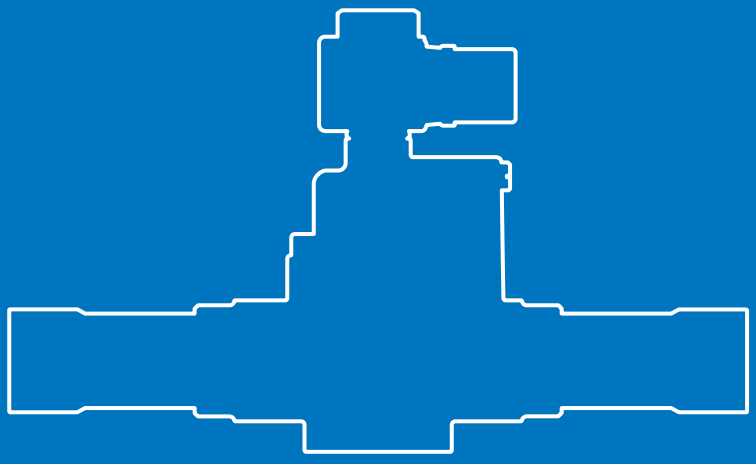


HANDBOOK

SOLENOID VALVE FOR REFRIGERATING SYSTEMS AND INDUSTRIAL PURPOSES

Castel®
Italian technology

INDEX

FROM QUALITY OUR NATURAL DEVELOPMENT

Achieved the goal of fifty years working in the industry of Refrigeration and Air Conditioning, Castel Quality Range of Products is well known and highly appreciated all over the world. Quality is the main issue of our Company and it has a special priority, in every step, all along the production cycle. UNI EN ISO 9001:2008, issued by ICIM, certifies the Quality System of the Factory. Moreover Castel Products count a number of certifications in conformity with EEC Directives and with European and American Quality Approval. We produce on high tech machinery and updated automatic production lines, operating in conformity with the safety and environment standards currently enforced. Castel offers to the Refrigeration and Air Conditioning Market and to the Manufacturers fully tested products suitable with HCFC and HFC Refrigerants currently used in the Refrigeration & Air Conditioning Industry.

External leakage

All the products illustrated in this Handbook are submitted, one by one, to tightness tests besides to functional tests. Allowable external leakage, measurable during the test, agrees to the definition given in Par. 9.4 of EN 12284 : 2003 Standard:
"During the test, no bubbles shall form over a period of at least one minute when the specimen is immersed in water with low surface tension…"

Pressure containment

All the products illustrated in this Handbook, if submitted to hydrostatic test, guarantee a pressure strength at least equal to 1,43 x PS in compliance with the Directive 97/23/EC.
All the products illustrated in this Handbook, if submitted to burst test, guarantee a pressure strength at least equal to 3 x PS according to EN 378-2 : 2008 Standard.

Weights

The weights of the items listed in this Handbook include packaging.

Guarantee

All Castel products are covered by a 12 – month's 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 expenses, the customer shall return the defective item with a detailed description of the claimed defects. The warranty doesn't apply if the defect of Castel products are due to mistakes either by customer or by third parties such wrong installations, use contrary to Castel indications, tampering. In case of defects of its own products, Castel will only replace the defective goods and will not refund damages of any kind.
The technical data shown on this catalogue are indicative. Castel reserves the right to modify the same at any time without any previous notice.

NORMALLY CLOSED SOLENOID VALVES FOR REFRIGERATING SYSTEMS

APPLICATIONS

The solenoid valves, shown in this chapter, are classified "Pressure accessories" in the sense of the Pressure Equipment Directive 94/23/EC, Article 1, Section 2.1.4 and are subject of Article 3, Section 1.3 of the same Directive.
They are designed for installation on commercial refrigerating systems and on civil and industrial conditioning plants, which use the following refrigerant fluids: R22 , R134a , R404A , R407C , R410A , R507
proper to the Group II (as defined in Article 9, Section 2.2 of Directive 97/23/EC and referred to in Directive 67/548/EEC). For specific applications with refrigerant fluids not listed above, always proper to the Group II, please contact Castel Technical Department.

OPERATION

The valves series 1020 ; 1028 ; 1034 ; 1038 ; 1040 ; 1048 ; 1049 ; 1050 ; 1058 ; 1059 , 1064 ; 1068 ; 1070 ; 1078 ; 1079 ; 1090 ; 1098 ; 1099 are normally closed valves.
NC = when the coil is de-energised the plunger stops the fluid flow, when the coil is electrically energised the plunger opens the valve seat connecting the inlet to the outlet.
The NC valves are supplied either without coil (S type) or with coil (A6 type with coil HM2–220/230 VAC and A7 type with coil HM2–240 VAC).

The valves series 1020 and 1028 are **direct acting valves**. The 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 and the valves can open with zero pressure differential.

The valves series 1064 ; 1068 ; 1070 ; 1078 (excluded /11 , /13 , /M42) ; 1079 (excluded /13 , /M42 , /17) ; 1090 ; 1098 (excluded /9) ; 1099 (excluded /11) are **diaphragm pilot operated valves**.
The operation depends not only on the magnetic field produced by the current flow into the coil but it's also necessary a minimum inlet pressure to move the diaphragm and to keep it lift off the main seat. Opening/closing of main seat is controlled by the diaphragm while opening/closing of pilot seat is controlled by the mobile plunger. These valves cannot work with zero pressure differential.

The valves 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**.
The operation depends not only on the magnetic field produced by the current flow into the coil but it's also necessary a minimum inlet pressure to move the piston and to keep it lift off the main seat. Opening/closing of main seat is controlled by the piston while opening/closing of pilot seat is controlled by the mobile plunger. These valves cannot work with zero pressure differential.

CONSTRUCTION

The main parts of the valves are made 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 plunger
- Austenitic stainless steel EN ISO 3506 – A2-70 for tightening screws between body and cover
- Chloroprene rubber (CR) for outlet seal gaskets
- P.T.F.E. for seat gaskets

INSTALLATION

The valves can be installed in all sections of a refrigerating system, in compliance with the limits and capacities indicated in TABLE 4. Castel recommends using piston valves in those applications with hard operating conditions (temperature/pressure), for example in hot gas line.
TABLES 1 and 2 show 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. That is the minimum pressure differential between inlet and outlet at which a solenoid valve, pilot operated, can open and stay opened.
- MOPD : maximum Opening Pressure Differential according to ARI STANDARD 760 : 2001. That is the maximum pressure differential between inlet and outlet at which a solenoid valve, pilot operated, 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 body of the valve. All the valves can be mounted in whatever position except with the coil pointing 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's 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.

TABLE 1: General Characteristics of NC valves (normally closed) with SAE Flare connections

Operating Principles	Catalogue Number	SAE Flare Connections	Seat size nominal Ø [mm]	Kv Factor [m^3/h]	Opening Pressure Differential [bar]					TS [°C]		PS [bar]	Risk Category according to PED
					min OPD	MOPD				min.	max.		
						Coil type							
						HM2 CM2 (AC)	HM4 (AC)	HM3 (AC)	HM3 (DC)				
Direct Acting	1020/2		2,5	0,175	0	21	28	35	21	-35	+110 (2)	45	Art. 3.3
	1020/3	3/8"	3	0,23									
Diaphragm Pilot Operated	1064/3	3/8"	6,5	0,80	0,05	21	28	35	18	-35	+105 (1)	45	Art. 3.3
	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	-35	+110 (2)	45	Art. 3.3
	1034/4	1/2"											
	1040/4	1/2"	12,5	2,40	0,07				18				
	1040/5	5/8"		3,00									
	1050/5	5/8"	16,5	3,80					16				
	1050/6	3/4"		4,80									

(1) Temperature peaks of 120 °C are allowed during defrosting
(2) Temperature peaks of 130 °C are allowed during defrosting

TABLE 2: General Characteristics of NC valves (normally closed) with ODS connections

