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REQUIREMENTS FOR LEAD MATERIALS AND FINISHES FOR COMPONENTS FOR SPACE APPLICATION

ESA/SCC Basic Specification No. 23500

space components
coordination group

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		SCCG Chairman	ESA Director General or his Deputy
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DOCUMENTATION CHANGE NOTICE

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		Para. 1	: Paragraph amended	21083
		Para. 2	: "and/or terminals" added to text where applicable	21083
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		P4. Para. 3.2	: Type "P" material added	221527
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'D'	Jan. '01	P1. Cover page		None
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		P4. Para. 3.2	: For Type D, "Silver" corrected to "Dilver"	23929

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1. SCOPE

This specification prescribes the materials and surface finishes to be used for component leads and terminals for Space application. The requirements specified herein are intended to ensure that such leads and terminals are compatible with Space assembly requirements.

Only approved materials, as specified in Para. 3.2 and finishes, as specified in Para. 3.3 of this specification, shall be used on ESA/SCC components.

The lead or terminal type and finish of a component shall be specified in its Detail Specification using these letters and numbers, e.g. Type A3.

2. APPLICABLE DOCUMENTS

This document complies with the requirements of ESA Document PSS-01-708, "The Manual Soldering of High Reliability Electrical Connections" as far as leads, terminals and finishes are concerned.

3. INTRODUCTION

3.1 GENERAL

The component Manufacturer shall establish a procurement specification to be used for the procurement of leads and terminals or lead material. This specification shall adequately establish the lead or terminal composition and type of lead finish, if any. In the case where the leads or terminals are an inherent part of a component package, the procurement specification for the package shall include full details of the lead or terminal material and finish required. These specifications shall be referenced in, and form part of, the Process Identification Document (P.I.D.).

3.2 APPROVED LEAD AND TERMINAL MATERIALS

The following materials are preferred for the manufacture of component leads and terminals:

- Type A: Copper (oxygen-free) electrolytic.
- Type B: Copper (electrolytic tough pitch).
- Type C: Iron-Nickel Alloy, copper-clad (e.g. Dumet).
- Type D: Iron-Nickel-Cobalt Alloy (e.g. "Kovar", "Nilo K" or "Dilver").
- Type E: Nickel.
- Type F: Iron-Nickel Alloy (Alloy 52).
- Type G: Iron-Nickel Alloy (Alloy 42).
- Type H: Copper-core, Nickel-Iron Alloy 52, Clad-ratio 3:1.
- Type I: Copper-core, Nickel-Iron Alloy 52, Clad-ratio 1.7:1.
- Type J: Iron-core, Copper-clad Wire CCFE 30.
- Type K: Iron-core, Copper-clad Wire CCFE 70.
- Type L: Steel, Copper-clad.
- Type M: Beryllium Copper.
- Type N: Phosphor Bronze.
- Type O: Silver of purity 98% or better.
- Type P: Copper Alloy > 97% Cu (Alloy K50 or K65).
- Type Q: Copper-Tungsten Alloy (15% Cu, 85% W).

N.B. The terminal material for chip carrier packages need not be from the above list and does not need to be specified in the Detail Specifications.

3.3 FINAL FINISH

The final finish of leads and terminals shall conform to one of the following, as appropriate and as specified:-

Type 1: No finish.

To be supplied without external finish. This is permitted only for Types A, B, C, J, K, L and O.

Type 2: Gold plating, electro-deposited.

The gold plating shall be of the type which is 99.7% gold minimum. The thickness of the gold plating shall be 1.3µm minimum to 5.7µm maximum.

Electrolytic nickel underplating is required for lead and terminal Types D, F, G, H and I and this shall conform to the requirements of Para. 3.3.1 of this specification.

Type 3: Tin-Lead plating.

The tin-lead plating shall be in accordance with the best commercial practice and have a composition of 30 to 70% tin (remainder lead). The thickness shall be minimum 2.5µm to maximum 13.0µm.

Type 4: Hot solder dip.

The solder shall be composition Sn 63 and the coating shall have a thickness of 2.5µm to 13.0µm.

