
**Welding — Studs and ceramic ferrules for
arc stud welding**

*Soudage — Goujons et bagues céramiques pour le soudage à l'arc des
goujons*

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 13918 was prepared by Technical Committee ISO/TC 44, *Welding and allied processes*, Subcommittee SC 10, *Unification of requirements in the field of metal welding*.

This second edition cancels and replaces the first edition (ISO 13918:1998), which has been technically revised.

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Introduction

The range of types of studs specified in this International Standard represents customary applications.

This International Standard can be used in all fields of the metal-working industry.

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Welding — Studs and ceramic ferrules for arc stud welding

1 Scope

This International Standard specifies:

- requirements for studs and ceramic ferrules for arc stud welding;
- dimensions, materials, mechanical properties and, when required, conditions of evaluation of conformity.

Table 1 shows types of studs and the symbols for studs and ceramic ferrules that are covered by this document.

Table 1 — Types of studs and symbols for studs and ceramic ferrules

Welding technique	Type of stud ^a	Symbol for studs	Symbol for ceramic ferrules
Drawn arc stud welding with ceramic ferrule or shielding gas	threaded stud (pitch)	PD	PF
	threaded stud with reduced shaft	RD	RF
	unthreaded stud	UD	UF
	stud with internal thread	ID	UF
	shear connector	SD	UF
Short-cycle drawn arc stud welding	threaded stud with flange (pitch)	PS	—
	unthreaded stud	US	—
	stud with internal thread	IS	—
Stud welding with tip ignition	threaded stud (pitch)	PT	—
	unthreaded stud	UT	—
	stud with internal thread	IT	—
^a Further types of stud and ceramic ferrules can be specified as required for special applications.			

2 Normative references

The following referenced documents are indispensable for the application 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 898-1, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part 1: Bolts, screws and studs*

ISO 3506-1, *Mechanical properties of corrosion-resistant stainless-steel fasteners — Part 1: Bolts, screws and studs*

ISO 4042, *Fasteners — Electroplated coatings*

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ISO 4759-1, *Tolerances for fasteners — Part 1: Bolts, screws, studs and nuts — Product grades A, B and C*

ISO 4964, *Steel — Hardness conversions*

ISO 6892, *Metallic materials — Tensile testing at ambient temperature*

ISO 6947, *Welds — Working positions — Definitions of angles of slope and rotation*

ISO 14555, *Welding — Arc stud welding of metallic materials*

ISO/TR 15608, *Welding — Guidelines for a metallic materials grouping system*

EN 573-3, *Aluminium and aluminium alloys — Chemical composition and form of wrought products — Part 3: Chemical composition and form of products*

EN 1301-2, *Aluminium and aluminium alloys — Drawn wire — Part 2: Mechanical properties*

EN 10088-1, *Stainless steels — Part 1: List of stainless steels*

EN 12166, *Copper and copper alloys — Wire for general purposes*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 14555 and the following apply.

3.1 inspection lot

arrangement of units of which a random sample is taken for testing and which requires the same chemical composition of the raw material, the same diameter of the finished product and the same manufacturing procedure during the stud production

3.2 manufacturing lot

quantity of studs of a single designation including type of stud, size, property class and material, manufactured from bar, wire, rod or flat product from a single cast, processed through the same or similar steps at the same time or over a continuous time period through the same heat treatment and/or coating process, if any

NOTE Same heat treatment or coating process means:

- for a continuous process, the same treatment cycle without any setting modification;
- for a discontinuous process, the same treatment cycle for identical consecutive loads (batches).

The manufacturing lot can be split into a number of manufacturing batches for processing purposes and then reassembled into the same manufacturing lot.

[Adapted from ISO 15330:1999, definition 3.3]

4 Symbols and abbreviated terms

- b length of the thread
- c_d depth of the crack in the head
- d_1 nominal diameter
- d_2 diameter at the weld area
- d_3 diameter of the weld collar

d_4	diameter of the tip
d_5	head diameter of headed studs
D_6	internal thread diameter
D_7	nominal diameter of the ceramic ferrule
d_8	grip diameter
d_9	base diameter of the ceramic ferrule
h_1	height of the flange
h_2	height of the ceramic ferrule
h_3	height of the head on headed stud
h_4	height of the weld collar
h_5	height of the unthreaded part of stud types PS and PT
l_1	overall length of the stud (excluding aluminium ball or welding tip)
l_2	nominal length of the stud
l_3	length of the welding tip
y	length of the unthreaded part
α	face angle

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5 Requirements

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5.1 Ordering information

At the time of order the manufacturer shall obtain the following information:

- a) reference to this International Standard if the purchaser demands compliance;
- b) quantities to be delivered;
- c) complete product designation;
- d) other requirements as agreed with the purchaser (e.g. low-temperature requirements).

