



HANDBOOK  
**SOLENOID VALVES**

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Ed. 2017

 **Castel**<sup>®</sup>  
Italian technology

# CHAPTER 4 ■

## NORMALLY-OPEN SOLENOID VALVES

### FOR REFRIGERATION PLANTS THAT USE HCFC, HFC OR HFO REFRIGERANTS



#### APPLICATION

The solenoid valves illustrated in this chapter are designed for installation on commercial refrigeration systems and on civil and industrial air conditioning plants that use the following refrigerant fluids:

- HCFC (R22)
- HFC (R134a , R404A , R407C , R410A , R507)
- HFO and HFO/HFC mixtures (R1234ze , R448A , R449A , R450A , and R452A)

belonging to Group 2, as defined in Article 13, Chapter 1, Point (b) of Directive 2014/68/EU, with reference to EC Regulation No. 1272/2008.

Furthermore, the same solenoid valves, up to DN 25, that is models 1178/9 and 1198/9, can also be installed on systems using the following refrigeration fluids:

- HFC (R32)
- HFO (R1234yf)

classified as A2L in the ASHRAE 34-2013 standard, and belonging to Group 1, as defined in Article 13, Chapter 1, Point (a) of Directive 2014/68/EU, with reference to EC Regulation No. 1272/2008.

For specific applications with refrigerant fluids not listed above, please contact Castel Technical Department.

#### OPERATION

The valves listed in this chapter are normally open valves (NO). This means that when the coil is not energized, the plunger opens the fluid flow. When the coil is energized, the plunger closes the fluid flow.

All the valves are exclusively sold in the model without coil (suffix S).

N.B.: the NO valve visually differs from the corresponding NC model by means of a red ring installed below the yellow nut that fastens the coil.

The valves series 1164 ; 1168 ; 1170 ; 1178 (excluded /11 , /13 , /M42) ; 1190 ; 1198 (excluded /9) are pilot-operated diaphragm valves. Their operation depends not only on the magnetic field produced by the current flow into the coil, but also on a minimum inlet pressure, which is necessary to:

- open the diaphragm and keep it lifted off the main opening
- close the diaphragm and ensure the tightness on the main opening

Opening/closing of main valve seat is controlled by the diaphragm while opening/closing of pilot seat is controlled by the mobile plunger of the coil.

**These valves cannot work with zero differential pressure.**

The valves series 1134 ; 1138 ; 1140 ; 1148 ; 1150 ; 1158 ; 1178 (/11 , /13 , /M42) ; 1198/9 are pilot operated piston valves. Their operation depends not only on the magnetic field produced by the current flow into the coil, but also on a minimum inlet pressure, which is necessary to:

- open the piston and keep it lifted off the main opening
- close the piston and ensure the tightness on the main opening

Opening/closing of main valve seat is controlled by the piston, while opening/closing of pilot seat is controlled by the mobile plunger of the coil.

**These valves cannot work with zero differential pressure.**

#### CONSTRUCTION

The main parts of the solenoid valves described in this chapter are constructed with the following materials:

- Hot forged brass EN 12420 – CW 617N for body and cover

- Copper tube EN 12735-1 – Cu-DHP for solder connections
- Austenitic stainless steel EN 10088-2 – 1.4303 for enclosure where the plunger moves
- Ferritic stainless steel EN 10088-3 – 1.4105 for the plunger
- Austenitic stainless steel EN ISO 3506 – A2-70 for tightening screws between body and cover.
- Chloroprene rubber (CR) for the outlet seal gaskets
- P.T.F.E. for seat gaskets

## INSTALLATION

The valves can be installed on the three main branches of a plant (hot gas line, liquid line, and suction line), while respecting the limits of use indicated in TABLES 12 and 13 and the capacities indicated in TABLE 15. TABLES 12 and 13 show the following functional characteristics of a solenoid valve:

- Connection dimensions
- PS: maximum allowable pressure of the refrigerant
- TS: maximum / minimum allowable temperature of the refrigerant
- TA: maximum / minimum allowable ambient temperature
- Kv: discharge factor
- minOPD: minimum Opening Pressure Differential. This is the minimum pressure differential between inlet and outlet at which a pilot-operated solenoid valve can open and stay opened or close and maintain the seal.
- MOPD: maximum Opening Pressure Differential according to AHRI STANDARD 760 : 2014. This is the maximum pressure differential between inlet and outlet at which a solenoid valve can open.

