# HANDBOOK
# SOLENOID VALVES FOR INDUSTRIAL PURPOSES

Castel

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## FROM QUALITY OUR NATURAL DEVELOPMENT

After more than forty years 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 9001:2000 issued by ICIM certifies the Quality System of the Factory.

We produce on high tech machinery and updated automatic production lines, operating in conformity with the safety and environment standards currently enforced.

Based on this experience, obtained in the market for production of components for Refrigeration, Castel is proud to present to the operators in the field and to the manufacturer companies, a new range of products including different type of solenoid valves, specifically studied for general purposes.

## 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.

## WEIGHTS

The weights of the items listed in this Handbook include packaging and are not binding for the Company.

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

## SOLENOID VALVES CODING

"TABLE 1" shows the code composition of Castel valves for industrial purposes.
Following some examples of coding:
- Valve 1145/01V025A6 = normally closed brass valve, direct acting, with 1/8" Gas connections, FPM gaskets, nominal seat size 2,5 mm, with coil 9200/RA6.

- Valve 1123/03E120S = normally closed brass valve, hung diaphragm pilot operated, with 3/8" Gas connections, EPDM gaskets, nominal seat size 12 mm, without coil.

- Valve 1233/08N240A6 = normally closed stainless steel valve, diaphragm pilot operated, with 1" Gas connections, NBR gaskets, nominal seat size 24 mm, with coil 9200/RA6.

- Valve 1136/02N045S = normally open brass valve, direct acting, with 1/4" Gas connections, NBR gaskets, nominal seat size 4,5 mm, without coil.

- Valve 1143/010E370A6 = normally open brass valve, diaphragm pilot operated, with 1.1/4" Gas connections, EPDM gaskets, nominal seat size 37 mm, with coil 9200/RA6.

**TABLE 1: solenoid valves code composition**

| Position | Description | Code | Reference |
|---|---|---|---|
| 1a - 2a | Macro Family | 11 | Brass solenoid valves |
| | | 12 | Stainless steel solenoid valves |
| 3a-- 4a | Operating principle | 45 | NC direct acting |
| | | 46 | NC direct acting |
| | | 23 | NC hung diaphragm pilot operated |
| | | 33 | NC diaphragm pilot operated |
| | | 35 | NO direct acting |
| | | 36 | NO direct acting |
| | | 43 | NO diaphragm pilot operated |
| 5a | | / | |
| 6a - 7a - 8a | Connections | from 01 | G 1/8" |
| | | up to 024 | G 3" |
| 9a | Seal material | N | NBR (Acrylonitrile butadiene ) |
| | | E | EPDM (Ethylene-propylene ) |
| | | V | FPM (Fluorocarbon - Viton) |
| 10 - 11a - 12a | Seat size | Ø x 10 | seat dimension, "mm ", multiplied per 10 |
| 13a - 14a | Packaging | S | Without coil |
| | | | With coil, 220-230 VAC |

# NORMALLY CLOSED SOLENOID VALVES

## 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 using:
- with fluids in 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 liquid state proper to the Group I (as defined in Article 9, Section 2.1 of Directive 97/23/EC and referred to in Directive 67/548/EEC).

## OPERATION

Solenoid valves series 1145/1245, 1146/1246, 1123, 1133/1233 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.
Castel puts at disposal of its own customers either normally closed valves with brass bodies, series 1145, 1146, 1123, 1133, or normally closed ones with stainless steel bodies, series 1245, 1246, 1233.

Valves series 1145/1245, 1146/1246 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.

Valves series 1133/1233 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.

Valves series1123 are mixed acting valves, hung diaphragm pilot operated. The operation of these valves is similar to the previous one shown for diaphragm pilot operated but in this case the plunger is mechanically constrained to the diaphragm. So there are two actions on this valve: the same explained for the diaphragm pilot operated valves plus the diaphragm dragging by the mobile plunger; these two actions allow the valve to work at zero pressure differential, as direct acting valves.
All the normally closed valves shown in this chapter are supplied either without coil (S type) or with coil (example: A6 type with coil SM2–220 VAC).

## CONSTRUCTION

The main parts of normally closed solenoid valves are made with the following materials:
- Hot forged brass for body and cover of valves series 11
- Bar machined or hot forged stainless steel for body and cover of valves series 12
- Austenitic stainless steel, or alternatively brass, for enclosure where the plunger moves ( depending of valve model)
- Ferritic stainless steel for plunger
- Acrylonitrile butadiene rubber (NBR) or ethylene-propylene rubber (EPDM) or fluorocarbon rubber (FPM) for outlet seal gaskets and diaphragms

The choice of materials for bodies, gaskets and diaphragms depends on the application where the valves are used. On this subject see "TABLE 2a" for the characteristics of gaskets/diaphragm materials and "TABLE 2b" for the compatibility of materials versus different fluids.


Valve 1145


Valve 1146

| TABLE 2a: Materials - Seal characteristics and typical applications | | | |
|---|---|---|---|
| Designation | Commercial denomination | General characteristics | Application |
| NBR<br>(Acrylonitrile butadiene ) | BUNA -N<br>PERBUNAN<br>ELAPRIM<br>JSR-N | A synthetic elastomer with good mechanical and thermal properties.<br>Good resistance to oils.<br>Poor resistance to ozone and atmospheric derivatives. | Water with max. temperature 70°C<br>Air with max. temperature 90°C.<br>Mineral oils and their derivatives<br>Hydrocarbons<br>Methane, Ethane<br>Propane, Butane<br>Kerosene oil, Fuel oil. |
| EPDM<br>(Ethylene-propylene ) | BUNA - AP<br>DUTRAL<br>NORDEL | A synthetic elastomer derived from the co-polyimerization of ethylene and propylene.<br>Suitable for use with non-phosphoric based hydraulic fluids(hold), water and steam to a max. temp of 140°C.<br>Not suitable for use with mineral based products.<br>(oil, grease , fuel oils and petrol) | Hot water and steam.<br>Detergents.<br>Potassium and sodium solutions.<br>Hydraulic fluids.<br>Polarised solvents.<br>Skydrol 500 and 700<br>* |
| FPM<br>(Fluorocarbon) | VITON<br>TECNOFLON<br>FLUOREL | A synthetic elastomer derived from flour-propylene.<br>Excellent resistance to the high temp.<br>Excellent resistance to ozone, oxygen, mineral oils, synthetic<br>hydraulic oil, petrol, hydro-carbons and many other chemicals.<br>Not suitable for use with superheated steam. | For general use<br>up to 160°C |

Valve 1246

Valve 1123

Valve1133

Valve 1233

| TABLE 2b: Materials - Media compatibility | | | | | |
|---|---|---|---|---|---|
| MEDIA | Body | | Seals | | |
| | brass | Stainless steel | NBR | EPDM | FPM |
| Ethyl acetate | • | • | - | - | - |
| Acetylene | • | • | - | • | • |
| Vinegard | • | • | - | • | - |
| Acetone | • | • | - | - | - |
| Hard water | • | • | • | • | • |
| Hot water <75°C | • | • | • | • | • |
| Hot water and steam <140°C | • | • | - | • | - |
| Water with glycol | • | • | - | - | • |
| De-ionised water | - | • | • | • | • |
| De-mineralised water | - | • | • | • | • |
| Hydrogen dioxide | - | • | - | - | • |
| Soapy water | • | • | • | - | • |
| Carbon dioxide (liquid) | - | • | - | - | - |
| Dry carbon dioxide (gas) | • | • | • | • | • |
| Argon hold | • | • | - | • | • |
| Nitrogen | • | • | • | • | • |
| Petrol | • | • | - | - | • |
| Benzol | • | • | - | - | - |
| Butane | • | • | - | - | • |
| Chloroform | • | • | - | - | - |
| Ethyl cloride | • | • | - | - | • |
| Methyl cloride | • | • | - | - | - |
| Helium | • | • | • | - | • |
| Heptane | • | • | • | - | • |
| Hexane | • | • | • | - | • |
| Ethane | • | • | • | - | • |
| Ethanol | • | • | - | - | - |
| Formaldehyde | • | • | • | • | • |
| Freon | • | • | - | - | - |
| Natural gas | • | • | • | - | • |
| Fuel oil | • | • | • | - | • |
| Glycerine | • | • | • | - | • |
| Ethylene glycol | • | • | • | • | • |
| Hydrogen | • | • | - | - | • |
| Isobutane | • | • | • | - | • |
| Isopentane | • | • | • | - | • |
| Methane | • | • | • | - | • |
| Methanol | • | • | - | • | - |
| Calcium monoxide | • | • | • | • | • |
| Neon | • | • | • | - | • |
| Nitrobenzene | • | • | - | - | - |
| Mineral oil | • | • | • | | • |
| Oxygen | • | • | • | - | • |
| Pentane | • | • | • | • | • |
| Propyl alcohol | • | • | - | • | • |
| Propane-n | • | • | • | • | • |
| Carbon disulphide | • | • | - | - | - |
| Toluene | • | • | - | - | • |
| Trichlorethylene dry | • | • | - | - | • |
| Xilol | - | • | - | - | • |

• = compatible - = not compatibile

## VALVE SELECTION

On "TABLES 3a/b/c and 5a/b" you can find the following functional characteristics that are decisive to select a normally closed valve:

- **PS: maximum allowable pressure**, according to PED definition
- **TS: maximum/minimum allowable temperature**, according to PED definition
- **Kv factor: cold water flow (volumetric mass ρ = 1000 kg/m³) in m³/h resulting in a 1 bar pressure drop with a completely open valve**, according to EN 60534-1, EN 60534-2-1 and EN 60534-2-3 European Standards. The correct selection of a component is based on the knowledge of the relationship between capacity and pressure drop through that component; the kv coefficient precisely defines the fluid-dynamic and construction characteristics of the product.

