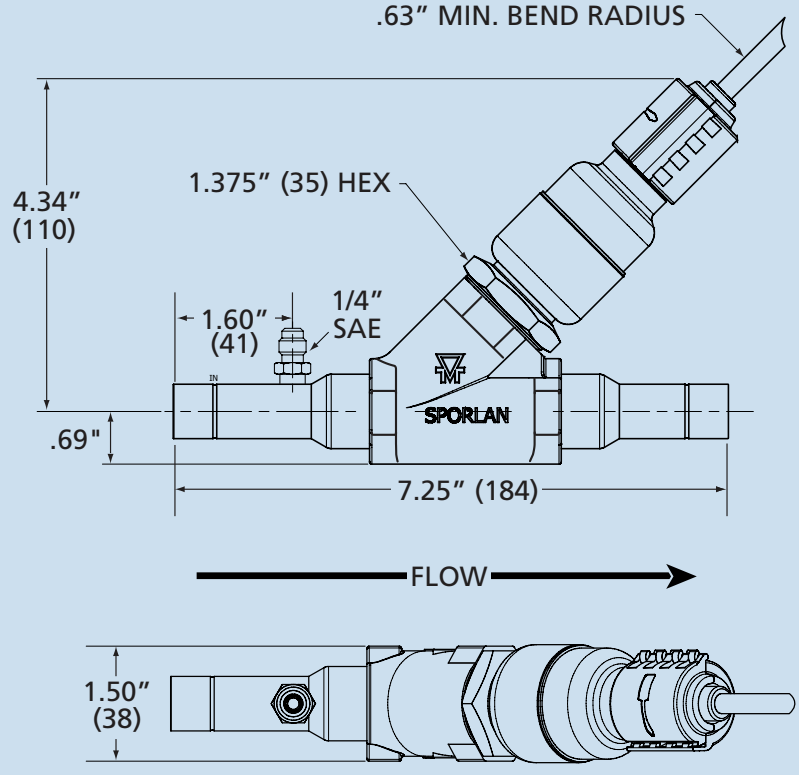
DIMENSIONS

CDST-7

2500 STEPS

Dimensions in inches (mm)

FITTINGS
5/8" ODF
7/8" ODF
1-1/8" ODF
1-3/8" ODF



CDS-9

SPECIFICATIONS

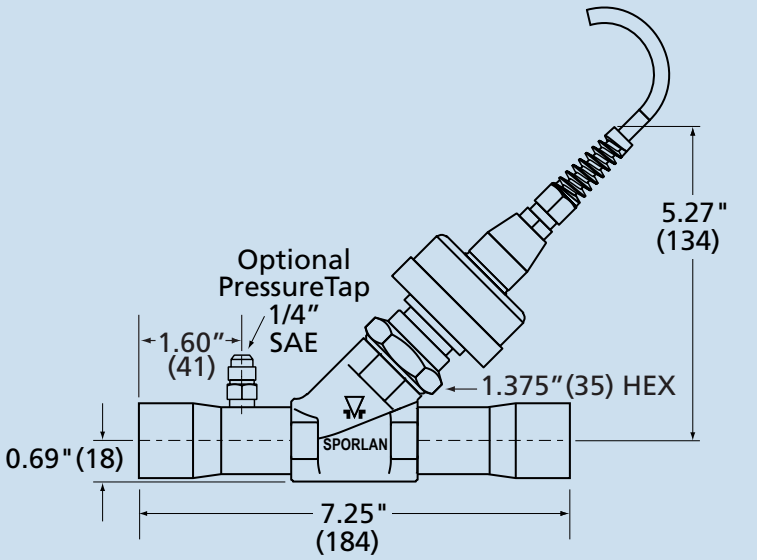
MOTOR TYPE:
2-phase permanent magnet, 2 coil bipolar
SUPPLY VOLTAGE:
12 VDC, -5% +10%, measured at the valve leads
CONNECTIONS:
4 lead, 18 AWG, PVC insulation jacketed cable
PHASE RESISTANCE:
75 ohms per winding ± 10%
CURRENT RANGE:
.131 to .215 amps per winding (.262 to .439 amps with two windings energized depending on temperature)
MAXIMUM POWER:
4 watts
INDUCTANCE PER WINDING:
62 ± 20% MHz
REQUIRED STEP RATE:
200 steps per second, other rates must be tested and approved
NUMBER OF STEPS:
6386
RESOLUTION:
.0000783 inches/step (.002 mm/step)
TOTAL STROKE:
.50 inches (12.7 mm)
MAXIMUM ALLOWABLE INTERNAL LEAKAGE:
less than 400 cc/min. at 100 PSIG
MAXIMUM ALLOWABLE EXTERNAL LEAKAGE:
less than .10 oz./year at 300 PSIG (.2 gr./year at 20 bar)
MAXIMUM RATED PRESSURE (MRP):
680 PSIG (47 bar)
OPERATING TEMPERATURE RANGE:
-50 to 140°F. (-45°C to +60°C)
MAXIMUM DEHYDRATION TEMPERATURE:
250°F. (120°C)
COMPATIBILITY:
all common CFC, HCFC and HFC refrigerants and all common mineral, polyolester and alkylbenzene oils
MATERIALS OF CONSTRUCTION:
copper - fittings; brass - valve body, motor housing, and adapters; synthetic materials - seating and seals