Hot solder dip may be used over final finish Type 2, 7, 8 or 12 gold plating, but prior to this the leads or terminals shall be de-golded using the procedure defined in Para. 3.3.6 of this document.

Type 5: Nickel-plating, electro-deposited.

The nickel-plating finish shall have a thickness of 1.3µm minimum to 3.8µm maximum.

Type 6: Gold-plating, electro-deposited with Nickel and Copper underplating.

The first layer to be applied shall be 10 to 14µm of electro-deposited copper. The second layer to be applied shall be 3 to 6µm of electro-deposited nickel. The final layer to be applied shall be Type 2 gold plating.

Type 7: Gold plating, electro-deposited with electroless Nickel underplating.

This shall have an underlayer of nickel, electroless deposited with a 2.0 to 4.0µm thickness. The final layer shall be gold plating with 99.7% gold minimum. The thickness of the gold plating shall be 0.7µm minimum to 5.7µm maximum.

Type 8: Gold plating, electro-deposited with Nickel and Palladium underplating.

The first layer to be applied shall be 1.75µm minimum of electro-deposited nickel. The second layer to be applied shall be 0.25µm minimum of electro-deposited palladium. The final layer shall be gold plating with 99.7% gold minimum. The thickness of the gold plating shall be 0.7µm minimum to 5.7µm maximum.

Type 9: Hot solder dip with Nickel underplating.

This shall have an underlayer of nickel, electroless deposited with a 2.0 to 5.0µm thickness. The final layer shall be hot solder dip in accordance with Type 4.

Type 10: Silver plating, electro-deposited.

The plating shall be of 98% minimum silver purity of thickness between 3.8µm and 8.9µm.

Type 11: Reflowed Tin-Lead plating, with Nickel and Silver underplating

The first layer to be applied shall be 2.0µm minimum of electro-deposited nickel. The second layer to be applied shall be 0.1µm minimum of electro-deposited silver. The final layer to be applied shall be reflowed electro-deposited tin-lead plating with a composition of 85 to 95% tin (remainder lead). The thickness of the tin-lead plating shall be 3.0µm minimum to 8.0µm maximum.

Type 12: Gold plating, electro-deposited, with Nickel and Silver underplating

The first layer to be applied shall be 2.0µm minimum of electro-deposited nickel. The second layer to be applied shall be 0.1µm minimum of electro-deposited silver. The final layer shall be 99.7% minimum gold plating. The thickness of the gold plating shall be 0.7µm minimum to 5.7µm maximum.

Type 13: Gold plating, electro-deposited, with Copper underplating

The first layer to be applied shall be 5.0µm minimum of copper. The final layer shall be 99.7% minimum gold plating. The thickness of the gold plating shall be 2.5µm minimum to 5.7µm maximum.

Type 14: Gold plating, electro-deposited with electrolytic Nickel underplating

This shall have an underlayer of nickel, electro-deposited with 2.0 to 9.0µm thickness. The final layer shall be gold-plating with 99.7% gold minimum. The thickness of the gold – plating shall be 0.7µm minimum to 5.7µm maximum.

Type 15: Tin-lead plating, electro-deposited with Silver underplating

The first layer shall be a nominal 0.1µm of electro-deposited silver. The final layer to be applied shall be electro-deposited tin-lead plating with a composition of 85 to 95% tin. The thickness of the tin-lead plating shall be 5.0 to 10µm.

N.B.

1. The final finish on a lead or terminal shall commence within 0.2mm of the device body, glass or metal seal or the lower end of the lead frame brazed joint. For epoxy sealed devices, the final finish shall commence not more than 1.5mm from the encapsulant.
2. Tin-lead plated or solder-dipped lead and terminal finish may only be tested in normal atmosphere at $T_{amb} \leq +125°C$. Where tests are performed at $T_{amb} > +125°C$, an inert atmosphere must be used and components which are so tested shall include a warning paragraph in Section 1 of the Detail Specification.

   The warning paragraph shall take the following form:-

   1.x High Temperature Test Precautions

   For tin-lead plated or solder-dipped lead finish, all tests to be performed at a temperature that exceeds +125°C shall be carried out in 100% inert atmosphere.

3.3.1 Underplating

An underplating of nickel is required prior to the gold-plated final finish on leads or terminals of Type D, F, G, H and I.

The thickness of leads and terminals procured with underplating shall be specified in the Manufacturer's procurement specification. When the underplating is performed by the Manufacturer, or his Sub-contractor, the underplating thickness shall be specified in his/the Subcontractor's process specification. The thickness of nickel shall be:-

(a) 0.5µm minimum to 3.0µm maximum.

(b) 1.3µm minimum to 3.8µm maximum.

3.3.2 Plating

All plating, whether for final finish or underplating, shall be deposited in such a manner that the plating is applied on clean, non-oxidized metal surfaces. The overall plating(s) shall be ductile such that when a plated lead or terminal is bent over a radius equal to twice the total lead or terminal thickness, there shall be no cracking and/or delamination of the plating layer visible at a magnification of X8.

All electroless-nickel plating shall have a bend test performed, on a sample basis, as part of the final inspection to ensure that this plating is sufficiently ductile as to avoid cracking or delamination during later operations when stress relief bends are being performed. The inside radius of the bend shall be equal to the lead or terminal diameter or thickness.

3.3.3 Pure Tin Finish

Tin finish with more than 98% tin purity is not acceptable due to the possibility of whisker growth and transformation to grey tin powder at low temperature.

3.3.4 Combinations of Lead and Terminal Materials and Finishes

Combinations of lead and terminal materials and finish types together with the appropriate assembly methods are shown in the table hereunder.

LEAD AND TERMINAL COMPOSITION		LEAD AND TERMINAL FINISHES														
TYPE	MATERIAL	TYPE 1	TYPE 2	TYPE 3	TYPE 4	TYPE 5	TYPE 6	TYPE 7	TYPE 8	TYPE 9	TYPE 10	TYPE 11	TYPE 12	TYPE 13	TYPE 14	TYPE 15
A	Copper (Oxygen-free)	W	S or W	S	S	S or W	S or W	S or W	S or W	S	S or W	S	S or W	S or W	S or W	-
B	Copper (ETP)	W	-	S	S	S or W	S or W	S or W	S or W	S	S or W	S	S or W	S or W	S or W	-
C	Copper-clad Iron-nickel alloy	W	S or W	S	S	S or W	S or W	S or W	S or W	S	S or W	S	S or W	S or W	S or W	-
D	Iron-nickel-cobalt alloy	-	-	S	S	S or W	S or W	S or W	S or W	S	S or W	S	S or W	-	S or W	-
E	Nickel	-	S or W	S	S	S or W	S or W	S or W	S or W	S	S or W	S	S or W	S or W	S or W	-
F	Alloy 52	-	-	S	S	S or W	S or W	S or W	S or W	S	S or W	S	S or W	-	S or W	-
G	Alloy 42	-	-	S	S	S or W	S or W	S or W	S or W	S	S or W	S	S or W	-	S or W	-
H	Alloy 52-clad Copper Core 3:1	-	-	S	S	S or W	S or W	S or W	S or W	S	S or W	S	S or W	-	S or W	-
I	Alloy 52-clad Copper Core 1.7:1	-	-	S	S	S or W	S or W	S or W	S or W	S	S or W	S	S or W	-	S or W	-
J	CCFE 30	-	S or W	S	S	S or W	S or W	S or W	S or W	S	S or W	S	S or W	S or W	S or W	-
K	CCFE 70	-	S or W	S	S	S or W	S or W	S or W	S or W	S	S or W	S	S or W	S or W	S or W	-
L	Copper-clad Steel	-	S or W	S	S	S or W	S or W	S or W	S or W	S	S or W	S	S or W	S or W	S or W	-
M	Beryllium Copper	-	S or W	S	S	S or W	S or W	S or W	S or W	S	S or W	S	S or W	S or W	S or W	-
N	Phosphor Bronze	-	S or W	S	S	S or W	S or W	S or W	S or W	S	S or W	S	S or W	S or W	S or W	-
O	Silver	S or W	-	-	S	-	-	-	-	-	-	-	-	-	-	-
P	Copper Alloy	-	-	-	-	-	-	-	-	-	-	-	-	-	-	S
Q	Copper-Tungsten Alloy	-	-	-	-	-	-	-	-	-	-	-	-	-	S	-

Legend: S = Solder, W = Weld.

4. ADDITIONAL REQUIREMENTS

4.1 CONDUCTIVE EPOXIES

Conductive epoxies will be considered for use as terminations on a case-by-case basis.

4.2 SUBSTITUTION OF LEAD OR TERMINAL TYPES

Substitution of any type of lead or terminal for the existing leads or terminals on a SCC-qualified electronic component shall not take place without prior determination of the effect of such substitution on the component quality and reliability.

The approval of the Qualifying Space Agency must always be obtained before any such substitution is implemented.

4.3 REMOVAL OF GOLD

When a Type 4 finish is specified and is produced from a lead or terminal which was initially gold-plated, the gold shall be removed and the final finish applied using the following procedure:-

(a) **Gold-stripping**

The leads or terminals shall be dipped in a tin-lead solder bath (Bath 1), held at $+250 \pm 30$ °C for 2 to 3 seconds. Regular analysis of the solder in this bath shall be made or, alternatively, the solder within the bath shall be regularly replaced, and the gold shall not exceed 1% by weight.

Prior to dipping, the molten surface of the bath shall be freshly skimmed to remove surface impurities such as oxides and the components' leads or terminals shall be lightly fluxed with a pure rosin flux which shall be removed afterwards using a cleaning solvent.

(b) **Final Finish**

After Bath 1 dipping, the leads or terminals shall be pretinned in a second solder bath (Bath 2), held at $+220 \pm 10$ °C, for a minimum of 2 to a maximum of 8 seconds (the recommended immersion period is 3 to 4 seconds).

As for (a), the solder shall be regularly analysed or replaced ensuring that it is not contaminated with copper in excess of 0.25% by weight, nor with gold in excess of 0.2%, with the total of gold plus copper not exceeding 0.3%.

Contamination of Bath 2 with zinc, aluminium or iron shall also be carefully avoided. The fluxing of the lead or terminal, using pure rosin flux, and the skimming of the molten surface prior to dipping shall be as for (a).

In instances of poor solderability, activated fluxes may be used, but these shall be immediately cleaned off after dipping, using an acceptable solvent (see Note 5).

Withdrawal of component leads or terminals from Bath 2 shall be slow and vertical, without pauses, resulting in a solder-coat of more than 2.0μm.

The cross-sectional area of the leads or terminals shall not be reduced by dissolution into the molten solder.

When the solder produces a dull, frosty or granular appearance on the work, the bath shall be removed from use.

(c) **NOTES** Applicable to both (a) and (b).

1. In no instances shall a component body or its glass meniscus be immersed in, or become wetted by, liquid solder. The limited tinning distance, where specified, shall not be exceeded.
2. On no account shall the final finishing be carried out in the solder which has been used for gold-dissolution.
3. On no account shall the absolute maximum soldering rating of the component be exceeded.
4. Suitable thermal shunts shall be used for the degolding and pre-tinning of temperature-sensitive components or whenever it is not certain whether the maximum temperature rating will be exceeded.
5. The following solvents may be used for flux removal:-
   (a) Ethyl alcohol, 99.5 or 95% pure by volume.
   (b) Isopropyl alcohol, 99% pure.
   (c) Trichlorotrifluorethane, clear, 99.8% pure.
   (d) Any mixture of the above.
   (e) Deionised water at 40°C maximum may be used for certain fluxes. Items shall be thoroughly dried directly after the use of deionised water.
6. The final finish shall be evident and continuous on all leads and terminals and, as a minimum, shall extend downwards from the seating plane.

   For components which do not have a seating plane, the final finish shall extend downwards from the minimum soldering distance specified in Table 1(b) of the Detail Specification.