Before connecting the valve to the pipe, it is advisable to make sure that the refrigerating system is clean. In fact, valves with P.T.F.E. gaskets, and particularly piston valves,

are sensitive to dirt and debris. Furthermore, check that the flow direction in the pipe corresponds to the arrow stamped on the valve body. All the valves can be mounted in any position so long as the coil does not point downwards. The brazing of valves with solder connections should be carried out with care, using a low melting point filler material. It is not necessary to disassemble the valves before brazing, but it is important to avoid direct contact between the torch flame and the valve body, which could be damaged and compromise the proper functioning of the valve.

Before connecting a valve to the electrical system, be sure that the line voltage and frequency correspond to the values marked on the coil.

**N.B. The NO valves have been designed to work only with direct current coils; therefore, they can be used solely with coils 9120/RD1 (HM3 type – 12 VDC) , 9120/RD2 (HM3 type – 24 VDC) , 9120/RD4 (HM3 type – 48 VDC). For applications with 220/230 VAC power supply, it is mandatory to couple the NO valves with the following components: Coil 9120/RD6 (HM3 types - 220 VRAC) + Connector/Rectifier 9150/R45 or 9150/R90. NO solenoid valves cannot be coupled with coils series 9100, 9110, 9120/RA6, 9160, 9300, and 9320.**

## TRACEABILITY

Pilot-operated diaphragm and piston valves series 1134, 1138, 1140, 1148, 1150, 1158, 1164, 1168, 1170, 1178, 1190, and 1198 are identified by marking on the yellow locking ring-nut for the coil. The marking on the ring-nut includes the following data: valve code, PS, and production lot.

**TABLE 12: General characteristics of NO valves with SAE Flare connections**

Operating Principles	Catalogue Number	SAE Flare Connections	Seat size nominal $\varnothing$ [mm]	Kv Factor [m <sup>3</sup> /h]	Opening Pressure Differential [bar]			PS [bar]	TS [°C]		TA [°C]		Risk Category according to PED Recast
					min OPD	MOPD 9120/RD6	MOPD 9120/RD1 9120/RD2		min.	max.	min. (3)	max.	
Diaphragm Pilot Operated	1164/3S	3/8"	6,5	0,80	0,05	30	16	45	-35	+105 (1)	-35	+50	Art. 4.3
	1170/4S	1/2"	12,5	2,20									
	1170/5S	5/8"		2,61									
	1190/5S	5/8"	16,5	3,80									
	1190/6S	3/4"		4,80									
Piston Pilot Operated	1134/3S	3/8"	6,5	1,00	0,07	30	30	45	-35	+110 (2)	-35	+50	Art. 4.3
	1140/4S	1/2"	12,5	2,40									
	1140/5S	5/8"		3,00									
	1150/5S	5/8"	16,5	3,80									
	1150/6S	3/4"		4,80									