5.2 Dangerous substances

Materials used in products shall not release any dangerous substances in excess of the maximum levels permitted in the relevant regulations of the state of destination.

5.3 Product requirements

5.3.1 Dimensions and tolerances on dimensions, form and position

Dimensions and tolerances on dimensions, form and position shall be in accordance with the requirements given in Clause 9.

For coated threaded studs the tolerances shall apply before coating.

5.3.2 Coating

Unless otherwise specified, studs PS, US, IS, PT, UT, IT of property class 4.8 shall be supplied with electroplated copper coating (C1E).

5.3.3 Materials and mechanical characteristics

5.3.3.1 General

The materials listed in Table 2 shall be used, under the provisions of 5.3.4.

The mechanical characteristics of the studs shall comply with the specifications in Table 2.

5.3.3.2 Shear strength

Shear strength shall be checked by testing the minimum tensile strength of the studs.

Table 2 — Materials and mechanical characteristics of finished studs

Symbol	Material/ Material group/ Property class	Standard	Mechanical properties of the finished stud
PD RD UD ID	4.8	ISO 898-1	See ISO 898-1
	A2-50, A2-70, A4-50, A4-70, A5-50, A5-70	ISO 3506-1	See ISO 3506-1
SD1	Material group 1 with the limits:	ISO 13918:2008	$R_m \geq 450 \text{ N/mm}^2$ $R_{eH} \geq 350 \text{ N/mm}^2$ $A_5 \geq 15 \%$
SD2	$C \leq 0,2\% \text{ }^a$ $CEV \leq 0,35 \text{ }^a$ $Al \geq 0,02 \% \text{ }^a, \text{ }^b$	ISO/TR 15608	$R_m = 400 \text{ N/mm}^2 \text{ to } 550 \text{ N/mm}^2$ $R_{eH} \geq 235 \text{ N/mm}^2$ $R_{p0,2} \geq 235 \text{ N/mm}^2$ $A_5 \geq 20 \%$
SD3	1.4301 1.4303	EN 10088-1	$R_m = 500 \text{ N/mm}^2 \text{ to } 780 \text{ N/mm}^2$ $R_{p0,2} \geq 350 \text{ N/mm}^2$ $A_5 \geq 25 \%$
PS US IS	4.8	ISO 898-1	See ISO 898-1
	A2-50	ISO 3506-1	See ISO 3506-1
PT	4.8	ISO 898-1	See ISO 898-1
	A2-50	ISO 3506-1	See ISO 3506-1
UT	CuZn37	EN 12166	$R_m \geq 370 \text{ N/mm}^2$
IT	1050A	EN 573-3	$R_m \geq 100 \text{ N/mm}^2$
	5754	EN 1301-2	$R_m \geq 230 \text{ N/mm}^2$
<p>^a Values from the ladle analysis.</p> <p>^b If other elements for killing are used, they shall be reported in the inspection document.</p>			

5.3.4 Weldability

Only weldable materials shall be used for studs.

Non-alloyed steel studs are weldable if the hardness increase is low. In general this is the case when the carbon content is $\leq 0,20$ %. Free-cutting steel studs are generally not weldable. Killed materials shall be used.

Austenitic stainless steel studs are generally weldable. Free-cutting steel studs are generally not weldable.

5.4 Durability

The durability of studs is dependent on their use and the environmental exposure to which they are subject.

The mechanical durability of studs is assured for a reasonable economic working life if the studs comply with the requirements of this International Standard.

6 Testing for conformity evaluation

6.1 General

When a conformity evaluation is required, 6.2 to 6.5 apply.

6.2 Testing for dangerous substances

Release of dangerous substances may be assessed indirectly by controlling the content of the substances in the materials used.

