

Technical Data

The technical data presented here refer mainly to the ELESAGANTER Standard elements, made of engineering plastics and metal materials.

The main technologies used for the manufacture of plastic products are:

- compression/transfer moulding for Duroplasts
- injection moulding for Technopolymers.

This primary process may be followed by secondary operations such as machining, finishing, assembly, decoration to customize the product (tampoprinting), packaging to guarantee adequate protection during transportation and identification of the product.

1. PLASTICS

DUROPLASTS: Phenolic based (PF) thermosetting plastics that harden during moulding due to irreversible polymerization.

TECHNOPOLYMERS: Thermoplastic polymer materials in which the chemical composition of the molecular chain provides a wide range of mechanical, thermal, and technological properties. The transformation process is based on the melting and subsequent hardening by solidification of the material in the mould. The material itself has a low environmental impact because it can be recycled (reversible solidification).

| The main TECHNOPOLYMERS used by ELESAGANTER | | | | | | |
|--|-------------------------------|--|--------------|-----------------------|-------------------|-------------------------|
| PA | PA-T | PP | POM | PC | PBT | TPE |
| Glass-fibre reinforced polyamide, glass reinforced polyamide, polyamide-based super-polymers | Special transparent polyamide | Glass-fibre reinforced polypropylene or with mineral fillers | Acetal resin | Special polycarbonate | Special polyester | Thermoplastic elastomer |

1.1 Mechanical Strength

DUROPLASTS: The use of a mineral filler and natural textile fibres, and optimum selection of the base resin give this material an excellent mechanical strength and a good impact strength.

TECHNOPOLYMERS: The rich selection of basic polymers available and the possibility of combining these with reinforcing fillers or additives, make a wide range of performance levels possible in terms of mechanical strength, impact strength, creep and fatigue.

For an indication of the mechanical strength of components moulded with the plastics listed above, see chapter 4. *MECHANICAL PROPERTIES OF PLASTIC PRODUCTS*.

1.2 Thermal Resistance



The use of thermosetting materials and reinforced thermoplastic polymers with a high thermal resistance, enables ELESAGANTER to obtain products with great thermal stability and a limited variation in their mechanical properties at both high and low temperatures.

The recommended operating temperature range for each plastic product in this catalogue is indicated by the "Temperature" symbol, which is shown on the left.



Within this temperature range:

- The material is stable and no significant degradation takes place.
- The user does not normally encounter any problems with the basic function of the product.

The mechanical strength, impact strength, maximum torque and maximum working pressure values indicated in the catalogue were obtained from tests carried out under laboratory conditions (23°C - relative humidity of 50%). These values may vary over the working temperature range indicated. Customers are therefore themselves responsible for checking the product's actual performance in their specific thermal working conditions.

A very general indication as to the working temperature range for the various types of plastics is given in the table below:

| | |
|--|--------------------------|
| Duroplasts (PF) | from -20°C to 100°/110°C |
| Special, high-resilience polypropylene-based (PP) technopolymers | from 0°C to 80°/90°C |
| Glass-fibre reinforced polypropylene-based (PP) technopolymers | from 0°C to 100°C |
| Polyamide-based (PA) technopolymers | from -20°C to 90°C |
| Glass-fibre reinforced polyamide-based (PA) technopolymers | from -30°C to 130°/150°C |
| Glass-fibre reinforced polyamide-based (PA) technopolymers for high temperatures | from -30°C to 200°C |

For some types of products with specific functional requirements, narrower operating temperature ranges are recommended.

1.3 Strength and surface hardness

DUROPLAST: The material and its glossy finish enables the surfaces to be kept in perfect condition, even after prolonged use in the presence of metal machining residues or in abrasive environments like those, for example, of metal machining applications with machine tools.

TECHNOPOLYMER: The surface hardness values are lower than those of Duroplast, but are still within the 60-98 Rockwell range, M scale. Technopolymers are however tougher and have a greater impact strength than Duroplasts.

1.4 Resistance to chemical agents

Some of the tables in Chapter 12 describe the resistance of the plastics used for ELESAGANTER products at an ambient temperature of 23°C, in the presence of the various chemical agents they may come into contact with in an industrial environment (acids, bases, solvents, lubricants, fuels, and aqueous solutions).

The tables on page A24, A25 and A28 indicate 3 classes of resistance:

- Good resistance = the product's functional and aesthetic properties remain unchanged.
- Fair resistance = the functional and/or aesthetic properties are affected to a degree that depends on the type of product and the working conditions. Some limitations in specific applications.
- Poor resistance = product susceptible to chemical aggression. Not recommended for use.

As a general rule, chemical resistance decreases as the working temperature and mechanical stresses to which the product is subjected increase.

Testing of the product's resistance to chemical agents is essential for use in the presence of high temperatures and high levels of mechanical stress.

1.5 Resistance to atmospheric agents and UV rays



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4

Technical data

In most cases, ELESAGANTER plastic standards are used for indoor applications. In any case, due to the properties of the materials and the measures taken during the design stage, these products may also be used for outdoor applications, where they are exposed to various atmospheric agents.

- **Rapid changes in temperature:** within the working temperature range recommended for each product, rapid changes in temperature do not create problems due to the impact strength of the materials used.

- **The presence of water or moisture** may result in processes of hydrolysis and the absorption of a certain percentage of the water/moisture until a state of equilibrium is reached. This may alter some of the material's mechanical properties. Examples of materials that absorb water include polyamides (PA), transparent polyamides (PA-T, and PA-T AR) and duroplasts (PF). Products made of these materials may undergo slight changes in size due to the absorption of water, which may affect dimensional tolerances. During the design stage, ELESAGANTER normally takes these possible variations into account in order to minimise their effects and to guarantee compliance with the technical specifications. The absorption of water results in a significant increase in impact strength.

The following polymers do not absorb water: polypropylene (PP), thermoplastic elastomers (TPE), and acetal resin (POM).

Occasional contact with rainwater followed by "drying" does not generally pose any problems in terms of the strength of the product.

When used in outdoor applications, it is advisable to prevent water accumulating on the product by installing in such a way that water runs off it quickly.

- **Exposure to the sunlight and UV rays** in particular. Specific resistance tests have been carried out using specific equipment for accelerated ageing testing, in accordance with the ISO 4892-2 standard, and setting the following parameters:
 - Radiation power: 550 [W]/[m]²
 - Internal temperature (Black Standard Temperature, BST): 65°C
 - OUTDOOR filter that simulates exposure to the open air, with low shielding against UV rays.
 - Relative humidity: 50%.

The relation between the hours of testing and the hours of actual exposure to an outdoor environment ("Equivalent Hours") obviously depends on the weather conditions of each geographic area. Taking the Average Radiant Exposure per Day (ARED) as a basis for comparison, the reference values adopted on an international scale include:

- Miami Equivalent Hours = high intensity exposure, typical of countries with a tropical or equatorial climate (ARED = 9.2 MJ/m²)
- Central Europe Equivalent Hours = mean intensity of exposure, typical of continental climates (ARED = 2 MJ/m²).

At the end of prolonged tests carried out at the ELESAGANTER laboratories, the variation in mechanical strength was measured (tensile/compression breaking, and impact breaking) was measured.

In general, the results show that the mechanical strength of polyamide (PA), polypropylene (PP) and Duroplast (PF) products is not significantly reduced by exposure to UV rays.

As to the **aesthetic appearance** of samples exposed to the action of the UV rays, in some cases a slight variation in the surface appearance of the product was found, on completion of the tests. For further details on UV ageing tests on specific products, contact the ELESAGANTER Technical Department.



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1.6 Flame resistance

The universally recognised classification used to describe the reaction of plastics to flames is obtained from two tests defined by UL (Underwriters Laboratories, USA). These tests are called UL-94 HB and UL-94 V, which define four main types of reaction to flames: HB, V2, V1 and V0 with progressively increasing levels of flame resistance.

UL-94 HB (Horizontal Burning)

The test consists of putting a set of three standardized samples of the plastic (in a horizontal position set at an angle of 45° with respect to their own axis) each one in contact for 30 seconds with a flame applied at their bottom free edge. Two marks are present on the samples at standardized distances from the free end.

A material may be classified HB if, for each of the three samples, the following conditions are applicable:

- the speed of burning between the two marks does not exceed a given standardized value that depends on the thickness of the samples being tested
- the flame is extinguished before the fire reaches the furthest mark from the free edge (that is, from the point of application of the flame).

UL-94 V (Vertical Burning)

The test entails putting a set of five standardised samples of the plastic (in a vertical position) into contact each one twice for 10 seconds with a flame applied at their bottom free edge. A sheet of cotton wool is placed underneath the samples. The following parameters are measured:

- the time required to extinguish each individual sample each time the flame is applied
- the sum of times required to extinguish the five samples (considering both flame applications specified)
- the post-incandescence time of each individual sample after the second flame application
- whether any material drips from the sample onto the cotton wool set underneath it with a risk of igniting it.

| UL Classification of plastics | | | | |
|-------------------------------|--|---------|---------|--------|
| UL-94 HB | For each of the three samples, the speed of combustion between the two marks does not exceed the standardized speed that depends on the thickness of the samples | | | |
| | For each of the three samples, the flame is extinguished before it reaches the further mark from the point of application of the flame | | | |
| UL-94 V | | V2 | V1 | V0 |
| | Time required to extinguish each individual sample after each flame application | ≤ 30 s | ≤ 30 s | ≤ 10 s |
| | Sum of times required to extinguish the five samples (considering both flame applications specified) | ≤ 250 s | ≤ 250 s | ≤ 50 s |
| | Post-incandescence time of each individual sample after the second flame application | ≤ 60 s | ≤ 60 s | ≤ 30 s |
| | Presence of any material dripping from the sample onto the cotton wool beneath it with the risk of igniting it | YES | NO | NO |

The variables that determine the reaction to the flame include the thickness of the samples and the colouring of the material (in fact, there may be differences between materials with their natural colour and those with an artificial colour and differences depending on the variation in thickness of the sample with the same colour).

Yellow Card: This is a document issued by the Underwriters Laboratories that certifies the reaction of a plastic to flames, following laboratory testing. This constitutes an official recognition of the product's flame resistance.

The "Yellow Card" indicates the trade name of the product, the manufacturer and related ID number, known as a UL File Number. The flame resistance is certified for specific material thickness and colour.

Some material manufacturers carry out flame resistance tests in independent laboratories, using the same test methods as the Underwriters Laboratories. In such cases, a declaration of conformity but no "Yellow Card" is issued by the manufacturer.



There are groups of ELESAGANTER standards with UL-94 V0 classification, identified as AE-V0 by the symbol shown to the left.

Most of the other ELESAGANTER products for which no specific indication is given in this regard belong to the UL94-HB category.

ELESAGANTER products identified as AE-V0 are made of environment-friendly plastics and are free of PBB (Polybromine Biphenyl), PBDE (Polybrominatediphenyl Ether) and in particular of Penta-BDE (Pentabromodiphenyl Ether) and of Octa-BDE (Octabromodiphenyl Ether).

1.7 Electrical properties

Plastics are generally good electrical insulators. This is particularly useful in certain applications in the electromechanical field, making plastic products preferable to similar metal products.

The extent of a material's insulating properties is determined by:

- Its surface resistivity
- Its volume resistivity

The table below classifies the materials on the basis of their surface resistivity [Ω].

| Conductive material | Semi-conductive material | Dissipative material | Anti-static material | Insulating material |
|---------------------|--------------------------|----------------------|----------------------|---------------------|
| $10^{-1} \Omega$ | $10^5 \Omega$ | $10^9 \Omega$ | $10^{12} \Omega$ | $>10^{12} \Omega$ |

Where specific resistivity characteristics (ESD - Electro-Static Discharge applications, conductive products, anti-static products) are required, contact the ELESAGANTER Technical Department, who are specialized in designing specific customized solutions.

Typical values for a few of the plastics used by ELESAGANTER are:

| Material | Property | State of material | Measuring Method | Value |
|--------------------------|---------------------|-----------------------------|------------------|----------------------------------|
| PA 30% Glass-fibre | Surface resistivity | Dry | IEC93, 23°C | $10^{13} \Omega$ |
| | | Conditioned (50% RH equil.) | | $10^{11} \Omega$ |
| | Volume resistivity | Dry | | $10^{15} \Omega \cdot \text{cm}$ |
| | | Conditioned (50% RH equil.) | | $10^{11} \Omega \cdot \text{cm}$ |
| PP 20% mineral filler | Surface resistivity | Conditioned (50% RH equil.) | ASTM D257 | $10^{13} \Omega$ |

1.8 Surface Finish and Cleanability

When moulding technopolymers, it is technically easier to make products with a rough matte surface finish, which hides any aesthetic defects such as shrinkage cavities, flow marks, or joining marks caused by non-optimum moulding processes.

However, a rough matte finish makes it more difficult to clean and handle the component after prolonged use. ELESAGANTER technopolymer standards have a very fine matte finish so that the product remains easy to clean in time, and is easier to handle for the user. Some groups of technopolymer products have recently been developed with a completely glossy finish, so that they remain clean for a long time.

1.9 Compliance with International Standards

Over the past few years, the national and international regulatory authorities have laid down a series of regulations for the control of substances that are harmful to man or the environment and for the environment safety management in the industrial field.

The ELESAGANTER Technical Department is able to give any kind of assistance also providing any technical information required on the following International Standards:

- European Directive 2000/53/CE, also known as the ELV (End Life of Vehicles) directive, which is applicable to the automotive. This provides for a gradual reduction in the quantity of heavy metals (Pb, Cd, Hg, and Cr6) present in vehicles.
- European Directive 2002/95/CE, also known as the RoHS, Restriction of Hazardous Substances, directive, which is applicable to the field of electrical and electronic equipment. This provides for a gradual reduction in the quantity of heavy metals (Pb, Cd, Hg, and Cr6) and PBB and PBDE type halogens present in the components used in the electrical and electronic industries.
- European Directive 94/9/CE (known as the ATEX directive), for products used in a potentially explosive atmosphere.
- WEEE Directive (Waste of Electrical and Electronic Equipment).
- European Regulation REACH (Registration, Evaluation, Authorisation and Restriction of Chemicals) n.1907/2006 of 18/12/2006 for the use of chemical substances.

