



Designation: F 738M – 02

## Standard Specification for Stainless Steel Metric Bolts, Screws, and Studs (Metric)<sup>1</sup>

This standard is issued under the fixed designation F 738M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reappraisal. A superscript epsilon (ε) indicates an editorial change since the last revision or reappraisal.

*This standard has been approved for use by agencies of the Department of Defense.*

### 1. Scope

1.1 This specification covers the chemical and mechanical requirements for stainless steel metric bolts, screws, and studs with nominal thread diameters M1.6 through M36 and is intended for use in engineering applications requiring general corrosion resistance.

1.2 Eight groups of stainless steel alloys are covered, including three austenitic (Grades A1, A2, and A4), one ferritic (Grade F1), three martensitic (Grades C1, C3, and C4), and one precipitation hardening (Grade P1).

1.3 Twenty property classes are covered, including nine austenitic, two ferritic, eight martensitic, and one precipitation hardening. The property classes with the permissible alloys for each are listed in [Table 1](#).

1.4 This specification is based in concept and content on [ISO 3506](#). The chemical and mechanical requirements specified for all property classes, except as given in [1.4.1](#), are essentially identical with classes of the same designation in [ISO 3506](#).

1.4.1 This specification includes all of the property classes covered in [ISO 3506](#). Additionally, it includes property classes A1-70, A2-70, A4-70, A1-80, A2-80, and A4-80 for products with nominal thread diameters larger than M20; and four non-ISO property classes, C1-110, C4-110, C3-120; and P1-90.

1.5 Supplementary requirements of an optional nature are provided, applicable only when agreed upon between the manufacturer and the purchaser at the time of the inquiry and order.

1.6 Suitable nuts for use with bolts, screws, and studs included in this specification are covered by Specification [F 836M](#).

1.7 The following safety hazards caveat pertains only to the test method described in this specification. *This standard does not purport to address the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee F16 on Fasteners and is the direct responsibility of Subcommittee F16.04 on Nonferrous Fasteners.

Current edition approved April 10, 2002. Published May 2002. Originally published as F 738 – 81. Last previous edition F 738M – 01.

### 2. Referenced Documents

2.1 *ASTM Standards:*

- [A 276](#) Specification for Stainless Steel Bars and Shapes<sup>2</sup>
  - [A 342/A 342M](#) Test Methods for Permeability of Feebly Magnetic Materials<sup>3</sup>
  - [A 380](#) Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems<sup>2</sup>
  - [A 484/A 484M](#) Specification for General Requirements for Stainless Steel Bars, Billets, and Forgings<sup>2</sup>
  - [A 493](#) Specification for Stainless Steel Wire and Wire Rods for Cold Heading and Cold Forging<sup>2</sup>
  - [A 555/A 555M](#) Specification for General Requirements for Stainless Steel Wire and Wire Rods<sup>2</sup>
  - [A 564/A 564M](#) Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes<sup>3</sup>
  - [A 582/A 582M](#) Specification for Free-Machining Stainless Steel Bars<sup>3</sup>
  - [A 751](#) Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products<sup>2</sup>
  - [D 3951](#) Practice for Commercial Packaging<sup>4</sup>
  - [E 29](#) Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications<sup>5</sup>
  - [E 353](#) Test Methods for Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron Alloys<sup>6</sup>
  - [F 606M](#) Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, and Rivets [Metric]<sup>7</sup>
  - [F 836M](#) Specification for Style 1 Stainless Steel Metric Nuts<sup>7</sup>
  - [F 1470](#) Guide for Fastener Sampling for Specified Mechanical Properties and Performance Inspection<sup>7</sup>
- 2.2 *ISO Standard:*

<sup>2</sup> *Annual Book of ASTM Standards*, Vol 01.03.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 03.04.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 15.09.

<sup>5</sup> *Annual Book of ASTM Standards*, Vol 14.02.

<sup>6</sup> *Annual Book of ASTM Standards*, Vol 03.05.

<sup>7</sup> *Annual Book of ASTM Standards*, Vol 01.08.

**TABLE 1 Property Classes of Stainless Steel Bolts, Screws, and Studs**

Property Class	Permissible Alloys
A1-50 A1-70 A1-80	304, 304L, 305 <sup>A</sup> 384, 18-9LW, 302HQ
A2-50 A2-70 A2-80	321, 347
A4-50 A4-70 A4-80	316, 316L
F1-45 F1-60	430 <sup>B</sup>
C1-50 C1-70 C1-110	410
C3-80 C3-120	431
C4-50 C4-70 C4-110	416, 416Se
P1-90	630

<sup>A</sup> When approved by the purchaser, Alloys 303, 303Se, or XM1 may be furnished.

