



HANDBOOK  
**SOLENOID VALVES**

---

Ed. 2017

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



# TABLE OF CONTENTS

CHAPTER 1	<b>Normally-closed solenoid valves</b> For refrigeration plants that use HCFC, HFC or HFO refrigerants	06
CHAPTER 2	<b>High-temperature normally-closed solenoid valves</b> For refrigeration plants that use HFC or HFO refrigerants	15
CHAPTER 3	<b>Normally-closed pulse solenoid valves</b> For refrigeration plants that use HFC or HFO refrigerants	24
CHAPTER 4	<b>Normally-open solenoid valves</b> For refrigeration plants that use HCFC, HFC or HFO refrigerants	28
CHAPTER 5	<b>Normally-closed solenoid valves</b> For refrigeration plants that use HC refrigerants	36
CHAPTER 6	<b>Normally-closed solenoid valves</b> For refrigeration plants that use the R744 refrigerant	41
CHAPTER 7	<b>Normally-closed solenoid valves, UL-approved</b> For refrigeration plants that use HCFC, HFC or HFO refrigerants	44
CHAPTER 8	<b>Normally-closed solenoid valves</b> For industrial applications	54
CHAPTER 9	<b>Standard coils and connectors</b>	59
CHAPTER 10	<b>Coils and connectors, ATEX-approved</b> For the solenoid valves in CHAPTER 5	64
CHAPTER 11	<b>Coils and connectors, UL-approved</b> For the solenoid valves in CHAPTER 7	66
CHAPTER 12	<b>“SMART CONNECTOR” system</b>	71
CHAPTER 13	<b>Magnetic tool</b>	75

---

## THE NATURAL DEVELOPMENT OF QUALITY

Having achieved the goal of fifty-five years working in the Refrigeration and Air Conditioning Industry, Castel's range of quality products is well known and highly appreciated around the world. Quality is the product of our Company philosophy and marks every step of the production cycle. It is certified by the company's Quality Management System (certified by TUV SUD in accordance with the UNI EN ISO 9001:2008 standard), as well as by the various product certifications of compliance with European Directives and European and extra-European Quality Marks.

Product quality is connected with the quality of manufacturing. We produce on high-tech machinery and updated automatic production lines, operating in compliance with the current safety and environmental protection standards.

Castel offers the Refrigeration and Air Conditioning Market and Manufacturers tested certified products suitable for use with the HCF and HFO refrigerants currently used in the Refrigeration & Air Conditioning Industry.

Based on the experience gained in the refrigeration field using fluorinated fluids, Castel is proud to present the Refrigeration and Air Conditioning Market and Manufacturers two complete lines of products developed and proven for use in systems using natural refrigerants: hydrocarbons (HC fluids) and carbon dioxide (R744).





## DIRECTIVE 2014/68/EU ISSUED OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL OF 15 MAY 2014 ON PRESSURE EQUIPMENT

Directive 2014/68/EU (PED Recast) applies to the design, manufacture and evaluation of compliance of pressure equipment and assemblies with a maximum allowable pressure, PS, greater than 0.5 bar excluding the cases listed in Article 1, Paragraph 2 of the Directive.

Directive 2014/68/EU was transposed into the Italian legal system by Legislative Decree No. 26 dated 15 February 2016, published in the Official Journal of the Republic of Italy No. 53 of 4 March 2016.

The revised PED Recast Directive repeals previous Directive 97/23/EC. More specifically:

- Article 13 of the PED Recast Directive, regarding the classification of pressure equipment, came into force as of 1 June 2015 and repeals Article 9 of the previous PED Directive.
- All other articles of the PED Recast Directive are in force as of 19 July 2016, repealing all articles of the previous PED directive.

All solenoid valves illustrated in this technical handbook are considered “Pressure Accessories” according to the definition provided in Article 2, Point 5 of said Directive and are subject to the classification indicated in Article 4, Points 1.c) and 3 of the same Directive.

## EXTERNAL LEAKAGE

All the products illustrated in this Handbook are submitted, one by one, to tightness tests as well as specific functional tests. The allowable external leakage, measurable during the test, complies with the requirements of standards:

- EN 12284 : 2003 – Refrigerating systems and heat pumps - Valves - Requirements, testing and marking
- EN 16084 : 2011 – Refrigerating systems and heat pumps - Qualification of tightness of components and joints

## PRESSURE CONTAINMENT

All the products illustrated in this Handbook, if submitted to hydrostatic testing, guarantee a pressure strength at least equal to  $1.43 \times PS$  in compliance with Directive 2014/68/EU.

All the products illustrated in this Handbook, if submitted to burst testing, guarantee a pressure strength at least equal to  $3 \times PS$  in compliance with standard EN 378-2:2016.

All the UL-certified products illustrated in this Handbook, if submitted to burst testing, guarantee a pressure strength at least equal to  $5 \times MWP$  in compliance with standard UL 429.

## WEIGHT

The weight of the items listed in this Handbook includes packaging and is not binding.

## WARRANTY

All Castel products are covered by a 12-month warranty. This warranty covers all products or parts thereof that turn out to be defective within the warranty period. In this case, at his own expense, the customer shall return the defective item with a detailed description of the claimed defects. The warranty does not apply if the defect of the Castel product is due to mistakes by the customer or by third parties, such as incorrect installation, use contrary to Castel instructions, or tampering. In the event of defects found in its products, Castel will only replace the defective goods and will not refund damages of any kind. Castel reserves the right to make changes or modifications to its products at any time without prior notice.

The products listed in this handbook are protected according to law.

# NORMALLY-CLOSED 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 1078\*9, 1098/9, 1079/11 and 1099/11, 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 coils listed in this chapter are normally closed (NC). This means that when the coil is not energised, the plunger closes the fluid passage. When the coil is energised, the plunger opens the valve seat connecting the inlet to the outlet.

All the above indicated valves are sold in the version without coil (with the S suffix), and in the version with coil series 9300, type HF2 - "FAST LOCK" (A6 suffix with coil 9300/RA6-220/230 VAC and A7 suffix with coil 9300/RA7 - 240 VAC).

The valves series 1020 and 1028 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.**

The valves series 1064 ; 1068 ; 1070 ; 1078 (excluded /11 , /13 , and /M42) ; 1079 (excluded /13 , /M42 , and /17) ; 1090 ; 1098 (excluded /9) ; 1099 (excluded /11) 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 valve series 1034 ; 1038 ; 1040 ; 1048 ; 1049 ; 1050 ; 1058 ; 1059 ; 1078 (/11 , /13 , /M42) ; 1079 (/13 , /M42 , /17) ; 1098/9 ; 1099/11 are piston pilot-operated 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 that make up the solenoid valves presented 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

All the valves in this chapter 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 1 and 2 and the capacities indicated in TABLE 4. TABLES 1 and 2 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.

## TRACEABILITY

Direct action valves in series 1020 and 1028 are identified by laser marking on the valve sleeve of the mobile plunger. This marking includes the following data: valve code, refrigerants, PS, TS, and production lot.

The pilot-operated diaphragm and piston valves, series 1034, 1038, 1040, 1048, 1049, 1050, 1058, 1059, 1064, 1068, 1070, 1078, 1079, 1090, 1098, and 1099 are identified by a plastic label fit on the valve sleeve of the mobile plunger (under the coil when indicated). This label includes the following data: valve code, refrigerants, PS, TS, and production lot.

TABLE 1: General characteristics of NC 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				min.	max.	min. (3)	max.		
						coil series									
						9100 9110 9300 (AC)	9160 (AC)	9120 9320 (AC)							9120 9320 (DC)
Direct Acting	1020/2#	1/4"	2,5	0,175	0	21	28	35	21	45	-35	+110 (2)	-35	+50	Art. 4.3
	1020/3#	3/8"	3	0,23											
Diaphragm Pilot Operated	1064/3#	3/8"	6,5	0,80	0,05	21	28	35	18	45	-35	+105 (1)	-35	+50	Art. 4.3
	1064/4#	1/2"													
	1070/4#	1/2"	12,5	2,20					13						
	1070/5#	5/8"	2,61												
	1090/5#	5/8"	16,5	3,80					10						
	1090/6#	3/4"		4,80											
Piston Pilot Operated	1034/3#	3/8"	6,5	1,00	0,05	21	28	35	18	45	-35	+110 (2)	-35	+50	Art. 4.3
	1034/4#	1/2"													
	1040/4#	1/2"	12,5	2,40					18						
	1040/5#	5/8"	3,00												
	1050/5#	5/8"	16,5	3,80					16						
	1050/6#	3/4"		4,80											

# = S , A6 , A7

(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 2: General characteristics of NC valves with ODS connections**

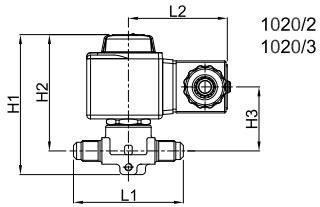
Operating Principles	Catalogue Number	Connections ODS		Seat size nominal Ø [mm]	Kv Factor [m³/h]	Opening Pressure Differential [bar]				PS [bar]	TS [°C]		TA [°C]		Risk Category according to PED Recast		
		Ø [in.]	Ø [mm]			min OPD	MOPD				min.	max.	min. (3)	max.			
							coil series										
							9100 9110 9300 (AC)	9160 (AC)	9120 9320 (AC)							9120 9320 (DC)	
Direct Acting	1028/2#	1/4"	–	2,2	0,15	0	21	28	35	21	45	– 35	+110 (2)	– 35	+50	Art. 4.3	
	1028/2#.E	1/4"	–	3	0,23												
	1028/3#	3/8"	–														
	1028/M10#	–	10														
Diaphragm Pilot Operated	1068/3#	3/8"	–	6,5	0,80	0,05	21	28	35	18	45	– 35	+105 (1)	– 35	+50	Art. 4.3	
	1068/M10#	–	10														
	1068/M12#	–	12														
	1068/4#	1/2"	–														
	1078/M12#	–	12	12,5	2,20					13							
	1078/4#	1/2"	–														
	1078/5#	5/8"	16	16,5	2,61					10							
	1079/7#	7/8"	22														
	1098/5#	5/8"	16														3,80
	1098/6#	3/4"	–														
	1098/7#	7/8"	22	5,70													
	1099/9#	1.1/8"	–		25,5					10							13
	1078/9#	1.1/8"	–														
1079/11#	1.3/8"	35															
Piston Pilot Operated	1038/3#	3/8"	–	6,5	1,00	0,05	21	28	35	18	45	– 35	+110 (2)	– 35	+50	Art. 4.3	
	1038/M10#	–	10														
	1038/M12#	–	12														
	1038/4#	1/2"	–														
	1048/M12#	–	12	12,5	2,40					18							
	1048/4#	1/2"	–														
	1048/5#	5/8"	16														3,00
	1049/7#	7/8"	22														
	1058/5#	5/8"	16	4,80													
	1058/6#	3/4"	–		16,5					5,70							16
	1058/7#	7/8"	22														
	1059/9#	1.1/8"	–	25,5	10					0,1							
	1098/9#	1.1/8"	–														
	1099/11#	1.3/8"	35														
	1078/11#	1.3/8"	35	27	16					18							
	1079/13#	1.5/8"	–														
	1079/M42#	–	42														
1078/13#	1.5/8"	–	34	25	0,15												
1078/M42#	–	42															
1079/17#	2.1/8"	54															

# = S , A6 , A7

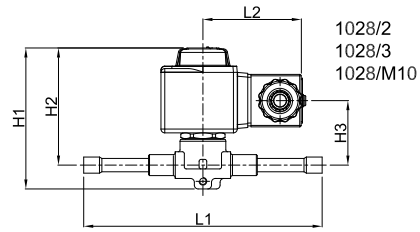
(1) Temperature peaks of 120 °C are allowed during defrosting

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

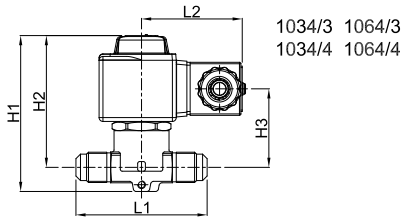
 (3) Check TA<sub>min</sub> of the chosen coil



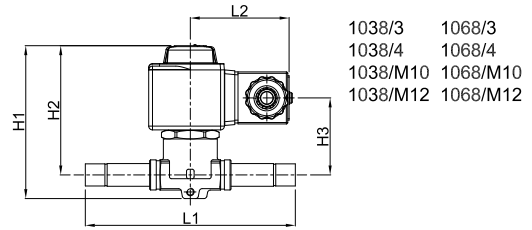
1020/2  
1020/3



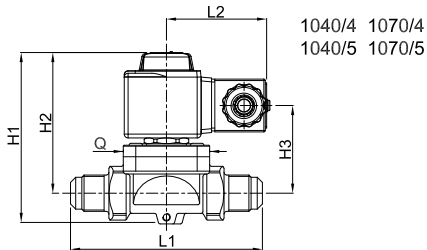
1028/2  
1028/3  
1028/M10



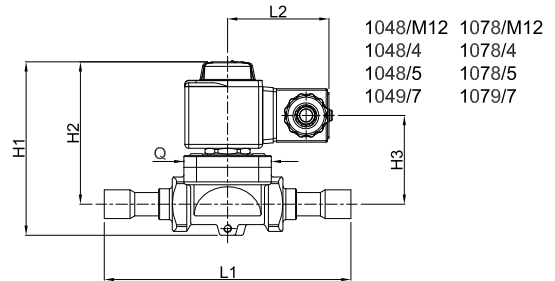
1034/3 1064/3  
1034/4 1064/4



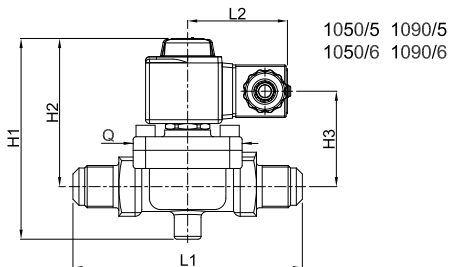
1038/3 1068/3  
1038/4 1068/4  
1038/M10 1068/M10  
1038/M12 1068/M12



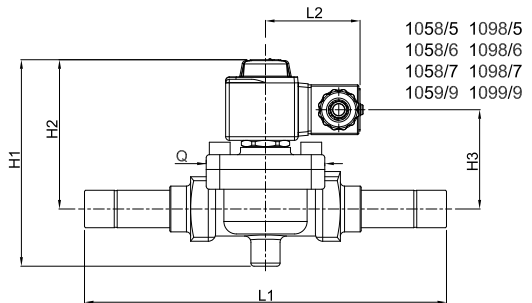
1040/4 1070/4  
1040/5 1070/5



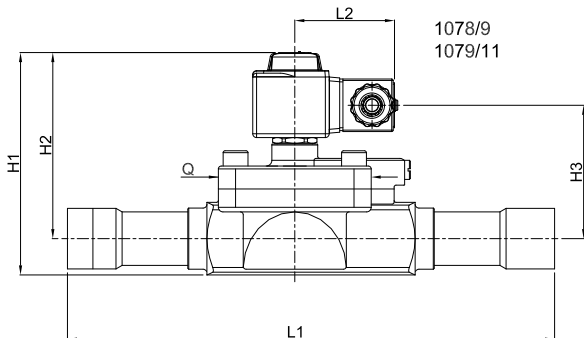
1048/M12 1078/M12  
1048/4 1078/4  
1048/5 1078/5  
1049/7 1079/7



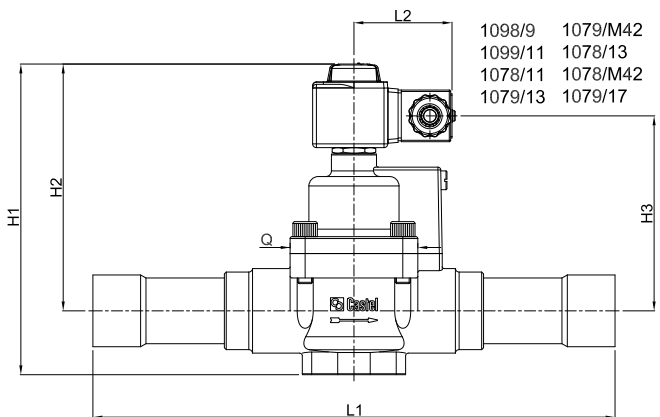
1050/5 1090/5  
1050/6 1090/6



1058/5 1098/5  
1058/6 1098/6  
1058/7 1098/7  
1059/9 1099/9



1078/9  
1079/11



1098/9 1079/M42  
1099/11 1078/13  
1078/11 1078/M42  
1079/13 1079/17

TABLE 3: Dimensions and weights of NC valves with 9300 coils (1)

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	
Direct Acting	1020/2#	75	62,5	34	58	52	-	340
	1020/3#				65			355
	1028/2#				125			350
	1028/2#.E				125			350
	1028/3#				125			365
	1028/M10#				125			365
Diaphragm Pilot Operated	1064/3#	82	69,5	40	68	52	-	400
	1064/4#				72			415
	1068/3#				111			400
	1068/M10#				111			395
	1068/M12#				127			420
	1068/4#				127			420
	1070/4#	91	75	47	100		45	710
	1070/5#				106			755
	1078/M12#				127			690
	1078/4#				127			680
	1078/5#				175			775
	1079/7#				190			765
	1090/5#	106	78	50	120		57	1035
	1090/6#				124			1365
	1098/5#				175			995
	1098/6#				175			1185
	1098/7#				180			1170
	1099/9#				216			1225
	1078/9#	115	96	72	250		80	2565
	1079/11#				292			2620
Piston Pilot Operated	1034/3#	92,5	80	50,5	68	52	-	440
	1034/4#				72			457
	1038/3#				111			440
	1038/M10#				111			435
	1038/M12#				127			462
	1038/4#				127			462
	1040/4#	100,5	84,5	56,5	100		45	781
	1040/5#				106			831
	1048/M12#				127			759
	1048/4#				127			748
	1048/5#				175			853
	1049/7#				190			842
	1050/5#	121	93	65	120		57	1157
	1050/6#				124			1487
	1058/5#				175			1117
	1058/6#				175			1307
	1058/7#				180			1292
	1059/9#				216			1347
	1098/9#	157	127	99	235		60	2050
	1099/11#				277			2130
	1078/11#	175	141	113	278		68	2710
	1079/13#							2750
	1079/M42#							2750
1078/13#	190	153	125	280	88	3810		
1078/M42#						3810		
1079/17#						3880		

# = S , A6 , A7

(1) : With coil 9320 the dimension L<sub>2</sub> is equal to 65 mm and the weights must be increased of 500 g.

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

**TABLE 4: Refrigerant flow capacity of NC valves [kW]**

Operating Principles	Catalogue Number	Liquid line												
		R134a	R22	R32	R404A	R407C	R410A	R507	R1234yf	R1234ze	R448A	R449A	R450A	R452A
Direct Acting	1020/2#	2,98	3,20	4,40	2,08	3,02	3,00	2,01	2,20	2,63	2,74	2,75	2,78	2,12
	1020/3#	3,91	4,21	5,78	2,74	3,96	3,95	2,65	2,89	3,46	3,60	3,62	3,66	2,79
	1028/2#	2,55	2,75	3,77	1,79	2,58	2,58	1,73	1,89	2,26	2,35	2,36	2,39	1,82
	1028/2#.E	3,91	4,21	5,78	2,74	3,96	3,95	2,65	2,89	3,46	3,60	3,62	3,66	2,79
	1028/3#													
	1028/M10#													
1028/M12#														
Diaphragm Pilot Operated	1064/3#	13,6	14,6	20,1	9,5	13,8	13,7	9,2	10,1	12,0	12,5	12,6	12,7	9,7
	1064/4#													
	1068/3#													
	1068/M10#													
	1068/M12#													
	1068/4#													
	1070/4#	37,4	40,3	55,3	26,2	37,9	37,8	25,3	27,7	33,1	34,4	34,6	35,0	26,7
	1070/5#	44,4	47,8	65,6	31,1	45,0	44,8	30,0	32,8	39,3	40,8	41,0	41,5	31,7
	1078/M12#	37,4	40,3	55,3	26,2	37,9	37,8	25,3	27,7	33,1	34,4	34,6	35,0	26,7
	1078/4#													
	1078/5#	44,4	47,8	65,6	31,1	45,0	44,8	30,0	32,8	39,3	40,8	41,0	41,5	31,7
	1079/7#													
	1090/5#	64,6	69,5	95,5	45,2	65,5	65,2	43,7	47,8	57,2	59,5	59,7	60,5	46,1
	1090/6#	81,6	87,8	120,6	57,1	82,7	82,4	55,2	60,4	72,2	75,1	75,5	76,4	58,2
	1098/5#	64,6	69,5	95,5	45,2	65,5	65,2	43,7	47,8	57,2	59,5	59,7	60,5	46,1
	1098/6#	81,6	87,8	120,6	57,1	82,7	82,4	55,2	60,4	72,2	75,1	75,5	76,4	58,2
	1098/7#	96,9	104,3	143,2	67,8	98,2	97,9	65,6	71,7	85,7	89,2	89,6	90,7	69,1
	1099/9#													
	1078/9#	170,0	183,0	251,3	119,0	172,3	171,7	115,0	125,8	150,4	156,5	157,2	159,1	121,3
	1079/11#													
Piston Pilot Operated	1034/3#	17,0	18,3	25,1	11,9	17,2	17,2	11,5	12,6	15,0	15,7	15,7	15,9	12,1
	1034/4#													
	1038/3#													
	1038/M10#													
	1038/M12#													
	1038/4#													
	1040/4#	40,8	43,9	60,3	28,6	41,4	41,2	27,6	30,2	36,1	37,6	37,7	38,2	29,1
	1040/5#	51,0	54,9	75,4	35,7	51,7	51,5	34,5	37,7	45,1	47,0	47,2	47,7	36,4
	1048/M12#	40,8	43,9	60,3	28,6	41,4	41,2	27,6	30,2	36,1	37,6	37,7	38,2	29,1
	1048/4#													
	1048/5#	51,0	54,9	75,4	35,7	51,7	51,5	34,5	37,7	45,1	47,0	47,2	47,7	36,4
	1049/7#													
	1050/5#	64,6	69,5	95,5	45,2	65,5	65,2	43,7	47,8	57,2	59,5	59,7	60,5	46,1
	1050/6#	81,6	87,8	120,6	57,1	82,7	82,4	55,2	60,4	72,2	75,1	75,5	76,4	58,2
	1058/5#	64,6	69,5	95,5	45,2	65,5	65,2	43,7	47,8	57,2	59,5	59,7	60,5	46,1
	1058/6#	81,6	87,8	120,6	57,1	82,7	82,4	55,2	60,4	72,2	75,1	75,5	76,4	58,2
	1058/7#	96,9	104,3	143,2	67,8	98,2	97,9	65,6	71,7	85,7	89,2	89,6	90,7	69,1
	1059/9#													
	1098/9#	170,0	183,0	251,3	119,0	172,3	171,7	115,0	125,8	150,4	156,5	157,2	159,1	121,3
	1099/11#													
1078/11#	272,0	292,8	-	190,4	275,7	274,7	184,0	-	240,6	250,4	251,5	254,6	194,1	
1079/13#														
1079/M42#														
1078/13#	425,0	457,5	-	297,5	430,8	429,3	287,5	-	376,0	391,3	393,0	397,8	303,3	
1078/M42#														
1079/17#														

