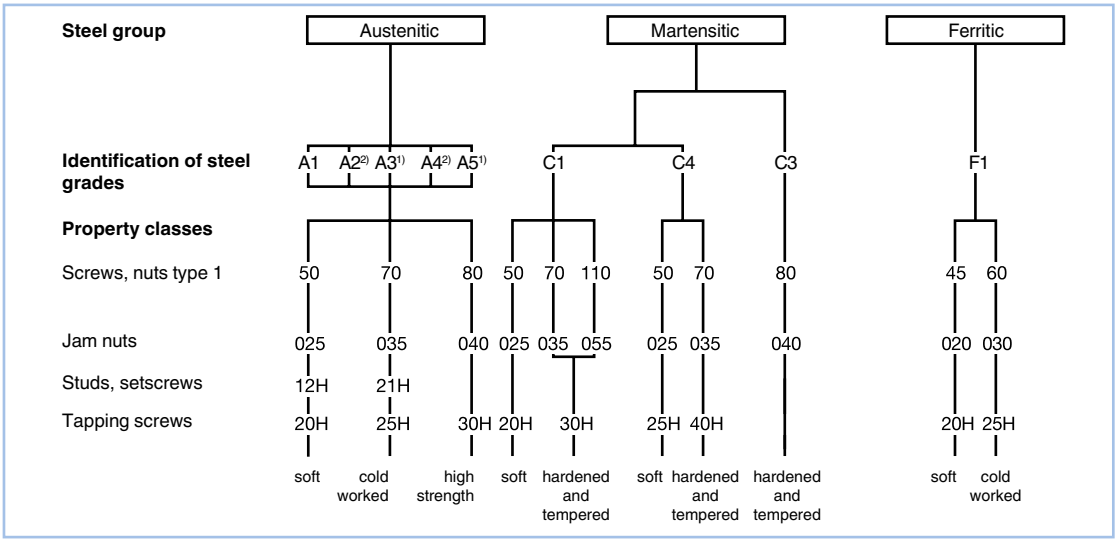
## ISO-designated steel groups

according to ISO 3506




[1] Stabilized against intergranular corrosion through addition of titanum, possibly niobium, tantalum.
[2] Low carbon austenitic stainless steels with carbon content not exceeding 0,03 % may additionally be marked with an «L», e.g. A4L-80.

Descriptions using a letter/figure combination mean the following:

**A2 – 70**

**Abbreviation of composition group:**
**A** = austenitic chromium-nickel steel

**Abbreviation of chemical composition:**
**1** = free-cutting steel with sulphur additive
**2** = cold-heading steel alloyed with chromium and nickel
**3** = cold-heading steel alloyed with chromium and nickel stabilised with Ti, Nb, Ta
**4** = cold-heading steel alloyed with chromium, nickel and molybdenum
**5** = cold-heading steel alloyed with chromium, nickel and molybdenum stabilized with Ti, Nb, Ta

**Abbreviation of property class:**
**50** = 1/10 of tensile strength (min. 500 N/mm²)
**70** = 1/10 of tensile strength (min. 700 N/mm²)
**80** = 1/10 of tensile strength (min. 800 N/mm²)

**Thin nuts:**
025 = proof stress min. 250 N/mm²
035 = proof stress min. 350 N/mm²
040 = proof stress min. 400 N/mm²

The designation of the steel grade (first block) consists of one of the letters:
– **A** for austenitic steel
– **C** for martensitic steel
– **F** for ferritic steel

Example: **A2-70** indicates: austenitic steel, cold worked, min. 700 N/mm² tensile strength
**C4-70** indicates: martensitic steel, hardened and tempered, min. 700 N/mm² tensile strength

The designation of the property class consists of two digits representing 1/10 of the tensile strength of the fasteners respectively 1/10 of the proof load of the nuts.

If fastener elements are classified over the hardness, the hardness class is given according to Vickers by 2 digits standing for 1/10 of the minimum hardness value. The letter H refers to the hardness.