**TABLE 3a: General Characteristics of NC brass valves (normally closed)**

| Catalogue Number | Coil Type | Seal | Media | FPT Female Conn. | Seat Size nominal Ø [mm] | Kv Factor [m³/h] | Operating Principles | Opening Pressure Differential [bar] | | | TS [°C] | | PS [bar] | Risk Category according to PED (Group 2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | minOPD | MOPD AC | MOPD DC | min. | max. | | |
| 1145/01N012 | SM2 | NBR | See Table 2 | G 1/8" | 1.2 | 0.04 | Direct acting | 0 | 25 | 25 | -10 | +90 | 50 | Art. 3.3 |
| 1145/01N015 | | | | | 1.5 | 0.06 | | | 16 | 16 | | | | |
| 1145/01N020 | | | | | 2.0 | 0.09 | | | 12 | 10 | | | | |
| 1145/01N025 | | | | | 2.5 | 0.14 | | | 8 | 5.5 | | | | |
| 1145/01N031 | | | | | 3.1 | 0.19 | | | 5 | 2 | | | | |
| 1145/01N040 | | | | | 4.0 | 0.35 | | | 4 | 1.5 | | | | |
| 1146/01N015 | HM6 | | | | 1.5 | 0.07 | | | 30 | 26 | | | | |
| 1146/01N020 | | | | | 2.0 | 0.10 | | | 22 | 20 | | | | |
| 1146/01N025 | | | | | 2.5 | 0.15 | | | 16 | 14 | | | | |
| 1146/01N035 | | | | | 3.5 | 0.32 | | | 10 | 8 | | | | |
| 1146/02N015 | | | | G 1/4" | 1.5 | 0.07 | | | 30 | 26 | | | | |
| 1146/02N020 | | | | | 2.0 | 0.10 | | | 22 | 20 | | | | |
| 1146/02N025 | | | | | 2.5 | 0.15 | | | 16 | 14 | | | | |
| 1146/02N035 | | | | | 3.5 | 0.32 | | | 10 | 8 | | | | |
| 1146/02N045 | | | | | 4.5 | 0.41 | | | 6.5 | 3.5 | | | | |
| 1146/02N052 | | | | | 5.2 | 0.47 | | | 4 | 1.8 | | | | |
| 1146/02N064 | | | | | 6.4 | 0.64 | | | 3 | 1 | | | | |
| 1123/03N120 | HM6 | | | G 3/8" | 12.0 | 2.00 | Hung diaphragm pilot operated | 0 | 10 | - | | | 25 | |
| 1123/04N120 | | | | G 1/2" | 12.0 | 2.20 | | | 10 | | | | | |
| 1123/06N180 | HM7 | | | G 3/4" | 18.0 | 4.50 | | | 9 | | | | | |
| 1123/08N240 | | | | G 1" | 24.0 | 8.50 | | | 7 | | | | | |
| 1133/03N120 | SM2 | | | G 3/8" | 12.0 | 2.20 | Diaphragm pilot operated | 0.15 | 15 | 15 | | | | |
| 1133/04N120 | | | | G 1/2" | 12.0 | 2.50 | | | 15 | 15 | | | | |
| 1133/06N180 | | | | G 3/4" | 18.0 | 5.50 | | | 13 | 13 | | | | |
| 1133/08N240 | | | | G 1" | 24.0 | 10.20 | | | 10 | 10 | | | | |
| 1133/010N300 | | | | G 1.1/4" | 30.0 | 15.00 | | | 10 | 10 | | | | |
| 1133/010N370 | HM6 | | | | 37.0 | 18.00 | | | 10 | 10 | | | | |
| 1133/012N370 | | | | G 1.1/2" | 37.0 | 21.00 | | | 10 | 10 | | | | |
| 1133/016N500 | | | | G 2" | 50.0 | 36.00 | | | 10 | 10 | | | 20 | |
| 1133/020N750 | | | Water | G 2.1/2" | 75.0 | 75.00 | | 0.30 | 10 | 10 | | | | |
| 1133/024N750 | | | | | 75.0 | 84.00 | | | | 10 | | | | |

So that, with the addition of other parameters more closely related to the nature and conditions of the fluid under consideration, the capacity/pressure drop ratio may be precisely determined.
- **minOPD: minimum opening pressure differential**, according to ARI STANDARD 760:2001 definition. This 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 definition. This is the maximum pressure differential between inlet and outlet at which a solenoid valve, pilot operated, can open.

On "TABLES 4 and 6" you can find dimensions and weights of normally closed solenoid valves.

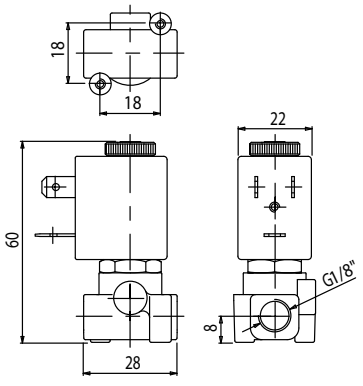
**TABLE 3b: General Characteristics of NC brass valves (normally closed)**

| Catalogue Number | Coil Type | Seal | Media | FPT Female Conn. | Seat Size nominal Ø [mm] | Kv Factor [m3/h] | Operating Principles | Opening Pressure Differential [bar] | | | TS [°C] | | PS [bar] | Risk Category according to PED (Group 2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | minOPD | MOPD | | min. | max. | | |
| | | | | | | | | | AC | DC | | | | |
| 1145/01E012 | SM2 | EPDM | See Table 2 | G 1/8" | 1.2 | 0.04 | Direct acting | 0 | 25 | 25 | -10 | +140 | 50 | Art. 3.3 |
| 1145/01E015 | | | | | 1.5 | 0.06 | | | 16 | 16 | | | | |
| 1145/01E020 | | | | | 2.0 | 0.09 | | | 12 | 10 | | | | |
| 1145/01E025 | | | | | 2.5 | 0.14 | | | 8 | 5.5 | | | | |
| 1145/01E031 | | | | | 3.1 | 0.19 | | | 5 | 2 | | | | |
| 1145/01E040 | | | | | 4.0 | 0.35 | | | 4 | 1.5 | | | | |
| 1146/01E015 | HM6 | | | | 1.5 | 0.07 | | | 30 | 26 | | | | |
| 1146/01E020 | | | | | 2.0 | 0.10 | | | 22 | 20 | | | | |
| 1146/01E025 | | | | | 2.5 | 0.15 | | | 16 | 14 | | | | |
| 1146/01E035 | | | | | 3.5 | 0.32 | | | 10 | 8 | | | | |
| 1146/02E015 | | | | G 1/4" | 1.5 | 0.07 | | | 30 | 26 | | | | |
| 1146/02E020 | | | | | 2.0 | 0.10 | | | 22 | 20 | | | | |
| 1146/02E025 | | | | | 2.5 | 0.15 | | | 16 | 14 | | | | |
| 1146/02E035 | | | | | 3.5 | 0.32 | | | 10 | 8 | | | | |
| 1146/02E045 | | | | | 4.5 | 0.41 | | | 6.5 | 3.5 | | | | |
| 1146/02E052 | | | | | 5.2 | 0.47 | | | 4 | 1.8 | | | | |
| 1146/02E064 | | | | | 6.4 | 0.64 | | | 3 | 1 | | | | |
| 1123/03E120 | HM6 | | | G 3/8" | 12.0 | 2.00 | Hung diaphragm pilot operated | 0 | 10 | - | | | 25 | |
| 1123/04E120 | | | | G 1/2" | 12.0 | 2.20 | | | 10 | | | | | |
| 1123/06E180 | HM7 | | | G 3/4" | 18.0 | 4.50 | | | 9 | | | | | |
| 1123/08E240 | | | | G 1" | 24.0 | 8.50 | | | 7 | | | | | |
| 1133/03E120 | SM2 | | | G 3/8" | 12.0 | 2.20 | Diaphragm pilot operated | 0.15 | 15 | 15 | | | | |
| 1133/04E120 | | | | G 1/2" | 12.0 | 2.50 | | | 15 | 15 | | | | |
| 1133/06E180 | | | | G 3/4" | 18.0 | 5.50 | | | 13 | 13 | | | | |
| 1133/08E240 | | | | G 1" | 24.0 | 10.20 | | | 10 | 10 | | | | |
| 1133/010E300 | | | | G 1.1/4" | 30.0 | 15.00 | | | 10 | 10 | | | | |
| 1133/010E370 | HM6 | | | | 37.0 | 18.00 | | | 10 | 10 | | | | |
| 1133/012E370 | | | | G 1.1/2" | 37.0 | 21.00 | | | 10 | 10 | | | | |
| 1133/016E500 | | | | G 2" | 50.0 | 36.00 | | | | 10 | | | 20 | |