Operating Principles	Catalogue Number	Connections ODS		Seat size nominal Ø [mm]	Kv Factor [m³/h]	Opening Pressure Differential [bar]					TS [°C]		PS [bar]	Risk Category according to PED
		Ø [in.]	Ø [mm]			min OPD	MOPD Coil type HM2 CM2 (AC)	HM4 (AC)	HM3 (AC)	HM3 (DC)	min.	max.		
Direct Acting	1028/2	1/4"	–	2,2	0,15	0	21	28	35	21	-35	+110 (2)	45	Art. 3.3
	1028/2E	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	-35	+105 (1)	45	Art. 3.3
	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		2,61									
	1079/7	7/8"	22											
	1098/5	5/8"	16	16,5	3,80					10				
	1098/6	3/4"	–		4,80									
	1098/7	7/8"	22		5,70									
	1099/9	1.1/8"	–											
	1078/9	1.1/8"	–	25,5	10					13				
	1079/11	1.3/8"	35											
Piston Pilot Operated	1038/3	3/8"	–	6,5	1,00	0,05	21	28	35	18	-35	+110 (2)	45	Art. 3.3
	1038/M10	–	10											
	1038/M12	–	12											
	1038/4	1/2"	–											
	1048/M12	–	12	12,5	2,40	0,07				18				
	1048/4	1/2"	–											
	1048/5	5/8"	16		3,00									
	1049/7	7/8"	22											
	1058/5	5/8"	16	16,5	3,80					16				
	1058/6	3/4"	–		4,80									
	1058/7	7/8"	22		5,70									
	1059/9	1.1/8"	–											
	1098/9	1.1/8"	–	25	10	0,1				18				
	1099/11	1.3/8"	35											
	1078/11	1.3/8"	35	27	16									
	1079/13	1.5/8"	–											
	1079/M42	–	42											
	1078/13	1.5/8"	–	34	25	0,15								1
	1078/M42	–	42											
	1079/17	2.1/8"	54											

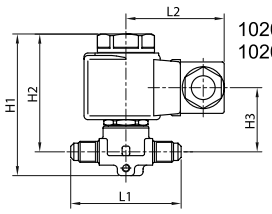
(1) Temperature peaks of 120 °C are allowed during defrosting
(2) Temperature peaks of 130 °C are allowed during defrosting

TABLE 3: Dimensions and Weights of NC valves with 9100 coils (1)

Operating Principles	Catalogue Number	Dimensions [mm]						Weight [g]
		H_1	H_2	H_3	L_1	L_2	Q	
Direct Acting	1020/2	75	62,5	34	58	50	–	340
	1020/3				65			355
	1028/2				125			350
	1028/2E				125			350
	1028/3				125			365
	1028/M10				125			365
Diaphragm Pilot Operated	1064/3	82	69,5	40	68	50	–	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	50	–	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

(1) : With coil 9120 the dimension L_2 is equal to 64 mm and theweights must be increased of 305 g.

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



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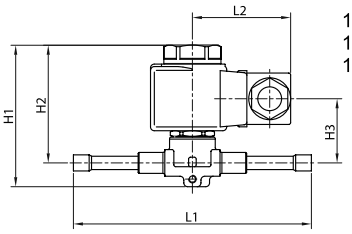
1020/3



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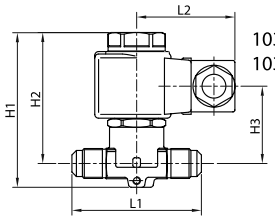
1028/3
1028/M10



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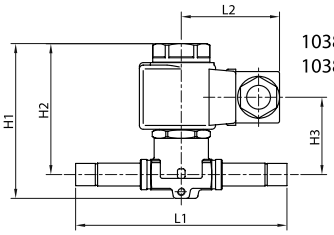
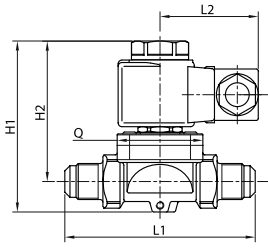
1034/4 1064/4



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



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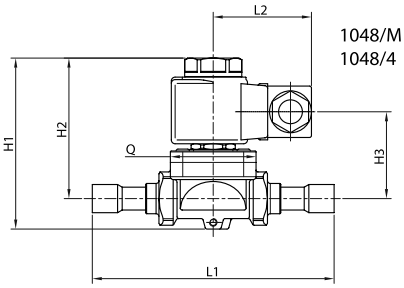
1040/5 1070/5



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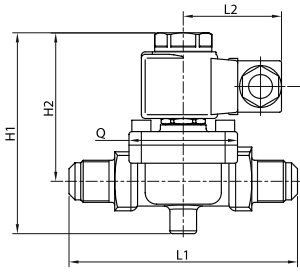
1048/4 1078/4 1049/7 1079/7



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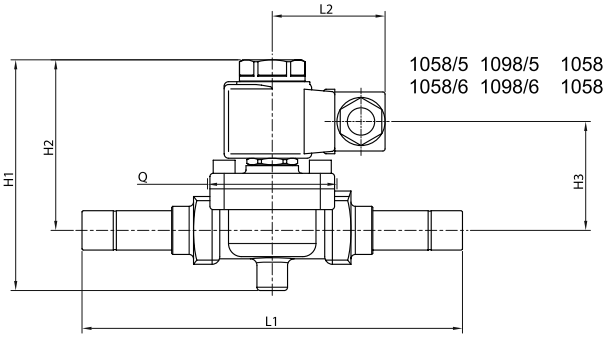
1050/6 1090/6



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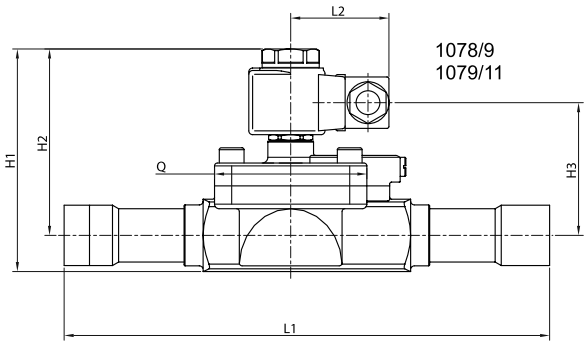
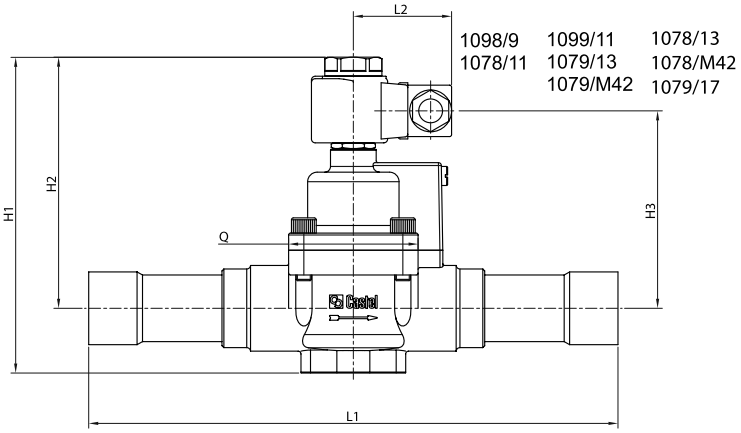


1078/9
1079/11



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

TABLE 4: Refrigerant Flow Capacity of NC valves [kW]

