# ECSS-Q-ST-60 Training Part 1

# Space Product Assurance  Electrical, Electronic and Electromechanical (EEE)components

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# ECSS-Q-ST-60C Rev.3 What is it for ?

**It is the** standard that defines **requirements for the selection, control, procurement and use of EEE components in a space project**.

The **customer** (e.g. Space Agency, Operator) of a given space project **defines** the **EEE component requirements** as part of the **project PA** requirements by calling ECSS-Q-ST-60C Rev.3 as an applicable document or by tailoring it. ECSS-Q-ST-60C is a pre-tailored document and further tailoring should be minimised.

The supplier must ensure to **pass these requirements down to lower level suppliers** and verify their compliance.

ECSS-Q-ST-60C rev 3 includes around **433 requirements** ("shall") divide between **3 classes** .

While there are few requirements for GSE and for EQM included the focus is on **flight** components.


www.ecss.nl

ECSS Secretariat
ESA-ESTEC
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Noordwijk, The Netherlands

# ECSS-Q-ST-60C Rev.3: Highlights

The ECSS-Q-ST-60C Rev.3 is written from **the parts user's perspective (= supplier in ECSS context)**
Its requirements define the supplier obligations to demonstrate consistently that the components are fit for purpose in a space project.

The standard defines requirements for EEE Parts with respect to their:

- Selection (rules)
- Control (management approach)
- Procurement (purchasing practice)
- Test and analysis
- Usage (e.g. call-up of derating, storage, shelf-life, …)
- Use of commercial components (often referred to as COTS) covered by reference to ECSS-Q-ST-60-13.

The ECSS-Q-ST-60C Rev.3 **only addresses project use/approval!**

The Requirements for **EEE Part Qualification are covered by the ESCC System of Specifications** (European Space Component Coordination)

# ECSS vs ESCC for components


…for the management, engineering, product assurance and sustainability in space projects and applications…

For EEE users


…providing a single and unified system for the standardisation, product specification, evaluation, qualification and procurement of European EEE space components and for the certification of components and component manufacturers.

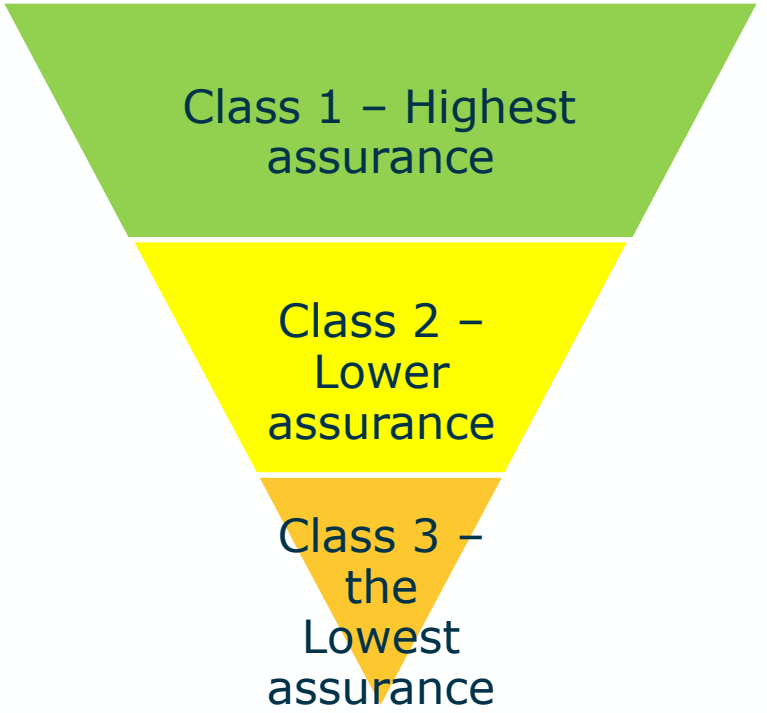
For EEE manufacturers and also procurers

# Risk versus Assurance

- **The ECSS-Q-ST-60C differentiates three classes [Class 1 highest to 3 lowest] of components**
- **Each Class corresponds to a different level of Product Assurance and thereby the level of risk taken on reliability and quality**
- **Class 1 components offer the lowest risk, while class 3 components reflect the highest advisable risk**

Note vocabulary risk and assurance, not reliability!

There is no quantification of the risk difference between the defined classes – it is a qualitative approach

# Use and tailoring of ECSS-Q-ST-60C

The ECSS-Q-ST-60C rev3 is in the list of ESA approved standards and, as such, it is to be used by all ESA projects.

Projects will normally tailor the document to their constraints, add requirements – such as those related to RHA, for example. Traditionally most ESA satellite projects specified requirements which met or exceeded Q-60 Class  1, now however Class 1 2 and 3 are used with more or less tailoring.

Tailoring exceeding ECSS-Q-ST-60C is typically for DPA and life test on hybrids.

This is done for ESA Project via the **ESA PARD (Product Assurance and Safety Requirement Document)**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esa

estec

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Keplerlaan 1
2201 AZ Noordwijk
The Netherlands

DOCUMENT

Product Assurance and Safety Requirements Document (PARD)
for Luna Mission : PILOT

| | |
|---|---|
| Prepared by | Sara Iacobellis |
| Reference | ESA-HRE-PILOT-PRD-0002 |
| Issue | 2 |
| Revision | 0 |
| Date of Issue | 03/07/2020 |
| Status | Approved |
| Document Type | Requirement Document |

European Space Agency
Agence spatiale européenne

# Tailoring of ECSS-Q-ST-60 on PARD for PILOT Mission


## 9 EEE COMPONENTS

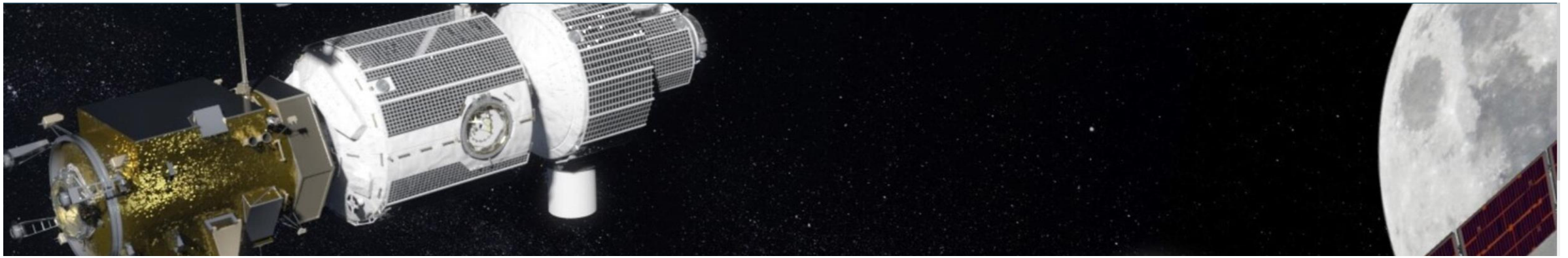
### 9.1 General

ECSS-Q-ST-60C Rev.2 shall be applied with the following modifications:

| Id | Type | Tailoring | Modified text / Comment |
|---|---|---|---|
| 4 | Requirement | Not applicable | ECSS-Q-ST-60C Rev2, Requirement for Class 1 components |
| 5.1.3e | Requirement | New | The Contractor shall define a procurement policy that uses an attrition rate agreed by Customer representative within the PCB meeting. |
| 5.1.3f | Requirement | New | For radiation sensitive components a Radiation Control Board (RCB) shall be established in order to assess compliance with ECSS-Q-ST-60-15C, ESSB-AS-Q-008 Issue 2 and the additional radiation hardness assurance requirements included in this PARD. |
| 5.1.3g | Requirement | New | Approval of radiation sensitive components by the PCB shall be subject to prior approval by the RCB. |
| 5.1.4a | Requirement | Modified | For each electronic equipment, an "as-design" DCL shall be issued in an editable and sortable electronic format, as a minimum compatible with CSV, identifying all component types needed.<br><br>For the flight-standard products:<br>- qualification model (EQM or QM)<br>- flight model<br>an "as-built" DCL shall be issued in an editable and sortable electronic format, as a minimum compatible with CSV, identifying all component part number used.<br><br>*NOTE: CSV is a common file format that can be used to transfer data between database or spreadsheet tables (a spreadsheet program is for example Excel®).* |

Note:

- Example only
- Cancelled project
- Tailoring to rev2 of ECSS-Q-ST-60C



# But first – what do we mean by EEE in ECSS?

Electrical Electronic Electromechanical

1. Capacitors
2. Connectors
3. Crystals
4. Discrete semiconductors (diodes and transistors)
5. Filters
6. Fuses
7. Magnetic components (e.g. inductors, transformers, including in-house products)
8. Monolithic Microcircuits (including MMICs)
9. Hybrid circuits
10. Relays
11. Resistors, heaters
12. Surface acoustic wave devices
13. Switches (including mechanical, thermal)
14. Thermistors
15. Wires and Cables
16. Optoelectronic Devices
17. Passive Microwave Devices

**Excluded are**

- **MEMS**
- **Solar cells (typically including shunt diode)**
- **RF switches (unless simple/single EEE design)**

# But first – what do we mean by EEE in ECSS?

**Is this black or white?**

- **No, many shades of grey!**
- **Examples:**
  - **MEMS most often treated as EEE**
  - **Cable assemblies (for which ESCC specifications now exist)**
  - **Non-hermetic oscillators**
  - **Various sensors**
  - **Coolers**
  - **…**
- **Advice for project – suggest an approach early and agree with customer chain and**
  - **<u>please</u> avoid cherry picking!**

# Terminology

- Generic ECSS definitions – see ECSS-S-ST-00-01.
- The term “EEE component“ is synonymous with the terms "EEE Part", "Component" or just "Part".
- Screening - tests, inspections or combination thereof, imposed on 100% of parts, to remove unsatisfactory items or those likely to exhibit early failures.
- Commercial components “part neither designed, nor manufactured with reference to military or space standards“. AKA COTS (Commercial Off The Shelf) though this is a wider term.
- Evaluation – activities to assure component is fit for purpose/application.
- LAT (Lot Acceptance Test), now renamed LVT (Lot Validation Test) within ESCC. Corresponds to Group or QCI (Quality Conformance Inspection) testing in Mil system.
- Qualified and qualification – in European EEE vocabulary this applies only to formally qualified components (ESCC, Mil and few others).