(1) Temperature peaks of 120 °C are allowed during defrosting

(2) Temperature peaks of 130 °C are allowed during defrosting

(3) Check TA<sub>min</sub> of the chosen coil

**TABLE 13: General characteristics of NO valves with ODS connections**

Operating Principles	Catalogue Number	Connections ODS		Seat size nominal $\varnothing$ [mm]	Kv Factor [m <sup>3</sup> /h]	Opening Pressure Differential [bar]			PS [bar]	TS [°C]		TA [°C]		Risk Category according to PED Recast			
		$\varnothing$ [in.]	$\varnothing$ [mm]			min OPD	MOPD 9120/RD6	MOPD 9120/RD1 9120/RD2		min.	max.	min.	max.				
Diaphragm Pilot Operated	1168/3S	3/8"	-	6,5	0,80	0,05	30	16	45	-35	+105 (1)	-35	+50	Art. 4.3			
	1168/M10S	-	10														
	1178/M12S	-	12	12,5	0,80												
	1178/4S	1/2"	-														
	1178/5S	5/8"	16	16,5	2,61												
	1198/5S	5/8"	16												3,80		
	1198/6S	3/4"	-	16,5	4,80												
	1198/7S	7/8"	22												5,70		
	1178/9S	1.1/8"	-	25,5	10											28	28
Piston Pilot Operated	1138/3S	3/8"	-	6,5	1,00	0,07	30	30	45	-35	+110 (2)	-35	+50	Art. 4.3			
	1138/M10S	-	10														
	1148/M12S	-	12	12,5	2,40												
	1148/4S	1/2"	-														
	1148/5S	5/8"	16	16,5	3,00												
	1158/5S	5/8"	16												3,80		
	1158/6S	3/4"	-	16,5	4,80												
	1158/7S	7/8"	22												5,70		
	1198/9S	1.1/8"	-	25	10											0,1	30
	1178/11S	1.3/8"	35	27	16												
	1178/13S	1.5/8"	-	34	25										0,15		
	1178/M42S	-	42														

(1) Temperature peaks of 120 °C are allowed during defrosting

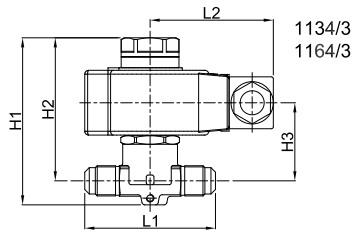
(2) Temperature peaks of 130 °C are allowed during defrosting

(3) Check TA<sub>min</sub> of the chosen coil

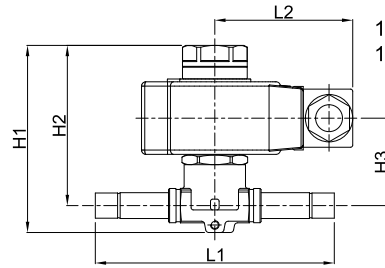
**TABLE 14: Dimensions and weights of NO valves with 9120 coils**

Operating Principles	Catalogue Number	Dimensions [mm]						Weight [g]
		H <sub>1</sub>	H <sub>2</sub>	H <sub>3</sub>	L <sub>1</sub>	L <sub>2</sub>	Q	
Diaphragm Pilot Operated	1164/3S	87	74,5	40	68	65	-	705
	1168/3S				111			705
	1168/M10S				111			700
	1170/4S	96	80	47	100		45	1015
	1170/5S				106			1060
	1178/M12S				127			995
	1178/4S				127			985
	1178/5S	111	83	50	175		57	1080
	1190/5S				120			1340
	1190/6S				124			1670
	1198/5S				175			1300
	1198/6S				175			1490
	1198/7S	120	101	72	180		80	1475
	1178/9S				250			2870
	Piston Pilot Operated	1134/3S	97,5	85	50,5		68	65
1138/3S		111				775		
1138/M11S		111				770		
1140/4S		105,5	89,5	56,5	100	45	1117	
1140/5S					106		1166	
1148/M12S					127		1095	
1148/4S					127		1084	
1148/5S		126	98	70	175	57	1188	
1150/5S					120		1462	
1150/6S					124		1792	
1158/5S					175		1422	
1158/6S					175		1612	
1158/7S		162	132	99	180	60	1597	
1198/9S					235		2355	
1178/11S					278		3015	
1178/13S		195	158	130	280	88	3820	
1178/M42S	3820							

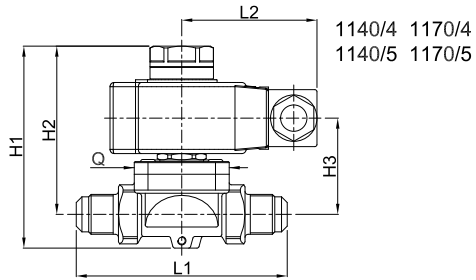
Connectors are not included in the boxes and have to be ordered separately



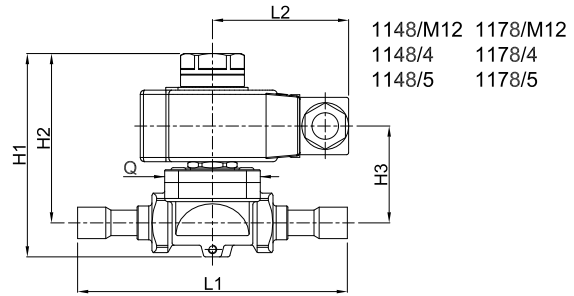
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1164/3