Operating Principles	Catalogue Number	Liquid line						Suction line						Hot Gas line					
		R134a	R22	R404A	R407C	R410A	R507	R134a	R22	R404A	R407C	R410A	R507	R134a	R22	R404A	R407C	R410A	R507
Direct Acting	1020/2	2,98	3,20	2,08	3,02	3,00	2,01	–	–	–	–	–	–	1,49	1,89	1,68	2,03	2,38	1,67
	1020/3	3,91	4,21	2,74	3,96	3,95	2,65							1,96	2,48	2,21	2,67	3,13	2,19
	1028/2	2,55	2,75	1,79	2,58	2,58	1,73							1,28	1,62	1,44	1,74	2,04	1,43
	1028/2E	3,91	4,21	2,74	3,96	3,95	2,65							1,96	2,48	2,21	2,67	3,13	2,19
	1028/3																		
	1028/M10																		
Diaphragm Pilot Operated	1064/3	13,6	14,6	9,5	13,8	13,7	9,2	1,51	2,04	1,78	1,82	2,40	1,78	6,8	8,6	7,7	9,3	10,9	7,6
	1064/4																		
	1068/3																		
	1068/M10																		
	1068/M12																		
	1068/4																		
	1070/4	37,4	40,3	26,2	37,9	37,8	25,3	4,16	5,61	4,91	4,99	6,60	4,91	18,7	23,8	21,1	25,6	29,9	21,0
	1070/5	44,4	47,8	31,1	45,0	44,8	30,0	4,93	6,66	5,82	5,92	7,83	5,82	22,2	28,2	25,1	30,3	35,5	24,9
	1078/M12	37,4	40,3	26,2	37,9	37,8	25,3	4,16	5,61	4,91	4,99	6,60	4,91	18,7	23,8	21,1	25,6	29,9	21,0
	1078/4																		
	1078/5	44,4	47,8	31,1	45,0	44,8	30,0	4,93	6,66	5,82	5,92	7,83	5,82	22,2	28,2	25,1	30,3	35,5	24,9
	1079/7																		
	1090/5	37,4	40,3	26,2	37,9	37,8	25,3	4,16	5,61	4,91	4,99	6,60	4,91	18,7	23,8	21,1	25,6	29,9	21,0
	1090/6	44,4	47,8	31,1	45,0	44,8	30,0	4,93	6,66	5,82	5,92	7,83	5,82	22,2	28,2	25,1	30,3	35,5	24,9
	1098/5	64,6	69,5	45,2	65,5	65,2	43,7	7,2	9,7	8,5	8,6	11,4	8,5	32,3	41,0	36,5	44,2	51,7	36,3
	1098/6	81,6	87,8	57,1	82,7	82,4	55,2	9,1	12,2	10,7	10,9	14,4	10,7	40,8	51,8	46,1	55,8	65,3	45,8
	1098/7	96,9	104,3	67,8	98,2	97,9	65,6	10,8	14,5	12,7	12,9	17,1	12,7	48,5	61,6	54,7	66,2	77,5	54,4
	1099/9																		
	1078/9	170,0	183,0	119,0	172,3	171,7	115,0	18,9	25,5	22,3	22,7	30,0	22,3	85,0	108,0	96,0	116,2	136,0	95,4
	1079/11																		
Piston Pilot Operated	1034/3	17,0	18,3	11,9	17,2	17,2	11,5	1,89	2,55	2,23	2,27	3,00	2,23	8,5	10,8	9,6	11,6	13,6	9,5
	1034/4																		
	1038/3																		
	1038/M10																		
	1038/M12																		
	1038/4																		
	1040/4	40,8	43,9	28,6	41,4	41,2	27,6	4,54	6,12	5,35	5,45	7,20	5,35	20,4	25,9	23,0	27,9	32,6	22,9
	1040/5	51,0	54,9	35,7	51,7	51,5	34,5	5,67	7,65	6,69	6,81	9,00	6,69	25,5	32,4	28,8	34,9	40,8	28,6
	1048/M12	40,8	43,9	28,6	41,4	41,2	27,6	4,54	6,12	5,35	5,45	7,20	5,35	20,4	25,9	23,0	27,9	32,6	22,9
	1048/4																		
	1048/5	51,0	54,9	35,7	51,7	51,5	34,5	5,67	7,65	6,69	6,81	9,00	6,69	25,5	32,4	28,8	34,9	40,8	28,6
	1049/7																		
	1050/5	64,6	69,5	45,2	65,5	65,2	43,7	7,2	9,7	8,5	8,6	11,4	8,5	32,3	41,0	36,5	44,2	51,7	36,3
	1050/6	81,6	87,8	57,1	82,7	82,4	55,2	9,1	12,2	10,7	10,9	14,4	10,7	40,8	51,8	46,1	55,8	65,3	45,8
	1058/5	64,6	69,5	45,2	65,5	65,2	43,7	7,2	9,7	8,5	8,6	11,4	8,5	32,3	41,0	36,5	44,2	51,7	36,3
	1058/6	81,6	87,8	57,1	82,7	82,4	55,2	9,1	12,2	10,7	10,9	14,4	10,7	40,8	51,8	46,1	55,8	65,3	45,8
	1058/7	96,9	104,3	67,8	98,2	97,9	65,6	10,8	14,5	12,7	12,9	17,1	12,7	48,5	61,6	54,7	66,2	77,5	54,4
	1059/9																		
	1098/9	170,0	183,0	119,0	172,3	171,7	115,0	18,9	25,5	22,3	22,7	30,0	22,3	85,0	108,0	96,0	116,2	136,0	95,4
	1099/11																		
	1078/11	272,0	292,8	190,4	275,7	274,7	184,0	30,2	40,8	35,7	36,3	48,0	35,7	136,0	172,8	153,6	185,9	217,6	152,6
	1079/13																		
	1079/M42																		
	1078/13	425,0	457,5	297,5	430,8	429,3	287,5	47,3	63,8	55,8	56,8	75,0	55,8	212,5	270,0	240,0	290,5	340,0	238,5
	1078/M42																		
	1079/17																		

Standard rating conditions according to AHRI Standard 760-2007

Condensing temperature	110 °F	(43,3 °C)
Liquid temperature	100 °F	(37,8 °C)
Subcooling	10 °R	(5,5 °K)
Evaporating temperature	40 °F	(4,4 °C)
Suction temperature	65 °F	(18,3 °C)
Superheating	25 °R	(13,9 °K)
Discharge temperature	160 °F	(71,1 °C)

NORMALLY OPEN SOLENOID VALVES FOR REFRIGERATING SYSTEMS

APPLICATIONS

The solenoid valves, shown in this chapter, are classified "Pressure accessories" in the sense of the Pressure Equipment Directive 94/23/EC, Article 1, Section 2.1.4 and are subject of Article 3, Section 1.3 of the same Directive.
They are designed for installation on commercial refrigerating systems and on civil and industrial conditioning plants, which use the following refrigerant fluids: R22 , R134a , R404A , R407C , R410A , R507 proper to the Group II (as defined in Article 9, Section 2.2 of Directive 97/23/EC and referred to in Directive 67/548/EEC). For specific applications with refrigerant fluids not listed above, always proper to the Group II, please contact Castel Technical Department.

OPERATION

The valves series 1134 ; 1138 ; 1140 ; 1148 ; 1150 ; 1158 ; 1164 ; 1168 ; 1170 ; 1178 ; 1190 ; 1198 are normally open valves.
NO = when the coil is de-energised the plunger opens the valve seat connecting the inlet to the outlet, when the coil is electrically energised the plunger stops the fluid flow.
The NO valves are supplied only without coil (S type).
N.B.: the NO valve visually differs from the corresponding NC model by means of the 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 **diaphragm pilot operated valves**.
The operation depends not only on the magnetic field produced by the current flow into the coil but it's also necessary a minimum inlet pressure to move the diaphragm and to keep it lift off the main seat. Opening/closing of main seat is controlled by the diaphragm while opening/closing of pilot seat is controlled by the mobile plunger. These valves cannot work with zero pressure differential.

The valves series 1134 ; 1138 ; 1140 ; 1148 ; 1150 ; 1158 ; 1178 (/11 , /13 , /M42) ; 1198/9 are **piston pilot operated valves**.
The operation depends not only on the magnetic field produced by the current flow into the coil but it's also necessary a minimum inlet pressure to move the piston and to keep it lift off the main seat. Opening/closing of main seat is controlled by the piston while opening/closing of pilot seat is controlled by the mobile plunger. These valves cannot work with zero pressure differential.

CONSTRUCTION

The main parts of the valves are made 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 plunger
- Austenitic stainless steel EN ISO 3506 – A2-70 for tightening screws between body and cover
- Chloroprene rubber (CR) for outlet seal gaskets
- P.T.F.E. for seat gaskets

INSTALLATION

The valves can be installed in all sections of a refrigerating system, in compliance with the limits and capacities indicated in TABLE 8. Castel recommends using piston valves in those applications with hard operating conditions (temperature/pressure), for example in hot gas line.
TABLES 5 and 6 show 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. That is the minimum pressure differential between inlet and outlet at which a solenoid valve, pilot operated, can open and stay opened.
- MOPD : maximum Opening Pressure Differential according to ARI STANDARD 760 : 2001. That is the maximum pressure differential between inlet and outlet at which a solenoid valve, pilot operated, 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 body of the valve. All the valves can be mounted in whatever position except with the coil pointing 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's 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; then 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). To use them in applications with 220/230 VAC supply it's necessary to mate the NO valve with the following components:
Coil 9120/RD6 (HM3 type – 220 VRAC) + Connector/ Rectifier 9150/R45 or 9150/R90.
NO solenoid valves are not be able to work with alternate current coils type HM2 , CM2 , HM4.