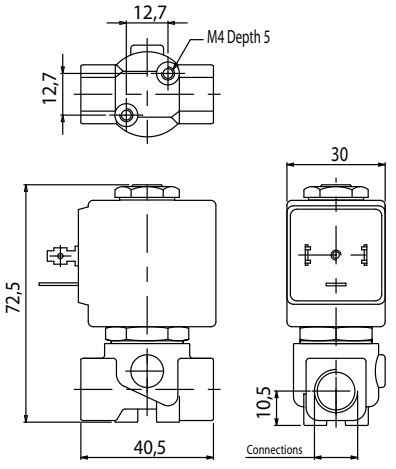
**TABLE 3c: General Characteristics of NC brass valves (normally closed)**

| Catalogue Number | Coil Type | Seal | Media | FPT Female Conn. | Seat Size nominal Ø [mm] | Kv Factor [m3/h] | Operating Principles | Opening Pressure Differential [bar] | | | TS [°C] | | PS [bar] | Risk Category according to PED (Group 2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | minOPD | MOPD | | min. | max. | | |
| | | | | | | | | | AC | DC | | | | |
| 1145/01V012 | SM2 | FPM | See Table 2 | G 1/8 | 1.2 | 0.04 | Direct acting | 0 | 25 | 25 | -10 | +130 | 50 | Art. 3.3 |
| 1145/01V015 | | | | | 1.5 | 0.06 | | | 16 | 16 | | | | |
| 1145/01V020 | | | | | 2.0 | 0.09 | | | 12 | 10 | | | | |
| 1145/01V025 | | | | | 2.5 | 0.14 | | | 8 | 5.5 | | | | |
| 1145/01V031 | | | | | 3.1 | 0.19 | | | 5 | 2 | | | | |
| 1145/01V040 | | | | | 4.0 | 0.35 | | | 4 | 1.5 | | | | |
| 1146/01V015 | HM6 | | | | 1.5 | 0.07 | | | 30 | 26 | | | | |
| 1146/01V020 | | | | | 2.0 | 0.10 | | | 22 | 20 | | | | |
| 1146/01V025 | | | | | 2.5 | 0.15 | | | 16 | 14 | | | | |
| 1146/01V035 | | | | | 3.5 | 0.32 | | | 10 | 8 | | | | |
| 1146/02V015 | | | | G 1/4" | 1.5 | 0.07 | | | 30 | 26 | | | | |
| 1146/02V020 | | | | | 2.0 | 0.10 | | | 22 | 20 | | | | |
| 1146/02V025 | | | | | 2.5 | 0.15 | | | 16 | 14 | | | | |
| 1146/02V035 | | | | | 3.5 | 0.32 | | | 10 | 8 | | | | |
| 1146/02V045 | | | | | 4.5 | 0.41 | | | 6.5 | 3.5 | | | | |
| 1146/02V052 | | | | | 5.2 | 0.47 | | | 4 | 1.8 | | | | |
| 1146/02V064 | | | | | 6.4 | 0.64 | | | 3 | 1 | | | | |
| 1123/03V120 | HM6 | | | G 3/8" | 12.0 | 2.00 | Hung diaphragm pilot operated | 0 | 10 | - | | | 25 | |
| 1123/04V120 | | | | G 1/2" | 12.0 | 2.20 | | | 10 | | | | | |
| 1123/06V180 | HM7 | | | G 3/4" | 18.0 | 4.50 | | | 9 | | | | | |
| 1123/08V240 | | | | G 1" | 24.0 | 8.50 | | | 7 | | | | | |
| 1133/03V120 | SM2 | | | G 3/8" | 12.0 | 2.20 | Diaphragm pilot operated | 0.15 | 15 | 15 | | | | |
| 1133/04V120 | | | | G 1/2" | 12.0 | 2.50 | | | 15 | 15 | | | | |
| 1133/06V180 | | | | G 3/4" | 18.0 | 5.50 | | | 13 | 13 | | | | |
| 1133/08V240 | | | | G 1" | 24.0 | 10.20 | | | 10 | 10 | | | | |
| 1133/010V300 | | | | G 1.1/4" | 30.0 | 15.00 | | | 10 | 10 | | | | |
| 1133/010V370 | HM6 | | | | 37.0 | 18.00 | | | 10 | 10 | | | | |
| 1133/012V370 | | | | G 1.1/2" | 37.0 | 21.00 | | | 10 | 10 | | | | |
| 1133/016V500 | | | | G 2" | 50.0 | 36.00 | | | 10 | 10 | | | 20 | |

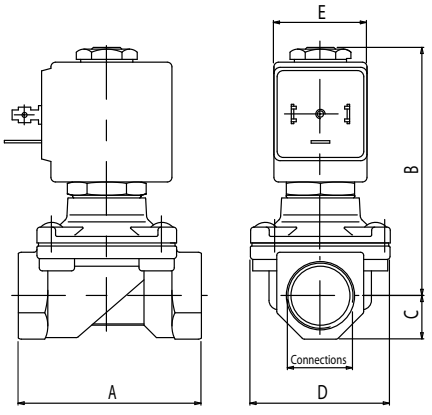
| TABLE 4: Dimensions and Weights of NC brass valves | | | | | | | |
|---|---|---|---|---|---|---|---|
| Catalogue Number | FPT Female Conn. | Dimensions [mm] | | | | | Weight [g] |
| | | A | B | C | D | E | |
| 1145/01 | G 1/8" | | | | | | 130 |
| 1146/01 | | | | | | | 300 |
| 1146/02 | G 1/4" | | | | | | |
| 1123/03_120 | G 3/8" | 59 | 83 | 14 | 45 | 30 | 580 |
| 1123/04_120 | G 1/2" | | | | | | 530 |
| 1123/06_180 | G 3/4" | 79 | 90 | 18 | 55 | 36 | 750 |
| 1123/08_240 | G 1" | 96 | 101 | 20 | 72 | | 1200 |
| 1133/03_120 | G 3/8" | 59 | 70 | 14 | 45 | 22 | 450 |
| 1133/04_120 | G 1/2" | | | | | | |
| 1133/06_180 | G 3/4" | 79 | 74 | 18 | 55 | | 660 |
| 1133/08_240 | G 1" | 96 | 85 | 20 | 72 | | 1050 |
| 1133/010_300 | G 1.1/4" | 119 | 92 | 25 | 85 | | 1800 |
| 1133/010_370 | | 142 | 107 | 28 | 102 | 30 | 3200 |
| 1133/012_370 | G 1.1/2" | | | | | | 2900 |
| 1133/016_500 | G 2" | 158 | 117 | 35 | 119 | | 4500 |
| 1133/020_750 | G 2.1/2" | 226 | 134 | 51 | 169 | | 10000 |
| 1133/024_750 | G 3" | | | | | | 9650 |