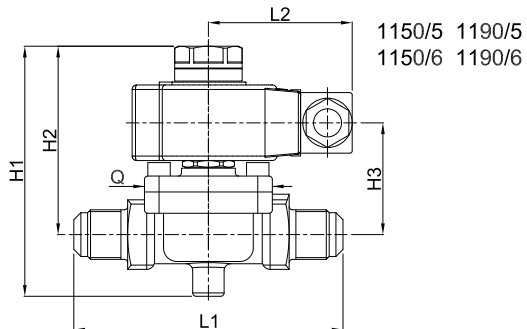
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1138/M10 1168/M10



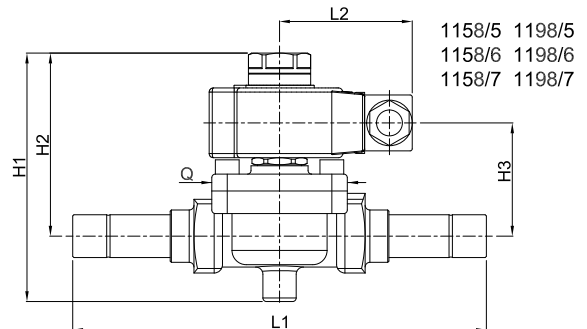
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1140/5 1170/5



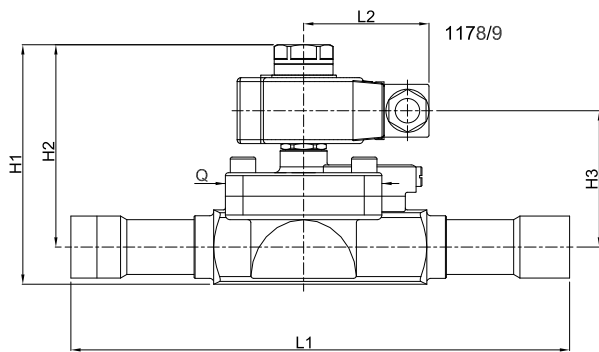
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1148/4 1178/4  
1148/5 1178/5



