International Standard

ISO 3506-7

First edition
2024-07

Fasteners — Mechanical properties of corrosion-resistant stainless steel fasteners —

Part 7: Flat washers with specified grades and property classes

Fixations — Caractéristiques mécaniques des fixations en acier inoxydable résistant à la corrosion —

Partie 7: Rondelles de forme plane de grades et classes de qualité spécifiés

Reference number
ISO 3506-7:2024(en)

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Published in Switzerland

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 2, *Fasteners*.

A list of all parts in the ISO 3506 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document is issued as an addition to the ISO 3506 series to provide a single point of reference for flat stainless steel washers, in order to standardize market expectations for users, distributors and manufacturers.

For mechanical properties of flat washers made of carbon steel and alloy steel, see ISO 898-3.

Fasteners — Mechanical properties of corrosion-resistant stainless steel fasteners —

Part 7:
Flat washers with specified grades and property classes

1 Scope

This document specifies the mechanical and physical properties of flat washers made of corrosion resistant austenitic, ferritic and duplex stainless steels, designed to be used in bolted joints in combination with bolts, screws, studs and nuts with specified grades and property classes in accordance with ISO 3506-1 and ISO 3506-2.

These types of washers are also used with other stainless steel fasteners such as screws forming their own mating thread (see e.g. ISO 3506-4).

ISO 3506-6 provides general rules and additional technical information on suitable stainless steels and their properties (detailed properties of stainless steel grades, corrosion behaviour with regards to pitting, crevice and intergranular corrosion, magnetic properties, etc.)

WARNING — Washers conforming to the requirements of this document are tested at the ambient temperature range of 10 °C to 35 °C and are used in applications ranging from –20 °C to +150 °C. However, these washers are also used outside this range down to –196 °C and up to +300 °C for specific applications. It is possible that they do not retain the specified mechanical and physical properties at lower and/or elevated temperatures. Therefore, it is the responsibility of the user to determine the appropriate choices based on the service environment conditions of the assembly (see also Clauses 6 and 7).

This document applies to the following flat non-captive and captive washers with thickness 0,2 mm to 6 mm (see 5.1):

— plain washers and flat washers (with or without knurls, ribs or chamfers),

— square washers,

— square hole washers,

— shaped plates.

The term “washer” is used in the following for all types of washers and plates within the scope of this document.

This document does not specify requirements for functional properties such as weldability.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 1891-4, *Fasteners — Vocabulary — Part 4: Control, inspection, delivery, acceptance and quality*

ISO 3506-1, *Fasteners — Mechanical properties of corrosion-resistant stainless steel fasteners — Part 1: Bolts, screws and studs with specified grades and property classes*

ISO 3506-2, *Fasteners — Mechanical properties of corrosion-resistant stainless steel fasteners — Part 2: Nuts with specified grades and property classes*

ISO 3506-6, *Fasteners — Mechanical properties of corrosion-resistant stainless steel fasteners — Part 6: General rules for the selection of stainless steels and nickel alloys for fasteners*

ISO 6507-1, *Metallic materials — Vickers hardness test — Part 1: Test method*

ISO 16228, *Fasteners - Types of inspection documents*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
stainless steel
steel with at least 10,5 % (mass fraction) of chromium (Cr) and maximum 1,2 % (mass fraction) of carbon (C)

[SOURCE: ISO 3506-1:2020, 3.5]

3.2
austenitic stainless steel
stainless steel (3.1) with high amounts of chromium and nickel, which usually cannot be hardened by heat treatment, providing excellent resistance to corrosion, good ductility, and usually low or non-magnetic properties.

[SOURCE: ISO 3506-1:2020, 3.6]

3.3
ferritic stainless steel
stainless steel (3.1) containing less than 0,1 % carbon and typically 11 % to 18 % chromium, which usually cannot be hardened by heat treatment, and with highly magnetic properties.

[SOURCE: ISO 3506-1:2020, 3.8]

3.4
duplex stainless steel
stainless steel (3.1) with a micro-structure that includes both austenitic and ferritic phases, providing excellent resistance to corrosion, containing a higher amount of chromium and a reduced quantity of nickel compared to austenitic steel, with high strength, and with magnetic properties.

[SOURCE: ISO 3506-1:2020, 3.9]