# Document / Requirement Structure

1 Scope

2 Normative references

3Terms, definitions and abbreviated terms

4 Requirements for Class 1 components

5 Requirements for Class 2 components

6 Requirements for Class 3 components

7 Quality Levels (in tabular form)

8 Evaluation and lot acceptance for retinned parts (reference to ECSS-Q-ST-60-13)

9 Pure tin lead finish – risk analysis

Annex A (norm.) Component Control Plan

Annex B (norm.) Declared Components List

Annex C (norm.) Procurement Specification

Annex D (norm.) Part Approval Document

Annex E (inform.) EEE documents delivery per review

# Component Program Management

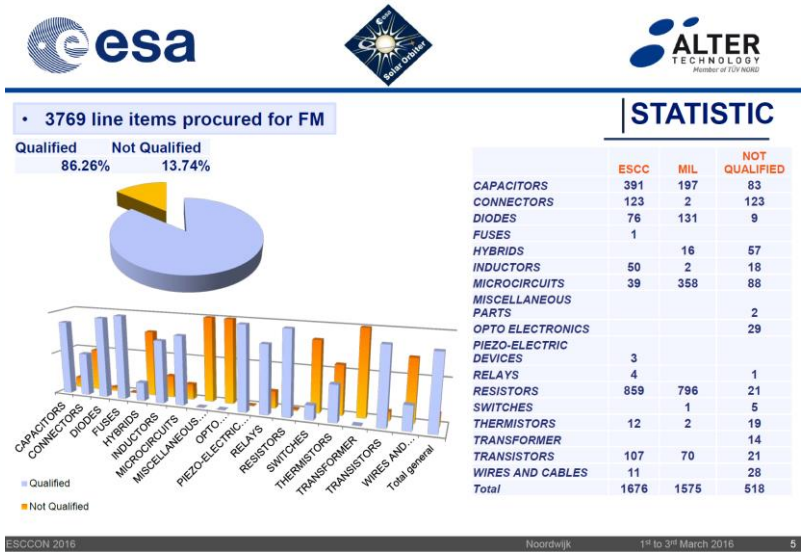
## Component Control Programme

The supplier must establish a **management organisation, define approaches/procedures** (incl. procurement) **compliant with ECSS-M-ST-10**

The supplier must establish a **Component Control Plan**

- Compulsory for class 1 (per Annex A), typically part of PA Plan
- For Class 2&3 only only SoC is required however in prime's PA Plan and PA&Safety Requirements EEE is always included

Note : Decision on central coordinated (recommended for more complex projects and especially for Science instruments) or self procurement. This is however not addressed in ECSS-Q-ST-60.




| | ESCC | MIL | NOT QUALIFIED |
|---|---|---|---|
| CAPACITORS | 391 | 197 | 83 |
| CONNECTORS | 123 | 2 | 123 |
| DIODES | 76 | 131 | 9 |
| FUSES | 1 | | |
| HYBRIDS | | 16 | 57 |
| INDUCTORS | 50 | 2 | 18 |
| MICROCIRCUITS | 39 | 358 | 88 |
| MISCELLANEOUS PARTS | | | 2 |
| OPTO ELECTRONICS | | | 29 |
| PIEZO-ELECTRIC DEVICES | 3 | | |
| RELAYS | 4 | | 1 |
| RESISTORS | 859 | 796 | 21 |
| SWITCHES | | 1 | 5 |
| THERMISTORS | 12 | 2 | 19 |
| TRANSFORMER | | | 14 |
| TRANSISTORS | 107 | 70 | 21 |
| WIRES AND CABLES | 11 | | 28 |
| Total | 1676 | 1575 | 518 |

Summary of Solar Orbiter CPPA procurement

# Class 1&2: Parts Control Board

**The approval of the selection and usage of EEE parts shall be implemented through Parts Control Boards (PCBs) held between the customer and the supplier (or lower tier subcontractor)**

- **Chaired by a member of the suppliers PA team + parts engineer + customer representative + …**
- **Part approval incl. evaluation activities;**
- **Problem assessments (Alerts, non-conformances, RFD, RFW, schedule)**
- **Comparative assessments (initial approval vs. actual docs / sampling)**
- **…**

**Note: for FM!**

**Note 1: For Class 3 PCB were previously excluded, with rev3 it is required through 6.2.4 a though ambiguous as in other paragraph stating not required. In any case required in ESA projects.**
**Note 2: Part approval is the main PCB activity**
**Note 3: Vast majority of PCBs are nowadays performed as online meetings addressing comments provided in advance.**

# Declared Components List

"For each equipment, its supplier shall issue a DCL in an editable and sortable electronic format, as a minimum compatible with CSV identifying all component types needed."

- Note: for all practical purposes CSV means excel

- DCL content as per annex B
- To be kept under configuration control,
- Minimally issued at PDR and CDR (as designed) and TRR (as built)
  - Note: As-built not required for Class 3 – expected and best practice though!
- Any change between CDR and assembly needs new PCB approval
- Changes during equipment manufacturing need RFW based customer approval before mounting.
- Consolidated as designed DCLs are required, i e up to satellite (or separate platform/payload) level

**DCLs, especially consolidated and as-built ones, are crucial for determining the impact of problem notifications, alerts etc.**

# Electrical and Mechanical GSE

**EEE components used in GSE, which are physically and directly interfacing to flight hardware, shall be:**

1. **Fit, Form and Function compatible;**
2. **Manufactured from materials identical to the flight opposite part and**
3. **Ensured to be visibly clean before each connection to flight hardware.**

**Flight hardware connector interfaces to GSE shall interface to a flight compatible connector**

**Note : This connector can be installed on the test harness or can be a saver."**

**Beware : 'inter-mateability' between connectors from different manufacturers is often an issue**

# EQM Components

**EEE components used in Engineering Qualification Model (EQM) shall be fit, form and function representative of the flight components and be from the same manufacturers.**

**If thermal vacuum tests are performed on the EQM, the EEE parts shall be material representative of the FM parts."**

**Note: Sometimes tailored, sometimes addressing also EM**

# Component Selection, Evaluation and Approval

**General requirements identical in the 3 classes (4.2.1, 5.2.1, 6.2.1)**

**To be considered already in the selection process:**

- **Project Requirements (e.g. quality levels, component policy, delivery and manufacturing schedules, quantity, attrition)**
- **Design requirements (e.g. component type, case, dimensions, materials)**
- **Production requirements (e.g. packaging, thermal and storage constraints, component mounting process),**
- **Operational requirements (e.g. electrical, mechanical, radiation, reliability, assembly, and lifetime).**

- **The selection, evaluation and approval of commercial EEE components shall be performed in conformance with ECSS-Q-ST-60-13**

**Note: Selection is probably the most important activity!**

# Manufacturer and Component Selection

**General requirements identical in the 3 classes (4.2.2.1, 5.2.2.1, 6.2.2.1)**

"b Components shall be selected on the basis of proven qualification, characterization, and previous space experience and data, relevant with regard to the requirements for the programme, from manufacturers or sources (**preferably European**) employing effective Product Assurance Programmes in manufacturing and test."

# Parts and Material Restrictions - 1

**Also identical in the 3 classes (4.2.2.2, 5.2.2.2, 6.2.2.2)**

… non-hermetically sealed materials of components must meet the requirements of ECSS-Q-ST-70 regarding off-gassing, out-gassing, flammability, toxicity and any other criteria specified for the intended use.

Note: off-gassing, toxicity and flammability mainly for space station

… shall evaluate the **robustness** of selected EEE components against the **stresses induced by the assembly techniques to be employed**.

Note: very important but often overlooked!

…with respect to health and safety, **beryllium oxide and lithium** (except if identified in the procurement specification), **cadmium, magnesium, mercury, zinc, radioactive material** and all material which can cause safety hazards shall not be used.

Note: components containing BeO does not need RFW as long as BeO flagged in specification and part marking

# Parts and Material Restrictions - 2

For limited life duration, known instability, safety hazards or reliability risk reasons, the EEE components **listed below shall not be used**:

1. Hollow core resistors,
2. Potentiometers (except for mechanism position monitoring),
3. Non-metallurgically bonded diodes,
4. Semiconductor dice with unglassivated active area,
5. Wet slug tantalum capacitors other than capacitor construction using double seals and a tantalum case,
6. Any component whose internal construction uses metallurgic bonding with a melting temperature not compatible with the end-application mounting conditions,
7. TO5 relays without double welding of the mechanism to the header or with any type of integrated diodes inside,
8. Aluminium liquid electrolytic capacitors,
9. Tin coated wires and cables,
10. PVC insulated wires and cables,
11. Electromechanical parts in commercial grade,
12. Feedthrough filter in commercial grade,
13. Connectors without gold plating contact in commercial grade.

