REQUIREMENTS FOR LEAD MATERIALS AND FINISHES FOR COMPONENTS FOR SPACE APPLICATION

ESCC Basic Specification No. 23500

Issue 6	September 2013

Document Custodian: European Space Agency – see https://escies.org

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DOCUMENTATION CHANGE NOTICE

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DCR No.	CHANGE DESCRIPTION
730, 759	Specification up-issued to incorporate technical changes per DCRs: modified material type P and added finish types 16 through 18. Specification converted to MSWord. Changes in presentation are possible.

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1 SCOPE

This specification prescribes the materials and surface finishes to be used for component leads, terminations and materials for Space application. The requirements specified herein are intended to ensure that such leads, terminations and materials are compatible with differing Space assembly requirements but in particular with the manual assembly requirements of ECSS Standards ECSS-Q-ST-70-08 and ECSS-Q-ST-70-38.

2 RELATED DOCUMENTS

2.1 APPLICABLE DOCUMENTS

The following documents are applicable to the extent specified herein:

ESCC 22700	Requirements and Guidelines for the Process Identification Document (PID)

2.2 REFERENCE DOCUMENTS

ECSS-Q-ST-70-08	Space Product Assurance Standard: Manual soldering of high-reliability electrical connections
ESCC 25500	Methodology for the detection of pure tin in the external surface finish of case and leads of EEE components
ECSS-Q-ST-70-38	Space Product Assurance Standard: High-reliability soldering for surface-mount and mixed technology

3 REQUIREMENTS

3.1 GENERAL

Except where otherwise stated, only approved materials and finishes as specified in this specification, shall be used on ESCC components. Under no circumstances shall Pure Tin finish, with more than 97% tin purity, be present on any exposed area of leads, terminations or materials. (This is due to the possibility of tin whisker growth and the transformation to grey tin powder at low temperature).

ESCC 25500 shall be used as a guideline for the detection of pure tin on the external surface finish of leads, terminations or materials.

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

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 (PID) prepared in accordance with ESCC Basic Specification No. 22700.

For variants with tin-lead plating with a composition of 85 – 95% tin, the manufacturer shall define a tin-lead control plan for all components (example: in the PID for ESCC qualified components).

3.2 APPROVED LEAD AND TERMINAL MATERIALS

The following materials are specified for the manufacture of ESCC component leads, terminations and materials:

Type	Description
A	Copper (oxygen-free) electrolytic
B	Copper (electrolytic tough pitch)
C	Iron-Nickel Alloy, copper-clad (e.g. Dumet)
D	Iron-Nickel-Cobalt Alloy (e.g. Kovar, Nilo K or Dilver)
E	Nickel
F	Iron-Nickel Alloy (Alloy 52)
G	Iron-Nickel Alloy (Alloy 42)
H	Copper-core, Iron-Nickel Alloy 52, Clad-ratio 3:1
I	Copper-core, Iron-Nickel Alloy 52, Clad-ratio 1.7:1
J	Iron-core, Copper-clad Wire CCFE 30
K	Iron-core, Copper-clad Wire CCFE 70
L	Steel, Copper-clad
M	Beryllium Copper
N	Phosphor Bronze
O	Silver of purity 98% or better
P	Copper Alloy > 97% Cu (Alloy K50 or K65 or K88 or KHP194)
Q	Copper-Tungsten Alloy (15% Cu, 85% W)
R	Tin-Lead Alloy S10/Pb90 (10% Sn, 90% Pb)
S	Copper-Zirconium

NOTES:

The terminal material for surface mount packages need not be from the above list and does not need to be specified in the Detail Specification.

3.3 FINAL FINISH

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

Type	Description
1	No finish. To be supplied without external finish. This is permitted only for Types A, B, C, J, K, L, O and R.
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 in accordance with Note 3.
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 13µm.
4	Hot solder dip. The solder shall be composition Sn60, Sn62 or Sn63. For leaded packages the coating shall have a thickness of 2.5µm to 13µm. For surface mount packages the coating shall have a maximum thickness of 300µm and 220µm coplanarity. Hot solder dip may be used over final finish Type 2, 7, 8, 12 or 14 gold plating, but prior to this, the leads or terminals shall be de-golded using the procedure defined in Para. 4.3(a) of this document.
5	Nickel-plating, electro-deposited. The nickel-plating finish shall have a thickness of 1.3µm minimum to 3.8µm maximum.
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.
7	Gold plating, electro-deposited with electroless Nickel underplating. This shall have an underlayer of nickel, electroless deposited with a 2 to 4µm 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.
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.
9	Hot solder dip with Nickel underplating. This shall have an underlayer of nickel, electroless deposited with a 2 to 5µm thickness. The final layer shall be hot solder dip in accordance with Type 4.
10	Silver plating, electro-deposited. The plating shall be of 98% minimum silver purity of thickness between 3.8 and 8.9µm.
11	Reflowed Tin-Lead plating, with Nickel and Silver underplating. The first layer to be applied shall be 2µm 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 3µm minimum to 8µm maximum.