1.10 Competence of the ELESAGANTER Technical Department

Ongoing research and experimentation with new materials that offer increasingly high levels of performance is part of the principle of continuous improvement on which the ELESAGANTER Quality System is based. Our partnership with leading plastics manufacturers in the world and the use of mechanical and process simulation programs, also allows us to offer the material that best suits the Client's specific application.

2. METAL MATERIALS

Many ELESAGANTER parts are completely made out of metal. Plastic elements very often contain inserts or functional components made out of metal. The tables in chapter 12 describe the chemical composition and mechanical strength as per the reference standards for the metals used.

Surface treatments for metal inserts and parts: the surface of metal inserts or functional parts is generally treated to ensure maximum protection against environmental agents, in order to maintain the product's aesthetic and functional qualities.

The protective treatments normally used include:

- Burnishing of steel bushings and hubs
- Zinc-plating of threaded studs (Fe/Zn 8 in compliance with the UNI ISO 2081 standard)
- Matte chromium plating of lever arms and revolving handles shanks.

Metal parts made of brass or stainless steel do not normally require surface treatment.

On request and for sufficient quantity, metal parts can be supplied with protective surface treatments like black/yellow zinc-plating, nickel-plating, Niploy-Kanigen process, chromium plating, anodising and others, heat treatments like nitriding, hardening and case-hardening.

3. OTHER MATERIALS

Gaskets: ELESAGANTER normally uses gaskets made of synthetic nitrile butadiene rubber (NBR) or acrylonitrile butadiene rubber (BUNA N) for its products, with hardness values ranging from 70 to 90 SHORE A depending on the type of product considered.

The working temperature range for continuous use is -30°C to +120°C. Where a higher chemical and thermal resistance is required, that is, for products in the HCX.INOX, HCX.INOX-BW and HGFT.HT-PR series, gaskets made of FKM fluorinated rubber are used. For an indication of the



chemical resistance values, see the table in chapter 12 on page A26-A27-A28.

The working temperature range is -25°C to +210°C.

On request and for sufficient quantity, flat washers and O-rings made of special materials such as EPDM, silicone rubber, or others may be supplied.

Air filters for filler breather caps (SFC., SFN., SFP., SFV., SFW., SMN. and SMW. series):

- **TECH-FOAM type filters:** polyester-based polyurethane foam mesh, degree of filtration 40 microns, recommended for temperatures of between -40°C and +100°C for continuous use, and brief peak temperatures of +130°C. This material does not swell in contact with water, petrol, soap, detergents, mineral oils or grease. Some solvents may cause slight swelling of the foam (benzene, ethanol, and chloroform).
- **TECH-FIL type filters:** made of zinc-plated iron wire (quality as per DIN 17140-D9-W.N.R 10312, zinc-plated as per DIN 1548), degree of filtration 50-60 microns.

4. MECHANICAL PROPERTIES OF PLASTIC PRODUCTS

The mechanical properties of a moulded plastic component may vary significantly according to its shape and the technological level of the manufacturing process.

For this reason, instead of providing tables containing specific data on the mechanical strength of test pieces of various types of material, ELESAGANTER has decided to inform designers of the forces which, in the most significant cases, may cause the component to break. For most products the mechanical strength values indicated in the catalogue are therefore breaking loads.

For some products for which deformation under a load is not negligible and may therefore jeopardise their performance, two load values are provided.

- **“maximum working load”** below which deformation DOES NOT jeopardise the component’s performance.
- **“load at breakage”** in accordance with the concepts outlined above.

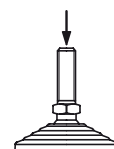
In these cases, the “maximum working load” will be used as design data to guarantee correct performance while the “load at breakage” will be used for safety tests, applying the relevant coefficients.

Working stress has been taken into account (e.g. the transmission of torque in the case of a handwheel, and the tensile strength of a handle) as well as accidental stress (e.g. an impact with the component), in order to provide designers with a reference for determining suitable safety coefficients, according to the type and importance of the application. All the strength values supplied were obtained from tests carried out at the ELESAGANTER Laboratories, under controlled temperature and humidity conditions (23°C - relative humidity of 50%), under specific working conditions, and applying a static load for a necessarily limited period of time.

The designer must therefore take into account an adequate safety coefficient according to the application and specific operating conditions (vibrations, dynamic loads, working temperatures at the limits of the allowed temperature range). In the end, however, the designer is responsible for checking that the product is suitable for its intended purpose.

For some thermoplastics, for which the mechanical properties vary significantly in relation to the percentage of moisture absorbed (see paragraph 1.5), the resistance tests on the element are carried out in compliance with ASTM D570, so that the moisture absorbed is in equilibrium with respect to ambient conditions of 23°C and a RH of 50%.

Compressive strength for levelling elements (working stress): the levelling element is assembled on its threaded metal stud and placed on special testing equipment. The element is then subjected to compressive stress with repeated and incremental loads until it breaks or undergoes a permanent plastic deformation.



Resistance to transmission of torque (working stress):

(working stress):

Use is made of an electronic dynamometer that applies increasing torque values as shown in **Figure 1**.

Here the dynamometric system is shown in a traditional way to make the comprehension easier.

The mean values of the torque C , obtained in the breaking tests are shown in the tables for the various components and expressed in [Nm].

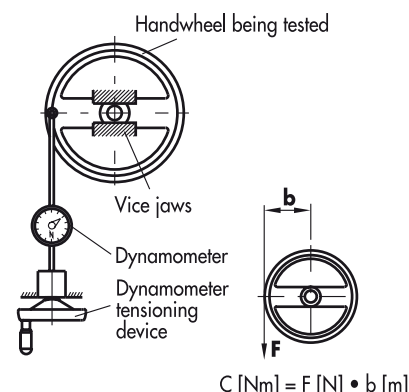


Fig. 1

Impact strength (accidental stress):

The special equipment shown in **Figure 2** is used. The mean values obtained in the breaking test, shown in the tables for the various models and expressed in [J], correspond to the breaking work L of the element subjected to repeated impacts, with the falling height of the percussion weight being increased by 0.1 m each time.

Percussion weight: metal cylinder with a rounded ogival shaped end and weighing 0.680 kg (6.7N).

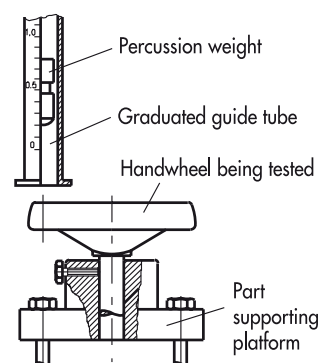
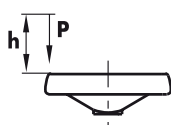
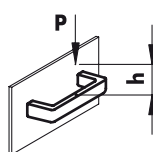


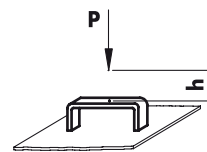
Fig. 2



$$L [J] = P [N] \cdot h [m]$$



$$L1 [J] = P [N] \cdot h [m]$$



$$L2 [J] = P [N] \cdot h [m]$$

Tensile strength of U-shaped handles (working stress):

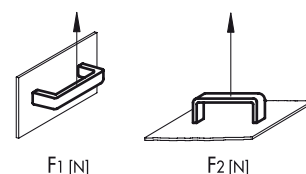
this test entails fitting the handle to be tested on a dynamometer, and applying two types of stress:

- perpendicular to the mounting screws (F_1).

Here the stress on the handle is a combination of pulling and bending

- parallel to the mounting screws (F_2).

The load applied by the electronic dynamometer increases gradually in order to obtain a deformation of the tested element within a limit of 20 mm/min.



5. PROPERTIES OF MOULDED-IN METAL INSERTS

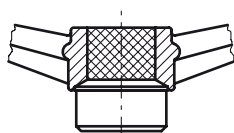


Fig. 3

With a view to ensuring the most effective anchoring of the metal inserts to the plastic and the best possible mechanical operation of the element, use is normally made of diamond knurling, of a shape, pitch and depth suited to the stress to be applied. This type of knurling ensures both axial anchoring (that contrasts axial tensile stress) and radial anchoring (to avoid rotation during the transmission of torque) (**Fig.3**).

For studs, instead of using a common screw available on the market, use is normally made of a specially shaped threaded insert which protrudes a few tenths of mm from the plastic body so as to form a metal face on the screwing plane, thus freeing the plastic of all stress.

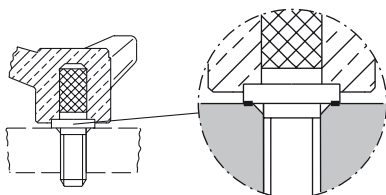
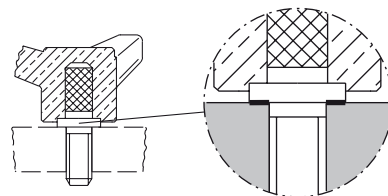
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10****Technical data**

5.1 Types of assembly of elements with threaded inserts

Types of assembly that create optimum clamping conditions:

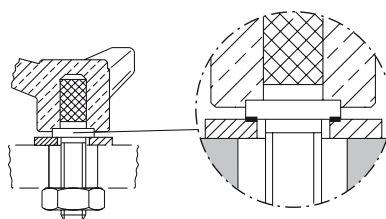
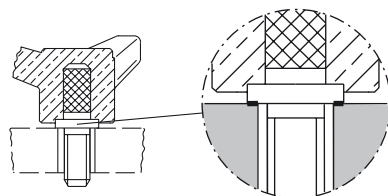
The plastic base on the clamping knob should never rest on the clamping surface. In this way the stud or threaded boss are never subjected to abnormal twisting ("corkscrew" effect) when axial tensile stress is applied. The metal stud (or boss) is therefore only subject to the torque applied to the knob to tighten it.

1. Tapped hole, without any chamfer or countersinking.



2. Tapped hole with chamfered edge or countersinking of a smaller diameter than that of the face on the stud, in order to ensure an adequate overlap between the metal insert and the clamping surface.

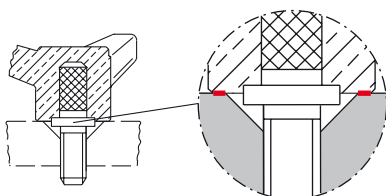
3. Plain cylindrical hole of a smaller diameter than that of the face on the stud, in order to ensure an adequate overlap between the metal insert and the clamping surface.



4. Plain cylindrical hole of a larger diameter than that of the face on the stud, setting in between a steel washer whose hole has a smaller diameter than that of the face of the stud. This guarantees an adequate overlap between the metal insert and the clamping surface.

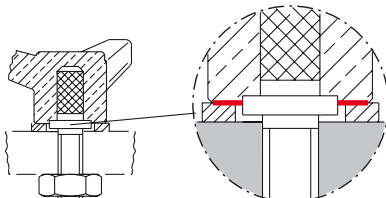
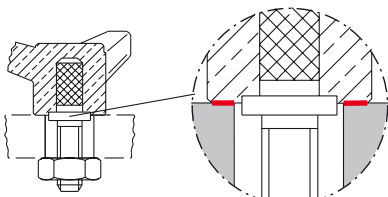
Incorrect types of assembly:

The plastic base of the clamping knob rests directly on the clamping surface and the stud or threaded boss are therefore also subject to an axial load ("corkscrew" effect), which could jeopardize its anchoring. The values of this force are always higher, with a broad safety margin, than those that may be applied by normal operations performed by hand, but designers who wish to take into account cases of improper use should avoid the situations illustrated in cases 5-6-7.



5. Tapped hole and chamfer or countersinking with a larger diameter than that of the face on the stud.

6. Cylindrical through hole with a larger diameter than that of the face on the stud.



7. Tapped hole without any chamfer or countersinking, setting in between a steel washer whose hole has a diameter larger than that of the face on the stud.

5.2 Through holes

5.3 End of threaded studs

For knobs in which through holes (FP type) have to be made, the insert is set in such a way that the machining of the hole or the broaching of a keyway only affects the metal part, without the plastic having to be machined in any way.

All threaded studs of the ELESAGANTER elements have a chamfered flat end in compliance with ISO 4753 (Fig.4).

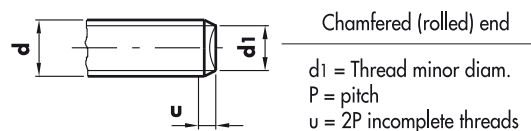
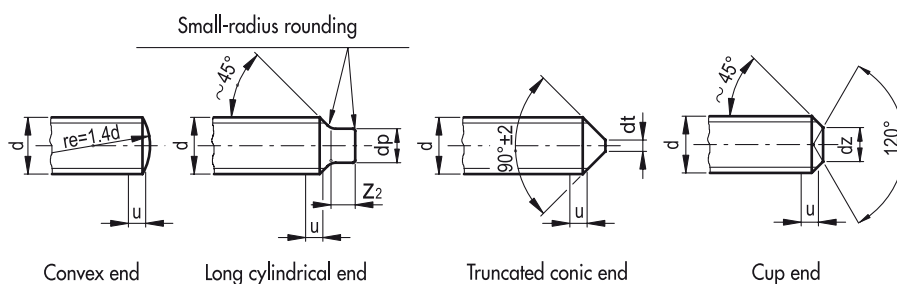


Fig. 4

On request and for sufficient quantity, studs with different kinds of ends may be provided. These ends may be of the types shown (Fig.5), as indicated in the ISO 4753 table for "Fixing elements: ends of elements with ISO metric outside threading".

| d | dp h14 | dt h16 | dz h14 | Z ₂ +IT 14* 0 |
|----|-----------|-----------|-----------|--------------------------------|
| 4 | 2.5 | 0.4 | 2 | 2 |
| 5 | 3.5 | 0.5 | 2.5 | 2.5 |
| 6 | 4 | 1.5 | 3 | 3 |
| 8 | 5.5 | 2 | 5 | 4 |
| 10 | 7 | 2.5 | 6 | 5 |
| 12 | 8.5 | 3 | 7 | 6 |
| 14 | 10 | 4 | 8.5 | 7 |
| 16 | 12 | 4 | 10 | 8 |

*IT = international tolerances



P = pitch
 $u = 2P$ incomplete threads

Fig. 5

6. MACHINING TOLERANCES

THE REFERENCE TOLERANCE SYSTEM IS THE ISO SYSTEM - BASIC HOLE

TOLERANCES FOR HOLES AND THREADS IN THE METAL INSERTS

• Plain holes in the bosses and hubs of knobs and handwheels.