Designation example of a minimum hardness 250 HV: **A4 25 H, austenitic steel, work hardened**

## Chemical composition of austenitic stainless steels

according to ISO 3506

More than 97 % of all fasteners made from stainless steels are produced from this steel composition group. They are characterised by impressive corrosion resistance and excellent mechanical properties.

Austenitic stainless steels are divided into 5 main groups whose chemical compositions are as follows:

| Steel group | Chemical composition in % (maximum values, unless otherwise indicated) | | | | | | | | | Notes |
|---|---|---|---|---|---|---|---|---|---|---|
| | C | Si | Mn | P | S | Cr | Mo | Ni | Cu | |
| A1 | 0,12 | 1,0 | 6,5 | 0,200 | 0,15–0,35 | 16–19 | 0,7 | 5–10 | 1,75–2,25 | 2) 3) 4) |
| A2 | 0,10 | 1,0 | 2,0 | 0,050 | 0,03 | 15–20 | – | 8–19 | 4 | 5) 6) |
| A3 | 0,08 | 1,0 | 2,0 | 0,045 | 0,03 | 17–19 | – | 9–12 | 1 | 1) 7) |
| A4 | 0,08 | 1,0 | 2,0 | 0,045 | 0,03 | 16–18,5 | 2–3 | 10–15 | 4 | 6) 8) |
| A5 | 0,08 | 1,0 | 2,0 | 0,045 | 0,03 | 16–18,5 | 2–3 | 10,5–14 | 1 | 1) 7) 8) |

1) Stabilized against intergranular corrosion through addition of titanium, possibly niobium, tantalum.
2) Sulfur may be replaced by selenum.
3) If the nickel content is below 8 %, the min. manganese content shall be 5 %.
4) There is no min. limit to the copper content, provided that the nickel content is greater than 8 %.
5) If the chromium content is below 17 %, the min. nickel content should be 12 %.
6) For austenitic stainless steels having a max. carbon content of 0,03 %, nitrogen may be present to a max. of 0,22 %.
7) This shall contain titanium ≥ 5 x C up to 0,8 % max. for stabilization and be marked appropriately as specified in this table, or shall contain niobium (columbium) and / or tantalum ≥ 10 x C up to 1 % maximum for stabilization and be marked appropriately as specified in this table.
8) At the discretion of the manufacturer, the carbon content may be higher where required in order to obtain the specified mechanical properties at larger diameters, but shall not exceed 0,12 % for austenitic steels.