<sup>B</sup> When approved by the purchaser, Alloy 430F may be furnished.

**ISO 3506 Corrosion-Resistant Stainless Steel Fasteners<sup>8</sup>**

**3. Classification**

3.1 The designation of each property class is composed of three parts: a letter, followed by a single digit, followed by either two or three digits.

3.1.1 The letter indicates the general composition type of stainless steel as follows:

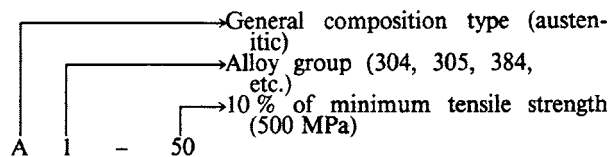
- 3.1.1.1 A for austenitic steels,
- 3.1.1.2 F for ferritic steels,
- 3.1.1.3 C for martensitic steels, and
- 3.1.1.4 P for precipitation-hardening steel.

3.1.2 The first digit (1, 2, 3, or 4) indicates the alloy group. The permissible alloys within each group are given in **Table 1**.

3.1.3 The last two or three digits (50, 70, 110, etc.) indicate 10 % of the specified minimum tensile strength of the property class.

3.1.4 For example, Class A1-50 is an austenitic steel of any one of six permitted alloys, and the manufactured fastener has a minimum tensile strength of 500 MPa.

<sup>8</sup> Available from American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036.



**4. Ordering Information**

4.1 Orders for bolts, screws and studs under this specification shall include the following:

- 4.1.1 Quantity (number of pieces of each item).
- 4.1.2 Name of item (bolt, screw, stud, etc.; specific type and style; and reference to dimensional standard when appropriate).
- 4.1.3 Size (nominal diameter, thread pitch, length).
- 4.1.4 Property class.
- 4.1.5 ASTM designation and date of issue. When date of issue is not specified, fasteners shall be furnished to the latest issue.

4.1.6 Supplementary requirements, if any (S1 through S5).

4.1.7 Additional requirements, if any, to be specified on the purchase order:

- 4.1.7.1 Forming (5.2.1).
- 4.1.7.2 Threading (5.2.2).
- 4.1.7.3 Alloy condition (5.2.3).
- 4.1.7.4 Protective finish (5.2.5).
- 4.1.7.5 Alloy selection (7.2).
- 4.1.7.6 Test report (9.2).
- 4.1.7.7 Heat number (9.1.1).
- 4.1.7.8 Additional testing (9.3).
- 4.1.7.9 Inspection (11.1).
- 4.1.7.10 Rejection (12.1).
- 4.1.7.11 Certification (13.1).
- 4.1.7.12 Marking (14.1.3 and 14.1.4).

NOTE 1—Examples:

10 000 hex-cap screws, ANSI B18.2.3.1M, M12 × 1.75 × 50, Class A2-70, furnish test report, ASTM F 738, dated \_\_\_\_.

15 000 oval-head machine screws, Type 1 recess, ANSI B18.6.7M, M3 × 0.5 × 25, Class C4-70, 416Se, Supplementary Requirement S2, ASTM F 738, dated \_\_\_\_.

**5. Materials and Manufacture**

5.1 *Materials:*

5.1.1 Specifications **A 276**, **A 493**, A 564/A 564M, and **A 582/A 582M** are noted for information only as suitable sources of material for the manufacture of bolts, hex cap screws, and studs to this specification.

5.2 *Manufacture:*

5.2.1 *Forming*—Unless otherwise specified, fasteners shall be cold-formed, hot-formed, or machined, at the option of the manufacturer.

5.2.2 *Threads*—Unless otherwise specified, threads shall be rolled or cut at the option of the manufacturer.

5.2.3 *Condition*—Fasteners shall be furnished in the condition specified for the property class in **Table 2**. If other