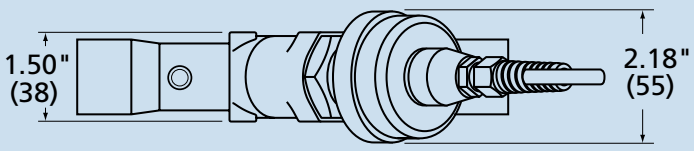
DIMENSIONS

CDS-9

Dimensions in inches (mm)

FITTINGS
5/8" ODF
7/8" ODF
1-1/8" ODF
1-3/8" ODF





CDS-16

SPECIFICATIONS

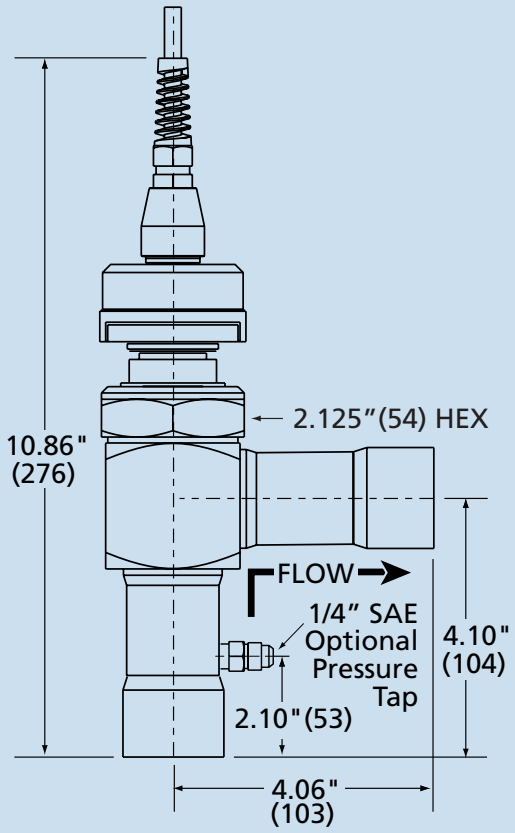
MOTOR TYPE:
2-phase permanent magnet, 2 coil bipolar
SUPPLY VOLTAGE:
12 VDC, -5% +10%, measured at the valve leads
CONNECTIONS:
4 lead, 18 AWG, PVC insulation jacketed cable
PHASE RESISTANCE:
75 ohms per winding ± 10%
CURRENT RANGE:
.131 to .215 amps per winding (.262 to .439 amps with two windings energized depending on temperature)
MAXIMUM POWER:
4 watts
INDUCTANCE PER WINDING:
62 ± 20% MHz
REQUIRED STEP RATE:
200 steps per second, other rates must be tested and approved
NUMBER OF STEPS:
6386
RESOLUTION:
.0000783 inches/step (.002 mm/step)
TOTAL STROKE:
.50 inches (12.7 mm)
MAXIMUM ALLOWABLE INTERNAL LEAKAGE:
less than 400 cc/min. at 100 PSIG
MAXIMUM ALLOWABLE EXTERNAL LEAKAGE:
less than .10 oz./year at 300 PSIG (.2 gr./year at 20 bar)
MAXIMUM RATED PRESSURE (MRP):
680 PSIG (47 bar)
OPERATING TEMPERATURE RANGE:
-50 to 140°F. (-45°C to +60°C)
MAXIMUM DEHYDRATION TEMPERATURE:
250°F. (120°C)
COMPATIBILITY:
all common CFC, HCFC and HFC refrigerants and all common mineral, polyolester and alkylbenzene oils
MATERIALS OF CONSTRUCTION:
copper - fittings; brass - valve body, motor housing, and adapters; synthetic materials - seating and seals

DIMENSIONS

CDS-16

Dimensions in inches (mm)