# Parts and Material Restrictions - 3

For limited life duration, known instability, safety hazards or reliability risk reasons, the EEE components **listed below shall not be used for new designs**:

1. RNC90 > 100 kOhm,
2. TO3 and DO4/DO5 packages,
3. Wire link fuses.

**Pure tin in internal cavities can be approved on case by case basis based on demonstration that there is no alternative product and that there is no risk. Any pure tin approval is subject to approval through PAD.**

# Parts and Material Restrictions – 4
# Pure tin terminations

**N.B. 1: ECSS-Q-ST-60Crev3 contains requirements only for EEE. For material and processes different requirements apply, pure tin is currently seen as prohibited and the issue should be discussed in MPCB!**

**N.B. 2: Entity setting up EEE requirements need to choose between two options. In ESA PARDs this is always the first option based on risk analysis and mitigation plan (4.2.2.2j, 5.2.2.2j, 6.2.2.2j)**

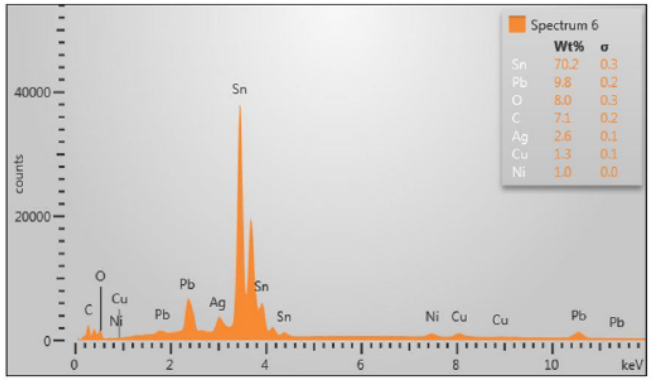



Figure 119

EDX spectrum No. 3: Lead plating (sample #1). EDX analysis was done before solderability test from top of the lead. According to manufacturer, standard solder coating should contain minimum 5% of Pb. Amount of Pb in this analysis is 9.8 %. According to applied specification (ESCC Detail Specification No. 3012/005 Iss. 1) finish shall be Tin-Lead plating, electro-deposited with Silver underplating which explains also the Silver peak.

# Parts and Material Restrictions – 5
# Pure tin terminations 1st option (4.2.2.2j, 5.2.2j, 6.2.2j)

1. **Collect and synthesize all information participating to the risk analysis in conformance with Clause 9.**
2. **Based on the risk analysis, elaborate a mitigation plan.**
3. **Include in the JD the risk analysis and mitigation plan for customer approval**

**…**

**The mitigation may be retinning, if so the retinning process needs customer approval and to be carefully evaluated and controlled as it is very critical. Also evaluation/LAT/screening to be performed on retinned parts.**

**New features in current issue; pure tin terminations not explicitly prohibited in any class and all documentation to be contained in Justification Document.**

# Parts and Material Restrictions – 6
# Pure tin terminations 1st option (4.2.2.2k/l, 5.2.2k/l, 6.2.2k/l)

**All the following conditions shall be fulfilled to use Parts with matte pure tin finish, >97% tin:**

1. **They pass the JESD-201A class 2 requirements or meet the GEIA-STD-0005-2/Level 2B requirements,**
2. **They are not used in power function, where both Voltage >15 V and Current >2 A conditions are applied at the same time,**
3. **They are not mechanically torqued on board or equipment.**

Not applicable in ESA projects!

**If one of the three conditions is not met, a mitigation plan shall be submitted to the customer for approval, through the JD approval process.**

**NOTE This mitigation plan can include, as an example, one of the following solutions:**

- **Conformal coating,**
- **Design analysis and risk assessment versus a possible short circuit**

# Preferred Sources - 1 (Class 1)

Parts shall be chosen from the EPPL part I (European Preferred Parts List)

For parts not selected from the EPPL part I, the following sources shall be considered in the following order of precedence:

1. EPPL part II (when compatible with the project requirements)
2. NPSL (NASA Parts Selection List) level 1 and level 2 or 3 (when compatible with the project requirements),
3. MIL QPL's and QML's.

Parts subject to export restrictions or regulations shall not be preferred

Preference shall be given to components which necessitate the least evaluation or qualification effort.

# Preferred Sources - 2

ESCC
European Space Components Coordination

ESCC QUALIFIED PARTS LIST (QPL)

ESCC/RP/QPL005-240 (REP 005)

July 2023

esa

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

Updated monthly

ESCC
European Space Components Coordination

Page 1 of 62

EUROPEAN PREFERRED PARTS LIST (EPPL)

ESCC/RP/EPPL007-46 (REP 007)

January 2023

esa

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

Updated 3-4 times/year.
Contains be default ESCC QPL.

Both available on escies.org

# Preferred Sources - 3 (Class 2&3)

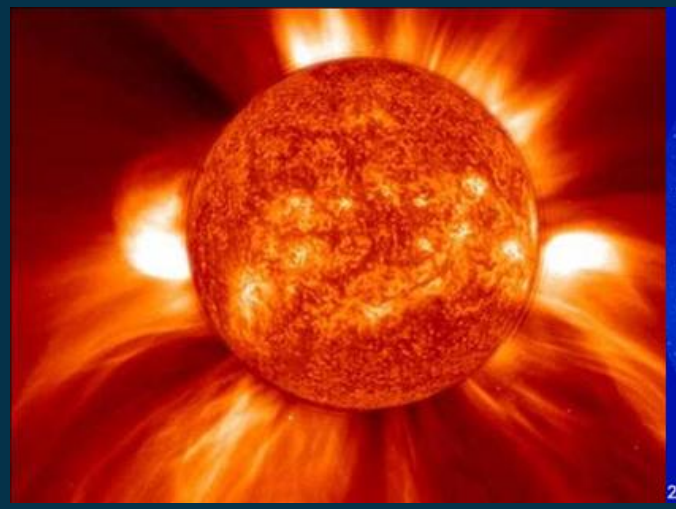
**Preference shall be given to components which necessitate the least evaluation or qualification effort.**

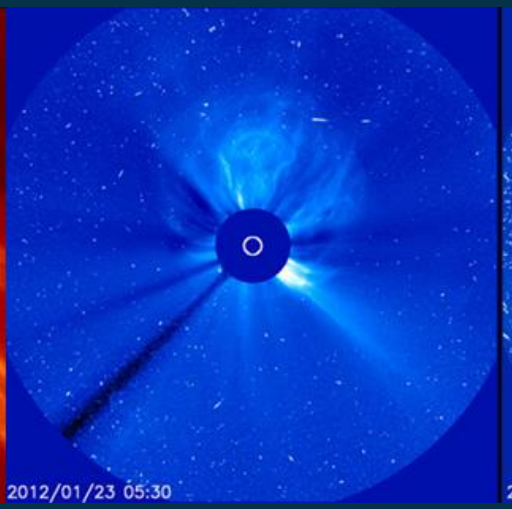
**When selecting items, the supplier shall check the current data, applicability of the basis of qualification, problem notifications and alerts, and adequacy of specifications.**

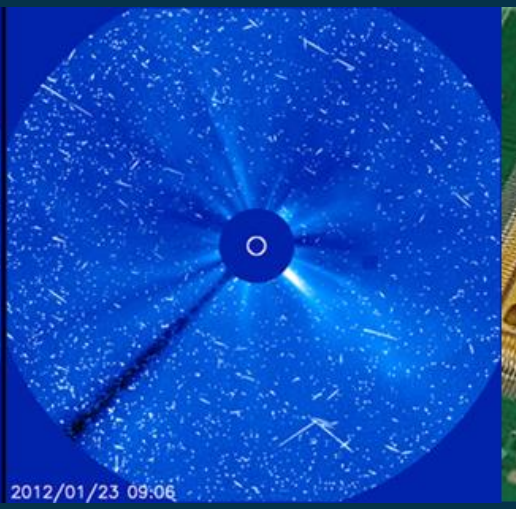
# EEE Component Radiation Hardness Assurance (RHA)

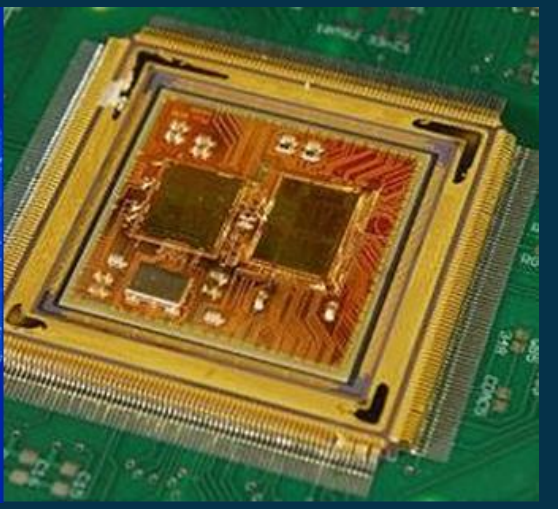
RHA consists of all activities undertaken to ensure that the electronics and materials of a space system perform to their design specifications after exposure to the space radiation environment.

