IEC 61190-1-3

Edition 2.0 2007-04

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Attachment materials for electronic assembly –
Part 1-3: Requirements for electronic grade solder alloys and fluxed and non-fluxed solid solders for electronic soldering applications

Matériaux de fixation pour les assemblages électroniques –
Partie 1-3: Exigences relatives aux alliages à braser de catégorie électronique et brasures solides fluxées et non fluxées pour les applications de brasage électronique

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For Sn96Ag2,5Bi1Cu,5:

US PAT No. 4879096
Cookson Electronics Assembly Materials
600 Route 440 Jersey City,New Jersey 07304

For Sn96,5Ag3Cu,5, Sn95,8Ag3,5Cu,7 and Sn95,5Ag3,8Cu,7:

US PAT No. 5527628
Iowa State University Research Foundation, Inc.
310 Lab of Mechanics
Ames, Iowa 50011-2131, U.S.A.

For Sn88In8Ag3,5Bi,5:
JP PAT No. 3040929
For Sn96,5Ag3Cu,5, Sn95,8Ag3,5Cu,7 and Sn95,5Ag3,8Cu,7:
JP PAT No. 3027441
Matsushita Electric Industrial Co., Ltd.
Matsushita IMP Building 20F 1-3-7, Shiromi, Chouh-ku, Osaka, 540-6319, Japan

For Sn92In4Ag3,5Bi,5
JP PAT No. 2805595
Mitsui Mining & Smelting Co., Ltd.
Gate City Ohsaki-West Tower 19th Fl. 1-11-1 Osaki, Shinagawa-ku, Tokyo, 141-8584, Japan

For Sn96,5Ag3Cu,5, Sn95,8Ag3,5Cu,7, Sn95,5Ag3,8Cu,7 and Sn95,5Ag4,0Cu,5
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International Standard IEC 61190-1-3 has been prepared by IEC technical committee 91: Electronics assembly technology.

This second edition cancels and replaces the first edition, published in 2002, and constitutes a technical revision. The main changes with regard to the first edition concern a definition of lead-free solder alloy and an amendment to Table B.1 concerning lead-free solder alloys.

This bilingual version, published in 2008-05, corresponds to the English version.

The text of this standard is based on the following documents:

FDIS	Report on voting
91/647/FDIS	91/679/RVD

Full information on the voting for the approval of this standard can be found in the report on voting indicated in the above table.

The French version of this standard has not been voted upon.

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

A list of all parts in the IEC 61190 series, under the general title *Attachment materials for electronic assembly*, can be found on the IEC website.

The committee has decided that the contents of this publication will remain unchanged until the maintenance result date indicated on the IEC web site under "http://webstore.iec.ch" in the data related to the specific publication. At this date, the publication will be

- reconfirmed;
- withdrawn;
- replaced by a revised edition, or
- amended.

ATTACHMENT MATERIALS FOR ELECTRONIC ASSEMBLY –

Part 1-3: Requirements for electronic grade solder alloys and fluxed and non-fluxed solid solders for electronic soldering applications

1 Scope

This part of IEC 61190 prescribes the requirements and test methods for electronic grade solder alloys, for fluxed and non-fluxed bar, ribbon, powder solders and solder paste, for electronic soldering applications and for “special” electronic grade solders. For the generic specifications of solder alloys and fluxes, see ISO 9453, ISO 9454-1 and ISO 9454-2. This standard is a quality control document and is not intended to relate directly to the material's performance in the manufacturing process

Special electronic grade solders include all solders which do not fully comply with the requirements of standard solder alloys and solder materials listed herein. Examples of special solders include anodes, ingots, preforms, bars with hook and eye ends, multiple-alloy solder powders, etc.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60194, *Printed board design, manufacture and assembly – Terms and definitions*

IEC 61190-1-1:2002, *Attachment materials for electronic assembly – Part 1-1: Requirements for soldering fluxes for high-quality interconnects in electronics assembly*

IEC 61190-1-2, *Attachment materials for electronic assembly – Part 1-2: Requirements for solder pastes for high-quality interconnections in electronics assembly*

IEC 61189-5, *Test methods for electrical materials, interconnection structures and assemblies – Part 5: Test methods for printed board assemblies*