# = S , A6 , A7

Continued

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)

**TABLE 4: Refrigerant flow capacity of NC valves [kW]**

Operating Principles	Catalogue Number	Suction line												
		R134a	R22	R32	R404A	R407C	R410A	R507	R1234yf	R1234ze	R448A	R449A	R450A	R452A
Direct Acting	1020/2#	-	-	-	-	-	-	-	-	-	-	-	-	-
	1020/3#													
	1028/2#													
	1028/2#.E													
	1028/3#													
	1028/M10#													
Diaphragm Pilot Operated	1064/3#	1,46	2,04	3,40	1,76	1,82	2,64	1,78	1,18	1,14	1,92	1,76	1,27	1,69
	1064/4#													
	1068/3#													
	1068/M10#													
	1068/M12#													
	1068/4#													
	1070/4#	4,00	5,61	9,35	4,84	4,99	7,26	4,91	3,23	3,12	5,28	4,84	3,50	4,64
	1070/5#	4,75	6,66	11,09	5,74	5,92	8,61	5,82	3,84	3,71	6,26	5,74	4,15	5,51
	1078/M12#	4,00	5,61	9,35	4,84	4,99	7,26	4,91	3,23	3,12	5,28	4,84	3,50	4,64
	1078/4#													
	1078/5#	4,75	6,66	11,09	5,74	5,92	8,61	5,82	3,84	3,71	6,26	5,74	4,15	5,51
	1079/7#	6,9	9,7	16,2	8,4	8,6	12,5	8,5	5,6	5,4	9,1	8,4	6,0	8,0
	1090/5#	8,7	12,2	20,4	10,6	10,9	15,8	10,7	7,1	6,8	11,5	10,6	7,6	10,1
	1090/6#	6,9	9,7	16,2	8,4	8,6	12,5	8,5	5,6	5,4	9,1	8,4	6,0	8,0
	1098/5#	8,7	12,2	20,4	10,6	10,9	15,8	10,7	7,1	6,8	11,5	10,6	7,6	10,1
	1098/6#	10,4	14,5	24,2	12,5	12,9	18,8	12,7	8,4	8,1	13,7	12,5	9,1	12,0
	1098/7#	18,2	25,5	42,5	22,0	22,7	33,0	22,3	14,7	14,2	24,0	22,0	15,9	21,1
	1099/9#													
1078/9#	18,2	25,5	42,5	22,0	22,7	33,0	22,3	14,7	14,2	24,0	22,0	15,9	21,1	
1079/11#														
Piston Pilot Operated	1034/3#	1,82	2,55	4,25	2,20	2,27	3,30	2,23	1,47	1,42	2,40	2,20	1,59	2,11
	1034/4#													
	1038/3#													
	1038/M10#													
	1038/M12#													
	1038/4#													
	1040/4#	4,37	6,12	10,20	5,28	5,45	7,92	5,35	3,53	3,41	5,76	5,28	3,82	5,06
	1040/5#	5,46	7,65	12,75	6,60	6,81	9,90	6,69	4,41	4,26	7,20	6,60	4,77	6,33
	1048/M12#	4,37	6,12	10,20	5,28	5,45	7,92	5,35	3,53	3,41	5,76	5,28	3,82	5,06
	1048/4#													
	1048/5#	5,46	7,65	12,75	6,60	6,81	9,90	6,69	4,41	4,26	7,20	6,60	4,77	6,33
	1049/7#	6,9	9,7	16,2	8,4	8,6	12,5	8,5	5,6	5,4	9,1	8,4	6,0	8,0
	1050/5#	8,7	12,2	20,4	10,6	10,9	15,8	10,7	7,1	6,8	11,5	10,6	7,6	10,1
	1050/6#	6,9	9,7	16,2	8,4	8,6	12,5	8,5	5,6	5,4	9,1	8,4	6,0	8,0
	1058/5#	8,7	12,2	20,4	10,6	10,9	15,8	10,7	7,1	6,8	11,5	10,6	7,6	10,1
	1058/6#	10,4	14,5	24,2	12,5	12,9	18,8	12,7	8,4	8,1	13,7	12,5	9,1	12,0
	1058/7#	18,2	25,5	42,5	22,0	22,7	33,0	22,3	14,7	14,2	24,0	22,0	15,9	21,1
	1059/9#													
	1098/9#	18,2	25,5	42,5	22,0	22,7	33,0	22,3	14,7	14,2	24,0	22,0	15,9	21,1
	1099/11#													
	1078/11#	29,1	40,8	-	35,2	36,3	52,8	35,7	-	22,7	38,4	35,2	25,4	33,8
1079/13#														
1079/M42#														
1078/13#	45,5	63,8	-	55,0	56,8	82,5	55,8	-	35,5	60,0	55,0	39,8	52,8	
1078/M42#														
1079/17#														

# = S , A6 , A7

Continued

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)

**TABLE 4: Refrigerant flow capacity of NC valves [kW]**

Operating Principles	Catalogue Number	Hot Gas line												
		R134a	R22	R32	R404A	R407C	R410A	R507	R1234yf	R1234ze	R448A	R449A	R450A	R452A
Direct Acting	1020/2#	1,49	1,96	3,18	1,68	2,08	2,38	1,67	1,16	1,20	2,07	1,89	1,34	1,75
	1020/3#	1,96	2,58	4,18	2,21	2,74	3,13	2,19	1,53	1,58	2,71	2,48	1,76	2,30
	1028/2#	1,28	1,68	2,72	1,44	1,79	2,04	1,43	1,00	1,03	1,77	1,62	1,15	1,50
	1028/2#.E	1,96	2,58	4,18	2,21	2,74	3,13	2,19	1,53	1,58	2,71	2,48	1,76	2,30
	1028/3#													
	1028/M10#													
1028/M12#														
Diaphragm Pilot Operated	1064/3#	6,8	9,0	14,5	7,7	9,5	10,9	7,6	5,3	5,5	9,4	8,6	6,1	8,0
	1064/4#													
	1068/3#													
	1068/M10#													
	1068/M12#													
	1068/4#													
	1070/4#	18,7	24,6	40,0	21,1	26,2	29,9	21,0	14,6	15,1	26,0	23,7	16,8	22,0
	1070/5#	22,2	29,2	47,4	25,1	31,1	35,5	24,9	17,3	17,9	30,8	28,1	20,0	26,0
	1078/M12#	18,7	24,6	40,0	21,1	26,2	29,9	21,0	14,6	15,1	26,0	23,7	16,8	22,0
	1078/4#													
	1078/5#	22,2	29,2	47,4	25,1	31,1	35,5	24,9	17,3	17,9	30,8	28,1	20,0	26,0
	1079/7#													
	1090/5#	32,3	42,6	69,0	36,5	45,2	51,7	36,3	25,2	26,0	44,8	41,0	29,1	37,9
	1090/6#	40,8	53,8	87,2	46,1	57,1	65,3	45,8	31,9	32,9	56,6	51,7	36,7	47,9
	1098/5#	32,3	42,6	69,0	36,5	45,2	51,7	36,3	25,2	26,0	44,8	41,0	29,1	37,9
	1098/6#	40,8	53,8	87,2	46,1	57,1	65,3	45,8	31,9	32,9	56,6	51,7	36,7	47,9
	1098/7#	48,5	63,8	103,5	54,7	67,8	77,5	54,4	37,8	39,0	67,3	61,4	43,6	56,9
	1099/9#													
	1078/9#	85,0	112,0	181,6	96,0	119,0	136,0	95,4	66,4	68,5	118,0	107,8	76,5	99,8
	1079/11#													
Piston Pilot Operated	1034/3#	8,5	11,2	18,2	9,6	11,9	13,6	9,5	6,6	6,9	11,8	10,8	7,7	10,0
	1034/4#													
	1038/3#													
	1038/M10#													
	1038/M12#													
	1038/4#													
	1040/4#	20,4	26,9	43,6	23,0	28,6	32,6	22,9	15,9	16,4	28,3	25,9	18,4	24,0
	1040/5#	25,5	33,6	54,5	28,8	35,7	40,8	28,6	19,9	20,6	35,4	32,3	23,0	29,9
	1048/M12#	20,4	26,9	43,6	23,0	28,6	32,6	22,9	15,9	16,4	28,3	25,9	18,4	24,0
	1048/4#													
	1048/5#	25,5	33,6	54,5	28,8	35,7	40,8	28,6	19,9	20,6	35,4	32,3	23,0	29,9
	1049/7#													
	1050/5#	32,3	42,6	69,0	36,5	45,2	51,7	36,3	25,2	26,0	44,8	41,0	29,1	37,9
	1050/6#	40,8	53,8	87,2	46,1	57,1	65,3	45,8	31,9	32,9	56,6	51,7	36,7	47,9
	1058/5#	32,3	42,6	69,0	36,5	45,2	51,7	36,3	25,2	26,0	44,8	41,0	29,1	37,9
	1058/6#	40,8	53,8	87,2	46,1	57,1	65,3	45,8	31,9	32,9	56,6	51,7	36,7	47,9
	1058/7#	48,5	63,8	103,5	54,7	67,8	77,5	54,4	37,8	39,0	67,3	61,4	43,6	56,9
	1059/9#													
	1098/9#	85,0	112,0	181,6	96,0	119,0	136,0	95,4	66,4	68,5	118,0	107,8	76,5	99,8
	1099/11#													
1078/11#	136,0	179,2	-	153,6	190,4	217,6	152,6	-	109,6	188,8	172,5	122,4	159,7	
1079/13#														
1079/M42#														
1078/13#	212,5	280,0	-	240,0	297,5	340,0	238,5	-	171,3	295,0	269,5	191,3	249,5	
1078/M42#														
1079/17#														

# = S , A6 , A7

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)

# CHAPTER 2 ■ HIGH-TEMPERATURE NORMALLY-CLOSED SOLENOID VALVES FOR REFRIGERATION PLANTS THAT USE HFC OR HFO REFRIGERANTS



## APPLICATION

The solenoid valves illustrated in this chapter have been developed by Castel for all those commercial, civil and industrial air conditioning refrigeration applications that **require higher temperature operation**. They can be installed on systems that use the following refrigerant fluids:

- 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; 1078N/9, 1098N/9, 1079N/11, and 1099N/11, can also be installed on systems using the following refrigeration fluids:

- HFC (R32)
- HFO (R1234yf)
- HC (R290 , R600 , R600a)

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 (see chapter 5 for more information on the use of HC refrigerant fluids).

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

**CAUTION! The solenoid valves in this chapter cannot be installed on systems that use HCFC (R22) refrigerants or other refrigerants blended 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 the above indicated valves 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).

The valves series 1020N and 1028N 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.**

The valves series 1064N ; 1068N ; 1070N ; 1078N (excluded /11 , /13 , and /M42) ; 1079N (excluded /13 , /M42 , and /17) ; 1090N ; 1098N (excluded /9) ; 1099N (excluded /11) 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 valve series 1034N ; 1038N ; 1040N ; 1048N ; 1049N ; 1050N ; 1058N ; 1059N ; 1078N (/11 , /13 , and /M42);

1079N (/13 , /M42 , and /17); 1098N/9 ; 1099N/11 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.
- Hydrogenated nitrile butadiene rubber (HNBR) for outlet seal gaskets
- P.T.F.E. for seat gaskets

## INSTALLATION

All the valves in this chapter 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 5 and 6 and the capacities indicated in TABLE 8. Castel recommends using piston pilot-operated solenoid valves for applications with the hot gas supply line in particularly harsh (temperature/pressure) operating conditions.

TABLES 5 and 6 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.

## TRACEABILITY

Direct action valves in series 1020N and 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 valves, series 1034N, 1038N, 1040N, 1048N, 1049N, 1050N, 1058N, 1059N, 1064N, 1068N, 1070N, 1078N, 1079N, 1090N, 1098N, and 1099N are identified by a plastic label fit on the valve enclosure of the mobile plunger (under the coil when indicated). This label includes the following data: valve code, refrigerants, PS, TS, and production lot.



**TABLE 5: General characteristics of NC valves (high temperature) 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				min.	max.	min. (2)	max.		
						coil series									
						9100 9110 9300 (AC)	9160 (AC)	9120 9320 (AC)							9120 9320 (DC)
Direct Acting	1020N/2# (1)	1/4"	2,5	0,175	0	21	28	35	21	45	- 40	+130	- 40	+50	Art. 4.3
	1020N/3# (1)	3/8"	3	0,23											
Diaphragm Pilot Operated	1064N/3# (1)	3/8"	6,5	0,80	0,05	21	28	35	18	45	- 40	+120	- 40	+50	Art. 4.3
	1064N/4# (1)	1/2"							13						
	1070N/4# (1)	1/2"	2,20												
	1070N/5# (1)	5/8"		2,61											
	1090N/5# (1)	5/8"	3,80												
	1090N/6# (1)	3/4"		16,5					4,80						
Piston Pilot Operated	1034N/3# (1)	3/8"	6,5	1	0,05	21	28	35	18	45	- 40	+120	- 40	+50	Art. 4.3
	1034N/4# (1)	1/2"							13						
	1040N/4# (1)	1/2"	2,40												
	1040N/5# (1)	5/8"		3,00											
	1050N/5# (1)	5/8"	3,80												
	1050N/6# (1)	3/4"		16,5					4,80						

# = S, A6

(1) NB: No use with R22, mineral and alchylbenzene oils

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

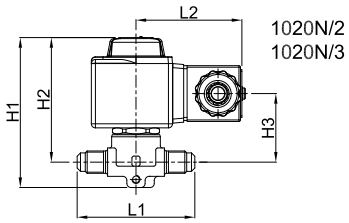
**TABLE 6: General characteristics of NC valves (high temperature) with ODS connections**

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	
		Ø [in.]	Ø [mm]			min OPD	MOPD				min.	max.	min. (2)	max.		
							coil series									
							9100 9110 9300 (AC)	9160 (AC)	9120 9320 (AC)							9120 9320 (DC)
Direct Acting	1028N/2 # (1)	1/4"	–	2,2	0,15	0	21	28	35	21	45	– 40	+130	– 40	+50	Art. 4.3
	1028N/2.E (1)	1/4"	–	3	0,23											
	1028N/3# (1)	3/8"	–													
	1028N/M10# (1)	–	10													
Diaphragm Pilot Operated	1068N/3# (1)	3/8"	–	6,5	0,80	0,05	21	28	35	18	45	– 40	+120	– 40	+50	Art. 4.3
	1068N/M10# (1)	–	10													
	1068N/M12# (1)	–	12													
	1068N/4# (1)	1/2"	–													
	1078N/M12# (1)	–	12	12,5	2,20											
	1078N/4# (1)	1/2"	–													
	1078N/5# (1)	5/8"	16	16,5	2,61											
	1079N/7# (1)	7/8"	22													
	1098N/5# (1)	5/8"	16													
	1098N/6# (1)	3/4"	–	25,5	10											
	1098N/7# (1)	7/8"	22													
	1099N/9# (1)	1.1/8"	–													
	1078N/9# (1)	1.1/8"	–	10	13											
	1079N/11# (1)	1.3/8"	35													
Piston Pilot Operated	1038N/3# (1)	3/8"	–	6,5	1,00	0,05	21	28	35	18	45	– 40	+120	– 40	+50	Art. 4.3
	1038N/M10# (1)	–	10													
	1038N/M12# (1)	–	12													
	1038N/4# (1)	1/2"	–													
	1048N/M12# (1)	–	12	12,5	2,40											
	1048N/4# (1)	1/2"	–													
	1048N/5# (1)	5/8"	16													
	1049N/7# (1)	7/8"	22													
	1058N/5# (1)	5/8"	16	16,5	3,80											
	1058N/6# (1)	3/4"	–													
	1058N/7# (1)	7/8"	22													
	1059N/9# (1)	1.1/8"	–	25	10											
	1098N/9# (1)	1.1/8"	–													
	1099N/11# (1)	1.3/8"	35													
	1078N/11# (1)	1.3/8"	35	27	16											
	1079N/13# (1)	1.5/8"	–													
	1079N/M42# (1)	–	42													
	1078N/13# (1)	1.5/8"	–	34	25											
1078N/M42# (1)	–	42														
1079N/17# (1)	2.1/8"	54														

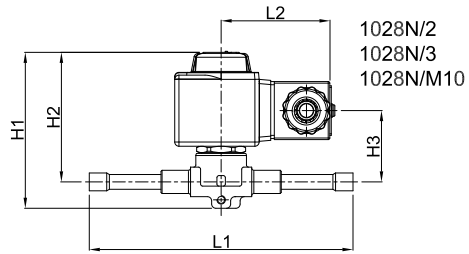
# = S , A6

(1) NB: No use with R22, mineral and alchylbenzene oils

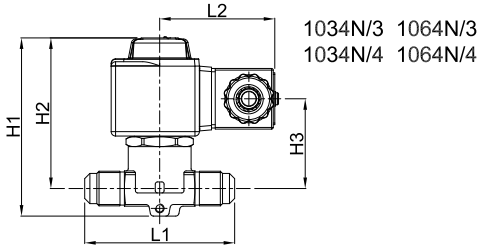
 (2) Check TA<sub>min</sub> of the chosen coil



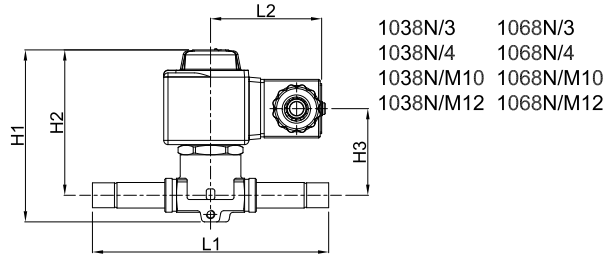
1020N/2  
1020N/3



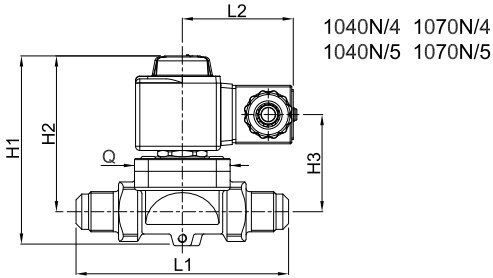
1028N/2  
1028N/3  
1028N/M10



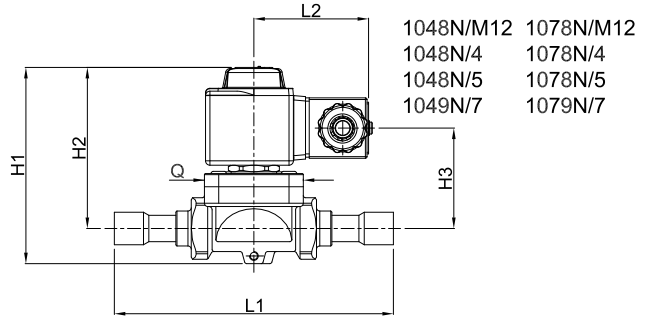
1034N/3 1064N/3  
1034N/4 1064N/4



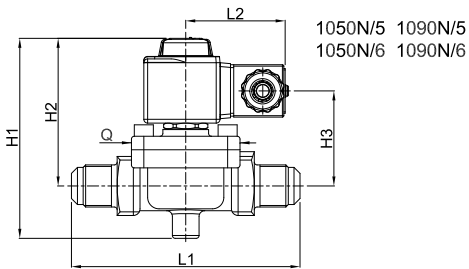
1038N/3 1068N/3  
1038N/4 1068N/4  
1038N/M10 1068N/M10  
1038N/M12 1068N/M12



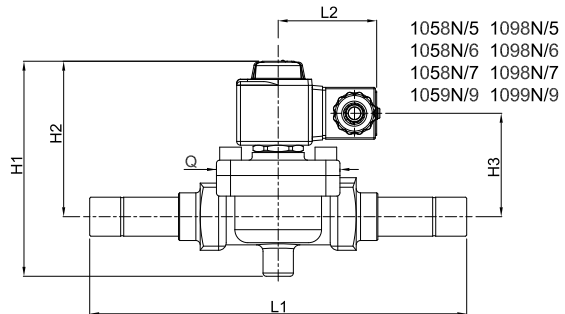
1040N/4 1070N/4  
1040N/5 1070N/5



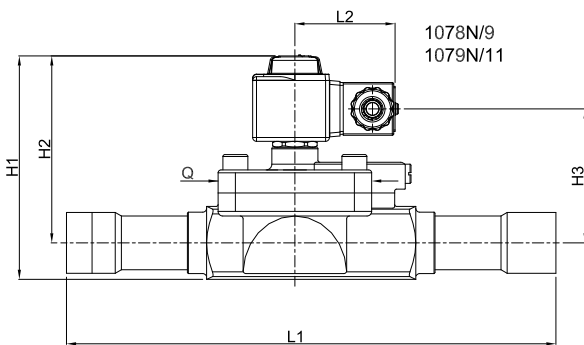
1048N/M12 1078N/M12  
1048N/4 1078N/4  
1048N/5 1078N/5  
1049N/7 1079N/7



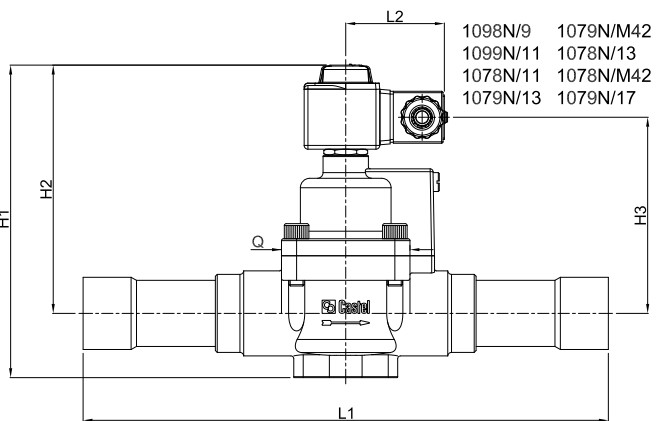
1050N/5 1090N/5  
1050N/6 1090N/6



1058N/5 1098N/5  
1058N/6 1098N/6  
1058N/7 1098N/7  
1059N/9 1099N/9



1078N/9  
1079N/11



1098N/9 1079N/M42  
1099N/11 1078N/13  
1078N/11 1078N/M42  
1079N/13 1079N/17

**TABLE 7: Dimensions and weights of NC valves (high temperature) with 9300 coils (1)**

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		
Direct Acting	1020N/2#	75	62,5	34	58	52	-	340	
	1020N/3#				65			355	
	1028N/2#				125			350	
	1028N/2#.E				125			350	
	1028N/3#				125			365	
	1028N/M10#				125			365	
Diaphragm Pilot Operated	1064N/3#	82	69,5	40	68	52	-	400	
	1064N/4#				72			415	
	1068N/3#				111			400	
	1068N/M10#				111			395	
	1068N/M12#				127			420	
	1068N/4#				127			420	
	1070N/4#	91	75	47	100		45	45	710
	1070N/5#				106				755
	1078N/M12#				127				690
	1078N/4#				127				680
	1078N/5#				175				775
	1079N/7#				190				765
	1090N/5#	106	78	50	120		57	57	1035
	1090N/6#				124				1365
	1098N/5#				175				995
	1098N/6#				175				1185
	1098N/7#				180				1170
	1099N/9#				216				1225
	1078N/9#	115	96	72	250		80	80	2565
	1079N/11#				292				2620
Piston Pilot Operated	1034N/3#	92,5	80	50,5	68	52	-	440	
	1034N/4#				72			457	
	1038N/3#				111			440	
	1038N/M10#				111			435	
	1038N/M12#				127			462	
	1038N/4#				127			462	
	1040N/4#	100,5	84,5	56,5	100		45	45	781
	1040N/5#				106				831
	1048N/M12#				127				759
	1048N/4#				127				748
	1048N/5#				175				853
	1049N/7#				190				842
	1050N/5#	121	93	65	120		57	57	1157
	1050N/6#				124				1487
	1058N/5#				175				1117
	1058N/6#				175				1307
	1058N/7#				180				1292
	1059N/9#				216				1347
	1098N/9#	157	127	99	235		60	60	2050
	1099N/11#				277				2130
	1078N/11#	175	141	113	278		68	68	2710
	1079N/13#								2750
	1079N/M42#								2750
	1078N/13#	190	153	125	280		88	88	3810
1078N/M42#	3810								
1079N/17#	3880								

# = S , A6

(1) : With coil 9320 the dimension L<sub>2</sub> is equal to 65 mm and the weights must be increased of 500 g.