Deals with environment definition, part selection, part testing, spacecraft layout, radiation tolerant design, and mission/system/subsystems requirements.

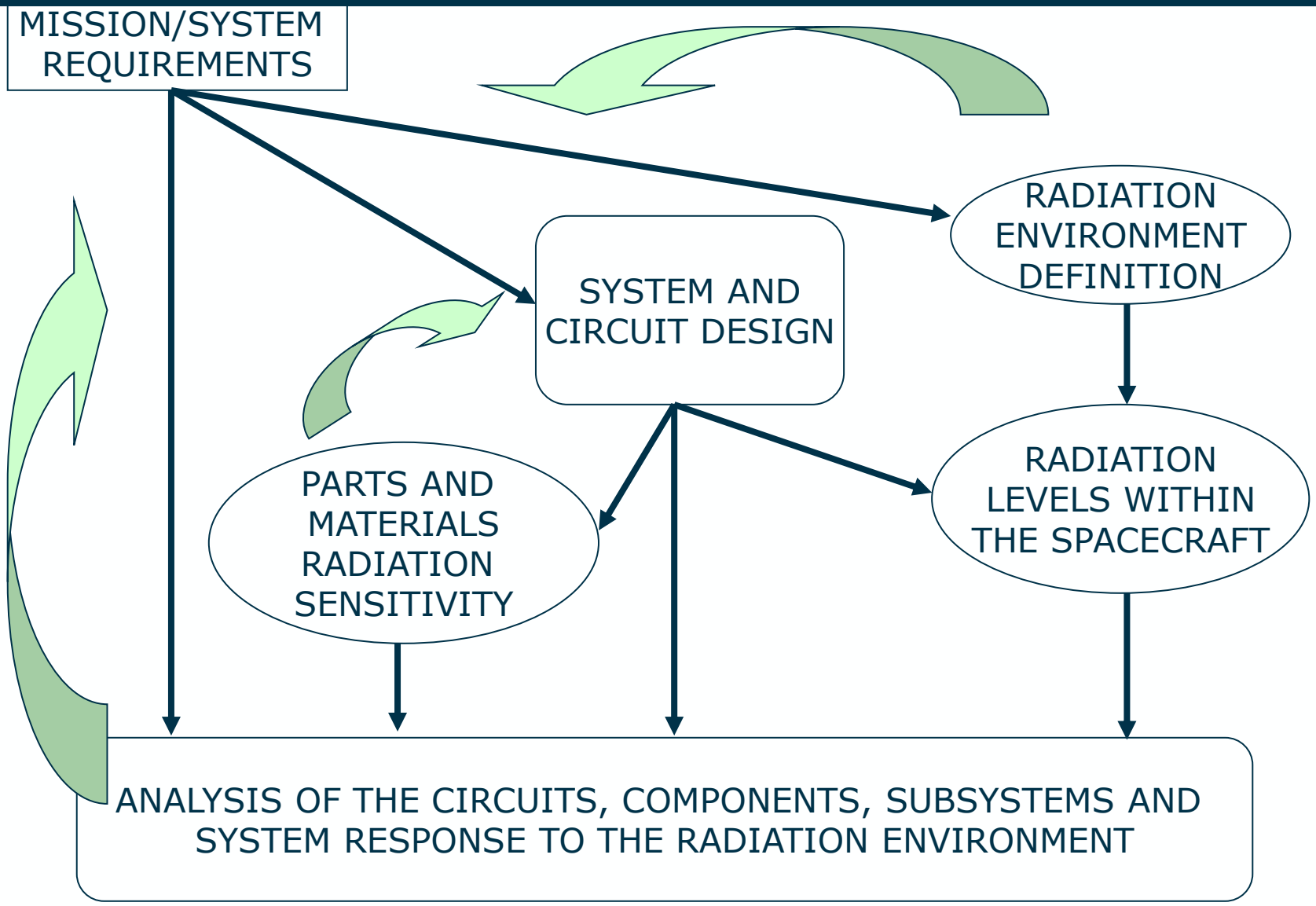




# Radiation Hardness Assurance (RHA) process



# Radiation Hardness Assurance - 1

**The radiation requirements for EEE components are project specific**

**The supplier responsible for the hardware design shall demonstrate the compliance of its components selection with the radiation constraints of the project in terms of cosmic radiation (Heavy Ions), electromagnetic, trapped (charged particles – electrons, protons – in radiation belts) and solar (flares) with due consideration to the mission orbit, trajectory, duration, the associated spatial and temporal variations of the radiation environment as well as all protective factors such as shielding.**

**The supplier shall assess the actual radiation tolerance of the selected components for compliance with the radiation requirements in term of total dose, displacement damage and Single Events Effects (SEE).**



**11 RADIATION HARDNESS ASSURANCE**

ECSS-Q-ST-60-15C and ESSB-AS-Q-008 Issue 2 (Adoption standard of the ECSS-Q-ST-60-15C document which tailors the ECSS-Q-ST-60-15C where needed), shall be applied.

For PILOT project, the following additional requirements shall be applied:

| Id | Type | Tailoring | Modified text / Comment |
|---|---|---|---|
| RHA1 | Requirement | New | The radiation environment as provided in the mission radiation specification:<br>1) Lunar Lander Space Radiation Environment Review, ESA Report, Issue 0 Revision 3, 22/02/2017<br>2) Luna-27 Interface Requirements Document for PILOT: Supporting Requirements on Environment ref. ESA-LEX-PIL-IRD-0002 iss 2.2 shall apply. |
| RHA2 | Requirement | New | Components shall not be sensitive to destructive SEE.<br>Whenever not feasible an analysis shall be performed in order to validate the use of sensitive components with following acceptance criterion:<br>Destructive SEE rate < device failure rate / 10<br><br>*NOTE: Examples of destructive SEE are: SEL, SEB, SEGR and SEDR.* |
| RHA3 | Requirement | New | Optocouplers and other optical semiconductors shall be selected also on the basis of their hardness against proton radiation, and displacement damage. |
| RHA4 | Requirement | New | For Single Event Upset (SEU) sensitivity, components with an assured LETth > 60 MeVcm$^2$/mg shall be considered as SEE insensitive. |
| RHA5 | Requirement | New | Components with a sensitivity of LETth < 60 MeVcm$^2$/mg shall be subjected to the appropriate Heavy Ion SEE.<br>Proton induced SEE rate predictions are needed for parts sensitive to LETth < 15 MeVcm$^2$/mg. |
| RHA6 | Requirement | New | Memory circuits shall have sufficient error detection and correction capability for protection against SEU such that the circuit performance goals are not affected by these errors. |
| RHA7 | Requirement | New | Parts shall be proven to be insensitive to Latch-up, this meaning a SEL LETth > 60 MeVcm$^2$/mg |

**Note: Typically lots of PARD tailoring for RHA, both because of very different environments and because ECSS-Q-ST-60-15C does not contain enough detailed requirements.**

# Radiation Hardness - 2

**The supplier shall identify components which are not compliant with the radiation requirements as critical radiation sensitive components.**

Typically part of PA Plan

**The supplier shall implement a Radiation Hardness Assurance Programme, in conformance with the requirements of ECSS-Q-ST-60-15, documented by a plan to be approved by the customer, for radiation sensitive components, covering the collection of all relevant information and specifying the necessary actions in terms of evaluation and procurement testing, planning and control.**

**The supplier shall issue an Equipment Radiation Analysis document identifying all sensitive components w.r.t. the relevant radiation effects, possibly their impact and giving an adequate engineering solution (e.g. local shielding, design solution, specific test, and RVT) for the relevant equipment.**