## Chemical composition of corrosion resistant stainless steels

| Material number | Chemical composition, % by mass | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | C | Si max. | Mn max. | P max. | S max. | Cr | Mo | Ni | Other |
| Martensitic steels | | | | | | | | | |
| 1.4006 | 0,08 to 0,15 | 1,0 | 1,5 | 0,04 | 0,030 | 11,0 to 13,5 | | max. 0,75 | |
| 1.4034 | 0,43 to 0,50 | 1,0 | 1,0 | 0,04 | 0,030 | 12,5 to 14,5 | | | |
| 1.4105 | max. 0,08 | 1,0 | 1,5 | 0,04 | 0,035 | 16,0 to 18,0 | 0,20 to 0,60 | | |
| 1.4110 | 0,48 to 0,60 | 1,0 | 1,0 | 0,04 | 0,015 | 13,0 to 15,0 | 0,50 to 0,80 | | V max. 0,15 |
| 1.4116 | 0,45 to 0,55 | 1,0 | 1,0 | 0,04 | 0,030 | 14,0 to 15,0 | 0,50 to 0,80 | | V 0,10 to 0,20 |
| 1.4122 | 0,33 to 0,45 | 1,0 | 1,5 | 0,04 | 0,030 | 15,5 to 17,5 | 0,80 to 1,30 | max. 1,0 | |
| Austenitic steels | | | | | | | | | |
| 1.4301 | max. 0,07 | 1,0 | 2,0 | 0,045 | 0,030 | 17,0 to 19,5 | | 8,0 to 10,5 | N max. 0,11 |
| 1.4305 | max. 0,10 | 1,0 | 2,0 | 0,045 | 0,15 to 0,35 | 17,0 to 19,0 | | 8,0 to 10,0 | Cu max. 1,00 / N max. 0,11 |
| 1.4310 | 0,05 to 0,15 | 2,0 | 2,0 | 0,045 | 0,015 | 16,0 to 19,0 | max. 0,80 | 6,0 to 9,5 | N max. 0,11 |
| 1.4401 | max. 0,07 | 1,0 | 2,0 | 0,045 | 0,030 | 16,5 to 18,5 | 2,00 to 2,50 | 10,0 to 13,0 | |
| 1.4435 | max. 0,03 | 1,0 | 2,0 | 0,045 | 0,030 | 17,0 to 19,0 | 2,50 to 3,00 | 12,5 to 15,0 | N max. 0,11 |
| 1.4439[1)] | max. 0,03 | 1,0 | 2,0 | 0,045 | 0,025 | 16,5 to 18,5 | 4,00 to 5,00 | 12,5 to 14,5 | N 0,12 to 0,22 |
| 1.4462[1)] | max. 0,03 | 1,0 | 2,0 | 0,035 | 0,015 | 21,0 to 23,0 | 2,50 to 3,50 | 4,5 to 6,5 | N 0,10 to 0,22 |
| 1.4529[1)] | max. 0,02 | 0,5 | 1,0 | 0,030 | 0,010 | 19,0 to 21,0 | 6,00 to 7,00 | 24,0 to 26,0 | N 0,15 to 0,25 / Cu 0,5 to 1,5 |
| 1.4539[1)] | max. 0,02 | 0,7 | 2,0 | 0,030 | 0,010 | 19,0 to 21,0 | 4,00 to 5,00 | 24,0 to 26,0 | N max. 0,15 / Cu 1,2 to 2,0 |
| 1.4565[1)] | max. 0,03 | 1,0 | 7,0 | 0,030 | 0,015 | 24,0 to 26,0 | 4,00 to 5,00 | 16,0 to 19,0 | N 0,30 to 0,60 / Nb max. 0,150 |
| 1.4568 | max. 0,09 | 0,7 | 1,0 | 0,040 | 0,015 | 16,0 to 18,0 | | 6,5 to 7,8 | Al 0,70 to 1,50 |
| 1.4571 | max. 0,08 | 1,0 | 2,0 | 0,045 | 0,030 | 16,5 to 18,5 | 2,00 to 2,50 | 10,5 to 13,5 | Ti 5xC ≤ 0,70 |

1) Austenitic stainless steels with particular resistance to chloride induced stress corrosion.
The risk of failure of bolts, screws and studs by chloride induced stress corrosion can be reduced by using the materials marked in the table. In particular recommended for indoor swimming pools and proven in practice: 1.4529 and 1.4565.