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

**TABLE 8: Refrigerant flow capacity of NC valves (high temperature) [kW]**

Operating Principles	Catalogue Number	Liquid line											
		R134a	R32	R404A	R407C	R410A	R507	R1234yf	R1234ze	R448A	R449A	R450A	R452A
Direct Acting	1020N/2#	2,98	4,40	2,08	3,02	3,00	2,01	2,20	2,63	2,74	2,75	2,78	2,12
	1020N/3#	3,91	5,78	2,74	3,96	3,95	2,65	2,89	3,46	3,60	3,62	3,66	2,79
	1028N/2#	2,55	3,77	1,79	2,58	2,58	1,73	1,89	2,26	2,35	2,36	2,39	1,82
	1028N/2#.E	3,91	5,78	2,74	3,96	3,95	2,65	2,89	3,46	3,60	3,62	3,66	2,79
	1028N/3#												
	1028N/M10#												
1028N/M12#													
Diaphragm Pilot Operated	1064N/3#	13,6	20,1	9,5	13,8	13,7	9,2	10,1	12,0	12,5	12,6	12,7	9,7
	1064N/4#												
	1068N/3#												
	1068N/M10#												
	1068N/M12#												
	1068N/4#												
	1070N/4#	37,4	55,3	26,2	37,9	37,8	25,3	27,7	33,1	34,4	34,6	35,0	26,7
	1070N/5#	44,4	65,6	31,1	45,0	44,8	30,0	32,8	39,3	40,8	41,0	41,5	31,7
	1078N/M12#	37,4	55,3	26,2	37,9	37,8	25,3	27,7	33,1	34,4	34,6	35,0	26,7
	1078N/4#												
	1078N/5#	44,4	65,6	31,1	45,0	44,8	30,0	32,8	39,3	40,8	41,0	41,5	31,7
	1079N/7#	64,6	95,5	45,2	65,5	65,2	43,7	47,8	57,2	59,5	59,7	60,5	46,1
	1090N/5#												
	1090N/6#												
	1098N/5#												
	1098N/6#												
	1098N/7#												
	1099N/9#	96,9	143,2	67,8	98,2	97,9	65,6	71,7	85,7	89,2	89,6	90,7	69,1
1078N/9#	170,0	251,3	119,0	172,3	171,7	115,0	125,8	150,4	156,5	157,2	159,1	121,3	
1079N/11#													
Piston Pilot Operated	1034N/3#	17,0	25,1	11,9	17,2	17,2	11,5	12,6	15,0	15,7	15,7	15,9	12,1
	1034N/4#												
	1038N/3#												
	1038N/M10#												
	1038N/M12#												
	1038N/4#												
	1040N/4#	40,8	60,3	28,6	41,4	41,2	27,6	30,2	36,1	37,6	37,7	38,2	29,1
	1040N/5#	51,0	75,4	35,7	51,7	51,5	34,5	37,7	45,1	47,0	47,2	47,7	36,4
	1048N/M12#	40,8	60,3	28,6	41,4	41,2	27,6	30,2	36,1	37,6	37,7	38,2	29,1
	1048N/4#												
	1048N/5#	51,0	75,4	35,7	51,7	51,5	34,5	37,7	45,1	47,0	47,2	47,7	36,4
	1049N/7#												
	1050N/5#	64,6	95,5	45,2	65,5	65,2	43,7	47,8	57,2	59,5	59,7	60,5	46,1
	1050N/6#	81,6	120,6	57,1	82,7	82,4	55,2	60,4	72,2	75,1	75,5	76,4	58,2
	1058N/5#	64,6	95,5	45,2	65,5	65,2	43,7	47,8	57,2	59,5	59,7	60,5	46,1
	1058N/6#	81,6	120,6	57,1	82,7	82,4	55,2	60,4	72,2	75,1	75,5	76,4	58,2
	1058N/7#	96,9	143,2	67,8	98,2	97,9	65,6	71,7	85,7	89,2	89,6	90,7	69,1
	1059N/9#												
	1098N/9#	170,0	251,3	119,0	172,3	171,7	115,0	125,8	150,4	156,5	157,2	159,1	121,3
	1099N/11#												
	1078N/11#	272,0	-	190,4	275,7	274,7	184,0	-	240,6	250,4	251,5	254,6	194,1
1079N/13#													
1079N/M42#													
1078N/13#	425,0	-	297,5	430,8	429,3	287,5	-	376,0	391,3	393,0	397,8	303,3	
1078N/M42#													
1079N/17#													

# = S , A6

Continued

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)

**TABLE 8: Refrigerant flow capacity of NC valves (high temperature) [kW]**

Operating Principles	Catalogue Number	Suction line											
		R134a	R32	R404A	R407C	R410A	R507	R1234yf	R1234ze	R448A	R449A	R450A	R452A
Direct Acting	1020N/2#	-	-	-	-	-	-	-	-	-	-	-	-
	1020N/3#												
	1028N/2#												
	1028N/2#.E												
	1028N/3#												
	1028N/M10#												
Diaphragm Pilot Operated	1064N/3#	1,46	3,40	1,76	1,82	2,64	1,78	1,18	1,14	1,92	1,76	1,27	1,69
	1064N/4#												
	1068N/3#												
	1068N/M10#												
	1068N/M12#												
	1068N/4#												
	1070N/4#	4,00	9,35	4,84	4,99	7,26	4,91	3,23	3,12	5,28	4,84	3,50	4,64
	1070N/5#	4,75	11,09	5,74	5,92	8,61	5,82	3,84	3,71	6,26	5,74	4,15	5,51
	1078N/M12#	4,00	9,35	4,84	4,99	7,26	4,91	3,23	3,12	5,28	4,84	3,50	4,64
	1078N/4#												
	1078N/5#	4,75	11,09	5,74	5,92	8,61	5,82	3,84	3,71	6,26	5,74	4,15	5,51
	1079N/7#	6,9	16,2	8,4	8,6	12,5	8,5	5,6	5,4	9,1	8,4	6,0	8,0
	1090N/5#												
	1090N/6#												
	1090N/6#												
	1098N/5#	6,9	16,2	8,4	8,6	12,5	8,5	5,6	5,4	9,1	8,4	6,0	8,0
	1098N/6#	8,7	20,4	10,6	10,9	15,8	10,7	7,1	6,8	11,5	10,6	7,6	10,1
	1098N/5#	6,9	16,2	8,4	8,6	12,5	8,5	5,6	5,4	9,1	8,4	6,0	8,0
1098N/6#	8,7	20,4	10,6	10,9	15,8	10,7	7,1	6,8	11,5	10,6	7,6	10,1	
1098N/7#	10,4	24,2	12,5	12,9	18,8	12,7	8,4	8,1	13,7	12,5	9,1	12,0	
1099N/9#													
1078N/9#	18,2	42,5	22,0	22,7	33,0	22,3	14,7	14,2	24,0	22,0	15,9	21,1	
1079N/11#	1,82	4,25	2,20	2,27	3,30	2,23	1,47	1,42	2,40	2,20	1,59	2,11	
1034N/3#													
1034N/4#													
1038N/3#													
1038N/M10#													
1038N/M12#													
1038N/4#													
1040N/4#	4,37	10,20	5,28	5,45	7,92	5,35	3,53	3,41	5,76	5,28	3,82	5,06	
1040N/5#	5,46	12,75	6,60	6,81	9,90	6,69	4,41	4,26	7,20	6,60	4,77	6,33	
1048N/M12#	4,37	10,20	5,28	5,45	7,92	5,35	3,53	3,41	5,76	5,28	3,82	5,06	
1048N/4#													
1048N/5#	5,46	12,75	6,60	6,81	9,90	6,69	4,41	4,26	7,20	6,60	4,77	6,33	
1049N/7#	6,9	16,2	8,4	8,6	12,5	8,5	5,6	5,4	9,1	8,4	6,0	8,0	
1050N/5#													
1050N/6#													
1050N/6#													
1058N/5#	6,9	16,2	8,4	8,6	12,5	8,5	5,6	5,4	9,1	8,4	6,0	8,0	
1058N/6#	8,7	20,4	10,6	10,9	15,8	10,7	7,1	6,8	11,5	10,6	7,6	10,1	
1058N/5#	6,9	16,2	8,4	8,6	12,5	8,5	5,6	5,4	9,1	8,4	6,0	8,0	
1058N/6#	8,7	20,4	10,6	10,9	15,8	10,7	7,1	6,8	11,5	10,6	7,6	10,1	
1058N/7#	10,4	24,2	12,5	12,9	18,8	12,7	8,4	8,1	13,7	12,5	9,1	12,0	
1059N/9#													
1098N/9#	18,2	42,5	22,0	22,7	33,0	22,3	14,7	14,2	24,0	22,0	15,9	21,1	
1099N/11#	29,1	-	35,2	36,3	52,8	35,7	-	22,7	38,4	35,2	25,4	33,8	
1078N/11#													
1079N/13#													
1079N/M42#													
1078N/13#	45,5	-	55,0	56,8	82,5	55,8	-	35,5	60,0	55,0	39,8	52,8	
1078N/M42#													
1078N/M42#													
1079N/17#													

# = S , A6

Continued

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)

**TABLE 8: Refrigerant flow capacity of NC valves (high temperature) [kW]**

Operating Principles	Catalogue Number	Hot Gas line																						
		R134a	R32	R404A	R407C	R410A	R507	R1234yf	R1234ze	R448A	R449A	R450A	R452A											
Direct Acting	1020N/2#	1,49	3,18	1,68	2,08	2,38	1,67	1,16	1,20	2,07	1,89	1,34	1,75											
	1020N/3#	1,96	4,18	2,21	2,74	3,13	2,19	1,53	1,58	2,71	2,48	1,76	2,30											
	1028N/2#	1,28	2,72	1,44	1,79	2,04	1,43	1,00	1,03	1,77	1,62	1,15	1,50											
	1028N/2#.E	1,96	4,18	2,21	2,74	3,13	2,19	1,53	1,58	2,71	2,48	1,76	2,30											
	1028N/3#																							
	1028N/M10#																							
1028N/M12#																								
Diaphragm Pilot Operated	1064N/3#	6,8	14,5	7,7	9,5	10,9	7,6	5,3	5,5	9,4	8,6	6,1	8,0											
	1064N/4#																							
	1068N/3#																							
	1068N/M10#																							
	1068N/M12#																							
	1068N/4#																							
	1070N/4#	18,7	40,0	21,1	26,2	29,9	21,0	14,6	15,1	26,0	23,7	16,8	22,0											
	1070N/5#	22,2	47,4	25,1	31,1	35,5	24,9	17,3	17,9	30,8	28,1	20,0	26,0											
	1078N/M12#	18,7	40,0	21,1	26,2	29,9	21,0	14,6	15,1	26,0	23,7	16,8	22,0											
	1078N/4#																							
	1078N/5#	22,2	47,4	25,1	31,1	35,5	24,9	17,3	17,9	30,8	28,1	20,0	26,0											
	1079N/7#	32,3	69,0	36,5	45,2	51,7	36,3	25,2	26,0	44,8	41,0	29,1	37,9											
	1090N/5#	40,8	87,2	46,1	57,1	65,3	45,8	31,9	32,9	56,6	51,7	36,7	47,9											
	1090N/6#	32,3	69,0	36,5	45,2	51,7	36,3	25,2	26,0	44,8	41,0	29,1	37,9											
	1098N/5#	40,8	87,2	46,1	57,1	65,3	45,8	31,9	32,9	56,6	51,7	36,7	47,9											
	1098N/6#	48,5	103,5	54,7	67,8	77,5	54,4	37,8	39,0	67,3	61,4	43,6	56,9											
	1098N/7#	85,0	181,6	96,0	119,0	136,0	95,4	66,4	68,5	118,0	107,8	76,5	99,8											
	1099N/9#																							
1078N/9#	85,0	181,6	96,0	119,0	136,0	95,4	66,4	68,5	118,0	107,8	76,5	99,8												
1079N/11#	8,5	18,2	9,6	11,9	13,6	9,5	6,6	6,9	11,8	10,8	7,7	10,0												
1034N/3#																								
1034N/4#																								
1038N/3#																								
1038N/M10#																								
1038N/M12#																								
1038N/4#																								
1040N/4#													20,4	43,6	23,0	28,6	32,6	22,9	15,9	16,4	28,3	25,9	18,4	24,0
1040N/5#													25,5	54,5	28,8	35,7	40,8	28,6	19,9	20,6	35,4	32,3	23,0	29,9
1048N/M12#													20,4	43,6	23,0	28,6	32,6	22,9	15,9	16,4	28,3	25,9	18,4	24,0
1048N/4#																								
1048N/5#													25,5	54,5	28,8	35,7	40,8	28,6	19,9	20,6	35,4	32,3	23,0	29,9
1049N/7#													32,3	69,0	36,5	45,2	51,7	36,3	25,2	26,0	44,8	41,0	29,1	37,9
1050N/5#													40,8	87,2	46,1	57,1	65,3	45,8	31,9	32,9	56,6	51,7	36,7	47,9
1050N/6#													32,3	69,0	36,5	45,2	51,7	36,3	25,2	26,0	44,8	41,0	29,1	37,9
1058N/5#													40,8	87,2	46,1	57,1	65,3	45,8	31,9	32,9	56,6	51,7	36,7	47,9
1058N/6#													48,5	103,5	54,7	67,8	77,5	54,4	37,8	39,0	67,3	61,4	43,6	56,9
1058N/7#													85,0	181,6	96,0	119,0	136,0	95,4	66,4	68,5	118,0	107,8	76,5	99,8
1059N/9#																								
1098N/9#	85,0	181,6	96,0	119,0	136,0	95,4	66,4	68,5	118,0	107,8	76,5	99,8												
1099N/11#	136,0	-	153,6	190,4	217,6	152,6	-	109,6	188,8	172,5	122,4	159,7												
1078N/11#																								
1079N/13#																								
1079N/M42#																								
1078N/13#	212,5	-	240,0	297,5	340,0	238,5	-	171,3	295,0	269,5	191,3	249,5												
1078N/M42#																								
1079N/17#																								

# = S , A6

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)

# CHAPTER 3 ■

## NORMALLY-CLOSED PULSE SOLENOID VALVES

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



#### APPLICATION

The solenoid valves illustrated in this chapter are designed for applications that require a solenoid valve that cycles at high frequencies for a short period, to accurately maintain the regulated temperature of the refrigeration fluid. They can be installed on systems that use the following refrigerant fluids:

- HFC (R134a , R404A , R407C , R410A , 507)
- 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 can also be installed on systems that use 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.

**CAUTION!:** The pulse solenoid valves in this chapter cannot be used with R22, 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 the valves are exclusively sold in the model without coil (suffix S). These valves can be coupled with the coils in series 9100, 9110, 9120, 9160, 9300, and 9320.

The valves series 1328N 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.**

The valves in series 1338N 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 NC pulse solenoid valves are equipped with a specific reinforced magnetic unit (mobile plunger + valve sleeve for holding it), specifically designed to guarantee a very high number of work cycles compared to a normal NC solenoid valve.

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



- Hot forged brass EN 12420 – CW 724R for mobile plunger valve sleeve
- Ferritic stainless steel EN 10088-3 – 1.4105 for the fixed and mobile plungers
- Hydrogenated nitrile butadiene rubber (HNBR) for outlet seal gaskets
- P.T.F.E. for seat gaskets

## INSTALLATION

The valve series 1328N and 1338N can be used as either a hot gas by-pass valve between the high and the low pressure sides of a system or as a liquid injection valve, within the limits of use indicated in TABLE 9 and the capacities indicated in TABLE 11.

TABLE 9 shows 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.

- No. of Cycles: useful operational life expected for the valve expressed in the number of operating cycles, considering a complete cycle consisting of an opening and successive closing of the valve.

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.

## TRACEABILITY

The direct action valves in series 1328N and the pilot-operated solenoid valves in series 1338N 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.

TABLE 9: General Characteristics of NC pulse valves with ODS connections

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]		Cycles No min	Risk Category according to PED Recast
		Ø [in.]	Ø [mm]			min OPD	MOPD					min.	max.	min. (2)	max.		
							coil series										
							9100 9110 9300 (AC)	9160 (AC)	9120 9320 (AC)	9120 9320 (DC)							
Direct Acting	1328N/2S020 (1)	1/4"	–	2,2	0,15	0	28	30	35	21	45	– 40	+150	– 40	+50	6.000.000	Art. 4.3
	1328N/2S030 (1)	1/4"	–	3	0,23	0	18	21	25	18							
	1328N/3S020 (1)	3/8"	–	2,2	0,15	0	28	30	35	21							
	1328N/3S030 (1)	3/8"	–	3	0,23	0	18	21	25	18							
	1328N/M13S020 (1)	–	10	2,2	0,15	0	28	30	35	21							
	1328N/M13S030 (1)	–	10	3	0,23	0	18	21	25	18							
Piston Pilot Operated	1338N/3S065 (1)	3/8"	–	6,5	1,00	0,05	21	28	35	18	45	– 40	+150	– 40	+50	6.000.000	Art. 4.3
	1338N/M10S065 (1)	–	10														
	1338N/M12S065 (1)	–	12														
	1338N/4S065 (1)	1/2"	–														

(1) NB: No use with R22, mineral and alchylbenzene oils

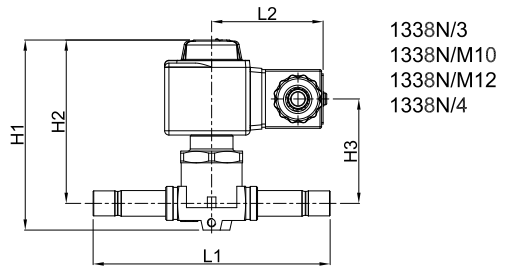
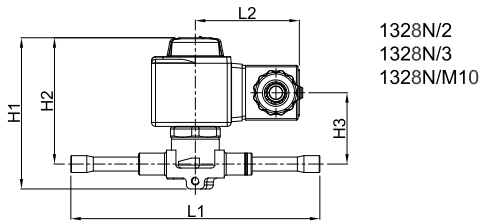
(2) Check TA<sub>min</sub> of the chosen coil

**TABLE 10: Dimensions and Weights of NC pulse valves with 9300 coils (1)**

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	
Direct Acting	1328N/2S020 (1)	75	62,5	34	125	52	-	350
	1328N/2S030 (1)							350
	1328N/3S020 (1)							365
	1328N/3S030 (1)							365
	1328N/M13S020 (1)							365
	1328N/M13S030 (1)							365
Piston Pilot Operated	1338N/3S065 (1)	92,5	80	50,5	111	52	-	440
	1338N/M10S065 (1)				111			435
	1338N/M12S065 (1)				127			462
	1338N/4S065 (1)				127			462

(1) : With coil 9320 the dimension L<sub>2</sub> is equal to 65 mm and the weights must be increased of 500 g.