4 Symbols

F test force for Vickers hardness determination, N

t_{nom} nominal thickness of washer, mm

t_{eff} effective thickness of the material measured on the washer, mm

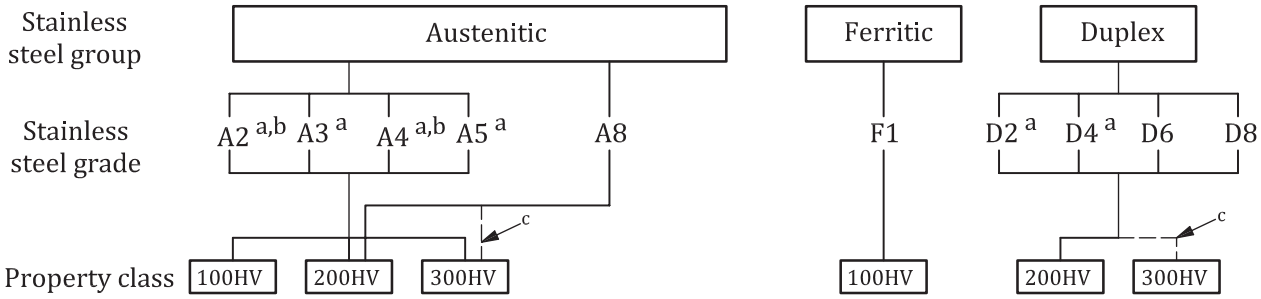
5 Designation system for stainless steel grades and property classes of washers, and combination with bolts, screws, studs and nuts

5.1 General

The designation system for stainless steel washers consists of two blocks, separated by a hyphen: the stainless steel grade and the property class, as specified in Figure 1.

The standard combinations in Figure 1 shall be considered together with Table 1, which shows thickness limits for each combination.

This designation system may be used for sizes outside the limits specified in this document, provided that all applicable chemical, mechanical and physical requirements are met. For non-standard fasteners, it is recommended that a fastener expert be consulted.



a Washers made of cold worked material which are subjected to tensile stresses (e.g. when they are used on slotted or enlarged holes) in service environment with chloride are more sensitive to stress corrosion cracking (SCC). For information regarding resistance to stress corrosion cracking, see ISO 3506-6.

b For low carbon austenitic stainless steels with carbon content not exceeding 0,030 %, washers shall additionally be designated with the letter "L" just after the grade. Example: A4L-200HV.

c Critical availability of flat raw materials in relation to this property class: thickness availability shall be checked between the purchaser and the manufacturer before ordering (see Table 1).

Figure 1 — Designation system for stainless steel washers

Although a great number of stainless steel grades combined with property classes are specified in this document for washers, this does not mean that all combinations are appropriate for all bolts/nuts/washers assemblies: see appropriate combinations in 5.4.

NOTE Martensitic stainless steels and austenitic stainless steel of grade A1 are not included in Figure 1 due to a lack of availability for such flat raw materials on the market.

Table 1 — Washer thickness limits in relation to stainless steel grades and property classes

Property class	Maximum thickness for t_{nom} (mm)									
	Austenitic					Ferritic	Duplex			
	A2	A3	A4	A5	A8	F1	D2	D4	D6	D8
100HV	6	6	6	6	a	6	a			
200HV	4	4	4	4	6	b	6	6	6	6
300HV	3	3	3	3	c	b	c			

a Property class 100HV does not apply as raw materials typically result in hardness values above 200 HV.

b Property classes 200HV and 300HV does not apply as typical maximum hardness is below 200 HV.

c Critical availability of flat raw materials in relation to this property class: thickness availability shall be checked between the purchaser and the manufacturer before ordering.

The achievable thickness for each combination of stainless steel grade and property class specified in Table 1 is limited because the achievable mechanical properties of the washers are limited by the raw material properties and manufacturing processes.

The marking, labelling and designation of washers with the stainless steel grade and the property class shall be as specified in Clause 10.

The combination of washers with bolts, screws, studs and nuts with regards to their stainless steel grades and property classes shall be as specified in 5.4.

5.2 Designation of stainless steel grades (first block)

The designation of the stainless steel grade (first block) consists of one letter, which specifies the stainless steel group:

— **A** for Austenitic steel,

— **F** for Ferritic steel,

— **D** for Duplex steel (austenitic-ferritic),

and

— a digit, which specifies the range of chemical compositions within this stainless steel group.

The chemical compositions of stainless steel groups and grades classified in Figure 1 are specified in Table 3.

5.3 Designation of property classes (second block)

The designation of the property class (second block) consists of two parts as specified in Table 4:

— the number to the left is the minimum Vickers hardness value,

and

— the letters HV to the right represent Vickers hardness.

EXAMPLE 1 **A2-100HV** specifies a washer in austenitic stainless steel of grade A2, with minimum hardness of 100HV.

EXAMPLE 2 **D6-200HV** specifies a washer in duplex stainless steel of grade D6, with minimum hardness of 200HV.

5.4 Combination of washers with bolts, screws, studs and nuts

5.4.1 Stainless steel grade combination

For corrosion resistance purpose, bolts, screws, studs and nuts should be mated with washers of the same stainless steel grade (e.g. bolts and nuts A2 with washers A2, etc.). Other combinations are possible (e.g. washers A2 with bolts D2), providing that:

— the component with the lowest corrosion resistance shall always be taken into account,

— the risk of galling during tightening should be considered, and

— it is strongly recommended that an experienced fastener metallurgist be consulted.

For corrosion resistance, see also 6.3.

5.4.2 Property class combination

Recommended combinations of property classes for stainless steel washers with bolts, screws, studs and nuts are specified in Table 2. RC represents the most suitable combinations with regards to the mechanical properties of the fasteners, however other combinations are possible.