FITTINGS
1-3/8" ODF



CDS-17

SPECIFICATIONS

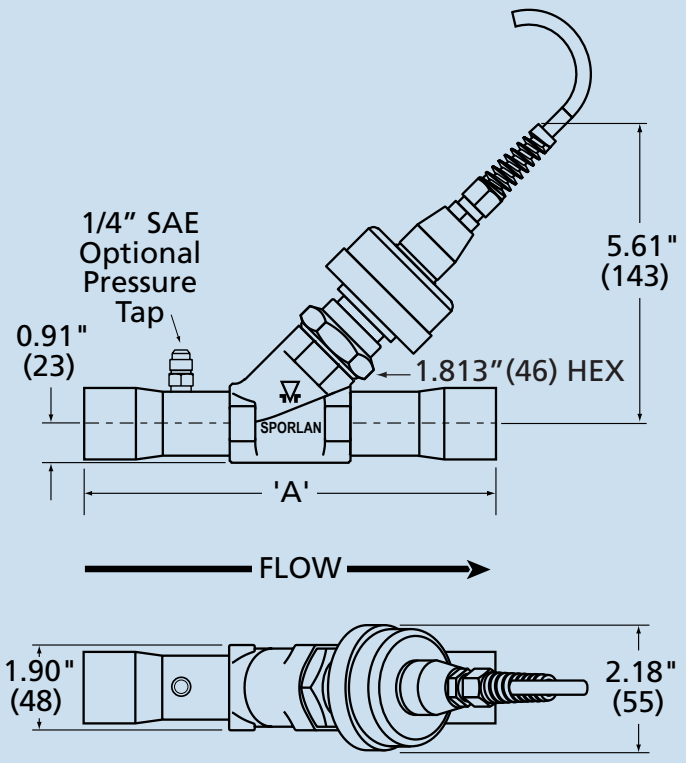
MOTOR TYPE:
2-phase permanent magnet, 2 coil bipolar
SUPPLY VOLTAGE:
12 VDC, -5% +10%, measured at the valve leads
CONNECTIONS:
4 lead, 18 AWG, PVC insulation jacketed cable
PHASE RESISTANCE:
75 ohms per winding ± 10%
CURRENT RANGE:
.131 to .215 amps per winding (.262 to .439 amps with two windings energized depending on temperature)
MAXIMUM POWER:
4 watts
INDUCTANCE PER WINDING:
62 ± 20% MHz
REQUIRED STEP RATE:
200 steps per second, other rates must be tested and approved
NUMBER OF STEPS:
6386
RESOLUTION:
.0000783 inches/step (.002 mm/step)
TOTAL STROKE:
.50 inches (12.7 mm)
MAXIMUM ALLOWABLE INTERNAL LEAKAGE:
less than 400 cc/min. at 100 PSIG
MAXIMUM ALLOWABLE EXTERNAL LEAKAGE:
less than .10 oz./year at 300 PSIG (.2 gr./year at 20 bar)
MAXIMUM RATED PRESSURE (MRP):
680 PSIG (47 bar)
OPERATING TEMPERATURE RANGE:
-50 to 140°F. (-45°C to +60°C)
MAXIMUM DEHYDRATION TEMPERATURE:
250°F. (120°C)
COMPATIBILITY:
all common CFC, HCFC and HFC refrigerants and all common mineral, polyolester and alkylbenzene oils
MATERIALS OF CONSTRUCTION:
copper - fittings; brass - valve body, motor housing, and adapters; synthetic materials - seating and seals

DIMENSIONS

CDS-17

Dimensions in inches (mm)

FITTINGS	'A'
1-3/8" ODF	9.88" (251)
1-5/8" ODF	9.88" (251)
2-1/8" ODF	10.62" (270)



SUCTION CAPACITY - (TONS)