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



**TABLE 11: Refrigerant Flow Capacity of NC pulse valves [kW]**

Operating Principles	Catalogue Number	Liquid line											
		R134a	R32	R404A	R407C	R410A	R507	R1234yf	R1234ze	R448A	R449A	R450A	R452A
Direct Acting	1328N/2S020	2,55	3,77	1,79	2,58	2,58	1,73	1,89	2,26	2,35	2,36	2,39	1,82
	1328N/2S030	3,91	5,78	2,74	3,96	3,95	2,65	2,89	3,46	3,60	3,62	3,66	2,79
	1328N/3S020	2,55	3,77	1,79	2,58	2,58	1,73	1,89	2,26	2,35	2,36	2,39	1,82
	1328N/3S030	3,91	5,78	2,74	3,96	3,95	2,65	2,89	3,46	3,60	3,62	3,66	2,79
	1328N/M13S020	2,55	3,77	1,79	2,58	2,58	1,73	1,89	2,26	2,35	2,36	2,39	1,82
	1328N/M13S030	3,91	5,78	2,74	3,96	3,95	2,65	2,89	3,46	3,60	3,62	3,66	2,79
Diaphragm Pilot Operated	1338N/3S065	13,6	20,1	9,5	13,8	13,7	9,2	10,1	12,0	12,5	12,6	12,7	9,7
	1338N/M10S065												
	1338N/M12S065												
	1338N/4S065												

t

**TABLE 11: Refrigerant Flow Capacity of NC pulse valves [kW]**

Operating Principles	Catalogue Number	Hot Gas line											
		R134a	R32	R404A	R407C	R410A	R507	R1234yf	R1234ze	R448A	R449A	R450A	R452A
Direct Acting	1328N/2S020	1,28	2,72	1,44	1,79	2,04	1,43	1,00	1,03	1,77	1,62	1,15	1,50
	1328N/2S030	1,96	4,18	2,21	2,74	3,13	2,19	1,53	1,58	2,71	2,48	1,76	2,30
	1328N/3S020	1,28	2,72	1,44	1,79	2,04	1,43	1,00	1,03	1,77	1,62	1,15	1,50
	1328N/3S030	1,96	4,18	2,21	2,74	3,13	2,19	1,53	1,58	2,71	2,48	1,76	2,30
	1328N/M13S020	1,28	2,72	1,44	1,79	2,04	1,43	1,00	1,03	1,77	1,62	1,15	1,50
	1328N/M13S030	1,96	4,18	2,21	2,74	3,13	2,19	1,53	1,58	2,71	2,48	1,76	2,30
Diaphragm Pilot Operated	1338N/3S065	6,8	14,5	7,7	9,5	10,9	7,6	5,3	5,5	9,4	8,6	6,1	8,0
	1338N/M10S065												
	1338N/M12S065												
	1338N/4S065												

# = S , A6

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)

# 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

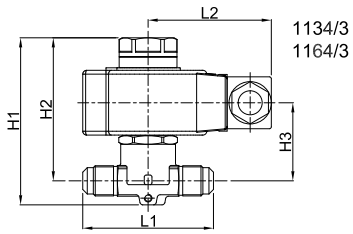
(2) Temperature peaks of 130 °C are allowed during defrosting

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

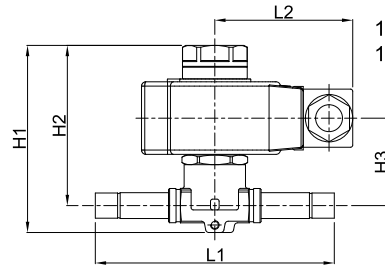
**TABLE 14: Dimensions and weights of NO valves with 9120 coils**

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		

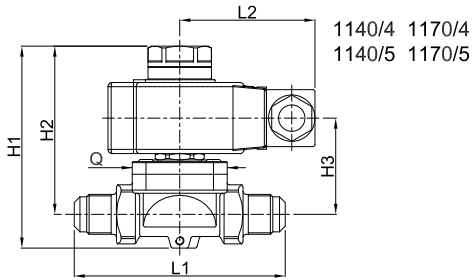
Connectors are not included in the boxes and have to be ordered separately



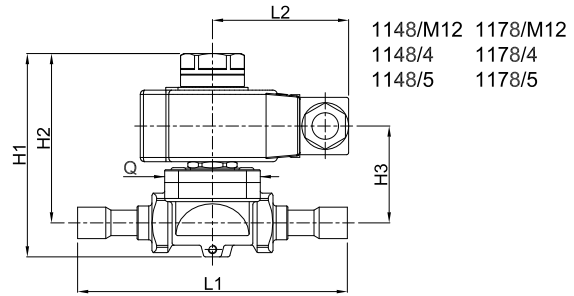
1134/3  
1164/3



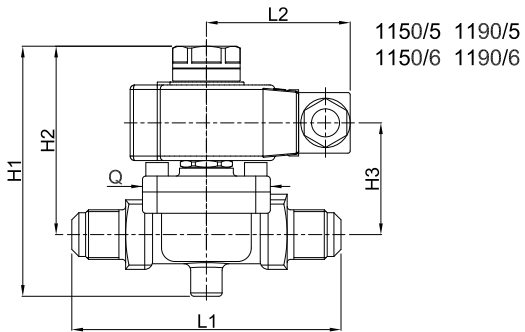
1138/3 1168/3  
1138/M10 1168/M10



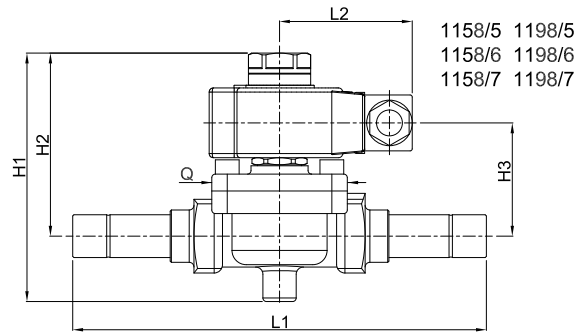
1140/4 1170/4  
1140/5 1170/5



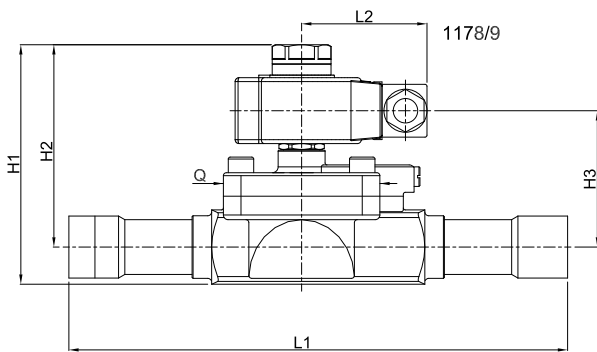
1148/M12 1178/M12  
1148/4 1178/4  
1148/5 1178/5



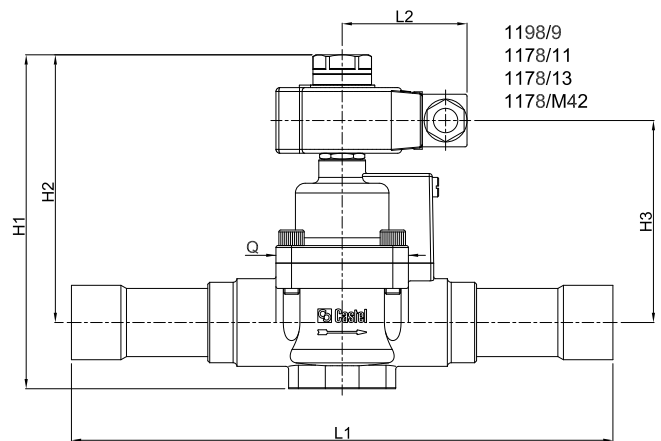
1150/5 1190/5  
1150/6 1190/6



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)

# 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	2,61					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					10						
	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													

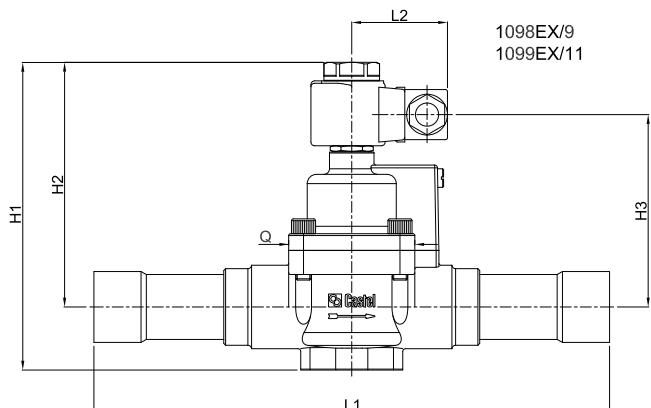
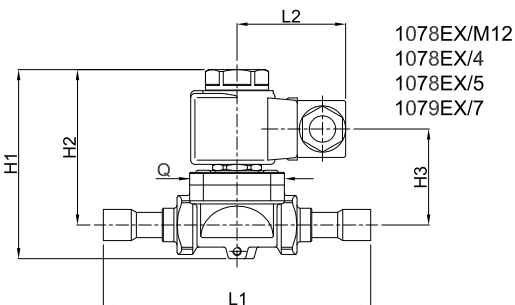
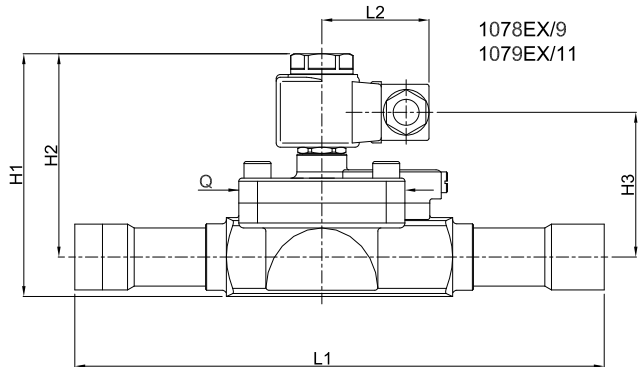
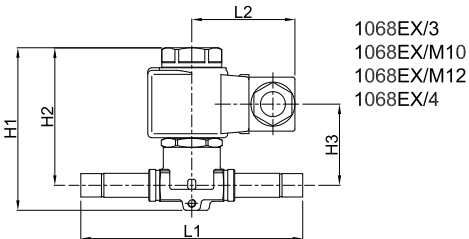
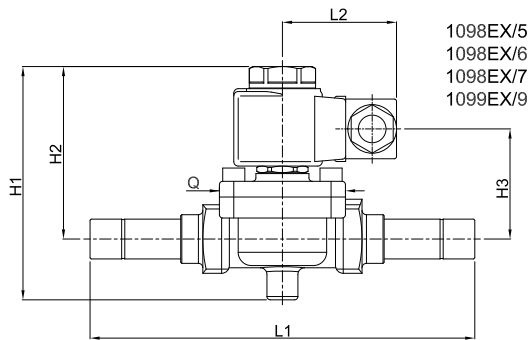
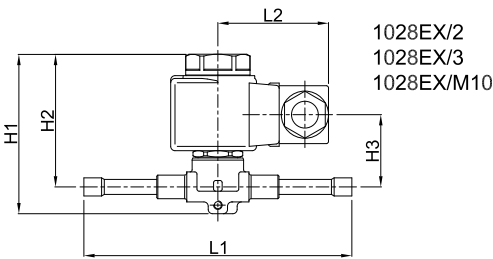
# = S , A6

 (3) Check TA<sub>min</sub> 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 <sub>1</sub>	H <sub>2</sub>	H <sub>3</sub>	L <sub>1</sub>	L <sub>2</sub>	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 L<sub>2</sub> 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	77,4	90,8	80,6	11,6	4,9	6,0	48,5	24,5	28,3
	1098N/5#	1098EX/5A6	97,8	114,7	101,8	14,6	6,2	7,6	61,2	31,0	35,7
	1098N/6#	1098EX/6A6	116,2	136,2	120,8	17,4	7,4	9,0	72,7	36,8	42,4
	1098N/7#	1098EX/7A6									
	1099N/9#	1099EX/9A6	203,8	239,0	212,0	30,5	12,9	15,8	127,6	64,6	74,4
	1078N/9#	1078EX/9A6									
	1079N/11#	1079EX/11A6									
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)



# CHAPTER 6

## NORMALLY-CLOSED SOLENOID VALVES

### FOR REFRIGERATION PLANTS THAT USE THE R744 REFRIGERANT



#### APPLICATION

The solenoid valves illustrated in this chapter have been developed by Castel for all the applications that use the sub-critical R744 refrigeration fluid belonging to Group 2, defined in Article 13, Chapter 1, Point (b) of Directive 2014/68/EU, with reference to EC Regulation No. 1272/2008.

**ATTENZIONE!: CAUTION!: the solenoid valves in this chapter cannot be used with other refrigerant fluids.**

#### 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 the valves are exclusively sold in the model without coil (suffix S). These valves can be coupled with the coils in series 9120 and 9320.

The valves series 1028EL 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.**

The valves in series 1038EL, 1048EL, and 1058EL 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.
- Ethylene propylene rubber (EPDM) for outlet seal gaskets
- P.T.F.E. for seat gaskets

#### INSTALLATION

The valves series 1028EL, 1038EL, 1048EL and 1058EL 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 21.

TABLE 19 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.

## TRACEABILITY

Direct action valves in series 1028EL 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 piston solenoid valves in series 1038EL, 1048EL and 1058EL 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.

TABLE 19: General characteristics of NC valves with ODS connections, for R744

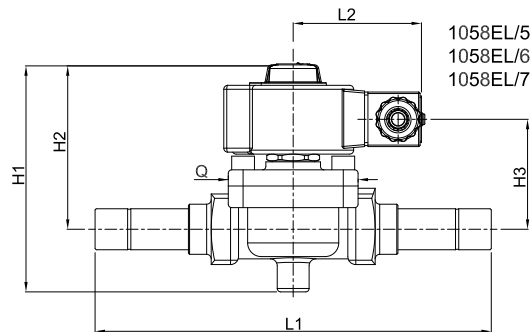
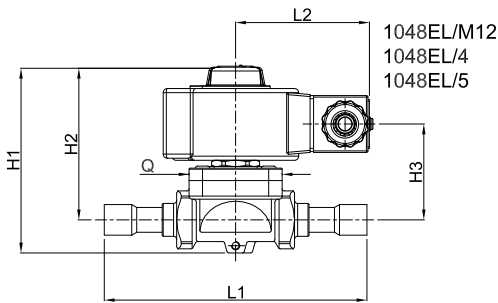
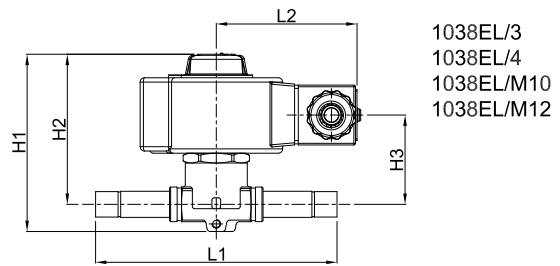
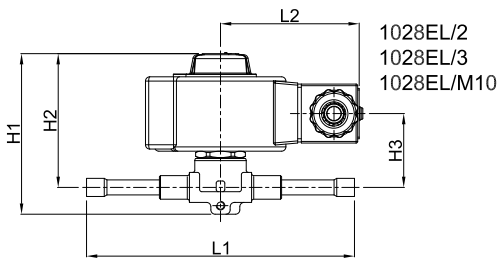
Operating Principles	Catalogue Number	Connections ODS		Seat size nominal $\emptyset$ [mm]	Kv Factor [m <sup>3</sup> /h]	Opening Pressure Differential [bar]			PS [bar]	TS [°C]		TA [°C]		Risk Category according to PED Recast	
		$\emptyset$ [in.]	$\emptyset$ [mm]			min OPD	MOPD			min.	max.	min.	max.		
							Coil series								
							9120 9320 (AC)	9120 9320 (DC)							
Direct Acting	1028EL/2S	1/4"	–	2,2	0,15	0	35	21	60	-40	+130	-40	+50	Art. 4.3	
	1028EL/2S.E	1/4"	–	3	0,23										
	1028EL/3S	3/8"	–												
	1028EL/M10S	–	10												
Piston Pilot Operated	1038EL/3S	3/8"	–	6,5	1,00	0,05	35	18	60	-40	+130	-40	+50	Art. 4.3	
	1038EL/M10S	–	10												
	1038EL/M12S	–	12												
	1038EL/4S	1/2"	–												
	1048EL/M12S	–	12	12,5	2,40	0,07	35	18	60	-40	+130	-40	+50	Art. 4.3	
	1048EL/4S	1/2"	–												
	1048EL/5S	5/8"	16	16,5	3,00										
	1058EL/5S	5/8"	16												3,80
	1058EL/6S	3/4"	–												
	1058EL/7S	7/8"	22	5,70											

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

**TABLE 20: Dimensions and weights of NC valves for R744, with 9320 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	
Direct Acting	1028EL/2S	75	62,5	34	125	65	-	677
	1028EL/2S.E				125			677
	1028EL/3S				125			691
	1028EL/M10S				125			691
Piston Pilot Operated	1038EL/3S	92,5	80,0	50,5	111	65	-	765
	1038EL/M10S				111			765
	1038EL/M12S				127			786
	1038EL/4S				127			786
	1048EL/M12S	100,5	84,5	56,5	127		45	1074
	1048EL/4S				127			1074
	1048EL/5S				175			1138
	1058EL/5S	100,5	84,5	56,5	175		57	1574
	1058EL/6S				175			1616
1058EL/7S	180				1470			

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



**TABLE 21: Refrigerant flow capacity of NC valves for R744 [kW]**

Operating Principles	Catalogue Number	Liquid line	Suction line	Hot Gas line
		R744	R744	R744
Direct Acting	1028EL/2S	4,02	5,30	3,03
	1028EL/2S.E			4,64
	1028EL/3S			
	1028EL/M10S			
Piston Pilot Operated	1038EL/3S	26,8	5,30	20,2
	1038EL/M10S			
	1038EL/M12S			
	1038EL/4S			
	1048EL/M12S	64,3	12,72	48,4
	1048EL/4S			
	1048EL/5S	80,4	15,90	60,5
	1058EL/5S	101,8	20,14	76,7
1058EL/6S	128,6	25,44	96,9	
1058EL/7S	152,8	30,21	115,0	

Standard rating conditions according to AHRI Standard 760-2007

Condensing temperature	30 °F (-1,2 °C)	Temperature leaving evaporator	-10 °F (-23,4°C)
Liquid temperature	20 °F (-6,7 °C)	Evaporator superheating	10 °R (5,5 °K)
Subcooling	10 °R (5,5 °K)	Suction line temperature	-5 °F (-15 °C)
Evaporating temperature	-20 °F (-28,9°C)	Suction superheating	15 °R (8,4 °K)
		Discharge temperature	80 °F (26,6°C)

# CHAPTER 7

## NORMALLY-CLOSED SOLENOID VALVES

### CERTIFIED BY UNDERWRITERS LABORATORIES INC.

#### 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.

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

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

These valves must be coupled with the coils in series 9105, 9115, 9116, 9125, 9185, and 9186.

The valves series 1020UL and 1028UL 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.**

The valves series 1064UL, 1068UL, 1070UL, 1078UL (excluded /11, /13, and /M42), 1079UL (excluded /13, /M42, and /17), 1090UL, 1098UL (excluded /9) and 1099UL (excluded /11) 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 valve series 1034UL, 1038UL, 1040UL, 1048UL, 1049UL, 1050UL, 1058UL, 1059UL, 1078UL (/11, /13, and /M42), 1079UL (/13, /M42, and /17), 1098/9UL, and 1099/11UL 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 that make up the solenoid valves presented 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

All the valves in this chapter 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 22 and 23 and the capacities indicated in TABLE 25. TABLES 22 and 23 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.

## APPROVALS

The solenoid valves series: 1020UL, 1028UL, 1034UL, 1038UL, 1040UL, 1048UL, 1049UL, 1050UL, 1058UL, 1059UL, 1064UL, 1068UL, 1070UL, 1078UL, 1079UL, 1090UL, 1098UL, and 1099UL have been approved by the American certification body Underwriters Laboratories Inc. The valves are certified **UL-CSA Listed** for the USA and Canada with file MH50005, in compliance with American standard UL 429 and Canadian standard C22.2 No. 139-13.

**N.B.: The UL Listed certification is valid only if the above-listed valves are coupled with the coils in series 9115, 9116, 9185, or 9186 illustrated in Chapter 11. If the same valves are coupled with coils in series 9105 and 9125, again illustrated in Chapter 11, a “UL Listed” certified valve is not obtained; rather, you obtain a “UL Recognized” certified valve.**

The coils in series 9105, 9115, 9116, 9125, 9185, and 9186 with voltages of 120 VAC, 208 VAC, 220/230 VAC, 240 VAC comply with the Low Voltage Directive, 2006/95/EC and the Electromagnetic Compatibility Directive (EMC) 2004/108/EC.

## TRACEABILITY

Direct action valves in series 1020 UL and 1028UL 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.

Pilot-operated diaphragm and piston valves in series 1034UL, 1038UL, 1040UL, 1048UL, 1049UL, 1050UL, 1058UL, 1059UL, 1064UL, 1068UL, 1070UL, 1078UL, 1079UL, 1090UL, 1098UL and 1099UL 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 22: General characteristics of NC valves with SAE Flare connections, UL Listed approved**

Operating Principles	Catalogue Number	SAE Flare Connections	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			
					min OPD	MOPD			min.	max.	min.	max.				
						coil series										
						9105 9115 9116 (AC)	9125 9185 9186 (AC)							9125 9185 9186 (DC)		
Direct Acting	1020UL/2S	1/4"	2,5	0,175	0	21	35	19	45	-35	+110 (2)	-20	+50	Art. 4.3		
	1020UL/3S	3/8"	3	0,23												
Diaphragm Pilot Operated	1064UL/3S	3/8"	6,5	0,80	0,05	21	35	18	45	-35	+105 (1)	-20	+50	Art. 4.3		
	1064UL/4S	1/2"														
	1070UL/4S	1/2"	12,5	2,20				18							41,5	
	1070UL/5S	5/8"	2,61	13				34,5								
	1090UL/5S	5/8"	3,80													
	1090UL/6S	3/4"	16,5												4,80	
Piston Pilot Operated	1034UL/3S	3/8"	6,5	1,00	0,05	21	35	19	45	-35	+110 (2)	-20	+50	Art. 4.3		
	1034UL/4S	1/2"														
	1040UL/4S	1/2"	12,5	2,40				18							41,5	
	1040UL/5S	5/8"	3,00													
	1050UL/5S	5/8"	3,80	13												41,5
	1050UL/6S	3/4"	16,5													

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

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

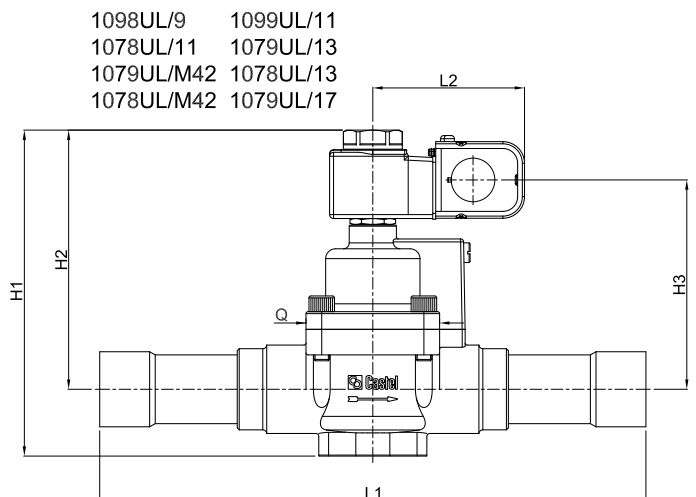
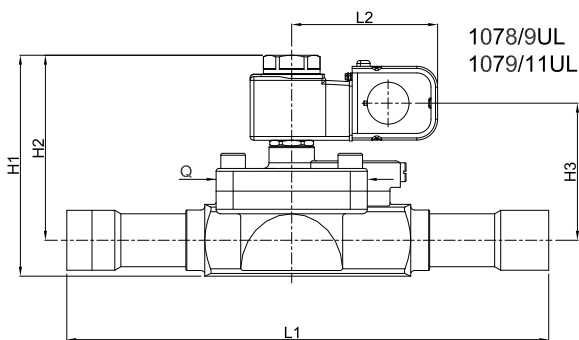
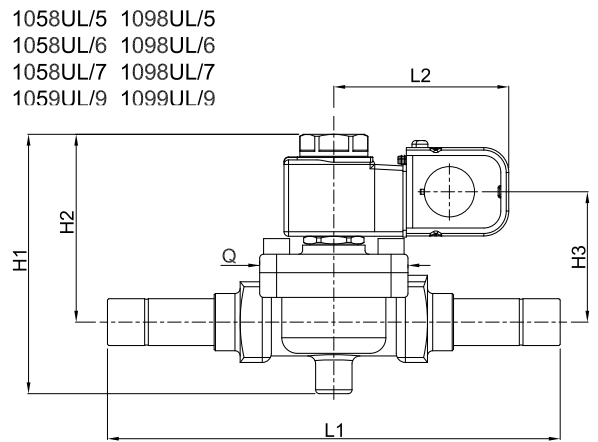
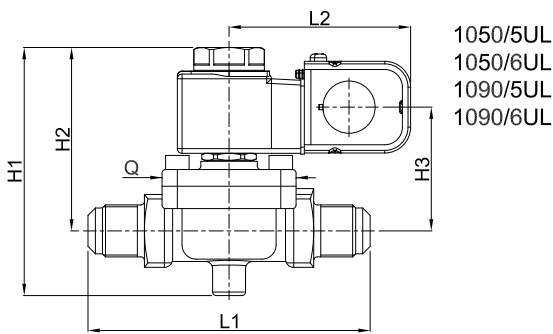
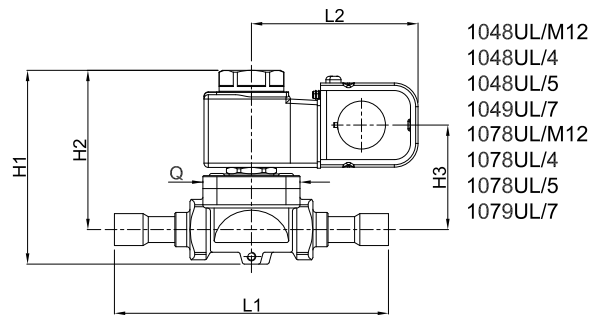
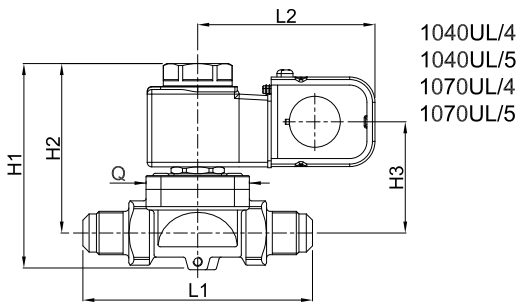
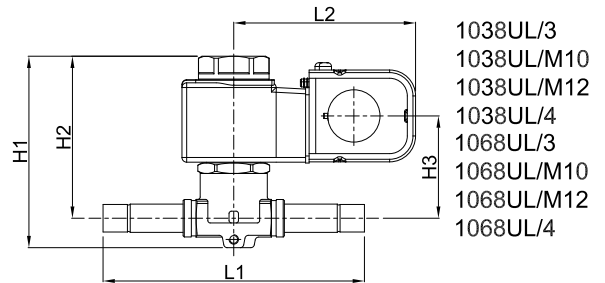
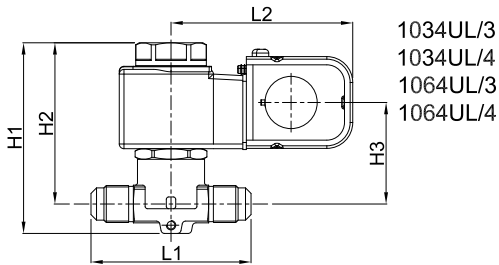
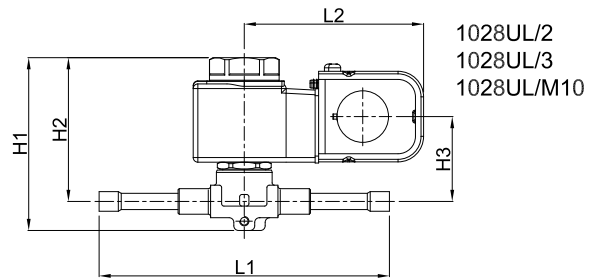
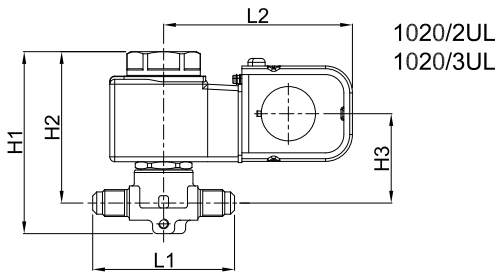
**TABLE 23: General characteristics of NC valves with ODS connections, UL Listed approved**