## Distinctive properties of stainless steels

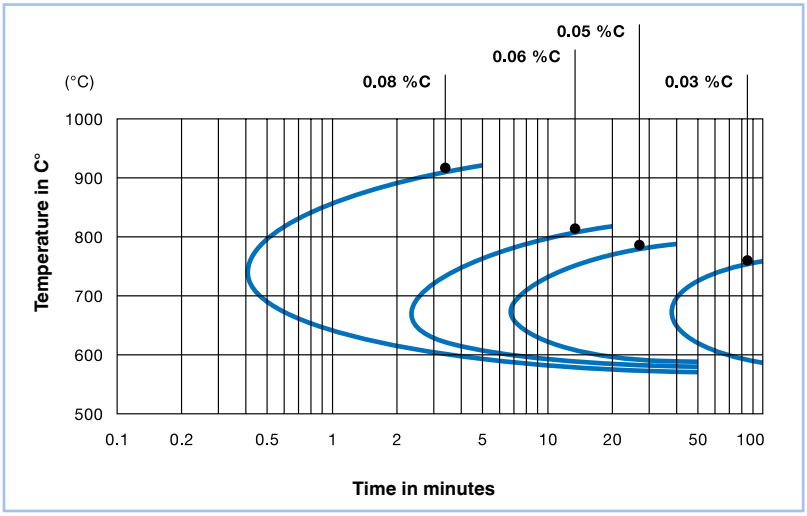
| Material designation | A1 | A2 | A3 | A4 | A5 |
|---|---|---|---|---|---|
| Material number | 1.4300 | 1.4301 | 1.4541 | 1.4401 | 1.4436 |
| | 1.4305 | 1.4303 | 1.4590 | 1.4435 | 1.4571 |
| | | 1.4306 | 1.4550 | 1.4439 | 1.4580 |
| Properties | for machining<br>– rust-resistant to a certain degree<br>– corrosion-resistant to a certain degree<br>– weldable to a certain degree | Standard quality<br>– rust-resistant<br>– acid-resistant<br>– weldable to a certain degree | | Highest resistance to corrosion<br>– rust-resistant<br>– highly acid-resistant<br>– easily weldable | |
| | A3, A5 as A2, A4 but stabilised against intergranular corrosion following welding, annealing or when used at high temperatures. | | | | |

Further details on the chemical stability of rust-resistant and acid-resistant steels can be found on **Page F.024**

## Time-temperature diagram of intergranular corrosion in austenitic stainless steels

Figure gives the approximate time for austenitic stainless steels, grade A2 (18/8 steels), with different carbon contents in the temperature zone between 550 °C and 925 °C before risk of intergranular corrosion occours.

**Note**
With lower carbon contents, the resistance against intergranular corrosion is improved.



## Chemical stability

based on information provided by the manufacturer's

**Austenitic steels A1, A2 and A4 obtain their resistance to corrosion** through a surface protective layer of oxide. If this is damaged it uses atmospheric oxygen to regenerate itself. If access to atmospheric oxygen is blocked by an unfavourable style of construction or through dirt, then even these steels will corrode!

**General rules:**
- A2 above water, inland climate
- A4 under water, coastal climate
- A1 this steel contains small particles of sulphur, which gives it a good machinability. Its resistance to corrosion is lower than that of A2.

**Please avoid:** cracks, separation joints, pockets of water, poor ventilation, layers of dirt

The resistance to corrosion can be reduced in the presence of a coating (prevents access to the air), or chemical blackening or a roughening of the surface.

**Media containing chlorine** can under certain conditions lead to dangerous inter-crystalline corrosion. This is often very difficult to see from the outside, and can lead to a sudden failure of the steel part.

**ISO standard 3506** defines rust and acid-resistant steels. It also contains details of their mechanical properties, chemical composition and a number of notes on the selection of the right steel for high and low temperature applications.

**The reference data with respect to corrosion resistance**
Indications on resistance to corrosion are preferably obtained from laboratory and practical trials!
Ask for information on our **«Bossard Analysis»** service.

**Attention**
- Martensitic chrome steels (e.g. 1.4110, 1.4116, 1.4112) are normally used for corrosion-resistantretaining rings and washers. The corrosion resistance of these steels is lower than that of austenitic chrome-nickel steels.
- Recent experience indicates that there is a risk of stress corrosion cracking. In order to reduce this risk the depth of the nuts can be selected so that the fitted rings are not subjected to stress. This will reduce their load-bearing capacity.