VAVLE TYPE	EVAPORATOR TEMPERATURE (°F	REFRIGERANT																							
		22						422D						404A/507						134a					
		PRESSURE DROP ACROSS VALVE (PSI)																							
		0.5	1	2	3	5	10	0.5	1	2	3	5	10	0.5	1	2	3	5	10	0.5	1	2	3	5	10
CDS-4	40	1.10	1.54	2.16	2.64	3.39	4.77	0.91	1.28	1.79	2.19	2.81	3.94	1.02	1.44	2.02	2.46	3.16	4.51	0.88	1.23	1.73	2.11	2.70	3.62
	30	1.00	1.40	1.97	2.40	3.08	4.28	0.82	1.14	1.61	1.96	2.51	3.47	0.92	1.30	1.82	2.22	2.85	4.02	0.79	1.10	1.55	1.89	2.39	3.15
	20	0.91	1.27	1.78	2.17	2.79	3.82	0.73	1.02	1.43	1.75	2.25	3.03	0.83	1.16	1.64	1.99	2.56	3.57	0.70	0.98	1.38	1.67	2.09	2.71
	10	0.82	1.15	1.61	1.96	2.51	3.37	0.64	0.90	1.27	1.55	1.97	2.62	0.74	1.04	1.46	1.78	2.29	3.13	0.62	0.87	1.22	1.46	1.81	2.29
	0	0.73	1.03	1.45	1.76	2.22	2.94	0.57	0.80	1.12	1.36	1.71	2.24	0.66	0.93	1.30	1.59	2.04	2.73	0.55	0.77	1.06	1.26	1.55	1.89
	-10	0.66	0.92	1.29	1.56	1.95	2.54	0.50	0.70	0.98	1.18	1.47	1.87	0.59	0.82	1.15	1.41	1.78	2.35	0.48	0.67	0.91	1.08	1.30	1.51
	-20	0.58	0.82	1.14	1.37	1.7	2.15	0.43	0.61	0.84	1.01	1.24	1.53	0.52	0.72	1.02	1.23	1.54	1.99	0.41	0.57	0.78	0.91	1.07	1.16
	-30	0.52	0.72	0.994	1.19	1.45	1.77	0.38	0.52	0.72	0.85	1.03	1.21	0.45	0.63	0.88	1.06	1.31	1.65	0.36	0.49	0.65	0.76	0.86	0.88
CDS-7	40	3.12	4.31	5.96	7.21	9.16	13.0	2.57	3.56	4.92	5.95	7.56	10.7	2.88	3.99	5.52	6.67	8.47	12.4	2.51	3.48	4.81	5.82	7.39	9.53
	30	2.85	3.94	5.45	6.58	8.36	11.6	2.31	3.20	4.42	5.35	6.79	9.33	2.61	3.61	4.99	6.04	7.67	11.0	2.25	3.12	4.32	5.23	6.47	8.15
	20	2.59	3.58	4.95	5.99	7.61	10.2	2.07	2.86	3.96	4.78	6.17	8.05	2.35	3.26	4.50	5.44	6.92	9.63	1.99	2.78	3.83	4.58	5.60	6.82
	10	2.34	3.24	4.49	5.42	6.87	8.89	1.84	2.55	3.52	4.26	5.36	6.84	2.11	2.92	4.04	4.89	6.21	8.37	1.75	2.44	3.35	3.97	4.78	5.55
	0	2.09	2.93	4.05	4.87	6.03	7.62	1.62	2.26	3.12	3.74	4.60	5.70	1.89	2.61	3.61	4.37	5.56	7.19	1.54	2.13	2.89	3.40	4.01	4.37
	-10	1.86	2.60	3.59	4.28	5.24	6.40	1.41	1.97	2.70	3.21	3.90	4.61	1.67	2.32	3.21	3.89	4.82	6.07	1.34	1.84	2.47	2.87	3.28	3.38
	-20	1.64	2.29	3.14	3.72	4.48	5.21	1.22	1.70	2.31	2.72	3.23	3.59	1.47	2.05	2.82	3.37	4.12	5.01	1.15	1.58	2.08	2.37	2.58	2.59
	-30	1.44	2.00	2.72	3.19	3.76	4.09	1.05	1.45	1.95	2.27	2.61	2.72	1.27	1.77	2.43	2.88	3.46	3.99	0.99	1.33	1.72	1.90	1.95	1.95
CDS-9	40	4.64	6.45	8.96	10.9	13.8	19.7	3.84	5.33	7.41	8.98	11.4	16.3	4.31	5.98	8.31	10.1	12.8	18.6	3.71	5.19	7.22	8.75	11.2	14.9
	30	4.24	5.88	8.18	9.91	12.6	17.6	3.45	4.79	6.65	8.06	10.3	14.3	3.89	5.41	7.52	9.11	11.6	16.6	3.31	4.65	6.47	7.84	9.83	12.9
	20	3.83	5.35	7.43	9.00	11.5	15.7	3.08	4.28	5.94	7.20	9.30	12.5	3.51	4.87	6.77	8.21	10.5	14.7	2.94	4.12	5.73	6.89	8.59	11.0
	10	3.45	4.84	6.72	8.15	10.4	13.8	2.72	3.80	5.28	6.41	8.13	10.7	3.15	4.37	6.07	7.36	9.38	12.9	2.59	3.63	5.02	6.02	7.42	9.28
	0	3.08	4.33	6.05	7.30	9.17	12.1	2.39	3.35	4.67	5.63	7.03	9.13	2.79	3.90	5.42	6.57	8.40	11.2	2.27	3.17	4.37	5.20	6.33	7.61
	-10	2.75	3.85	5.35	6.45	8.04	10.3	2.09	2.92	4.05	4.86	6.02	7.61	2.47	3.46	4.82	5.84	7.32	9.61	1.98	2.75	3.76	4.44	5.31	6.01
	-20	2.43	3.40	4.71	5.64	6.96	8.71	1.81	2.52	3.48	4.15	5.08	6.18	2.16	3.03	4.22	5.07	6.32	8.11	1.71	2.37	3.20	3.74	4.35	4.60
	-30	2.14	2.98	4.10	4.88	5.94	7.13	1.55	2.16	2.96	3.50	4.20	4.83	1.88	2.63	3.64	4.36	5.38	6.70	1.47	2.02	2.68	3.08	3.44	3.47
CDS-16	40	7.72	10.7	14.7	17.8	22.6	31.9	6.37	8.80	12.2	14.7	18.7	26.2	7.14	9.86	13.6	16.5	20.9	30.3	6.22	8.61	11.9	14.4	18.1	23.2
	30	7.05	9.74	13.5	16.3	20.7	28.3	5.73	7.91	10.9	13.2	16.8	22.8	6.46	8.93	12.3	14.9	18.9	26.9	5.54	7.74	10.7	12.8	15.8	19.8
	20	6.41	8.87	12.3	14.8	18.8	24.9	5.12	7.08	9.79	11.8	15.2	19.6	5.83	8.06	11.1	13.5	17.1	23.6	4.91	6.85	9.43	11.2	13.7	16.4
	10	5.77	8.03	11.1	13.4	16.9	21.7	4.55	6.31	8.72	10.5	13.1	16.6	5.24	7.24	10.0	12.1	15.3	20.5	4.33	6.02	8.23	9.73	11.7	13.3
	0	5.16	7.22	10.0	12.0	14.8	18.5	4.00	5.58	7.70	9.20	11.3	13.8	4.68	6.47	8.94	10.8	13.7	17.5	3.79	5.25	7.11	8.31	9.73	10.4
	-10	4.59	6.41	8.82	10.5	12.8	15.4	3.48	4.85	6.65	7.88	9.50	11.1	4.13	5.75	7.95	9.57	11.8	14.7	3.30	4.54	6.06	6.99	7.91	8.06
	-20	4.06	5.64	7.71	9.12	10.9	12.5	3.01	4.18	5.68	6.66	7.86	8.55	3.62	5.05	6.94	8.27	10.1	12.1	2.84	3.88	5.09	5.75	6.17	6.17
	-30	3.56	4.93	6.67	7.80	9.12	9.74	2.59	3.56	4.78	5.53	6.31	6.49	3.14	4.37	5.97	7.05	8.43	9.53	2.43	3.27	4.18	4.58	4.66	4.66
CDS-17	40	8.30	11.6	16.1	19.5	24.9	35.6	6.87	9.56	13.3	16.1	20.6	29.3	7.71	10.7	14.9	18.1	23.1	33.7	6.68	9.29	12.9	15.7	20.2	26.7
	30	7.57	10.5	14.7	17.8	22.7	31.8	6.16	8.57	11.9	14.5	18.5	25.8	6.97	9.69	13.5	16.4	20.9	30.0	5.99	8.33	11.6	14.1	17.7	23.1
	20	6.87	9.57	13.3	16.2	20.6	28.3	5.50	7.66	10.7	12.9	16.8	22.4	6.27	8.73	12.1	14.7	18.8	26.5	5.33	7.44	10.4	12.5	15.5	19.7
	10	6.22	8.65	12.0	14.6	18.7	24.9	4.89	6.81	9.47	11.5	14.7	19.3	5.62	7.83	10.9	13.2	16.9	23.2	4.70	6.57	9.08	10.9	13.3	16.5
	0	5.60	7.79	10.8	13.2	16.6	21.6	4.32	6.02	8.37	10.2	12.7	16.3	5.02	6.98	9.72	11.8	15.2	20.1	4.12	5.75	7.89	9.37	11.4	13.4
	-10	4.98	6.98	9.70	11.7	14.5	18.5	3.78	5.29	7.33	8.78	10.8	13.5	4.45	6.20	8.63	10.5	13.2	17.2	3.59	4.99	6.79	7.99	9.48	10.5
	-20	4.41	6.16	8.52	10.2	12.5	15.5	3.28	4.57	6.29	7.49	9.11	10.9	3.92	5.47	7.61	9.17	11.4	14.5	3.10	4.29	5.76	6.70	7.71	8.02
	-30	3.87	5.40	7.41	8.80	10.7	12.6	2.82	3.91	5.34	6.30	7.51	8.44	3.42	4.77	6.59	7.88	9.67	11.9	2.66	3.64	4.82	5.49	6.04	6.06