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		
		Ø [in.]	Ø [mm]			min OPD	MOPD			min.	max.	min.	max.			
							coil series									
							9105 9115 9116 (AC)	9125 9185 9186 (AC)							9125 9185 9186 (DC)	
Direct Acting	1028UL/2S	1/4"	–	2,2	0,15	0	21	35	19	45	– 35	+110 (2)	–20	+50	Art. 4.3	
	1028UL/2S.E	1/4"	–	3	0,23											
	1028UL/3S	3/8"	–													
	1028UL/M10S	–	10													
Diaphragm Pilot Operated	1068UL/3S	3/8"	–	6,5	0,80	0,05	21	35	19	45	– 35	+105 (1)	–20	+50	Art. 4.3	
	1068UL/M10S	–	10													
	1068UL/M12S	–	12													
	1068UL/4S	1/2"	–													
	1078UL/M12S	–	12	2,20												
	1078UL/4S	1/2"	–													
	1078UL/5S	5/8"	16	2,61												
	1079UL/7S	7/8"	22													
	1098UL/5S	5/8"	16	3,80												
	1098UL/6S	3/4"	–		4,80											
	1098UL/7S	7/8"	22						5,70							
1099UL/9S	1.1/8"	–														
Piston Pilot Operated	1038UL/3S	3/8"	–	6,5	1,00	0,05	21	35	19	45	– 35	+110 (2)	–20	+50	Art. 4.3	
	1038UL/M10S	–	10													
	1038UL/M12S	–	12													
	1038UL/4S	1/2"	–													
	1048UL/M12S	–	12	2,40												
	1048UL/4S	1/2"	–		18				41,5							
	1048UL/5S	5/8"	16													
	1049UL/7S	7/8"	22													
	1058UL/5S	5/8"	16	3,80	0,07											
	1058UL/6S	3/4"	–						4,80							
	1058UL/7S	7/8"	22							5,70						
	1059UL/9S	1.1/8"	–													
	1098UL/9S	1.1/8"	–	25	10				0,1	18						34,5
	1099UL/11S	1.3/8"	35													
	1078UL/11S	1.3/8"	35	27	16											
	1079UL/13S	1.5/8"	–													
	1079UL/M42S	–	42													
	1078UL/13S	1.5/8"	–	34	25				0,15	18						30
	1078UL/M42S	–	42													
1079UL/17S	2.1/8"	54														

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

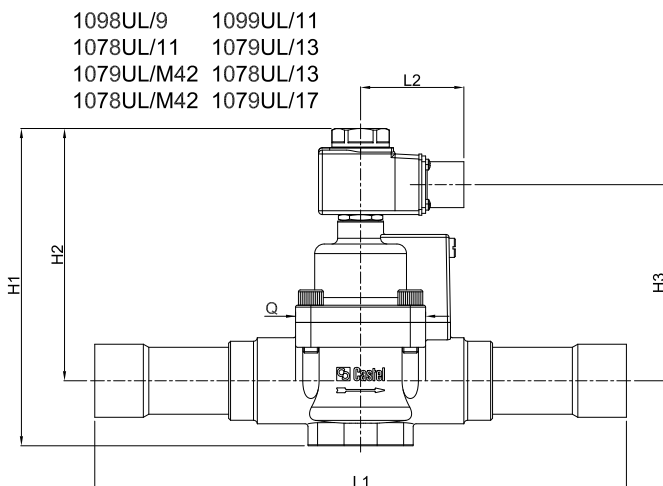
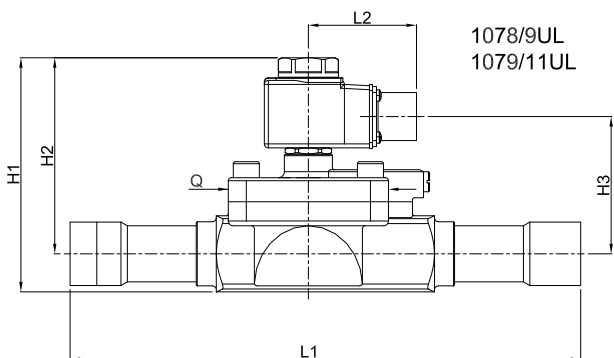
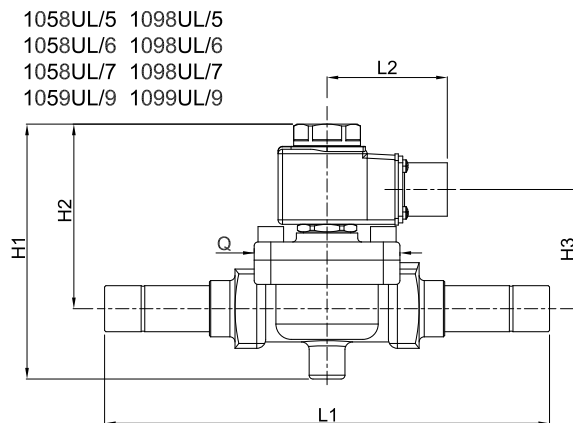
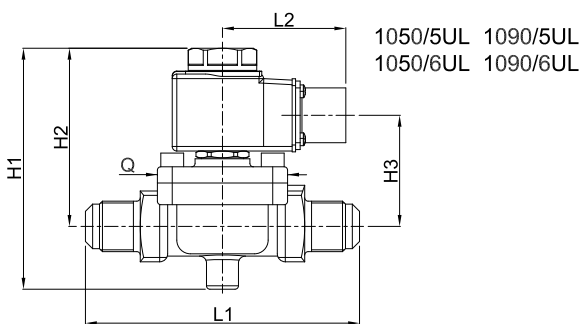
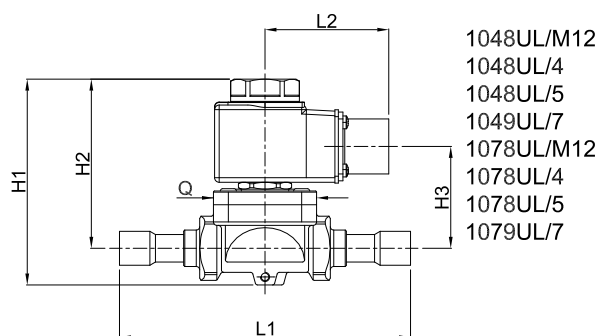
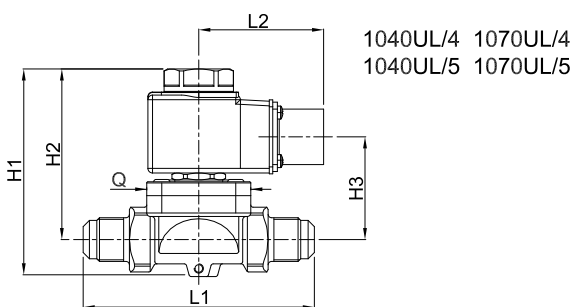
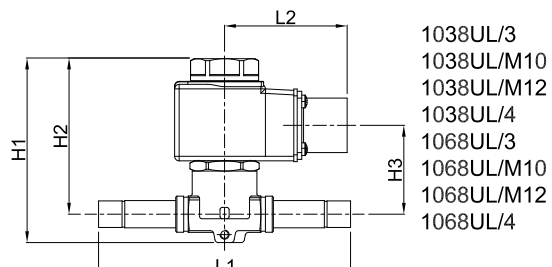
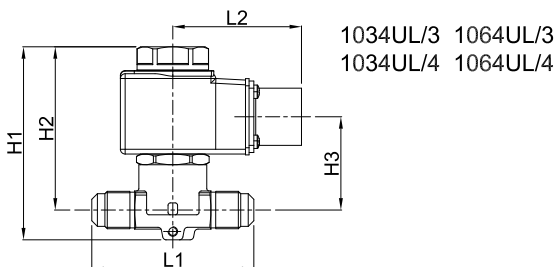
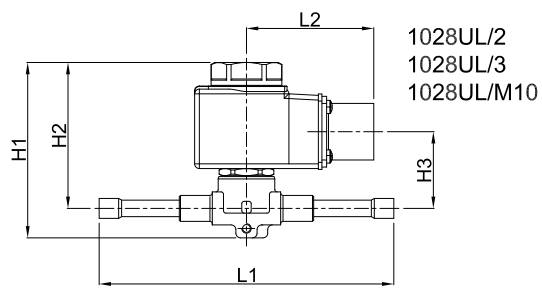
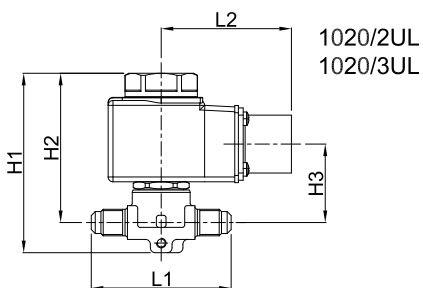
(2) Temperature peaks of 130 °C are allowed during defrosting

# JUNCTION BOX CONNECTION





# CONDUIT HUB CONNECTION



**TABLE 24: Dimensions and weights of NC valves with 9105 coils (1), UL Listed approved**

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	
Direct Acting	1020UL/2S	75	62,5	34	58	52	-	340
	1020UL/3S				65			355
	1028UL/2S				125			350
	1028UL/2S.E				125			350
	1028UL/3S				125			365
	1028UL/M10S				125			365
Diaphragm Pilot Operated	1064UL/3S	82	69,5	40	68	52	-	400
	1064UL/4S				72			415
	1068UL/3S				111			400
	1068UL/M10S				111			395
	1068UL/M12S				127			420
	1068UL/4S				127			420
	1070UL/4S	91	75	47	100		45	710
	1070UL/5S				106			755
	1078UL/M12S				127			690
	1078UL/4S				127			680
	1078UL/5S				175			775
	1079UL/7S				190			765
	1090UL/5S	106	78	50	120		57	1035
	1090UL/6S				124			1365
	1098UL/5S				175			995
	1098UL/6S				175			1185
	1098UL/7S				180			1170
	1099UL/9S				216			1225
Piston Pilot Operated	1034UL/3S	92,5	80	50,5	68	52	-	440
	1034UL/4S				72			457
	1038UL/3S				111			440
	1038UL/M10S				111			435
	1038UL/M12S				127			462
	1038UL/4S				127			462
	1040UL/4S	100,5	84,5	56,5	100		45	781
	1040UL/5S				106			831
	1048UL/M12S				127			759
	1048UL/4S				127			748
	1048UL/5S				175			853
	1049UL/7S				190			842
	1050UL/5S	121	93	65	120		57	1157
	1050UL/6S				124			1487
	1058UL/5S				175			1117
	1058UL/6S				175			1307
	1058UL/7S				180			1292
	1059UL/9S				216			1347
	1098UL/9S	157	127	99	235		60	2050
	1099UL/11S				277			2130
	1078UL/11S	175	141	113	278		68	2710
	1079UL/13S							2750
	1079UL/M42S							2750
	1078UL/13S	190	153	125	280		88	3810
1078UL/M42S	3810							
1079UL/17S	3880							

With coil 9125 the dimension L<sub>2</sub> is equal to 65 mm and the weights must be increased of 500 g.

With coil 9115 the dimension L<sub>2</sub> is equal to 77 mm and the weights must be increased of 310 g.

With coil 9116 the dimension L<sub>2</sub> is equal to 54 mm and the weights must be increased of 240 g.

With coil 9185 the dimension L<sub>2</sub> is equal to 90 mm and the weights must be increased of 590 g.

With coil 9186 the dimension L<sub>2</sub> is equal to 67 mm and the weights must be increased of 472 g.

Connectors are not included in the boxes and have to be ordered separately for coils 9015 and 9125.

**TABLE 25: Refrigerant flow capacity of NC valves [kW], UL Listed approved**

Operating Principles	Catalogue Number	Liquid line										
		R134a	R22	R404A	R407C	R410A	R507	R1234ze	R448A	R449A	R450A	R452A
Direct Acting	1020UL/2S	2,98	3,20	2,08	3,02	3,00	2,01	2,63	2,74	2,75	2,78	2,12
	1020UL/3S	3,91	4,21	2,74	3,96	3,95	2,65	3,46	3,60	3,62	3,66	2,79
	1028UL/2S	2,55	2,75	1,79	2,58	2,58	1,73	2,26	2,35	2,36	2,39	1,82
	1028UL/2S.E	3,91	4,21	2,74	3,96	3,95	2,65	3,46	3,60	3,62	3,66	2,79
	1028UL/3S											
1028UL/M10S												
Diaphragm Pilot Operated	1064UL/3S	13,6	14,6	9,5	13,8	13,7	9,2	12,0	12,5	12,6	12,7	9,7
	1064UL/4S											
	1068UL/3S											
	1068UL/M10S											
	1068UL/M12S											
	1068UL/4S											
	1070UL/4S	37,4	40,3	26,2	37,9	37,8	25,3	33,1	34,4	34,6	35,0	26,7
	1070UL/5S	44,4	47,8	31,1	45,0	44,8	30,0	39,3	40,8	41,0	41,5	31,7
	1078UL/M12S	37,4	40,3	26,2	37,9	37,8	25,3	33,1	34,4	34,6	35,0	26,7
	1078UL/4S											
	1078UL/5S	44,4	47,8	31,1	45,0	44,8	30,0	39,3	40,8	41,0	41,5	31,7
	1079UL/7S	64,6	69,5	45,2	65,5	65,2	43,7	57,2	59,5	59,7	60,5	46,1
	1090UL/5S	81,6	87,8	57,1	82,7	82,4	55,2	72,2	75,1	75,5	76,4	58,2
	1098UL/5S	64,6	69,5	45,2	65,5	65,2	43,7	57,2	59,5	59,7	60,5	46,1
	1098UL/6S	81,6	87,8	57,1	82,7	82,4	55,2	72,2	75,1	75,5	76,4	58,2
1098UL/7S	96,9	104,3	67,8	98,2	97,9	65,6	85,7	89,2	89,6	90,7	69,1	
1099UL/9S												
Piston Pilot Operated	1034UL/3S	17,0	18,3	11,9	17,2	17,2	11,5	15,0	15,7	15,7	15,9	12,1
	1034UL/4S											
	1038UL/3S											
	1038UL/M10S											
	1038UL/M12S											
	1038UL/4S											
	1040UL/4S	40,8	43,9	28,6	41,4	41,2	27,6	36,1	37,6	37,7	38,2	29,1
	1040UL/5S	51,0	54,9	35,7	51,7	51,5	34,5	45,1	47,0	47,2	47,7	36,4
	1048UL/M12S	40,8	43,9	28,6	41,4	41,2	27,6	36,1	37,6	37,7	38,2	29,1
	1048UL/4S											
	1048UL/5S	51,0	54,9	35,7	51,7	51,5	34,5	45,1	47,0	47,2	47,7	36,4
	1049UL/7S	64,6	69,5	45,2	65,5	65,2	43,7	57,2	59,5	59,7	60,5	46,1
	1050UL/5S	81,6	87,8	57,1	82,7	82,4	55,2	72,2	75,1	75,5	76,4	58,2
	1050UL/6S	64,6	69,5	45,2	65,5	65,2	43,7	57,2	59,5	59,7	60,5	46,1
	1058UL/5S	81,6	87,8	57,1	82,7	82,4	55,2	72,2	75,1	75,5	76,4	58,2
	1058UL/6S	64,6	69,5	45,2	65,5	65,2	43,7	57,2	59,5	59,7	60,5	46,1
	1058UL/7S	96,9	104,3	67,8	98,2	97,9	65,6	85,7	89,2	89,6	90,7	69,1
	1059UL/9S											
	1098UL/9S	170,0	183,0	119,0	172,3	171,7	115,0	150,4	156,5	157,2	159,1	121,3
	1099UL/11S											
1078UL/11S	272,0	292,8	190,4	275,7	274,7	184,0	240,6	250,4	251,5	254,6	194,1	
1079UL/13S												
1079UL/M42S												
1078UL/13S	425,0	457,5	297,5	430,8	429,3	287,5	376,0	391,3	393,0	397,8	303,3	
1078UL/M42S												
1079UL/17S												

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 25: Refrigerant flow capacity of NC valves [kW], UL Listed approved**

Operating Principles	Catalogue Number	Suction line										
		R134a	R22	R404A	R407C	R410A	R507	R1234ze	R448A	R449A	R450A	R452A
Direct Acting	1020UL/2S	-	-	-	-	-	-	-	-	-	-	-
	1020UL/3S											
	1028UL/2S											
	1028UL/2S.E											
	1028UL/3S											
	1028UL/M10S											
Diaphragm Pilot Operated	1064UL/3S	1,46	2,04	1,76	1,82	2,64	1,78	1,14	1,92	1,76	1,27	1,69
	1064UL/4S											
	1068UL/3S											
	1068UL/M10S											
	1068UL/M12S											
	1068UL/4S											
	1070UL/4S	4,00	5,61	4,84	4,99	7,26	4,91	3,12	5,28	4,84	3,50	4,64
	1070UL/5S	4,75	6,66	5,74	5,92	8,61	5,82	3,71	6,26	5,74	4,15	5,51
	1078UL/M12S	4,00	5,61	4,84	4,99	7,26	4,91	3,12	5,28	4,84	3,50	4,64
	1078UL/4S											
	1078UL/5S	4,75	6,66	5,74	5,92	8,61	5,82	3,71	6,26	5,74	4,15	5,51
	1079UL/7S	6,9	9,7	8,4	8,6	12,5	8,5	5,4	9,1	8,4	6,0	8,0
	1090UL/5S	8,7	12,2	10,6	10,9	15,8	10,7	6,8	11,5	10,6	7,6	10,1
	1090UL/6S	6,9	9,7	8,4	8,6	12,5	8,5	5,4	9,1	8,4	6,0	8,0
	1098UL/5S	8,7	12,2	10,6	10,9	15,8	10,7	6,8	11,5	10,6	7,6	10,1
	1098UL/6S	10,4	14,5	12,5	12,9	18,8	12,7	8,1	13,7	12,5	9,1	12,0
	1098UL/7S	10,4	14,5	12,5	12,9	18,8	12,7	8,1	13,7	12,5	9,1	12,0
	1099UL/9S											
Piston Pilot Operated	1034UL/3S	1,82	2,55	2,20	2,27	3,30	2,23	1,42	2,40	2,20	1,59	2,11
	1034UL/4S											
	1038UL/3S											
	1038UL/M10S											
	1038UL/M12S											
	1038UL/4S											
	1040UL/4S	4,37	6,12	5,28	5,45	7,92	5,35	3,41	5,76	5,28	3,82	5,06
	1040UL/5S	5,46	7,65	6,60	6,81	9,90	6,69	4,26	7,20	6,60	4,77	6,33
	1048UL/M12S	4,37	6,12	5,28	5,45	7,92	5,35	3,41	5,76	5,28	3,82	5,06
	1048UL/4S											
	1048UL/5S	5,46	7,65	6,60	6,81	9,90	6,69	4,26	7,20	6,60	4,77	6,33
	1049UL/7S	6,9	9,7	8,4	8,6	12,5	8,5	5,4	9,1	8,4	6,0	8,0
	1050UL/5S	8,7	12,2	10,6	10,9	15,8	10,7	6,8	11,5	10,6	7,6	10,1
	1050UL/6S	6,9	9,7	8,4	8,6	12,5	8,5	5,4	9,1	8,4	6,0	8,0
	1058UL/5S	8,7	12,2	10,6	10,9	15,8	10,7	6,8	11,5	10,6	7,6	10,1
	1058UL/6S	10,4	14,5	12,5	12,9	18,8	12,7	8,1	13,7	12,5	9,1	12,0
	1058UL/7S	10,4	14,5	12,5	12,9	18,8	12,7	8,1	13,7	12,5	9,1	12,0
	1059UL/9S											
	1098UL/9S	18,2	25,5	22,0	22,7	33,0	22,3	14,2	24,0	22,0	15,9	21,1
	1099UL/11S	29,1	40,8	35,2	36,3	52,8	35,7	22,7	38,4	35,2	25,4	33,8
	1078UL/11S											
1079UL/13S												
1079UL/M42S												
1078UL/13S	45,5	63,8	55,0	56,8	82,5	55,8	35,5	60,0	55,0	39,8	52,8	
1078UL/M42S												
1079UL/17S												

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 25: Refrigerant flow capacity of NC valves [kW], UL Listed approved**