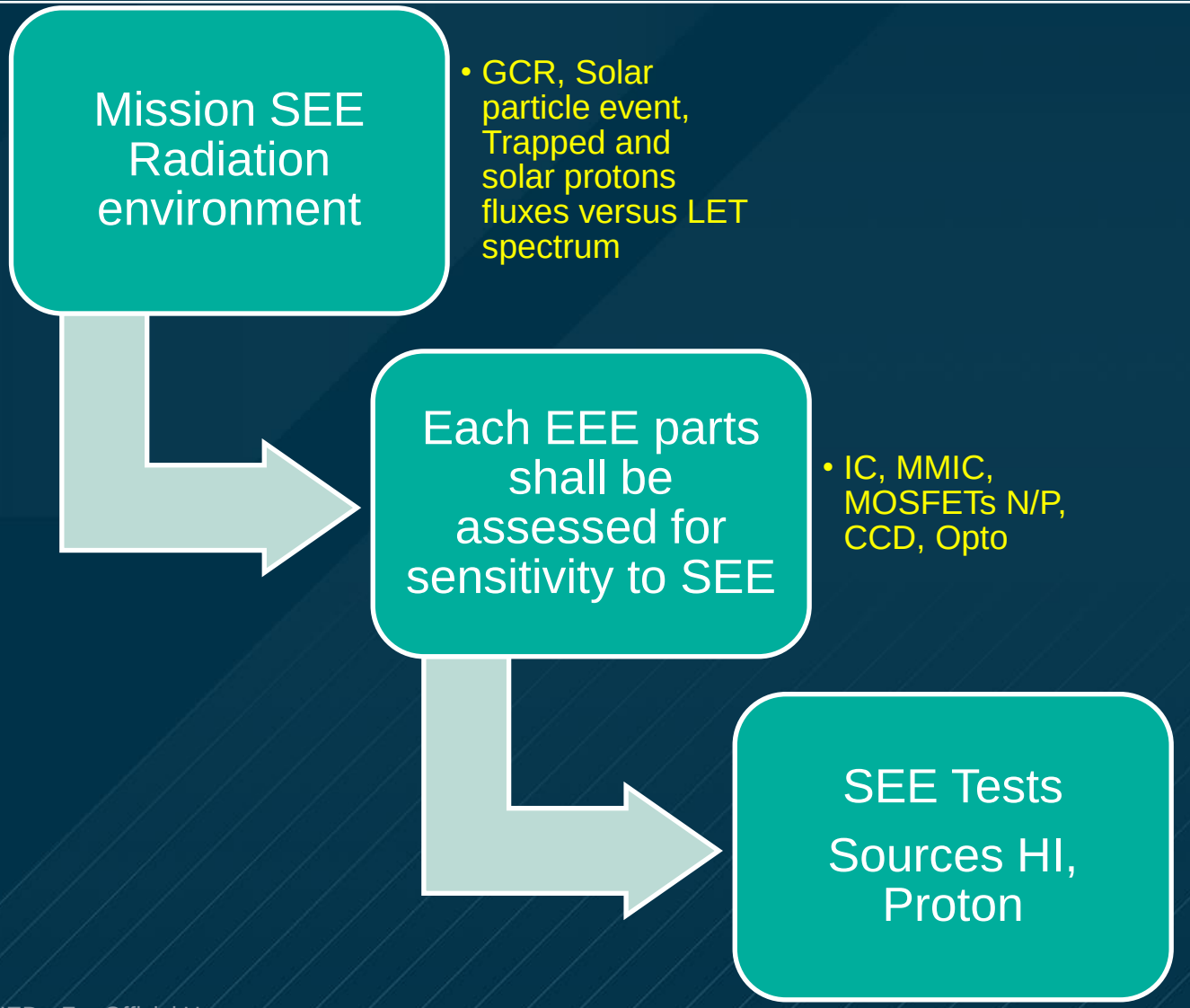
**The Equipment Radiation Analysis document shall be submitted to the customer for approval.**

**NOTE : More detailed environment information in ECSS-E-ST-10-12 and -Q-ST-60-15**

**Please note:**

- **ECSS-Q-ST-60-15C is being updated. In current version it is not detailed enough with respect to requirements and does not reflect current working practice with Radiation Control Boards**
- **ESA applies ESA Adoption Notice ESSB-AS-Q-008 issue 3 for ECSS-Q-ST-60-15C, also in update.**

# Mission SEE RHA Process (ECSS-Q-ST-60-15C)




No SEE shall cause damage to a system or a subsystem or induce performance anomalies or outages not compliant with mission specifications

Alternative Sources: Cf-252, Focused Pulsed Laser, Neutron, Alpha sources

Alternative sources shall not be used for SEE qualification.
They can be used to check the test H/W and S/W and to investigate the device relative hardness or specific failure modes as a function of device operations

# Typical RHA During the Program Life

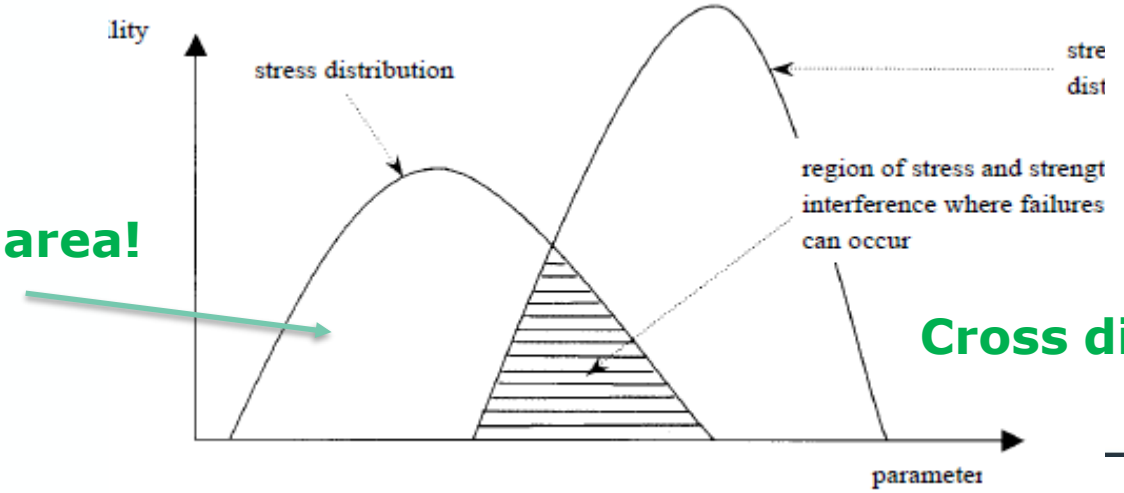
- Pre Phase A, Phase A
  - Draft environment definition
  - Draft hardness assurance requirements (top level)
  - Preliminary studies
- Phase B – PDRs
  - Final environment definition
  - Electronic design approach
  - Preliminary spacecraft layout for shielding analysis
  - Preliminary shielding analysis & hardness assurance requirements update
  - As-designed Radiation Control Board (RCB) starts
- Phase C –CDRs
  - Radiation test results
  - Final shielding analysis & final hardness assurance requirement
  - Circuit design analysis results
  - As-designed RCB completed
- Phase D
  - Radiation Lot Acceptance Tests (RLAT) also known as Radiation Verification Testing (RVT)
  - As-built RCB completed
- Phase E
  - Failure analysis

A good Radiation Analysis document saves a lot of time in reviews and discussions: Follow ECSS-Q-ST-60-15C; ensure all active parts are listed and match the Declared Components List

# Derating (aka Part Stress Analysis, PSA)

**The supplier shall implement derating rules for components used in his designs in accordance with the requirements of ECSS-Q-ST-30-11.**

**Derating is the deliberate reduction of electrical parameters (maximum limits) and temperature used in an application circuit to reduce part stress levels, increase margins and achieve a longer lifetime.**




**Keep well into this area!**

ECSS-Q-ST-30-11C Rev.2
23 June 2021

EUROPEAN COOPERATION
ECSS
FOR SPACE STANDARDIZATION

**Space product assurance**

**Derating - EEE components**

**Cross disciplinary; design, RAMS, EEE.**

ECSS Secretariat
ESA-ESTEC

# Component Evaluation - 1

**Very important but very often ignored!**

**Similar requirements in Class 1&2&3 (4.2.3, 5.2.3, 6.2.3)**

**The supplier shall perform a component evaluation in absence of an approved demonstration that a component has the ability to conform to the requirements for functional performance, quality, dependability, and environmental resistance as required for the project.**

Can be a new part but also a new application or environment.

**The scope and planning of the component evaluation shall be derived from the results of an assessment of the design and intended application of the Component**

**An evaluation plan shall be sent to the customer for approval, and include the following elements:** Typically covered by PAD or Justification Documents with annexes.

1. **Component Manufacturer Assessment, Class 1 only**
2. **Constructional Analysis,**
3. **Evaluation Testing,**
4. **Radiation Hardness**

# Component Evaluation - 2

**In the definition of the evaluation programme any information including reliability, analysis and test data from the manufacturer of the component and previous use in comparable applications shall be considered.**

**All tests and inspections shall be carried out on representative samples of the component type from the current production of the manufacturer selected for the component procurement for the flight hardware.**

**For programmable devices, the representativeness shall include the programming hardware tools and the compatibility of the software.**

**The supplier shall review the evaluation results to determine their impact on the content of the procurement specification which shall be amended as necessary.**

# Component Evaluation – 3 (Manufacturer Assessment class 1 only)

## Class 1 only: Component Manufacturer Assessment

**Manufacturer assessment is expected in any case to be performed as normal business, the formal approach applies in Class 1.**

**The supplier shall perform an evaluation against the ESCC basic specification no. 20200 and the ancillary specifications for dedicated component families and shall include, but not necessarily be limited to, a survey of:**

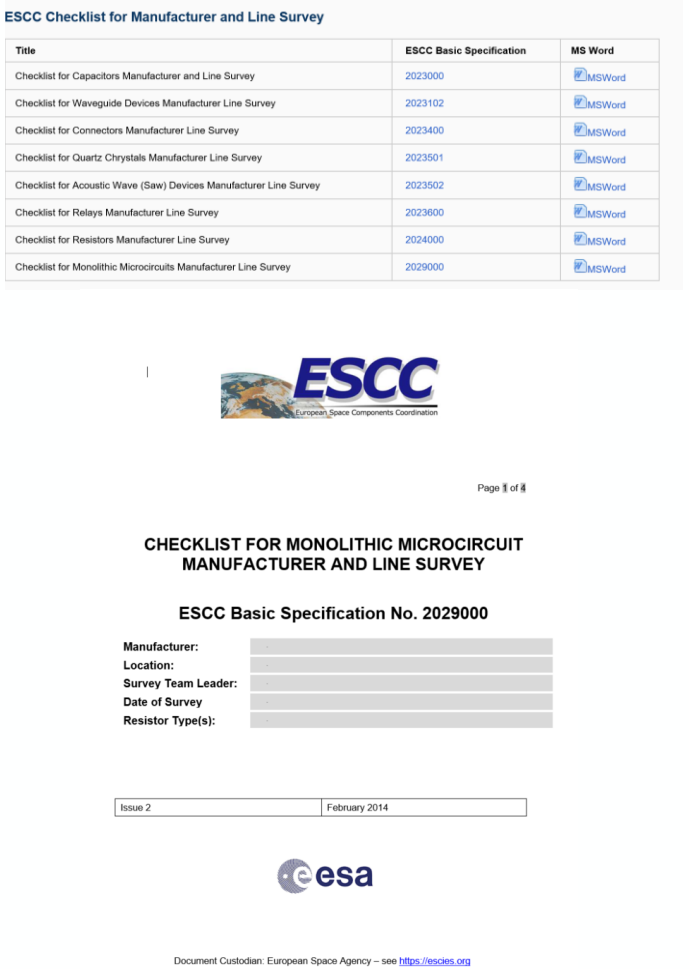
**1. The overall manufacturing facility and its organization and management,**