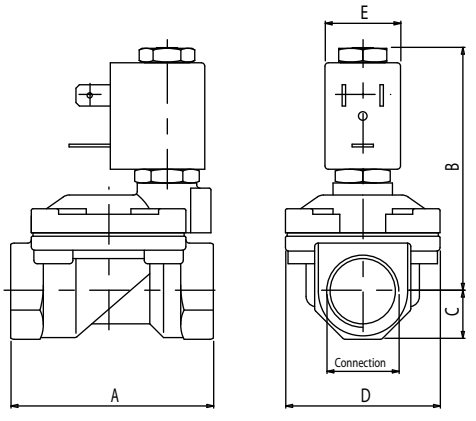

Valve 1145




Valve 1146




Valve 1123




Valve 1133

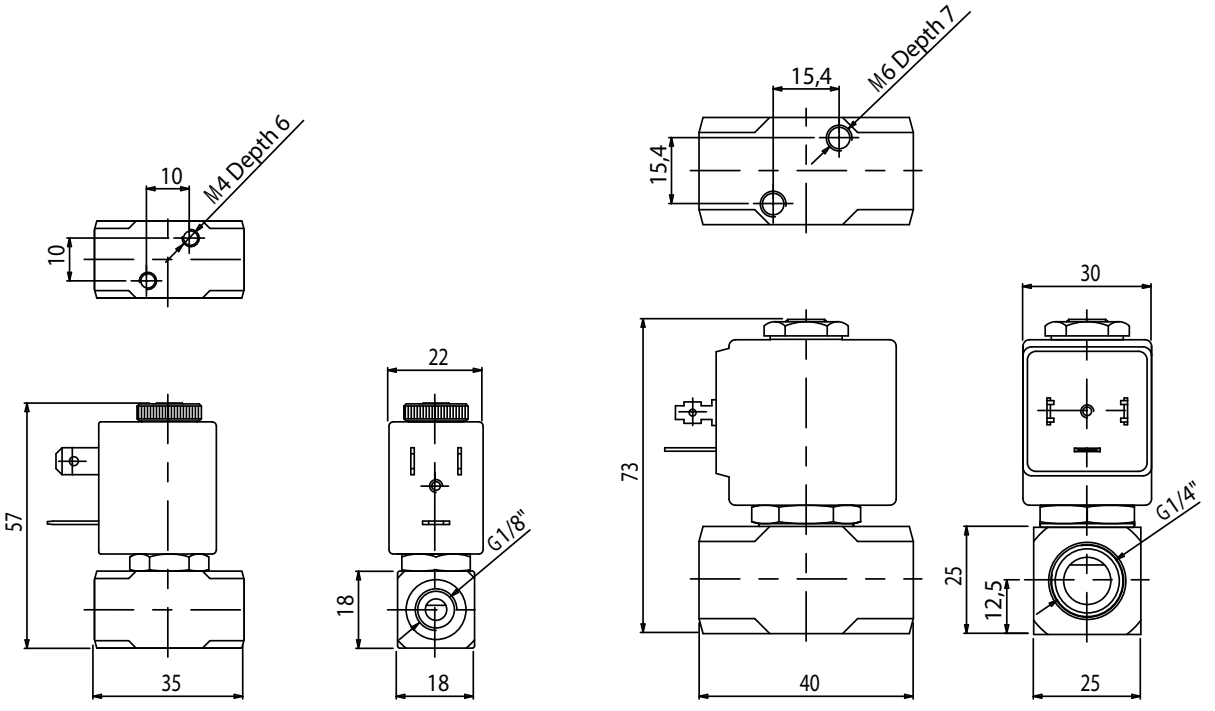
**TABLE 5a: General Characteristics of NC stainless steel valves (normally closed)**

| Catalogue Number | Coil Type | Seal | Media | FPT Female Conn. | Seat Size nominal Ø [mm] | Kv Factor [m³/h] | Operating Principles | Opening Pressure Differential [bar] | | | TS [°C] | | PS [bar] | Risk Category according to PED (Group 2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | minOPD | MOPD | | min. | max. | | |
| | | | | | | | | | AC | DC | | | | |
| 1245/01N012 | SM2 | NBR | See Table 2 | G 1/8" | 1.2 | 0.04 | Direct acting | 0 | 25 | 25 | -10 | +90 | 50 | Art. 3.3 |
| 1245/01N015 | | | | | 1.5 | 0.06 | | | 16 | 16 | | | | |
| 1245/01N020 | | | | | 2.0 | 0.09 | | | 12 | 10 | | | | |
| 1245/01N025 | | | | | 2.5 | 0.14 | | | 8 | 5.5 | | | | |
| 1245/01N031 | | | | | 3.1 | 0.19 | | | 5 | 2 | | | | |
| 1246/02N020 | HM6 | | | G 1/4" | 2.0 | 0.10 | | | 22 | 20 | | | 100 | |
| 1246/02N025 | | | | | 2.5 | 0.15 | | | 16 | 14 | | | | |
| 1246/02N035 | | | | | 3.5 | 0.32 | | | 10 | 8 | | | | |
| 1246/02N045 | | | | | 4.5 | 0.41 | | | 6.5 | 3.5 | | | | |
| 1246/02N052 | | | | | 5.2 | 0.47 | | | 4 | 1.8 | | | | |
| 1233/03N120 | SM2 | | | G 3/8" | 12.0 | 2.20 | Diaphragm pilot operated | 0.15 | 15 | 15 | | | 25 | |
| 1233/04N120 | | | | G 1/2" | 12.0 | 2.50 | | | 15 | 15 | | | | |
| 1233/06N180 | | | | G 3/4" | 18.0 | 5.50 | | | 13 | 13 | | | | |
| 1233/08N240 | | | | G 1" | 24.0 | 10.20 | | | | 10 | | | | |

**TABLE 5b: General Characteristics of NC stainless steel valves (normally closed)**

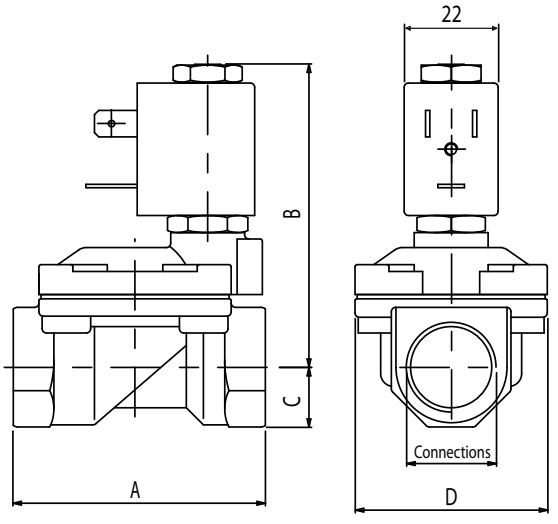
| Catalogue Number | Coil Type | Seal | Media | FPT Female Conn. | Seat Size nominal Ø [mm] | Kv Factor [m³/h] | Operating Principles | Opening Pressure Differential [bar] | | | TS [°C] | | PS [bar] | Risk Category according to PED (Group 2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | minOPD | MOPD | | min. | max. | | |
| | | | | | | | | | AC | DC | | | | |
| 1245/01V012 | SM2 | NBR | See Table 2 | G 1/8" | 1.2 | 0.04 | Direct acting | 0 | 25 | 25 | -10 | +90 | 50 | Art. 3.3 |
| 1245/01V015 | | | | | 1.5 | 0.06 | | | 16 | 16 | | | | |
| 1245/01V020 | | | | | 2.0 | 0.09 | | | 12 | 10 | | | | |
| 1245/01V025 | | | | | 2.5 | 0.14 | | | 8 | 5.5 | | | | |
| 1245/01V031 | | | | | 3.1 | 0.19 | | | 5 | 2 | | | | |
| 1246/02V020 | HM6 | | | G 1/4" | 2.0 | 0.10 | | | 22 | 20 | | | 100 | |
| 1246/02V025 | | | | | 2.5 | 0.15 | | | 16 | 14 | | | | |
| 1246/02V035 | | | | | 3.5 | 0.32 | | | 10 | 8 | | | | |
| 1246/02V045 | | | | | 4.5 | 0.41 | | | 6.5 | 3.5 | | | | |
| 1246/02V052 | | | | | 5.2 | 0.47 | | | 4 | 1.8 | | | | |
| 1233/03V120 | SM2 | | | G 3/8" | 12.0 | 2.20 | Diaphragm pilot operated | 0.15 | 15 | 15 | | | 25 | |
| 1233/04V120 | | | | G 1/2" | 12.0 | 2.50 | | | 15 | 15 | | | | |
| 1233/06V180 | | | | G 3/4" | 18.0 | 5.50 | | | 13 | 13 | | | | |
| 1233/08V240 | | | | G 1" | 24.0 | 10.20 | | | | 10 | | | | |

| TABLE 6: Dimensions and Weights of NC stainless steel valves | | | | | | |
|---|---|---|---|---|---|---|
| Catalogue Number | FPT Female Conn. | Dimensions [mm] | | | | Weight [g] |
| | | A | B | C | D | |
| 1245/01 | G 1/8" | | | | | 150 |
| 1246/02 | G 1/4" | | | | | 360 |
| 1233/03_120 | G 3/8" | 59 | 70 | 14 | 45 | 510 |
| 1233/04_120 | G 1/2" | | | | | |
| 1233/06_180 | G 3/4" | 79 | 74 | 18 | 55 | 750 |
| 1233/08_240 | G 1" | 96 | 85 | 20 | 72 | 1350 |




Valve 1245

Valve 1246




Valve 1233

# NORMALLY OPEN SOLENOID VALVES

## 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 using:
- with fluids in 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 liquid state proper to the Group I (as defined in Article 9, Section 2.1 of Directive 97/23/EC and referred to in Directive 67/548/EEC).

## OPERATION

Solenoid valves series 1135, 1136 and 1143 are normally open valves.
NA = 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.
Castel puts at disposal of its own customers only normally open valves with brass bodies.

Valves series 1135, 1136 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.

Valves series 1143 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.

All the normally open valves shown in this chapter are supplied either without coil (S type) or with coil (example: A6 type with coil SM2–220 VAC).

