ASME B18.13-2017

[Revision of ASME B18.13-1996 (R2013)]

Screw and Washer Assemblies – SEMS (Inch Series)

AN AMERICAN NATIONAL STANDARD

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The American Society of Mechanical Engineers

Two Park Avenue • New York, NY • 10016 USA

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The American Society of Mechanical Engineers
Two Park Avenue, New York, NY 10016-5990

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FOREWORD

American National Standards Committee B27 for the standardization of plain and lock washers was organized in March 1926 as Sectional Committee B27 under the aegis of the American Standards Association (later the United States of America Standards Institute and, as of October 6, 1969, the American National Standards Institute, Inc.) with the Society of Automotive Engineers and the American Society of Mechanical Engineers as joint sponsors. (Since 1950, this Committee has also been assigned responsibility for standardization of washers and machine rings.) The Committee was reorganized in May 1928, at which time two subcommittees were established to carry on development work: Subcommittee 1[1] on plain washers and Subcommittee 2 on lock washers.

In 1940 the B27 Committee was reactivated and Subcommittee 2 proceeded to draft a proposal covering helical spring lock washers. It was further amended in 1943 and, following approval by the B27 Committee and sponsor organizations, accepted as an American Standard under the designation ASA B27.1-1994.

A draft proposal completed by Subcommittee 2 in September 1949 incorporated requirements applicable to helical spring lock washers made from materials other than carbon steel and included specifications for tooth lock washers, both helical spring and tooth lock washers, and machine screw assemblies. Subsequent to approval by the B27 Committee and sponsors, this proposal was forwarded to the American Standards Association and declared an American Standard on May 22, 1950.

During the years 1951 through 1956, Subcommittee 2 considered numerous refinements to the coverage for helical spring lock washers and heat treated machine screw and lock washer assemblies. A formal draft dated June 1957 was approved by letter ballot of the B27 Committee and the sponsor organizations and submitted to the American Standards Association for designation as an American Standard. This was granted on November 3, 1958.

In 1961 a study group comprised of members of the B18 and B27 Committees recommended that the screw and washer assemblies commonly known as SEMS, be published as a separate document under the jurisdiction of the B18 Committee, but subject to approval of both Sectional Committees and the affected subcommittees thereof. This recommendation was accepted by the B27 and B18 Committees, respectively, on the 28th and 30th of November 1961. Subcommittee 27[2] of Committee B18 was subsequently appointed.

At the initial meeting of Subcommittee 27 on February 1, 1962 a proposal was submitted consisting of pertinent data for lock washer SEMS, extracted from ASA B27.1-1958 and for plain washer SEMS proposed for inclusion in ASA B27.2, plus information gleaned from SAE Standard J773, Conical Spring Washers. It was agreed that the proposal should be extended to include tapping screw SEMS. Consequently, additional meetings of the subcommittee were held at which new drafts incorporating data for these products were reviewed and further changes and corrections were recommended. On February 15, 1963, a formal proposal was circulated for comment to Subcommittees 3, 9, and 27 of the B18 Committee, and Subcommittees 1 and 2 of the B27 Committee. On November 15, 1963, a revised draft incorporating resolutions to the comments received and additional refinements was letter balloted to Sectional Committees B18 and B27. The resulting comments and disapprovals were resolved at a meeting of Sectional Committee B18 on June 4, 1964, and by circulation of the recommended dispositions to Sectional

[1] As of April 1, 1966, Subcommittee 1 was redesignated Subcommittee 2 on plain washers; Subcommittee 2 was redesignated Subcommittee 1 on lock washers under American National Standards Committee 27. As of March 16, 1972, Subcommittees 1 and 2 became Subcommittees 22 and 21, respectively, of American National Standards Committee B18.

[2] As of April 1, 1966, Subcommittee 3 was redesignated Subcommittee 6, Subcommittee 9 was redesignated Subcommittee 3, and Subcommitteee 27 was redesignated Subcommittee 13 of American National Standards Committee B18.

Committee B27 on February 12, 1965. Subsequent to approval by the sponsor organizations and the American Standards Association, the document was formally designated an American Standard, ASA B18.13-1965, on September 29, 1965.

Over the next 18 years attempts were made to update and refine the document. However, due to extended vacancies in the chairmanship and continual shifts in membership of Subcommittee 13, none of these efforts proved successful and the standard was reaffirmed for three review periods. At the December 5, 1984, meeting of Subcommittee 13, it was agreed the standard should be revised to incorporate those changes necessary to bring it into agreement with the latest versions of the referenced B18 document covering the screw and washer components and for possible additional refinements. Recommendations for changes were reviewed and discussed further at a meeting held on May 18, 1985, and task groups were established to prepare detailed proposals relative to specific product lines. A proposed revision was drafted that relegated the coverage for round and truss head SEMS and Type A and Type C tapping screw SEMS to appendices under "Not recommended for new design" status. The revision included dimensional coverage for smaller sizes where applicable, changes to the helical spring lock washer sections and hardness, plus other technical and editorial updating previously accepted. This proposal was reviewed at the December 3, 1985, meeting of Subcommittee 13. Numerous editorial refinements were considered and adopted.

A formal proposal dated February 1986 was circulated to Subcommittees 3, 6, 13, 21, and 22 of the B18 Committee. A revised proposal incorporating resolutions to the comments received was given letter ballot approval by Standards Committee B18 in March 1987. Following its acceptance by ASME and the American National Standards Institute, this revision was granted recognition as an American National Standard on January 12, 1996.

At the 2014 Fall meeting of Subcommittee 13 a vote was taken and approved to revise the Standard to incorporate the new material regarding SEMS manufacturing that was introduced in the recent revision of ASME B18.13.1M and to update the format to be consistent with the other recently revised B18 standards.

The scope of the Standard was revised to more clearly reflect what is covered by the Standard and the previously included reference standards were moved out of the scope and into a separate Reference Standards sections as in all other B18 standards.

In particular, information was added to this Standard to more thoroughly explain that there are two distinctly different means of manufacturing SEMS products depending on the characteristics of the washer and screw being combined during manufacturing. One method is to assemble screws and washers and heat treat them as a unit after assembly and the other method is to heat treat the washer and screw separately and then assemble them together.

The referenced quality section was updated to remove the previous section listing specific fastener characteristics and sampling levels and to simply refer to the requirements in ASME B18.18 as is now done in all B18 standards.

This revision was approved as an American National Standard on January 3, 2017.

Suggestions for the improvement of this Standard are welcome. They should be addressed to the Secretary, B18 Standards Committee, The American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016-5990.

ASME B18 COMMITTEE
Standardization of Bolts, Nuts, Rivets, Screws, Washers, and Similar Fasteners

(The following is the roster of the Committee at the time of approval of this Standard.)

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General. ASME Standards are developed and maintained with the intent to represent the consensus of concerned interests. As such, users of this Standard may interact with the Committee by requesting interpretations, proposing revisions or a case, and attending Committee meetings. Correspondence should be addressed to:

Secretary, B18 Standards Committee
The American Society of Mechanical Engineers
Two Park Avenue
New York, NY 10016-5990
http://go.asme.org/Inquiry

Proposing Revisions. Revisions are made periodically to the Standard to incorporate changes that appear necessary or desirable, as demonstrated by the experience gained from the application of the Standard. Approved revisions will be published periodically.

The Committee welcomes proposals for revisions to this Standard. Such proposals should be as specific as possible, citing the paragraph number(s), the proposed wording, and a detailed description of the reasons for the proposal, including any pertinent documentation.

Proposing a Case. Cases may be issued to provide alternative rules when justified, to permit early implementation of an approved revision when the need is urgent, or to provide rules not covered by existing provisions. Cases are effective immediately upon ASME approval and shall be posted on the ASME Committee Web page.

Requests for Cases shall provide a Statement of Need and Background Information. The request should identify the Standard and the paragraph, figure, or table number(s), and be written as a Question and Reply in the same format as existing Cases. Requests for Cases should also indicate the applicable edition(s) of the Standard to which the proposed Case applies.

Interpretations. Upon request, the B18 Standards Committee will render an interpretation of any requirement of the Standard. Interpretations can only be rendered in response to a written request sent to the Secretary of the B18 Standards Committee.

Requests for interpretation should preferably be submitted through the online Interpretation Submittal Form. The form is accessible at http://go.asme.org/InterpretationRequest. Upon submittal of the form, the Inquirer will receive an automatic e-mail confirming receipt.