## Technical arguments for the use of fasteners made from rust-resistant austenitic chrome-nickel steels A1, A2, A4

| Advantages | Avoidance of potential problems |
|---|---|
| Bright-finished surface, good appereance | Rusty screws create a bad impression. The customer loses trust in the product. |
| Savety | Corrosion reduces the strength and operational reliability of the fasteners.<br>They become weak points. |
| No traces of red-rust | Red rust can discolour white-coloured plastic components and textiles and make them unusable. |
| No risk to health | Cutting yourself on a rusty part can lead to blood poisoning. |
| Food grade material | Parts made from zinc-coated steel must not be allowed to come into contact with foodstuffs. |
| Lick-resistant | Small children must not be able to get within reach of and lick small, zinc-coated or cadmium-coated parts. |
| Easy to clean and hygienic | Products or efflorescences caused by corrosion can build up on bright-polished or zinc-coated fasteners which then become difficult to remove. |
| Austenitic chrome-nickel steel is almost entirely non-magnetic | Magnetic fasteners used in the construction of types of apparatus or measuring devices can lead to disruptions.<br>Magnetic parts attract iron filings. This gives rise to additional problems of corrosion. |
| Good temperature resistance | At temperatures above 80 °C the chromating on zinc-plated and chrome-plated fasteners is destroyed.<br>The corrosion resistance drops dramatically. |
| The screw and nuts are bright-polished and so always remain workable. | If the permissible thickness of the coating on galvanically finished screws is exceeded, the parts jam up when being assembled. |
| No problems during maintenance work | Rusty screws or nuts just cannot be unscrewed. In order to disassemble the unit the fasteners have to be destroyed, and this involves considerable force and effort.<br>This often results in damage to the parts. |
| Ecologically-oriented use of austenitic screw elements into wood | The environmental influences lead to a chemical reaction at galvanized screws with the tannic acid existing in the wood. A gray/black coloring which penetrate into the wood can not be eliminated any more.<br>Due to the time restricted anti-corrosion protection and possible stress corrosion risk, the usage of highstrength martensitic steel is not recommended.<br>In all corrosion relevant wood applications use of austenitic steels is recommended. |

## Mechanical properties for fasteners made from austenitic stainless steel

according to ISO 3506

### Screws

| Steel group | Steel grade | Property class | Thread diameter range | Tensile strength $R_{m\,min}$ [1] [N/mm²] | Stress at 0,2 % permanent strain $R_{p\,0,2\,min}$ [1] [N/mm²] | Elongation after fracture $A_{min}$ [2] [mm] |
|---|---|---|---|---|---|---|
| Austenitic | A1, A2 | 50 | ≤ M39 | 500 | 210 | 0,6 d |
| | A3, A4 | **70** | **≤ M39** [3] | **700** | **450** | **0,4 d** |
| | A5 | 80 | ≤ M39 [3] | 800 | 600 | 0,3 d |

[1] All values are calculated values and refer to the stressed cross-section of the thread.
[2] The elongation after fracture is to be determined for the whole screw and not for unscrewed test pieces.
[3] Strength of the screw is indicated by the head marking and defined by the applicable product standard.

### Nuts

| Steel group | Steel grade | Property class | | Thread diameter range | Stress under proof load $S_{P\,min}$ [N/mm²] | |
|---|---|---|---|---|---|---|
| | | Nuts Style 1 m ≥ 0,8 d | thin nuts 0,5 d ≤ m < 0,8 d | d [mm] | Nuts Style 1 m ≥ 0,8 d | thin nuts 0,5 d ≤ m < 0,8 d |
| Austenitic | A1, A2 | 50 | 025 | ≤ M39 | 500 | 250 |
| | A3, A4 | **70** | **035** | **≤ M39** [3] | **700** | **350** |
| | A5 | 80 | 040 | ≤ M39 [3] | 800 | 400 |

m = nut height
d = nominal thread diameter

The commercial quality of steel grades A2 and A4 is property class 70 (tensile strength 700 N/mm²). Strength of the screw is indicated by the head marking and defined by the applicable product standard.
We keep a wide range available for you from stock.

Use of screws of property class 80 is only economically justifiable if the components are made from stainless steel (high strength).