**2.The manufacturer's system for inspection and manufacturing control including all relevant specifications, procedures, and internal documents,**

**3. The production line used for the component.**

**The complete manufacturer assessment, including the survey report and the associated corrective actions, shall be part of the evaluation report.**

**Note: tailored approach depending on manufacturer and component type is expected.**



ESCC Checklist for Manufacturer and Line Survey

| Title | ESCC Basic Specification | MS Word |
|---|---|---|
| Checklist for Capacitors Manufacturer and Line Survey | 2023000 | MSWord |
| Checklist for Waveguide Devices Manufacturer Line Survey | 2023102 | MSWord |
| Checklist for Connectors Manufacturer Line Survey | 2023400 | MSWord |
| Checklist for Quartz Chrystals Manufacturer Line Survey | 2023501 | MSWord |
| Checklist for Acoustic Wave (Saw) Devices Manufacturer Line Survey | 2023502 | MSWord |
| Checklist for Relays Manufacturer Line Survey | 2023600 | MSWord |
| Checklist for Resistors Manufacturer Line Survey | 2024000 | MSWord |
| Checklist for Monolithic Microcircuits Manufacturer Line Survey | 2029000 | MSWord |

ESCC
European Space Components Coordination

Page 1 of 4

CHECKLIST FOR MONOLITHIC MICROCIRCUIT MANUFACTURER AND LINE SURVEY

ESCC Basic Specification No. 2029000

Manufacturer:
Location:
Survey Team Leader:
Date of Survey
Resistor Type(s):

| Issue 2 | February 2014 |
|---|---|

esa

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

# Component Evaluation – 4 (Constructional Analysis)

**The primary aim is to provide an early indication of a component's constructional suitability for meeting the specified performances of the space project application.**

**The Constructional Analysis shall comprise destructive and non-destructive inspections, analysis, and testing, to identify:**

1. **Design and construction technology,**
2. **Materials used,**
3. **Inherent reliability aspects,**
4. **Quality of workmanship,**
5. **Potential hazards.**

**Constructional Analysis is similar to DPA but more extensive, for example with respect to material analysis and micro sections.**

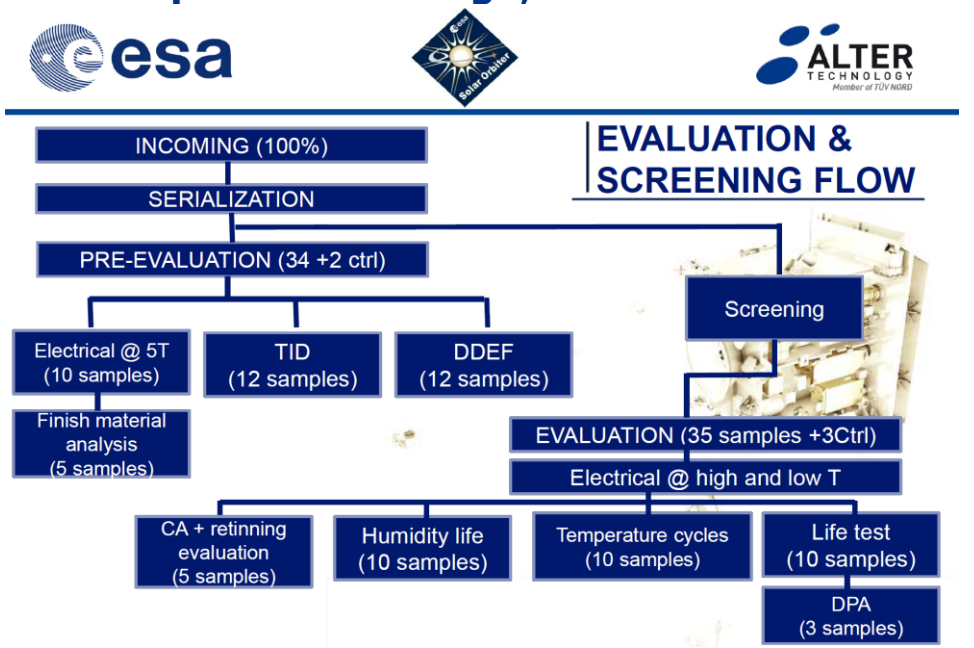
**References for analysis flow can be found in ECSS-Q-ST-60-13Crev1 for commercial components, in ESCC 21001 (though this is for DPA) and in some ESCC evaluation test programme specifications**

# Component Evaluation - 5 (Evaluation Testing)

**The supplier shall review the already existing data in order to adapt and minimize the content of the evaluation testing while ensuring that there are inputs and pertinent results covering the following topics:**

1. **Endurance test (operating at elevated temperature and electrical stress),**
2. **Mechanical stress (shock, vibration, constant acceleration),**
3. **Environmental stress (thermal shock, temperature cycling, high and low temperature storage, humidity),**
4. **Assembly capability testing,** Don't forget!
5. **Radiation testing, for total dose and single event effects sensitivity.**

- As there are a wide variety of component families it isn't possibly to prescribe detailed flows for all.
- Commercial components are addressed in ECSS-Q-ST-60-13C. Flow to the right is an example of a tailored test flow.
- ESCC evaluation programme test flows may be used as guideline noting however that they are addressing another situation than project use.
- Evaluation testing and LAT can often be combined.



# Component Evaluation - 8

- **Key take away from today – do not forget evaluation!**
- **It may not contain all the elements presented here but it should be whatever it takes to prove that part is suitable for application/environment/assembly.**

# Parts Approval - 1

**Identical in the three classes (though with PCB ambiguity for Class 3)**

**All components shall be reviewed and approved by the customer through the PCB**

**Approval process must be fully traceable note not only PADs but also all DCL line items!**

**Approval process depends on part qualification status:**

**1 Space qualified parts are approved through the DCL except in the following case where a PAD in conformance with Annex D is delivered for customer's approval:**

**(a) additional controls are required (e.g. precap, buy-off, LAT or LVT, RVT, DPA)**

**(b) used outside the specified limits - note this does not eliminate the need of an RFD/RFW!**

**(c) specific tests are required during procurement**

**2. Other hirel parts; a PAD, in conformance with Annex D is delivered to the customer for approval, -note in Class 3 we often approved non-qualified hi-rel parts from DCL**

**3. Commercial part, a Justification Document, as per ECSS-Q-ST-60-13Crev1 Annex F is delivered to the customer for approval**

# Parts Approval - 2

**The parts approval process, including PAD and JD approval, shall be completed prior to CDR, or MRR for recurring units if there is no CDR.**

**This is new in ECSS-Q-ST-60Crev3. It is often violated, more focus needed to finalise EEE review and approval before CDR!**

**Simplified approach, minimization of PADs and more information in DCL, is often agreed, especially for Class 3.**

# Procurement General

**..components shall meet the quality levels and supplementary conditions specified in Table 7-1/2/3**

**The supplier shall be responsible for manufacturer surveillance and control throughout the procurement programme.**

For each Class, see later slides

**For non qualified parts, the supplier shall put in place a configuration control system to ensure that any change of the product (e.g. mask, manufacturing and assembly process) affecting evaluation, performance, quality, reliability and interchangeability is communicated to him by the manufacturer (e.g. PCN).**

**The supplier shall ensure the compatibility of the change with its application and update all related documentation.**

This is only included for Class 1&2 but expected to be done also in Class 3

**To reduce the risk of procuring counterfeit components, when parts are not directly procured from the manufacturer, the supplier shall procure parts only from distributors duly franchised by the parts manufacturer.**

Very important! Procurement through space EEE agency also an option.