Operating Principles	Catalogue Number	Hot Gas line										
		R134a	R22	R404A	R407C	R410A	R507	R1234ze	R448A	R449A	R450A	R452A
Direct Acting	1020UL/2S	1,96	3,18	2,08	2,38	1,67	1,16	2,07	1,89	1,34	1,75	1,75
	1020UL/3S	2,58	4,18	2,74	3,13	2,19	1,53	2,71	2,48	1,76	2,30	2,30
	1028UL/2S	1,68	2,72	1,79	2,04	1,43	1,00	1,77	1,62	1,15	1,50	1,50
	1028UL/2S.E	2,58	4,18	2,74	3,13	2,19	1,53	2,71	2,48	1,76	2,30	2,30
	1028UL/3S											
	1028UL/M10S											
1028UL/M10S												
Diaphragm Pilot Operated	1064UL/3S	6,8	9,0	7,7	9,5	10,9	7,6	5,5	9,4	8,6	6,1	8,0
	1064UL/4S											
	1068UL/3S											
	1068UL/M10S											
	1068UL/M12S											
	1068UL/4S											
	1070UL/4S	18,7	24,6	21,1	26,2	29,9	21,0	15,1	26,0	23,7	16,8	22,0
	1070UL/5S	22,2	29,2	25,1	31,1	35,5	24,9	17,9	30,8	28,1	20,0	26,0
	1078UL/M12S	18,7	24,6	21,1	26,2	29,9	21,0	15,1	26,0	23,7	16,8	22,0
	1078UL/4S											
	1078UL/5S	22,2	29,2	25,1	31,1	35,5	24,9	17,9	30,8	28,1	20,0	26,0
	1079UL/7S	32,3	42,6	36,5	45,2	51,7	36,3	26,0	44,8	41,0	29,1	37,9
	1090UL/5S	40,8	53,8	46,1	57,1	65,3	45,8	32,9	56,6	51,7	36,7	47,9
	1090UL/6S	40,8	53,8	46,1	57,1	65,3	45,8	32,9	56,6	51,7	36,7	47,9
	1098UL/5S	32,3	42,6	36,5	45,2	51,7	36,3	26,0	44,8	41,0	29,1	37,9
	1098UL/6S	40,8	53,8	46,1	57,1	65,3	45,8	32,9	56,6	51,7	36,7	47,9
	1098UL/7S	48,5	63,8	54,7	67,8	77,5	54,4	39,0	67,3	61,4	43,6	56,9
	1099UL/9S											
Piston Pilot Operated	1034UL/3S	8,5	11,2	9,6	11,9	13,6	9,5	6,9	11,8	10,8	7,7	10,0
	1034UL/4S											
	1038UL/3S											
	1038UL/M10S											
	1038UL/M12S											
	1038UL/4S											
	1040UL/4S	20,4	26,9	23,0	28,6	32,6	22,9	16,4	28,3	25,9	18,4	24,0
	1040UL/5S	25,5	33,6	28,8	35,7	40,8	28,6	20,6	35,4	32,3	23,0	29,9
	1048UL/M12S	20,4	26,9	23,0	28,6	32,6	22,9	16,4	28,3	25,9	18,4	24,0
	1048UL/4S											
	1048UL/5S	25,5	33,6	28,8	35,7	40,8	28,6	20,6	35,4	32,3	23,0	29,9
	1049UL/7S	32,3	42,6	36,5	45,2	51,7	36,3	26,0	44,8	41,0	29,1	37,9
	1050UL/5S	40,8	53,8	46,1	57,1	65,3	45,8	32,9	56,6	51,7	36,7	47,9
	1050UL/6S	40,8	53,8	46,1	57,1	65,3	45,8	32,9	56,6	51,7	36,7	47,9
	1058UL/5S	32,3	42,6	36,5	45,2	51,7	36,3	26,0	44,8	41,0	29,1	37,9
	1058UL/6S	40,8	53,8	46,1	57,1	65,3	45,8	32,9	56,6	51,7	36,7	47,9
	1058UL/7S	48,5	63,8	54,7	67,8	77,5	54,4	39,0	67,3	61,4	43,6	56,9
	1059UL/9S											
	1098UL/9S	85,0	112,0	96,0	119,0	136,0	95,4	68,5	118,0	107,8	76,5	99,8
	1099UL/11S											
	1078UL/11S	136,0	179,2	153,6	190,4	217,6	152,6	109,6	188,8	172,5	122,4	159,7
	1079UL/13S											
1079UL/M42S												
1078UL/13S	212,5	280,0	240,0	297,5	340,0	238,5	171,3	295,0	269,5	191,3	249,5	
1078UL/M42S												
1079UL/17S												

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)

# CHAPTER 8

## NORMALLY-CLOSED SOLENOID VALVES

### FOR INDUSTRIAL APPLICATIONS



#### APPLICATION

The solenoid valves illustrated in this chapter are designed for the applications specified in TABLE 26, where the different fluids are indicated with the following symbols, according to an already established code:

- W = Water
- L = Air
- B = Secondary coolants (solutions of glycol and water)
- O = Light oils (diesel fuel)

In conclusion, these valves can be used:

- with fluids in the gaseous state 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.
- with fluids in the liquid state 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.

#### 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 the above indicated valves 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).

The valves in series 1512 and 1522 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.**

The valves in series 1132 e 1142 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.**

#### 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
- 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.
- Fluorocarbon rubber (FPM) for outlet seal gaskets, seat gasket and diaphragm

#### VALVE SELECTION AND FLOW RATE CALCULATION

TABLE 26 shows the following functional characteristics for the selection of a solenoid valve for industrial applications:

- Connection dimensions
- PS: maximum allowable pressure of the fluid
- TS: maximum / minimum allowable temperature of the fluid
- 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 ARI STANDARD 760 : 2001. This is the maximum pressure differential between inlet and outlet at which a solenoid valve can open.

With the Kv factor listed in TABLE 26 it is possible to calculate the flow rate through the valve, if you know the acceptable pressure drop, the type of fluid and the operating pressure; in addition, it is also possible to check the pressure drop through the valve, if you know the flow rate.

With the following formula it's possible to calculate the volumetric flow rate of a liquid:

$$Q = Kv \times \sqrt{\frac{\Delta p}{\rho}}$$

For water with a temperature between 5 and 30 °C and density ( $\rho$ ) equal to 1 kg/dm<sup>3</sup> the formula is:

$$Q = Kv \times \sqrt{\Delta p}$$

With the following formula, it is possible to calculate the volumetric flow rate of a gas:

$$\text{if } \Delta p < \frac{p_1}{2} \quad Q_n = 514 \times Kv \times \sqrt{\frac{\Delta p \times p_2}{\rho_n \times (273 + t_1)}}$$

$$\text{if } \Delta p > \frac{p_1}{2} \quad Q_n = 257 \times Kv \times \frac{p_1}{\sqrt{\rho_n \times (273 + t_1)}}$$

For air at 20 °C and density ( $\rho$ ) equal to 1.29 kg/dm<sup>3</sup> the formulas are:

$$\text{if } \Delta p < \frac{p_1}{2} \quad Q_n = 26,4 \times Kv \times \sqrt{\Delta p \times p_2}$$

$$\text{if } \Delta p > \frac{p_1}{2} \quad Q_n = 13,2 \times Kv \times p_1$$

where:

Kv = Kv factor of the valve [m<sup>3</sup>/h]

Q = volumetric flow rate for a liquid [m<sup>3</sup>/h]

Q<sub>n</sub> = volumetric flow rate for a gas at "normal" reference conditions, 0 °C and 760 mm Hg [m<sup>3</sup>/h]

p<sub>1</sub> = absolute pressure upstream from the valve [bar abs]

p<sub>2</sub> = absolute pressure downstream from the valve [bar abs]

t<sub>1</sub> = temperature upstream from the valve [°C]

Δp = pressure drop through the valve [bar]

ρ = density of a liquid [kg/dm<sup>3</sup>]

ρ<sub>n</sub> = volumetric mass for a gas at "normal" reference conditions, 0 °C and 760 mm Hg [kg/m<sup>3</sup>]

Entering the following data in TABLE 27:

- p<sub>1</sub> = absolute pressure upstream from the valve [bar abs]

- Δp = pressure drop through the valve [bar]

It is possible to identify the corresponding airflow rate value under the following reference conditions:

- Temperature at the valve inlet = 20 °C
- Pressure at the outlet (absolute) = 1 bar
- Kv factor of the valve considered = 1 m<sup>3</sup>/h

Example of the use of TABLE 27: Select the valve suitable for use with a flow rate of 200 m<sup>3</sup>/h of air, assuming an absolute pressure of 8 bars at the valve inlet (= 7 bars of relative

pressure + 1 bar) and an acceptable pressure drop across the valve of 1.5 bar.

Intersecting the column p<sub>1</sub> = 8 bar abs with the line Δp = 1.5 bar, the flow rate value is equal to 87 m<sup>3</sup>/h. This is the flow rate value of a hypothetical valve with Kv = 1 m<sup>3</sup>/h working under the above-mentioned conditions. Dividing 200 by 87 equals 2.29 m<sup>3</sup>/h. This is the Kv value required in the case under consideration. In TABLE 26, select the valve with the Kv value nearest to 2,29, rounding up, and subsequently checking that all the characteristics of the selected valve (max. opening pressure differential, connections, etc.) are suitable.

## VISCOSITY

The values of MOPD (maximum opening pressure differential) specified in TABLE 26, are suitable for fluids with maximum kinematic viscosity of 12 cSt, where:

$$1 \text{ cSt} = 10^{-6} \text{ m}^2/\text{sec}$$

For kinematic viscosity values greater than 12 cSt, it is necessary to multiply the maximum differential pressure by the following reducing factors:

Kinematic viscosity, cSt	Reducing factors
12	1
12 / 30	0.8
30 / 45	0.7

When the viscosity of the fluid is expressed as dynamic viscosity, i.e. in cP, where:

$$1 \text{ cP} = 10^{-3} \text{ N sec/m}^2.$$

The corresponding value of kinematic viscosity in cSt is obtained by the following relation:

$$v = \frac{\mu}{\rho}$$

where:

v = Kinematic viscosity [cSt]

μ = dynamic viscosity [cP]

ρ = volumetric mass of the fluid at the temperature considered [kg/dm<sup>3</sup>]

TABLE 28 shows the approximate equivalences among the most common units of measure of viscosity at the same temperature.

Moreover, remember that the viscosity of a fluid may change, even significantly, as the temperature varies. Therefore, if the temperature of the fluid does not ensure viscosity values compatible with the correct operation of the valve, the valve might not open.

## INSTALLATION

Before installation, check that the valve model meets the application requirements and check that the flow direction

in the pipe corresponds to the arrow stamped on the body of the valve.

Make sure that the pipes are clean. If possible, fit an inspectable filter before the valve, avoid that foreign matter enter the valve. Make sure that the sealing materials (tape, jointing paste, etc.) do not obstruct the valve supply holes or exiting pilot holes (pilot-operated versions).

Connect the valve to the pipes or fittings, using the wrench only on the dedicated body surfaces. Do not use the coil or the plunger enclosure as a lever arm.

The valves can be mounted in any position as long as the coil does not point downwards. An assembly that keeps the coil upwards is recommended to avoid any accumulation of impurities inside the guide pipe. When using hoses, fix the valve using the dedicated fixing holes in the body.

Before connecting a valve to the electrical system, make sure that the line voltage and frequency correspond to the values marked on the coil. Direct current valves do not require a fixed polarity. To promote heat dissipation from the

coil, position the valve in a ventilated environment, far from any other heat sources. The increase in the coil temperature, added to the environment and fluid temperatures, may lead to a temperature that can cause burns. It is recommended to suitably protect the coil from water and humidity.

### TRACEABILITY

Direct action valves in series 1512 are identified by laser marking on the valve enclosure of the mobile plunger. This marking includes the following data: valve code, fluids, PS, TS, and production lot.

The direct action valves in series 1522 and the pilot-operated diaphragm solenoid valves in series 1132 and 1142 are identified by a plastic label fit on the valve enclosure of the mobile plunger (below the coil when present). This label includes the following data: valve code, fluids, PS, TS, and production lot.

**TABLE 26: General characteristics of general purpose valves**

Catalogue Number	Seal	Media	FPT Connections	Seat size nominal Ø [mm]	Kv Factor [m³/h]	Operating Principles	Opening Pressure Differential [bar]				PS [bar]	TS [°C]		TA [°C]		Risk Category according to PED Recast	
							min OPD	MOPD				min.	max.	min.	max.		
								coil series									
								9100 9110 9300 (AC)	9160 (AC)	9120 9320 (AC)							9120 9320 (DC)
1512/01#	FPM	W.L.O.	G 1/8"	1,5	0,07	Direct Acting	0	30	30	30	30	-15	+130	-15	+50	Art. 4.3	
1522/02#		W.O.	G 1/4"	4,5	0,40			10	10	12	8						
1522/03#			G 3/8"					12	8								
1522/04#			G 1/2"					8									
1132/03#	FPM	W.L.O..B.	G 3/8"	12,5	2,1	Diaphragm Pilot Operated	0,1	25	25	30	15	-15	+130	-15	+50	Art. 4.3	
1132/04#			G 1/2"		2,2												
1132/06#			G 3/4"	20	5,5												
1132/08#			G 1"		6,0												
1142/010#			G 1.1/4"	38	22												
1142/012#			G 1.1/2"		24												

# = S , A6



**TABLE 27 - Air Capacity [m<sub>n</sub><sup>3</sup>/h] (1)**

Pressure Drop [bar]	Inlet pressure [bar abs]																								
	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1,500	1,300	1,200	1,100	1,050	1,030	1,015	
0,0025																						1,38	1,35	1,33	1,33
0,005																				2,00	1,95	1,91	1,89	1,88	
0,010																			2,94	2,82	2,76	2,69	2,66	2,65	
0,015																		3,94	3,59	3,44	3,37	3,29	3,25	3,23	
0,025																	5,9	5,07	4,62	4,43	4,33	4,23	4,17		
0,05																10,1	8,2	7,11	6,47	6,19	6,05	5,90			
0,1	35,3	34,3	33,3	32,2	31,1	30,0	28,8	27,6	26,3	24,9	23,5	21,9	20,3	18,5	16,5	14,2	11,5	9,88	8,95	8,55	8,35				
0,15	43,2	42,0	40,7	39,4	38,1	36,7	35,2	33,7	32,1	30,4	28,6	26,8	24,7	22,5	20,1	17,3	13,9	11,88	10,72	10,22					
0,25	55,6	54,0	52,4	50,7	48,9	47,1	45,2	43,3	41,2	39,0	36,7	34,3	31,7	28,8	25,6	21,9	17,5	14,76	13,20						
0,5	78,1	75,8	73,5	71,1	68,6	66,0	63,3	60,5	57,5	54,4	51,1	47,6	43,8	39,6	34,9	29,5	22,9	18,67							
1	108,8	105,6	102,2	98,8	95,2	91,5	87,6	83,5	79,2	74,7	69,8	64,7	59,0	52,8	45,7	37,3	26,4								
1,5	131,3	127,3	123,1	118,8	114,3	109,6	104,8	99,7	94,3	88,5	82,4	75,8	68,6	60,5	51,1	39,6									
2	149,3	144,6	139,7	134,6	129,3	123,8	118,1	112,0	105,6	98,8	91,5	83,5	74,7	64,7	52,8										
2,5	164,3	158,9	153,4	147,6	141,6	135,3	128,7	121,7	114,3	106,4	97,9	88,5	78,1	66,0											
3	177,1	171,1	164,9	158,4	151,7	144,6	137,2	129,3	121,0	112,0	102,2	91,5	79,2												
3,5	188,1	181,5	174,6	167,5	160,0	152,2	144,0	135,3	125,9	115,8	104,8	92,4													
4	197,6	190,4	182,9	175,1	167,0	158,4	149,3	139,7	129,3	118,1	105,6														
4,5	205,8	198,0	189,9	181,5	172,6	163,3	153,4	142,8	131,3	118,8															
5	212,8	204,5	195,8	186,7	177,1	167,0	156,2	144,6	132,0																
5,5	218,9	210,0	200,6	190,8	180,5	169,6	157,8	145,2																	
6	224,0	214,5	204,5	194,0	182,9	171,1	158,4																		
6,5	228,2	218,1	207,5	196,2	184,3	171,6																			
7	231,7	220,9	209,5	197,6	184,8																				
7,5	234,3	222,8	210,8	198,0																					
8	236,1	224,0	211,2																						
8,5	237,2	224,4																							
9	237,6																								

(1) The table provides air capacity values in m<sup>3</sup>/h under the following conditions:  
 - temperature at valve inlet: + 20°C  
 - pressure at outlet (absolute): 1 bar  
 - Kv of the solenoid valve: 1 m<sup>3</sup>/h

**TABLE 28: Viscosity equivalence**

Cinematic Viscosity [cSt] o [mm <sup>2</sup> /s]	Engler Degree [°E]	Saybolt Universal Seconds [Ssu]	Seconds Redwood N.1 [SRW N.1]
1	1	---	---
2	1,1	32,7	31
3	1,2	36	33,5
4	1,3	39	36
5	1,4	42,5	38,5
7	1,5	49	44
10	1,8	59	52
15	2,3	77,5	68
20	2,9	98	86
25	3,4	119	105
30	4	140	120
35	4,7	164	145
40	5,3	186	165
50	6,6	232	205
60	8	278	245
70	9,2	324	286
80	10,5	370	327
90	12	415	370
100	13	465	410

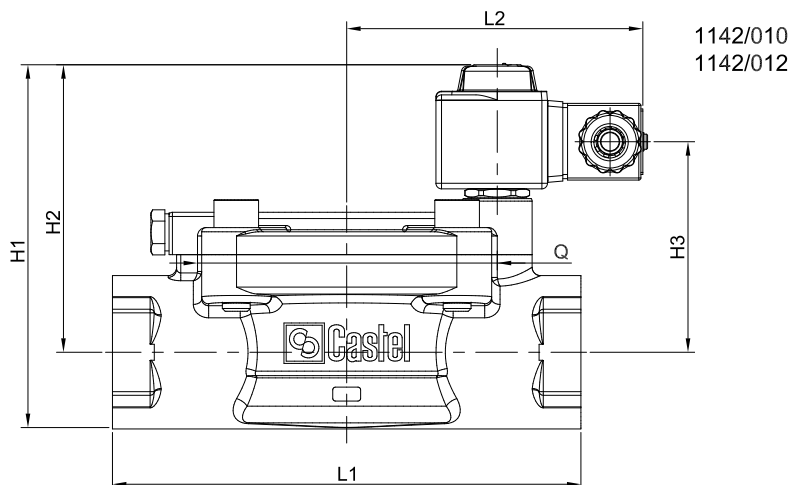
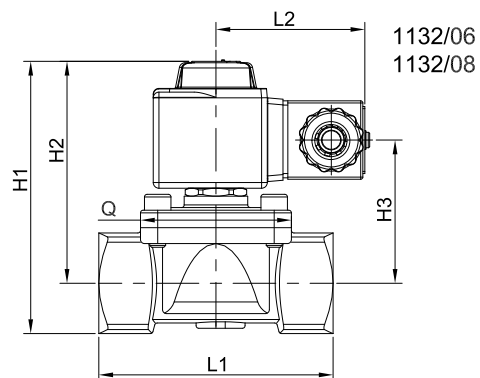
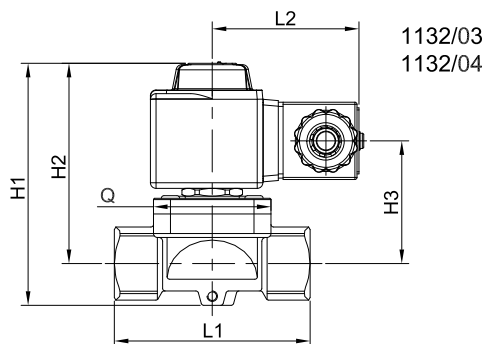
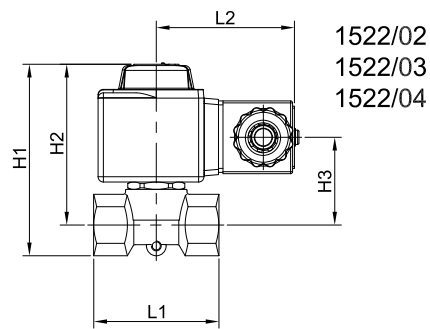
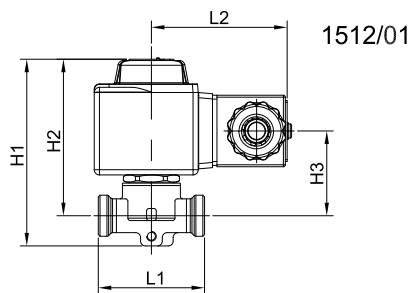


TABLE 29: Dimensions and weights of GP valves (valves with 9300 coils)

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					
1512/01#	69	57	34	44	52	-	310				
1522/02#	71	59	36	51		-	385				
1522/03#						-	370				
1522/04#						-	355				
1132/03#	91	75	47	75	52	45	670				
1132/04#							635				
1132/06#						101	81	52	88	57	960
1132/08#											670
1142/010#	131	104	76	168	104	104	3850				
1142/012#							4000				

With coil 9320 the dimension L<sub>2</sub> is equal to 65 mm and the weights must be increased of 500 g.

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

# CHAPTER 9 ■ STANDARD COILS AND CONNECTORS



## APPLICATION

For the NC (normally-closed) solenoid valves presented in Chapters 1, 2, 3, 6, and 7, Castel provides its customers with the following new series of coils that use the “FAST LOCK” system:

- **Series 9300** (coil type HF2), interchangeable with coils in series 9100 (coils type HM2) that are out of production. The coils in series 9300 can be used on all NC solenoid valves produced by Castel that used the coils in series 9100.
- **Series 9320** (coils type HF3) are interchangeable with coils in series 9120 (coils type HM3), that are still in production in direct current and rectified versions. The coils in series 9320 can be used on all NC solenoid valves produced by Castel that used the coils in series 9120.

The new “FAST LOCK” system (protected by law) guarantees secure fixing, without errors or carelessness, of the coil on the valve, making assembly and disassembly easy and quick. Coils using the “FAST LOCK” system can be assembled on valves, and later disassembled, without the need of additional equipment.

**N.B.: the coils equipped with the “FAST LOCK” system cannot be assembled on the normally-open valves produced by Castel.**

Furthermore, with regard to the NC (normally-closed) solenoid valves in Chapters 1, 2, 3, 6, and 7, the following types of coils are still available:

- **Series 9110** (coils type CM2)
- **Series 9120** (coils type HM3)
- **Series 9160** (coils type HM4)

**For NO (normally-open) solenoid valves shown in Chapter 4, the choice must fall on the direct current coils in series 9120. For NO solenoid valves with a power supply of 220 VAC, Castel has developed a dedicated 220 V rectified coil (part number 9120/RD6).**

Coils in series 9110, 9120, 9300, and 9320 can be coupled with all connectors in series 9150 and 9900 manufactured

by Castel. With the exception of connector 9155/R01, the protection rating guaranteed by the coil + connector system is IP65 according to the EN 60529 standard.

Coils in series 9160 must be used preferably with connector type 9155/R01. The protection rating of the coil + connector 9155/R01 system is IP65/IP68 according to the EN 60529 standard. Alternatively, these coils can be coupled with connectors in series 9150 or 9900. In this case, the protection rating of these systems is IP65.

**The coil code 9120/RD6 must be coupled only with connectors/rectifiers codes 9150/R45 or 9150/R90. The protection rating guaranteed by the coil + connector system is IP65 according to the EN 60529 standard.**

## CONSTRUCTION

In compliance with IEC standard 85, the coils in series 9110, 9120, 9160, and 9320 have Class F encapsulation, while the coils in series 9300 have Class H encapsulation, and their production is compliant with standards EN 60730-1 and EN 60730-2-8. The windings are made of copper wire, with insulation class H (180 °C), in compliance with IEC standard 85. The outer casing is made of waterproof, dielectric resins that guarantee reinforced insulation and allow any type of assembly.