IEC 61189-6, *Test methods for electrical materials, interconnection structures and assemblies – Part 6: Test methods for materials used in manufacturing electronic assemblies*

ISO 9001, *Quality management systems – Requirements*

ISO 9453, *Soft solder alloys – Chemical compositions and forms*

ISO-9454-1:1990, *Soft soldering fluxes – Classification and requirements – Part 1: Classification, labelling and packing*

ISO-9454-2:1998, *Soft soldering fluxes – Classification and requirements – Part 2: Performance requirements*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60194, as well as the following apply. Terms marked with an asterisk (*) are taken from IEC 60194 and are reprinted here for convenience.

3.1
acceptance tests *
those tests deemed necessary to determine the acceptability of a product and as agreed to by both purchaser and vendor

3.2
alloy
substance having metallic properties and being composed of two or more chemical elements of which at least one is an elemental metal

3.3
basis metal *
metal upon which coatings are deposited, also referred to as base metal

3.4
corrosion (chemical/electrolytic) *
attack of chemicals, flux, and flux residues on base metals

3.5
density (phototool) *
mass of a surface per unit volume, usually expressed in grams per cubic centimetre

3.6
dewetting *
condition that results when molten solder coats a surface and then recedes to leave irregularly shaped mounds of solder that are separated by areas that are covered with a thin film of solder and with the basis metal not exposed

3.7
eutectic (n.) *
alloy having the composition indicated by the eutectic point on an equilibrium diagram or an alloy structure of intermixed solid constituents formed by a eutectic reaction

3.8
eutectic (adj.) *
isothermal reversible reaction in which, on cooling, a liquid solution is converted into two or more intimately mixed solids, with the number of solids formed being the same as the number of components

3.9
flux *
chemically - and physically-active compound that, when heated, promotes the wetting of a base metal surface by molten solder by removing minor surface oxidation and other surface films and by protecting the surfaces from reoxidation during a soldering operation

3.10
flux characterization *
series of tests that determines the basic corrosive and conductive properties of fluxes and flux residues

3.11
flux residue *
flux-related contaminant that is present on or near the surface of a solder connection

3.12
liquidus
temperature at which a solder alloy changes from a paste form to a liquid form

3.13
nonwetting (solder) *
partial adherence of molten solder to a surface that it has contacted and where basis metal remains exposed

3.14
lead-free solder
solder alloy the lead content of which is equal to, or less than 0,10 % by mass

3.15
solder *
metal alloy with a melting temperature that is below 450 °C.

NOTE Metal alloy with a melting temperature less than 450 °C is classified as “soft solder”.

3.16
solderability *
ability of a metal to be wetted by molten solder

3.17
solidus
temperature at which a solder alloy changes from a solid to a paste form

3.18
wetting, solder *
formation of a relatively uniform, smooth, unbroken, and adherent film of solder to a basis metal.

4 Classification

Soldering materials covered by this standard shall be classified by alloy composition, solder form, flux type, flux percentage and by other characteristics peculiar to the solder material form.

4.1 Alloy composition

The solder alloys covered by this standard are the alloys listed in Tables B.1, B.2 and B.3 and include pure tin and pure indium. Each alloy is identified by an alloy name composed of a series of alphanumeric characters. These characters identify the component elements in the alloy by chemical symbol and nominal percentage by mass. They terminate with an arbitrarily assigned alloy variation letter (A, B, C, D). Alloys are also identified by an alloy short name. This is an alphanumeric designation composed of the chemical symbol for the key element in the alloy (see Clause A.4), the nominal percentage of that element in the alloy and the arbitrarily assigned alloy variation letter.

Tables B.1, B.2 and B.3 identify alloy composition, short name and temperature characteristics; Table B.4 cross-references solidus and liquidus temperatures to alloy names and Table B.5 cross-references ISO alloy numbers and designations from ISO 9453 to alloy names.

4.2 Solder form

Table 1 shows the forms of solder materials covered by this standard listed with their single-letter designating symbols.

Table 1 – Solder materials

Identifying symbol	Solder form
F	Flux (only)
P	Paste (cream)
B	Bar
D	Powder
R	Ribbon
W	Wire
S	Special

4.3 Flux type

The flux types used in/on solders covered by this standard are listed in Table 2. The requirements for fluxes are covered by IEC 61190-1-1.