**For COTS see ECSS-Q-ST-60-13Crev1**

# Procurement Specification - 1 (Class 1)

a) The supplier shall procure EEE components according to controlled specifications.

b) International specifications systems, recognized as suitable for space applications (e.g. ESCC, MIL), shall be used by the supplier.

c) Any new specification shall be prepared and designed by the supplier as per existing international specification systems (ESCC, MIL). Preference shall be given to ESCC format when agreed by the manufacturer.

d) The content of any new specification shall be in conformance with Annex C.

e) The use of any new specification shall be submitted to the customer for approval through the PAD process (see clause 4.2.4).

f) Upon request, any new procurement specification prepared in the frame of the project, shall be delivered to the customer.

g) The supplier shall keep each procurement specification under configuration control

# Procurement Specification – 2 (Class 2&3)

Difference to Class 1 – manufacturer datasheet allowed.

a) The supplier shall procure EEE components according to controlled specifications.

b) International specifications systems, *new specifications or manufacturer's datasheets under configuration shall be used by the supplier*.

c) Any new specification shall be prepared and designed by the supplier as per existing international specification systems (ESCC, MIL). Preference shall be given to ESCC format when agreed by the manufacturer.

d) The content of any new specification shall be in conformance with Annex C.

e) The use of any new specification shall be submitted to the customer for approval through the PAD process (see clause 4.2.4)

f) Upon request, any new procurement specification prepared in the frame of the project, shall be delivered to the customer.

g) The supplier shall keep each procurement specification or manufacturer's datasheet under configuration control

# Procurement Specification – 3 (Annex C part 1)

**Annex C contains normative requirements for what needs to be addressed in procurement specification**

**For all practical purposes, the terms detailed specification and procurement specification are interchangeable for EEE.**

1. **A description of the purpose, content and the reason prompting its preparation,**
2. **A list of the applicable and reference documents,**
3. **Any additional terms, definitions or abbreviations,**
4. **Absolute maximum ratings,** — **don't forget!**
5. **Electrical and mechanical parameters and limits,** — **and conditions!**
6. **Screening, burn-in, and acceptance requirements,** — **including conditions**
7. **Package material and lead finish,** — **don't forget!**
8. **Documentation/data requirements,**

# Procurement Specification – 4 (Annex C part 2)

9. Delta limits when applicable, aka drift limits
10. Criteria for percent defective allowable, PDA
11. LAT or LVT, QCI or TCI,
12. Marking,
13. Storage requirements,
14. Requirements for lot homogeneity,
15. Serialization (when applicable),
16. Protective packaging and handling requirements,
17. Radiation Verification Testing requirements, when applicable.

**Note: the procurement should fully describe the component, and how it is tested, including exterior dimensions, materials, performance, maximum ratings and test flows.**

# Screening – 1

**Same generic type of requirements applies in Class 1/2/3 but the quality levels in Table 7-1, 7-2 and 7-3 which are described in next slide are different.**

**All components to be incorporated into flight standard hardware shall be subjected to screening.**

**In fact does not always apply for commercial components Class 2&3**

**The screening test requirements shall be defined such that accumulated stress does not jeopardize component reliability.**

**All screening tests shall be performed at the component manufacturer's premises or at a facility approved either by the qualification approval authority, where applicable (e.g. ESCC), or otherwise by the supplier.**

**Not imposed, may be at test house,**

**The quality levels defined in Table 7-1/2/3 shall apply**

**When a component is available in a qualified version according to quality level specified in Table 7-1/2/3 it shall be selected.**

**Cause of controversy!**

**In case of X-rays inspection, the total dose deposited shall not deteriorate part performance or reliability.**

# Screening – 2 (Quality levels per Table 7-1, 7-2, 7-3)

**First 3 lines of 56. Also please note an update is in progress.**

Table 7-1: Quality levels for Class 1 components

| EEE part family | Quality level | | | Supplementary Conditions |
|---|---|---|---|---|
| | ESCC | MIL | Other | |
| Capacitors, chip, ceramic | ESCC 3009 level C | MIL-PRF-55681<br>EFR level R min<br>MIL-PRF-123 | | For ceramic capacitors procured through ESCC or MIL specifications but in an extended, non qualified, range of values or not belonging to ESCC QPL or MIL QML/QPL, the humidity, steady state, low voltage test (cf ESCC 3009, § 5.2.2) is mandatory if U rated < 50V and C > 1µF. |
| Capacitors, molded, ceramic | ESCC 3001 level C | MIL-PRF-39014<br>EFR level R min<br>MIL-PRF-20<br>EFR level R min<br>MIL-PRF-123<br>MIL-PRF-49470<br>EFR level T | | For ceramic capacitors procured through ESCC or MIL specifications but in an extended, non qualified, range of values or not belonging to ESCC QPL or MIL QML/QPL, the humidity, steady state, low voltage test (cf ESCC 3009, § 5.2.2) is mandatory if U rated < 50V and C > 1µF. |
| Capacitors, glass (CYR type) | - | MIL-PRF-23269<br>EFR level R min | | Lifetest 1000 h / 125 °C/ 1,5 Ur on each lot/date code.<br>Not recommended for new designs |

**Level C will disappear(no levels in these ESCCs any longer)**

**Will be updated wrt Mil-Prf-39014**

# Screening – 3 (Quality levels per Table 7-1, 7-2, 7-3)

**Please note these are examples only. Also please note an update is planned.**

| | Class 1 (Table 7-1) | Class 2 (Table 7-2) | Class 3 (Table 7-3) |
|---|---|---|---|
| Integrated Circuits | ESCC 9000<br>Mil-Prf-38535 Class V | ESCC 9000<br>Mil-Prf-38535 Class Q+PIND | ESCC 9000<br>Mil-Prf-38535 Class Q+PIND |
| Hybrids | ECSS-Q-ST-60-05 level 1<br>Mil-Prf-38534 Class K | ECSS-Q-ST-60-05 level 2<br>Mil-Prf-38534 Class K | ECSS-Q-ST-60-05 level 2<br>Mil-Prf-38534 Class H+PIND |
| Diodes, transistors (non-microwave) | ESCC 5000<br>Mil-Prf-19500 JANS | ESCC 5000<br>Mil-Prf-19500 JANTXV+PIND | ESCC 5000<br>Mil-Prf-19500 JANTXV+PIND |
| Connectors (unfiltered D-sub and circular, PCB) | ESCC 3401 | ESCC 3401 | ESCC 3401 |
| Film resistor chip | ESCC 4001<br>Mil-Prf-55342 EFR R | ESCC 4001<br>Mil-Prf-55342 EFR R<br>CECC 40401+burn-in | ESCC 4001<br>Mil-Prf-55342 EFR R<br>CECC 40401+burn-in |

# Customer Source Inspections - 1

**Two types of CSI are included**

1. **Initial CSI, pre-cap (pre-encapsulation). This is visual inspection prior to seal. Equivalent of MIP (Mandatory Inspection Point) at higher integration level.**
2. **Final CSI, buy-off. This is final delivery prior to delivery, corresponding to DRB (Delivery Review Board) at unit level.**

**There are ESCC basic specifications for pre-cap and buy-off; ESCC 21002 and ESCC 21003**

**For CSI there are big differences between the three classes:**

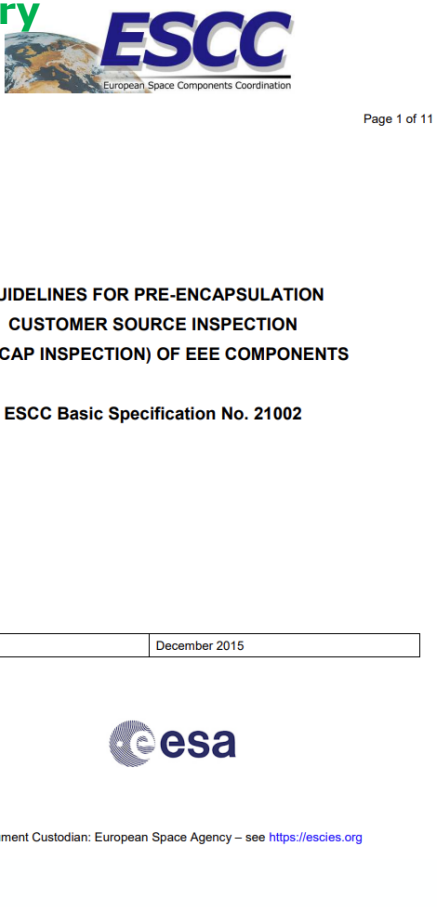
**<u>Precap</u>**

- **Class 1 on extensive list of qualified parts and some qualified**
- **Class 2 on non-qualified relays, crystals, oscillators and hybrids**
- **Class 3 not required**

**<u>Buy-off</u>**

- **Class 1 on non-qualified parts**
- **Class 2 on non-qualified parts**
- **Class 3 not required**

**If pre-cap isn't possible an extended DPA sample size can be suggested.**
**Extended incoming inspection can be proposed instead of buy-off.**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Page 1 of 11

GUIDELINES FOR PRE-ENCAPSULATION
CUSTOMER SOURCE INSPECTION
(PRECAP INSPECTION) OF EEE COMPONENTS

ESCC Basic Specification No. 21002

| Issue 1 | December 2015 |
|---|---|

esa

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

# Customer Source Inspections -2 (Class 1 precap)

**The procurement entity shall carry out, at the manufacturer's premises, a customer precap inspection for non-space qualified parts listed below:**

1. Capacitors (ceramic, mica and plastic film)
2. Crystals
3. Oscillators
4. Discrete semiconductors (including diodes and transistors)
5. Filters
6. Fuses (cermet)
7. Inductors, coils and transformers (not applicable to in-house products)
8. Monolithic microcircuits (including MMICs)
9. Hybrid circuits
10. Relays
11. Resistors (high precision, fixed, metal foil – RNC90)
12. Switches (including mechanical and thermal)
13. Optoelectronic devices (e.g. opto-couplers, LEDs, CCDs and sensors).

NB: Common sense and best engineering practice prevails!