TABLE 5: General Characteristics of NO valves (normally open) with SAE Flare connections

Operating Principles	Catalogue Number	SAE Flare Connections	Seat size nominal Ø [mm]	Kv Factor [m^3/h]	Opening Pressure Differential [bar]		TS [°C]		PS [bar]	Risk Category according to PED
					min OPD	MOPD	min.	max.		
Diaphragm Pilot Operated	1164/3	3/8"	6,5	6,5	0,05	21	- 35	+105 (1)	45	Art. 3.3
	1170/4	1/2"	12,5	12,5						
	1170/5	5/8"								
	1190/5	5/8"	16,5	16,5		19				
	1190/6	3/4"								
Piston Pilot Operated	1134/3	3/8"	6,5	1,00	0,05	21	- 35	+110 (2)	45	Art. 3.3
	1140/4	1/2"	12,5	2,40	0,07					
	1140/5	5/8"		3,00						
	1150/5	5/8"	16,5	3,80		19				
	1150/6	3/4"		4,80						

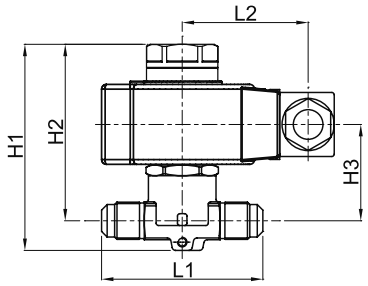
(1) Temperature peaks of 120 °C are allowed during defrosting
(2) Temperature peaks of 130 °C are allowed during defrosting

TABLE 6: General Characteristics of NO valves (normally open) with ODS connections											
Operating Principles	Catalogue Number	Connections ODS		Seat size nominal Ø [mm]	Kv Factor [m^3/h]	Opening Pressure Differential [bar]		TS [°C]		PS [bar]	Risk Category according to PED
		Ø [in.]	Ø [mm]			min OPD	MOPD	min.	max.		
Diaphragm Pilot Operated	1168/3	3/8"	–	6,5	0,80	0,05	21	- 35	+105 (1)	45	Art. 3.3
	1168/M10	–	10								
	1178/M12	–	12	12,5	2,20						
	1178/4	1/2"	–								
	1178/5	5/8"	16		2,61						
	1198/5	5/8"	16	16,5	3,80		19				
	1198/6	3/4"	–		4,80						
	1198/7	7/8"	22		5,70						
	1178/9	1.1/8"	–	25,5	10						
Piston Pilot Operated	1138/3	3/8"	–	6,5	1,00	0,05	21	- 35	+110 (2)	45	Art. 3.3
	1138/M10	–	10								
	1148/M12	–	12	12,5	2,40	0,07					
	1148/4	1/2"	–								
	1148/5	5/8"	16		3,00						
	1158/5	5/8"	16	16,5	3,80		19				
	1158/6	3/4"	–		4,80						
	1158/7	7/8"	22		5,70						
	1198/9	1.1/8"	–	25	10	0,1					
	1178/11	1.3/8"	35	27	16						
	1178/13	1.5/8"	–	34	25	0,15					I
	1178/M42	–	42								

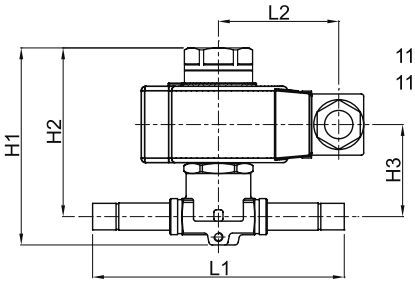
(1) Temperature peaks of 120 °C are allowed during defrosting
(2) Temperature peaks of 130 °C are allowed during defrosting

TABLE 7: Dimensions and Weights of NO valves with 9120 coils								
Operating Principles	Catalogue Number	Dimensions [mm]						Weight [g]
		H_1	H_2	H_3	L_1	L_2	Q	
Diaphragm Pilot Operated	1164/3	87	74,5	40	68	50	–	705
	1168/3				111			705
	1168/M10				111			700
	1170/4	96	80	47	100		45	1015
	1170/5				106			1060
	1178/M12				127			995
	1178/4				127			985
	1178/5				175			1080
	1190/5	111	83	50	120		57	1340
	1190/6				124			1670
	1198/5				175			1300
	1198/6				175			1490
	1198/7				180			1475
	1178/9	120	101	72	250		80	2870
Piston Pilot Operated	1134/3	97,5	85	50,5	68	50	–	775
	1138/3				111			775
	1138/M11				111			770
	1140/4	105,5	89,5	56,5	100		45	1117
	1140/5				106			1166
	1148/M12				127			1095
	1148/4				127			1084
	1148/5				175			1188
	1150/5	126	98	70	120		57	1462
	1150/6				124			1792
	1158/5				175			1422
	1158/6				175			1612
	1158/7				180			1597
	1198/9	162	132	99	235		60	2355
	1178/11	180	146	113	278		68	3015
	1178/13	195	158	130	280		88	3820
	1178/M42							3820

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



1134/3 1164/3



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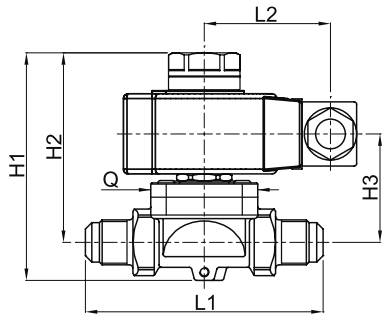

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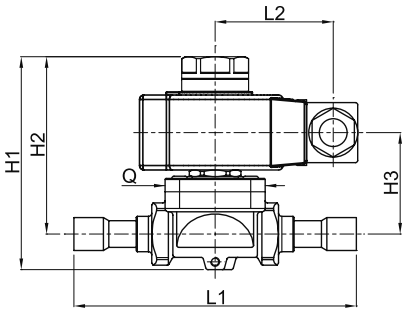

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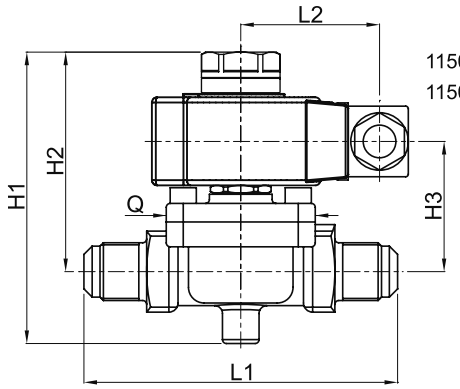

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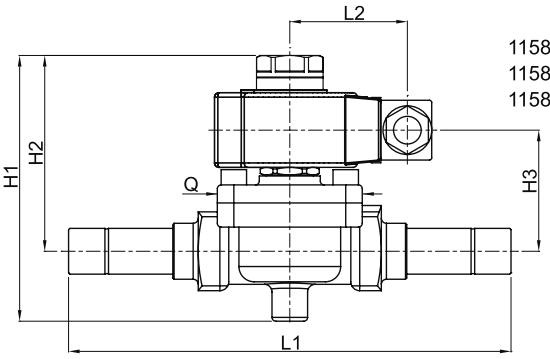

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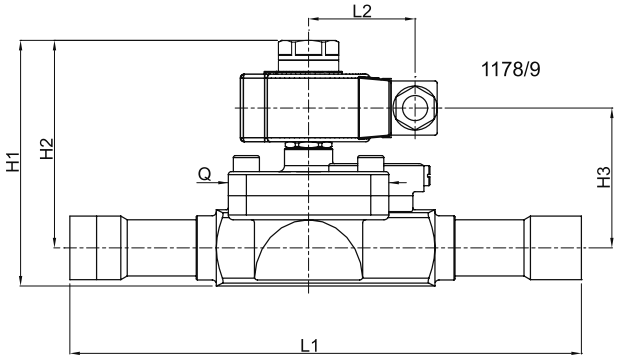
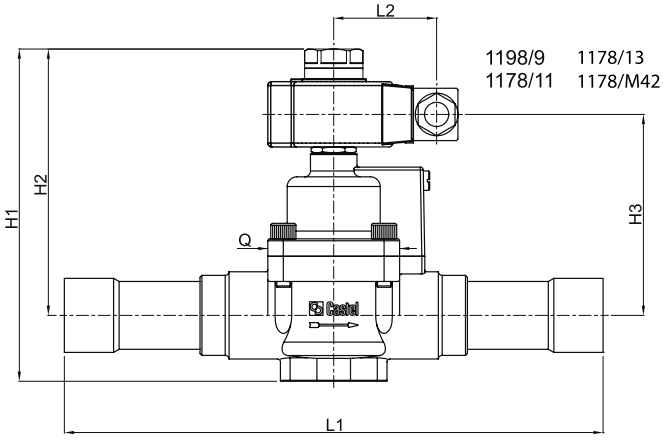
1158/6 1198/6
1158/7 1198/7