## CONSTRUCTION

The main parts of normally open solenoid valves are made with the following materials:
- Hot forged brass for body and cover
- Austenitic stainless steel, or alternatively brass, for enclosure where the plunger moves ( depending of valve model)
- Ferritic stainless steel for plunger
- Acrylonitrile butadiene rubber (NBR) or ethylene-propylene rubber (EPDM) or fluorocarbon rubber (FPM) for outlet seal gaskets and diaphragms

The choice of materials for bodies, gaskets and diaphragms depends on the application where the valves are used. On this subject see "TABLE 2a" for the characteristics of gaskets/diaphragm materials and "TABLE 2b" for the compatibility of materials versus different fluids.

Valve 1143


■ Valve 1136

**TABLE 7a: General Characteristics of NO brass valves (normally open)**

| Catalogue Number | Coil Type | Seal | Media | FPT Female Conn. | Seat Size nominal Ø [mm] | Kv Factor [$m^3/h$] | Operating Principles | Opening Pressure Differential [bar] | | | TS [°C] | | PS [bar] | Risk Category according to PED (Group 2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | minOPD | MOPD | | min. | max. | | |
| | | | | | | | | | AC | DC | | | | |
| 1135/01N015 | SM2 | NBR | See Table 2 | G 1/8" | 1.5 | 0.06 | Direct acting | 0 | 14 | 14 | -10 | +90 | 50 | Art. 3.3 |
| 1135/01N020 | | | | | 2.0 | 0.09 | | | 9 | 9 | | | | |
| 1136/01N015 | HM6 | | | | 1.5 | 0.07 | | | 23 | 23 | | | | |
| 1136/01N020 | | | | | 2.0 | 0.10 | | | 17 | 17 | | | | |
| 1136/02N025 | | | | G 1/4" | 2.5 | 0.15 | | | 12 | 12 | | | | |
| 1136/02N035 | | | | | 3.5 | 0.32 | | | 7 | 4 | | | | |
| 1136/02N045 | | | | | 4.5 | 0.41 | | | 4.5 | 3 | | | | |
| 1143/03N120 | SM2 | | | G 3/8" | 12.0 | 2.20 | Diaphragm pilot operated | 0.15 | 15 | 15 | | | 25 | |
| 1143/04N120 | | | | G 1/2" | 12.0 | 2.50 | | | 15 | 15 | | | | |
| 1143/06N180 | | | | G 3/4" | 18.0 | 5.50 | | | 13 | 13 | | | | |
| 1143/08N240 | | | | G 1" | 24.0 | 10.20 | | | 10 | 10 | | | | |
| 1143/010N300 | | | | G 1.1/4" | 30.0 | 15.00 | | | 10 | 10 | | | | |
| 1143/010N370 | HM6 | | | | 37.0 | 18.00 | | | 10 | 10 | | | | |
| 1143/012N370 | | | | G 1.1/2" | 37.0 | 21.00 | | | 10 | 10 | | | | |
| 1143/016N500 | | | | G 2" | 50.0 | 36.00 | | | 10 | 10 | | | 20 | |
| 1143/020N750 | | | Water | G 2.1/2" | 75.0 | 75.00 | | 0.30 | 10 | 10 | | | | |
| 1143/024N750 | | | | | 75.0 | 84.00 | | | | 10 | | | | |

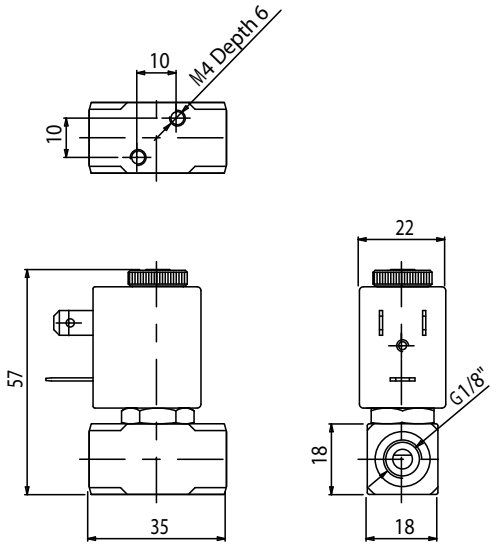
**TABLE 7b: General Characteristics of NO brass valves (normally open)**

| Catalogue Number | Coil Type | Seal | Media | FPT Female Conn. | Seat Size nominal Ø [mm] | Kv Factor [$m^3/h$] | Operating Principles | Opening Pressure Differential [bar] | | | TS [°C] | | PS [bar] | Risk Category according to PED (Group 2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | minOPD | MOPD | | min. | max. | | |
| | | | | | | | | | AC | DC | | | | |
| 1135/01E015 | SM2 | EPDM | See Table 2 | G 1/8" | 1.5 | 0.06 | Direct acting | 0 | 14 | 14 | -10 | +140 | 50 | Art. 3.3 |
| 1135/01E020 | | | | | 2.0 | 0.09 | | | 9 | 9 | | | | |
| 1136/01E015 | HM6 | | | | 1.5 | 0.07 | | | 23 | 23 | | | | |
| 1136/01E020 | | | | | 2.0 | 0.10 | | | 17 | 17 | | | | |
| 1136/02E025 | | | | G 1/4" | 2.5 | 0.15 | | | 12 | 12 | | | | |
| 1136/02E035 | | | | | 3.5 | 0.32 | | | 7 | 4 | | | | |
| 1136/02E045 | | | | | 4.5 | 0.41 | | | 4.5 | 3 | | | | |
| 1143/03E120 | SM2 | | | G 3/8" | 12.0 | 2.20 | Diaphragm pilot operated | 0.15 | 15 | 15 | | | 25 | |
| 1143/04E120 | | | | G 1/2" | 12.0 | 2.50 | | | 15 | 15 | | | | |
| 1143/06E180 | | | | G 3/4" | 18.0 | 5.50 | | | 13 | 13 | | | | |
| 1143/08E240 | | | | G 1" | 24.0 | 10.20 | | | 10 | 10 | | | | |
| 1143/010E300 | | | | G 1.1/4" | 30.0 | 15.00 | | | 10 | 10 | | | | |
| 1143/010E370 | HM6 | | | | 37.0 | 18.00 | | | 10 | 10 | | | | |
| 1143/012E370 | | | | G 1.1/2" | 37.0 | 21.00 | | | 10 | 10 | | | | |
| 1143/016E500 | | | | G 2" | 50.0 | 36.00 | | | | 10 | | | 20 | |

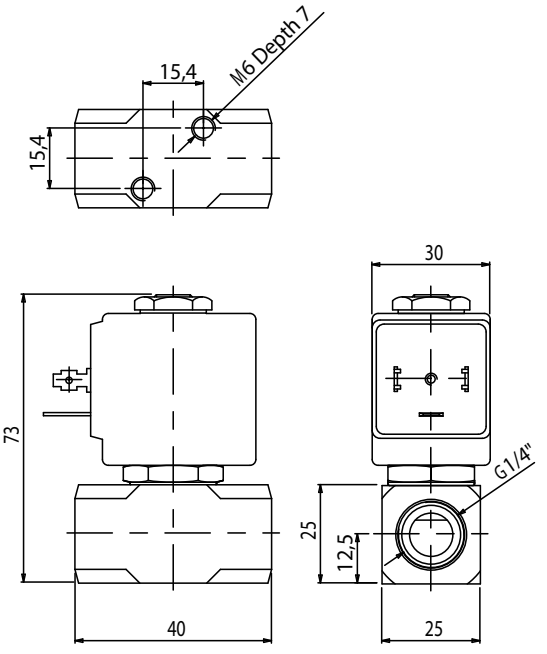
**TABLE 7c: General Characteristics of NO brass valves (normally open)**

| Catalogue Number | Coil Type | Seal | Media | FPT Female Conn. | Seat Size nominal Ø [mm] | Kv Factor [$m^3/h$] | Operating Principles | Opening Pressure Differential [bar] | | | TS [°C] | | PS [bar] | Risk Category according to PED (Group 2) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | minOPD | MOPD | | min. | max. | | |
| | | | | | | | | | AC | DC | | | | |
| 1135/01V015 | SM2 | FPM | See Table 2 | G 1/8" | 1.5 | 0.06 | Direct acting | 0 | 14 | 14 | -10 | +130 | 50 | Art. 3.3 |
| 1135/01V020 | | | | | 2.0 | 0.09 | | | 9 | 9 | | | | |
| 1136/01V015 | HM6 | | | | 1.5 | 0.07 | | | 23 | 23 | | | | |
| 1136/01V020 | | | | | 2.0 | 0.10 | | | 17 | 17 | | | | |
| 1136/02V025 | | | | G 1/4" | 2.5 | 0.15 | | | 12 | 12 | | | | |
| 1136/02V035 | | | | | 3.5 | 0.32 | | | 7 | 4 | | | | |
| 1136/02V045 | | | | | 4.5 | 0.41 | | | 4.5 | 3 | | | | |
| 1143/03V120 | SM2 | | | G 3/8" | 12.0 | 2.20 | Diaphragm pilot operated | 0.15 | 15 | 15 | | | 25 | |
| 1143/04V120 | | | | G 1/2" | 12.0 | 2.50 | | | 15 | 15 | | | | |
| 1143/06V180 | | | | G 3/4" | 18.0 | 5.50 | | | 13 | 13 | | | | |
| 1143/08V240 | | | | G 1" | 24.0 | 10.20 | | | 10 | 10 | | | | |
| 1143/010V300 | | | | G 1.1/4" | 30.0 | 15.00 | | | 10 | 10 | | | | |
| 1143/010V370 | HM6 | | | | 37.0 | 18.00 | | | 10 | 10 | | | | |
| 1143/012V370 | | | | G 1.1/2" | 37.0 | 21.00 | | | 10 | 10 | | | | |
| 1143/016V500 | | | | G 2" | 50.0 | 36.00 | | | 10 | 10 | | | 20 | |

