

HANDBOOK
SOLENOID VALVES

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 **Castel**[®]
Italian technology

CHAPTER 5

NORMALLY-CLOSED SOLENOID VALVES

FOR REFRIGERATION PLANTS THAT USE HC REFRIGERANTS



APPLICATION

The solenoid valves illustrated in this chapter have been developed by Castel for all those refrigeration applications that use the following HC refrigeration fluids: R290, R600, R600a, belonging to Group 1, defined in Article 13, Chapter 1, Point (a) of Directive 2014/68/EU, with reference to EC Regulation No. 1272/2008.

The solenoid valves with an “N” suffix (1028N, 1068N, 1078N, 1079N, 1098N, 1099N) must be employed only in refrigeration systems located in areas not classified as at risk of explosion, according to the definition in Annex I of Directive 1999/92/EC.

The solenoid valves with an “EX” suffix (1028EX, 1068EX, 1078EX, 1079EX, 1098EX, 1099EX) comply with the European Standard EN 13463-1:2009 and, therefore, comply with the ESR of Directive 2014/34/EU – ATEX. This equipment is suitable for use on refrigeration systems located in areas classified as “Zone 2” risk of explosion, according to the definition in Annex I of Directive 1999/92/EC.

CAUTION!: The solenoid valves in this chapter cannot be used with mineral oils or alkylbenzene oils.

OPERATION

The valves listed in this chapter are normally closed valves (NC). This means that when the coil is not energised, the plunger closes the fluid flow. When the coil is energised, the plunger opens the valve seat connecting the inlet to the outlet.

All valves with an “N” suffix are sold in the version without coil (with the S suffix), and in the version with series 9300,

type HF2 - “FAST LOCK” coils (A6 suffix with coil 9300/RA6-220/230 VAC).

All valves with an “EX” suffix are sold only in the version with coil series 9100EX (A6 suffix with coil, 9100EX-220/230 VAC, ATEX certified).

The valves series 1028N and 1028EX are direct acting valves. Their operation depends only on the magnetic field produced by the current flow into the coil. Opening/closing of main valve seat, the only seat, is directly controlled by the mobile plunger.

These valves can work with zero pressure differential.

Valves 1068N, 1068EX, 1078N, 1078EX, 1079N, 1079EX, 1098N/7, 1098EX/7, 1099N/9, and 1099EX/9 are pilot-operated diaphragm solenoid 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 1098N/9, 1098EX/9, 1099N/11, and 1099EX/11 are pilot-operated piston solenoid 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 valves 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.
- Hydrogenated nitrile butadiene rubber (HNBR) for outlet seal gaskets
- P.T.F.E. for seat gaskets

All solenoid valves with an “EX” suffix are also equipped with:

- Identification label for compliance of the valve to the ATEX Directive.
- Operating instructions regarding installation of the valve in areas classified as at risk of explosion.
- Operating instructions regarding installation of the coil in areas classified as at risk of explosion.

INSTALLATION

The valves series 1028N, 1028EX, 1068N, 1068EX, 1078N, 1078EX, 1079N, 1079EX, 1098N, 1098EX, 1099N, and 1099EX can be installed on the three main branches of a system (hot gas line, liquid line, and suction line), while respecting the limits of use and the capacities indicated in TABLE 18.

TABLE 16 shows the following functional characteristics of a solenoid valve:

- Connections
- PS: maximum allowable pressure
- TS: maximum / minimum allowable 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.: PRODUCT SUITABLE FOR HYDROCARBON REFRIGERANTS

The products in this chapter can be used with HC refrigerants classified as flammable fluids and that are in Safety Group A3 according to Standard EN 378-1:2016.

These products must be used exclusively in refrigeration systems that comply with the current regulations for flammable refrigerant fluids (series EN 60335).

Installation, maintenance and repair operations must be performed only by authorized personnel, qualified to work on flammable refrigeration systems.

Note: In the specific case of solenoid valves with an “EX” suffix, the personnel must carefully follow the operating instructions provided in the packaging of said valves.

TRACEABILITY

Direct action valves in series 1028N are identified by laser marking on the valve enclosure of the mobile plunger. This marking includes the following data: valve code, refrigerants, PS, TS, and production lot.

The pilot-operated diaphragm and piston solenoid valves in series 1068N, 1078N, 1079N, 1098N, and 1099N are identified by a plastic label fit on the valve enclosure of the mobile plunger. This label includes the following data: valve code, refrigerants, PS, TS, and production lot.

The direct action valves in series 1028EX and the pilot-operated diaphragm and piston solenoid valves in series 1068EX, 1078EX, 1079EX, 1098EX, and 1099EX are identified by a plastic label fit on the valve enclosure of the mobile plunger, below the coil. This label provides the following information: valve code, PS, TA, type of ATEX certification, ATEX certification file number.