1178/9



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

TABELLA 8: Rese frigorifere valvole NA [kW]

Operating Principles	Catalogue Number	Liquid line						Suction line						Hot Gas line					
		R134a	R22	R404A	R407C	R410A	R507	R134a	R22	R404A	R407C	R410A	R507	R134a	R22	R404A	R407C	R410A	R507
Diaphragm Pilot Operated	1164/3	13,6	14,6	9,5	13,8	13,7	9,2	1,51	2,04	1,78	1,82	2,40	1,78	6,8	8,6	7,7	9,3	10,9	7,6
	1168/3																		
	1168/M10																		
	1170/4	37,4	40,3	26,2	37,9	37,8	25,3	4,16	5,61	4,91	4,99	6,60	4,91	18,7	23,8	21,1	25,6	29,9	21,0
	1170/5	44,4	47,8	31,1	45,0	44,8	30,0	4,93	6,66	5,82	5,92	7,83	5,82	22,2	28,2	25,1	30,3	35,5	24,9
	1178/M12	37,4	40,3	26,2	37,9	37,8	25,3	4,16	5,61	4,91	4,99	6,60	4,91	18,7	23,8	21,1	25,6	29,9	21,0
	1178/4																		
	1178/5	44,4	47,8	31,1	45,0	44,8	30,0	4,93	6,66	5,82	5,92	7,83	5,82	22,2	28,2	25,1	30,3	35,5	24,9
	1190/5	64,6	69,5	45,2	65,5	65,2	43,7	7,2	9,7	8,5	8,6	11,4	8,5	32,3	41,0	36,5	44,2	51,7	36,3
	1190/6	81,6	87,8	57,1	82,7	82,4	55,2	9,1	12,2	10,7	10,9	14,4	10,7	40,8	51,8	46,1	55,8	65,3	45,8
	1198/5	64,6	69,5	45,2	65,5	65,2	43,7	7,2	9,7	8,5	8,6	11,4	8,5	32,3	41,0	36,5	44,2	51,7	36,3
	1198/6	81,6	87,8	57,1	82,7	82,4	55,2	9,1	12,2	10,7	10,9	14,4	10,7	40,8	51,8	46,1	55,8	65,3	45,8
	1198/7	96,9	104,3	67,8	98,2	97,9	65,6	10,8	14,5	12,7	12,9	17,1	12,7	48,5	61,6	54,7	66,2	77,5	54,4
	1178/9	170,0	183,0	119,0	172,3	171,7	115,0	18,9	25,5	22,3	22,7	30,0	22,3	85,0	108,0	96,0	116,2	136,0	95,4
Piston Pilot Operated	1134/3	17,0	18,3	11,9	17,2	17,2	11,5	1,89	2,55	2,23	2,27	3,00	2,23	8,5	10,8	9,6	11,6	13,6	9,5
	1138/3																		
	1138/M10																		
	1140/4	40,8	43,9	28,6	41,4	41,2	27,6	4,54	6,12	5,35	5,45	7,20	5,35	20,4	25,9	23,0	27,9	32,6	22,9
	1140/5	51,0	54,9	35,7	51,7	51,5	34,5	5,67	7,65	6,69	6,81	9,00	6,69	25,5	32,4	28,8	34,9	40,8	28,6
	1148/M12	40,8	43,9	28,6	41,4	41,2	27,6	4,54	6,12	5,35	5,45	7,20	5,35	20,4	25,9	23,0	27,9	32,6	22,9
	1148/4																		
	1148/5	51,0	54,9	35,7	51,7	51,5	34,5	5,67	7,65	6,69	6,81	9,00	6,69	25,5	32,4	28,8	34,9	40,8	28,6
	1150/5	64,6	69,5	45,2	65,5	65,2	43,7	7,2	9,7	8,5	8,6	11,4	8,5	32,3	41,0	36,5	44,2	51,7	36,3
	1150/6	81,6	87,8	57,1	82,7	82,4	55,2	9,1	12,2	10,7	10,9	14,4	10,7	40,8	51,8	46,1	55,8	65,3	45,8
	1158/5	64,6	69,5	45,2	65,5	65,2	43,7	7,2	9,7	8,5	8,6	11,4	8,5	32,3	41,0	36,5	44,2	51,7	36,3
	1158/6	81,6	87,8	57,1	82,7	82,4	55,2	9,1	12,2	10,7	10,9	14,4	10,7	40,8	51,8	46,1	55,8	65,3	45,8
	1158/7	96,9	104,3	67,8	98,2	97,9	65,6	10,8	14,5	12,7	12,9	17,1	12,7	48,5	61,6	54,7	66,2	77,5	54,4
	1198/9	170,0	183,0	119,0	172,3	171,7	115,0	18,9	25,5	22,3	22,7	30,0	22,3	85,0	108,0	96,0	116,2	136,0	95,4
	1178/11	272,0	292,8	190,4	275,7	274,7	184,0	30,2	40,8	35,7	36,3	48,0	35,7	136,0	172,8	153,6	185,9	217,6	152,6
	1178/13	425,0	457,5	297,5	430,8	429,3	287,5	47,3	63,8	55,8	56,8	75,0	55,8	212,5	270,0	240,0	290,5	340,0	238,5
	1178/M42																		

Standard rating conditions according to AHRI Standard 760-2007

Condensing temperature	110 °F	(43,3 °C)
Liquid temperature	100 °F	(37,8 °C)
Subcooling	10 °R	(5,5 °K)
Evaporating temperature	40 °F	(4,4 °C)
Suction temperature	65 °F	(18,3 °C)
Superheating	25 °R	(13,9 °K)
Discharge temperature	160 °F	(71,1 °C)

APPLICATION

For the normally closed solenoid valves Castel puts the following types of coils at disposal of its own customers:

- coils series HM2, only for A.C. (catalogue numbers 9100)
- coils series CM2, only for A.C. (catalogue number 9110)
- coils series HM3, either for A.C. or for D.C. (catalogue number 9120)
- coils series HM4, only for A.C. (catalogue number 9160)
- coils series HM6, either for A.C. or for D.C. (catalogue number 9220)

N.B.

For normally open solenoid valves, always shown in this Handbook, the customer's selection must compulsorily apply to the coils series HM3 – D.C. For applications of the NO solenoid valves with a voltage supply of 220 V AC, Castel has designed a specific coil at 220 V RAC (code 9120/RD6) that must be used solely with the 220 VAC connector/rectifier circuit (codes 9150/R45 or 9150/R90).

N.B.

For industrial purpose solenoid valves series 1133, the customer's selection must compulsorily apply to the coils series HM6. Coils series HM6 cannot be used with all the other solenoid valves shown on this handbook.

CONSTRUCTION

Coils HM2 (9100) are class H , whereas coils CM2 , HM3 , HM4 and HM6 are class F , in compliance with IEC 85 standard and their construction is in compliance with EN 60730-1 and EN 60730-2-8 standards. The windings are made with copper wire, insulation class H 180 °C, in compliance with IEC 85 standard. The outer casing is provided with dielectric and waterproof resins that assure a reinforced insulation making the coils suitable for all assemblies.

Protection against electric contacts is class I for all the coils. Therefore, for safety purposes, coils must be effectively connected to a ground system. Rubber gaskets on the upper and lower ends of coil ensure moisture protection of winding.

Coils HM2, HM3 and HM6 may be joined to all connectors produced by Castel except type 9155/R01; protection degree guaranteed by this system, coil (HM2, HM3, HM6) + connector, is IP65 according to EN 60529.

Coils HM4 must be preferably used with connector type 9155/R01; protection degree guaranteed by this other system, coil HM4 + connector 9155/R01, is IP65/IP68 according to EN 60529. Coils HM4 can be used with connectors series 9150 and 9900 too; protection degree guaranteed by this system is IP65.