Table 2 – Flux types and designating symbols

Flux materials of composition [a]	Flux activity levels wt. % halide [b]		IEC flux designator [c]	ISO flux designator [d]
Rosin	Low (<0,01)	L0	ROL0	1.1.1
(RO)	Low (<0,15)	L1	ROL1	1.1.2.W, 1.1.2.X
	Moderate (<0,01)	M0	ROM0	1.1.3.W
	Moderate (0,15–2,0)	M1	ROM1	1.1.2.Y, 1.1.2.Z
	High (<0,01)	H0	ROH0	1.1.3.X
	High (>2,0)	H1	ROH1	1.1.2.Z
Resin	Low (<0,01)	L0	REL0	1.2.1
(RE)	Low (<0,15)	L1	REL1	1.2.2.W, 1.2.2.X
	Moderate (<0,01)	M0	REM0	1.2.3.W
	Moderate (0,15 – 2,0)	M1	REM1	1.2.2.Y, 1.2.2.Z
	High (<0,01)	H0	REH0	1.2.3.X
	High (>2,0)	H1	REH1	1.2.2.Z
Organic	Low (<0,01)	L0	ORL0	2.1., 2.2.3.E
(OR)	Low (<0,15)	L1	ORL1	-
	Moderate (<0,01)	M0	ORM0	-
	Moderate (0,15 – 2,0)	M1	ORM1	2.1.2, 2.2.2
	High (<0,01)	H0	ORH0	2.2.3.0
	High (>2,0)	H1	ORH1	2.2.2
Inorganic	Low (<0,01)	L0	INL0	Not applicable
(IN)	Low (<0,15)	L1	INL1	(inorganic ISO flux is different)
	Moderate (<0,01)	M0	INM0	
	Moderate (0,15 – 2,0)	M1	INM1	
	High (<0,01)	H0	INH0	
	High (>2,0)	H1	INH1	

[a] Fluxes are available in S (solid), P (paste/cream) or L (liquid) forms.

[b] See 7.1 and 7.2 of IEC 61190-1-1 for comparisons of RO, RE, OR and IN composition classes and L, M and H activity levels with the traditional classes such as R, RMA, RA, water soluble and low solids "no-clean.".

[c] The 0 and 1 indicate absence and presence of halides, respectively. See 4.2.3 of IEC 61190-1-1 for an explanation of L, M and H nomenclature.

[d] ISO designations are similar to IEC designators with minor differences in characteristics

4.4 Flux percentage and metal content

The nominal percentage of flux, by mass, in solid-form solder products is identified as the flux percentage. The flux percentage in/on solid solders is identified by a single alphanumeric character in accordance with Table 3. "Metal content" refers to the percentage of metal in solder paste (see IEC 61190-1-2).

Table 3 – Flux percentage

Design symbol	Nominal %	Allowable range %	Design symbol	Nominal %	Allowable range %	Design symbol	Nominal %	Allowable range %
0	None		5	2,5	2,2 – 2,8	A	5,0	4,7 – 5,3
1	0,5	0,2 – 0,8	6	3,0	2,7 – 3,3	B	5,5	5,2 – 5,8
2	1,0	0,7 – 1,3	7	3,5	3,2 – 3,8	C	6,0	5,7 – 6,3
3	1,5	1,2 – 1,8	8	4,0	3,7 – 4,3	D	6,5	6,2 – 6,8
4	2,0	1,7 – 2,3	9	4,5	4,2 – 4,8			

4.5 Other characteristics

Standard bar solders are further classified by unit mass. Wire solders are further classified by wire size (outside diameter) and unit mass. Ribbon solders are further classified by thickness, width and unit mass. Powder solders are further classified by powder particle size distribution and unit mass.

5 Requirements

5.1 Materials

Materials shall be used which permit the solder product to conform to the specified requirements. The use of recovered or recycled materials is encouraged. Recovered or recycled materials shall conform to or exceed comparable standards for virgin raw materials.