6.3 Testing of dimensional requirements of the studs

The dimensions of the studs given in Tables 6 to 16 shall be checked by standard gauges or measuring equipment with an accuracy ≤ 10 % of the given tolerances.

6.4 Testing of mechanical characteristics of studs

The mechanical characteristics of studs shall be tested in accordance with Table 3.

Table 3 — Mechanical characteristics of studs to be tested

Mechanical characteristic	Test	Reference standard		
		Threaded studs		Unthreaded studs
		Carbon steel and alloy steel	Stainless steel	
Elongation	Tensile test	ISO 898-1	ISO 3506-1	ISO 6892
Tensile strength				
Yield strength				
Shear strength				

The tensile test to be used shall be a full-size tensile test. However, if the dimensions of the studs do not allow a full-size tensile test, the test may be carried out on the raw material provided the mechanical properties corresponding to those of the current part of the stud are not modified by the manufacturing process.

If tensile testing is not possible, a hardness test shall be carried out for ferritic materials, thus determining the tensile strength in accordance with ISO 4964. The particular properties of the cold-formed material, especially in the peripheral zone, shall be taken into account. For cold-formed studs, the mean value of a minimum of three test points shall be determined, whereas the whole cross-section shall be included. This mean value shall achieve at least the tensile strength according to Table 3. For the rest, the mechanical properties of the raw material shall be used.

The correlation of hardness and tensile strength is laid down likewise in ISO/TR 10108.

6.5 Weldability

A material is considered weldable if a qualified welding procedure can be developed for the material (see ISO 14555).

7 Evaluation of conformity

7.1 General

When an evaluation of conformity is required, 7.2 and 7.3 apply.

The conformity of the studs to the requirements of this International Standard shall be demonstrated by:

- initial type testing;
- factory production control by the manufacturer, including product assessment.

For the purposes of testing, the products may be grouped into families where it is considered that the selected properties are common to all the products within that family.

7.2 Initial type testing

7.2.1 General

An initial type test is the complete set of tests or other procedures determining the performance of samples of products representative of the product type.

Initial type testing shall be performed to show conformity with this International Standard on its first use for products being put on to the market and:

- at the beginning of the production of a new type of stud or different raw material;
- at the beginning of a new or modified method of production.

In the case of products for which initial type testing in accordance with this International Standard was already performed, testing may be reduced:

- if it has been established that the performance characteristics compared with the products already tested have not been affected or
- in accordance with the rules for grouping and/or direct application or application by extrapolation of test results.

NOTE Studs CE marked in accordance with appropriate specifications may be presumed to have the performance stated with the CE marking, although this does not replace the responsibility of the stud manufacturer to ensure that the stud is correctly designed and has the necessary performance values to meet the design.

7.2.2 Characteristics

All characteristics in Clause 5 shall be subject to initial type testing, with the following exception:

- release of dangerous substances may be assessed indirectly by controlling the content of the substance concerned.

7.2.3 Use of historical data

Tests previously performed on the same products in accordance with the provisions of this International Standard (same characteristics, test method, sampling procedure, system of attestation of conformity, etc.) may be taken into account.

7.2.4 Sampling, testing and conformity criteria

7.2.4.1 Sampling

Initial type testing shall be performed on samples of products representative of the manufactured product type.

7.2.4.2 Testing and conformity criteria

The number of studs to be tested shall be in accordance with the Table 4. All samples shall pass the test.

The results of all type tests shall be recorded and held by the manufacturer for at least ten years after the products to which the type test refers ceases to be placed on the market.

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Table 4 — Number of samples to be tested for initial type testing

Characteristics	Requirement see subclause	Type of test	Number of tests
Dimensions	5.3.1	According to 6.3	5 ^a
Minimum tensile strength	5.3.3	Tensile test	3 ^b
Lower yield strength or stress at 0,2 % non-proportional elongation			
Elongation A_5			
^a For each dimension. ^b To be carried out for the smallest and biggest diameter in production for each type of material.			

7.3 Factory production control (FPC)

7.3.1 General

The manufacturer shall establish, document and maintain an FPC system to ensure that the products placed on the market conform to the declared performance characteristics. The FPC system shall consist of written procedures (works manual), regular inspections and tests and/or assessments, and the use of the results to control raw and other incoming materials or components, equipment, the production process and the product.