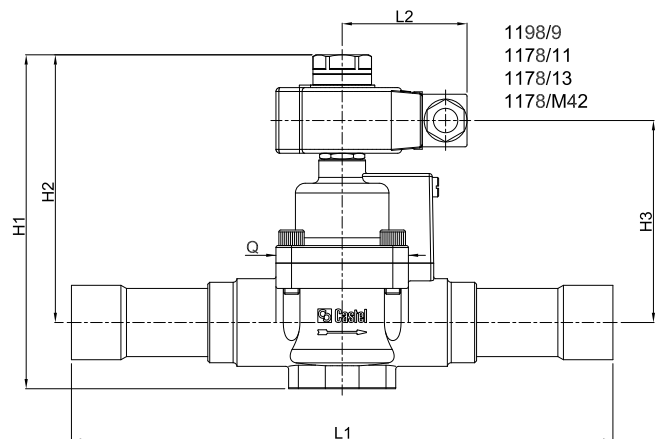
1150/5 1190/5  
1150/6 1190/6



1158/5 1198/5  
1158/6 1198/6  
1158/7 1198/7



1178/9



1198/9  
1178/11  
1178/13  
1178/M42

**TABLE 15: Refrigerant flow capacity of NO valves [kW]**

Operating Principles	Catalogue Number	Liquid line											
		R134a	R22	R404A	R407C	R410A	R507	R1234yf	R1234ze	R448A	R449A	R450A	R452A
Diaphragm Pilot Operated	1064/3S	13,6	14,6	9,5	13,8	13,7	9,2	10,1	12,0	12,5	12,6	12,7	9,7
	1068/3S												
	1068/M10S												
	1070/4S	37,4	40,3	26,2	37,9	37,8	25,3	27,7	33,1	34,4	34,6	35,0	26,7
	1070/5S	44,4	47,8	31,1	45,0	44,8	30,0	32,8	39,3	40,8	41,0	41,5	31,7
	1078/M12S	37,4	40,3	26,2	37,9	37,8	25,3	27,7	33,1	34,4	34,6	35,0	26,7
	1078/4S												
	1078/5S	44,4	47,8	31,1	45,0	44,8	30,0	32,8	39,3	40,8	41,0	41,5	31,7
	1090/5S	64,6	69,5	45,2	65,5	65,2	43,7	47,8	57,2	59,5	59,7	60,5	46,1
	1090/6S	81,6	87,8	57,1	82,7	82,4	55,2	60,4	72,2	75,1	75,5	76,4	58,2
	1098/5S	64,6	69,5	45,2	65,5	65,2	43,7	47,8	57,2	59,5	59,7	60,5	46,1
	1098/6S	81,6	87,8	57,1	82,7	82,4	55,2	60,4	72,2	75,1	75,5	76,4	58,2
	1098/7S	96,9	104,3	67,8	98,2	97,9	65,6	71,7	85,7	89,2	89,6	90,7	69,1
	1078/9S	170,0	183,0	119,0	172,3	171,7	115,0	125,8	150,4	156,5	157,2	159,1	121,3
Piston Pilot Operated	1034/3S	17,0	18,3	11,9	17,2	17,2	11,5	12,6	15,0	15,7	15,7	15,9	12,1
	1038/3S												
	1038/M10S												
	1040/4S	40,8	43,9	28,6	41,4	41,2	27,6	30,2	36,1	37,6	37,7	38,2	29,1
	1040/5S	51,0	54,9	35,7	51,7	51,5	34,5	37,7	45,1	47,0	47,2	47,7	36,4
	1048/M12S	40,8	43,9	28,6	41,4	41,2	27,6	30,2	36,1	37,6	37,7	38,2	29,1
	1048/4S												
	1048/5S	51,0	54,9	35,7	51,7	51,5	34,5	37,7	45,1	47,0	47,2	47,7	36,4
	1050/5S	64,6	69,5	45,2	65,5	65,2	43,7	47,8	57,2	59,5	59,7	60,5	46,1
	1050/6S	81,6	87,8	57,1	82,7	82,4	55,2	60,4	72,2	75,1	75,5	76,4	58,2
	1058/5S	64,6	69,5	45,2	65,5	65,2	43,7	47,8	57,2	59,5	59,7	60,5	46,1
	1058/6S	81,6	87,8	57,1	82,7	82,4	55,2	60,4	72,2	75,1	75,5	76,4	58,2
	1058/7S	96,9	104,3	67,8	98,2	97,9	65,6	71,7	85,7	89,2	89,6	90,7	69,1
	1098/9S	170,0	183,0	119,0	172,3	171,7	115,0	125,8	150,4	156,5	157,2	159,1	121,3
	1078/11S	272,0	292,8	190,4	275,7	274,7	184,0	-	240,6	250,4	251,5	254,6	194,1
	1078/13S	425,0	457,5	297,5	430,8	429,3	287,5	-	376,0	391,3	393,0	397,8	303,3
1078/M42S													

Standard rating conditions according to AHRI Standard 760-2007

Continued

Condensing temperature	110 °F	(43,3 °C)	Temperature leaving evaporator	50 °F	(9,9 °C)
Liquid temperature	100 °F	(37,8 °C)	Evaporator superheating	10 °R	(5,5 °K)
Subcooling	10 °R	(5,5 °K)	Suction line temperature	65 °F	(18,3 °C)
Evaporating temperature	40 °F	(4,4 °C)	Suction superheating	15 °R	(8,4 °K)
			Discharge temperature	160 °F	(71,1 °C)