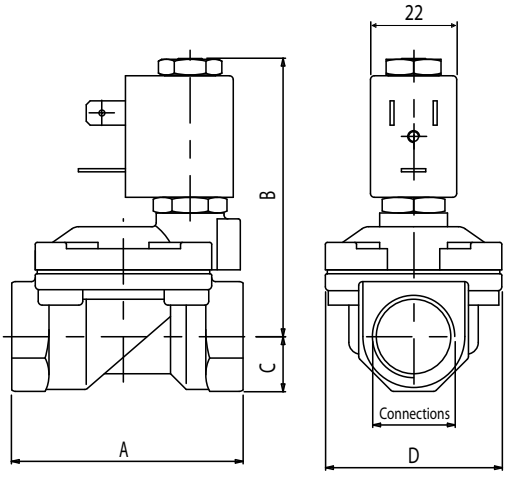
| TABLE 8: Dimensions and Weights of NA brass valves | | | | | | | |
|---|---|---|---|---|---|---|---|
| Catalogue Number | FPT Female Conn. | Dimensions [mm] | | | | | Weight [g] |
| | | A | B | C | D | E | |
| 1135/01 | G 1/8" | | | | | | 130 |
| 1136/01 | | | | | | | 300 |
| 1136/02 | G 1/4" | | | | | | |
| 1143/03_120 | G 3/8" | 59 | 73 | 14 | 45 | 22 | 450 |
| 1143/04_120 | G 1/2" | | | | | | |
| 1143/06_180 | G 3/4" | 79 | 75 | 18 | 55 | | 660 |
| 1143/08_240 | G 1" | 96 | 85 | 20 | 72 | | 1050 |
| 1143/010_300 | G 1.1/4" | 119 | 96 | 25 | 85 | | 1800 |
| 1143/010_370 | | 142 | 105 | 28 | 102 | 30 | 3200 |
| 1143/012_370 | G 1.1/2" | | | | | | 2900 |
| 1143/016_500 | G 2" | 158 | 119 | 35 | 119 | | 4500 |
| 1143/020_750 | G 2.1/2" | 226 | 135 | 51 | 169 | | 10000 |
| 1143/024_750 | G 3" | | | | | | 9650 |




valve 1135




valve 1136




valve 1143

## CAPACITY CALCULATION

With the Kv factors, listed for normally closed valves on "TABLES 3a/b/c and 5a/b" and for normally open valves on "TABLES 7a/b/c" , it's 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/dm³ the formula become

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

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

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

if

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

If gas is air at 20 °C and density ρ equal to 1,29 Kg/dm³ the formulas becomes:
if

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

if

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

With the following formulas it's possible to calculate the vapour mass flow:
if

$$\Delta p < \frac{p_1}{2} \qquad G = 31{,}6 \times Kv \times \sqrt{\frac{\Delta p}{v_2}}$$

if

$$\Delta p > \frac{p_1}{2} \qquad G = 31{,}6 \times Kv \times \sqrt{\frac{p_1}{2 \times v^*}}$$

where:

Kv = valve Kv factor [m³/h]
Q = volumetric capacity for a liquid [m³/h]
$Q_n$ = "normal" volumetric capacity for a gas at 0 °C e 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/dm³]
ρn = "normal" gas density at 0 °C e 760 mm Hg [Kg/$m_n^3$]
G = vapour mass flow [Kg/h]
$V_2$ = vapour specific volume at $p_2$ and $t_1$ [m³/Kg].
See "TABLE 9".
V* = vapour specific volume at $p_1/2$ and $t_1$ [m³/Kg].
See "TABLE 9".

Entering the following data: in "TABLE 10"
- $p_1$ = absolute pressure upstream the valve [bar abs]
- Δp = pressure drop through the valve [bar]

It's 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 m³/h

Using example of "TABLE 10": Select the valve suitable for use with approximately 200 m³/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 m³/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 m³/h is the kv value required in the case under consideration. In "TABLE 3/5/7": 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.

**TABLE 9: Steam characteristics**

| Relative Pressure [bar] | Absolute Pressure [bar] | Temperature [°C] | Steam specific volume [m³/kg] |
|---|---|---|---|
| --- | 0.050 | 32.88 | 28.192 |
| --- | 0.500 | 81.33 | 3.240 |
| 0.00 | 1.013 | 100.00 | 1.673 |
| 0.10 | 1.113 | 102.66 | 1.533 |
| 0.20 | 1.213 | 105.10 | 1.414 |
| 0.35 | 1.363 | 108.50 | 1.268 |
| 0.50 | 1.513 | 111.61 | 1.149 |
| 0.70 | 1.713 | 115.40 | 1.024 |
| 1.00 | 2.013 | 120.42 | 0.881 |
| 1.50 | 2.513 | 127.62 | 0.714 |
| 2.00 | 3.013 | 133.69 | 0.603 |
| 2.50 | 3.513 | 139.02 | 0.522 |
| 3.00 | 4.013 | 143.75 | 0.461 |
| 3.50 | 4.513 | 148.02 | 0.413 |
| 4.00 | 5.013 | 151.96 | 0.374 |
| 4.50 | 5.513 | 155.55 | 0.342 |
| 5.00 | 6.013 | 158.92 | 0.315 |
| 6.00 | 7.013 | 165.04 | 0.272 |
| 7.00 | 8.013 | 170.50 | 0.240 |
| 8.00 | 9.013 | 175.43 | 0.215 |
| 9.00 | 10.013 | 179.97 | 0.194 |
| 10.00 | 11.013 | 184.13 | 0.177 |

**TABLE 10 - 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 |
| 0.003 | | | | | | | | | | | | | | | | | | | | | 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 $m^3/h$

## 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 (direct acting types with 1/8", 1/4", 3/8",1/2" connections).

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. The coil fixing nut should not be over tightened, don't exceed a torque more than 1.5Nm.

## VISCOSITY

The values of MOPD, maximum opening pressure differential, specified in TABLES 3a/b/c and 5a/b, for normally closed valves, and in TABLES 7a/b/c, for normally open valves, are suitable for fluids with maximum cinematic viscosity of 25 cSt, where

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

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

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

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

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

where:
$\nu$ = cinematic viscosity [cSt]
$\mu$ = dynamic viscosity [cP]
$\rho$ = volumetric mass of the fluid at the considered temperature [kg/$dm^3$]

"TABLE 11" 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.

**TABLE 11: Viscosity equivalence**

| Cinematic Viscosity [cSt] o [$mm^2$/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 |

## OPENING/CLOSING RESPONSE TIMES

The Response time of a solenoid valve, normally closed or normally open, is the elapse period between the electric supply (or electrical disconnection) of the coil and the moment where the outlet pressure reach the 50% of the maximum value.
The response time depends from the type of valve, from nature of the media, from the pressure and from the current (AC or DC), if it's considered the moment of electrical connection or disconnection. "TABLE 12" shows the opening and closing approximate times for different types of valves, checked with air. On the bigger pilot operated models either closing times or opening times can be modified/prolonged to avoid the "water hammer" phenomena in piping that can causes serious damages in a system.