Capacities based on 60°F liquid and 25°F superheated vapor.

REFRIGERANT	LIQUID TEMPERATURE ENTERING VALVE °F										
	0°	10°	20°	30°	40°	50°	60°	70°	80°	90°	100°
	CORRECTION FACTOR, CF LIQUID TEMPERATURE										
22	1.22	1.18	1.15	1.11	1.07	1.04	1.00	0.96	0.92	0.88	0.84
422D	1.35	1.29	1.23	1.18	1.12	1.06	1.00	0.94	0.88	0.81	0.75
404A/507	1.35	1.29	1.24	1.18	1.12	1.06	1.00	0.94	0.87	0.81	0.74
134a	1.27	1.22	1.18	1.14	1.09	1.05	1.00	0.95	0.91	0.86	0.81

* Use the correction factor for 100°F liquid temperature and the capacities at 40°F evaporator temperature to determine ARI standard capacity ratings.

Example: The capacity of a CDS-9 using R-422D, evaporator temperature of 20°F, 2 psi pressure drop across the valve and a liquid temperature of 50°F is equal to (5.94x1.06) 6.30 tons.

These factors correct for net refrigerating effect and are based on an average temperature of 0°F. However, they may be used for any evaporator temperature from -35°F to 40°F since the variation in the actual factors across this range is insignificant.

SUCTION CAPACITY - (kW)