**TABLE 15: Refrigerant flow capacity of NO valves [kW]**

Operating Principles	Catalogue Number	Suction line											
		R134a	R22	R404A	R407C	R410A	R507	R1234yf	R1234ze	R448A	R449A	R450A	R452A
Diaphragm Pilot Operated	1064/3S	1,46	2,04	1,76	1,82	2,64	1,78	1,18	1,14	1,92	1,76	1,27	1,69
	1068/3S												
	1068/M10S												
	1070/4S	4,00	5,61	4,84	4,99	7,26	4,91	3,23	3,12	5,28	4,84	3,50	4,64
	1070/5S	4,75	6,66	5,74	5,92	8,61	5,82	3,84	3,71	6,26	5,74	4,15	5,51
	1078/M12S	4,00	5,61	4,84	4,99	7,26	4,91	3,23	3,12	5,28	4,84	3,50	4,64
	1078/4S												
	1078/5S	4,75	6,66	5,74	5,92	8,61	5,82	3,84	3,71	6,26	5,74	4,15	5,51
	1090/5S	6,9	9,7	8,4	8,6	12,5	8,5	5,6	5,4	9,1	8,4	6,0	8,0
	1090/6S	8,7	12,2	10,6	10,9	15,8	10,7	7,1	6,8	11,5	10,6	7,6	10,1
	1098/5S	6,9	9,7	8,4	8,6	12,5	8,5	5,6	5,4	9,1	8,4	6,0	8,0
	1098/6S	8,7	12,2	10,6	10,9	15,8	10,7	7,1	6,8	11,5	10,6	7,6	10,1
	1098/7S	10,4	14,5	12,5	12,9	18,8	12,7	8,4	8,1	13,7	12,5	9,1	12,0
	1078/9S	18,2	25,5	22,0	22,7	33,0	22,3	14,7	14,2	24,0	22,0	15,9	21,1
Piston Pilot Operated	1034/3S	1,82	2,55	2,20	2,27	3,30	2,23	1,47	1,42	2,40	2,20	1,59	2,11
	1038/3S												
	1038/M10S												
	1040/4S	4,37	6,12	5,28	5,45	7,92	5,35	3,53	3,41	5,76	5,28	3,82	5,06
	1040/5S	5,46	7,65	6,60	6,81	9,90	6,69	4,41	4,26	7,20	6,60	4,77	6,33
	1048/M12S	4,37	6,12	5,28	5,45	7,92	5,35	3,53	3,41	5,76	5,28	3,82	5,06
	1048/4S												
	1048/5S	5,46	7,65	6,60	6,81	9,90	6,69	4,41	4,26	7,20	6,60	4,77	6,33
	1050/5S	6,9	9,7	8,4	8,6	12,5	8,5	5,6	5,4	9,1	8,4	6,0	8,0
	1050/6S	8,7	12,2	10,6	10,9	15,8	10,7	7,1	6,8	11,5	10,6	7,6	10,1
	1058/5S	6,9	9,7	8,4	8,6	12,5	8,5	5,6	5,4	9,1	8,4	6,0	8,0
	1058/6S	8,7	12,2	10,6	10,9	15,8	10,7	7,1	6,8	11,5	10,6	7,6	10,1
	1058/7S	10,4	14,5	12,5	12,9	18,8	12,7	8,4	8,1	13,7	12,5	9,1	12,0
	1098/9S	18,2	25,5	22,0	22,7	33,0	22,3	14,7	14,2	24,0	22,0	15,9	21,1
	1078/11S	29,1	40,8	35,2	36,3	52,8	35,7	-	22,7	38,4	35,2	25,4	33,8
	1078/13S	45,5	63,8	55,0	56,8	82,5	55,8	-	35,5	60,0	55,0	39,8	52,8
1078/M42S													

Standard rating conditions according to AHRI Standard 760-2007

Continued

Condensing temperature	110 °F	(43,3 °C)	Temperature leaving evaporator	50 °F	(9,9 °C)
Liquid temperature	100 °F	(37,8 °C)	Evaporator superheating	10 °R	(5,5 °K)
Subcooling	10 °R	(5,5 °K)	Suction line temperature	65 °F	(18,3 °C)
Evaporating temperature	40 °F	(4,4 °C)	Suction superheating	15 °R	(8,4 °K)
			Discharge temperature	160 °F	(71,1 °C)