**TABLE 12: opening/closing response times**

| VALVE TYPE | Tr (ms) With air P=6 bar | | NOTE |
|---|---|---|---|
| | Opening | Closing | |
| 2 and 3 ways NC direct acting | 8 | 25 | With liquids from + 50% up to + 150% on depending of viscosity |
| 2 and 3 ways NO direct acting | 25 | 8 | |
| NC pilot operated | | | |
| G3/8 and G1/2 | 30 | 50 | |
| G3/4 and G1 | 50 | 70 | |
| NO pilot operated | | | |
| G3/8 and G1/2 | 50 | 30 | |
| G3/4 and G1 | 70 | 50 | |
| pilot operated G1"1/4 -1"1/2 - G2" | Adjustable time | | |
| pilot operated G2"1/2 - G3" | Adjustable time with calibrated orifice | | |

# COILS

## APPLICATION

For the normally closed and normally open solenoid valves, previously shown in this Handbook, Castel puts the following types of coils at disposal of its own customers:

- coils series SM2 with hole for plunger enclosure Ø 10,2 mm and "industrial form" junction box according to EN 175301-803 Standard. (catalogue numbers 9200 - 9202)
- coils series HM5 with hole for plunger enclosure Ø 10,2 mm and "A-ISO 4400" junction box according to EN 175301-803 Standard. (catalogue numbers 9210 - 9212)
- coils series HM6 with hole for plunger enclosure Ø 13,2 mm and "A-ISO 4400" junction box according to EN 175301-803 Standard. (catalogue numbers 9220 - 9222)
- coils series HM7 with hole for plunger enclosure Ø 13,2 mm and "A-ISO 4400" junction box according to EN 175301-803 Standard. (catalogue number 9232)

"TABLE 13" shows the code composition of Castel coils for industrial purposes.


■ 9200

## CONSTRUCTION

Coils SM2 (9200), HM5 (9210) and HM6 (9220) 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.
Coils SM2 (9202), HM5 (9212), HM6 (9222) e HM7 (9322) are class H , 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 ºC, 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. The coils are designed for continuous use, the maximum ambient temperature are:

- 50 ºC for class F coils
- 80 ºC for class H coils

Protection against electric contacts is class I for all the coils. Therefore, for safety purposes, coils must be effectively connected to an earth system. The terminals of all the coils consist of two Fast-on line connections plus one Fast-on earth connection.
Coils SM2 must be used with connector type 9149/R01; protection degree guaranteed by this system, coil + connector, is IP65 according to EN 60529
Coils HM5 , HM6 and HM7 may be joined either to connectors type 9150/R01, 9150/R02 or to cabled connectors type 9900/X66 , 9900/X73 , 9900/X55 , 9900/X54; protection degree guaranteed by this system, coil + connector, is IP65 according to EN 60529

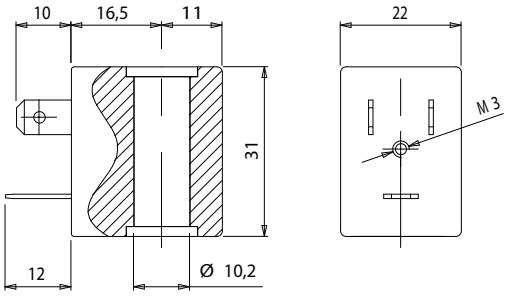

■ 9220

## ELECTRIC TYPE APPROVAL

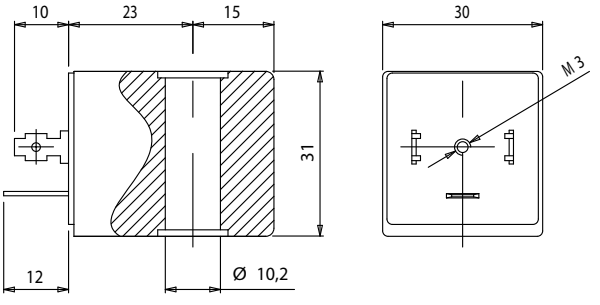
All the coils with 110 VAC , 220/230 VAC and 240 VAC supply are CE marked according to Low Voltage (LV) Directive 2006/95/EC and Electromagnetic Compatibility (EMC) Directive 2004/108/EC. All the coils with 24 VAC supply are CE marked according to Electromagnetic Compatibility (EMC) Directive 2004/108/CE.


■ 9232

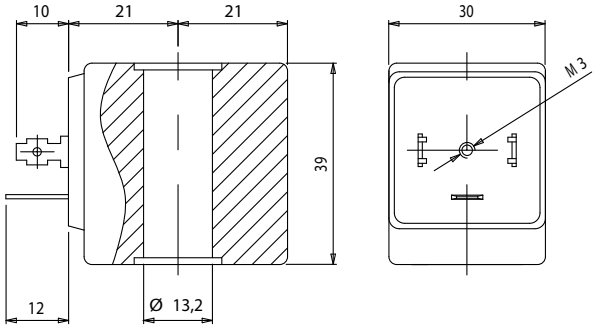
| TABLE 13: coils code composition | | | |
|---|---|---|---|
| Position | Description | Code | Reference |
| 1ª - 2ª | Family | 92 | Coils for industrial purposes |
| 3ª | Size | 0 | Hole for enclosure Ø = 10,2 mm ; H = 31 mm ; Apparent power. = 8 VA |
| | | 1 | Hole for enclosure Ø = 10,2 mm ; H = 31 mm ; Apparent power. = 11 VA |
| | | 2 | Hole for enclosure Ø = 13,2 mm ; H = 39 mm ; Apparent power. = 15 VA |
| | | 3 | Hole for enclosure Ø = 13,2 mm ; H = 39 mm ; Apparent power. = 30 VA |
| 4ª | Insulation | 0 | F Class |
| | | 2 | H Class |
| 5ª | | / | |
| 6ª - 7ª - 8ª | Voltage | RA2 | 24 VAC - 50/60 Hz |
| | | RA4 | 110 VAC - 50/60 Hz |
| | | RA6 | 220/230 VAC - 50/60 Hz |
| | | RA7 | 240 VAC - 50/60 Hz |
| | | RD1 | 12 VDC |
| | | RD2 | 24 VDC |



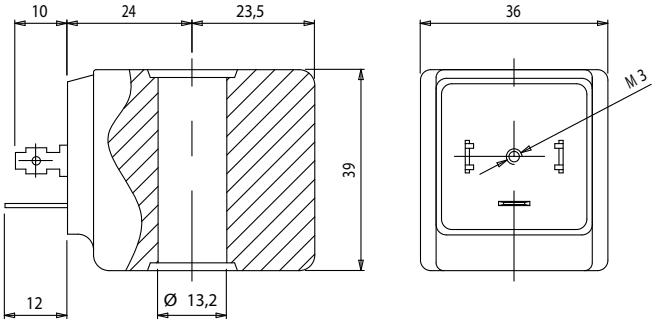

Coil SM2




Coil HM5




Coil HM6




Coil HM7

**TABLE 14: General Characteristics of coils**

| Coil Type | Catalogue Number | Voltage [V] | Apparent power [VA] | Power [W] | Voltage tolerance [%] | Frequecy [Hz] | Insulation class | Connections | Protection Degree |
|---|---|---|---|---|---|---|---|---|---|
| SM2 | 9200/RA2 | 24 A.C. | 8 | - | +15 / -10 | 50 / 60 | F | Junction box EN 175301-803 (ex DIN 43650) Industrial Form | IP65 EN 60529 (with junction box) |
| | 9200/RA4 | 110 A.C. | | | | | | | |
| | 9200/RA6 | 220/230 A.C. | | | | | | | |
| | 9200/RA7 | 240 A.C. | | | | | | | |
| | 9200/RD1 | 12 D.C. | | 6.5 | + / -10 | - | | | |
| | 9200/RD2 | 24 D.C. | | | | | | | |
| | 9202/RA2 | 24 A.C. | 8 | - | +15 / -10 | 50 / 60 | H | | |
| | 9202/RA4 | 110 A.C. | | | | | | | |
| | 9202/RA6 | 220/230 A.C. | | | | | | | |
| | 9202/RA7 | 240 A.C. | | | | | | | |
| | 9202/RD1 | 12 D.C. | - | 6.5 | + / -10 | - | | | |
| | 9202/RD2 | 24 D.C. | | | | | | | |
| HM5 | 9210/RA2 | 24 A.C. | 11 | - | +15 / -10 | 50 / 60 | F | Junction box EN 175301-803 (ex DIN 43650) A-ISO 4400 | |
| | 9210/RA4 | 110 A.C. | | | | | | | |
| | 9210/RA6 | 220/230 A.C. | | | | | | | |
| | 9210/RA7 | 240 A.C. | | | | | | | |
| | 9212/RA2 | 24 A.C. | | | | | H | | |
| | 9212/RA4 | 110 A.C. | | | | | | | |
| | 9212/RA6 | 220/230 A.C. | | | | | | | |
| | 9212/RA7 | 240 A.C. | | | | | | | |
| HM6 | 9220/RA2 | 24 A.C. | 15 | - | +15 / -10 | 50 / 60 | F | | |
| | 9220/RA4 | 110 A.C. | | | | | | | |
| | 9220/RA6 | 220/230 A.C. | | | | | | | |
| | 9220/RA7 | 240 A.C. | | | | | | | |
| | 9220/RD1 | 12 D.C. | - | 10 | + / -10 | - | | | |
| | 9220/RD2 | 24 D.C. | | | | | | | |
| | 9222/RA2 | 24 A.C. | 15 | - | +15 / -10 | 50 / 60 | H | | |
| | 9222/RA4 | 110 A.C. | | | | | | | |
| | 9222/RA6 | 220/230 A.C. | | | | | | | |
| | 9222/RA7 | 240 A.C. | | | | | | | |
| | 9222/RD1 | 12 D.C. | - | 10 | + / -10 | - | | | |
| | 9222/RD2 | 24 D.C. | | | | | | | |
| HM7 | 9232/RA2 | 24 A.C. | 30 | - | +15 / -10 | 50 / 60 | H | | |
| | 9232/RA4 | 110 A.C. | | | | | | | |
| | 9232/RA6 | 220/230 A.C. | | | | | | | |
| | 9232/RA7 | 240 A.C. | | | | | | | |
| | 9232/RD1 | 12 D.C. | - | 27 | + / -10 | - | | | |
| | 9232/RD2 | 24 D.C. | | | | | | | |