VAVLE TYPE	EVAPORATOR TEMPERATURE (°C)	REFRIGERANT																							
		407C						410A						404A/507						134a					
		PRESSURE DROP ACROSS VALVE (BAR)																							
		0.03	0.06	0.1	0.2	0.4	0.7	0.03	0.06	0.1	0.2	0.4	0.7	0.03	0.06	0.1	0.2	0.4	0.7	0.03	0.06	0.1	0.2	0.4	0.7
CDS-4	5	3.54	4.97	6.38	8.96	12.6	16.4	4.54	6.37	8.18	11.5	16.1	21.2	3.36	4.72	6.06	8.51	12.0	16.0	2.89	4.06	5.22	7.32	10.2	12.9
	0	3.22	4.52	5.8	8.14	11.5	14.7	4.17	5.86	7.52	10.6	14.8	19.5	3.07	4.31	5.53	7.76	10.9	14.4	2.62	3.68	4.72	6.63	9.10	11.4
	-5	2.91	4.09	5.25	7.37	10.3	13.1	3.83	5.37	6.90	9.68	13.6	18.1	2.79	3.91	5.03	7.06	9.91	13.0	2.36	3.32	4.26	5.96	8.07	9.95
	-10	2.63	3.69	4.74	6.65	9.18	11.5	3.49	4.9	6.30	8.84	12.4	16.3	2.53	3.55	4.55	6.39	9.06	11.6	2.12	2.98	3.83	5.30	7.09	8.60
	-15	2.36	3.31	4.26	5.97	8.11	10.1	3.18	4.46	5.73	8.04	11.3	14.7	2.28	3.20	4.11	5.77	8.09	10.3	1.90	2.67	3.41	4.67	6.17	7.31
	-20	2.11	2.97	3.81	5.29	7.11	8.67	2.88	4.04	5.19	7.28	10.2	13.0	2.05	2.88	3.69	5.18	7.17	9.01	1.69	2.37	3.01	4.09	5.3	6.07
	-25	1.88	2.64	3.38	4.64	6.16	7.35	2.59	3.64	4.68	6.57	9.11	11.5	1.83	2.57	3.30	4.64	6.31	7.84	1.49	2.08	2.64	3.54	4.48	4.89
	-30	1.67	2.34	2.97	4.04	5.27	6.09	2.33	3.27	4.20	5.89	8.04	10	1.63	2.29	2.94	4.09	5.51	6.72	1.31	1.82	2.29	3.03	3.70	3.83
CDS-7	5	10.1	14.0	17.7	24.5	34.0	44.5	12.8	17.8	22.5	31.2	43.2	56.1	9.50	13.1	16.7	23.1	31.9	43.8	8.30	11.5	14.6	20.2	27.7	33.9
	0	9.21	12.7	16.2	22.4	31.6	39.4	11.8	16.4	20.8	28.8	39.8	51.7	8.69	12.0	15.3	21.1	29.2	39.3	7.49	10.4	13.3	18.3	24.5	29.5
	-5	8.35	11.6	14.7	20.3	28.1	34.7	10.9	15.1	19.1	26.5	36.6	49.6	7.93	11.0	13.9	19.3	26.6	35.1	6.73	9.42	12.0	16.4	21.5	25.2
	-10	7.51	10.5	13.3	18.4	24.8	30.1	9.98	13.8	17.5	24.2	33.5	44.5	7.20	9.97	12.7	17.5	24.9	31.0	6.02	8.41	10.7	14.5	18.7	21.1
	-15	6.72	9.42	12.0	16.4	21.7	25.7	9.11	12.6	16.0	22.1	30.6	39.6	6.52	9.02	11.5	15.9	22.1	27.2	5.36	7.46	9.44	12.7	15.9	17.2
	-20	5.99	8.38	10.6	14.5	18.8	21.6	8.25	11.5	14.5	20.1	28.0	34.8	5.87	8.14	10.3	14.3	19.4	23.5	4.75	6.59	8.29	11.0	13.3	13.8
	-25	5.31	7.41	9.38	12.6	16.0	17.5	7.41	10.4	13.2	18.2	24.8	30.3	5.23	7.31	9.29	12.8	16.9	20.1	4.18	5.77	7.21	9.36	10.9	10.9
	-30	4.68	6.50	8.19	10.9	13.3	13.9	6.63	9.29	11.9	16.3	21.7	25.9	4.64	6.49	8.24	11.2	14.6	16.7	3.65	5.01	6.21	7.85	8.53	8.53
CDS-9	5	15.0	20.9	26.6	37.0	51.4	67.7	19.1	26.6	33.9	47.1	65.4	85.3	14.2	19.7	25.1	34.9	48.4	66.0	12.2	17.1	21.8	30.3	42.0	52.8
	0	13.6	19.0	24.2	33.7	47.5	60.5	17.6	24.5	31.2	43.4	60.3	78.6	13.0	18.0	22.9	31.9	44.3	59.5	11.0	15.5	19.8	27.5	37.5	46.6
	-5	12.3	17.3	22.0	30.6	42.5	53.7	16.2	22.5	28.7	39.9	55.4	74.7	11.8	16.4	20.9	29.0	40.3	53.4	9.92	13.9	17.8	24.6	33.2	40.6
	-10	11.1	15.6	19.9	27.7	37.8	47.3	14.8	20.6	26.3	36.5	50.7	67.4	10.7	14.9	19.0	26.4	37.4	47.6	8.88	12.5	15.9	21.9	29.1	34.9
	-15	9.91	13.9	17.8	24.7	33.4	41.1	13.5	18.8	24.0	33.3	46.2	60.4	9.65	13.5	17.2	23.9	33.4	42.1	7.92	11.1	14.1	19.3	25.3	29.5
	-20	8.84	12.4	15.8	21.8	29.2	35.3	12.2	17.1	21.8	30.2	42.3	53.7	8.65	12.1	15.5	21.5	29.6	36.9	7.02	9.80	12.4	16.8	21.6	24.3
	-25	7.84	11.0	14.0	19.1	25.2	29.7	10.9	15.4	19.7	27.3	37.6	47.2	7.71	10.8	13.9	19.2	26.0	32.0	6.19	8.61	10.9	14.5	18.2	19.4
	-30	6.92	9.67	12.3	16.6	21.5	24.4	9.77	13.7	17.6	24.4	33.1	41.0	6.84	9.60	12.3	16.9	22.6	27.4	5.42	7.51	9.44	12.4	14.9	15.2
CDS-16	5	25.0	34.6	43.9	60.7	83.9	109	31.8	43.9	55.8	77.1	107	138	23.5	32.5	41.3	57.0	78.8	108	20.5	28.5	36.1	49.9	68.0	82.5
	0	22.8	31.5	40.0	55.3	77.6	96.4	29.3	40.5	51.4	71.1	98.3	128	21.5	29.7	37.8	52.2	72.1	96.4	18.5	25.9	32.8	45.3	60.1	71.5
	-5	20.6	28.7	36.4	50.3	69.0	84.5	27.0	37.3	47.3	65.4	90.4	122	19.6	27.1	34.4	47.6	65.8	85.9	16.6	23.2	29.6	40.3	52.6	60.9
	-10	18.5	26.0	33.0	45.6	60.9	73.2	24.7	34.2	43.4	59.9	82.8	109	17.8	24.7	31.3	43.3	61.0	75.9	14.9	20.7	26.3	35.5	45.5	50.7
	-15	16.6	23.2	29.6	40.4	53.1	62.3	22.6	31.2	39.6	54.7	75.6	96.8	16.2	22.3	28.4	39.2	54.1	66.3	13.2	18.4	23.2	31.0	38.7	41.0
	-20	14.8	20.7	26.2	35.5	45.8	51.9	20.4	28.4	36.0	49.8	68.8	85.1	14.5	20.2	25.6	35.4	47.6	57.2	11.7	16.2	20.4	26.8	32.2	32.8
	-25	13.1	18.3	23.1	30.9	38.9	41.8	18.3	25.7	32.6	45.1	60.7	73.8	12.9	18.1	23.0	31.5	41.4	48.6	10.3	14.2	17.7	22.8	26.0	26.0
	-30	11.5	16.0	20.1	26.6	32.2	33.1	16.4	22.9	29.2	40.0	53.0	62.8	11.4	16.0	20.3	27.5	35.5	40.3	9.01	12.3	15.2	19.0	20.3	20.3
CDS-17	5	26.8	37.4	47.7	66.4	92.4	122	34.2	47.7	60.8	84.6	118	154	25.4	35.3	45.0	62.7	87.2	119	22.0	30.7	39.1	54.4	75.9	94.9
	0	24.4	34.0	43.4	60.4	85.9	109	31.6	43.9	56.0	78.0	109	142	23.2	32.3	41.1	57.3	79.7	108	20.0	27.8	35.5	49.4	67.6	83.5
	-5	22.2	30.9	39.4	54.8	76.8	96.6	29.0	40.3	51.5	71.6	99.7	135	21.1	29.4	37.5	52.2	72.6	96.4	18.0	25.1	32.1	44.5	59.7	72.6
	-10	20.1	27.9	35.6	49.6	68.2	84.8	26.5	36.9	47.1	65.5	91.2	122	19.2	26.7	34.0	47.3	67.6	85.8	16.1	22.6	28.8	39.5	52.3	62.1
	-15	18.0	25.1	32.1	44.6	60.1	73.6	24.2	33.6	42.9	59.7	83.1	109	17.3	24.1	30.8	42.8	60.3	75.8	14.4	20.1	25.5	34.7	45.3	52.2
	-20	16.0	22.5	28.7	39.4	52.5	62.9	21.9	30.5	39.0	54.2	76.4	96.6	15.6	21.7	27.7	38.6	53.3	66.3	12.7	17.8	22.5	30.3	38.6	42.6
	-25	14.2	19.9	25.3	34.6	45.3	52.7	19.8	27.6	35.2	49.0	67.8	84.8	14.0	19.5	24.8	34.6	46.8	57.3	11.2	15.6	19.7	26.1	32.3	33.8
	-30	12.6	17.5	22.2	30.0	38.4	42.9	17.7	24.8	31.7	44.1	59.7	73.6	12.4	17.4	22.2	30.5	40.7	48.8	9.83	13.6	17.0	22.2	26.2	26.5