**TABLE 15: Refrigerant flow capacity of NO valves [kW]**

Operating Principles	Catalogue Number	Hot Gas line											
		R134a	R22	R404A	R407C	R410A	R507	R1234yf	R1234ze	R448A	R449A	R450A	R452A
Diaphragm Pilot Operated	1064/3S	6,8	9,0	7,7	9,5	10,9	7,6	5,3	5,5	9,4	8,6	6,1	8,0
	1068/3S												
	1068/M10S												
	1070/4S	18,7	24,6	21,1	26,2	29,9	21,0	14,6	15,1	26,0	23,7	16,8	22,0
	1070/5S	22,2	29,2	25,1	31,1	35,5	24,9	17,3	17,9	30,8	28,1	20,0	26,0
	1078/M12S	18,7	24,6	21,1	26,2	29,9	21,0	14,6	15,1	26,0	23,7	16,8	22,0
	1078/4S												
	1078/5S	22,2	29,2	25,1	31,1	35,5	24,9	17,3	17,9	30,8	28,1	20,0	26,0
	1090/5S	32,3	42,6	36,5	45,2	51,7	36,3	25,2	26,0	44,8	41,0	29,1	37,9
	1090/6S	40,8	53,8	46,1	57,1	65,3	45,8	31,9	32,9	56,6	51,7	36,7	47,9
	1098/5S	32,3	42,6	36,5	45,2	51,7	36,3	25,2	26,0	44,8	41,0	29,1	37,9
	1098/6S	40,8	53,8	46,1	57,1	65,3	45,8	31,9	32,9	56,6	51,7	36,7	47,9
	1098/7S	48,5	63,8	54,7	67,8	77,5	54,4	37,8	39,0	67,3	61,4	43,6	56,9
	1078/9S	85,0	112,0	96,0	119,0	136,0	95,4	66,4	68,5	118,0	107,8	76,5	99,8
Piston Pilot Operated	1034/3S	8,5	11,2	9,6	11,9	13,6	9,5	6,6	6,9	11,8	10,8	7,7	10,0
	1038/3S												
	1038/M10S												
	1040/4S	20,4	26,9	23,0	28,6	32,6	22,9	15,9	16,4	28,3	25,9	18,4	24,0
	1040/5S	25,5	33,6	28,8	35,7	40,8	28,6	19,9	20,6	35,4	32,3	23,0	29,9
	1048/M12S	20,4	26,9	23,0	28,6	32,6	22,9	15,9	16,4	28,3	25,9	18,4	24,0
	1048/4S												
	1048/5S	25,5	33,6	28,8	35,7	40,8	28,6	19,9	20,6	35,4	32,3	23,0	29,9
	1050/5S	32,3	42,6	36,5	45,2	51,7	36,3	25,2	26,0	44,8	41,0	29,1	37,9
	1050/6S	40,8	53,8	46,1	57,1	65,3	45,8	31,9	32,9	56,6	51,7	36,7	47,9
	1058/5S	32,3	42,6	36,5	45,2	51,7	36,3	25,2	26,0	44,8	41,0	29,1	37,9
	1058/6S	40,8	53,8	46,1	57,1	65,3	45,8	31,9	32,9	56,6	51,7	36,7	47,9
	1058/7S	48,5	63,8	54,7	67,8	77,5	54,4	37,8	39,0	67,3	61,4	43,6	56,9
	1098/9S	85,0	112,0	96,0	119,0	136,0	95,4	66,4	68,5	118,0	107,8	76,5	99,8
	1078/11S	136,0	179,2	153,6	190,4	217,6	152,6	-	109,6	188,8	172,5	122,4	159,7
	1078/13S	212,5	280,0	240,0	297,5	340,0	238,5	-	171,3	295,0	269,5	191,3	249,5
1078/M42S													

Standard rating conditions according to AHRI Standard 760-2007

Condensing temperature	110 °F	(43,3 °C)	Temperature leaving evaporator	50 °F	(9,9 °C)
Liquid temperature	100 °F	(37,8 °C)	Evaporator superheating	10 °R	(5,5 °K)
Subcooling	10 °R	(5,5 °K)	Suction line temperature	65 °F	(18,3 °C)
Evaporating temperature	40 °F	(4,4 °C)	Suction superheating	15 °R	(8,4 °K)
			Discharge temperature	160 °F	(71,1 °C)

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