**TABLE 15: Coils Consumptions and Weights**

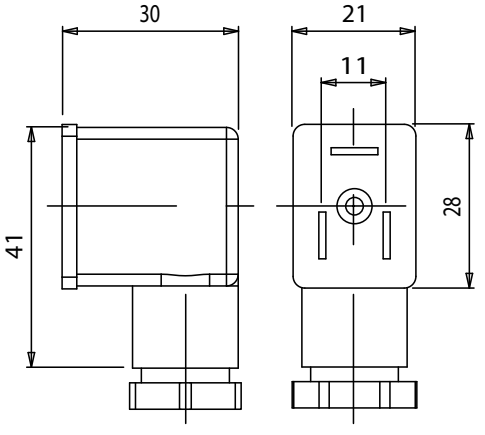
| Coil type | Catalogue Number | Voltage [V] | Consumption at 20 °C [mA] | | | | | | Weight [g] |
|---|---|---|---|---|---|---|---|---|---|
| | | | Start | | | Working | | | |
| | | | 50 [Hz] | 60 [Hz] | D.C. | 50 [Hz] | 60 [Hz] | D.C. | |
| SM2 | 9200/RA2 | 24 A.C. | 0.500 | 0.420 | | 0.330 | 0.277 | | 50 |
| | 9200/RA4 | 110 A.C. | 0.109 | 0.092 | | 0.073 | 0.061 | | |
| | 9200/RA6 | 220/230 A.C. | 0.052 | 0.044 | | 0.035 | 0.029 | | |
| | 9200/RA7 | 240 A.C. | 0.050 | 0.042 | | 0.033 | 0.028 | | |
| | 9200/RD1 | 12 D.C. | | | 0.54 | | | 0.54 | |
| | 9200/RD2 | 24 D.C. | | | 0.27 | | | 0.27 | |
| | 9202/RA2 | 24 A.C. | 0.500 | 0.420 | | 0.330 | 0.277 | | 50 |
| | 9202/RA4 | 110 A.C. | 0.109 | 0.092 | | 0.073 | 0.061 | | |
| | 9202/RA6 | 220/230 A.C. | 0.052 | 0.044 | | 0.035 | 0.029 | | |
| | 9202/RA7 | 240 A.C. | 0.050 | 0.042 | | 0.033 | 0.028 | | |
| | 9202/RD1 | 12 D.C. | | | 0.54 | | | 0.54 | |
| | 9202/RD2 | 24 D.C. | | | 0.27 | | | 0.27 | |
| HM5 | 9210/RA2 | 24 A.C. | 0.625 | 0.525 | | 0.458 | 0.385 | | 100 |
| | 9210/RA4 | 110 A.C. | 0.136 | 0.115 | | 0.100 | 0.084 | | |
| | 9210/RA6 | 220/230 A.C. | 0.065 | 0.055 | | 0.048 | 0.040 | | |
| | 9210/RA7 | 240 A.C. | 0.063 | 0.053 | | 0.046 | 0.039 | | |
| | 9212/RA2 | 24 A.C. | 0.625 | 0.525 | | 0.458 | 0.385 | | 100 |
| | 9212/RA4 | 110 A.C. | 0.136 | 0.115 | | 0.100 | 0.084 | | |
| | 9212/RA6 | 220/230 A.C. | 0.065 | 0.055 | | 0.048 | 0.040 | | |
| | 9212/RA7 | 240 A.C. | 0.063 | 0.053 | | 0.046 | 0.039 | | |
| HM6 | 9220/RA2 | 24 A.C. | 0.833 | 0.700 | | 0.625 | 0.525 | | 120 |
| | 9220/RA4 | 110 A.C. | 0.182 | 0.153 | | 0.136 | 0.115 | | |
| | 9220/RA6 | 220/230 A.C. | 0.087 | 0.073 | | 0.065 | 0.055 | | |
| | 9220/RA7 | 240 A.C. | 0.083 | 0.070 | | 0.063 | 0.053 | | |
| | 9220/RD1 | 12 D.C. | | | 0.86 | | | 0.86 | |
| | 9220/RD2 | 24 D.C. | | | 0.44 | | | 0.44 | |
| | 9222/RA2 | 24 A.C. | 0.833 | 0.700 | | 0.625 | 0.525 | | 120 |
| | 9222/RA4 | 110 A.C. | 0.182 | 0.153 | | 0.136 | 0.115 | | |
| | 9222/RA6 | 220/230 A.C. | 0.087 | 0.073 | | 0.065 | 0.055 | | |
| | 9222/RA7 | 240 A.C. | 0.083 | 0.070 | | 0.063 | 0.053 | | |
| | 9222/RD1 | 12 D.C. | | | 0.86 | | | 0.86 | |
| | 9222/RD2 | 24 D.C. | | | 0.44 | | | 0.44 | |
| HM7 | 9232/RA2 | 24 A.C. | 1.667 | 1.400 | | 1.250 | 1.050 | | 200 |
| | 9232/RA4 | 110 A.C. | 0.364 | 0.305 | | 0.273 | 0.229 | | |
| | 9232/RA6 | 220/230 A.C. | 0.174 | 0.146 | | 0.130 | 0.110 | | |
| | 9232/RA7 | 240 A.C. | 0.167 | 0.140 | | 0.125 | 0.105 | | |
| | 9232/RD1 | 12 D.C. | | | 2.26 | | | 2.26 | |
| | 9232/RD2 | 24 D.C. | | | 1.13 | | | 1.13 | |

## CONNECTORS

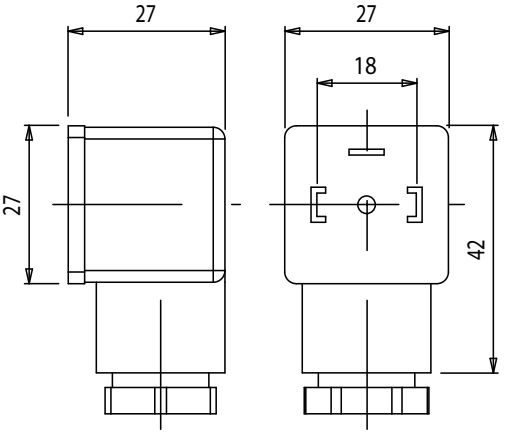
The junction boxes 9149/R01, 9150/R01 and 9150/R02, DIN 43650 standardized, represent an effective system for the connection of the coil to the supply circuit, thus ensuring safety also in the presence of moisture.
Junction box type 9149/R01 with "industrial form" terminal block doesn't allow choosing the position of outer casing compared to inner terminal block. The clamping screw of casing is PG9 which is suitable for cables with an external diameter of 6 ÷ 8.
Junction boxes type 9150 with "A-ISO 4400" terminal block, according to assembly requirements, allow choosing the position of outer casing compared to inner terminal block. The clamping screw of casing may be PG9 or PG11, which are respectively suitable for cables with an external diameter of 6 ÷ 8 or 8 ÷ 10 mm. A cable sized 3 x 0,75 $mm^2$ is to be preferred for all types 9149 and 9150.
The junction boxes type 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.
All Castel junction boxes 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.

**TABLE 16: General Characteristics of connectors**

| Catalogue Number | Pg | Cable length [m] | Cable thickness [$mm^2$] | Standard | Degree of protection | Class of insulation |
|---|---|---|---|---|---|---|
| 9149/R01 | 9 | – | – | Junction box EN 175301-803 (ex DIN 43650) Industrial Form | IP65 EN 60529 | C Group VDE 0110-1/ 89 |
| 9150/R01 | 9 | – | – | Junction box EN 175301-803 (ex DIN 43650) A-ISO 4400 | | |
| 9150/R02 | 11 | | | | | |
| 9900/X66 | – | 1 | 3 x 0,75 | | | |
| 9900/X73 | | 2 | | | | |
| 9900/X55 | | 3 | | | | |
| 9900/X54 | | 5 | | | | |




Connector 9149/R01




Connector 9150/R01

Connector 9149/R01

Connector 9150/R01


Castel

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