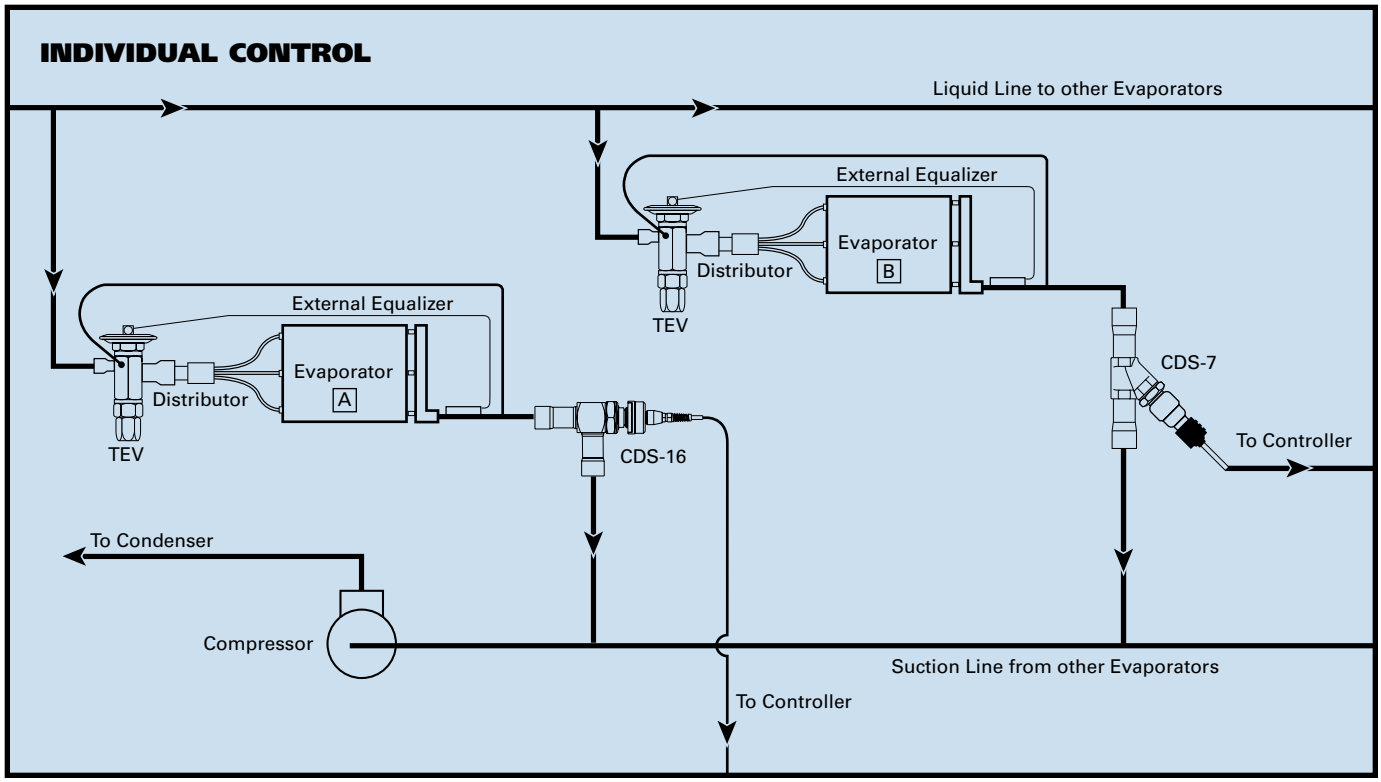
Capacities based on 16°C liquid and 14°C superheated vapor.