If the Inquirer is unable to use the online form, he/she may e-mail the request to the Secretary of the B18 Standards Committee at the above address. The request for an interpretation should be clear and unambiguous. It is further recommended that the Inquirer submit his/her request in the following format:

Subject:	Cite the applicable paragraph number(s) and the topic of the inquiry in one or two words.
Edition:	Cite the applicable edition of the Standard for which the interpretation is being requested.
Question:	Phrase the question as a request for an interpretation of a specific requirement suitable for general understanding and use, not as a request for an approval of a proprietary design or situation. Please provide a condensed and precise question, composed in such a way that a “yes” or “no” reply is acceptable.
Proposed Reply(ies):	Provide a proposed reply(ies) in the form of “Yes” or “No,” with explanation as needed. If entering replies to more than one question, please number the questions and replies.
Background Information:	Provide the Committee with any background information that will assist the Committee in understanding the inquiry. The Inquirer may also include any plans or drawings that are necessary to explain the question; however, they should not contain proprietary names or information.

Requests that are not in the format described above may be rewritten in the appropriate format by the Committee prior to being answered, which may inadvertently change the intent of the original request.

ASME procedures provide for reconsideration of any interpretation when or if additional information that might affect an interpretation is available. Further, persons aggrieved by an interpretation may appeal to the cognizant ASME Committee or Subcommittee. ASME does not "approve," "certify," "rate," or "endorse" any item, construction, proprietary device, or activity.

Attending Committee Meetings. The B18 Standards Committee regularly holds meetings and/or telephone conferences that are open to the public. Persons wishing to attend any meeting and/or telephone conference should contact the Secretary of the B18 Standards Committee. Future Committee meeting dates and locations can be found on the Committee Page at go.asme.org/B18committee.

SCREW AND WASHER ASSEMBLIES — SEMS (INCH SERIES)

1 INTRODUCTION

1.1 Scope

This Standard covers general and dimensional data pertinent to the various types of screw and captive washer assemblies, otherwise known as *SEMS*. SEMS products may include screws, tapping screws, or bolts in sizes No. 0 through ½ in. diameters in various grades and materials. The word SEMS is recognized in the United States as a generic term applicable to screw and washer assemblies. Also included in this Standard is Nonmandatory Appendix A illustrating the relative proportions of plain and conical washer SEMS.

NOTE: The word lock, which appears in the names of products in this Standard, is a generic term historically associated with their identification and is not intended to imply an indefinite fixity in attachments where the fasteners are used.

1.2 Use and Application

The SEMS covered by this Standard are general purpose fasteners intended for mass production and other assembly operations where speed and convenience are paramount factors. Further attributes of the various washers, recognized herein, are given in detail for each type of SEMS. Products having washers of styles and shapes not shown in this Standard may be considered SEMS; however, these products must be covered by the purchaser's drawing, standard, or the supplier's standards.

1.3 Types of SEMS

Included in this Standard are SEMS comprised of the following types of screws and washers:

(a) Helical Spring Lock Washers
- *(1)* socket head cap screws (see Table 1)
- *(2)* hex cap screws (see Table 2)
- *(3)* machine screws (see Tables 2 and 3)
- *(4)* tapping screws (see Tables 2 and 3)

(b) Tooth Lock Washers
- *(1)* machine screws (see Tables 4 and 5)
- *(2)* tapping screws (see Tables 4 and 5)
- *(3)* hex cap screws (see Tables 4 and 5)

(c) Conical Spring Washers
- *(1)* hex cap screws (see Table 6)
- *(2)* machine screws (see Table 6)
- *(3)* tapping screws (see Table 6)

(d) Plain Washers
- *(1)* machine screws (see Table 7)
- *(2)* tapping screws (see Table 7)
- *(3)* hex cap screws (see Table 7)

(e) Products having washers of styles and shapes not shown in this Standard may be considered SEMS; however, these products must be covered by the purchaser's drawing or standard.

1.4 Screw Heads

1.4.1 Head Styles. The head styles applicable to the various types of SEMS shall be as depicted in the illustrations and designated in the tables for each type. Where only the slotted head SEMS are illustrated, it should be understood that this Standard also applies to the corresponding cross-recessed head.

1.5 Dimensions

All dimensions in this Standard are given in inches unless stated otherwise.

1.6 Options

Options, where specified, shall be at the discretion of the manufacturer, unless otherwise agreed upon by the manufacturer and the purchaser.

1.7 Responsibility for Modification

Parts made to this Standard can be subject to the effects of hydrogen embrittlement, either from electroplating operations or exposure in the environment. The manufacturer shall not be held responsible for modifications, such as plating (done by the purchaser to unplated SEMS supplied in the original order), when these modifications are not made by the manufacturer.

1.8 Terminology

For definitions of terms relating to fasteners or component features thereof used in this Standard, refer to ASME B18.12.

1.9 Reference Standards

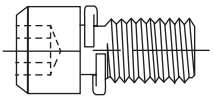
The following is a list of publications referenced in this Standard. The latest edition shall apply.

ASME B18.2.1, Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)

ASME B18.3, Socket Cap, Shoulder, Set Screws, and Hex Keys (Inch Series)

ASME B18.6.3, Machine Screws, Tapping Screws, and Metallic Drive Screws (Inch Series)

Table 1 Dimensions of Helical Spring Lock Washers for Socket Head Cap Screw SEMS



Socket Head Cap Screw

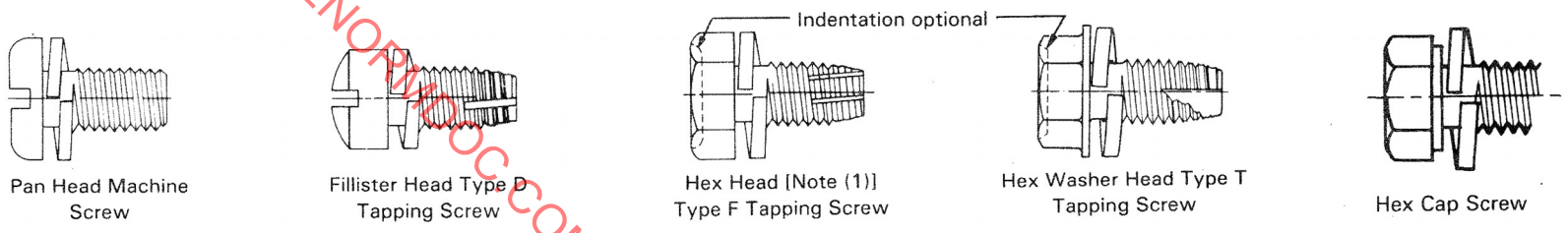
Nominal Size [Note (1)] of Basic Screw Diameter		Washer Inside Diameter		Washer Section		Washer Outside Diameter	
		Max.	Min.	Minimum Width	Minimum Thickness	Max.	Min.
2	0.0860	0.080	0.075	0.022	0.022	0.129	0.119
3	0.0990	0.091	0.086	0.030	0.030	0.158	0.147
4	0.1120	0.106	0.101	0.030	0.030	0.174	0.161
5	0.1250	0.118	0.113	0.040	0.040	0.206	0.193
6	0.1380	0.129	0.124	0.040	0.040	0.217	0.204
8	0.1640	0.155	0.149	0.047	0.047	0.257	0.243
10	0.1900	0.179	0.173	0.062	0.047	0.311	0.297
1/4	0.2500	0.238	0.230	0.062	0.062	0.380	0.354
5/16	0.3125	0.298	0.290	0.078	0.078	0.462	0.446
3/8	0.3750	0.361	0.353	0.094	0.094	0.557	0.541
7/16	0.4375	0.420	0.411	0.109	0.109	0.646	0.629
1/2	0.5000	0.482	0.473	0.125	0.125	0.740	0.723
5/8	0.6250	0.601	0.592	0.156	0.156	0.921	0.904
3/4	0.7500	0.722	0.713	0.188	0.188	1.106	1.069

GENERAL NOTE: For additional requirements, refer to sections 2 and 3.

NOTE:

(1) Where specifying nominal size in decimals, zeros preceding the decimal and in the fourth place shall be omitted.

Table 2 Dimensions of Helical Spring Lock Washers for SEMS With Machine and Tapping Screws Having Machine Screw Thread Diameter–Pitch Combinations



Representative Examples of Helical Spring Lock Washer SEMS

Nominal Size [Note (2)] or Basic Screw Diameter		Washer Inside Diameter		Pan Head Screw				Fillister Head Screw				Hex Head Screw [Note (1)]				Hex Washer Head Screw			
				Washer Section		Washer Outside Diameter		Washer Section		Washer Outside Diameter		Washer Section		Washer Outside Diameter		Washer Section		Washer Outside Diameter	
				Width	Thick-ness			Width	Thick-ness			Width	Thick-ness			Width	Thick-ness		
		Max.	Min.	Min.	Min.	Max.	Min.	Min.	Min.	Max.	Min.	Min.	Min.	Max.	Min.	Min.	Min.	Max.	Min.
2	0.0860	0.080	0.075	0.035	0.020	0.156	0.145	0.030	0.020	0.146	0.135	0.030	0.020	0.146	0.135	0.035	0.020	0.156	0.145
3	0.0990	0.091	0.086	0.040	0.025	0.178	0.166	0.035	0.020	0.168	0.156	0.035	0.020	0.168	0.156	0.040	0.025	0.178	0.166
4	0.1120	0.105	0.101	0.047	0.031	0.280	0.195	0.035	0.020	0.184	0.171	0.040	0.025	0.192	0.181	0.047	0.031	0.208	0.195
5	0.1250	0.118	0.113	0.047	0.031	0.220	0.207	0.035	0.020	0.196	0.183	0.047	0.031	0.220	0.207	0.047	0.031	0.220	0.207
6	0.1380	0.129	0.124	0.062	0.034	0.261	0.248	0.047	0.031	0.231	0.218	0.047	0.031	0.231	0.218	0.062	0.034	0.261	0.248
8	0.1640	0.155	0.149	0.078	0.031	0.319	0.305	0.047	0.031	0.257	0.243	0.055	0.040	0.271	0.259	0.078	0.031	0.319	0.305
10	0.1900	0.179	0.173	0.093	0.047	0.373	0.359	0.055	0.040	0.297	0.283	0.062	0.047	0.311	0.297	0.093	0.047	0.373	0.359
12	0.2160	0.203	0.196	0.109	0.062	0.429	0.414	0.062	0.047	0.335	0.320	0.070	0.056	0.351	0.336	0.109	0.062	0.429	0.414
1/4	0.2500	0.238	0.230	0.125	0.062	0.495	0.480	0.077	0.063	0.400	0.384	0.109	0.062	0.464	0.448	0.125	0.062	0.496	0.480
5/16	0.3125	0.298	0.290	0.156	0.078	0.618	0.602	0.109	0.062	0.524	0.508	0.125	0.078	0.556	0.540	0.156	0.078	0.618	0.602
3/8	0.3750	0.361	0.353	0.171	0.093	0.711	0.695	0.125	0.062	0.619	0.603	0.141	0.094	0.651	0.635	0.171	0.093	0.711	0.695
7/16	0.4375	0.420	0.411	...	...	...	...	...	...	...	...	0.156	0.109	0.740	0.723	...	...	...	...
1/2	0.5000	0.482	0.473	...	...	...	...	...	...	...	...	0.171	0.125	0.834	0.815	...	...	...	...

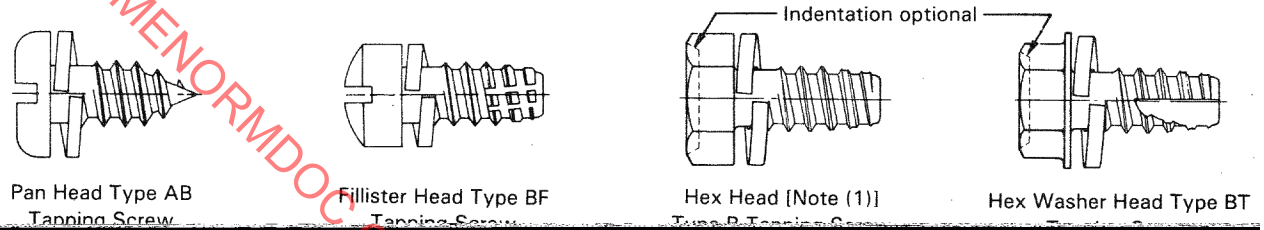
GENERAL NOTE: For additional requirements, refer to sections 2 and 3.

NOTES:

(1) The regular trimmed or upset hex head screws shall apply for the washers shown. Where upset large hex head screws in sizes No. 4, 5, 8, 12, and 1/4 in. are specified by the purchaser, the washers shown for the corresponding size hex washer head screw shall apply. Refer to appropriate tables for hex head machine and tapping screws in ASME B18.6.3.

(2) Where specifying nominal size in decimals, zeros preceding the decimal and in the fourth place shall be omitted.

Table 3 Dimensions of Helical Spring Lock Washers for SEMS With Screws Having Type B Tapping Screw Thread Diameter–Pitch Combinations



Nominal Size [Note (2)] or Basic Screw Diameter		Washer Inside Diameter		Pan Head Screw				Fillister Head Screw				Hex Head Screw [Note (1)]				Hex Washer Head Screw			
				Washer Section		Washer Outside Diameter		Washer Section		Washer Outside Diameter		Washer Section		Washer Outside Diameter		Washer Section		Washer Outside Diameter	
		Max.	Min.	Width Min.	Thickness Min.	Max.	Min.	Width Min.	Thickness Min.	Max.	Min.	Width Min.	Thickness Min.	Max.	Min.	Width Min.	Thickness Min.	Max.	Min.
4	0.1120	0.101	0.096	0.055	0.034	0.217	0.206	0.040	0.025	0.187	0.176	0.040	0.025	0.187	0.176	0.055	0.034	0.217	0.206
5	0.1250	0.112	0.107	0.055	0.034	0.228	0.217	0.047	0.031	0.214	0.201	0.047	0.031	0.214	0.201	0.055	0.034	0.228	0.217
6	0.1380	0.121	0.116	0.062	0.034	0.253	0.240	0.047	0.031	0.223	0.210	0.047	0.031	0.223	0.210	0.062	0.034	0.253	0.240
7	0.1510	0.135	0.130	0.062	0.034	0.267	0.254	0.047	0.031	0.237	0.224	0.047	0.031	0.237	0.224	0.062	0.034	0.267	0.254
8	0.1640	0.144	0.138	0.078	0.040	0.308	0.294	0.055	0.040	0.262	0.248	0.055	0.040	0.262	0.248	0.078	0.040	0.308	0.294
10	0.1900	0.162	0.156	0.093	0.047	0.356	0.342	0.062	0.047	0.294	0.280	0.062	0.047	0.294	0.280	0.093	0.047	0.356	0.342
12	0.2160	0.188	0.181	0.109	0.056	0.414	0.399	0.070	0.056	0.336	0.321	0.070	0.056	0.336	0.321	0.109	0.056	0.414	0.399
1/4	0.2500	0.217	0.209	0.120	0.062	0.465	0.449	0.109	0.062	0.443	0.427	0.109	0.062	0.443	0.427	0.120	0.062	0.465	0.449
5/16	0.3125	0.278	0.270	0.156	0.078	0.598	0.582	0.125	0.078	0.536	0.520	0.125	0.078	0.536	0.520	0.156	0.078	0.598	0.582
3/8	0.3750	0.338	0.330	0.171	0.093	0.688	0.672	0.141	0.094	0.628	0.612	0.141	0.094	0.628	0.612	0.171	0.093	0.688	0.672
7/16	0.4375	0.397	0.388	...	...	...	...	...	...	...	...	0.156	0.109	0.717	0.700	...	...	...	...
1/2	0.5000	0.460	0.451	...	...	...	...	...	...	...	...	0.171	0.125	0.812	0.793	...	...	...	...

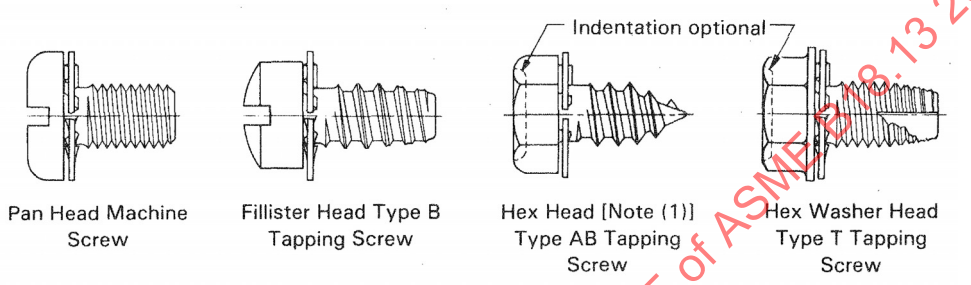
GENERAL NOTE: For additional requirements, refer to sections 2 and 3.

NOTES:

(1) The regular trimmed or upset hex head screws shall apply for the washers shown. Where upset large hex head screws in sizes No. 4, 5, 8, 12, and 1/4 in. are specified by the purchaser, the washers shown for the corresponding size hex washer head screw shall apply. Refer to appropriate tables for hex head tapping screws in ASME B18.6.3.

(2) Where specifying nominal size in decimals, zeros preceding the decimal and in the fourth place shall be omitted.

Table 4 Dimensions of Internal Tooth Lock Washers for SEMS



Representative Examples of Internal Tooth Lock Washer SEMS

Nominal Size [Note (2)] or Basic Screw Diameter		Pan, Filister, Hex [Note (1)], and Hex Washer [Note (3)] Head Screws			
		Washer Thickness		Washer Outside Diameter	
		Max.	Min.	Max.	Min.
2 [Note (2)]	0.0860	0.016	0.010	0.185	0.175
3 [Note (2)]	0.0990	0.016	0.010	0.225	0.215
4 [Note (2)]	0.1120	0.018	0.012	0.268	0.258
5 [Note (2)]	0.1250	0.018	0.012	0.268	0.258
6	0.1380	0.022	0.016	0.288	0.278
7	0.1510	0.022	0.016	0.288	0.278
8	0.1640	0.023	0.018	0.338	0.327
10	0.1900	0.024	0.018	0.383	0.372
12	0.2160	0.027	0.020	0.408	0.396
1/4	0.2500	0.028	0.023	0.478	0.466
5/16	0.3125	0.034	0.028	0.610	0.597
3/8	0.3750	0.040	0.032	0.692	0.678

GENERAL NOTE: For additional requirements, refer to sections 2 and 4.

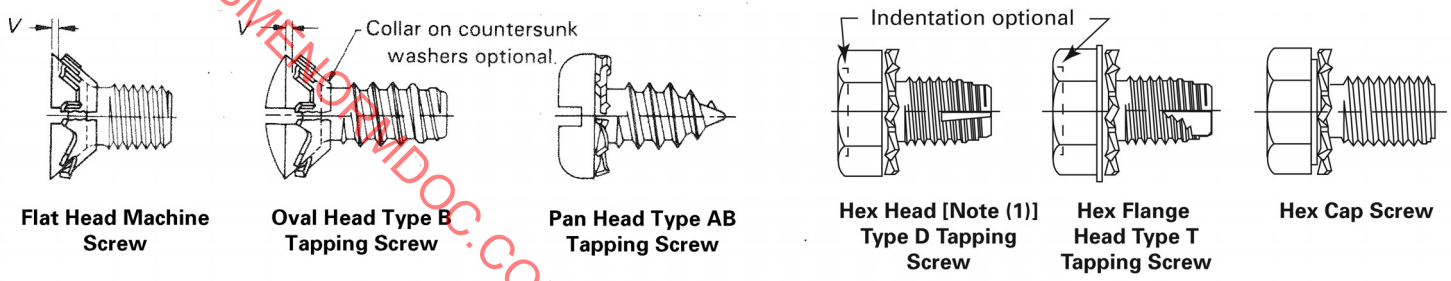
NOTES:

(1) The regular trimmed or upset hex head screws shall apply except for sizes No. 4, 5, 8, 12, and 1/4 in., which shall have upset large hex head screws. Refer to appropriate tables for hex head machine and tapping screws in ASME B18.6.3. Refer to appropriate tables for hex cap screws in ASME B18.2.1.

(2) Where specifying nominal size in decimals, zeros preceding the decimal and in the fourth place shall be omitted.

(3) Hex washer head SEMS are not available in sizes smaller than No. 6.

Table 5 Dimensions of External Tooth Lock Washers for SEMS



Representative Examples of External Tooth Lock Washer SEMS

Nominal Size [Note (2)] or Basic Screw Diameter		Flat and Oval Head Screws			Pan Head Screw				Hex Head and Hex Cap Screws [Note (1)]				Hex Washer Head Screw			
		Washer Thickness		Flush to Minus Tolerances of, V	Washer Thickness		Washer Outside Diameter		Washer Thickness		Washer Outside Diameter		Washer Thickness		Washer Outside Diameter	
		Max.	Min.		Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.
2	0.0860	...	...	...	0.016	0.010	0.180	0.170	0.016	0.010	0.180	0.170	0.016	0.010	0.180	0.170
3	0.0990	0.014	0.009	0.019	0.016	0.010	0.205	0.195	0.016	0.010	0.205	0.195	0.016	0.010	0.205	0.195
4	0.1120	0.014	0.009	0.022	0.018	0.012	0.230	0.220	0.018	0.012	0.230	0.220	0.018	0.012	0.230	0.220
5	0.1250	0.019	0.015	0.024	0.020	0.014	0.255	0.245	0.020	0.014	0.255	0.245	0.020	0.014	0.255	0.245
6	0.1380	0.020	0.016	0.026	0.022	0.015	0.285	0.270	0.022	0.016	0.285	0.270	0.022	0.016	0.317	0.306
7	0.1510	0.020	0.016	0.047	0.022	0.016	0.285	0.270	0.022	0.016	0.285	0.270	0.022	0.016	0.317	0.306
8	0.1640	0.020	0.016	0.030	0.023	0.018	0.320	0.305	0.023	0.018	0.320	0.305	0.023	0.018	0.317	0.306
10	0.1900	0.025	0.019	0.036	0.024	0.018	0.381	0.365	0.024	0.018	0.381	0.365	0.024	0.018	0.406	0.395
12	0.2160	0.025	0.019	0.041	0.027	0.020	0.420	0.395	0.027	0.020	0.410	0.395	0.027	0.020	0.406	0.395
1/4	0.2500	0.025	0.019	0.047	0.028	0.023	0.510	0.494	0.031	0.028	0.475	0.460	0.028	0.023	0.580	0.567
5/16	0.3125	0.028	0.023	0.060	0.034	0.028	0.610	0.588	0.031	0.028	0.580	0.567	0.034	0.028	0.654	0.540
3/8	0.3750	0.034	0.028	0.072	0.040	0.032	0.760	0.740	0.040	0.032	0.660	0.640	0.040	0.032	0.760	0.740

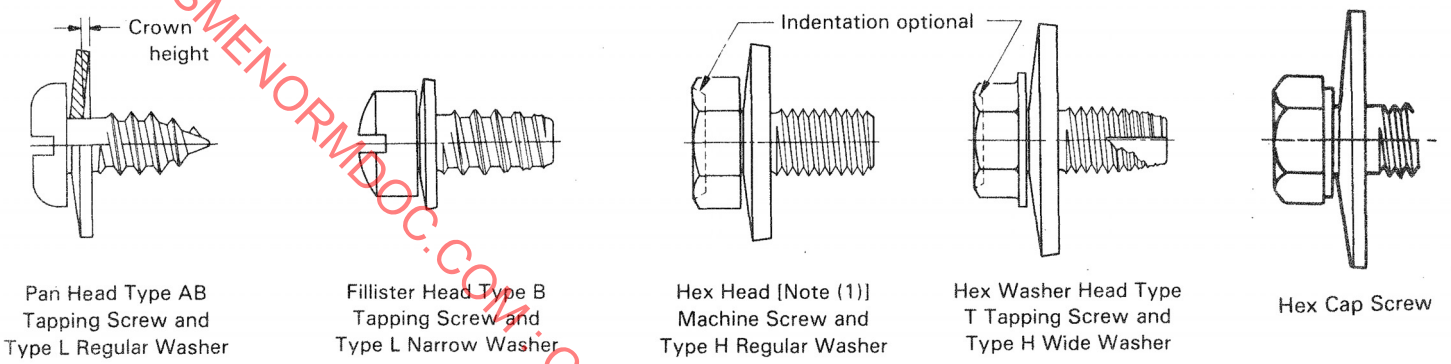
GENERAL NOTE: For additional requirements, refer to sections 2 and 3.

NOTES:

(1) The regular trimmed or upset hex head screws shall apply except for No. 4, 5, 8, 12, and 1/4 in., which shall have upset large hex head screws. Refer to appropriate tables for hex head machine and tapping screws in ASME B18.6.3. Refer to appropriate tables for hex cap screws in ASME B18.2.1.

(2) Where specifying nominal size in decimals, zeros preceding the decimal and in the fourth place shall be omitted.

Table 6 Dimensions of Conical Spring Washers for SEMS



Pan Head Type AB Tapping Screw and Type L Regular Washer

Fillister Head Type B Tapping Screw and Type L Narrow Washer

Hex Head [Note (1)] Machine Screw and Type H Regular Washer

Hex Washer Head Type T Tapping Screw and Type H Wide Washer

Hex Cap Screw

Representative Examples of Conical Spring Washer SEMS

Nominal Size [Note (2)] or Basic Screw Diameter		Washer Series	Washer Outside Diameter		Type L Washer					Type H Washer				
					Thickness			Crown Height		Thickness			Crown Height	
			Max.	Min.	Basic	Max.	Min.	Max.	Min.	Basic	Max.	Min.	Max.	Min.
		Narrow	0.320	0.307	0.025	0.029	0.023	0.025	0.015	0.035	0.040	0.033	0.025	0.015
6	0.1380	Regular	0.446	0.433	0.030	0.034	0.028	0.025	0.015	0.040	0.046	0.037	0.025	0.015
		Wide	0.570	0.557	0.030	0.034	0.028	0.031	0.021	0.040	0.046	0.037	0.029	0.019
		Narrow	0.383	0.370	0.035	0.040	0.033	0.025	0.015	0.040	0.046	0.037	0.025	0.015
8	0.1640	Regular	0.508	0.495	0.035	0.040	0.033	0.030	0.020	0.045	0.050	0.042	0.026	0.016
		Wide	0.640	0.620	0.035	0.040	0.033	0.037	0.027	0.045	0.050	0.042	0.040	0.030
		Narrow	0.446	0.433	0.035	0.040	0.033	0.025	0.015	0.050	0.056	0.047	0.025	0.015
10	0.1900	Regular	0.570	0.557	0.040	0.046	0.037	0.027	0.017	0.055	0.060	0.052	0.026	0.016
		Wide	0.765	0.743	0.040	0.046	0.037	0.036	0.026	0.055	0.060	0.052	0.034	0.024
		Narrow	0.446	0.433	0.040	0.046	0.037	0.025	0.015	0.055	0.060	0.052	0.025	0.015
12	0.2160	Regular	0.640	0.620	0.040	0.046	0.037	0.033	0.023	0.055	0.060	0.052	0.026	0.016
		Wide	0.890	0.868	0.045	0.050	0.042	0.044	0.034	0.064	0.071	0.059	0.033	0.023
		Narrow	0.515	0.495	0.045	0.050	0.042	0.025	0.015	0.064	0.071	0.059	0.025	0.015
1/4	0.2500	Regular	0.765	0.743	0.050	0.054	0.047	0.033	0.023	0.079	0.087	0.074	0.032	0.022
		Wide	1.015	0.993	0.055	0.060	0.052	0.040	0.030	0.079	0.087	0.074	0.039	0.029
		Narrow	0.640	0.620	0.055	0.060	0.052	0.026	0.016	0.079	0.087	0.074	0.026	0.016
5/16	0.3125	Regular	0.890	0.868	0.064	0.071	0.059	0.041	0.031	0.095	0.103	0.090	0.029	0.019
		Wide	1.140	1.118	0.064	0.071	0.059	0.044	0.034	0.095	0.103	0.090	0.040	0.030

Table 6 Dimensions of Conical Spring Washers for SEMS (Cont'd)

Nominal Size [Note (2)] or Basic Screw Diameter		Washer Series	Washer Outside Diameter		Type L Washer					Type H Washer				
					Thickness			Crown Height		Thickness			Crown Height	
			Max.	Min.	Basic	Max.	Min.	Max.	Min.	Basic	Max.	Min.	Max.	Min.
3/8	0.3750	Narrow	0.765	0.743	0.071	0.079	0.066	0.025	0.015	0.095	0.103	0.090	0.025	0.015
		Regular	1.015	0.993	0.071	0.079	0.066	0.043	0.033	0.118	0.126	0.112	0.033	0.023
		Wide	1.265	1.243	0.079	0.087	0.074	0.047	0.037	0.118	0.126	0.112	0.045	0.035
7/16	0.4375	Narrow	0.890	0.868	0.079	0.087	0.074	0.028	0.018	0.128	0.136	0.122	0.026	0.016
		Regular	1.140	1.118	0.095	0.103	0.090	0.041	0.031	0.128	0.136	0.122	0.038	0.028
		Wide	1.530	1.493	0.095	0.103	0.090	0.059	0.049	0.132	0.140	0.126	0.049	0.039
1/2	0.5000	Narrow	1.015	0.993	0.100	0.108	0.094	0.031	0.021	0.142	0.150	0.136	0.030	0.020
		Regular	1.265	1.243	0.111	0.120	0.106	0.043	0.033	0.142	0.150	0.136	0.037	0.027
		Wide	1.780	1.743	0.111	0.120	0.106	0.062	0.052	0.152	0.160	0.146	0.052	0.042

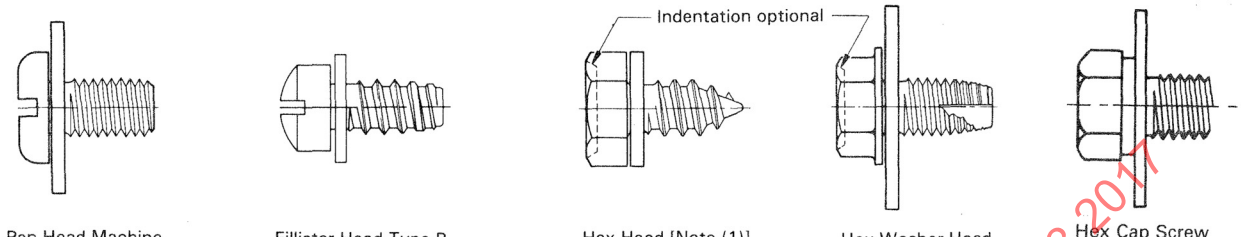
GENERAL NOTE: For additional requirements, refer to sections 2 and 3.

NOTES:

(1) The regular trimmed or upset hex head screws shall apply unless upset large hex head screws in sizes No. 8, 12, and 1/4 in. are by the purchaser. Refer to appropriate tables for hex head machine and tapping screws in ASME B18.6.3. Refer to appropriate tables for hex cap screws in ASME B18.2.1.

(2) Where specifying nominal size in decimals, zeros preceding the decimal and in the fourth place shall be omitted.

Table 7 Dimensions of Plain Washers for SEMS



Pan Head Machine Screw and Regular Washer

Fillister Head Type B Tapping Screw and Narrow Washer

Hex Head [Note (1)] Type AB Tapping Screw and Narrow Washer

Hex Washer Head Type T Tapping Screw and Wide Washer

Hex Cap Screw

Representative Examples of Plain Washer SEMS

Nominal Size [Note (2)] or Basic Screw Diameter		Pan, Fillister, Hex [Note (1)], and Hex Washer Head Screws						Nominal Size [Note (2)] or Basic Screw Diameter		Pan, Fillister, Hex [Note (1)], and Hex Washer Head Screws					
		Washer Series	Washer Outside Diameter		Washer Thickness					Washer Series	Washer Outside Diameter		Washer Thickness		
			Max.	Min.	Basic	Max.	Min.				Max.	Min.	Basic	Max.	Min.
		Narrow	0.188	0.183	0.025	0.028	0.022			Narrow	0.446	0.433	0.040	0.045	0.036
2	0.0860	Regular	0.250	0.245	0.032	0.036	0.028	10	0.1900	Regular	0.570	0.557	0.040	0.045	0.036
		Wide	0.312	0.307	0.032	0.036	0.028			Wide	0.749	0.727	0.063	0.071	0.056
		Narrow	0.219	0.214	0.025	0.028	0.022			Narrow	0.446	0.433	0.040	0.045	0.036
3	0.0990	Regular	0.312	0.307	0.032	0.036	0.028	12	0.2160	Regular	0.640	0.620	0.063	0.071	0.056
		Wide	0.383	0.370	0.040	0.045	0.036			Wide	0.890	0.868	0.063	0.071	0.056
		Narrow	0.250	0.245	0.032	0.036	0.028			Narrow	0.515	0.495	0.063	0.071	0.056
4	0.1120	Regular	0.383	0.370	0.040	0.045	0.036	1/4	0.2500	Regular	0.749	0.727	0.063	0.071	0.056
		Wide	0.446	0.433	0.040	0.045	0.036			Wide	1.015	0.993	0.063	0.071	0.056
		Narrow	0.281	0.276	0.032	0.036	0.028			Narrow	0.640	0.620	0.063	0.071	0.056
5	0.1250	Regular	0.446	0.433	0.040	0.045	0.036	5/16	0.3125	Regular	0.890	0.868	0.063	0.071	0.056
		Wide	0.508	0.495	0.040	0.045	0.036			Wide	1.140	1.118	0.063	0.071	0.056
		Narrow	0.312	0.307	0.032	0.036	0.028			Narrow	0.749	0.727	0.063	0.071	0.056
6	0.1380	Regular	0.446	0.433	0.040	0.045	0.036	3/8	0.3750	Regular	1.015	0.993	0.063	0.071	0.056
		Wide	0.570	0.557	0.040	0.045	0.036			Wide	1.280	1.243	0.100	0.112	0.090
		Narrow	0.312	0.307	0.032	0.036	0.028			Narrow	0.890	0.868	0.063	0.071	0.056
7	0.1510	Regular	0.446	0.433	0.040	0.045	0.036	7/16	0.4375	Regular	1.140	1.118	0.063	0.071	0.056
		Wide	0.570	0.557	0.040	0.045	0.036			Wide	1.499	1.462	0.100	0.112	0.090
		Narrow	0.383	0.370	0.032	0.036	0.028			Narrow	1.015	0.993	0.063	0.071	0.056
8	0.1640	Regular	0.508	0.495	0.040	0.045	0.036	1/2	0.5000	Regular	1.280	1.243	0.100	0.112	0.090
		Wide	0.640	0.620	0.063	0.071	0.056			Wide	1.780	1.743	0.100	0.112	0.090

GENERAL NOTES:

(a) For additional requirements, refer to sections 2 and 3.

(b) For relative proportions of screw heads and plain washers, see Nonmandatory Appendix A.

NOTES:

(1) The regular trimmed or upset hex head screw shall apply unless upset large hex head screws in sizes No. 4, 5, 8, 12, and 1/4 in. are specified by the purchaser. Refer to appropriate tables for hex head machine and tapping screws in ASME B18.6.3. Refer to appropriate tables for hex cap screws in ASME B18.2.1.

(2) Where specifying nominal size in decimals, zeros preceding the decimal and in the fourth place shall be omitted.

ASME B18.12, Glossary of Terms for Mechanical Fasteners
ASME B18.18, Quality Assurance for Fasteners
ASME B18.21.1, Washers: Helical Spring-Lock, Tooth Lock, and Plain Washers (Inch Series)
ASME B18.24, Part Identifying Number (PIN) Code System for B18 Fastener Products
Publisher: The American Society of Mechanical Engineers (ASME), Two Park Avenue, New York, NY 10016-5990 (www.asme.org)

ASTM F1941/F1941M, Standard Specification for Electrodeposited Coatings on Threaded Fasteners
Publisher: American Society for Testing and Materials (ASTM International), 100 Barr Harbor Drive, Box C700, West Conshohocken, PA 19428-2959 (www.astm.org)

SAE J429, Mechanical and Material Requirements for Externally Threaded Fasteners
SAE J773, Conical Spring Washers
Publisher: SAE International, 400 Commonwealth Drive, Warrendale, PA 15096 (www.sae.org)

1.10 Designation

Designation of SEMS products conforming to this Standard can be designated by the following data, in the sequence shown: ASME B18.13, nominal size (number, fraction, or decimal equivalent) and threads per inch, nominal length, point (tapping screw or header point for machine screws), head style and driving provision, screw type, washer type, and the product name ("SEMS"), material and protective finish as required. See examples below.

EXAMPLES:

(1) ASME B18.13, ¼–14 × 1¼ Type AB Slotted Pan Head Tapping Screw and Wide Plain Washer SEMS, Steel, Zinc Plated, ASTM F1941/F1941M, Fe/Zn 5A
(2) ASME B18.13, 6–32 × ¾ Type 1A Cross-Recessed Pan Head Machine Screw and Type H Regular Conical Spring Washer SEMS, Steel
(3) ASME B18.13, 0.375–16 × 1.50 Hex Head Machine Screw, Header Point and Header Pointed Hex Head Machine Screw and External Tooth Lock Washer SEMS, Steel, Phosphate Coated, ASTM F1137, Grade D
(4) ASME B18.13, 8–32 × ½ Type T Hex Head Tapping Screw and Helical Spring Lock Washer SEMS, Steel

1.11 Part Identifying Number (PIN) Code System

When the PIN numbering system in ASME B18.24 is used to describe the SEMS, either manufacturing Method 1 or Method 2 may be used at the manufacturer's discretion. When the specific method of manufacturing is required by the purchaser, the PIN system cannot be used.

1.12 Manufacturing

SEMS can be made of any screw type with any washer type; however, the method of manufacture is affected by the materials used for the screw and washer and the properties required in the finished part.

SEMS are made using two methods of production

(a) washer assembly and thread rolling before heat treat

(b) washer assembly and thread rolling after heat treat

This Standard acknowledges these two methods of SEMS manufacture. The material choice in the first method requires skilled selection of the screw and washer materials, since the properties of each have to be realized by a single set of heat treat conditions. The selection of materials depends on the heat treat system involved, the size and shape of the washer and screw, and the austenitizing and quenching of the SEMS unit in oil. The second method is used when the desired properties of the screw and washer cannot be made by the first method of heat treating the screw and washer at the same time.

1.12.1 Method 1 — Roll Thread Before Heat Treat. In this process, a nonheat-treated bolt or screw is assembled with a nonheat-treated washer and then roll threaded as an assembly. Following threading, the assembly is heat treated simultaneously as a single unit. Since two different sets of properties must be achieved using a single heat treat process, the choice of material chemistries for both the screw and washer requires careful evaluation and selection.

1.12.2 Method 2 — Roll Thread After Heat Treat. In this process, a fully heat-treated bolt or screw blank is assembled with a fully heat-treated washer and then roll threaded to form an assembly. Following threading, no further heat treatment of the assembly is required. SEMS manufacturing using Method 2 may not be reheat treated as a corrective action.

Unless determined and stated otherwise at the time of order agreement, Method 1 processing is used.

NOTES:

(1) Due to work hardening, screws thread rolled after heat treatment increase in core and surface hardness. This may cause the screws to have hardnesses greater than that allowed by the material specification after thread rolling. To keep the finished screws within hardness requirements, the hardness of the screws before thread rolling will have to be somewhat lower than the final product desired hardness. This can only be determined through experimentation.
(2) Method 1 is considered the default method and used where possible. However, if hardness requirements are unattainable with available materials using Method 1, Method 2 automatically applies.

1.13 Quality Assurance

Products shall conform to the requirements of this and other standards as referred to in the applicable sections and be inspected in accordance with ASME B18.18.

Fig. 1 Unthreaded Length on Screws With Machine Screw Thread Diameter–Pitch Combinations

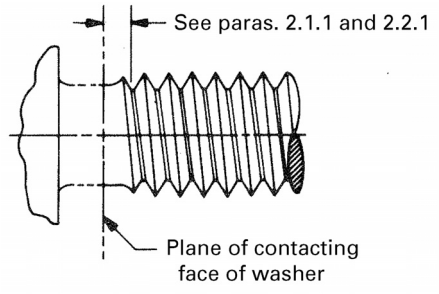
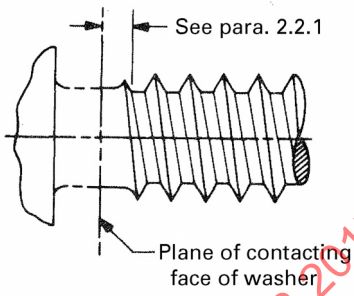


Fig. 2 Unthreaded Length on Tapping Screws With Spaced Thread Diameter–Pitch Combinations



2 GENERAL DATA

2.1 Machine Screws for SEMS

2.1.1 General. The machine screw component of SEMS shall conform to the specifications for machine screws published in ASME B18.6.3, except for the following:

(a) The maximum diameter of the unthreaded shank shall be less than the maximum major diameter of the thread by an amount sufficient to prevent disassembly of the washer from the screw.

(b) On screws threaded full length, the unthreaded length is the distance measured parallel to the axis of the screw from the underside of the washer to the face of a nonchamfered or noncounterbored standard GO ring gage. The unthreaded length is a maximum of one thread pitch (see Fig. 1).

(c) The minimum underhead fillet radius shall be equivalent to 5% of the basic screw diameter on protruding head styles and 20% of the basic screw diameter for countersunk head styles.

(d) If so specified, the SEMS for greater strength shall be heat treated in accordance with para. 2.1.2.

2.1.2 Heat-Treated Hex Cap Screws and Machine Screws

(a) Testing, material, and heat treatment shall comply with the requirements shown in SAE J429.

(b) Identification Markings. Heat-treated hex and hex washer head SEMS of nominal thread diameters $\frac{1}{4}$ in. and larger shall be permanently and legibly marked with the strength, grade, and manufacturer's identification. Markings for these sizes shall comply with the requirements shown in SAE J429.

(c) Ductility Test. Whereas the wedge tensile test shall be considered the referee method, the following test for ductility of through-hardened screws may be used:

(1) The test for ductility of screws with heads having a bearing surface perpendicular to the axis of the shank, such as pan heads, shall be tested according to the requirements in ASME B18.6.3 using a test block having a 5-deg wedge angle. Washers may be removed prior to testing. For referee testing, washers shall be removed.

(2) Flat and oval countersunk head screws shall be held in a vise and shall be capable of taking a 20-deg bend when the head is hammered to one side.

(3) The screws so tested shall exhibit no sign of failure.

2.2 Tapping Screws for SEMS

2.2.1 General. The tapping screw component of SEMS shall conform to the specifications for the respective types of tapping screws published in ASME B18.6.3, except for the following:

(a) The maximum diameter of the unthreaded shank shall be less than the maximum major diameter of the thread by an amount sufficient to prevent disassembly of the washer from the screws.

(b) On screws threaded full length, the unthreaded length is the distance measured parallel to the axis of the screw from the underside of the washer to the point where the minor diameter is at the maximum dimension specified in ASME B18.6.3. The unthreaded length is a maximum of one pitch (see Figs. 1 and 2).

(c) The minimum underhead fillet radius shall be equivalent to 5% of the basic screw diameter on protruding head styles and 20% of the basic screw diameter on countersunk head styles.

2.3 Socket Head Cap Screws for SEMS

The socket head cap screw component of SEMS shall conform to the specifications for cap screws published in ASME B18.3, except for the following:

(a) The maximum diameter of the unthreaded shank shall be less than the maximum major diameter of the thread by an amount sufficient to prevent disassembly of the washer from the screw.

(b) On socket cap screws threaded full length, the unthreaded length is the distance measured parallel to the axis of the screw from the underside of the washer to the face of a nonchamfered or noncounterbored standard GO ring gage. The unthreaded length is a maximum of two thread pitches (see Fig. 1). When required,

threads extending closer than two pitches to the contacting face of the washer may be negotiated between the manufacturer and purchaser.

2.4 Hex Cap Screws for SEMS

The hex head cap screws component of SEMS shall conform to the specifications for cap screws published in ASME B18.2.1, except for the following:

(a) The maximum diameter of the unthreaded shank shall be sufficient to allow free assembly and rotation of the washer relative to the screw.

(b) On hexagon cap screws threaded full length, the unthreaded length is the distance measured parallel to the axis of the screw from the underside of the washer to the face of a nonchamfered or noncounterbored standard GO ring gage. The unthreaded length is a maximum of two thread pitches (see Fig. 1). When required, threads extending closer than two pitches to the contacting face of the washer may be negotiated between the manufacturer and purchaser.

2.5 Applicability of Screw Sizes

To the extent that coverage is provided in the respective dimensional tables, numbered nominal sizes shall apply to all types of screws, including Type A tapping screws, and fractional nominal sizes shall apply to all types of screws except Type A tapping screws.

2.6 Washers for SEMS

The washer components of SEMS shall conform with the dimensions and specifications given for the various types in this Standard. It should be noted that the washers for SEMS may differ dimensionally from the equivalent over-the-thread washers as specified in ASME B18.21.1. Except for helical spring lock washers where the inside diameters are included for manufacturing purposes, the holes in the SEMS washers are not specified inasmuch as the washers shall be assembled onto the screw blanks before the threads are rolled. The edge contour of the hole on the head side of the washer and the size relationship between the washer inside diameter and the diameter of the unthreaded shank on the screw shall be such that the washer will be retained on the screw after the threads are rolled, and shall be free to rotate after assembly.

2.7 Finish

2.7.1 General. Unless otherwise specified by the purchaser, SEMS shall be supplied with a natural (as-processed) finish, unplated or uncoated. Where corrosion preventive treatment is required, SEMS shall be plated or coated as specified by the purchaser. The application of heavy coating deposits or supplemental treatments entailing organic compounds may result in a bonding of the SEMS components at points that abut. In such instances, the washers shall turn freely on the screw after breaking of the initial bond.

2.7.2 Electroplating. When electroplating is specified by the purchaser, ASTM F1941/F1941M shall be used. When the screw and/or washer have a specified hardness of HRC 40 or above, the post-plating procedures in ASTM F1941/F1941M to prevent hydrogen embrittlement shall be followed and embrittlement testing as specified in para. 2.8 shall be conducted.

2.8 Embrittlement Test

Carbon and/or alloy steel fastener/washer assemblies, SEMS, that have a specified hardness above HRC 39 and that are subsequently electroplated to enhance corrosion resistance shall be tested for embrittlement using the method detailed in ASME B18.6.3. Evidence of screw or washer fracture when visually examined without supplementary magnification shall constitute test failure.

3 DATA FOR HELICAL SPRING LOCK WASHER SEMS

3.1 Application

The helical spring lock washers covered herein are intended for general applications. Helical spring lock washers compensate for developed looseness between component parts of an assembly, distribute the load over a larger area for some head styles, and provide a hardened bearing surface.

3.2 Specifications

The washers shall conform to the specifications for helical spring washers published in ASME B18.21.1, except for modifications contained herein.

3.3 Washer Components

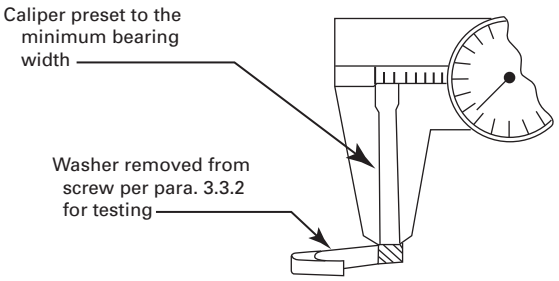
3.3.1 Dimensions. The dimensions of helical spring lock washers shall be as specified in Tables 1, 2, and 3. The corners at the outer and inner peripheries of the washer may be slightly rounded. However, the extent of the rounding shall be such that the bearing width of the washer section is not reduced to less than the equivalent of 70% of the specified minimum section width. See Fig. 3 for the check method.

3.3.2 Tests. After heat treatment of the SEMS, the washers shall be removed, undamaged, from the screws for testing. The washers shall meet all test requirements for standard over-the-thread washers specified in ASME B18.21.1.

3.4 Screw Components

(a) Socket head cap screws shall be assembled with washers shown in Table 1.

Fig. 3 Verification of Bearing Width on Helical Spring Lock Washers



(b) Machine screws, hex cap screws, and tapping screws having machine thread diameter–pitch combinations, in the head styles indicated, shall be assembled with washers shown in Table 2.

(c) Tapping screws having Type B spaced thread diameter–pitch combinations, in the head styles indicated, shall be assembled with washers shown in Table 3.

4 DATA FOR TOOTH LOCK WASHER SEMS

4.1 Application

The tooth lock washer SEMS covered herein are intended for general industrial application. The tooth lock washers serve to increase the friction between the screws and the assembly. Internal tooth lock washer SEMS are preferred where it is desirable to provide a smooth periphery.

4.2 Specifications

The washers shall conform to the specifications for toothed washers published in ASME B18.21.1, except for modifications contained herein.