TABLE 16: General characteristics of NC valves with ODS connections, for HC (R290 , R600 , R600a)

Operating Principles	Catalogue Number		Connections ODS		Seat size nominal Ø [mm]	Kv Factor [m³/h]	Opening Pressure Differential [bar]				PS [bar]	TS [°C]		TA [°C]		Risk Category according to PED Recast	
	ATEX No compliance	ATEX Compliance for use in EX Zone 2	Ø [in.]	Ø [mm]			min OPD	MOPD				min.	max.	min. (1)	max.		
								coil series									
								9100 9100EX 9110 9110EX 9300 (AC)	9160 (AC)	9120 9320 (AC)							9120 9320 (DC)
Direct Acting	1028N/2#	1028EX/2A6	1/4"	–	2,2	0,15	0	21	28	35	21	45	– 40	+130	– 40	+50	Art. 4.3
	1028N/2#.E	1028EX/2A6.E	1/4"	–	3	0,23											
	1028N/3#	1028EX/3A6	3/8"	–													
	1028N/M10#	1028EX/M10A6	–	10													
Diaphragm Pilot Operated	1068N/3#	1068EX/3A6	3/8"	–	6,5	0,80	0,05	21	28	35	18	45	– 40	+120	– 40	+50	Art. 4.3
	1068N/M10#	1068EX/M10A6	–	10													
	1068N/M12#	1068EX/M12A6	–	12													
	1068N/4#	1068EX/4A6	1/2"	–													
	1078N/M12#	1078EX/M12A6	–	12	12,5	2,20					13						
	1078N/4#	1078EX/4A6	1/2"	–													
	1078N/5#	1078EX/5A6	5/8"	16	16,5	3,80					10						
	1079N/7#	1079EX/7A6	7/8"	22													
	1098N/5#	1098EX/5A6	5/8"	16													
	1098N/6#	1098EX/6A6	3/4"	–	16,5	4,80											
	1098N/7#	1098EX/7A6	7/8"	22													
	1099N/9#	1099EX/9A6	1.1/8"	–	25,5	5,70					13						
	1078N/9#	1078EX/9A6	1.1/8"	–													
1079N/11#	1079EX/11A6	1.3/8"	35														
Piston Pilot Operated	1098N/9#	1098EX/9A6	1.1/8"	–	25	10	0,1	21	28	35	18	45	– 40	+120	– 40	+50	Art. 4.3
	1099N/11#	1099EX/11A6	1.3/8"	35													

= S , A6

 (3) Check TA_{min} of the chosen coil

TABLE 17: Dimensions and weights of NC valves for HC, with 9300 coils (1)

Operating Principles	Catalogue Number		Dimensions [mm]						Weight [g]	
			H ₁	H ₂	H ₃	L ₁	L ₂	Q		
Direct Acting	1028N/2#	1028EX/2A6	75	62,5	34	125	52	-	350	
	1028N/2#.E	1028EX/2A6.E							350	
	1028N/3#	1028EX/3A6							365	
	1028N/M10#	1028EX/M10A6							365	
Diaphragm Pilot Operated	1068N/3#	1068EX/3A6	82	69,5	40	111	52	-	400	
	1068N/M10#	1068EX/M10A6							395	
	1068N/M12#	1068EX/M12A6							420	
	1068N/4#	1068EX/4A6							420	
	1078N/M12#	1078EX/M12A6	91	75	47	127	52	45	690	
	1078N/4#	1078EX/4A6							680	
	1078N/5#	1078EX/5A6							775	
	1079N/7#	1079EX/7A6	106	78	50	175	52	57	765	
	1098N/5#	1098EX/5A6							995	
	1098N/6#	1098EX/6A6							1185	
	1098N/7#	1098EX/7A6							1170	
	1099N/9#	1099EX/9A6							1225	
	Piston Pilot Operated	1078N/9#	1078EX/9A6	115	96	72	250	52	80	2565
		1079N/11#	1079EX/11A6							2620
		1098N/9#	1098EX/9A6	157	127	99	235	52	60	2050
1099N/11#	1099EX/11A6	2130								

(1) : With coil 9320 the dimension L₂ is equal to 64 mm and the weights must be increased of 500 g.