All coils have Class I protection ratings against electric contacts. Consequently, their safety requires an efficient ground system. Rubber gaskets assembled on the upper and lower ends of the coils (only on the lower end for coils in series 9300 and 9320) complete the protection of the windings from humidity.

The terminals of the coils in series 9120, 9160, 9300, and 9320 consist of two Faston connectors plus a Faston ground connector. Coils in series 9110 are equipped with an encapsulated co-moulded cable 1 m long. All coils in this chapter are designed for continuous use. The solid construction of these coils makes them suitable for use in refrigeration systems operating in heavy-duty environments

## APPROVALS

Coils in series 9300 with 110 VAC, 220/230 VAC and 240 VAC power supply are approved by the German registration body, VDE. Coils in series 9110, 9160, and 9300 with 110 VAC, 220/230 VAC and 240 VAC power supply, and coils in series 9120 and 9320 with 220/230 VAC power supply are manufactured according to the Low Voltage (LV) Directive (2006/95/EC). All coils in this chapter comply with the Electromagnetic Compatibility (EMC) Directive (2004/108/EC).

## CONNECTORS

DIN 43650 standardized connectors 9150 represent an effective system for the connection of the coil to the power system, thus ensuring safety also in the presence of moisture. Based on the assembly requirements, these connectors allow you to choose the orientation of the outer casing with respect to the inner terminal block. The gland nut of the outer casing is suitable for receiving cables with an external diameter of 6 to 9 mm and is equipped with a self-locking device. Three-pole cables with a cross-section greater than or equal to 0.75 mm<sup>2</sup> are recommended.

The connectors in series 9900 are available with co-moulded cables of different lengths. In these versions, the orientation of the casing cannot be changed with respect to the terminal block.

As long as they are used with the gaskets provided, both types ensure IP65 protection rating according to EN 60529.

Castel developed specific connectors, series 9155, suitable for use in refrigeration systems operating in heavy-duty environments, for example:

- exposure to the atmospheric conditions
- rooms with high degree of moisture
- cyclic condensing / evaporation on the valve
- cyclic icing / defrosting on the valve

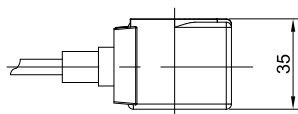
Based on the assembly requirements, these connectors allow you to choose the side orientation of the outer casing with respect to the inner terminal block. It is not possible to point the exit of the cable upwards. The gland nut of the outer casing is suitable for receiving cables with an external diameter of 6 to 9 mm and is equipped with a self-locking device. It is again recommended that three-pole cables with a cross-section greater than or equal to 0.75 mm<sup>2</sup> be used. As long as they are used with the gaskets provided, the connectors in series 9155 ensure IP65/IP68 protection rating according to the EN 60529 standard.

Connectors 9150/R45 and 9150/R90 are equipped with a full-wave bridge rectifier plus VDR for protection. Connector 9150/R90 is the version with a 2 m long, co-moulded cable, with remote rectified circuit (with respect to the connector). The VDR (Voltage e-Dependent-Resistor) device is a special type of resistor, mounted in parallel to the windings. Its purpose is to protect the diodes and the coil from any voltage surges generated within the alternating current supply circuit.

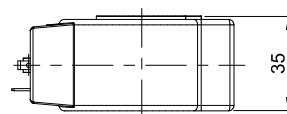
**WARNING: connectors 9150/R45 and 9150/R90 must be used only with coil 9120/RD6 (220 V RAC). Incorrect use of these connectors with other types of Castel coils leads to the rapid destruction of the coil.**

**TABLE 30: General characteristics of coils**

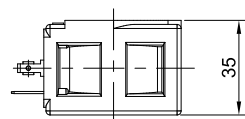
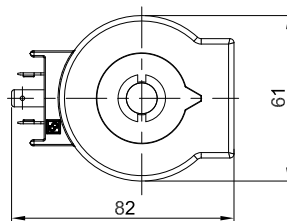
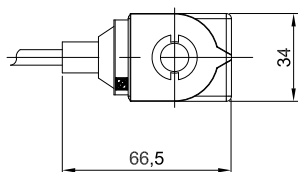
Catalogue Number	Coil Type	Voltage [V]	Voltage tolerance [%]	Frequency [Hz]	Insulation class EN 60730	TA [°C]		Connection	Connectors	Protection Degree
						min.	max.			
9110/RA2	CM2	24 A.C.	+10 / -10	50 / 60	H	-20	+50	Three wires cable	-	IP 66
9110/RA4		110 A.C.								
9110/RA6		220/230 A.C.	+6 / -10							
9110/RA7		240 A.C.	+10 / -10							
9120/RD1	HM3	12 D.C.	+10 / -5	-	F	-20	+50	Terminal block for DIN 43650/A	9150/R02 9900/X##	IP 65 (with connector)
9120/RD2		24 D.C.								
9120/RD3		27 D.C.								
9120/RD4		48 D.C.								
9120/RD6		220 RAC								
9160/RA2	HM4	24 A.C.	+10 / -10	50 / 60	F	-20	+50	Terminal block for DIN 43650/A	9150/R02 9155/R01 9155/R02 9900/X##	IP 65 (with connectors 9150 , 9900)  IP 65 / IP 68 (with connector 9155)
9160/RA4		110 A.C.								
9160/RA6		220/230 A.C.	+6 / -10							
9160/RA7		240 A.C.	+10 / -10							
9300/RA2	HF2	24 A.C.	+10 / -10	50 / 60	H	-20	+50	Terminal block for DIN 43650/A	9150/R## 9900/X##	IP 65 (with connector)
9300/RA4		110 A.C.								
9300/RA6		220/230 A.C.	+6 / -10							
9300/RA7		240 A.C.	+10 / -10							
9300/RA8		380 A.C.								
9320/RA6	HF3	220/230 A.C.	+6 / -10	50 / 60	F	-20	+50	Terminal block for DIN 43650/A	9150/R02 9900/X##	IP 65 (with connector)
9320/RD1		12 D.C.								
9320/RD2		24 D.C.								
9320/RD4		48 D.C.								
9320/RD6		220 RAC								



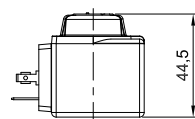
9110 (Type CM2)



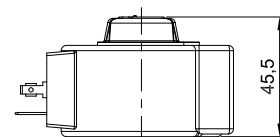
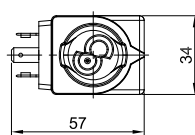
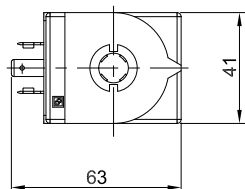
9120 (Type HM3)



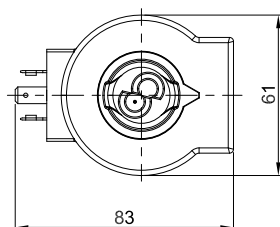
9160 (Type HM4)



9300 (Type HF2)



9320 (Type HF3)

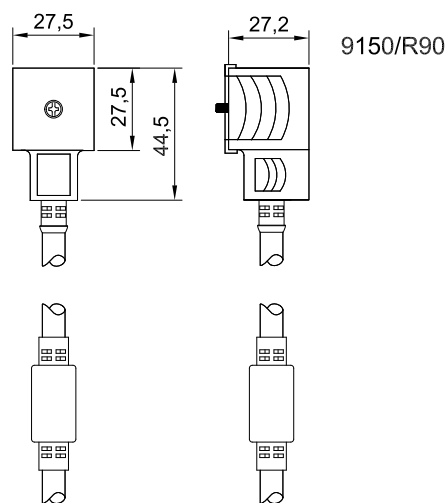
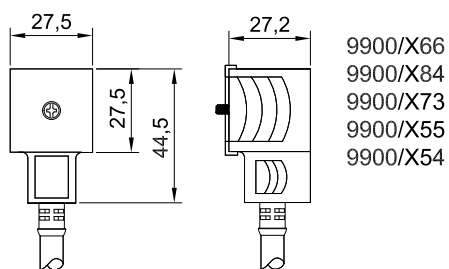
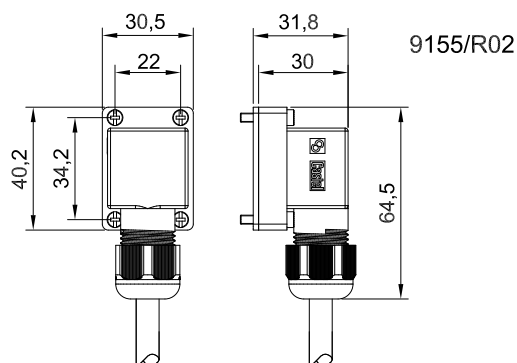
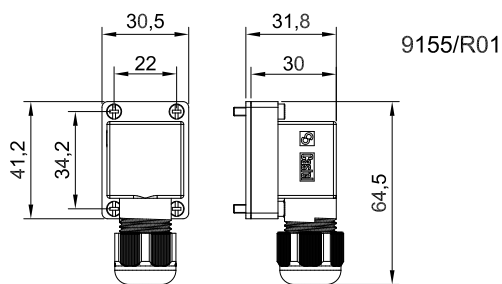
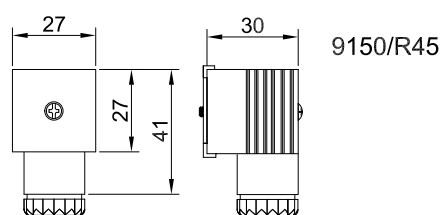
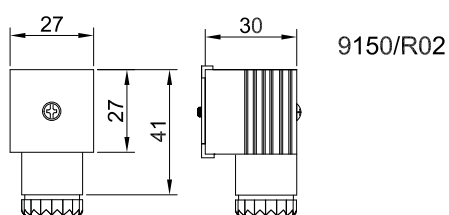


**TABLE 31: Coils consumptions and weights**

Catalogue Number	Coil Type	Voltage [V]	Power [W]	Consumption at 20 °C [mA]						Weight [g]			
				Start			Working						
				50 [Hz]	60 [Hz]	D.C.	50 [Hz]	60 [Hz]	D.C.				
9110/RA2	CM2	24 A.C.	8	920	825	-	527	420	-	230			
9110/RA4		110 A.C.		230	205		128	114					
9110/RA6		220/230 A.C.		120	105		68	58					
9110/RA7		240 A.C.		100	87		54	43					
9120/RD1	HM3	12 D.C.	20	-	-	-	-	-	-	470			
9120/RD2		24 D.C.									20	1720	895
9120/RD3		27 D.C.									20	800	800
9120/RD4		48 D.C.									22	460	460
9120/RD6		220 RAC									18	93	93
9160/RA2	HM4	24 A.C.	8	1490	1320	-	700	530	-	220			
9160/RA4		110 A.C.		330	300		156	118					
9160/RA6		220/230 A.C.		162	142		76	57					
9160/RA7		240 A.C.		147	130		70	53					
9300/RA2	HF2	24 A.C.	8	920	825	-	527	420	-	180			
9300/RA4		110 A.C.		230	205		128	114					
9300/RA6		220/230 A.C.		140	128		68	58					
9300/RA7		240 A.C.		100	87		54	43					
9300/RA8		380 A.C.		58	51		32	23					
9320/RA6	HF3	220/230 A.C.	12	190	160	-	110	80	-	500			
9320/RD1		12 D.C.	20	-	-	-	-	-	1720				
9320/RD2		24 D.C.	20						895				
9320/RD4		48 D.C.	22						460		460		
9320/RD6		220 RAC	18						93		93		

**TABLE 32: General characteristics of connectors**

Catalogue Number	Supply Voltage [V]		Cable length [m]	Cable thickness [mm <sup>2</sup> ]	Standard	Degree of protection	Class of insulation
	Nominal	Maximum					
9150/R02	-	-	-	-	DIN 43650	IP65 EN 60529	Group C VDE 0110-1 / 89
9150/R45	220 A.C.	250 A.C.					
9150/R90	220 A.C.	250 A.C.	2	3 x 0,75			
9900/X66	-	-	1	3 x 0,75			
9900/X84			1,5				
9900/X73			2				
9900/X55			3				
9900/X54			5				
9155/R01	-	-	-	-			
9155/R02			1		3 x 0,75		



# CHAPTER 10 ■ ATEX-CERTIFIED COILS AND CONNECTORS



## APPLICATION

For the normally-closed solenoid valves manufactured in compliance with the ATEX Directive (valves with an “EX” suffix presented in Chapter 5), Castel provides its customers with the following types of coils:

- Series 9100EX (coils type HM2)
- Series 9110EX (coils type CM2)

These coils are classified as Group II, Category 3 equipment according to the ATEX Directive (2014/34/EU). This equipment is suitable for use on refrigeration systems located in areas classified as “Zone 2” potentially explosive environments according to the definitions in Annex I of Directive 1999/92/EC.

Coils in series 9100EX must be used only with connector type 9150EX/R02. The protection rating of the coil + connector system is IP65 according to the EN 60529 standard.

## CONSTRUCTION

The coils in series 9100EX and 9120EX are produced in compliance with European standards EN 60079-0:2009 and 60079-18:2009, which ensure their compliance to the Essential Health and Safety Requirements of Directive 2014/34/EU. The two series of coils are Class F encapsulated and have Class H enamelled copper wire windings, in compliance with IEC standard 85. The outer casing is made of waterproof, dielectric resins that guarantee reinforced insulation and allow any type of assembly.

All coils have Class I protection ratings against electric contacts. Consequently, their safety requires an efficient ground system. Rubber gaskets assembled on the upper and lower ends of the coils complete the protection of the windings from humidity.

The terminals of the coils in series 9100EX consist of two Faston connectors plus a Faston ground connector. Coils in series 9110EX are equipped with a 1 m long power supply cable incorporated in the encapsulated section. The cable has a polyurethane sheath with operating temperature of up to 125 °C and cable insulation in special PVC with an operating temperature of up to 125 °C. All coils in this chapter are suitable for continuous operation. The solid

construction of these coils makes them suitable for use in refrigeration systems operating in heavy-duty environments

## APPROVALS

Compliance of the coils in series 9100EX to Directive 2014/34/EU is certified by the Italian notified body IMQ, with certificate No. IMQ 13 ATEX 002X (Certified Type Test). Protection type of the coils in series 9100EX: Ex mc IIC T5 Gc / Ex mc IIIC T100°C Dc IP65.

Compliance of the coils in series 9110EX to Directive 2014/34/EU is certified by the Italian notified body IMQ, with certificate No. IMQ 13 ATEX 001X (Certified Type Test).

Protection type of the coils in series 9110EX: Ex mc IIC T4 Gc / Ex mc IIIC T135°C Dc IP65.

Coils in series 9100EX and 9110EX with 110 VAC, 220/230 VAC and 240 VAC voltages are produced in accordance with the Low Voltage Directive (2006/95/EC). All coils in series 9100EX and 9110EX comply with the Electromagnetic Compatibility (EMC) Directive (2004/108/EC).

## CONNECTOR

Connector 9150EX/R02 is classified as Group II, Category 3 equipment according to the ATEX Directive (2014/34/EU). This equipment is suitable for use on refrigeration systems located in areas classified as “Zone 2” potentially explosive environments according to the definitions in Annex I of Directive 1999/92/EC.

The DIN 43650 standardized connector 9150EX/R02 represents an effective system for the connection of the coil to the power system, thus ensuring safety also in the presence of moisture. Based on the assembly requirements, this connector allows you to choose the orientation of the outer casing with respect to the inner terminal block. The gland nut of the outer casing is suitable for receiving cables with an external diameter of 6 to 9 mm and is equipped with a self-locking device. Three-pole cables with a cross-section greater than or equal to 0.75 mm<sup>2</sup> are recommended.

As long as it is used with the gaskets provided, connector 9150EX/R02 ensures IP65 protection rating according to the EN 60529 standard.





**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.

**N.B.: The personnel must carefully follow the operating instructions provided in the packaging of said valves.**

**TABLE 33: General characteristics of coils ATEX compliance for use in EX Zone 2**

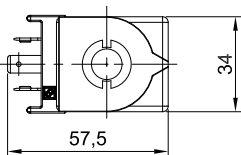
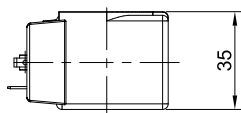
Catalogue Number	Coil Type	Voltage [V]	Voltage tolerance [%]	Frequency [Hz]	Insulation class EN 60730	TA [°C]		Connection	Connectors	Protection Degree
						min.	max.			
9100EX/RA2	HM2	24 A.C.	+10 / -10	50 / 60	H	-20	+50	Terminal block for DIN 43650/A	9150EX/R02	IP 65 (with connector)
9100EX/RA4		110 A.C.								
9100EX/RA6		220/230 A.C.	+6 / -10							
9100EX/RA7		240 A.C.								
9110EX/RA2	CM2	24 A.C.	+10 / -10	50 / 60	H	-20	+50	Three wires cable	-	IP 66
9110EX/RA4		110 A.C.								
9110EX/RA6		220/230 A.C.	+6 / -10							
9110EX/RA7		240 A.C.								

**TABLE 34: Coils consumptions and weights**

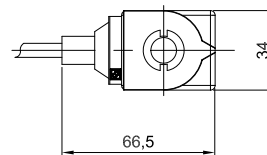
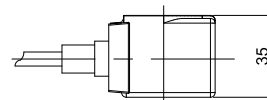
Catalogue Number	Coil Type	Voltage [V]	Power [W]	Consumption at 20 °C [mA]						Weight [g]
				Start			Working			
				50 [Hz]	60 [Hz]	D.C.	50 [Hz]	60 [Hz]	D.C.	
9100EX/RA2	HM2	24 A.C.	8	920	825	-	527	420	-	230
9100EX/RA4		110 A.C.		230	205		128	114		
9100EX/RA6		220/230 A.C.		120	105		68	58		
9100EX/RA7		240 A.C.		100	87		54	43		
9110EX/RA2	CM2	24 A.C.	8	920	825	-	527	420	-	230
9110EX/RA4		110 A.C.		230	205		128	114		
9110EX/RA6		220/230 A.C.		120	105		68	58		
9110EX/RA7		240 A.C.		100	87		54	43		

**TABLE 35: General characteristics of connectors**

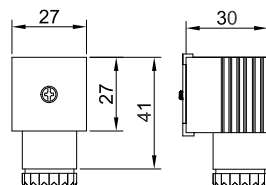
Catalogue Number	Standard	Degree of protection	Class of insulation	Approval
9150EX/R02	DIN 43650	IP65 EN 60529	Group C VDE 0110-1 / 89	ATEX compliance for use in EX Zone 2



9100EX (Type HM2)



9120EX (Type CM2)



9150EX/R02

# CHAPTER 11 ■

## COILS AND CONNECTORS

CERTIFIED BY UNDERWRITERS LABORATORIES INC.



### APPLICATION

For normally-closed solenoid valves approved by the American certification authority Underwriters Laboratories Inc. (valves with an “UL” suffix presented in Chapter 7), Castel provides its customers with the following types of coils:

- **Series 9105** (coil type HM2), with connection type DIN 43650
- **Series 9125** (coil type HM3), with connection type DIN 43650
- **Series 9115** (coil type CM2-N2), with connection type “Junction Box NEMA 2”.
- **Series 9116** (coil type CM2-N4), with connection type “Conduit Hub NEMA 4”.
- **Series 9185** (coil type CM3-N2), with connection type “Junction Box NEMA 2”.
- **Series 9186** (coil type CM3-N4), with connection type “Conduit Hub NEMA 4”.

Coils in series 9105 and 9125 must be coupled with connector type 9150UL/R02. The protection rating of the coil + connector system is IP65 according to the EN 60529 standard.

The coils in series 9115 and 9185 are complete with a connection system and a metal sheath. The protection rating guaranteed by the “Junction Box” connection system is similar to IP12-32 according to the EN 60529 standard.

The coils in series 9116 and 9186 are complete with a connection system and a metal sheath. The protection rating guaranteed by the “Conduit Hub” connection system is similar to IP54 according to the EN 60529 standard.

### CONSTRUCTION

In compliance with IEC standard 85, the coils in series 9105, 9125, 9115, 9116, 9185 and 9186 have Class F encapsulation and their production is compliant with standards EN 60730-1 and EN 60730-2-8. The windings are made of copper wire, with insulation class H (155°C), in

compliance with IEC standard 85. The outer casing is made of waterproof, dielectric resins that guarantee reinforced insulation and allow any type of assembly.

All coils have Class I protection ratings against electric contacts. Consequently, their safety requires an efficient ground system. Rubber gaskets assembled on the upper and lower ends of the coils complete the protection of the windings from humidity.

The coils in series 9105 and 9125 are equipped with three flat terminals, two Faston connections in line plus a Faston ground connection.

The coils in series 9115 and 9185 are equipped with two cables, at least 153 mm long, and ground screws incorporated in the body of the metal casing. The body of the casing is screwed onto the metal reinforcement of the coil and there are two semi-sheared slots to screw on a metal sheath. A metal cover screwed on the body closes the casing and encloses the joints between the power cable and the coil wires.

Coils in series 9116 and 9186 are equipped with two wires, at least 457 mm long. The flange of the inlet plug is screwed to the metal reinforcement of the coil. The inlet plug is threaded in order to screw on a metal sheath.

All coils in this chapter are designed for continuous use. The solid construction of these coils makes them suitable for use in refrigeration systems operating in heavy-duty environments

### APPROVALS

Coils in series 9105, 9125, 9115, 9116, 9185, and 9186 have been approved by the American certification authority Underwriters Laboratories Inc. These coils are certified UL-CSA Recognized for the USA and Canada with file E243604, in compliance with American standard UL 429 and Canadian standard C22.2 No. 139-13.

**Only when a coil in series 9115, 9116, 9185 or 9186 is used with a coil-less valve in Chapter 7 (valve with a “UL” suffix) is a solenoid valve obtained that is UL Listed**

certified according to file MH50005, in compliance with American standard UL 429 and Canadian standard C22.2 No. 139-13.

**Note: coupling a coil in series 9105 or 9125 with the same valve with “UL” suffix does not result in a “UL Listed” certified valve; rather, you obtain a “UL Recognized” certified valve.**

The coils in series 9015, 9125, 9115, 9116, 9185, and 9186 with voltages of 120 VAC, 208 VAC, 220/230 VAC, 240 VAC comply with the Low Voltage Directive (2006/95/EC). All coils in this chapter comply with the Electromagnetic Compatibility (EMC) Directive (2004/108/EC).

## CONNECTOR

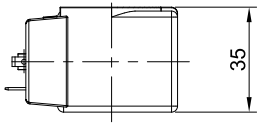
Connector 9150UL/R02 has been approved by the American certification authority Underwriters Laboratories Inc. This

connector is certified **UL-CSA Recognized** for the USA and Canada with file E333724, in compliance with American standard UL 1977 and Canadian standard C22.2 No. 182.3. The DIN 43650 standardized connector 9150UL/R02 represents an effective system for the connection of the coil to the power system, thus ensuring safety also in the presence of moisture. Based on the assembly requirements, this connector allows you to choose the orientation of the outer casing with respect to the inner terminal block. The gland nut of the outer casing is suitable for receiving cables with an external diameter of 6 to 9 mm and is equipped with a self-locking device. Three-pole cables with a cross-section greater than or equal to 0.75 mm<sup>2</sup> are recommended.

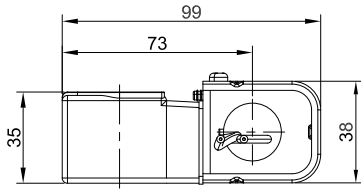
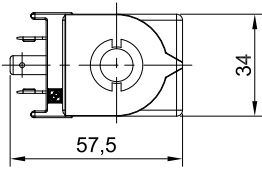
As long as it is used with the gaskets provided, connector 9150UL/R02 ensures IP65 protection rating according to the EN 60529 standard.

**TABLE 36: General characteristics of coils, UL Recognized approved**

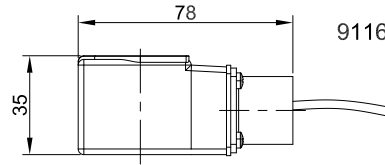
Catalogue Number	Coil Type	Voltage [V]	Voltage tolerance [%]	Frequency [Hz]	Insulation class EN 60730	TA [°C]		Connection	Connectors	Protection Degree
						min.	max.			
9105/RA2	HM2	24 A.C.	+10 / -10	60	F	-20	+50	Terminal block for DIN 43650/A	9150UL/R02	IP 65 (with connector)
9105/RA4		120 A.C.								
9105/RA5		208 A.C.								
9105/RA6		220/230 A.C.	+6 / -10							
9105/RA7		240 A.C.	+10 / -10							
9115/RA2	CM2-N2	24 A.C.	+10 / -10	60	F	-20	+50	Junction box NEMA 2	-	~ IP 12-32
9115/RA4		120 A.C.								
9115/RA5		208 A.C.								
9115/RA6		220/230 A.C.	+6 / -10							
9115/RA7		240 A.C.	+10 / -10							
9116/RA2	CM2-N4	24 A.C.	+10 / -10	60	F	-20	+50	Conduit hub NEMA 4	-	~ IP 54
9116/RA4		120 A.C.								
9116/RA5		208 A.C.								
9116/RA6		220/230 A.C.	+6 / -10							
9116/RA7		240 A.C.	+10 / -10							
9125/RD1	HM3	12 D.C.	+10 / -5	-	F	-20	+50	Terminal block for DIN 43650/A	9150UL/R02	IP 65 (with connector)
9125/RD2		24 D.C.								
9125/RA2		24 A.C.								
9125/RA4		120 A.C.	+10 / -10							
9125/RA5		208 A.C.								
9125/RA6		220/230 A.C.	+6 / -10							
9125/RA7		240 A.C.	+10 / -10							
9185/RD1	CM3-N2	12 D.C.	+10 / -5	-	F	-20	+50	Junction box NEMA 2	-	~ IP 12-32
9185/RD2		24 D.C.								
9185/RA2		24 A.C.								
9185/RA4		120 A.C.	+10 / -10							
9185/RA5		208 A.C.								
9185/RA6		220/230 A.C.	+6 / -10							
9185/RA7		240 A.C.	+10 / -10							
9186/RD1	CM3-N4	12 D.C.	+10 / -5	-	F	-20	+50	Conduit hub NEMA 4	-	~ IP 54
9186/RD2		24 D.C.								
9186/RA2		24 A.C.								
9186/RA4		120 A.C.	+10 / -10							
9186/RA5		208 A.C.								
9186/RA6		220/230 A.C.	+6 / -10							
9186/RA7		240 A.C.	+10 / -10							



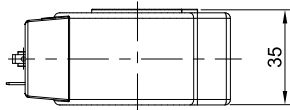
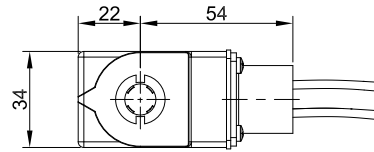
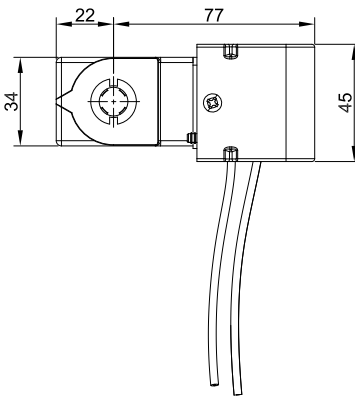
9105 (Type HM2)



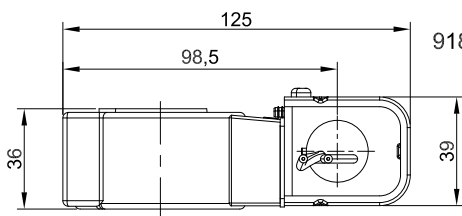
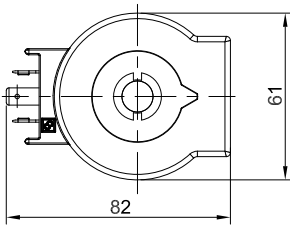
9115 (Type CM2-N2)



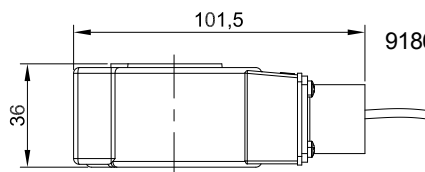
9116 (Type CM2-N4)



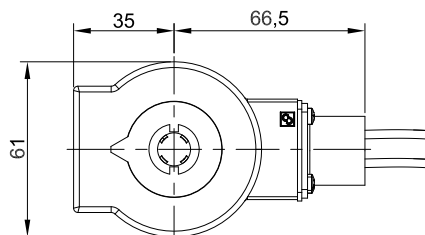
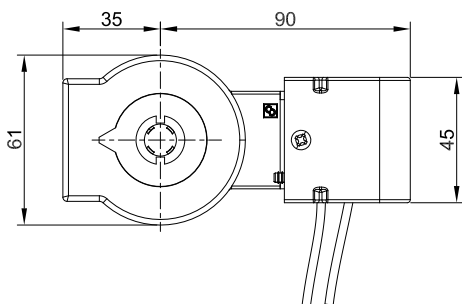
9125 (Type HM3)



9185 (Type CM3-N2)



9186 (Type CM3-N4)



**TABLE 37: Coils consumptions and weights**

Catalogue Number	Coil Type	Voltage [V]	Power [W]	Consumption at 20 °C [mA]				Weight [g]
				Start		Working		
				60 [Hz]	D.C.	60 [Hz]	D.C.	
9105/RA2	HM2	24 A.C.	11	1746	-	725	-	170
9105/RA4		120 A.C.		353		154		
9105/RA5		208 A.C.		195		84		
9105/RA6		220/230 A.C.		140		63		
9105/RA7		240 A.C.		140		63		
9115/RA2	CM2-N2	24 A.C.	11	1746	-	725	-	310
9115/RA4		120 A.C.		353		154		
9115/RA5		208 A.C.		195		84		
9115/RA6		220/230 A.C.		140		63		
9115/RA7		240 A.C.		140		63		
9116/RA2	CM2-N4	24 A.C.	11	1746	-	725	-	240
9116/RA4		120 A.C.		353		154		
9116/RA5		208 A.C.		195		84		
9116/RA6		220/230 A.C.		140		63		
9116/RA7		240 A.C.		140		63		
9125/RD1	HM3	12 D.C.	24	-	1720	-	1720	470
9125/RD2		24 D.C.		-	895	-	895	
9125/RA2		24 A.C.	20	2060	-	1015	-	
9125/RA4		120 A.C.		506		261		
9125/RA5		208 A.C.		286		152		
9125/RA6		220/230 A.C.		260		133		
9125/RA7		240 A.C.		235		122		
9185/RD1	CM3-N2	12 D.C.	24	-	1720	-	1720	590
9185/RD2		24 D.C.		-	895	-	895	
9185/RA2		24 A.C.	20	2060	-	1015	-	
9185/RA4		120 A.C.		506		261		
9185/RA5		208 A.C.		286		152		
9185/RA6		220/230 A.C.		260		133		
9185/RA7		240 A.C.		235		122		
9186/RD1	CM3-N4	12 D.C.	24	-	1720	-	1720	530
9186/RD2		24 D.C.		-	895	-	895	
9186/RA2		24 A.C.	20	2060	-	1015	-	
9186/RA4		120 A.C.		506		261		
9186/RA5		208 A.C.		286		152		
9186/RA6		220/230 A.C.		260		133		
9186/RA7		240 A.C.		235		122		

**TABLE 38: General characteristics of connectors, UL Recognized approved**

Catalogue Number	Standard	Degree of protection	Class of insulation	Approval
9150UL/R02	DIN 43650	IP65 EN 60529	Group C VDE 0110-1 / 89	UL Recognized

# CHAPTER 12 ■ “SMART CONNECTOR” SYSTEM



## APPLICATION

The “SMART CONNECTOR” systems series 9910 are formed by coupling a connector in series 9152, equipped with an integrated electronic circuit in the connector, with a specific series 9300 coil designed for the connector. These systems have been designed by Castel to be installed on:

- Normally-closed solenoid valves in series 1024, 1028, 1034, 1038, 1040, 1048, 1050, 1058, 1059, 1064, 1068, 1070, 1078, 1079, 1090, 1098 and 1099
- PWM expansion valves in series 2028

and allow:

- a reduction in energy consumption when fully operational
- a consequent reduction in the operating temperature
- an extension of the coil life
- an increase in the MOPD value

**N.B.:** Castel does not sell the two parts (coil and connector) that make up a “SMART CONNECTOR” system separately.

## CONNECTION CONSTRUCTION

EN 175301-803 (former DIN 43650) standardized connectors 9152 represent an effective system for the connection of the coil to the power system, thus ensuring safety also in the presence of moisture.

Connectors 9152 are available in both the direct current version (with 12 VDC and 24 VDC voltages) and in the alternating current version (with 24 VAC or 220/240 VAC voltages).

The direct current versions are equipped with polarity inversion protection.

The alternating current versions are equipped with a bridge rectifier circuit integrated on the circuit.

All versions, both direct current and alternating current, are equipped with a diode device that guarantees surge protection. All versions have the voltage for use and the wiring diagram printed on the casing. The gland nut of the outer casing is suitable for receiving cables with an external diameter of 6 to 9 mm and is equipped with a self-locking device. It is recommended that three-pole cables with a cross-section greater than or equal to 0.75 mm<sup>2</sup> be used. There are no versions with co-moulded cables.

**Each connector in a “SMART CONNECTOR” system must be used only for the type of coil with which it is coupled in the system. Incorrect use of the connector with other types of coils produced by Castel will quickly damage the coil and the connector.**

## COIL CONSTRUCTION

Coils in series HF2 (9300) used in the “SMART CONNECTOR” systems are special coils available in both the direct current version (with 12 VDC and 24 VDC voltages) and rectified current version (with 24 VRAC, 220 VRAC, or 240 VRAC).

These coils are in Class H, in accordance with IEC standard 85 and their production is compliant with standards EN 60730-1 and EN 60730-2-8. The windings are made of enamelled copper wire, with insulation class H (180 °C), in compliance with IEC standard 85. The terminals of the coils consist of two Faston connectors plus a Faston ground connector. The outer casing is made of waterproof, dielectric resins that guarantee reinforced insulation and allow any type of assembly.

They have Class I protection ratings against electric contacts. Consequently, their safety requires an efficient ground system. A rubber gasket assembled on the lower end of the coil completes the protection of the windings from humidity. When coupled with connectors 9152, these coils guarantee an IP65 protection rating according to standard EN 60529.

The coils are designed for continuous use. The solid construction of these coils makes them suitable for use in refrigeration systems operating in heavy-duty environments. The maximum ambient temperature for all coils is 50 °C.

**Each coil in a “SMART CONNECTOR” system must be used only in combination with the type of connector with which it is coupled in the system. Incorrect use of the coil with other types of connectors produced by Castel will quickly damage the coil and the connector.**

## OPERATION

Through the integrated circuit in the connector, and coupling with the specific coil, connectors 9152 are capable of

improving the MOPD characteristics of Castel solenoid valves, reducing the power consumption by up to 50% over time, extending the coil life, and decreasing the noise.

The integrated circuit located inside the connector works in different modes based on the power supply voltage. Specifically, there are two main families with different operating logics.

Connectors 9152/RD (direct current) supercharge the dedicated coil 9300 to its maximum allowed power for a short, pre-set interval. This is called the “Boost” time. It generates a greater attraction force on the valve’s magnetic unit, and consequently increases the MOPD value. At the end of the “Boost” phase, during normal operation, connectors 9152/RD maintain the electric consumption of the dedicated coil 9300 at a lower value, from 45% to 55% lower than the power absorbed by the coil. The power reduction occurs by powering the coil with a high-frequency pulsed current (ON/OFF cycles), from 15 to 30 kHz. This frequency is aimed at guaranteeing the minimum magnetic force to keep the valve open during operation.

Connectors 9152/RA (alternating current) supercharge the coils 9300 for a pre-set interval. This is called the “Boost” time. It generates a greater attraction force on the valve’s magnetic unit, and consequently increases the MOPD value. Once this period is over, the electronics remove one phase wave every second one, with an effect comparable to powering the coil with pulsed/rectified current with a frequency half of that of the network. By using this system, you obtain an electric power consumption reduction of the unit to a value from 35% to 45%, while maintaining the minimum magnetic force that allows the valve to be opened. This operating logic makes the “Smart Connector” system

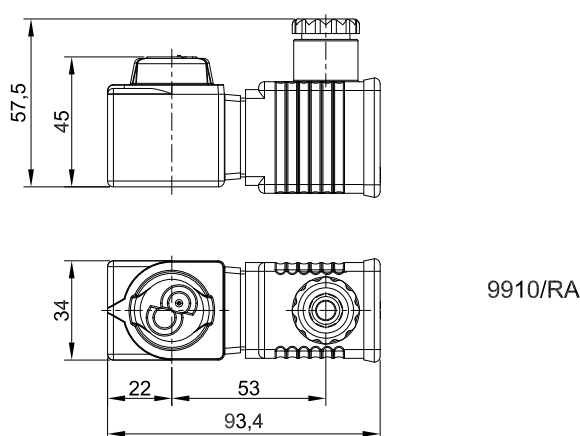
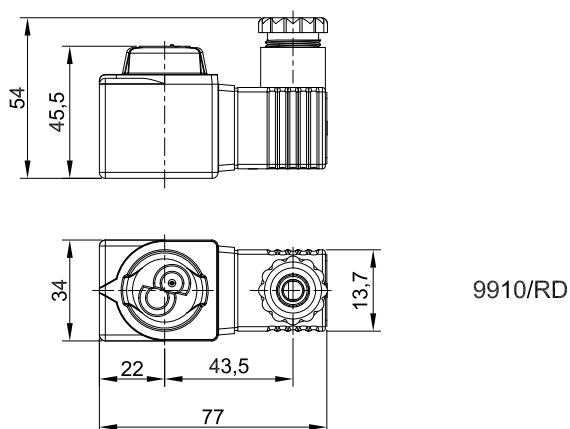
powered in alternating current very quiet, reducing the normal noise level, which can be up to 13 dB, to values less than 4 dB based on the valve installation.

Using the afore-mentioned logic, it is possible to significantly reduce the electricity consumption (which can be important considering the system of refrigerator aisles in a supermarket). Also, it leads to a lower operating temperature of the coil and therefore, in conclusion, less wear on the electromechanical drive system. Obviously, these reductions in consumption are strictly related to the use of the coils. For proper evaluation of the real energy savings, it is necessary to consider the number of coil interventions with respect to the normal power supply time of the valve. If the number of interventions is reduced, the consumption is reduced; if the number of interventions increases, the consumption grows. Table 39 shows the main characteristics of the “SMART CONNECTOR” systems. Table 40 indicates the MOPD values that can be attained by the various families of solenoid valves produced by Castel if coupled with the various models of the “SMART CONNECTOR” system.

As indicated in the paragraph APPLICATION, the “SMART CONNECTOR” systems can also be used with the series of valves PWM 2028 manufactured by Castel, if suitably sized to have opening / closing cycles with a frequency greater than 0.6 seconds.

## APPROVALS

All connectors and coils in this chapter comply with the Electromagnetic Compatibility (EMC) Directive (2004/108/EC). The connectors with 220/240 VAC voltage and the coils with 220 VRAC and 240 VRAC voltage comply with the Low Voltage Directive (2006/95/EC).





**TABLE 39: General characteristics of systems SMART CONNECTOR**

Catalogue Number	Voltage [V]	Voltage tolerance [%]	Frequency [Hz]	Working nominal power [W]	Nominal power tolerance [%]	Insulation class IEC 85	TA [°C]		Boost Time [msec]	Protection Degree
							min.	max.		
9910/RD1 (1)	12 VDC	+/-10	-	3	+/-10	H	-20	+50	130	IP65
9910/RD2 (1)	24 VDC	+/-10	-	5	+/-10	H	-20	+50	130	IP65
9910/RA2	24 VAC	+/-10	50/60	7	+/-10	H	-20	+50	200	IP65
9910/RA6	220 VAC	+/-10	50/60	7	+/-10	H	-20	+50	200	IP65
9910/RA7	240 VAC	+/-10	50/60	7	+/-10	H	-20	+50	200	IP65

(1): Warning if these connectors are supplied via unidirectional direct current or rectified by means of the Graetz bridge, they could not perform a correct cycle of operation but always remain in Boost conditions, leading to fast damage of the coil. For correct operation the kits series 9910/RD MUST be powered by direct current stabilized or rectified.

**TABLE 40: Solenoid valves with SMART CONNECTOR: MOPD values [bar]**

Solenoid Valves Codes			SMART CONNECTOR					Codes
			9910/RD1	9910/RD2	9910/RA2	9910/RA6	9910/RA7	
Refrigerants			12 VDC	24 VDC	24 VAC	220 VAC	240 VAC	Voltage [V]
HCFC - HFC - HFO	HFC - HFO	R744	-	-	50/60	50/60	50/60	Frequency [Hz]
1020/2#	1020N/2#	-	24	24	28	35	35	
1020/3#	1020N/3#							
1028/2#	1028N/2#							
1028/2#.E	1028N/2#.E							
1028/3#	1028N/3#							
1028/M10#	1028N/M10#							
1064/3#	1064N/3#	-	25	25	28	35	35	
1064/4#	1064N/4#							
1068/3#	1068N/3#							
1068/M10#	1068N/M10#							
1068/M12#	1068N/M12#							
1068/4#	1068N/4#							
1070/4#	1070N/4#	-	18	18	28	35	35	
1070/5#	1070N/5#							
1078/M12#	1078N/M12#							
1078/4#	1078N/4#							
1078/5#	1078N/5#							
1079/7#	1079N/7#							
1090/5#	1090N/5#	-	18	18	28	35	35	
1090/6#	1090N/6#							
1098/5#	1098N/5#							
1098/6#	1098N/6#							
1098/7#	1098N/7#							
1099/9#	1099N/9#							
1078/9#	1078N/9#	-	25	25	28	35	35	
1079/11#	1079N/11#							
1034/3#	1034N/3#	-	25	25	28	35	35	
1034/4#	1034N/4#							
1038/3#	1038N/3#							
1038/M10#	1038N/M10#							
1038/M12#	1038N/M12#							
1038/4#	1038N/4#							

# = S , A6 , A7

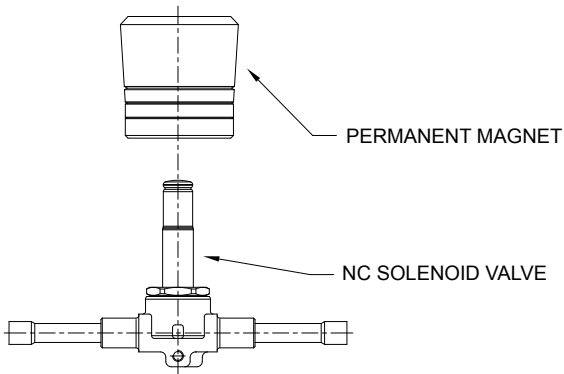
Continued

**TABLE 40: Solenoid valves with SMART CONNECTOR: MOPD values [bar]**

Solenoid Valves Codes			SMART CONNECTOR					Codes
			9910/RD1	9910/RD2	9910/RA2	9910/RA6	9910/RA7	
Refrigerants			12 VDC	24 VDC	24 VAC	220 VAC	240 VAC	Voltage [V]
HCFC - HFC - HFO	HFC - HFO	R744	-	-	50/60	50/60	50/60	Frequency [Hz]
1040/4#	1040N/4#	-	25	25	28	35	35	
1040/5#	1040N/5#							
1048/M12#	1048N/M12#							
1048/4#	1048N/4#							
1048/5#	1048N/5#							
1049/7#	1049N/7#							
1050/5#	1050N/5#	-	25	25	28	35	35	
1050/6#	1050N/6#							
1058/5#	1058N/5#							
1058/6#	1058N/6#							
1058/7#	1058N/7#							
1059/9#	1059N/9#							
1098/9#	1098N/9#	-	28	28	28	35	35	
1099/11#	1099N/11#							
1078/11#	1078N/11#							
1079/13#	1079N/13#							
1079/M42#	1079N/M42#							
1078/13#	1078N/13#							
1078/M42#	1078N/M42#							
1079/17#	1079N/17#							
	1328N/2S020	-	26	26	28	35	35	
	1328N/2S030							
	1328N/3S020							
	1328N/3S030							
	1328N/M13S020							
	1328N/M13S030							
	1338N/3S065	-	28	28	28	35	35	
	1338N/M10S065							
	1338N/M12S065							
	1338N/4S065							
			24	24	28	35	35	
	1028EL/2S							
	1028EL/2S.E							
	1028EL/3S							
			25	25	28	35	35	
	1028EL/M10S							
	1038EL/3S							
	1038EL/M10S							
			25	25	28	35	35	
	1038EL/M12S							
	1038EL/4S							
			25	25	28	35	35	
	1048EL/M12S							
	1048EL/4S							
			25	25	28	35	35	
	1048EL/5S							
	1058EL/5S							
			25	25	28	35	35	
	1058EL/6S							
	1058EL/7S							

# = S , A6 , A7

# CHAPTER 13 ■ MAGNETIC TOOL



## APPLICATION

Castel supplies to its customers the permanent magnet tool code 9900/X91 for the normally-closed solenoid valves illustrated in the previous chapters.

This tool can be used when brazing the copper connections to the plant pipes: once fit on the valve stem of the mobile plunger, instead of the coil, it allows the protective gas (nitrogen) flow and avoids any damage to the plunger gasket and to the diaphragm.

## CONSTRUCTION

The permanent magnet tool code 9900/X91 consists of three anisotropic ferrite rings in an anodized aluminium body.

[www.castel.it](http://www.castel.it)



ed. 001-VS-ENG

Castel can accept no responsibility for any errors or changes in the catalogues, handbooks, brochures and other printed material. Castel reserves the right to make changes and improvements to its products without notice. All trademarks mentioned are the property of their respective owners.  
The name and Castel logotype are registered trademarks of Castel Srl.  
All rights reserved.

Castel Srl - Via Provinciale 2-4 - 20060 Pessano con Bornago - MI