Either the terminals of coils series HM2, HM3 and HM6 or the ones of coils series HM4 consist of two line terminals plus one ground terminal. Coil type CM2 has a pre-assembled cable (length 1 meter).

The coils are designed for continuous use. The solid construction of these coils is suitable for heavy-duty applications in refrigerant systems. The maximum ambient temperature for all coils is 50 °C.

ELECTRIC TYPE APPROVAL

Coils series 9100 , 220/230 V AC and 240 V AC supply, are approved by the German registration body VDE.

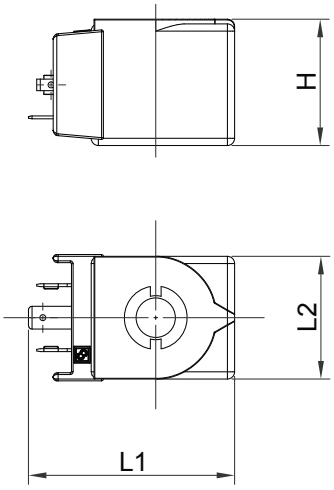
Coils series 9100 , 9110 , 9160 and 9220, 110 V AC , 220/230 V AC and 240 V AC supply, and coils series 9120 , 220/230 V AC supply, are manufactured according to Low Voltage (LV) Directive 2006/95/EC. Coils series 9100 , 9110 , 9120 , 9160 and 9220 are manufactured according to Electromagnetic Compatibility (EMC) Directive 2004/108/EC.

TABLE 9: General Characteristics of coils						
Coil Type	Catalogue Number	Voltage [V]	Voltage Tolerance [%]	Frequency [Hz]	Connections	Protection Degree
HM2	9100/RA2	24 A.C.	+10 / -10	50 / 60	Junction box DIN 43650	IP65 EN 60529 (with junction box)
	9100/RA4	110 A.C.				
	9100/RA6	220/230 A.C.	+6 / -10			
	9100/RA7	240 A.C.	+10 / -10			
	9100/RA8	380 A.C.				
CM2	9110/RA2	24 A.C.	+10 / -10	50 / 60	Three wire cable	IP65 EN 60529
	9110/RA4	110 A.C.				
	9110/RA6	220/230 A.C.	+6 / -10			
	9110/RA7	240 A.C.	+10 / -10			
HM3	9120/RA6	220/230 A.C.	+6 / -10	50 / 60	Junction box DIN 43650	IP65 EN 60529 (with junction box)
	9120/RD1	12 D.C.	+10 / -5	–		
	9120/RD2	24 D.C.				
	9120/RD4	48 D.C.				
	9120/RD6	220 RAC				
HM4	9160/RA2	24 A.C.	+10 / -10	50 / 60	Junction box DIN 43650 or Connector 9155/ R01 (1)	IP65 EN 60529 (with junction box) IP65/IP68 EN 600529 (with connector)
	9160/RA4	110 A.C.				
	9160/RA6	220/230 A.C.	+6 / -10			
	9160/RA7	240 A.C.	+10 / -10			
HM6	9220/RA2	24 A.C.	+10 / -10	50 / 60	Junction box DIN 43650	IP65 EN 60529 (with junction box)
	9220/RA4	110 A.C.				
	9220/RA6	220/230 A.C.	+6 / -10			
	9220/RA7	240 A.C.	+10 / -10			
	9220/RD1	12 D.C.	+10 / -5	–		
	9220/RD2	24 D.C.				

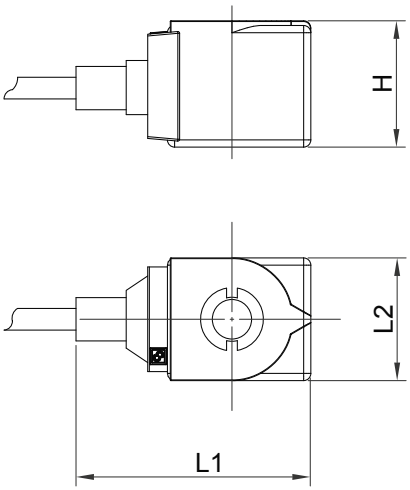
(1) Coil HM4 can also be coupled to connectors series 9150 and 9900, achieving a degree of protection IP65. The “versatile” degree of protection (IP65/IP68) is achieved coupling coil HM4 with four screws connector 9155/R01

TABLE 10: Coils Consumptions, Dimensions and Weights

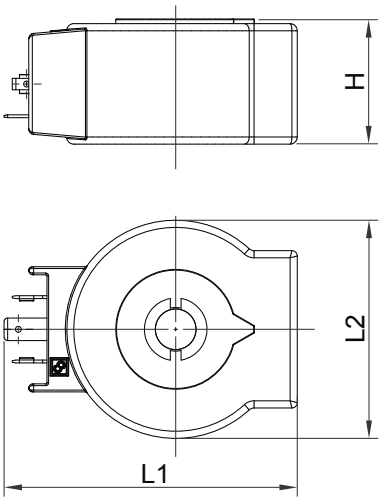
Coil type	Catalogue Number	Voltage [V]	Consumption at 20 °C [mA]						Dimensions [mm]			Weight [g]
			Start			Working						
			50 [Hz]	60 [Hz]	D.C.	50 [Hz]	60 [Hz]	D.C.	L_1	L_2	H	
HM2	9100/RA2	24 A.C.	920	825	-	527	420	-	57,5	34	35	165
	9100/RA4	110 A.C.	230	205		128	114					
	9100/RA6	220/230 A.C.	140	128		68	58					
	9100/RA7	240 A.C.	100	87		54	43					
	9100/RA8	380 A.C.	58	51		32	23					
CM2	9110/RA2	24 A.C.	920	825	-	527	420	-	66,5	34	35	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					
HM3	9120/RA6	220/230 A.C.	190	160	-	110	80	-	82	61	35	470
	9120/RD1	12 D.C.	-	-	1720	-	-	1720				
	9120/RD2	24 D.C.			895			895				
	9120/RD4	48 D.C.			460			460				
	9120/RD6	220 RAC			93			93				
HM4	9160/RA2	24 A.C.	1490	1320	-	700	530	-	63	41	35	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					
HM6	9220/RA2	24 A.C.	833	700	-	625	525	-	52	30	39	120
	9220/RA4	110 A.C.	182	153		136	115					
	9220/RA6	220/230 A.C.	87	73		65	55					
	9220/RA7	240 A.C.	83	70		63	53					
	9220/RD1	12 D.C.	-	-	860	-	-	860				
	9220/RD2	24 D.C.			440			440				



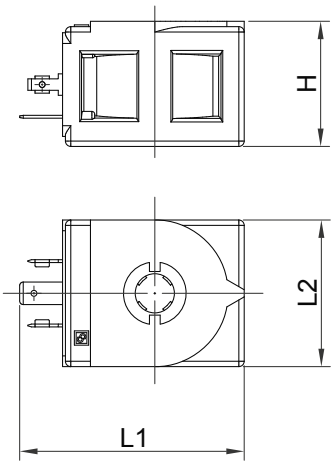
9100 (HM2)



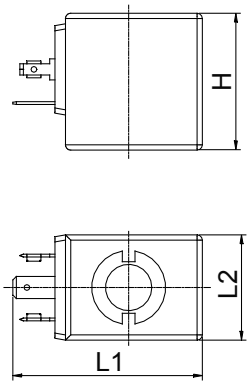
9110 (CM2)



9120 (HM3)



9160 (HM4)



9220 (HM6)

The junction boxes 9150, DIN 43650 standardized, represent an effective system for the connection of the coil to the supply circuit, thus ensuring safety also in the presence of moisture.
These junction boxes, according to assembly requirements, allow choosing the position of outer casing compared to inner terminal block. The gland nut of casing is suitable to receive cables with an external diameter of 6 ÷ 9 mm and is provided with a self-locking device. Cables sized 3 x 0,75 mm^2 are to be preferred.