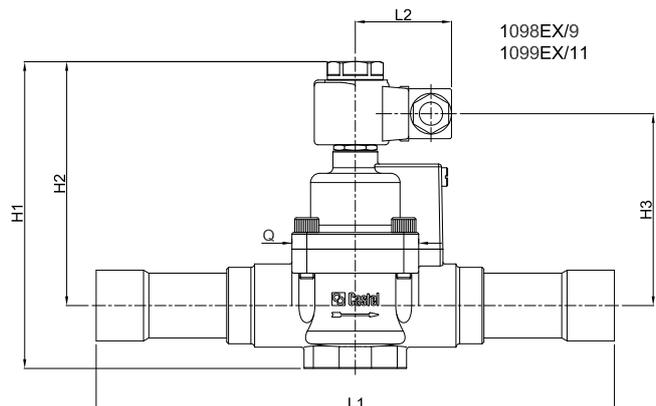
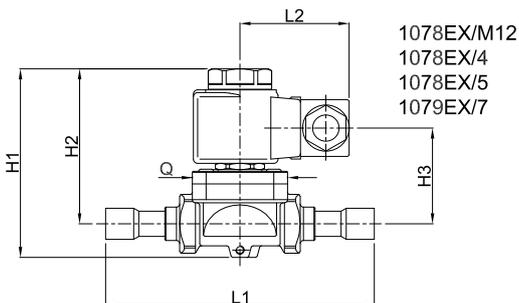
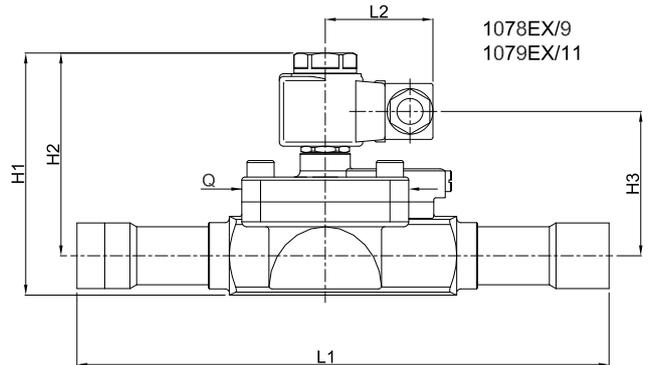
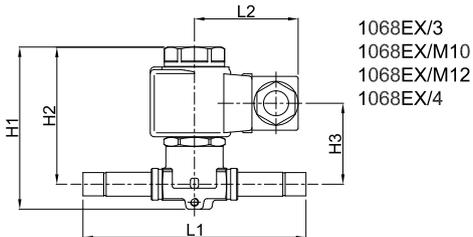
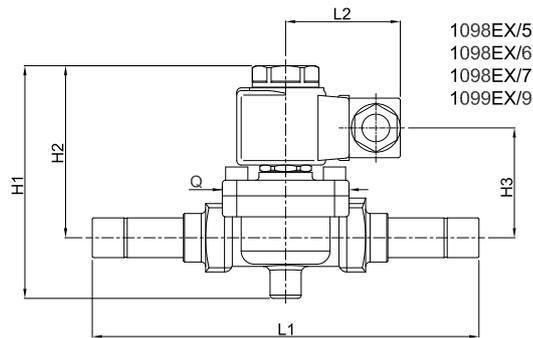
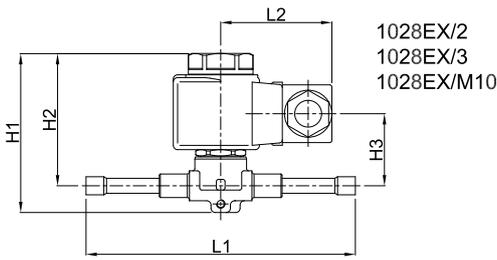


TABLE 18: Refrigerant flow capacity of NC valves for HC [kW]

Operating Principles	Catalogue Number		Liquid line			Suction line			Hot Gas line		
			R290	R600	R600a	R290	R600	R600a	R290	R600	R600a
Direct Acting	1028N/2#	1028EX/2A6	3,06	3,59	3,18	-	-	-	1,91	0,97	1,12
	1028N/2#.E	1028EX/2A6.E	4,69	5,50	4,88				2,93	1,49	1,71
	1028N/3#	1028EX/3A6									
	1028N/M10#	1028EX/M10A6									
Diaphragm Pilot Operated	1068N/3#	1068EX/3A6	16,3	19,1	17,0	2,44	1,03	1,26	10,2	5,2	6,0
	1068N/M10#	1068EX/M10A6									
	1068N/M12#	1068EX/M12A6									
	1068N/4#	1068EX/4A6									
	1078N/M12#	1078EX/M12A6	44,8	52,6	46,6	6,71	2,84	3,48	28,1	14,2	16,4
	1078N/4#	1078EX/4A6	53,2	62,4	55,3	7,96	3,37	4,12	33,3	16,9	19,4
	1078N/5#	1078EX/5A6									
	1079N/7#	1079EX/7A6									
	1098N/5#	1098EX/5A6	77,4	90,8	80,6	11,6	4,9	6,0	48,5	24,5	28,3
	1098N/6#	1098EX/6A6	97,8	114,7	101,8	14,6	6,2	7,6	61,2	31,0	35,7
	1098N/7#	1098EX/7A6	116,2	136,2	120,8	17,4	7,4	9,0	72,7	36,8	42,4
	1099N/9#	1099EX/9A6									
	1078N/9#	1078EX/9A6									
	1079N/11#	1079EX/11A6	203,8	239,0	212,0	30,5	12,9	15,8	127,6	64,6	74,4
Piston Pilot Operated	1098N/9#	1098EX/9A6	203,8	239,0	212,0	30,5	12,9	15,8	127,6	64,6	74,4
	1099N/11#	1099EX/11A6									

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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