**TABLE 2 Mechanical Property Requirements**

Property Class	Condi- tion <sup>A</sup>	Alloy/ Mechanical Property Marking	Nominal Thread Diameter	Product Length <sup>B</sup>	Full Size Product Tests				Machined Specimen Tests			Hardness			
					Tensile Strength, MPa <sup>C</sup>	Yield Strength, MPa <sup>C,D</sup>	Exten- sion <sup>E</sup>	Torsional Strength, N-m <sup>F</sup>	Tensile Strength, MPa	Yield Strength, MPa	Elonga- tion, %	Vickers		Rockwell	
					min	min	min	min	min	min	min	min	max	min	max
A1-50		F 738A	M1.6–M5	all	500	...	...	Table 6	...	...	...	...	165	...	B85
A2-50 A4-50	AF	F 738B F 738C	M6–M36	all	500	210	0.6D	...	500	210	30	...	165	...	B85
A1-70 A2-70 A4-70	CW	F 738D F 738E F 738F	M1.6–M5 M6–M20 over M20–M36	8D 8D 8D	700 700 550	... 450 300	... 0.4D 0.2D x	Table 6 ... ...	... 650 520	... 400 270	... 20 25	220 220 160	330 330 310	B96 B96 B83	C33 C33 C31
A1-80 A2-80	SH	F 738G F 738H	M1.6–M5 over M20–M24	8D 8D	800 800 700	... 600 500	... 0.3D 0.2D	Table 6 ... ...	... 780 680	... 600 480	... 12 15	240 240 220	350 350 330	C23 C23 B96	C36 C36 C33
A4-80		F 738J	over M24–M30 over M30–M36	8D 8D	650 600	400 300	0.2D 0.2D	... ...	620 570	370 270	20 28	200 180	310 285	B93 B89	C30 C28
F1-45	AF	F 738K	M1.6–M5 M6–M36	all all	450 450	... 250	... 0.2D	... ...	... 450	... 250	... 25	... ...	165 165	... ...	B85 B85
F1-60	CW	F 738L	M1.6–M5 M6–M36	8D 8D	600 600	... 410	... 0.2D	... ...	... 550	... 360	... 20	180 180	285 285	B89 B89	C28 C28
C1-50 C4-50	A	F 738M F 738N	M1.6–M5 M6–M36	all all	500 500	... 250	... 0.2D	... ...	... 500	... 250	... 20	... ...	165 165	... ...	B85 B85
C1-70 C4-70	H	F 738P F 738R	M1.6–M5 M6–M36	all all	700 700	... 410	... 0.2D	... ...	... 700	... 410	... 18	... 220	330 330	B96 B96	C34 C34
C1-110 C4-110	HT	F 738S F 738T	M1.6–M5 M6–M36	all all	1100 1100	... 820	... 0.2D	... ...	... 1100	... 820	... 12	350 350	440 440	C36 C36	C45 C45
C3-80	H	F 738U	M1.6–M5 M6–M36	all all	800 800	... 640	... 0.2D	... ...	... 800	... 640	... 15	240 240	340 340	C23 C23	C35 C35
C3-120	HT	F 738V	M1.6–M5 M6–M36	all all	1200 1200	... 950	... 0.2D	... ...	... 1200	... 950	... 10	380 380	480 480	C39 C39	C48 C48
P1-90	AH	F 738W	M1.6–M5 M6–M36	all all	900 900	... 700	... 0.2D	... ...	... 900	... 700	... 16	285 285	370 370	C28 C28	C38 C38

<sup>A</sup> Legend of conditions:

AF — headed and rolled from annealed stock and then reannealed.

CW — headed and rolled from annealed stock, thus acquiring a degree of cold work; products with nominal thread diameters larger than M20 may be hot-worked and solution annealed.

SH — machined from strain-hardened stock or cold worked to develop the specified properties.

A — machined from annealed or solution-annealed stock, thus retaining the properties of the original material.

H — hardened and tempered at 565°C minimum.

HT — hardened and tempered at 275°C minimum.

AH — solution-annealed and age-hardened after forming.

<sup>B</sup> For product lengths:

"all" means all lengths

"8D" means 8 times nominal diameter maximum.

<sup>C</sup> Tensile strength and yield strength values for full-size products of each property class are given in table on yield and tensile strength.

<sup>D</sup> Yield strength is the stress at which an offset of 0.2 % gage length occurs.

<sup>E</sup> Extension measurement is determined in accordance with the test procedure specified in 10.2.3.

<sup>F</sup> Torsional strength requirements apply only to austenitic steel fasteners with nominal thread diameters M5 and smaller. Values are given in table on torsional strength.

conditions are required, the condition and resultant mechanical properties shall be as agreed upon between the manufacturer and the purchaser.

5.2.4 *Surface Finish*—Fasteners shall have a surface finish produced in accordance with Practice A 380.

5.2.5 *Protective Finishes*—Unless otherwise specified, fasteners shall be furnished without an additive chemical or metallic finish.

## 6. Heat Treatment

### 6.1 Austenitic Alloys, Grades A1, A2, and A4

6.1.1 When Condition AF is specified, the fasteners, following manufacture, shall be annealed by heating to  $1040 \pm 30^\circ\text{C}$ , at which time the chromium carbide will go into solution. The fasteners shall be held for a sufficient time and then cooled at a rate sufficient to prevent precipitation of the carbide and to provide the properties specified in **Table 2**.

6.1.2 When Condition CW is specified, the austenitic alloy shall be annealed as specified in **6.1.1**, generally by the raw material manufacturer, and then cold-worked to develop the properties specified in **Table 2**.