## Minimum breaking torque $M_{B\,min}$ for screws made from austenitic steel with threads M1,6 to M16 (normal thread)

according to ISO 3506

| Threads | Minimum breaking torque $M_{B\,min}$ [Nm] | | |
|---|---|---|---|
| | Property class | | |
| | 50 | 70 | 80 |
| M1,6 | 0,15 | 0,2 | 0,24 |
| M2 | 0,3 | 0,4 | 0,48 |
| M2,5 | 0,6 | 0,9 | 0,96 |
| M3 | 1,1 | 1,6 | 1,8 |
| M4 | 2,7 | 3,8 | 4,3 |
| M5 | 5,5 | 7,8 | 8,8 |
| M6 | 9,3 | 13 | 15 |
| M8 | 23 | 32 | 37 |
| M10 | 46 | 65 | 74 |
| M12 | 80 | 110 | 130 |
| M16 | 210 | 290 | 330 |

## Reference values for 0,2 % $R_{p0,2}$ at higher temperatures as % of the values at room temperature

according to ISO 3506

| Steel grade [1] | 0,2 % $R_{p0,2}$ | | | |
|---|---|---|---|---|
| | +100 °C | +200 °C | +300 °C | +400 °C |
| **A2, A4** | 85 % | 80 % | 75 % | 70 % |

[1] applies for property classes 70 and 80

For applicability at low temperature see **Page F.018**

## Marking of screws and nuts

according to ISO 3506

### Requirement

Screws and nuts made from stainless austenitic steels must be marked.

**Caution**

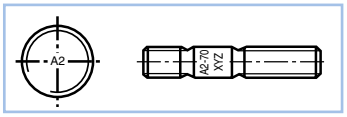
Only those fasteners marked to standard will have the desired properties. Products not marked to standard will often only correspond to property classes A2-50 or A4-50.

### Screws

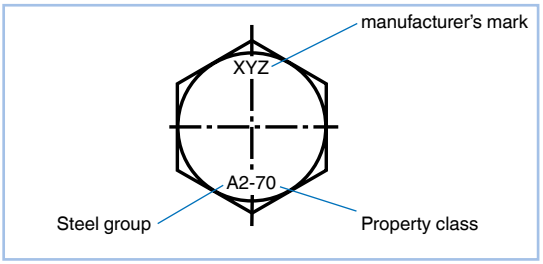
Hexagon head screws, and hexagon or hexalobular socket head cap screws from nominal diameter M5 must be marked. The marking must show the steel group, the property class and the manufacturer's mark. Locking screws must be marked on the shaft or screw end.

### Studbolts

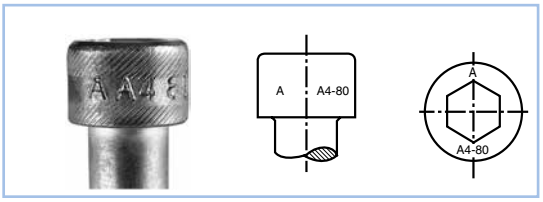
Bolts from nominal diameter M6 must be marked on the shank or the end of the thread with the steel group, the property class and the manufacturer's mark.




### Hexagon screws

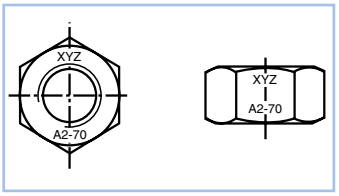



### Socket head cap screws




### Nuts

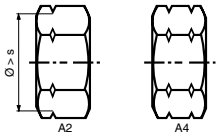
Nuts from minimal diameter M5 must be marked with the steel group, the property class and the manufacturer's mark.




When the marking is made with grooves and the property class is not indicated, property class 50 or 025 will apply.

It is possible that certain nuts would not fulfil the proof load requirements because of fine pitch thread or the geometry of the nut. These nuts may be marked with the steel grade, but shall **not be marked with the property class.**

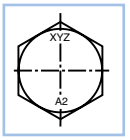
Alternative groove marking
(for steel grades A2 and A4 only)




### Other markings

Other types of bolts and screws can be marked in the same way, where it is possible to do so and on the head portion only. Additional marking is allowed, provided it does not cause confusion.

Fasteners that do not fulfil the tensile or torsional requirements because of the geometry may be marked with the steel grade, but shall **not be marked with the property class.**




**Note**

Markings analogous to ISO 898-1 using the «supplementary **0**» (e.g. A2-**0**70) are intended to be included in the next revision of ISO 3506-1.