Type	Description
12	Gold plating, electro-deposited, with Nickel and Silver underplating. The first layer to be applied shall be 2µm 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.
13	Gold plating, electro-deposited, with Copper underplating. The first layer to be applied shall be 5µm 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.
14	Gold plating, electro-deposited with electrolytic Nickel underplating. This shall have an underlayer of nickel, electro-deposited with 2 to 9µm 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
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 to 10µm.
16	Reflowed Tin/Lead plating, with Nickel and Silver underplating. Surface finish on active soldering surface: The first layer shall be 0.05-1µm of electro-deposited nickel. The second layer shall be 0.05-1µm of electro-deposited silver. The final layer shall be reflowed electro-deposited tin-lead plating with a composition of 85-95% tin (remainder lead). The thickness of the tin-lead plating shall be 3-8.5µm.
17	Reflowed Tin/Lead plating, with Nickel and Silver underplating. Surface finish on active soldering surface: The first layer shall be 0.05-1µm of electro-deposited nickel. The second layer shall be 0.05-1µm of electro-deposited silver. The final layer shall be reflowed electro-deposited tin-lead plating with a composition of 85-95% tin (remainder lead). The thickness of the tin-lead plating shall be 4.5-10µm.
18	Tin-Lead plating, electro-deposited with Nickel underplating. This shall have an underlayer of electro-deposited nickel with a thickness of 1.3µm to 3.8µm. The final layer shall be electro-deposited tin-lead plating with a composition of 85% to 95% tin. The thickness of the tin-lead plating shall be 2.5µm to 13µm.

NOTES:

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, Tin-lead plated or solder-dipped lead and terminal material and finish may only be tested in normal atmosphere at $T_{amb} \leq +125$ ˚C. Where tests are performed at $T_{amb} > +125$ ˚C, a 100% inert atmosphere must be used and components which are so tested shall include a warning paragraph or note to this effect in Section 1 of the Detail Specification.
3. An underplating of nickel is required prior to the Type 2 gold-plated final finish on leads, terminations or materials 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 3µm maximum.
   (b) 1.3µm minimum to 3.8µm maximum.

4. 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.
5. Combinations of material and finish types together with the appropriate assembly methods are as follows:

Material Type	Finish Type																	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
A	W	S W	S	S	S W	S W	S W	S W	S	S W	S	S W	S W	S W	-	-	-	S
B	W	-	S	S	S W	S W	S W	S W	S	S W	S	S W	S W	S W	-	-	-	S
C	W	S W	S	S	S W	S W	S W	S W	S	S W	S	S W	S W	S W	-	-	-	S
D	-	S W	S	S	S W	S W	S W	S W	S	S W	S	S W	-	S W	-	-	-	S
E	-	S W	S	S	S W	S W	S W	S W	S	S W	S	S W	S W	S W	-	-	-	S
F	-	S W	S	S	S W	S W	S W	S W	S	S W	S	S W	-	S W	-	-	-	S
G	-	S W	S	S	S W	S W	S W	S W	S	S W	S	S W	-	S W	-	-	-	S
H	-	S W	S	S	S W	S W	S W	S W	S	S W	S	S W	-	S W	-	-	-	S
I	-	S W	S	S	S W	S W	S W	S W	S	S W	S	S W	-	S W	-	-	-	S
J	-	S W	S	S	S W	S W	S W	S W	S	S W	S	S W	S W	S W	-	-	-	S
K	-	S W	S	S	S W	S W	S W	S W	S	S W	S	S W	S W	S W	-	-	-	S
L	-	S W	S	S	S W	S W	S W	S W	S	S W	S	S W	S W	S W	-	-	-	S
M	-	S W	S	S	S W	S W	S W	S W	S	S W	S	S W	S W	S W	-	-	-	S
N	-	S W	S	S	S W	S W	S W	S W	S	S W	S	S W	S W	S W	-	-	-	S
O	S W	-	-	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-
P	-	-	-	-	-	-	-	-	-	-	-	-	-	-	S	S	S	-
Q	-	-	-	-	-	-	-	-	-	-	-	-	-	S	-	-	-	-
R	S	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
S	-	-	-	S	-	-	-	-	-	-	-	-	-	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 an ESCC qualified component shall not take place without prior determination of the effect of such substitution on the component quality and reliability.

The approval of the ESCC Executive must always be obtained before any such substitution is implemented.

4.3 DE-GOLDING AND APPLICATION OF FINAL FINISH FOR TYPE 4

When a Type 4 finish is specified and is produced from a lead, termination or material which was initially gold-plated, the gold shall be removed and the final finish applied in accordance with the de-golding and pre-tinning requirements of ECSS-Q-ST-70-08 clause 7.2.3.