### 6.2 Ferritic Alloys, Grade F1

6.2.1 When Condition AF is specified, the ferritic alloy shall be heated to a temperature of  $790 \pm 30^\circ\text{C}$ , held for an appropriate time, and then air-cooled to provide the properties specified in **Table 2**.

6.2.2 When Condition CW is specified, the ferritic alloy shall be annealed as specified in **6.2.1**, generally by the raw material manufacturer and then cold-worked to develop the properties specified in **Table 2**.

### 6.3 Martensitic Alloys, Grades C1, C3, and C4

6.3.1 When Condition A is specified, the fasteners, following manufacture, shall be annealed to provide the properties specified in **Table 2**.

6.3.2 When Condition H is specified, the fasteners shall be hardened and tempered by heating to  $1010 \pm 30^\circ\text{C}$  sufficient for austenitization, holding for at least  $\frac{1}{2}$  h, rapid air- or oil-quenching, reheating to  $565^\circ\text{C}$  minimum, and holding for at least 1 h and then air-cooling to provide the properties specified in **Table 2**.

6.3.3 When Condition HT is specified, the fasteners shall be hardened and tempered by heating to  $1010 \pm 30^\circ\text{C}$  sufficient for austenitization, holding for at least  $\frac{1}{2}$  h, rapid air- or oil-quenching, reheating to  $275^\circ\text{C}$  minimum, holding for at least 1 h, and then air-cooling to provide the properties specified in **Table 2**.

6.4 *Precipitation-Hardening Alloy, Grade P1*—When Condition AH is specified, the fasteners shall be solution-annealed and aged by heating to  $1040 \pm 15^\circ\text{C}$ , holding for at least  $\frac{1}{2}$  h, rapid air- or oil-quenching to  $27^\circ\text{C}$  maximum, reheating to  $620 \pm 10^\circ\text{C}$  minimum, holding for 4 h, and then air-cooling to provide the properties specified in **Table 2**.

## 7. Chemical Composition

7.1 It is the intent of this specification that fasteners shall be ordered by property class.

7.2 Unless otherwise specified in the inquiry and purchase order (see Supplementary Requirement S2), when two or more alloys are permitted for fasteners of a specified property class, the choice of alloy to be used shall be that of the fastener manufacturer as determined by his fastener fabrication methods and material availability. The specific alloy used by the manufacturer shall be clearly identified on any certification

required in the purchase order and shall have a chemical composition conforming to the limits specified in **Table 3**.

7.2.1 When the purchaser specifies that a specific alloy be used, the alloy shall have a chemical composition conforming to the limits specified in **Table 3**.

7.3 Product analysis may be made by the purchaser from finished fasteners representing each lot. The chemical composition thus determined shall conform to the limits specified in **Table 3** for the specific alloy within the product analysis tolerances specified in Specification **A 555/A 555M**.

7.3.1 In the event of discrepancy, a referee analysis of samples for each lot shall be made in accordance with **9.3.1**.

## 8. Mechanical Properties

8.1 Bolts, screws, and studs shall be tested in accordance with the mechanical testing requirements for the applicable product type, property class, nominal thread diameter, length, and specified minimum tensile strength as specified in **Table 4**, and shall meet the mechanical requirements specified for that product in **Tables 2-6**.

8.2 For products on which both hardness and tension tests are performed, acceptance based on tensile requirements shall take precedence over low hardness readings.

## 9. Number of Tests and Retests

9.1 The requirements of this specification shall be met in continuous mass production for stock and the manufacturer shall make sample inspections to ensure that the product conforms to the specified requirements. Additional tests of individual shipments of material are not ordinarily necessary.

9.1.1 Individual heats of steel are not identified in the finished product. When specified in the purchase order that the heat number shall be identified for the products in an individual shipment, the manufacturer shall control the product by heat analysis and additionally shall conduct the testing program specified in **9.3.1**.

9.2 When specified in the purchase order, the manufacturer shall furnish a test report certified to be the last complete set of chemical analysis and mechanical tests for each stock size in each shipment.

9.3 When the purchaser requires that additional tests be performed by the manufacturer to determine that the properties of products in an individual shipment are within specified limits, the purchaser shall specify the testing requirements, including the sampling plan and basis of acceptance, in the inquiry and purchase order.

9.3.1 When the purchaser does not specify the sampling plan and basis of acceptance the following shall apply:

9.3.1.1 The lot, for purposes of selecting samples, shall consist of all products offered for inspection and testing, at one time, that are the same type, style, nominal diameter, thread pitch, nominal length, material (alloy), property class, and surface finish.

9.3.1.2 From each lot, samples shall be selected at random and tested for each requirement in accordance with the following plan: