Designation: B32 – 08

Standard Specification for Solder Metal[1]

This standard is issued under the fixed designation B32; 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 solder metal alloys (commonly known as soft solders) used in non-electronic applications, including but not limited to, tin-lead, tin-antimony, tin-antimony-copper-silver, tin-antimony-copper-silver-nickel, tin-silver, tin-copper-silver, and lead-tin-silver, used for the purpose of joining together two or more metals at temperatures below their melting points. Electronic grade solder alloys and fluxed and non-fluxed solid solders for electronic soldering applications are not covered by this specification as they are under the auspices of IPC – Association Connecting Electronic Industries.

1.1.1 These solders include those alloys having a liquidus temperature not exceeding 800°F (430°C).

1.1.2 This specification includes solders in the form of solid bars, ingots, powder and special forms, and in the form of solid and flux-core ribbon, wire, and solder paste.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to become familiar with all hazards including those identified in the appropriate Material Safety Data Sheet (MSDS) for this product/material as provided by the manufacturer, to establish appropriate safety and health practices, and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D269 Test Method for Insoluble Matter in Rosin and Rosin Derivatives
D464 Test Methods for Saponification Number of Naval Store Products Including Tall Oil and Other Related Products
D465 Test Methods for Acid Number of Naval Stores Products Including Tall Oil and Other Related Products
D509 Test Methods of Sampling and Grading Rosin
E28 Test Methods for Softening Point of Resins Derived from Naval Stores by Ring-and-Ball Apparatus
E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
E46 Test Methods for Chemical Analysis of Lead- and Tin-Base Solder (Withdrawn 1994)[3]
E51 Method for Spectrographic Analysis of Tin Alloys by the Powder Technique (Withdrawn 1983)[3]
E55 Practice for Sampling Wrought Nonferrous Metals and Alloys for Determination of Chemical Composition
E87 Methods for Chemical Analysis of Lead, Tin, Antimony and Their Alloys (Photometric Method) (Withdrawn 1983)[3]
E88 Practice for Sampling Nonferrous Metals and Alloys in Cast Form for Determination of Chemical Composition

2.2 *Federal Standard:* [4]
Fed. Std. No. 123 Marking for Shipment (Civil Agencies)

2.3 *Military Standard:* [5]
MIL-STD-129 Marking for Shipment and Storage

3. Terminology

3.1 *Definitions:*

3.1.1 *producer, n*—the primary manufacturer of the material.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *lot, n*—The term "lot" as used in this specification is defined as follows:

[1] This specification is under the jurisdiction of ASTM Committee B02 on Nonferrous Metals and Alloys and is the direct responsibility of Subcommittee B02.02 on Refined Lead, Tin, Antimony, and Their Alloys.

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[2] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[3] The last approved version of this historical standard is referenced on www.astm.org.

[4] Available from Global Engineering Documents, 15 Inverness Way, East Englewood, CO 80112-5704, http://global.ihs.com.

[5] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, http://www.dodssp.daps.mil.

3.2.1.1 *Discussion*—For solid solder metal, a lot consists of all solder of the same type designation, produced from the same batch of raw materials under essentially the same conditions, and offered for inspection at one time.

3.2.1.2 *Discussion*—For flux–core solder, a lot consists of all solder of the same core mixture, produced from the same batch of raw materials under essentially the same conditions and offered for inspection at one time.

3.2.2 *lot number,, n*—The term “lot number” as used in this specification refers to an alphanumeric or numerical designation for a lot which is traceable to a date of manufacture.

4. Classification

4.1 *Type Designation*—The type designation uses the following symbols to properly identify the material:

4.1.1 *Alloy Composition*—The composition is identified by a two-letter symbol and a number. The letters typically indicate the chemical symbol for the critical element in the solder and the number indicates the nominal percentage, by weight, of the critical element in the solder. The designation followed by the letters *A* or *B* distinguishes between different alloy grades of similar composition (see Table 1).

4.1.2 *Form*—The form is indicated by a single letter in accordance with Table 2.

4.1.3 *Flux Type*—The flux type is indicated by a letter or combination of letters in accordance with Table 3.

4.1.4 *Core Condition and Flux Percentage (applicable only to flux-cored solder)*—The core condition and flux percentage is identified by a single letter and a number in accordance with Table 4.

4.1.5 *Powder Mesh Size and Flux Percentage (applicable only to solder paste)*—The powder mesh size and flux percentage is identified by a single letter and a number in accordance with Table 5.

5. Ordering Information

5.1 Orders for material under this specification indicate the following information, as required, to adequately describe the desired material.

5.1.1 Type designation (see 4.1),

5.1.2 Detailed requirements for special forms,

5.1.3 Dimensions of ribbon and wire solder (see 9.2),

5.1.4 Unit weight,

5.1.5 Packaging (see Section 18),

5.1.6 Marking (see Section 17),

5.1.7 ASTM specification number and issue, marked on (*a*) purchase order and (*b*) package or spool, and

5.1.8 Special requirements, as agreed upon between supplier and purchaser.

6. Materials and Manufacture

6.1 The producer must have each lot of solder metal as uniform in quality as practicable and of satisfactory appearance in accordance with best industrial practices. Each bar, ingot, or other form in which the solder is sold must be uniform in composition with the entire lot.

7. Chemical Composition

7.1 *Solder Alloy*—The solder alloy composition is as specified in Table 1.

NOTE 1—By mutual agreement between supplier and purchaser, analysis may be required and limits established for elements or compounds not specified in Table 1.

7.2 *Flux (applicable to flux-core ribbon, wire, and solder paste):*

7.2.1 *Type R*—The flux is composed of Grade WW or WG gum rosin of Test Methods D509. The rosin shall have a toluene–insoluble matter content of not more than 0.05 weight % in accordance with Test Method D269, a minimum acid number of 160 mg KOH/1 g sample in accordance with Test Methods D465, a minimum softening point of 70°C in accordance with Test Methods E28, and a minimum saponification number of 166 in accordance with Test Methods D464. When solvents or plasticizers are added, they must be nonchlorinated.

7.2.2 *Type RMA*—The flux is composed of rosin conforming to 7.2.1. Incorporated additives provide a material meeting the requirements of 8.1.2 for type RMA. When solvents or plasticizers are added, they must be nonchlorinated.

7.2.3 *Type RA*—The flux is composed of rosin conforming to 7.2.1. Incorporated additives provide a material meeting the requirements of 8.1.2 for Type RA. When solvents or plasticizers are added, they must be nonchlorinated.

7.2.4 *Type OA*—The flux is composed of one or more water-soluble organic materials.

7.2.5 *Type OS*—The flux is composed of one or more water-insoluble organic materials, other than Types R, RMA, and RA, which are soluble in organic solvents.

7.2.6 *Type IS*—The flux is composed of one or more inorganic salts or acids with or without an organic binder and solvents.

8. Physical Properties and Performance Requirements

8.1 *Solder Paste*—Solder paste must exhibit smoothness of texture (no lumps) and the absence of caking and drying.

8.1.1 *Powder Mesh Size*—The solder powder mesh size shall be as specified (see 5.1.1 and 4.1.5) when the extracted solder powder is tested as specified in 13.4.

8.1.2 *Viscosity*—The viscosity of solder paste and the method used to determine the viscosity must be agreed upon between the supplier and purchaser. The following variables must be taken into account when relating one viscosity measurement to another type of viscometer used, spindle size and shape, speed (r/min), temperature of sample, and the use or non-use of a helipath.

8.2 *Requirements for Flux*—The flux must meet the physical and performance requirements specified in Table 6 as applicable.

8.2.1 *Solder Pool*—When solder is tested as specified in 13.3.2, there must be no spattering, as indicated by the presence of flux particles outside the main pool of residue. The flux must promote spreading of the molten solder over the coupon to form integrally thereon a coat of solder that shall

TABLE 1 Solder Compositions - wt% (range or maximum)

Alloy Grade	Composition, %[A] Sn 1	Pb 2	Sb 3	Ag 4	Cu 5	Cd 6	Al 7	Bi 8	As 9	Fe 10	Zn 11	Ni 12	Ce 13	Se 14	Melting Range[B] Solidus °F	Solidus °C	Liquidus °F	Liquidus °C	UNS Number
Section 1: Solder Alloys Containing Less than 0.2 % Lead[C]																			
Sn96	Rem	0.10	0.12	3.4–3.8	0.08	0.005	0.005	0.15	0.05 max	0.02	0.005	...	...	...	430	221	430	221	L13965
Sn95	Rem	0.10	0.12	4.4–4.8	0.08	0.005	0.005	0.15	0.05	0.02	0.005	...	...	...	430	221	473	245	L13967
Sn94	Rem	0.10	0.12	5.4–5.8	0.08	0.005	0.005	0.15	0.05	0.02	0.005	...	...	...	430	221	536	280	L13969
Sb5	94.0 min	0.20	4.5-5.5	0.015	0.08	0.005	0.005	0.15	0.05	0.04	0.005	...	...	...	450	233	464	240	L13950
E[D]	Rem	0.10	0.05	0.25–0.75	3.0–5.0	0.005	0.005	0.02	0.05	0.02	0.005	...	...	...	440	225	660	349	L13935
HA[D]	Rem	0.10	0.5–4.0	0.1–3.0	0.1–2.0	0.005	0.005	0.15	0.05	0.02	0.5–4.0	...	...	...	420	216	440	227	L13955
HB[D]	Rem	0.10	4.0–6.0	0.05–0.5	2.0–5.0	0.005	0.005	0.15	0.05	0.02	0.01	0.05–2.0	...	...	460	238	660	349	L13952
HN[D]	Rem	0.10	0.05	0.05–0.15	3.5–4.5	0.005	0.005	0.15	0.05	0.02	0.005	0.15-0.25	...	...	440	225	660	350	L13933
PT[D]	Rem	0.2	0.25–4.0	0.05–0.50	0.25–4.0	0.005	0.005	0.15	0.01	0.02	0.005	0.005	0.01–0.25	...	430	221	435	224	
AC[D]	Rem	0.10	0.05	0.2–0.3	0.1–0.3	0.005	0.005	2.75–3.75	0.05	0.02	0.005	0.001	...	...	403	206	453	234	L13964
OA[D]	Rem	0.2	0.05	0.05–0.3	2.0–4.0	0.005	0.005	0.5–1.5	0.05	0.04†	0.05	...	...	...	420	216	460	238	L13937
AM	Rem	0.10	0.8–1.2	0.4–0.6	2.8–3.2	0.005	0.005	0.15	0.05	0.02	0.005	...	...	...	430	220	446	230	L13938
TC	Rem	0.20	0.05	0.015	4.0–5.0	0.005	0.005	0.05	0.05	0.04	0.005	0.005	...	0.04–0.20	419	215	660	350	L13931
WS	Rem	0.10	1.0–1.5	0.2–0.6	3.5–4.5	0.005	0.005	0.02	0.05	0.02	0.005	...	...	...	440	225	660	350	L13939
Section 2: Solder Alloys Containing Lead																			
Sn70	69.5–71.5	Rem	0.50	0.015	0.08	0.001	0.005	0.25	0.03	0.02	0.005	...	...	...	361	183	377	193	L13700
Sn63	62.5–63.5	Rem	0.50	0.015	0.08	0.001	0.005	0.25	0.03	0.02	0.005	...	...	...	361	183	361	183	L13630
Sn62	61.5–62.5	Rem	0.50	1.75–2.25	0.08	0.001	0.005	0.25	0.03	0.02	0.005	...	...	...	354	179	372	189	L13620
Sn60	59.5–61.5	Rem	0.50	0.015	0.08	0.001	0.005	0.25	0.03	0.02	0.005	...	...	...	361	183	374	190	L13600
Sn50	49.5–51.5	Rem	0.50	0.015	0.08	0.001	0.005	0.25	0.025	0.02	0.005	...	...	...	361	183	421	216	L55031
Sn45	44.5–46.5	Rem	0.50	0.015	0.08	0.001	0.005	0.25	0.025	0.02	0.005	...	...	...	361	183	441	227	L54951
Sn40A	39.5–41.5	Rem	0.50	0.015	0.08	0.001	0.005	0.25	0.02	0.02	0.005	...	...	...	361	183	460	238	L54916
Sn40B	39.5–41.5	Rem	1.8–2.4	0.015	0.08	0.001	0.005	0.25	0.02	0.02	0.005	...	...	...	365	185	448	231	L54918
Sn35A	34.5–36.5	Rem	0.50	0.015	0.08	0.001	0.005	0.25	0.02	0.02	0.005	...	...	...	361	183	447	247	L54851
Sn35B	34.5–36.5	Rem	1.6–2.0	0.015	0.08	0.001	0.005	0.25	0.02	0.02	0.005	...	...	...	365	185	470	243	L54852
Sn30A	29.5–31.5	Rem	0.50	0.015	0.08	0.001	0.005	0.25	0.02	0.02	0.005	...	...	...	361	183	491	255	L54821
Sn30B	29.5–31.5	Rem	1.4–1.8	0.015	0.08	0.001	0.005	0.25	0.02	0.02	0.005	...	...	...	365	185	482	250	L54822
Sn25A	24.5–26.5	Rem	0.50	0.015	0.08	0.001	0.005	0.25	0.02	0.02	0.005	...	...	...	361	183	511	266	L54721
Sn25B	24.5–26.5	Rem	1.1–1.5	0.015	0.08	0.001	0.005	0.25	0.02	0.02	0.005	...	...	...	365	185	504	263	L54722
Sn20A	19.5–21.5	Rem	0.50	0.015	0.08	0.001	0.005	0.25	0.02	0.02	0.005	...	...	...	361	183	531	277	L54711
Sn20B	19.5–21.5	Rem	0.8–1.2	0.015	0.08	0.001	0.005	0.25	0.02	0.02	0.005	...	...	...	363	184	517	270	L54712
Sn15	14.5–16.5	Rem	0.50	0.015	0.08	0.001	0.005	0.25	0.02	0.02	0.005	...	...	...	437	225	554	290	L54560
Sn10A	9.0–11.0	Rem	0.50	0.015	0.08	0.001	0.005	0.25	0.02	0.02	0.005	...	...	...	514	268	576	302	L54520
Sn10B	9.0–11.0	Rem	0.20	1.7–2.4	0.08	0.001	0.005	0.03	0.02	0.02	0.005	...	...	...	514	268	570	299	L54525
Sn5	4.5–5.5	Rem	0.50	0.015	0.08	0.001	0.005	0.25	0.02	0.02	0.005	...	...	...	586	308	594	312	L54322
Sn2	1.5–2.5	Rem	0.50	0.015	0.08	0.001	0.005	0.25	0.02	0.02	0.005	...	...	...	601	316	611	322	L54210
Ag1.5	0.75–1.25	Rem	0.40	1.3–1.7	0.30	0.001	0.005	0.25	0.02	0.02	0.005	...	...	...	588	309	588	309	L50132
Ag2.5	0.25	Rem	0.40	2.3–2.7	0.30	0.001	0.005	0.25	0.02	0.02	0.005	...	...	...	580	304	580	304	L50151
Ag5.5	0.25	Rem	0.40	5.0–6.0	0.30	0.001	0.005	0.25	0.02	0.02	0.005	...	...	...	580	304	716	380	L50180

[A] For purposes of determining conformance to these limits, an observed value or calculated value obtained from analysis shall be rounded to the nearest unit in the last right-hand place of figures used in expressing the specified limit, in accordance with the rounding method of Practice E29.

[B] Temperatures given are approximations and for information only.

[C] For alloys not identified, named elements shall conform to the following tolerances (wt%): >5% ±0.5%, >=5%± 0.25%; Impurity elements (maximum): Sn-0.2, Pb-0.2, Sb-0.5, Ag-0.015, Cu-0.08, Cd-0.005, Al-0.05, Bi-0.15, As-0.02, Fe-0.02, Zn-0.005.

[D] Grades E and OA are covered by U.S. patents held by Engelhard Corp, Mansfield, MA, and Oatey Co. Cleveland, OH respectively. Federated Fry Metals, Altoona, PA and Taracorp Inc., Atlanta, GA have applied for patents on grades AC and TC respectively. Grades HA, HB, and HN are covered by patents assigned to J. W. Harris Co., Cincinnati, OH. Grade PT is covered by a patent issued to Precise Alloys Corporation, Bronx, NY. Interested parties are invited to submit information regarding identification of acceptable alternatives to these patented items to the Committee on Standards, ASTM International Headquarters, 100 Barr Harbor Drive, West Conshohocken, PA 19428. Your comments will receive careful consideration at a meeting of the responsible technical committee[1], which you may attend.

† OA value for Fe 10 was corrected editorially.

TABLE 2 Form

Symbol	Form
B	Bar
I	Ingot
P	Powder
R	Ribbon
S	Special[A]
W	Wire

[A] Includes pellets, preforms, etc.

TABLE 3 Flux Type

Symbol	Description
S	Solid, no flux
R	Rosin, nonactivated
RMA	Rosin, mildly activated
RA	Rosin, activated
OA	Organic, water-soluble
OS	Organic, organic solvent-soluble (other than R, RMA, or RA)
IS	Inorganic acids and salts

TABLE 4 Core Condition and Flux Percentage

Condition Symbol	Condition		
D	Dry powder		
P	Plastic		
Percentage Symbol	Flux Percentage by Weight		
	Nominal	*Min*	*Max*
1	1.1	0.8	1.5
2	2.2	1.6	2.6
3	3.3	2.7	3.9
4	4.5	4.0	5.0
6[A]	6.0	5.1	7.0

[A] Not applicable to flux types R, RMA, and RA.

TABLE 5 Powder Mesh Size and Flux Percentage

Size Symbol	Powder Mesh Size	
A	<325	
B	<200	
C	<100	
Percentage Symbol	Flux Percentage by Weight	
	Min	*Max*
1	1	5
2	6	10
3	11	15
4	16	20
5	21	25
6	26	30
7	>30	

feather out to a thin edge. The complete edge of the solder pool must be clearly visible through the flux residue.

8.2.2 *Dryness*—When solder is tested as specified in 13.3.2, the surface of the residue must be free of tackiness, permitting easy and complete removal of applied powdered chalk.

8.2.3 *Chlorides and Bromides Test*—When the extracted flux is tested as specified in 13.3.6, the test paper will show no chlorides or bromides by a color change of the paper to off-white or yellow white.

8.2.4 *Copper Mirror Test*—When tested as specified in 13.3.7, the extracted flux will have failed the test if, when examined against a white background, complete removal of the copper film is noted, as evidenced by the white background showing through, and must be rejected. Discoloration of the copper due to a superficial reaction or to only a partial reduction of the thickness of the copper film is not cause for rejection.

9. Dimensions and Unit Weight

9.1 *Bar and Ingot Solder*—The dimensions and unit weight of bar and ingot solder will be as agreed upon between supplier and purchaser.

9.2 *Wire solder (solid and flux-cored)*—The dimensions and unit weight of wire solder are specified in 5.1.3 and 5.1.4. The tolerance on the specified outside diameter shall be ±5 % or ±0.002 in. (0.05 mm), whichever is greater.

9.3 *Other Forms:*

9.3.1 Dimensions for ribbon and special forms will be agreed upon between supplier and purchaser.

9.3.2 The unit weight of solder paste is specified in 5.1.4.

10. Workmanship, Finish, and Appearance

10.1 All forms of solder must be processed in such a manner as to be uniform in quality and free of defects that will affect life, serviceability, or appearance.

11. Sampling

11.1 Care must be taken to ensure that the sample selected for testing is representative of the material. The method of sampling consists of one of the following methods:

11.1.1 Samples taken from the final solidified cast or fabricated product.

11.1.2 Representative samples obtained from the lot of molten metal during casting. The molten sample is poured into a cool mold, forming a bar approximately ¼ in. (6.4 mm) thick.

11.2 *Frequency of Sampling*—Frequency of sampling for determination of chemical composition shall be in accordance with Table 7. For spools and coils, the sample is obtained by cutting back 6 ft (1.8 m) of wire from the free end and then taking the next 6 ft for test. In other forms, an equivalent sample is selected at random from the container.

11.3 *Other Aspects of Sampling*—Other aspects of sampling conforms in the case of bar and ingots, to Practice E88. For fabricated solders the appropriate reference is Practice E55.

12. Specimen Preparation

12.1 *Flux-Cored Ribbon and Wire Solder and Solder Paste*—Each sample of flux-cored ribbon or wire solder or solder paste is melted in a clean container under oil and mixed thoroughly. After the flux has risen to the top, the alloy is poured carefully into a cool mold (care should be taken to allow the flux and alloy to separate completely), forming a bar approximately ¼ in. (6.4 mm) thick. The bar is cleaned of flux residue and sampled for analysis as specified in 12.3.

12.1.1 *Flux Extraction Procedure:*

12.1.1.1 *Flux-Cored Solder*—The flux core is extracted as follows: Cut a length of the flux-cored solder weighing approximately 150 g and seal the ends. Wipe the surface clean with a cloth moistened with acetone. Place the sample in a