REFRIGERANT	LIQUID TEMPERATURE ENTERING VALVE °C										
	-10°	-5°	0°	5°	10°	15°	20°	25°	30°	35°	40°
	CORRECTION FACTOR, CF LIQUID TEMPERATURE										
407C	1.21	1.17	1.13	1.09	1.05	1.01	0.97	0.92	0.88	0.84	0.79
410A	1.21	1.17	1.13	1.09	1.05	1.01	0.97	0.92	0.87	0.83	0.78
404A/507	1.27	1.22	1.17	1.12	1.07	1.01	0.96	0.90	0.84	0.78	0.72
134a	1.21	1.17	1.13	1.09	1.05	1.01	0.97	0.92	0.88	0.84	0.79

* Use the correction factor for 38°C liquid temperature and the capacities at 5°C evaporator temperature to determine ARI standard capacity ratings.

Example: The capacity of a CDS-7 using R-407C, evaporator temperature of -25°C, 0.06 bar pressure drop across the valve and a liquid temperature of 10°C is equal to (7.41x1.05) 7.78 kilowatts.

These factors correct for net refrigerating effect and are based on an average temperature of -15°C. However, they may be used for any evaporator temperature from -30°C to 5°C since the variation in the actual factors across this range is insignificant.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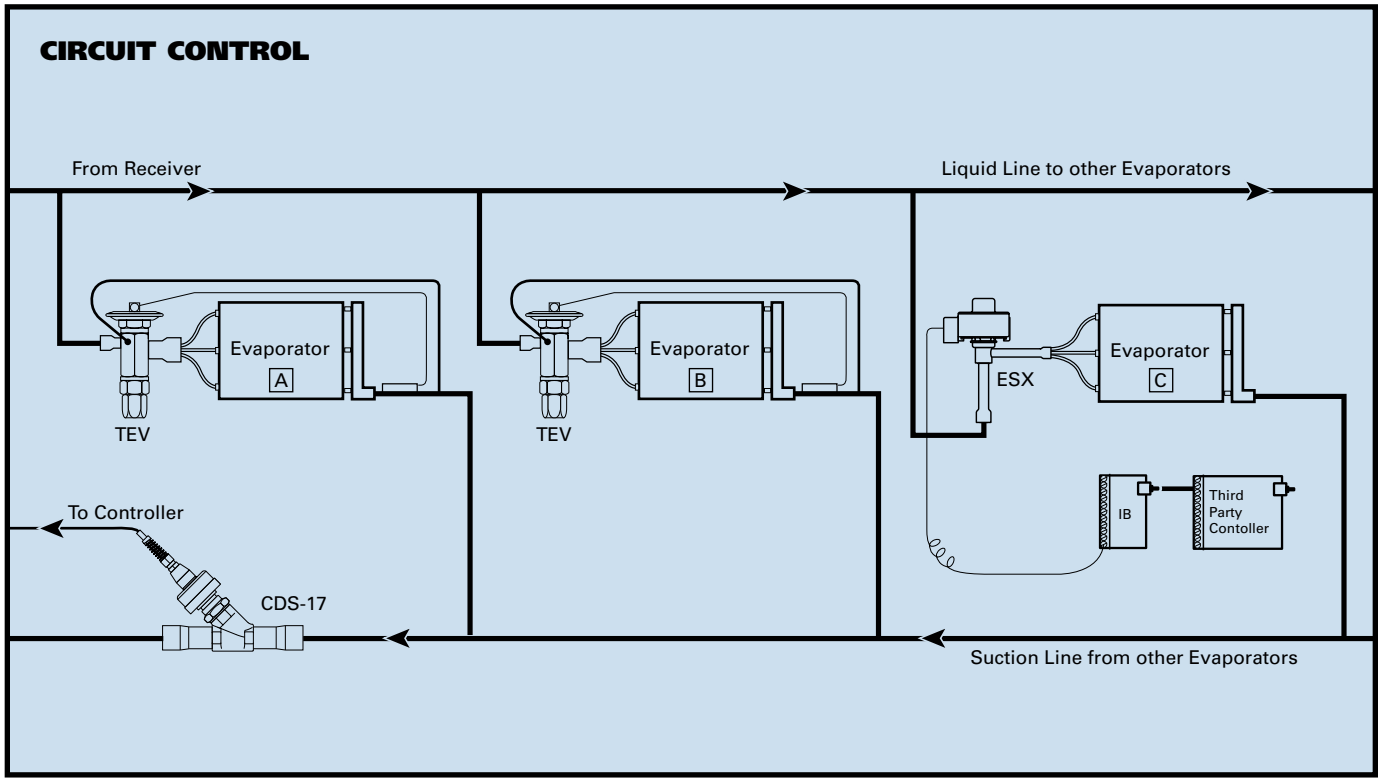
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