5.2 Alloys

The solder alloy shall be as specified (see Annex B). For the purposes of this standard, electronic grade solder alloys are all those listed in Tables B.1, B.2 and B.3, including pure tin (Sn99) and pure indium (In99). The elements listed in Tables B.1, B.2 and B.3 for an alloy are considered to be the component elements of that alloy. Only the component elements of an alloy are desirable and all other elements are impurities for that alloy. To the maximum extent feasible and unless otherwise specified, solder alloy metal, including solder powder, shall be a homogenous mixture of the component elements of the alloy, such that each particle of the metal is the same alloy. Unless otherwise specified, the percentage by mass of impurity elements in alloys which are identified with an “A”, “B”, or “C” suffix shall not exceed the following values and the values listed in 5.2.1, 5.2.2, and 5.2.3 respectively, and the percentage by mass of impurity elements in alloys which are identified with a “D” suffix shall conform to the requirements in 5.2.4.

Ag: 0,05	Au: 0,05	Cu: 0,05	Ni: 0,01	Sn: 0,25
Al: 0,001	Bi: 0,10	Fe: 0,02	Pb: 0,10	Zn: 0,001
As: 0,03	Cd: 0,002	In: 0,10		

The percentage of each element in an alloy shall be determined by any standard analytical procedure. Wet chemistry shall be used as the referee procedure.

5.2.1 Variation A alloys

In alloys which are identified with an “A” suffix, the percentage by mass of antimony (Sb) as an impurity element shall not exceed 0,50.

5.2.2 Variation B alloys

In alloys which are identified with a “B” suffix, the percentage by mass of antimony as an impurity element shall not exceed 0,20.

5.2.3 Variation C alloys

In alloys which are identified with a “C” suffix, the percentage by mass of antimony as an impurity element shall not exceed 0,05.

5.2.4 Variation D alloys

Alloys identified with a “D” suffix are ultra-pure alloys that are intended for use in barrier-free die attachment applications. In alloys identified with a “D” suffix, the combined total percentage by mass of all impurity elements shall not exceed 0,05 and the combined total percentage by mass of each of the following sets of impurity elements shall not exceed 0,000 5:

Set 1: Be, Hg, Mg, and Zn. Set 2: As, Bi, P, and Sb.

5.3 Solder forms

This standard covers solders in the form of bars, wires, ribbons, and powders, and special solders. Normally bar solders and solder powder are not fluxed, and wire, ribbon, and special solders may be non-fluxed, flux-cored, flux-coated, or both flux-cored and flux-coated. Users should determine from prospective sources the standard solder form characteristics that are available and should specify standard characteristics to the maximum extent feasible.

5.3.1 Bar solder

The nominal cross-section area, the nominal length, and the nominal mass shall be as specified (see Clause A.2 c)). Unless otherwise specified (see Clause A.2 d)), the actual cross-section area shall not vary from the nominal value by more than 50 %, the actual length shall not vary from the nominal value by more than 20 %, and the actual mass shall not vary from the nominal value by more than 10 %. Bars with special end configurations, such as hooks or eyes, are classified as special solders.

5.3.2 Wire solder

The wire size, flux type, and flux percentage shall be as specified (see Clause A.2 e)). Unless otherwise specified (see Clause A.2f)), wire solders shall have a circular cross-section, the wire size shall indicate the nominal outside diameter of the wire and the actual outside diameter shall not vary from the nominal diameter by more than ±5 % or ±0,05 mm, whichever is greater.

5.3.3 Ribbon solder

The ribbon thickness and width, flux type, and flux percentage shall be as specified (see Clause A.2 g)). Unless otherwise specified (see Clause A.2 h)), ribbon solders shall have a rectangular cross-section, and the actual thickness and width shall not vary from their nominal values by more than ±5 % or ±0,05 mm, whichever is greater.

5.3.4 Solder powder

The powder size and shape shall be as specified (see Clauses A.2 i)) and A.2 j)). The characteristics of six standard solder powders, sizes 1 through 6, are listed in Table 4. When shape is not specified, solder powder shall be spherical. Solder powder shall be smooth and bright and free of adhering small particles and oxides to the maximum extent possible.

NOTE Solder powders made with high-lead alloys are not “bright” by nature, but they should not appear unusually dark. Solder powders which contain more than one solder alloy (multiple-alloy powders) are classified as special solders.