

MEMO

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Subject: Printed Circuit Board requirements for mission classification

1. SCOPE

This memo provides an overview of requirements and recommendations for Printed Circuit Board (PCB) technology as an input to Product Assurance Requirements Documents (PAR) for ESA projects. It implements the ESA mission classification and the associated tailoring of ECSS standards.

ESA-TECMSP-MO-2024-002027 dated 24/06/2024 was drafted based on the old ESA missions classification 1-5.

The current revision 1 issue 2 is drafted based on the new ESA mission classification alpha, beta, gamma, delta.

2. MISSION CLASS ALPHA AND BETA

ECSS-Q-ST-70 shall apply, with the following modifications:

- New req 6.2j of ECSS-Q-ST-70:
ECSS-Q-ST-70-60 shall apply to the procurement and qualification of PCBs.

NOTE1: The following guidelines and checklists provide guidance for the procurement and qualification of PCB (available for download in <https://escies.org>):

ESA-TECMSP-MX-11320 Checklist for ENIG ENEPIG ENIPIG finish

ESA-TECMSP-MX-12940 Checklist for review of PCB technology in MPCBs

ESA-TECMSP-MX-14192 Input to checklist for MRR

NOTE2: Requirement 7.7.2.p of ECSS-Q-ST-70-60 provides an option for PCB procurement as per IPC standards by submitting it to the RFA approval process as specified in this requirement.

- New req 6.2k of ECSS-Q-ST-70:
ECSS-Q-ST-70-12 shall apply to the design of PCBs.

3. MISSION CLASS GAMMA

ECSS-Q-ST-70 shall apply, with the following modifications:

- New req 6.2f of ECSS-Q-ST-70:

The following standards and quality class shall be applied to PCBs:

IPC-6012F class 3 with space addendum, as modified by requirements from 6.2g to 6.2l below,

IPC-6018D class 3 with space addendum for RF boards,

IPC-6013E class 3 (space addendum is not available) for flex and rigid-flex boards.

NOTE1: In alternative, ECSS-Q-ST-70-60 can be used.

NOTE2: The following guidelines and checklists provide guidance for the procurement and qualification of PCB (available for download in <https://escies.org>):

ESA-TECMSP-MX-11320 Checklist for ENIG ENEPIG ENIPIG finish

- New req 6.2g of ECSS-Q-ST-70:

Any "state-of-the-art" or "critical" PCB technologies, and the tests and inspections for their verification, shall be submitted to the approval of ESA.

NOTE1: Examples of those technologies are rigid-flex, microvias, back-drilling, metal core, 3-ounce (75 micron) copper foil or thicker, embedded film passives. It is recommended to use an aspect ratio for vias of max 7. In case microvias are used, it is recommended to use an aspect ratio of max 0.7 and not to stack them.

NOTE2: It is recommended NOT to use tented vias (covered with solder mask) or blind vias with depth-controlled drilling. Depth-controlled back-drilling for RF purpose is acceptable.

NOTE3: The assessment of state-of-the-art or criticality can be substantiated by the producibility level as described in 1.6.3 of IPC-2221, and HDI types as described in 1.5 of IPC-2226, among others.

NOTE4: The requirements 4.3.a and b of ECSS-Q-ST-70C Rev 2 prescribe that parts, materials and processes satisfy the functional and environmental constraints of the mission. This can lead to a project qualification of the PCB technology if it operates outside of the proven performance envelope.

- New req 6.2h of ECSS-Q-ST-70:

Accelerated coupon testing that meets the project environmental conditions shall be performed for the procurement of "state-of-the-art" technology PCB.

NOTE: IST is an example of accelerated coupon testing and specified in 7.5.5 of ECSS-Q-ST-70-60 and 2.6.26A(A) of IPC-TM-650. Other test methods can be proposed, for instance D-coupon testing as specified in 2.6.27B and 2.6.7.2C of IPC-TM-650. It is noted that only ECSS-Q-ST-70-60 specifies concrete performance levels, while the other mentioned standards describe the test methods only. For any accelerated testing of copper barrel cracking it is good practice to use a fatigue ductility exponent of 1.67 in a Coffin-Manson equation.

- New req 6.2i of ECSS-Q-ST-70:

In case PCB surface finish is ENIG, ENEPIG or ENIPIG, the following conditions shall be met:

- a. Compliance to IPC-4552 and IPC-4556, demonstrated using the check-list ESA-TECMSP-MX-11320.
- b. Hyper-corrosion level of ENIG is zero (hyper-corrosion level 1 is acceptable provided it is incidental).

- New req 6.2j of ECSS-Q-ST-70:

Inspection on coupons and PCBs shall be performed and documented by the procurement authority.

- New req 6.2k of ECSS-Q-ST-70:

PCB manufacturers shall be qualified as per one of the following methods:

- a. Approved by the procurement authority through a point-by-point assessment of compliance to individual requirements for the applicable quality class.
- b. Qualified as per ECSS-Q-ST-70-60C Corrigendum 1.
- c. Listed on IPC QML for the applicable quality class.

NOTE: To fulfil qualification method a, it is good practice to perform an audit at the premisses of the PCB manufacturer. Therefore, a local PCB manufacturer is preferred.

- New req 6.2l of ECSS-Q-ST-70:
In case assembly process verification takes place through microsectioning (e.g. soldering microsectioning), the evaluation of such microsectioning shall include the assessment of the quality of the PCB after test.
- New req 6.2m of ECSS-Q-ST-70:
An MRR should be held between PCB manufacturer and procurement authority to review PCB design for manufacturability and reliability.
- New req 6.2n of ECSS-Q-ST-70:
The MRR for electronic assemblies (e.g. electronic boards) shall include the review of the CoC, qualification and incoming inspection of PCBs.
- New req 6.2o of ECSS-Q-ST-70:
Design of PCB shall be in accordance with standard IPC-2221C.
NOTE: ECSS-Q-ST-70-12 can be used in alternative to IPC-2221C. In addition, the following additional standards are used depending on the PCB technology: IPC-2222 for rigid PCB, IPC-2223 for flex-rigid PCB, IPC-2226 for HDI PCB, IPC-2252 for RF PCB, etc.

4. MISSION CLASS DELTA

The following ECSS-Q-ST-70, ECSS-Q-ST-70-60 and ECSS-Q-ST-70-61 requirements are applicable:

- ECSS-Q-ST-70-60 modified:
PCB quality class, procurement and qualification should be in compliance with IPC-6012E class 3 (without space addendum).
NOTE: This is as specified in 10.3.f of ESA-TEC-TN-021473 COTS guidelines for Q2.
- ECSS-Q-ST-70-60 clause 5 modified:
Review of qualification of the PCB manufacturer is not specified.
PCB technology qualification is not specified.

NOTE: It is expected to be covered by equipment or spacecraft level qualification.

- ECSS-Q-ST-70-60 clause 8 modified:
IPC-6012E shall be applicable to the PCB manufacturer for CoC, lab reporting, inspection on coupons and PCBs.
- ECSS-Q-ST-70-60 clause 8.4 modified:
Inspection on coupons and PCBs should be performed and documented by the procurement authority.
NOTE: This is specified in 15, 16, 17 of Annex 5 of ESA-TEC-TN-02147.
- ECSS-Q-ST-70-60 clause 6.6 modified:
The PCB surface finish should be compliant to applicable IPC standards, including IPC-4552 for ENIG and IPC-4556 for ENEPIG.