Designation: F 738M – 01

METRIC

Standard Specification for Stainless Steel Metric Bolts, Screws, and Studs[1]

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 reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

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.*

2. Referenced Documents

2.1 *ASTM Standards:*

A 276 Specification for Stainless Steel Bars and Shapes[2]

A 342 Test Methods for Permeability of Feebly Magnetic Materials[3]

A 380 Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems[2]

A 484/A 484M Specification for General Requirements for Stainless Steel Bars, Billets, and Forgings[2]

A 493 Specification for Stainless Steel Wire and Wire Rods for Cold Heading and Cold Forging [2]

A 555/A 555M Specification for General Requirements for Stainless Steel Wire and Wire Rods[2]

A 564/A564M Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes[3]

A 582 Specification for Free-Machining Stainless Steel Bars[3]

A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products[2]

D 3951 Practice for Commercial Packaging[4]

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications[5]

E 353 Test Methods for Chemical Analysis of Stainless, Heat-Resisting, Maraging, and Other Similar Chromium-Nickel-Iron Alloys[6]

F 606M Test Methods for Determining the Mechanical Properties of Externally and Internally Threaded Fasteners, Washers, and Rivets [Metric][7]

F 836M Specification for Style 1 Stainless Steel Metric Nuts[7]

[1] 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 Oct. 10, 2001. Published November 2001. Originally published as F 738 – 81. Last previous edition F 738M – 00.

[2] *Annual Book of ASTM Standards*, Vol 01.03.
[3] *Annual Book of ASTM Standards*, Vol 03.04.
[4] *Annual Book of ASTM Standards*, Vol 15.09.
[5] *Annual Book of ASTM Standards*, Vol 14.02.
[6] *Annual Book of ASTM Standards*, Vol 03.05.
[7] *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	304, 304L, 305[A]
A1-70	384, XM7
A1-80	
A2-50	
A2-70	321, 347
A2-80	
A4-50	
A4-70	316, 316L
A4-80	
F1-45	430[B]
F1-60	
C1-50	
C1-70	410
C1-110	
C3-80	431
C3-120	
C4-50	
C4-70	416, 416Se
C4-110	
P1-90	630

[A] When approved by the purchaser, Alloys 303, 303Se, or XM1 may be furnished.

[B] When approved by the purchaser, Alloy 430F may be furnished.

F 1470 Guide for Fastener Sampling for Specified Mechanical Properties and Performance Inspection[7]

2.2 *ISO Standard:*

ISO 3506 Corrosion-Resistant Stainless Steel Fasteners[8]

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

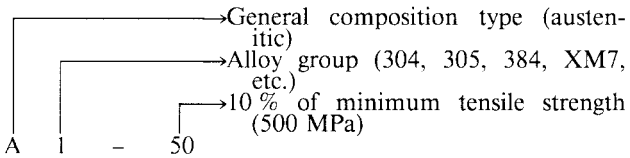
3.1.1.4 P for precipitation-hardening steel.

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 seven permitted alloys, and the manufactured fastener has a minimum tensile strength of 500 MPa.

[8] 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 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.

TABLE 2 Mechanical Property Requirements

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

[A] 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.
[B] For product lengths:
"all" means all lengths
"8*D*" means 8 times nominal diameter maximum.
[C] Tensile strength and yield strength values for full-size products of each property class are given in table on yield and tensile strength.
[D] Yield strength is the stress at which an offset of 0.2 % gage lingth occurs.
[E] Extension measurement is determined in accordance with the test procedure specified in 10.2.3.
[F] Torsional strength requirements apply only to austenitic steel fasteners with nominal thread diameters M5 and smaller. Values are given in table on torsional strength.

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 ± 30°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 ± 30°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 ± 30°C sufficient for austenitization, holding for at least ½ h, rapid air- or oil-quenching, reheating to 565°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 ± 30°C sufficient for austenitization, holding for at least ½ h, rapid air- or oil-quenching, reheating to 275°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 ± 15°C, holding for at least ½ h, rapid air- or oil-quenching to 27°C maximum, reheating to 620 ± 10°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 Chemical Requirements

Alloy Group	Alloy	UNS Designation	Composition, % maximum except as shown									
			Carbon	Manganese	Phosphorus	Sulfur	Silicon	Chromium	Nickel	Copper	Molybdenum	Others
						Austenitic Alloys						
A1	303	S30300	0.15	2.00	0.20	0.15 min	1.00	17.0–19.0	8.0–10.0		0.60 max[A]	
A1	303Se	S30323	0.15	2.00	0.20	0.060	1.00	17.0–19.0	8.0–10.0			Se 0.15 min
A1	304	S30400	0.08	2.00	0.045	0.030	1.00	18.0–20.0	8.0–10.5	1.00		
A1	304L	S30403	0.03	2.00	0.045	0.030	1.00	18.0–20.0	8.0–12.0	1.00		
A1	305	S30500	0.12	2.00	0.045	0.030	1.00	17.0–19.0	10.5–13.0	1.00		
A1	384	S38400	0.08	2.00	0.045	0.030	1.00	15.0–17.0	17.0–19.0			
A1	XM1	S20300	0.08	5.0 to 6.5	0.040	0.18 to 0.35	1.00	16.0–18.0	5.0–6.5	1.75–2.25	0.50 max[A]	
A1	XM7	S30430	0.03	2.00	0.045	0.030	1.00	17.0–19.0	8.0–10.0	3.0–4.0		
A4	316	S31600	0.08	2.00	0.045	0.030	1.00	16.0–18.0	10.0–14.0		2.00–3.00	
A4	316L	S31603	0.03	2.00	0.045	0.030	1.00	16.0–18.0	10.0–14.0		2.00–3.00	
A2	321	S32100	0.08	2.00	0.045	0.030	1.00	17.0–19.0	9.0–12.0			Ti 5 × C min
A2	347	S34700	0.08	2.00	0.045	0.030	1.00	17.0–19.0	9.0–13.0			Cb + Ta 10 × C min
						Ferritic Alloys						
F1	430	S43000	0.12	1.00	0.040	0.030	1.00	16.0–18.0				
F1	430F	S43020	0.12	1.25	0.060	0.15 min	1.00	16.0–18.0			0.60 max[A]	
						Martensitic Alloys						
C1	410	S41000	0.15	1.00	0.040	0.030	1.00	11.5–13.5				
C4	416	S41600	0.15	1.25	0.060	0.15 min	1.00	12.0–14.0			0.60 max[A]	
C4	416Se	S41623	0.15	1.25	0.060	0.060	1.00	12.0–14.0				Se 0.15 min
C3	431	S43100	0.20	1.00	0.040	0.030	1.00	15.0–17.0	1.25–2.50			
						Precipitation Hardening Alloy						
P1	630	S17400	0.07	1.00	0.040	0.030	1.00	15.0–17.5	3.0–5.0	3.0–5.0		Cb + Ta 0.15–0.45

[A] At manufacturer's option, determined only when intentionally added.