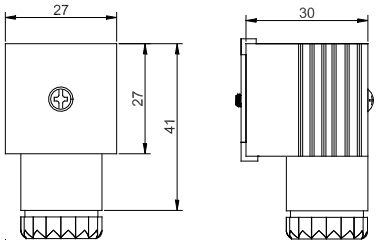
The junction boxes series 9900 are available with cabled core of different length. In this case, it is not possible to change the position of casing compared to terminal block.
Both the two types offer a protection degree IP65 against dust and water, according to EN 60529, when correctly installed with the proper gaskets, which are supplied as standard.

Castel developed specific junction boxes, series 9155, suitable for use on those refrigerating systems working in heavy duty environments, for example:
- exposition to the atmospheric conditions
- rooms with high moisture degree
- cyclic condensing / evaporating on the valve
- cyclic icing / defrosting on the valve

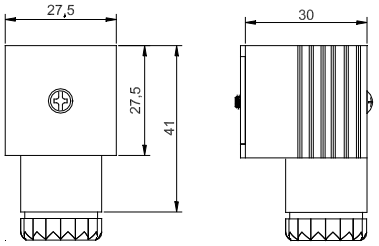
These junction boxes, according to assembly requirements, allow choosing the side position of outer casing compared to inner terminal block; but it is not possible to point the cable upwards. The gland nut of casing is suitable to receive cables with an external diameter of 6 ÷ 9 mm and is provided with a self-locking device. Cables sized 3 x 0,75 mm2 are to be preferred for these junction boxes too.
The junction boxes series 9155 offer a protection degree IP65/IP68 against dust and water, according to EN 60529, when correctly installed with the proper gaskets, which are supplied as standard.

The junction box 9150/R45 is equipped with a full-wave bridge rectifier plus VDR for protection. The VDR device, Voltage e-Dependent-Resistor, is a special type of resistor, placed in parallel to the coil; its purpose is to protect the diodes and the coil from any excessive voltage generated within the ac supply circuit.
WARNING: junction box 9150/R45 must be solely used with coil 9120/RD6 (220 V RAC). The wrong use of this junction box with other types of Castel coils takes quickly to the destruction of the coil.

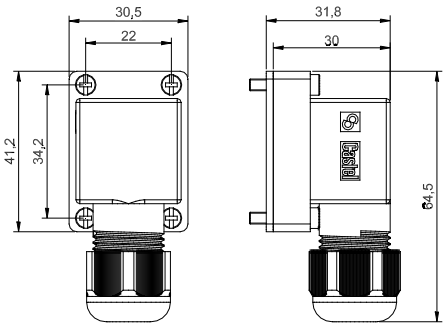
TABLE 11: General Characteristics of connectors								
Catalogue Number	Supply Voltage [V]		Cable length [m]	Cable thickness [mm²]	Standard	Degree of protection	Class of insulation	Approval
	Nominal	Maximum						
9150/R02	-	-	-	-	DIN 43650	IP65 EN 60529	Gruppo C VDE 0110-1 / 89	-
9150/R45	220 A.C.	250 A.C.						-
9900/X66	-	-	1	3 x 0,75				-
9900/X84			1,5					
9900/X73			2					
9900/X55			3					
9900/X54			5					
9155/R01	-	-	-	-	-	IP65/IP68 EN 60529		
9155/R02			1	3 x 0,75				



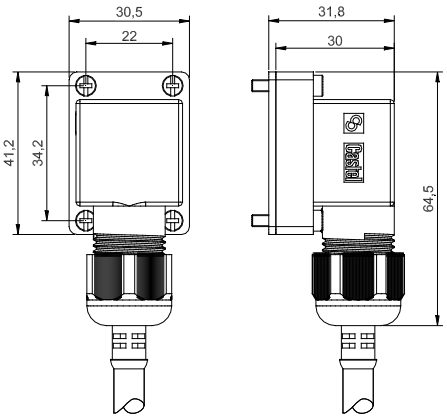
9150/R02



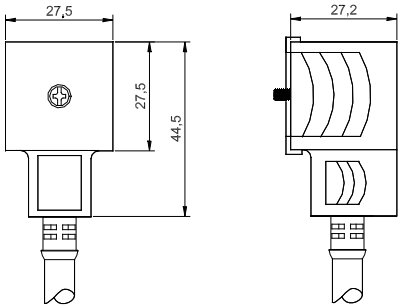
9150/R45



9155/R01



9155/R02



9900/X66
9900/X84
9900/X73
9900/X55
9900/X54

NORMALLY CLOSED SOLENOID VALVES FOR INDUSTRIAL PURPOSES

APPLICATIONS

The solenoid valves, shown in this chapter, are classified "Pressure accessories" in the sense of the Pressure Equipment Directive 94/23/EC, Article 1, Section 2.1.4 and are subject of Article 3, Section 1.3 of the same Directive.

They are designed for the applications specified in TABLE 12 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 (gas oil)

In short these valves may be used:

- with fluids in the gaseous state proper to the Group II (as defined in Article 9, Section 2.2 of Directive 97/23/EC and referred to in Directive 67/548/EEC)
- with fluids in the liquid state proper to the Group I (as defined in Article 9, Section 2.1 of Directive 97/23/CE and referred to in Directive 67/548/EEC)

OPERATION

All the solenoid valves for industrial purposes are normally closed.

NC = when the coil is de-energised the plunger stops the fluid flow, when the coil is electrically energised the plunger opens the valve seat connecting the inlet to the outlet.

The valves series 1512 and 1522 are **direct acting**. The 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 and the valves can open with zero pressure differential.

The valves series 1132 e 1133 are **pilot operated with diaphragm**. The operation depends not only on the magnetic field produced by the current flow into the coil but it's also necessary a minimum inlet pressure to move the diaphragm and to keep it lift off the main seat. Opening/closing of main seat is controlled by the diaphragm while opening/closing of pilot seat is controlled by the mobile plunger. These valves cannot work with zero pressure differential.

Solenoid valves for industrial purposes are supplied either without coil (S type) or with coil (A6 type with coil 220/230 VAC).

CONSTRUCTION

The main parts of the valves are made 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 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

TABLE 12 shows the following functional characteristics of a solenoid valve:

- Connections
- PS : maximum allowable pressure
- TS: maximum / minimum allowable temperature,
- Kv : capacity factor
- minimum Opening Pressure Differential (minOPD). This is the minimum pressure differential between inlet and outlet at which a solenoid valve, pilot operated, can open and stay opened.
- Maximum Opening Pressure Differential (MOPD according to ARI STANDARD 760 : 2001). This is the maximum pressure differential between inlet and outlet at which a solenoid valve, pilot operated, can open.

CAPACITY CALCULATION

With the Kv factors, listed on TABLE 12 it is possible to calculate the flow capacity through the valve giving the accepted pressure drop, the media and the working pressure, or to check the pressure drop through the valve giving the flow capacity.

With the following formula it's possible to calculate the volumetric liquid capacity:

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

If liquid is water with temperature between 5 and 30 °C and density ρ equal to 1 Kg/dm^3 the formula becomes:

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

With the following formulas it's possible to calculate the volumetric gas capacity:

if

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

if

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

If gas is air at 20 °C and density ρ equal to 1,29 Kg/dm^3 the formulas become:

if

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

if

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

where:

Kv = valve Kv factor [m^3/h]
Q = volumetric capacity for a liquid [m^3/h]
Q_n = "normal" volumetric capacity for a gas at 0 °C and 760 mm Hg [m_n^3/h]
p_1 = absolute pressure upstream the valve [bar abs]
p_2 = absolute pressure downstream the valve [bar abs]
t_1 = temperature upstream the valve [°C]
Δp = pressure drop through the valve [bar]
ρ = liquid density [kg/dm^3]
ρ_n = "normal" gas density at 0 °C e 760 mm Hg [Kg/m_n^3]

Entering the following data in TABLE 13:
- p_1 = absolute pressure upstream the valve [bar abs]
- Δp = pressure drop through the valve [bar]

It is possible to select to corresponding value of air capacity under these conditions:
- temperature upstream the valve = 20°C
- absolute pressure downstream the valve = 1 bar
- valve Kv factor = 1 m^3/h

Using example of TABLE 13: Select the valve suitable for use with approximately 200 m^3/h of air, assuming an absolute pressure of 8 bars at valve inlet (= 7 bars of relative pressure + 1 bar) and an acceptable pressure drop across the valve of 1.5 bars.
Intersecting the column p_1 = 8 bar abs with the line Δp = 1,5 bar you can find a capacity value equal to 87 m^3/h. This is the capacity value of a hypothetical valve with kv = 1 , working under the above mentioned conditions. The ratio 200 / 87 = 2,29 m^3/h is the kv value required in the case under consideration. In TABLE 12 select the valve with the kv value nearest to 2,29, rounding off the value and subsequently checking that all the characteristics of the selected valve (max. opening pressure differential, temperature, connections, etc.) are suitable.

VISCOSITY

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

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

If the cinematic viscosity of the fluid under consideration is more than 12 cSt it is necessary to multiply the value of the maximum differential pressure by the following reducing factors:

Cinematic viscosity cSt	Reducing factors
12	1
12/30	0,8
30/45	0,7

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

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

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

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

where:
ν = cinematic viscosity [cSt]
μ = dynamic viscosity [cP]
ρ = volumetric mass of the fluid at the considered temperature [kg/dm^3]

TABLE 14 shows the approximate equivalences among the most common viscosity units of measure at the same temperature.

Moreover, the fluid viscosity may remarkably vary according to changes in temperature. Therefore, if the temperature of the fluid does not ensure viscosity values compatible with the correct operation of the valve, the valve may 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 fitting a filter before the valve; avoid the ingress of foreign matter inside the valve or that sealing materials (tape, jointing paste, etc) can obstruct the internal seats or pilot holes (servo operated valves).
Connect the valve to the pipes applying the wrench only to the specific surfaces on the body; don't use the coil or the plunger enclosure as lever arm.
The valves can be mounted in whatever position except with the coil pointing downwards; however it is advisable to mount the coil above the horizontal position in order to avoid the eventual precipitation of impurities inside the enclosure. When connecting with flexible pipes, fix the valve using the specific holes provided in the body.
Before connecting a valve to the electrical system, be sure that the line voltage and frequency correspond to the values marked on the coil, the direct current valves don't require a fixed polarity. To help heat dissipation of the coil put valve in a ventilated environment away from any other heat source. It's possible that the coil working temperature could, in conjunction with ambient and fluid temperatures, cause burns. It's recommended an appropriate protection of the coil from water and humidity.

N.B. : Industrial purpose solenoid valves can be used solely with coils series 9220 (coil type HM6). The other Industrial purpose solenoid valves can be used with all Castel coils except coils series 9220.

TABLE 12: General Characteristics

Catalogue Number	Coil Type	Seal	Media	FPT Connections	Seat Size nominal Ø [mm]	Kv Factor [m³/h]	Operating Principles	Opening Pressure Differential [bar]		TS [°C]		PS [bar]	Risk Category according to PED
								min OPD	MOPD (HM2 AC) HM6 AC)	min.	max.		
1512/01	HM2 (A.C.) CM2 (A.C.) HM3 (A.C.; D.C.) HM4 (A.C.)	FPM	W.L.O.	G 1/8"	1,5	0,070	Direct Acting	0	30	-15	+130	30	Art. 3.3
1522/02			W.O.	G 1/4"	4,5	0,40			4				
1522/03				G 3/8"									
1522/04				G 1/2"									
1132/03			W.L.O..B.	G 3/8"	12,5	2,6	Diaphragm Pilot Operated	0,1	17				
1132/04				G 1/2"		2,7							
1132/06				G 3/4"	20	5,50		0,15	12			15	
1132/08				G 1"		6,00							
1133/010V370	HM6			G 1.1/4"	37	18		0,15	10	-10	+130	25	
1133/012V370				G 1.1/2"		21							

TABLE 13: Air Capacity [m_n^3/h] (1)

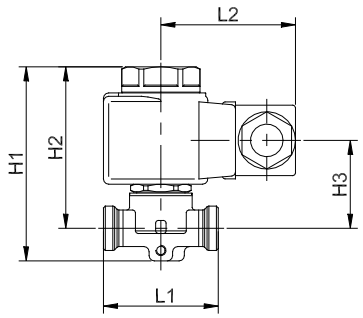
Pressure Drop [bar]	Inlet pressure [bar abs]																							
	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1,500	1,250	1,150	1,100	1,050	1,025	1,015
0,0025																					1,38	1,35	1,33	1,33
0,005																				2,00	1,95	1,91	1,89	1,88
0,010																			2,94	2,82	2,76	2,69	2,66	2,65
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^3/h under the following conditions:
- temperature at valve inlet: + 20°C
- pressure at outlet (absolute): 1 bar
- Kv of the solenoid valve: 1 m^3/h

TABLE 14: Viscosity equivalence			
Cinematic Viscosity [cSt] or [mm²/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 15: Dimensions and Weights (valves with 9100 coils)							
Catalogue Number	Dimensions [mm]						Weight [g]
	H_1	H_2	H_3	L_1	L_2	Q	
1512/01	75	62	34	44	50	-	310
1522/02	76	63	36	51		-	385
1522/03							370
1522/04							355
1132/03	91	75	47	75	50	45	670
1132/04							635
1132/06	101	81	52	88		57	960
1132/08							670
1133/010N370	133	105	84,5	142	52	102	3200
1133/012N370							2900

With coil 9120 the dimension L2 is equal to 64 mm and the weights must be increased of 305 g.
Connectors are not included in the boxes and have to be ordered separately



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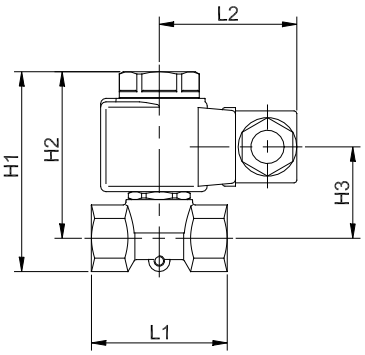
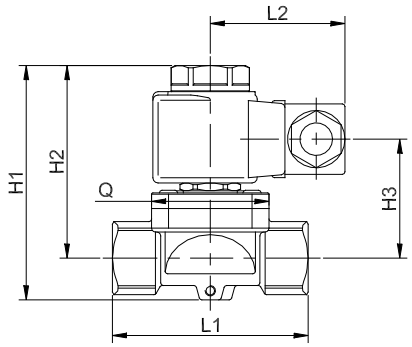
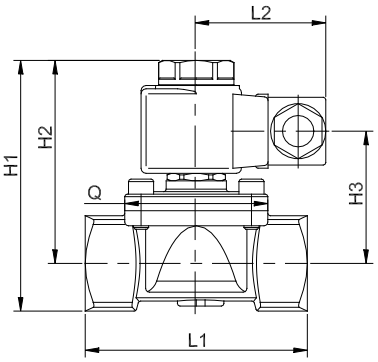


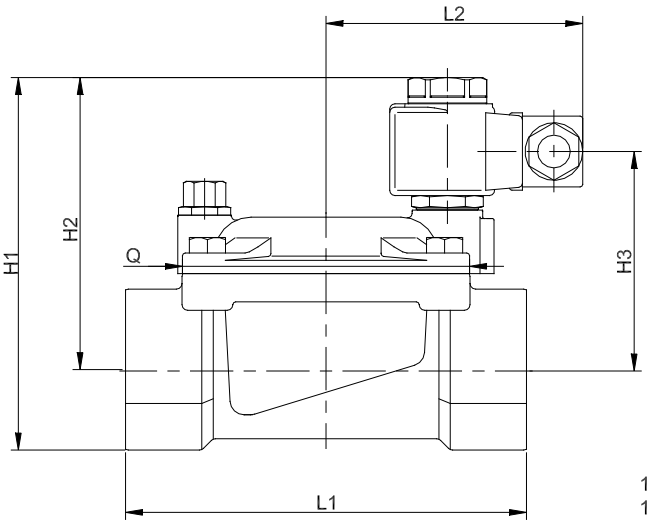
1522/02
1522/03
1522/04



1132/03
1132/04



1132/06
1132/08



1133/010
1133/012

PERMANENT MAGNET

APPLICATION

Castel supplies to its customers the permanent magnet code 9900/X91 for the normally closed solenoid valves, shown in this chapter.

This product can be used during brazing of the valve copper connections to the plant pipes; slipping it on the armature, instead of the coil, it allows the protective gas (nitrogen) flowing and avoids any damage to the plunger gasket and to the diaphragm.

CONSTRUCTION

The main parts of the permanent magnet code 9900/X91 are made with the following materials:

- three rings of anisotropic ferrite
- anodized aluminum for the body