For the most widely used models, there are various kinds of standardized holes available so the user has a wide selection and is saved the costly task of remachining the hole on assembly. The tolerance of these holes is normally grade H7, but in a few cases it is grade H9. The degree of tolerance is always indicated in the tables of each article, in the hole size column. For cases in which it is more difficult to propose a standardization of the holes that satisfies the broadest range of assembly needs, either a pre-drilled hole with a simple roughing tolerance (hole with a smaller diameter than that of the shaft on which it is expected to be assembled), or a hub with no hole (not drilled) is used.

• Tapped holes in the bosses and threads of the studs.

Machining in accordance with the ISO metric threads for a normal screwing length (see table in chapter 12, page A19).

- tapped holes of built-in metal bosses = tolerance 6H.
- metal studs or ends of shanks for revolving handles = tolerance 6g.



7. SPECIAL CONSTRUCTION FEATURES

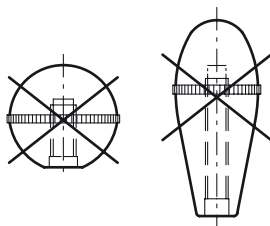


Fig. 7

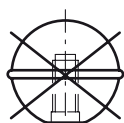


Fig. 8

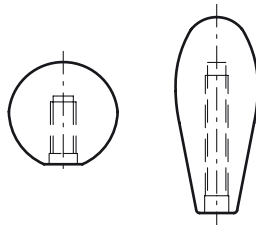


Fig. 9

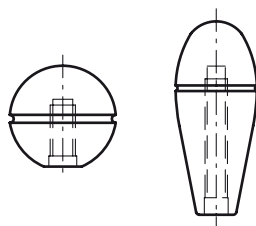


Fig. 10

TOLERANCES OF HOLES AND THREADS OBTAINED FROM MOULDED PLASTIC

- **Plain holes** (for handles with a through hole for assembly in an idle condition on pins).

Despite the considerable difficulties encountered in maintaining the tolerances in a machining process in which numerous factors influence the end result, the size of the diameter of the axial hole is normally respected with a tolerance of C11. The handles may therefore also be assembled on pins made from normal drawn parts. If the pin is obtained by turning from a bar with a greater diameter, a machining process with a tolerance of h11 is recommended, as this gives a suitable free coupling, with the advantage of a quick, simple and inexpensive machining process.

- **Inside threads** (for handles with no metal bushing to be screwed in and fixed to threaded pins).

They are normally kept undersized so that assembly is slightly forced at ambient temperature.

- **Outside threads** (for filler breather caps or level indicators with a threaded connector).

In this case, for reasons related to the process technology and the type of plastic, which may absorb small amounts of moisture from the outside environment, the tolerances must be interpreted taking this into account though the tightening of the component assembled is never actually jeopardized in practice.

Ball knobs

On all ball knobs or handles of other types, the knurled band indicated as an example in **Fig.7** has been ruled out on principle.

This solution is used to hide the burrs that form on the joining line of the mould, thus eliminating the cost of deburring and finishing. From the functional and ergonomic points of view, this solution is not rational, however, in that it causes considerable irritation to the operator's hands after prolonged use. In addition, apart from this ergonomic consideration, which is, in any case, important, the knurled band accumulates dust and dirt which is almost impossible to remove, with the result that the handle made in this way always appears "dirty" and is therefore not at all "inviting" to the touch.

The solution of facilitating the elimination of burrs by creating a raised edge along the joining line of the mould (**Fig.8**) presents the same problems, though to a lesser extent.

Consequently, the following two solutions have been exclusively adopted:

- completely smooth finish: (**Fig.9**) which entails a higher cost for deburring (to remove the joining line of the mould), subsequent smoothing (to join the surfaces) and polishing (to restore the gloss) but makes the handle comfortable to hold and makes it look always "clean";

- finishing with an equatorial groove: (**Fig.10**) which represents a more economical solution in that it reduces the deburring to simply eliminating the joining line of the mould by turning a small equatorial groove, without having to join the surfaces by lapping and also without any need for polishing.

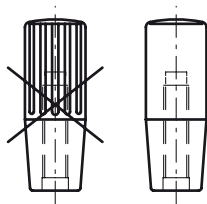


Fig. 11

7.1 Fixed handles: types of assembly.

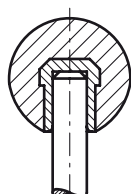


Fig. 12

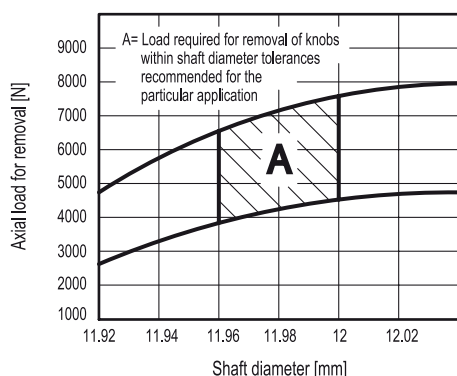


Fig. 13

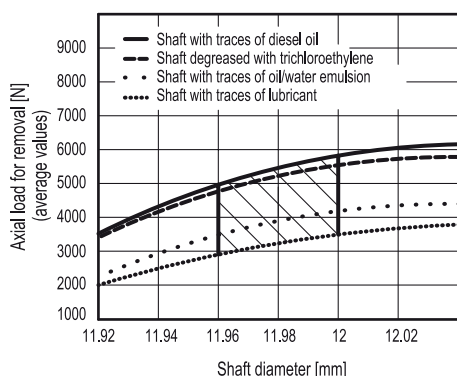


Fig. 14

Elongated handles

For elongated handles both for fixed assembly (at the end of levers) and for revolving assembly on shanks, smooth shapes free of grooves and knurls have been adopted exclusively (**Fig. 11**), this benefits the operation of the handles, which is to be used only for gripping a mechanical part that is to be subjected to translating movements. Also in the case of the revolving handles on a shank, knurls, grooves and edges simply irritate the hand of the operator who has to hold it and accumulates dust and dirt.

Various kinds of couplings are used for securing fixed handles to the shaft:

- Handles with brass boss for screwed assembly on a threaded shaft.
- Handles with the nut screw moulded into the plastic for screwed assembly on a threaded shaft.
- Handles with built-in self-locking boss made of special technopolymer (original ELESa design) for push-fit assembly on a plain shaft (unthreaded) made from a normal drawn rod (ISO tolerance h9). This solution prevents spontaneous unscrewing in time due to the vibrations to which the lever is subjected or the rotary forces exerted inadvertently by the operator's hand while handling the lever itself.

For executions with threaded holes obtained from the plastic in the mould, the measure of keeping the thread undersized with respect to the specifications laid down in the standards has been taken.

This enables the threads of the nut screw to adapt slightly to the screw, when tightening at ambient temperature, thus creating a coupling with an elastic reaction that gives an effective locking effect. Even better results may be obtained by hot assembly: the handle is heated to 80÷90°C before being screwed onto the threaded pin. This method of assembly initially facilitates the screwing operation in that the thread of the nut screw is expanded when screwed in and subsequently enables an extremely efficient locking effect to be obtained from shrinkage on cooling, due to the slight roughness of the surface of the thread on the shaft.

The solution with a self-locking bushing made of special technopolymer (**Fig. 12**) is, in any case, the most effective against spontaneous unscrewing in that the elastic coupling is not susceptible to any vibrations or rotary forces exerted by the operator's hand.

The lock is also such as to ensure that the handle does not come out even when subjected to a normal pulling action along its axis. In relation to this, the results of the research work and tests carried out at the ELESa+GANter laboratories are provided and they confirm the technical validity of the coupling with self-locking bushings made of special technopolymer (**Fig. 13 and 14**).

The graph in **Fig. 13** shows the variations in axial translation effort expressed in [N] as a function of the variations in diameter of the shaft (mm), dry and degreased with trichloroethylene. The two curves represent the minimum and maximum values in hundreds of tests conducted on a type of self-locking handle with a hole having a $\varnothing 12$ mm. The area A contains the values that refer to shaft with a commercial diameter of 12 mm (tol. h9).

The graph in **Fig. 14** shows the variations in axial translation effort (mean values) as a function of the surface area of the shaft. As may well be imagined, the presence of lubricating or emulsifying oil on the surface of the shaft lowers the handle removal effort. It may however be readily noted that, even in this unfavourable condition, the axial effort required to slide the handle out is always such as to ensure that this cannot actually happen in practice.

The use of this kind of handle ensures a considerable saving in that it does not entail machining



8. MEASURES TO BE TAKEN IN ASSEMBLING PLASTIC PARTS

thread on the end of the shaft. The self-locking bushing made of special technopolymer enables an elastic coupling to be obtained and the handle itself maintains all its surface hardness and wear resistance typical of thermosetting materials.

Assembly instructions: fit the handle onto slight chamfered shaft end and push as far as possible by hand or by means of a small press. Alternatively it is possible to tap the handle with a plastic or wooden mallet until firmly in place. In this case we strongly recommend to use a cloth or other suitable soft material over the product to avoid any surface damage.

Plastic is a poor conductor of heat and has a different thermal expansion coefficient from that of the metal inserts so measures must be taken, while remachining the hole, to stop the hubs and bushings from overheating: in fact, the heat produced is not dissipated and the metal parts expand and create stress inside the body of the plastic which has a damaging effect on the strength of the assembly (Duroplasts).

In addition, for thermoplastics (Technopolymers), temperatures close to their softening point could be reached with the risk of the metal insert coming loose.

It is therefore always necessary to adopt cutting and feed rates that do not produce marked localized heating and to cool intensively when the holes have a large diameter and depth with respect to the size of the bushing.

To conserve maximum gloss of the surfaces, we recommend, once machining has been completed, to avoid leaving the plastic wet for a long time, by removing all residual emulsified water from the surfaces; use oil only, if possible.

8.1 Types of machining process

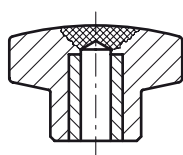


Fig. 15

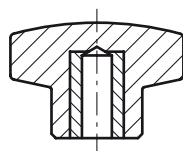


Fig. 16

The machining processes commonly required for the assembly of handwheels or knobs are:

- Remachining of axial hole in the bosses (blind hole). When remachining the hole of a built-in metal boss, always avoid operating as shown in **Fig. 15**, because both during the drilling operation and during the insertion of the small shaft, an area of the plastic covering may be subjected to stress, with the risk of cracking or detaching the part indicated with cross shading. The operation shown in **Fig. 16** is the most rational.

Note that in the ELESAGANTER parts, remachining of the axial hole may be performed under the correct conditions indicated above in that the length of the built-in bushings is always indicated in the table of each article so, for the depth of the hole, reference should simply be made to the basic plan.

- Remachining of the axial hole in the bosses (case of a through hole). If the drilling operation affects not only the metal boss but also a layer of the covering material, the handwheel must be centred carefully and drilling should be started from the plastic side otherwise, chipping may occur when the tool is removed.
- Transversal threading in the boss for grub-screw. To be performed in accordance with the instructions given above. Avoid threading both the metal and the plastic: it is better to drill the hole in the plastic part and thread the metal part only.

Drilling or threading operations to be performed entirely in the plastic are exceptional. Bear in mind that the difficulty with which the heat produced locally is dissipated, also through the abrasive action of the plastic on the tool, worsens considerably the latter's working conditions, resulting a rapid wear of the cutting edges (use hard metal tools).













9. SPECIAL EXECUTIONS

The range of ELESAGANTER elements is extremely broad and offers designers valid alternatives as regards designs, properties and performance of materials, sizes..., to satisfy the most diverse applicational needs. The customer may however need to ask for changes to the standard part or have it made in different colours to adapt it to special applications. In these cases, the ELESAGANTER engineers are at the customer's full disposal to satisfy these requests for specially designed parts which, as such and for the modifications they may entail to the mould, must be required in sufficient quantity.

10. THE COLOURS OF PLASTIC AND METAL ELESAGANTER STANDARDS

In addition to black, which represents the most commonly used colour for plastic and metal components, a large number of standard elements in this catalogue are available in the following colours:

| | | | |
|----------|--|----------|---|
| RAL 7021 |  | RAL 5024 |  |
| RAL 2004 |  | RAL 3000 |  |
| RAL 7035 |  | RAL 9005 |  |
| RAL 1021 |  | RAL 9006 |  |
| RAL 9011 |  | RAL 9002 |  |

The RAL code is indicated indicatively in that the tone of the colour of the moulded part may differ slightly, depending on various factors such as the base of the polymer pigments (polyamide or polypropylene), the finish (glossy or matte), the thickness and the shape of the product.

Warning: the RAL table refers to the colour of paints and are therefore colours with a glossy surface.

11. TEST VALUES

All the information about the test values are based on our experience and on laboratory tests conducted under specific standard conditions and in a necessarily limited time interval.

Any values indicated must therefore be taken only as a reference for the designer who will apply adequate safety coefficients to them according to the application of the product. The designer and the purchaser are responsible for checking the suitability of our products for the purpose for which they are to be used under the actual operating conditions.