4.3 Washer Components

4.3.1 Dimensions. The dimensions of internal and external tooth lock washers shall be as specified in Tables 4 and 5, respectively. Extrusion of a slight collar at the inside diameter of countersunk external tooth washers for use on flat and oval head screws shall be optional.

4.3.2 Tooth Design. Type A or Type B tooth design shall be optional. Refer to ASME B18.21.1 for details pertaining to tooth design.

4.3.3 Tests. After heat treatment of the SEMS, the washers shall be removed undamaged from the screws for testing. The washers shall meet a hardness of 40 HRC to 50 HRC, or 392 HV to 513 HV, and shall meet all other test requirements for standard over-the-thread washers specified in ASME B18.21.1.

4.4 Screw Components

Machine screws, hex cap screws, and tapping screws of the sizes and head styles shown in Tables 4 and 5 shall be assembled with internal or external tooth washers specified.

5 DATA FOR CONICAL SPRING WASHER SEMS

5.1 Application

The conical spring washer SEMS covered herein is intended for general application where it is desirable to

(a) compensate for loss of screw tension due to such factors as smoothing out or wearing of parts, thermal expansion, or compression set of gaskets

(b) distribute load over larger areas

(c) span large or elongated clearance holes

5.2 Washer Components

5.2.1 Dimensions. The dimensions of Type L and Type H conical washer components of SEMS are given in Table 6. Washers generally conform to the specifications in SAE J773 except that the crown height on some sizes is increased in order to facilitate the SEMS assembly operation. In the cases where the crown has been increased, the recovery test should be based on the SAE standard crown heights.

5.2.2 Types. Conical spring washers are available in a light series (Type L) and heavy series (Type H) for use with screws as described in the following:

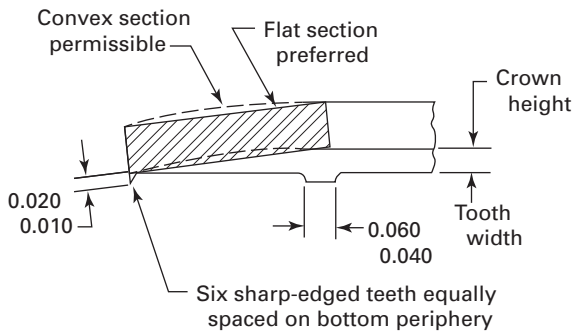
(a) Type L. Type L conical spring washers are intended for use on machine screw SEMS with screw components of materials having a specified minimum ultimate tensile strength of 74,000 psi or less. They shall also be used on tapping screw SEMS capable of safely accommodating these tensile requirements.

(b) Type H. Type H conical spring washers are intended for use on heat-treated SEMS with screw components of materials having a specified minimum ultimate tensile strength of 120,000 psi.

(c) Tooth Washers. Tooth-type conical spring washers having the same dimensions and characteristics as those defined above may also be used on SEMS for nonslip or positive electrical grounding purposes. Unless designated otherwise by the purchaser, when tooth-type washers are specified they shall be furnished with six sharp-edged teeth equally spaced about the outer periphery on the bottom face of the washer conforming with the dimensions shown in Fig. 4.

5.2.3 Series. Both the Type L and Type H conical spring washers for each screw size are specified in the same narrow, regular, and wide series having proportions designed to fulfill the purpose of distributing load over larger areas. Where used in conjunction with large

Fig. 4 Enlarged Conical Spring Washer Section and Tooth Washer Dimensions



clearance holes, it is recommended that the hole relationship be such as to permit washers to be in contact over at least 70% of their bearing area.

5.2.4 Tests for Washers on Heat-Treated SEMS. After heat treatment of SEMS, the washers shall be removed, undamaged, from the screws and subjected to the following tests:

(a) Hardness. The washers shall have a hardness of 40 HRC to 48 HRC, or the equivalent. Hardness shall be checked by grinding or filing a flat spot on the top side of the washer to permit seating on an anvil with the reading to be taken on the undisturbed inner face of the washer. If the hardness as obtained above is not within specified limits, washers may be qualified by checking hardness on a cut-out section of the washer on which both sides have been ground flat. However, an excessively decarburized surface, especially on lighter gage materials, may be grounds for rejection if the performance of the washer is adversely affected.

(b) Twist Test. The rim of the washer shall be cut, and the ends shall be gripped by pliers, vise and pliers, or wrench, whichever is most suitable for the washer section under test. Separation of the severed ends in the form of a helix to a distance equal to the inside diameter of the washer shall not result in fracture (see Fig. 5). When, at a greater degree of twist, the washer fractures, the structure at the point of fracture shall exhibit a fine grain, and the washer up to the instant of fracture shall deliver a tough springy reaction.

(c) Recovery Test. The washers shall retain at least one-third of the minimum crown height specified in SAE J773 after flattening between two hardened plates and then released.

5.3 Screw Components

Machine screws, hex cap screws, and tapping screws of the sizes and head styles indicated shall be assembled with the washers shown in Table 6. Care should be taken, however, to assure that mating materials will provide tensile requirements consistent with the selection of washer type.

5.4 Assembly Detail

The washers shall be assembled on headed screw blanks with the convex side adjacent to the screw head.

5.5 Assembly Considerations

5.5.1 Installation. The desired installed position shall be with the washer flat.

5.5.2 Load Conditions. Since it is intended that the washers in this Standard be loaded beyond the elastic limit of their material, they should not be used in applications involving dynamic loading of the washer.

6 DATA FOR PLAIN WASHER SEMS

6.1 Application

The plain washer SEMS covered herein are intended for general application where it is desirable to

(a) increase the area of bearing under the head of the screw when used against soft materials such as aluminum, plastic, wood, etc.

(b) span large or elongated clearance holes

(c) provide uniform bearing surfaces on rough workpiece surfaces

6.2 Washer Components

6.2.1 Dimensions. The dimensions of plain washer components of SEMS are given in Table 7. The tolerances specified are intended to apply to metal washers but do not preclude the use of other materials. Washers shall conform to specifications for Type B plain washers published in ASME B18.22.1, except for the modifications contained herein.

(a) Concentricity. The inside and outside diameters of the washers shall be concentric within 0.005 in. for No. 10 and smaller sizes, and within 0.010 in. for larger sizes.

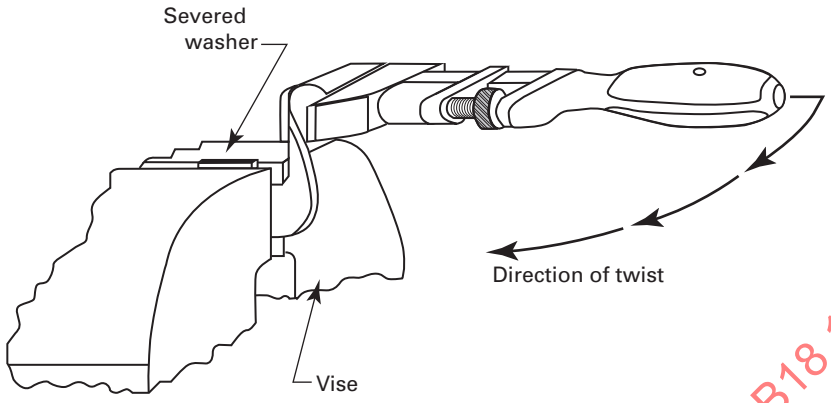
(b) Flatness. The washers shall be flat within 0.005 in. for washers having outside diameters up to and including 0.890 in., and within 0.010 in. for washers having larger outside diameters.

6.2.2 Series. The plain washers for each screw size are specified in narrow, regular, and wide series having proportions designed to fulfill the purpose of distributing load over larger areas.

6.2.3 Materials. Plain washers for SEMS may be steel, soft or hardened; nonferrous metals; plastics; or other suitable materials as specified by the purchaser.

(a) Soft steel washers, where no hardness requirement is specified, shall normally be made from low carbon steel. Where incorporated in tapping screw SEMS and heat-treated machine screw SEMS, the washers may be surface hardened at heat treatment of the screws, but must not be brittle so as to break on application.

Fig. 5 Conical Spring Washer Twist Test



(b) Hardened steel washers, where specified by the purchaser, shall be alloy or carbon steel, quenched, and tempered to a hardness of 40 HRC to 50 HRC or the equivalent.

6.3 Screw Components

Machine and tapping screws of the sizes and head styles indicated shall be assembled with washers specified in Table 7.