12. TECHNICAL TABLES



A
16

Technical data

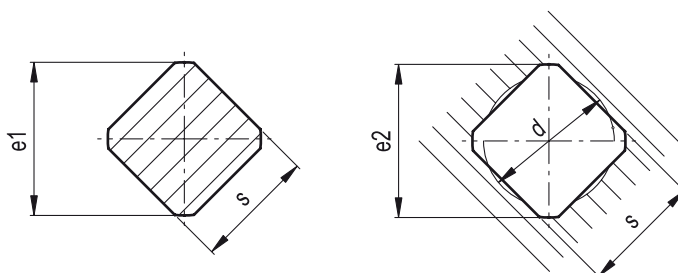
CONVERSION TABLE

| Parameter | IS unit | To convert IS unit into | multiply by |
|-----------|---------|-------------------------|-------------|
| Force | N | kg | 0.1 |
| Torque | Nm | kg · m | 0.1 |
| Work | J | kg · m | 0.1 |

| To convert | into | multiply by |
|------------|---------|-------------------------------------|
| mm | inches | 0.039 |
| N | lbf | 0.224 |
| Nm | lb · ft | 0.737 |
| J | ft · lb | 0.737 |
| g | lb | 0.002 |
| °C | °F | $(^{\circ}\text{C} \cdot 9/5) + 32$ |

DIN 79 SQUARE HOLES AND SHAFTS

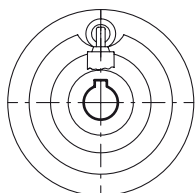
| s H11/h11 | d max. | e1 max. | e1 min. | e2 min. |
|--------------|-----------|------------|------------|------------|
| 4 | 4.2 | 5 | 4.8 | 5.3 |
| 5 | 5.3 | 6.5 | 6 | 6.6 |
| 5.5 | 5.8 | 7 | 6.6 | 7.2 |
| 6 | 6.3 | 8 | 7.2 | 8.1 |
| 7 | 7.3 | 9 | 8.4 | 9.1 |
| 8 | 8.4 | 10 | 9.6 | 10.1 |
| 9 | 9.5 | 12 | 10.8 | 12.1 |
| 10 | 10.5 | 13 | 12 | 13.1 |
| 11 | 11.6 | 14 | 13.2 | 14.1 |
| 12 | 12.6 | 16 | 14.4 | 16.1 |
| 13 | 13.7 | 17 | 15.6 | 17.1 |
| 14 | 14.7 | 18 | 16.8 | 18.1 |
| 16 | 16.8 | 21 | 19.2 | 21.2 |
| 17 | 17.9 | 22 | 20.4 | 22.2 |
| 19 | 20 | 25 | 22.8 | 25.2 |
| 22 | 23.1 | 28 | 26.4 | 28.2 |
| 24 | 25.3 | 32 | 28.8 | 32.2 |
| 27 | 28.4 | 36 | 32.4 | 36.2 |
| 30 | 31.7 | 40 | 36 | 40.2 |
| 32 | 33.7 | 42 | 38.4 | 42.2 |
| 36 | 38 | 48 | 43.3 | 48.2 |
| 41 | 43.2 | 54 | 49.3 | 54.2 |
| 46 | 48.5 | 60 | 55.2 | 60.2 |
| 50 | 52.7 | 65 | 60 | 65.2 |
| 55 | 57.9 | 72 | 66 | 72.2 |



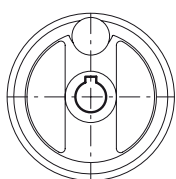
elesa+GANTER

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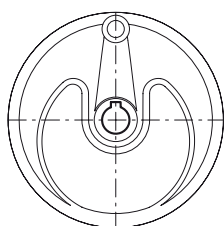
Orientation of keyways



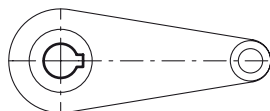
Solid handwheels



Spoked handwheels



Monospoke handwheels



Crank handles

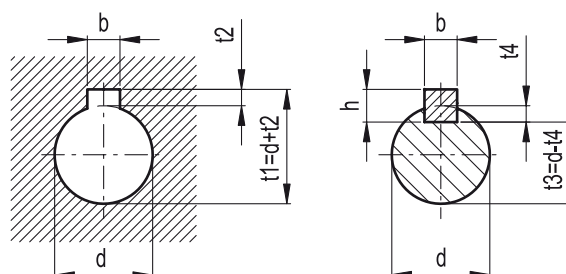
DIN 6885/1 KEYWAYS

| d | b P9/JS9 Hub keyway | b P9/N9 Shaft-keyway | h | t2 | t4 |
|---------------|------------------------|-------------------------|---|----------|----------|
| from 6 to 8 | 2 | 2 | 2 | 1 +0.1 | 1.2 +0.1 |
| over 8 to 10 | 3 | 3 | 3 | 1.4 +0.1 | 1.8 +0.1 |
| over 10 to 12 | 4 | 4 | 4 | 1.8 +0.1 | 2.5 +0.1 |
| over 12 to 17 | 5 | 5 | 5 | 2.3 +0.1 | 3 +0.1 |
| over 17 to 22 | 6 | 6 | 6 | 2.8 +0.1 | 3.5 +0.1 |
| over 22 to 30 | 8 | 8 | 7 | 3.3 +0.2 | 4 +0.2 |
| over 30 to 38 | 10 | 10 | 8 | 3.3 +0.2 | 5 +0.2 |
| over 38 to 44 | 12 | 12 | 8 | 3.3 +0.2 | 5 +0.2 |
| over 44 to 50 | 14 | 14 | 9 | 3.8 +0.2 | 5.5 +0.2 |

Width of keyway:

P9 tight fit (standard design)

JS or N9 loose fit (requires agreement in writing)



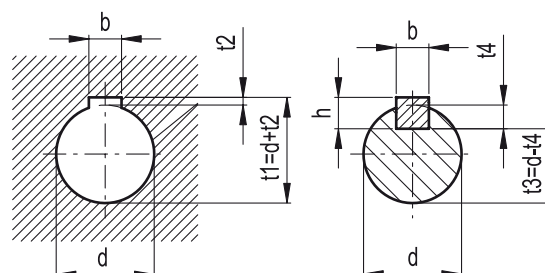
DIN 6885/2 KEYWAYS

| d | b P9/JS9 Hub keyway | b P9/N9 Shaft-keyway | h | t2 | t4 |
|---------------|------------------------|-------------------------|---|----------|----------|
| from 10 to 12 | 4 | 4 | 4 | 1.1 +0.1 | 3 +0.1 |
| over 12 to 17 | 5 | 5 | 5 | 1.3 +0.1 | 3.8 +0.1 |
| over 17 to 22 | 6 | 6 | 6 | 1.7 +0.1 | 4.4 +0.1 |
| over 22 to 30 | 8 | 8 | 7 | 1.7 +0.2 | 5.4 +0.2 |
| over 30 to 38 | 10 | 10 | 8 | 2.1 +0.2 | 6 +0.2 |
| over 38 to 44 | 12 | 12 | 8 | 2.1 +0.2 | 6 +0.2 |
| over 44 to 50 | 14 | 14 | 9 | 2.6 +0.2 | 6.5 +0.2 |

Width of keyway:

P9 tight fit (standard design)

JS or N9 loose fit (requires agreement in writing)



Information

The connection between the operating devices and the axis consists very often of a cross pin or a grub screw.

As a result the user is faced with relatively high costs since cross holes on operating devices are in general not readily available.

Components with cross holes to GN 110 are not only offered at very competitive prices but they also save the manufacturer unnecessary drawing work. The geometrical form of some of the operating devices, however, does not lend itself to modification to this particular GN standard.

The radial positioning of the cross holes is only specified as per above three specifications of product groups (control levers, cranked handles, handwheels).

For all other operating devices it can be arranged any way.

The pin hole d2 H11 is drilled to suit drive spring pins.

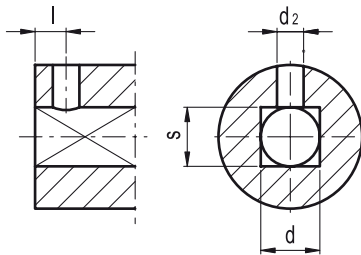
How to order

**(Handwheel DIN 950-GG-160-B14-A)
with cross drilled hole
GN 110-QE**

Code No. _____
Type _____

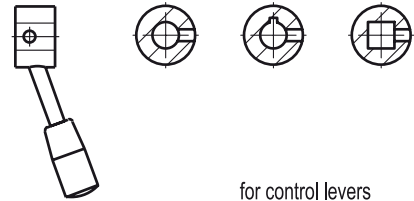
GN 110 CROSS HOLES

| d H7 | s H11 | d2 H11 | d3 | l -0.1 standard | l -0.1 for DIN 950 only |
|------|-------|--------|----|--------------------|----------------------------|
| 6 | 7 | 2.5 | M3 | 4.5 | - |
| 8 | 9 | 3 | M5 | 5.5 | 4.5 |
| 10 | 11 | 3 | M5 | 5.5 | 4.5 |
| 12 | 13 | 4 | M6 | 6.5 | 5.5 |
| 14 | 15 | 4 | M6 | 6.5 | 5.5 |
| 16 | 17 | 5 | M6 | 8 | 7 |
| 18 | 19 | 5 | M6 | 8 | 7 |
| 20 | 21 | 5 | M6 | 8 | 7 |
| 22 | 23 | 6 | M6 | 10 | 9 |
| 24 | 25 | 6 | M6 | 10 | 9 |
| 26 | 27 | 6 | M6 | 10 | 9 |

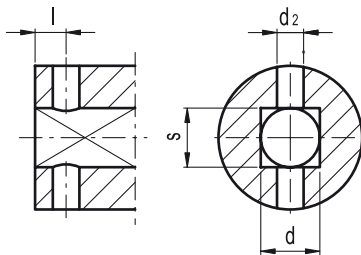


Type QE
One sided cross hole

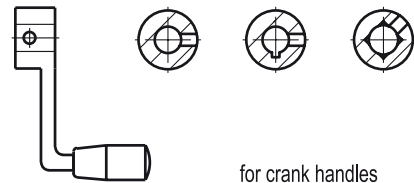
Positioning of the radial cross hole with respect to keyway/square hole



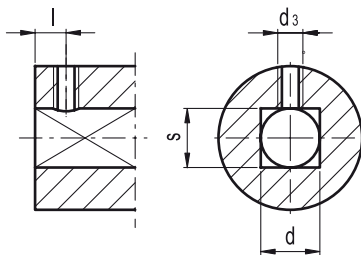
for control levers



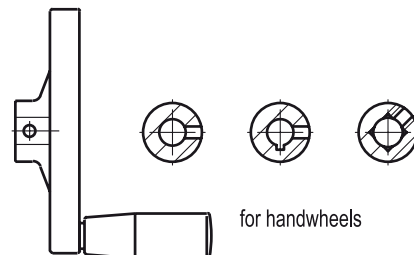
Type QD
Double sided cross hole



for crank handles



Type GE
One sided threaded hole



for handwheels



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19

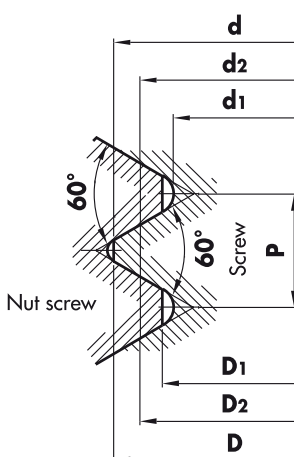
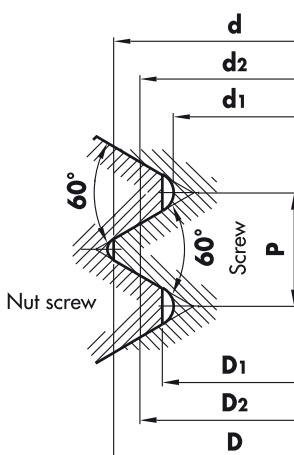
Technical data

ISO METRIC FINE THREADS - DIN 13 (thread limits)

| | P (mm) | Screw with tolerance of 6g | | | | | | Nut screw with tolerance of 6H | | | | | |
|-----|-----------|----------------------------|--------|---------------------------|--------|---------------------------|--------|--------------------------------|---------------|---------------------------|--------|---------------------------|--------|
| | | Ø major d | | Ø pitch d ₂ | | Ø minor d ₁ | | Ø major D | | Ø pitch D ₂ | | Ø minor D ₁ | |
| | | max. | min. | max. | min. | max. | min. | min. | max. | min. | max. | min. | max. |
| M5 | 0.5 | 4.980 | 4.874 | 4.655 | 4.580 | 4.367 | 4.273 | 5.000 | Not specified | 4.675 | 4.775 | 4.459 | 4.599 |
| M6 | 0.5 | 5.980 | 5.874 | 5.655 | 5.570 | 5.367 | 5.263 | 6.000 | | 5.675 | 5.787 | 5.459 | 5.599 |
| M8 | 0.5 | 7.980 | 7.874 | 7.655 | 7.570 | 7.367 | 7.263 | 8.000 | | 7.675 | 7.787 | 7.459 | 7.599 |
| M10 | 0.5 | 9.980 | 9.874 | 9.655 | 9.570 | 9.367 | 9.263 | 10.000 | | 9.675 | 9.787 | 9.459 | 9.599 |
| M12 | 0.5 | 11.980 | 11.874 | 11.655 | 11.565 | 11.367 | 11.258 | 12.000 | | 11.675 | 11.793 | 11.459 | 11.599 |
| M6 | 0.75 | 5.978 | 5.838 | 5.491 | 5.391 | 5.058 | 4.929 | 6.000 | | 5.513 | 5.645 | 5.188 | 5.378 |
| M8 | 0.75 | 7.978 | 7.838 | 7.491 | 7.391 | 7.058 | 6.929 | 8.000 | | 7.513 | 7.645 | 7.188 | 7.378 |
| M10 | 0.75 | 9.978 | 9.838 | 9.491 | 9.391 | 9.058 | 8.929 | 10.000 | | 9.513 | 9.645 | 9.188 | 9.378 |
| M12 | 0.75 | 11.978 | 11.838 | 11.491 | 11.385 | 11.058 | 10.923 | 12.000 | | 11.513 | 11.653 | 11.188 | 11.378 |
| M16 | 0.75 | 15.978 | 15.838 | 15.491 | 15.385 | 15.508 | 14.923 | 16.000 | | 15.513 | 11.653 | 15.188 | 15.378 |
| M8 | 1 | 7.974 | 7.974 | 7.324 | 7.212 | 6.747 | 6.596 | 8.000 | | 7.350 | 7.500 | 6.917 | 7.153 |
| M10 | 1 | 9.974 | 9.974 | 9.324 | 9.212 | 8.747 | 8.596 | 10.000 | | 9.350 | 9.500 | 8.917 | 9.153 |
| M12 | 1 | 11.974 | 11.974 | 11.324 | 11.206 | 10.747 | 10.590 | 12.000 | | 11.350 | 11.510 | 10.917 | 11.153 |
| M16 | 1 | 15.974 | 15.974 | 15.324 | 15.206 | 14.747 | 14.590 | 16.000 | | 15.350 | 15.510 | 14.917 | 15.153 |
| M20 | 1 | 19.974 | 19.974 | 19.324 | 19.206 | 18.747 | 18.590 | 20.000 | | 19.350 | 19.510 | 18.917 | 19.153 |
| M12 | 1.5 | 11.968 | 11.732 | 10.994 | 10.854 | 10.128 | 9.930 | 12.000 | | 11.026 | 11.216 | 10.376 | 10.676 |
| M14 | 1.5 | 13.968 | 13.732 | 12.994 | 12.854 | 12.128 | 11.930 | 14.000 | | 13.026 | 13.216 | 12.376 | 12.676 |
| M16 | 1.5 | 15.968 | 15.732 | 14.994 | 14.854 | 14.128 | 13.930 | 16.000 | | 15.026 | 15.216 | 14.376 | 14.676 |
| M18 | 1.5 | 17.968 | 17.732 | 16.994 | 16.854 | 16.128 | 15.930 | 18.000 | | 17.026 | 17.216 | 16.376 | 16.676 |
| M20 | 1.5 | 19.968 | 19.732 | 18.994 | 18.854 | 18.128 | 17.930 | 20.000 | | 19.026 | 19.216 | 18.376 | 18.676 |
| M22 | 1.5 | 21.968 | 21.732 | 20.994 | 20.854 | 20.128 | 19.930 | 22.000 | | 21.026 | 21.216 | 20.376 | 20.676 |
| M26 | 1.5 | 25.968 | 25.732 | 24.994 | 24.844 | 24.128 | 23.920 | 26.000 | | 25.026 | 25.226 | 24.376 | 24.676 |
| M27 | 1.5 | 26.968 | 26.732 | 25.994 | 25.844 | 25.128 | 24.920 | 27.000 | | 25.026 | 26.226 | 25.376 | 25.676 |
| M30 | 1.5 | 29.968 | 29.732 | 28.994 | 28.844 | 28.128 | 27.920 | 30.000 | | 29.026 | 29.226 | 28.376 | 28.676 |
| M35 | 1.5 | 34.968 | 34.732 | 33.994 | 33.844 | 33.128 | 32.920 | 35.000 | | 34.026 | 34.226 | 33.376 | 33.676 |
| M40 | 1.5 | 39.968 | 39.732 | 38.994 | 38.844 | 38.128 | 37.920 | 40.000 | | 39.026 | 39.226 | 38.376 | 38.676 |
| M20 | 2 | 19.962 | 19.682 | 18.663 | 18.503 | 17.508 | 17.271 | 20.000 | | 18.701 | 18.913 | 17.835 | 18.210 |
| M24 | 2 | 23.962 | 23.682 | 22.663 | 22.493 | 21.508 | 21.261 | 24.000 | | 22.701 | 22.925 | 21.835 | 22.210 |
| M30 | 2 | 29.962 | 29.682 | 28.663 | 28.493 | 27.508 | 27.261 | 30.000 | | 28.701 | 28.925 | 27.835 | 28.210 |
| M36 | 2 | 35.962 | 35.682 | 34.663 | 34.493 | 33.508 | 33.261 | 36.000 | | 34.701 | 34.925 | 33.835 | 34.210 |
| M42 | 2 | 41.962 | 41.682 | 40.663 | 40.493 | 39.508 | 39.261 | 42.000 | | 40.701 | 40.925 | 39.835 | 40.210 |

ISO METRIC THREADS - DIN 13 (thread limits)

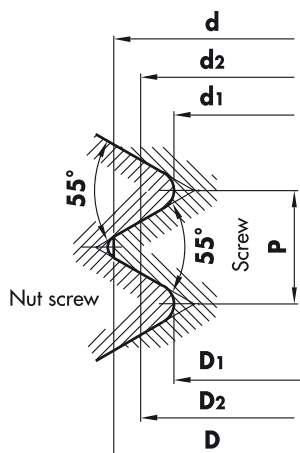
| | P (mm) | Screw with tolerance of 6g | | | | | | Nut screw with tolerance of 6H | | | | | |
|-----|-----------|----------------------------|--------|---------------------------|--------|---------------------------|--------|--------------------------------|---------------|---------------------------|--------|---------------------------|--------|
| | | Ø major d | | Ø pitch d ₂ | | Ø minor d ₁ | | Ø major D | | Ø pitch D ₂ | | Ø minor D ₁ | |
| | | max. | min. | max. | min. | max. | min. | min. | max. | min. | max. | min. | max. |
| M3 | 0.5 | 2.980 | 2.874 | 2.655 | 2.580 | 2.367 | 2.273 | 3.000 | Not specified | 2.675 | 2.775 | 2.459 | 2.599 |
| M4 | 0.7 | 3.978 | 3.838 | 3.523 | 3.433 | 3.119 | 3.002 | 4.000 | | 3.545 | 3.663 | 3.242 | 3.422 |
| M5 | 0.8 | 4.976 | 4.826 | 4.456 | 4.361 | 3.995 | 3.869 | 5.000 | | 4.480 | 4.605 | 4.134 | 4.334 |
| M6 | 1 | 5.974 | 5.794 | 5.324 | 5.212 | 4.747 | 4.596 | 6.000 | | 5.350 | 5.500 | 4.917 | 5.153 |
| M8 | 1.25 | 7.972 | 7.760 | 7.160 | 7.042 | 6.438 | 6.272 | 8.000 | | 7.188 | 7.348 | 6.647 | 6.912 |
| M10 | 1.5 | 9.968 | 9.732 | 8.994 | 8.862 | 8.128 | 7.938 | 10.000 | | 9.026 | 9.206 | 8.376 | 8.676 |
| M12 | 1.75 | 11.966 | 11.701 | 10.829 | 10.679 | 9.819 | 9.602 | 12.000 | | 10.863 | 11.063 | 10.106 | 10.441 |
| M14 | 2 | 13.962 | 13.682 | 12.663 | 12.503 | 11.508 | 11.271 | 14.000 | | 12.701 | 12.913 | 11.835 | 12.210 |
| M16 | 2 | 15.962 | 15.682 | 14.663 | 14.503 | 13.508 | 13.271 | 16.000 | | 14.701 | 14.913 | 13.835 | 14.210 |
| M18 | 2.5 | 17.958 | 17.623 | 16.334 | 16.164 | 15.252 | 14.541 | 18.000 | | 16.376 | 16.600 | 15.294 | 15.744 |
| M20 | 2.5 | 19.958 | 19.623 | 18.344 | 18.164 | 16.891 | 16.625 | 20.000 | | 18.376 | 18.600 | 17.294 | 17.744 |
| M24 | 3 | 23.952 | 23.577 | 22.003 | 21.803 | 20.271 | 19.955 | 24.000 | | 22.051 | 22.316 | 20.752 | 21.252 |
| M30 | 3.5 | 29.947 | 29.522 | 27.674 | 27.462 | 26.158 | 25.189 | 30.000 | | 27.727 | 28.007 | 26.211 | 26.771 |





A
20

Technical data



Cylindrical GAS-BSP THREADS DIN 228 (thread limits)

| * | Z threads x 1" | Screw with tolerance of Classe B | | | | | | Nut screw | | | | | |
|----------|----------------------|----------------------------------|--------|---------------|--------|---------------|--------|--------------|---------------|---------------|--------|---------------|--------|
| | | Ø major d | | Ø pitch d2 | | Ø minor d1 | | Ø major D | | Ø pitch D2 | | Ø minor D1 | |
| | | max. | min. | max. | min. | max. | min. | min. | max. | min. | max. | min. | max. |
| G 1/8" | 28 | 9.728 | 9.514 | 9.147 | 8.933 | 8.566 | 8.298 | 9.728 | Not specified | 9.147 | 9.254 | 8.566 | 8.848 |
| G 1/4" | 19 | 13.157 | 12.907 | 12.301 | 12.051 | 11.445 | 11.133 | 13.157 | | 12.301 | 12.426 | 11.445 | 11.890 |
| G 3/8" | 19 | 16.662 | 16.408 | 15.806 | 15.552 | 14.950 | 14.632 | 16.662 | | 15.806 | 15.933 | 14.950 | 15.395 |
| G 1/2" | 14 | 20.955 | 20.671 | 19.793 | 19.509 | 18.631 | 18.276 | 20.955 | | 19.793 | 19.935 | 18.631 | 19.172 |
| G 5/8" | 14 | 22.911 | 22.627 | 21.749 | 21.465 | 20.587 | 20.232 | 22.911 | | 21.749 | 21.891 | 20.587 | 21.128 |
| G 3/4" | 14 | 26.441 | 26.157 | 25.279 | 24.995 | 24.117 | 23.762 | 26.441 | | 25.279 | 25.421 | 24.117 | 24.658 |
| G 7/8" | 14 | 30.201 | 29.917 | 29.039 | 28.755 | 27.877 | 27.522 | 30.201 | | 29.039 | 29.181 | 27.877 | 28.418 |
| G 1" | 11 | 33.249 | 32.889 | 31.770 | 31.410 | 30.291 | 29.841 | 33.249 | | 31.770 | 31.950 | 30.291 | 30.931 |
| G 1 1/8" | 11 | 37.897 | 37.537 | 36.418 | 36.058 | 34.939 | 34.489 | 37.897 | | 36.418 | 36.598 | 34.939 | 35.579 |
| G 1 1/4" | 11 | 41.910 | 41.550 | 40.431 | 40.071 | 38.952 | 38.502 | 41.910 | | 40.431 | 40.611 | 38.952 | 39.592 |
| G 1 3/8" | 11 | 44.323 | 43.963 | 42.844 | 42.484 | 41.365 | 40.915 | 44.323 | | 42.844 | 43.024 | 41.365 | 42.005 |
| G 1 1/2" | 11 | 47.803 | 47.443 | 46.324 | 45.964 | 44.845 | 44.395 | 47.803 | | 46.324 | 46.504 | 44.845 | 45.485 |
| G 1 3/4" | 11 | 53.746 | 53.386 | 52.267 | 51.907 | 50.788 | 50.338 | 53.746 | | 52.267 | 52.447 | 50.788 | 51.428 |
| G 2" | 11 | 59.614 | 59.254 | 58.135 | 57.775 | 56.656 | 56.206 | 59.614 | | 58.135 | 58.315 | 56.656 | 57.296 |

* G in accordance with UNI-ISO 228

$$P = \frac{25.4}{Z}$$

STRENGTH VALUES OF BOLTS/NUTS EN ISO 898-1 EN 20 898-2

| | Strength classes of bolts | | | | | | |
|---|---------------------------|-----|-----|-----|-----|------|------|
| | 4.6 | 5.6 | 5.8 | 6.8 | 8.8 | 10.9 | 12.9 |
| Nominal tensile strength Rm, Nenn N/mm ² | 400 | 500 | 500 | 600 | 800 | 1000 | 1200 |
| Lower yield point ReL N/mm ² | 240 | 300 | 400 | 480 | - | - | - |
| 0.2 % yield limit Rp 0.2 N/mm ² | - | - | - | - | 640 | 900 | 1080 |
| Tension under test force Sp N/mm ² | 225 | 280 | 380 | 440 | 580 | 830 | 970 |
| Elongation A % | 22 | 20 | - | - | 12 | 9 | 8 |

The strength class identification marking consists of two numerals:

- the first number corresponds to 1/100 of the nominal tensile strength in N/mm² (see table)
- the second number shows ten times the ratio of lower yield point ReL (or 0.2 % yield limit Rp 0.2) and nominal tensile strength Rm, nom (yield point ratio).

Example: Strength class 5.8 means Minimum tensile strength Rm = 500 N/mm²
 Minimum yield point ReL = 400 N/mm²

Also, multiplying both numerals results in 1/10 of the yield point in N/mm2

| | Strength classes of nuts | | | | |
|---|--------------------------|-----|-----|------|------|
| Nominal tension Sp N/mm ² for thread | 5 | 6 | 8 | 10 | 12 |
| below M 4 | 520 | 600 | 800 | 1040 | 1150 |
| Above M 4 below M 7 | 580 | 670 | 855 | 1040 | 1150 |
| Above M 7 below M 10 | 590 | 680 | 870 | 1040 | 1160 |
| Above M 10 below M 16 | 610 | 700 | 880 | 1050 | 1190 |
| Above M 16 below M 39 | 630 | 720 | 920 | 1060 | 1200 |

The designation of a strength class consists of a distinctive number which provides information of the test tension of the material used:

- distinctive number x 100 = test tension Sp
- the test tension is equal to the minimum tensile strength in N/mm² of a bolt which, if paired with the appropriate nut, can be loaded up to the minimum yield of the bolt.

Example: Bolt 8.8 - nut 8, connection can be loaded up to the minimum yield point of the bolt.



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This ISO Standard represents the basic for a system of nominal dimensions and sizes whereby the table mirrors the calculated values of basic tolerances relating to basic dimensions.

The use of this table is limited to smooth circular cylindrical workpieces or such with two parallel fitting planes or contact areas.

The values attributed to an ISO tolerance grade (IT) specify the tolerance value and hence the tolerance area. With ascending numbers, the size of the tolerance increases.

For identification purpose of the position of the tolerance area in relation to the nominal dimension (zero), the number chosen as tolerance grade IT is preceded by a letter.

Tolerance area H is the most common value for bores. It specifies that the minimum dimension of the bore corresponds to the nominal dimension.

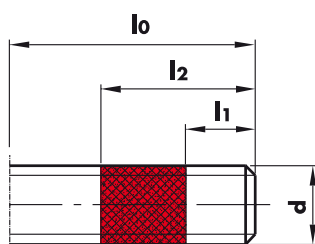
The permissible maximum dimension corresponds to the nominal dimension plus the IT tolerance.

Examples:

bore 20 H7 = 20 +0.021/0 bore 8 H11 = 8 +0.090/0
min. dimens.: 20.000 min. dimens.: 8.000
max. dimens.: 20.021 min. dimens.: 8.090

| ISO-Fundamental tolerance series DIN ISO 286 | | | | | | | | | | | | | |
|--|---------------|-------|--------|--------|--------|--------|--------|---------|---------|---------|---------|---------|---------|
| Tol. (µm) | Nominal sizes | | | | | | | | | | | | |
| | - | >3 | >6 | >10 | >18 | >30 | >50 | >80 | >120 | >180 | >250 | >315 | >400 |
| Grades | ... 3 | ... 6 | ... 10 | ... 18 | ... 30 | ... 50 | ... 80 | ... 120 | ... 180 | ... 250 | ... 315 | ... 400 | ... 500 |
| IT | | | | | | | | | | | | | |
| 01 | 0.3 | 0.4 | 0.4 | 0.5 | 0.6 | 0.6 | 0.8 | 1 | 1.2 | 2 | 2.5 | 3 | 4 |
| 0 | 0.5 | 0.6 | 0.6 | 0.8 | 1 | 1 | 1.2 | 1.5 | 2 | 3 | 4 | 5 | 6 |
| 1 | 0.8 | 1 | 1 | 1.2 | 1.5 | 1.5 | 2 | 2.5 | 3.5 | 4.5 | 6 | 7 | 8 |
| 2 | 1.2 | 1.5 | 1.5 | 2 | 2.5 | 2.5 | 3 | 4 | 5 | 7 | 8 | 9 | 10 |
| 3 | 2 | 2.5 | 2.5 | 3 | 4 | 4 | 5 | 6 | 8 | 10 | 12 | 13 | 15 |
| 4 | 3 | 4 | 4 | 5 | 6 | 7 | 8 | 10 | 12 | 14 | 16 | 18 | 20 |
| 5 | 4 | 5 | 6 | 8 | 9 | 11 | 13 | 15 | 18 | 20 | 23 | 25 | 27 |
| 6 | 6 | 8 | 9 | 11 | 13 | 16 | 19 | 22 | 25 | 29 | 32 | 36 | 40 |
| 7 | 10 | 12 | 15 | 18 | 21 | 25 | 30 | 35 | 40 | 46 | 52 | 57 | 63 |
| 8 | 14 | 18 | 22 | 27 | 33 | 39 | 46 | 54 | 63 | 72 | 81 | 89 | 97 |
| 9 | 25 | 30 | 36 | 43 | 52 | 62 | 74 | 87 | 100 | 115 | 130 | 140 | 155 |
| 10 | 40 | 48 | 58 | 70 | 84 | 100 | 120 | 140 | 160 | 185 | 210 | 230 | 250 |
| 11 | 60 | 75 | 90 | 110 | 130 | 160 | 190 | 220 | 250 | 290 | 320 | 360 | 400 |
| 12 | 100 | 120 | 150 | 180 | 210 | 250 | 300 | 350 | 400 | 460 | 520 | 570 | 630 |
| 13 | 140 | 180 | 220 | 270 | 330 | 390 | 460 | 540 | 630 | 720 | 810 | 890 | 970 |
| 14 | 250 | 300 | 360 | 430 | 520 | 620 | 740 | 870 | 1000 | 1150 | 1300 | 1400 | 1550 |
| 15 | 400 | 480 | 580 | 700 | 840 | 1000 | 1200 | 1400 | 1600 | 1850 | 2100 | 2300 | 2500 |
| 16 | 600 | 750 | 900 | 1100 | 1300 | 160 | 1900 | 2200 | 2500 | 2900 | 3200 | 3600 | 4000 |
| 17 | 1000 | 1200 | 1500 | 1800 | 2100 | 2500 | 3000 | 3500 | 4000 | 4600 | 5200 | 5700 | 6300 |
| 18 | 1400 | 1800 | 2200 | 2700 | 3300 | 3900 | 4600 | 5400 | 6300 | 7200 | 8100 | 8900 | 9700 |

| Tol. (µm) | Nominal sizes | | | | | | | | | | | | |
|------------------|---------------|------|------|-------|------|------|------|-------|-------|-------|-------|-------|-------|
| | ... | >3 | >6 | >10 | >18 | >30 | >50 | >80 | >120 | >180 | >250 | >315 | >400 |
| classes for bore | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... | ... |
| D9 | +45 | +60 | +76 | +93 | +117 | +142 | +174 | +207 | +245 | +285 | +330 | +370 | +415 |
| D12 | +120 | +150 | +190 | +230 | +275 | +330 | +400 | +470 | +545 | +630 | +720 | +810 | +900 |
| E8 | +28 | +38 | +47 | +59 | +73 | +89 | +106 | +126 | +148 | +172 | +200 | +225 | +255 |
| G6 | +8 | +12 | +14 | +17 | +20 | +25 | +29 | +34 | +39 | +44 | +50 | +56 | +63 |
| G7 | +2 | +4 | +5 | +6 | +7 | +9 | +10 | +12 | +14 | +15 | +18 | +20 | +22 |
| H7 | +10 | +12 | +15 | +18 | +21 | +25 | +30 | +35 | +40 | +46 | +52 | +58 | +65 |
| H8 | +14 | +18 | +22 | +27 | +33 | +39 | +46 | +54 | +63 | +72 | +81 | +90 | +100 |
| H9 | +25 | +30 | +36 | +43 | +52 | +62 | +74 | +87 | +100 | +115 | +130 | +140 | +155 |
| H11 | +60 | +75 | +90 | +110 | +130 | +160 | +190 | +220 | +250 | +290 | +320 | +360 | +400 |
| H12 | +100 | +120 | +150 | +180 | +210 | +250 | +300 | +350 | +400 | +460 | +520 | +570 | +630 |
| H13 | +140 | +180 | +220 | +270 | +330 | +390 | +460 | +540 | +630 | +720 | +810 | +900 | +1000 |
| H14 | +250 | +300 | +360 | +430 | +520 | +620 | +740 | +870 | +1000 | +1150 | +1300 | +1400 | +1550 |
| JS9 | ±12.5 | ±15 | ±18 | ±21.5 | ±26 | ±31 | ±37 | ±43.5 | ±50 | ±57.5 | ±66 | ±75 | ±84 |
| N9 | -4 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| P9 | -29 | -30 | -36 | -43 | -52 | -62 | -74 | -87 | -100 | -115 | -130 | -140 | -155 |
| for shaft | | | | | | | | | | | | | |
| f7 | -6 | -10 | -13 | -16 | -20 | -25 | -30 | -36 | -43 | -50 | -56 | -63 | -72 |
| h6 | -16 | -22 | -28 | -34 | -41 | -50 | -60 | -71 | -83 | -96 | -110 | -125 | -140 |
| h7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| h8 | -6 | -8 | -9 | -11 | -13 | -16 | -19 | -22 | -25 | -29 | -33 | -37 | -41 |
| h9 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| h11 | -10 | -12 | -15 | -18 | -21 | -25 | -30 | -35 | -40 | -46 | -52 | -58 | -65 |
| h13 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| h14 | -14 | -18 | -22 | -27 | -33 | -39 | -46 | -54 | -63 | -72 | -81 | -90 | -100 |
| js14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| n6 | -25 | -30 | -36 | -43 | -52 | -62 | -74 | -87 | -100 | -115 | -130 | -140 | -155 |
| p6 | ±125 | ±150 | ±180 | ±215 | ±260 | ±310 | ±370 | ±435 | ±500 | ±575 | ±660 | ±750 | ±840 |
| | +10 | +16 | +19 | +23 | +28 | +33 | +39 | +45 | +52 | +60 | +68 | +77 | +86 |
| | +4 | +8 | +10 | +12 | +15 | +17 | +20 | +23 | +27 | +31 | +35 | +39 | +43 |
| | +12 | +20 | +24 | +29 | +35 | +42 | +51 | +59 | +68 | +79 | +90 | +100 | +110 |
| | +6 | +12 | +15 | +18 | +22 | +26 | +32 | +37 | +43 | +50 | +57 | +64 | +72 |



$l_0 \approx$ length of thread

$l_1 \approx$ from 2 to 3 times the pitch (p) of the thread

$l_2 \approx$ 1.5 times the diameter (d) of the thread

MVK

Fixing the threads (by self-gluing).

Coating with microencapsulated hardener (red).

| d | l_1 | $l_2 \approx$ | Max screwing torque (Nm) | Min craking torque (Nm) | Max unscrewing torque (Nm) |
|-----|----------------|---------------|--------------------------|-------------------------|----------------------------|
| M5 | $1.5 \div 2.5$ | 7.5 | 1 | 1 | 6.5 |
| M6 | $2 \div 3$ | 9 | 1.5 | 1.8 | 10 |
| M8 | $2.5 \div 4$ | 12 | 3 | 4 | 26 |
| M10 | $3 \div 4.5$ | 15 | 5.5 | 10 | 55 |
| M12 | $3.5 \div 5$ | 18 | 7.5 | 16 | 95 |
| M16 | $4 \div 6$ | 24 | 14 | 35 | 250 |
| M20 | $5 \div 7.5$ | 30 | 22 | 45 | 500 |

The torque values respect the DIN 267 standard, part 27, and are based on clamping tests without preloading, with a 6H nut and at ambient temperature.

For a thread of $l_0 < l_2$, the length l_2 is reduced to the point that one or two of the last thread turns are left uncovered (l_1).

The glue is made up of a liquid plastic and a hardener contained in microcapsules of polymer coated with a red film visible on a part of the thread.

During the screwing operation, the capsules open under the pressure caused by the friction between the two threads.

The liquid plastic and the hardener react chemically with one another to lock the thread in position.

The setting and positioning operations must be completed within a period of about 5 minutes, as the glue will start to set after about 10-15 minutes. An initial hardening sufficient to fix the thread is reached after about 30 minutes while complete hardening of the fixture will take place over a period of 24 hours.

The threaded element glued in this way may be unlocked by applying a torque equivalent to the one indicated in the table for each thread or by heating the element up to a temperature of over 180°C.

Reuse after unlocking is not recommended.

Threads free of oil and grease guarantee the maximum fixing effect of the glue.

Elements treated with this glue may be stored for a period of up to 4 years, without any deterioration in their properties.

Threads with MVK microencapsulated glue are generally used on machines subjected to vibrations, in order to prevent spontaneous unscrewing.

Not suitable for adjusting bolts or screws.

This security aspect may be essential for certain applications of standard parts. Stock holding of liquid glue is eliminated.

Low torque.

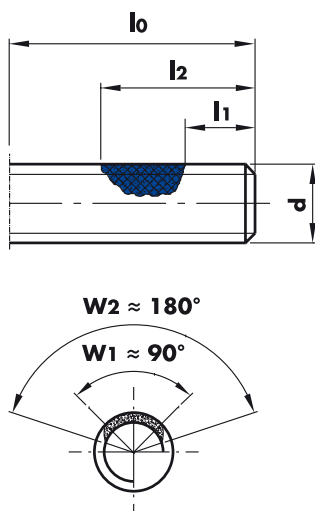
The working temperature range is from -40°C to +170°C.

To order an article with microencapsulated glue, add the abbreviation MVK to the product description.

Example:

Spring plunger

GN 615.3-M8-K-MVK



$l_0 \approx$ length of thread

$l_1 \approx$ from 2 to 3 times the pitch (p) of the thread

$l_2 \approx$ 1.5 times the diameter (d) of the thread

w_1 = coating core zone

w_2 = coating including edge zone

PFB

Fixing threads with locking action.

Polyamide-based coating (blue).

| d | l_1 | $l_2 \approx$ | Max screwing torque (Nm) | Min unscrewing torque (Nm) |
|-----|-----------|---------------|--------------------------|----------------------------|
| M3 | 1 ÷ 1.5 | 4.5 | 0.43 | 0.1 |
| M4 | 1.5 ÷ 2 | 6 | 0.9 | 0.15 |
| M5 | 1.5 ÷ 2.5 | 7.5 | 1.0 | 0.2 |
| M6 | 2 ÷ 3 | 9 | 2.0 | 0.5 |
| M8 | 2.5 ÷ 4 | 12 | 4.0 | 1.0 |
| M10 | 3 ÷ 4.5 | 15 | 5.0 | 1.5 |
| M12 | 3.5 ÷ 5 | 18 | 7.0 | 2.3 |
| M16 | 4 ÷ 6 | 24 | 10.0 | 4 |

The torque values are based on clamping tests without preloading, with a 6H nut and at ambient temperature.

For a thread of $l_0 < l_2$, the length l_2 is reduced to the point that one or two of the last thread turns are left uncovered (l_1).

Application of the PFB polyamide-based coating is a process in which the elastic plastic (polyamide) is applied to a part of the thread, to create a locking action while a screw is being tightened.

The play between the screw and the nut screw is filled with polyamide, thus ensuring a high degree of contact between the remaining uncoated threaded surfaces. The coating contrasts accidental unlocking and accidental unscrewing. The parts locked together may always be separated by applying a minimum unlocking torque.

There is no need to wait for it to be activated as the locking action between the threads is instantaneous.

Elements threaded with PFB polyamide-based coating may be stored for a virtually unlimited period.

Features.

High thread locking action.

Excellent for adjusting bolts.

This security aspects may be essential for certain applications of standard parts.

Stock holding of liquid glue is eliminated.

Multi use is possible whereby the jamming effect after the 5th removal is still around 50% of its original strength.

The working temperature range is from -50°C to +90°C.

To order an article with the polyamide-based coating, add the abbreviation PFB to the product description.

Example:

Spring plunger

GN 615.3-M8-K-PFB

**A
24****Technical data**

PROPERTIES OF METAL MATERIALS

STAINLESS STEELS

| Description | AISI 303 | AISI 304+Cu | AISI 304 | AISI 316 | AISI 316 LHC | AISI 301 | AISI 302 | AISI CF-8 |
|--|--|--|---|---|---|---|---|---|
| Designation in accordance with EN 10088-1-2-3 EN 10283 (AISI CF-8) SINT C40 (AISI 316 LMC) | X 8 CrNiS 18-9 | X 3 CrNiCu 18-9-4 | X 5 CrNi 18-10 | X 5 CrNiMo 17-12 | Sint C40 X 2 CrNiMo 17-12-2 | EN 100088-1;2;3 X10CrNi 18-8 | X 10 CrNi 18-09 | EN 10283 GX5CrNi 19-10 |
| % components of alloy | C ≤ 0.10 Si ≤ 1.0 Mn ≤ 2.0 P ≤ 0.045 S ≤ 0.15 ÷ 0.35 Cr 17.0 ÷ 19.0 Ni 8.0 ÷ 10.0 | C ≤ 0.04 Si ≤ 1.0 Mn ≤ 2.0 P ≤ 0.045 S ≤ 0.030 Cr 17.0 ÷ 19.0 Ni 8.5 ÷ 10.5 | C ≤ 0.07 Si ≤ 1.0 Mn ≤ 2.0 P ≤ 0.045 S ≤ 0.030 Cr 17.0 ÷ 19.5 Ni 8.0 ÷ 10.5 | C ≤ 0.08 Si ≤ 1.0 Mn ≤ 2.0 P ≤ 0.045 S ≤ 0.030 Cr 16.0 ÷ 18.5 Ni 10.0 ÷ 13.0 | C ≤ 0.08 Si ≤ 0.9 Mn ≤ 0.1 Mo ≤ 2.0 ÷ 4.0 Cr 16.0 ÷ 19.0 Ni 10.0 ÷ 14.0 | C ≤ 0.05 ÷ 0.15 Si ≤ 2.0 Mn ≤ 2.0 P ≤ 0.045 S ≤ 0.015 Cr 16.0 ÷ 19.0 Mo ≤ 0.8 Ni 6.0 ÷ 9.5 | C ≤ 0.08 Si ≤ 0.6 Mn ≤ 1.2 Cr 18.0 Ni 9.0 | C ≤ 0.07Si ≤ 2.0 Si ≤ 1.5 Mn ≤ 1.5 P ≤ 0.04 S ≤ 0.03 Cr 18.0 ÷ 20.0 Ni 8.0 ÷ 11.0 |
| Minimum load at breakage Rm N/mm ² | 500 - 700 | 450 - 650 | 500 - 700 | 500 - 700 | 330 | 500 - 750 | 600 - 800 | 440 - 640 |
| Yield point Rp 0.2 n/mm ² | ≥ 190 | ≥ 175 | ≥ 190 | ≥ 205 | ≥ 250 | ≥ 195 | ≥ 210 | ≥ 175 |
| Machinability | Very good | Excellent | Fair | Fair | - | Poor | Good | Medium |
| Forgeability | Poor | Good | Good | Good | - | Good | Poor | - |
| Suitability for welding | Poor | Very good | Excellent | Good | - | Good | Poor | Good |
| Special features | Non-magnetic structure Excellent for machining on automatic machines | Non-magnetic structure suitable for low temperatures | Non-magnetic structure suitable for low temperatures may be used at up to 700 °C | Magnetic structure suitable for low temperatures | Non-magnetic structure | Austenitic structure | Magnetic structure suitable for low temperatures | Antimagnetic, austenitic structure |
| Corrosion resistance | Fair Due to sulphur content, use in environments containing acids or chlorides should be avoided. | Very good Resistant to corrosion in natural environments: water, urban or country climates with no significant concentrations of chlorides, in the food industry. | Good Resistant to corrosion in natural environments: water, urban or country climates with no significant concentrations of chlorides, in the food industry. | Excellent Resistant to corrosion also in marine environments or wet environments and in the presence of acids. | Medium By virtue of its coarser porosity the corrosion resistance is in general reduced as compared with stainless steel. Reservations especially in acid and salty environment. | Good Corrosion resistant in a natural environment; water, rural, urban and industrial atmosphere. | Fair | Good Corrosion resistant. Material is to a large extent comparable with AISI 304 |
| Main fields of application | Construction of vehicles. Electronics. Furniture finishings. | Food, chemical and pharmaceutical industries. Agriculture. Construction of machines. Electronics. Shipping. Furniture finishings | Food, chemical and pharmaceutical industries. Agriculture. Construction of vehicles and machines. Building. Furniture finishings. | Food and chemical industries. Ship building and manufacture of components for marine environments or use in highly corrosive conditions. | Chemical, cellulose and paper industry. Paint, oil, soap and textile industry. Daires. Breweries. | Springs for temperature up to 300 °C. Tools (knives). Sheet metal for vehicles automotive industry. Chemical and food industry. | Used for the manufacture of springs in various fields of application. | Food, beverage and packing industry. Armatures. Pumps. Mixers. |

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PROPERTIES OF METAL MATERIALS

CARBON STEELS, ZINC ALLOYS, ALUMINIUM AND BRASS

| Description | Steel for threaded studs | Steel for threaded studs | Zinc alloy for pressure die-casting | Aluminium for handle tubes | Brass for bosses with threaded or plain hole | Brass for reinforcing square holes |
|--------------------------------|--|---|---|---|---|---|
| Designation | 11SMnPb37 | C10C U+C | ZnAl4Cu1 | Alloy EN AW-6060 | Brass CW614N | Brass CW508L |
| UNI standard | UNI EN 10277 : 2000 | UNI EN 10263-2 : 2003 | UNI EN 1774 : 1999 | UNI EN 573-3 | UNI EN 12164 | EN 12449 : 99 |
| % components of alloy | C ≤ 0.14 Pb ≤ 0.20-0.35 Si ≤ 0.05 Mn 1.00 ÷ 1.50 P ≤ 0.11 S 0.340.40 Fe rest | C 0.08-0.12 Si ≤ 0.10 Mn 0.30-0.50 P ≤ 0.025 S ≤ 0.025 Al 0.02-0.06 Fe rest | Cu 0.7-1.1 Pb ≤ 0.003 Fe ≤ 0.020 Al 3.8-4.2 Sn ≤ 0.001 Si ≤ 0.02 Ni ≤ 0.001 Mg 0.035-0.06 Cd ≤ 0.003 Zn rest | Si 0.03-0.6 Fe 0.1-0.3 Cu ≤ 0.10 Mn ≤ 0.10 Mg 0.035-0.06 Cr ≤ 0.05 Zn ≤ 0.15 Ti ≤ 0.10 Total impurities ≤ 0.15 Al rest | Cu 57-59 Pb 2.5-3.5 Fe ≤ 0.30 Al ≤ 0.05 Sn ≤ 0.30 Si ≤ 0.90 Ni ≤ 0.30 Total impurities ≤ 0.20 Zn rest | Cu 62-64 Pb ≤ 0.10 Fe ≤ 0.10 Al ≤ 0.05 Sn ≤ 0.10 Ni ≤ 0.30 Total impurities ≤ 0.10 Zn rest |
| Tensile breaking load Rm [MPa] | 400-650 | 510-520 | 280-350 | 120-190 | 490-530 | 340-360 |
| Yield point Rp 0.2 [MPa] | ≤ 305 | / | 220-250 | 60-150 | / | / |
| Modulus of elasticity [Mpa] | / | / | 100000 | 67000 | 100000 | 103400 |
| Ultimate elongation % | 9 | 58 | 2-5 | 16 | 12-16 | 45 |
| Special features | Steel for high-speed machining. Used for parts obtained by turning. | Steel for moulding. | | | Brass for high-speed machining. Used for parts obtained by turning. | Brass for machining with good plastic deformability. |

PROPERTIES OF PLASTIC MATERIALS

Resistance to chemical agents at ambient temperature (23°C)

DUROPLAST

- = good resistance
- = fair resistance (limited use according to working conditions)
- ▲ = poor resistance (should not be used)

Blanks stand for data not available

| CHEMICAL AGENTS RESISTANCE | DUROPLAST (PF) | PAINTED DUROPLAST CLEAN |
|---|----------------|-------------------------|
| Alcohol (methanol, ethanol, isopropanol...) | ● | ● |
| Boiling water | □ | □ |
| Edible oils | ● | ● |
| Esters (methyl acetate, ethyl acetate, ...) | ● | |
| Ether (ethyl eter, oil ether, ...) | ● | |
| Fat | ● | |
| Ketons (acetone) | ● | ● |
| Mineral oils | ● | ● |
| Petrol, gas oil, benzene | ● | ● |
| Strong acids (hydrochloric, nitric, sulphuric, ...) | ▲ | ▲ |
| Strong alkali | ▲ | ▲ |
| Toluene | ● | □ (milk effect) |
| Water | ● | ● |
| Weak acids (butyric, oleic, lactic, ...) | □ | |
| Weak alkali | □ | |
| Xylene | ● | □ (milk effect) |

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PROPERTIES OF PLASTIC MATERIALS

Resistance to chemical agents at ambient temperature (23°C)

TECNOPOLYMERS AND RUBBERS

| CHEMICAL AGENTS AND SOLVENTS | Polyamide (PA) | | | Transparent polyamide (PA-T) | | | Alcohol-Resistant transparent polyamide (PA-T AR) | | | Polypropylene (PP) | | | Acetal resin (POM) | | | Soft-Touch thermoplastic elastomer (TPE) | | Rubber NBR | | | Flourated Rubber FKM | | |
|---------------------------------|-------------------|---------|------|------------------------------------|---------|------|---|---------|------|-----------------------|---------|------|-----------------------|---------|------|--|------|---------------|---------|------|-------------------------|---------|------|
| | notes | conc. % | 23°C | notes | conc. % | 23°C | notes | conc. % | 23°C | notes | conc. % | 23°C | notes | conc. % | 23°C | notes | 23°C | notes | conc. % | 23°C | notes | conc. % | 23°C |
| Acetic acid | Sol. | 10 | ● | Sol. | 10 | ● | Sol. | 10 | □ | | 40 | ● | Sol. | 20 | ▲ | | ● | | | ▲ | | | ▲ |
| Acetone | | 100 | ● | | | □ | | | ● | | | ● | | | ● | | ● | | | ▲ | | | ▲ |
| Acrylonitrile | | 100 | ● | | | ▲ | | | ▲ | | | | | | □ | | ▲ | | | ▲ | | | ▲ |
| Alimentary oils | | | ● | | | ● | | ● | | | | ● | | | ● | Up to 60°C | ● | | ● | | | | ● |
| Aluminium chloride | Sol. | 10 | ● | | | ● | | | ● | | | ● | | | | | ● | Sol. | | ● | Sol. | | ● |
| Aluminium sulphate | Sol. | 10 | ● | Sol. | 10 | ● | Sol. | 10 | ● | | | ● | | | | | ● | Sol. | | ● | Sol. | | ● |
| Ammonia | Sol. | 10 | ● | Sol. | 10 | ● | Sol. | 10 | ● | Conc. | | ● | | | | □ | | Sol. | | □ | Sol. | | ▲ |
| Ammonia - gaseous | | | □ | | | ● | | | ● | | | ● | | | | □ | | | | ● | | | ▲ |
| Ammonium chloride | Sol. | 10 | ● | Sol. | 10 | ● | Sol. | 10 | ● | | | ● | Sol. | 10 | ● | | ● | | | ● | Sol. | | ● |
| Amyl alcohol | | 100 | ● | | | ▲ | | | ● | | | ● | | | ● | | ● | | | ● | | | ● |
| Aniline | | 100 | □ | | | ▲ | | | ▲ | | | ● | | | ● | | ▲ | | | ▲ | | | ● |
| Beer | | | ● | | | ● | | | ● | | | ● | | | ● | | ● | | | ● | | | ● |
| Benzoic acid | Sol. | Sat. | □ | Sol. | 10 | ▲ | Sol. | 10 | □ | | Sat. | ● | | | | Up to 60°C | ● | Sol. | | □ | Sol. | | ● |
| Benzol/benzene | | 100 | | | | ● | | | ● | | | ▲ | | | ● | | ▲ | | | ▲ | | | ● |
| Boiling water | Swell. | | □ | Swell. | | □ | Swell. | | □ | | | ● | | | | □ | | | □ | | | | □ |
| Boric acid | Sol. | 10 | ● | | | □ | | | □ | | Sat. | ● | | | | | ● | Sol. | | ● | | | ● |
| Butter | | | ● | | | ● | | | ● | | | ● | | | ● | | ● | | | ● | Sol. | | ● |
| Butyl acetate | | 100 | ● | | 100 | ● | | 100 | ● | | | ● | | | | | □ | | | | | | |
| Butyl alcohol | | 100 | ● | | | ▲ | | | ● | | | ● | | | ● | | ● | | | ● | | | ● |
| Calcium chloride | Sol. | 10 | ● | | | ● | | | ● | Sol. | 50 | ● | | | ● | | ● | Sol. | | ● | Sol. | | ● |
| Carbon disulphide | | 100 | ● | | | | | | | | | ● | | | | | ▲ | | | ▲ | | | ● |
| Carbon tetrachloride | | | ● | | | □ | | | ● | | | ▲ | | | ● | | ▲ | | | ▲ | | | ● |
| Caustic soda 10% | Sol. | 5,10 | ● | Sol. | 5,10 | ● | Sol. | 5,10 | ● | Sol. | 5,10 | ● | Sol. | 10 | ● | | ● | Sol. | 5,10 | □ | Sol. | 5,10 | ▲ |
| Caustic soda 50% | Sol. | 50 | □ | Sol. | 50 | ● | Sol. | 50 | ● | Sol. | 50 | ● | | | | | ● | Sol. | 50 | ▲ | Sol. | 50 | ▲ |
| Citric acid | Sol. | 10 | □ | Sol. | 10 | □ | Sol. | 10 | □ | | 10 | ● | | | ● | Up to 60°C | ● | Sol. | | ● | Sol. | | ● |
| Cloroform | | 100 | ● | | | ▲ | | | ▲ | | | ▲ | | | | | ▲ | | | ▲ | | | ● |
| Copper sulphate | Sol. | 10 | ● | | | | | | | | | ● | | | ● | | ● | Sol. | | ● | Sol. | | ● |
| Dichloropropan | | | | | | | | | | | | □ | | | | | ▲ | | | | | | |
| Distilled water | | | ● | | | ● | | | ● | | | ● | | | ● | | ● | | | ● | | | ● |
| Edible fat | | | ● | | | ● | | | ● | | | | | | ● | | ● | | | ● | | | |
| Ethyl acetate | | 100 | ● | | 100 | ● | | 100 | ● | | | ● | | | ● | | □ | | | ▲ | | | |
| Ethyl alcohol | | 96 | ● | | | ▲ | | | ● | | 96 | ● | | | ● | | ● | | | □ | | | □ |
| Ethyl chloride | | 100 | ● | | | ▲ | | | ▲ | | | ▲ | | | | | | | | ● | | | ● |
| Ethyl ether | | 100 | ● | | | ● | | | ● | | | ● | | | | | ▲ | | | □ | | | ▲ |
| Ethylene glycol | | | ● | | | ▲ | | | □ | | | ● | | | | | □ | | | ● | | | ● |
| Ferric chloride | Sol. | 10 | ● | | | ● | | | ● | | | ● | | | ● | | ● | Sol. | | ● | Sol. | | ● |
| Formaldehyde (formalin) | Sol. | 30 | ● | Sol. | 40 | □ | Sol. | 40 | ● | Sol. | 40 | ● | | | | | ▲ | Sol. | 40 | ● | Sol. | 40 | ● |
| Formic acid | Sol. | 10 | ● | Sol. | | ▲ | Sol. | | ▲ | Sol. | 10 | ● | | 100 | ▲ | Up to 60°C | ● | Sat. | | ● | Sat, | | ▲ |
| Freon 11 | | | | | | | | | | | | □ | | | ● | | | | | ● | Sol. | | □ |
| Freon 12 | Liq. | | ● | | | ● | | | ● | | | □ | | | ● | | | | | ● | | | □ |
| Freon 13 | | | | | | | | | | | | □ | | | ● | | | | | ● | | | ● |
| Gas oil | | | ● | | | ● | | | ● | | | ● | | | ● | | ▲ | | | ● | | | ● |
| Glycerine | | | ● | | | ● | | | ● | | | ● | | | | | ▲ | | | ● | | | ● |
| Glycol butylene | | 100 | ● | | | ▲ | | | □ | | | | | | | | □ | | | ● | | | ● |
| Hydrochloric acid | Sol. | 10 | ▲ | Sol. | 10 | □ | Sol. | 10 | □ | Sol. | 30 | ● | Sol. | 10 | ▲ | Up to 60°C | ● | | 10 | □ | | 10 | ● |
| Hydrofluoric acid | Sol. | 40 | ▲ | Sol. | 10 | ▲ | Sol. | 10 | ▲ | Sol. | 40 | ● | | | ▲ | | □ | | 50 | ▲ | Sol. | 50 | ● |
| Hydrogen peroxide | Sol. | 3 | ▲ | Sol. | 3 | ▲ | Sol. | 3 | ▲ | | 30 | ● | Sol. | 90 | ▲ | | □ | Sol. | 80 | ▲ | Sol. | 80 | □ |
| Iodine tincture-alcoholic | | | ▲ | | | ▲ | | | ▲ | | | ● | | | | | ● | | | | | | |
| Isopropyl alcohol | | | ● | | | ▲ | | | ● | | | ● | | | ● | | ● | | | □ | | | ● |

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- = good resistance
- = fair resistance (limited use according to working conditions)
- ▲ = poor resistance (should not be used)

Blanks stand for data not available

- Conc. = concentration
- Sol. = solution
- Liq. = liquid
- Sat. = saturated
- Swell. = swelling

| CHEMICAL AGENTS AND SOLVENTS | Polyamide (PA) | | | Transparent polyamide (PA-T) | | | Alcohol-Resistant transparent polyamide (PA-T AR) | | | Polypropylene (PP) | | | Acetal resin (POM) | | | Soft-Touch thermoplastic elastomer (TPE) | | Rubber NBR | | | Flourated Rubber FKM | | |
|--|-------------------|---------|------|------------------------------------|---------|------|---|---------|------|-----------------------|---------|------|-----------------------|---------|------|--|------|---------------|---------|------|-------------------------|---------|------|
| | notes | conc. % | 23°C | notes | conc. % | 23°C | notes | conc. % | 23°C | notes | conc. % | 23°C | notes | conc. % | 23°C | notes | 23°C | notes | conc. % | 23°C | notes | conc. % | 23°C |
| Kerosene | | | ● | | | ● | | | ● | | | □ | | | ● | | ▲ | | | ● | | | ● |
| Lactic acid | Sol. | 10 | ● | Sol. | 10 | □ | Sol. | 10 | □ | Sol. | 20 | ● | | | ● | Up to 60°C | ● | Sol. | | ● | Sol. | | ● |
| Linseed oil | | | ● | | | ● | | | ● | | | ● | | | ● | Up to 60°C | ● | | | ● | | | ● |
| Magnesium chloride | Sol. | 10 | ● | | | ● | | | ● | Sol. | Sat. | ● | | | ● | | ● | Sol. | | ● | Sol. | | ● |
| Mercuric chloride | Sol. | 6 | ● | | | | | | | | | ● | | | | | ● | | | | | | |
| Mercury | | | ● | | | ● | | | ● | | | ● | | | | | ● | | | ● | | | ● |
| Methyl acetate | | 100 | ● | | 100 | ● | | 100 | ● | | | | | | | | □ | | | | | | ● |
| Methyl alcohol | | 100 | ● | | | ▲ | | | ● | | 100 | ● | | | ● | | ● | | | □ | | | ▲ |
| Methyl ethyl ketone | | | ● | | | ▲ | | | ● | | | □ | | | ▲ | | ▲ | | | ▲ | | | ▲ |
| Methylene chloride | | 100 | ● | | | ▲ | | | ▲ | | | □ | | | | | ▲ | | | ▲ | | | ● |
| Milk | | | ● | | | ● | | | ● | | | ● | | | ● | | ● | | | ● | | | ● |
| Mineral oil | | | ● | | | ● | | | ● | | | ● | | | ● | Up to 60°C | ● | | | ● | | | ● |
| Nitric acid | | 10 | ▲ | Sol. | 2 | □ | Sol. | 2 | □ | Sol. | 10 | ● | Sol. | 10 | ▲ | | □ | Sol. | 10 | □ | Sol. | 10 | □ |
| Oil | | | ● | | | ● | | | ● | | | □ | | | ● | | ▲ | | | ● | | | ● |
| Oil ether | | | ● | | | ● | | | ▲ | | | ● | | | ● | | ▲ | | | | | | |
| Oils for transformers | | | ● | | | ● | | | ● | | | □ | | | ● | Up to 60°C | □ | | | ● | | | ● |
| Oleic acid | | 100 | ● | | | ● | | | ● | Sol. | | ● | | | ● | Up to 60°C | ● | | | □ | | | |
| Paraffin oil | | | ● | | | ● | | | ● | | | ● | | | | Up to 60°C | ● | | | ● | | | ● |
| Petrol | | | ● | | | ● | | | ● | | | □ | | | ● | | ▲ | Swell. | | □ | | | ● |
| Petrol vapor | | | ● | | | ● | | | ● | Swell. | | □ | | | ● | | ▲ | | | □ | | | ● |
| Phenol | Sol. | | ▲ | | | ▲ | | | ▲ | | | ● | | | ▲ | | ▲ | | | ▲ | | | ● |
| Phosphoric acid | Sol. | 10 | ▲ | | | ▲ | | | ▲ | Sol. | 85 | ● | Sol. | 10 | ▲ | Up to 60°C | ● | Sol. | 20 | □ | Sol. | 20 | ● |
| (Caustic Potash) Potassium hydroxide 50% | Sol. | 50 | ● | Sol. | 50 | ● | Sol. | 50 | ● | Sol. | 50 | ● | | | | | ● | Sol. | 50 | ● | Sol. | 50 | ▲ |
| (Caustic Potash) Potassium hydroxide 10% | Sol. | 5,10 | ● | Sol. | 5,10 | ● | Sol. | 5,10 | ● | Sol. | 5,10 | ● | Sol. | 10 | □ | | ● | Sol. | 5,10 | □ | Sol. | 5,10 | ▲ |
| Potassium nitrate | Sol. | 10 | ● | Sol. | 10 | ● | Sol. | 10 | ● | Sat. | | ● | | | | | ● | | | ● | | | ● |
| Sea, river and drinkable water | | | ● | | | ● | | | ● | | | ● | | | ● | | ● | | | ● | | | ● |
| Silicone oil | | | ● | | | ● | | | ● | | | ● | | | | | | | | ● | | | ● |
| Silver nitrate | | | ● | Sol. | 10 | ● | Sol. | 10 | ● | Sol. | 20 | ● | | | | | ● | Sol. | | □ | | | |
| Soap solution | Sol. | | ● | Sol. | | ● | Sol. | | ● | Sol. | | ● | | | ● | | ● | Sol. | | ● | Sol. | | ● |
| Sodium carbonate | Sol. | 10 | ● | | | ● | | | ● | Sol. | Sat. | ● | | | ● | | ● | Sol. | | ● | Sol. | | ● |
| Sodium chloride | Sol. | 10 | ● | Sol. | 25 | ● | Sol. | 25 | ● | Sol. | Sat. | ● | | | ● | | ● | Sol. | | ● | Sol. | | ● |
| Sodium hypochlorite | Sol. | | ● | | | ▲ | | | ▲ | Sol. | 20 | ● | Sol. | 5 | ▲ | | ● | Sol. | 10 | ▲ | Sol. | 10 | ● |
| Sodium nitrate | Sol. | 10 | ● | Sol. | 10 | ● | Sol. | 10 | ● | Sat. | | ● | | | | | ● | | | ● | | | ● |
| Sodium silicate | | | ● | | | | | | ● | | | ● | | | | | ● | Sol. | | ● | Sol. | | ● |
| Sodium sulphate | Sol. | 10 | ● | Sol. | 10 | ● | Sol. | 10 | ● | | | ● | | | ● | | ● | Sol. | | ● | Sol. | | ● |
| Steam | | | ● | | | ● | | | ● | | | ● | | | | | ● | | | □ | | | ● |
| Sulphuric acid | Sol. | 10 | ▲ | Sol. | 2 | ● | Sol. | 2 | ● | | 98 | ● | Sol. | 10 | ▲ | Up to 60°C | ● | Sol. | 20 | □ | Sol. | 20 | ● |
| Tartaric acid | | | ● | Sol. | | □ | Sol. | | □ | Sol. | 10 | ● | | | ● | Up to 60°C | ● | Sol. | | ● | Sol. | | ● |
| Tetralin | | | ● | | | ● | | | ● | | | ▲ | | | | | ▲ | | | ▲ | | | ● |
| Toluol/toluene | | | ● | | | ● | | | ● | | | □ | | | ● | | ▲ | | | ▲ | | | □ |
| Trichloroethylene | | | □ | | | ● | | | ● | | | ▲ | | | | | ▲ | | | ▲ | | | □ |
| Unleaded petrol | | | ● | | | ● | | | ● | Swell. | | □ | | | ● | | ▲ | Swell. | | □ | | | ● |
| Vaseline | | | ● | | | ● | | | ● | | | ● | | | | | □ | | | ● | | | ● |
| Vinegar | | | | | | | | | | | | ● | | | | | ● | | | □ | | | □ |
| Whisky | | | ● | | | □ | | | ● | | | ● | | | ● | | ● | | | ● | | | ● |
| Wine | | | ● | | | ● | | | ● | | | ● | | | ● | | ● | | | ● | | | ● |
| Xiyol | | | ● | | | ● | | | ● | | | ▲ | | | ● | | ▲ | | | ▲ | | | ● |
| Zinc chloride | | 10 | □ | Sol. | 50 | ● | Sol. | 50 | ● | Sol. | 20 | ● | | | ● | | ● | Sol. | | ● | Sol. | | ● |

The characteristics described should be treated as guidelines only. No guarantee is made.
The user is responsible for checking the exact operating conditions.

MATERIAL PROPERTIES OF ELASTOMERS (rubber)

| International symbol | NBR | CR | FKM - FPM | TPE | PUR |
|---------------------------------------|--|--------------------|-----------------|----------------------|-----------------|
| Brand name (e.g.) | Perbunan® | Neoprene® | Viton® | SANTOPRENE® | Bayflex® |
| Chemical name | Acrylonitrile-butadiene rubber | Chloroprene rubber | Fluorine rubber | Thermoplastic rubber | Polyurethane |
| Hardness (Shore A) | 25 to 95 | 30 to 90 | 65 to 90 | 55 to 87 | 65 to 90 |
| Temperature resistance | | | | | |
| short-term | -40° to +150°C | -30° to +150°C | -30° to +280°C | -40° to +150°C | -40° to +130°C |
| long-term | -30° to +120°C | -20° to +120°C | -20° to +230°C | -30° to +125°C | -25° to +100°C |
| Tensile strength [N/mm ²] | 25 | 25 | 20 | 8.5 | 20 |
| Wear / Abrasion resistance | good | good | good | good | excellent |
| Resistance to: | | | | | |
| oil, grease | outstanding | good | good | good | very good |
| solvents | good in part | good in part | very good | outstanding | satisfactory |
| acids | restricted | good | very good | outstanding | not suitable |
| caustic solutions | good | very good | very good | outstanding | not suitable |
| fuels | good | slight | outstanding | good | good |
| general | <p><i>NBR is a synthetic special rubber for rubber parts with high requirements for resistance to swelling when in contact with oils and fuels.</i></p> <p><i>Standard material for O-rings.</i></p> | | | | |
| | <p><i>CR is one of the most frequently used synthetic rubbers with a wide range of applications for parts which require exceptional resistance to ageing, atmospheric and environmental influences.</i></p> | | | | |
| | <p><i>FPM is unmatched for applications with contact to fuels, oils, solvents, as well as many acids and caustic solutions; resistant to atmospheric and environmental influences.</i></p> <p><i>Due to its high price its use is restricted to high quality rubber parts which are exposed to extremely heavy wear.</i></p> | | | | |
| | <p><i>SANTOPRENE® is a thermoplastic rubber, the performance characteristics of which are comparable to those of many customary vulcanised special rubbers.</i></p> <p><i>SANTOPRENE® is a multi-purpose material with outstanding dynamic fatigue life and excellent resistance to ozone and atmospheric influences (environmental influences).</i></p> | | | | |
| | <p><i>PUR is known for exceptionally good mechanical characteristics with very good resistance to atmospheric and environmental influences.</i></p> <p><i>In addition, the extreme resistance to tearing and to wear, should also be mentioned.</i></p> | | | | |

The characteristics described should be treated as guidelines only. No guarantee is made. The exact conditions of use have to be taken into account individually.

Perbunan® and **Bayflex®** are registered trade-marks of Bayer. - **Viton®** is a registered trade-mark of DuPont Dow Elastomer.

Neoprene® is a registered trade-mark of DuPont SBR. - **SANTOPRENE®** is a registered trade-mark of Advanced Elastomer Systems.

[illegible]