**A precap inspection is required on critical space qualified parts, including as a minimum**

- relays
- crystals
- oscillators
- hybrids

# Lot Acceptance Class 1

**The supplier shall ensure that any lot/date code of EEE parts is submitted to a lot acceptance procedure, in line with applied normative systems, according to the following rules:**

1. **Space qualified parts:**
   **ESCC and Mil (as defined in Table 7-1) qualified parts – covered by periodic testing.**
2. **Other hi-rel qualified parts:**
   - **(a) The content of the lot acceptance is ESCC level LAT1 or level LAT2 or LVT (subgroups 1, 2 and 3) or comparable QCI.**
   - **(b) In absence of any changes (design, construction, process) LAT may be replaced by the review of available data less than 2 years old.**
   - **(c) In case of partial available data, any complementary lot acceptance content is defined by the supplier subject to PCB agreement.**
   - **(d) The PCB documents and justifies any reduced lot acceptance based on available data for customer approval.**
3. **Commercial parts – see ECSS-Q-ST-60-13Crev1**

**NB: Does not say only LAT2 needed and every 2nd year automatically accepted!**

# Lot Acceptance Class 2&3

**The supplier shall ensure that any lot/date code of EEE parts is submitted to a lot acceptance procedure, in line with applied normative systems, according to the following rules:**

1. **Space qualified parts:**
   **ESCC and Mil (as defined in Table 7-2/7-3) qualified parts – covered by periodic testing.**
2. **Other hi-rel qualified parts:**
   **(a)The content of the lot acceptance is defined according to the available data.**
   **(b)The proposed lot acceptance is approved through the approval process.**
3. **Commercial parts – see ECSS-Q-ST-60-13Crev1**

**In fact very vague requirements.**

**The sample size for lot acceptance which may be reduced in some cases, shall be submitted to the customer for approval through the PAD process.**

# Incoming Inspection - 1

**The procurement entity shall perform incoming inspection at his premises on all components to verify conformance with the purchase order requirements.**

**The incoming inspection shall include the following items:**

1. **<u>For any part: the minimum inspections required in ESCC 21004</u>**
2. **For the non-space qualified parts, when the final customer source inspection has not been performed, the following additional items:**
   a) **External visual inspection by sampling (AQL 0,65% level II or 20 parts min)**
   b) **Electrical measurements at room temperature on 20 parts or 100% (if lot size < 20 parts), <u>or a data package review.</u>**

**Not required for Class 3**

**GUIDELINES FOR INCOMING INSPECTION OF EEE COMPONENTS**

**ESCC Basic Specification No. 21004**

# Incoming Inspection - 2

**If the parts have passed successfully a final CSI (or buy-off), the incoming inspection may be reduced to the following minimum:**

1. **Verification of the manufacturer's CoC - note this is conformance to PO!**
2. **Packing checking,**
3. **Quantity verification.**

**In case the incoming inspection has been performed by a procurement agent, the incoming inspection performed by the end-user, may be reduced to the following minimum:**

1. **Packing checking,**
2. **Quantity verification.**

**Note "procurement agent" to be understood as CPPA or equivalent.**

# Radiation Verification Testing (RVT)

**Radiation sensitive components for which applicable existing test data is insufficient shall be subjected to RVT.**

**RVT shall be performed in accordance with internationally recognized standards, such as ESCC Basic Specifications No. 22900 and 22500.**

**NOTE Additional information on test methods is given in MIL-STD-750 Test Method 1019, MIL-STD-883 Test Method 1019.**

**The results of RVT shall be documented by a report.**

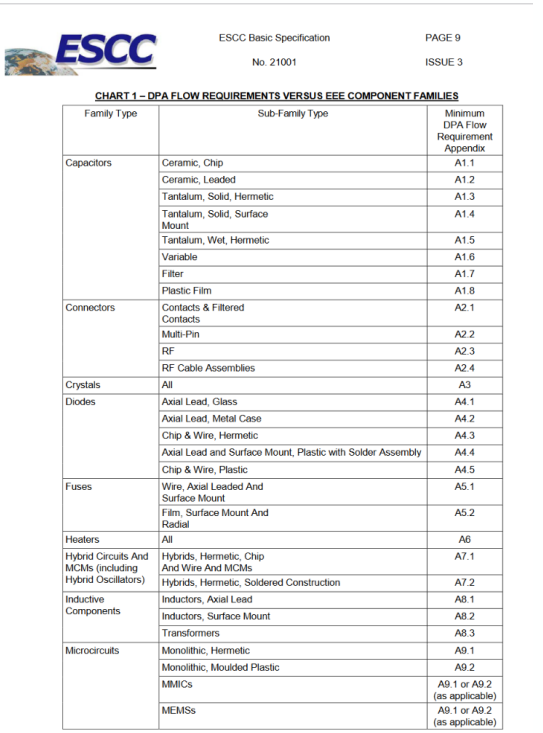
**When RVT is performed in the frame of the project, the supplier shall send the related report to the customer for information.**

# Destructive Physical Analysis (DPA) - 1

## ESCC 21001 DESTRUCTIVE PHYSICAL ANALYSIS OF EEE COMPONENTS

**Destructive Physical Analysis (DPA) is a set of tests performed on samples randomly selected from each production lot to inspect and verify the design, materials, construction and workmanship of the component. It can also be used to monitor processes, to pre-assess lots, to compare suppliers or to suggest corrective actions. The information derived from the DPA may be used:**

- **To preclude installation of components having patent or latent defects**
- **To assist in lot disposition**
- **To aid in defining improvements or changes in design, materials, or processes**
- **To evaluate supplier production trends**



ESCC Basic Specification PAGE 9
No. 21001 ISSUE 3

CHART 1 – DPA FLOW REQUIREMENTS VERSUS EEE COMPONENT FAMILIES

| Family Type | Sub-Family Type | Minimum DPA Flow Requirement Appendix |
|---|---|---|
| Capacitors | Ceramic, Chip | A1.1 |
| | Ceramic, Leaded | A1.2 |
| | Tantalum, Solid, Hermetic | A1.3 |
| | Tantalum, Solid, Surface Mount | A1.4 |
| | Tantalum, Wet, Hermetic | A1.5 |
| | Variable | A1.6 |
| | Filter | A1.7 |
| | Plastic Film | A1.8 |
| Connectors | Contacts & Filtered Contacts | A2.1 |
| | Multi-Pin | A2.2 |
| | RF | A2.3 |
| | RF Cable Assemblies | A2.4 |
| Crystals | All | A3 |
| Diodes | Axial Lead, Glass | A4.1 |
| | Axial Lead, Metal Case | A4.2 |
| | Chip & Wire, Hermetic | A4.3 |
| | Axial Lead and Surface Mount, Plastic with Solder Assembly | A4.4 |
| | Chip & Wire, Plastic | A4.5 |
| Fuses | Wire, Axial Leaded And Surface Mount | A5.1 |
| | Film, Surface Mount And Radial | A5.2 |
| Heaters | All | A6 |
| Hybrid Circuits And MCMs (including Hybrid Oscillators) | Hybrids, Hermetic, Chip And Wire And MCMs | A7.1 |
| | Hybrids, Hermetic, Soldered Construction | A7.2 |
| Inductive Components | Inductors, Axial Lead | A8.1 |
| | Inductors, Surface Mount | A8.2 |
| | Transformers | A8.3 |
| Microcircuits | Monolithic, Hermetic | A9.1 |
| | Monolithic, Moulded Plastic | A9.2 |
| | MMICs | A9.1 or A9.2 (as applicable) |
| | MEMSs | A9.1 or A9.2 (as applicable) |

# Destructive Physical Analysis (DPA) - 2

**The list of what to perform DPA on differs a lot between Class 1, 2 and 3**

**Some common requirements for all classes:**

**DPA may be carried out on representative samples of the components families:**

1. **procured from the same manufacturer and same package without major change in the process,**
2. **with a limited date code range of 13 weeks,**
3. **approved by the customer through the PAD process.**

**The DPA sample size may be reduced in some cases which shall be submitted to the customer for approval through the PAD process.**

Typically done for expensive parts.

**The supplier shall verify that the outcome of the DPA is satisfactory prior to the installation of the components into flight hardware.**

**Not only DPA – also all additional testing (RVT, LAT)!**

# Destructive Physical Analysis (DPA) - 3

## Continued common requirements for all classes:

**DPA may be performed by the manufacturer if witnessed by the supplier (or approved representative).**

Witnessing DPA is not practical

**For health and safety reasons, any test producing beryllium oxide dust shall be omitted.**

Different labs have different rules

**The results of DPA shall be documented by a report sent to the customer, on request, for information.**

This is indeed the requirement!

# Destructive Physical Analysis (DPA) – 4 (Class 1)

**Non-space qualified parts : on 3 samples per lot/date code for :**

1. Capacitors (glass, ceramic, tantalum and variable)
2. Crystals
3. Oscillators
4. Discrete semiconductors (including diodes and transistors)
5. Filters
6. Monolithic microcircuits (including MMICs)
7. Hybrid circuits
8. Relays
9. Switches (including mechanical and thermal)
10. Optoelectronic devices (e.g. opto-couplers, LED's, CCD's and sensors)
11. Passive microwave devices (e.g. mixers, couplers, isolators and switches)

Often tailored in ESA projects to all non-qualified; to avoid disagreement on exotic parts.

ESA projects often add hybrids and switches.

**Space qualified parts : on 3 samples per lot/date code on critical space qualified parts, including as a minimum relays and oscillators. For other space qualified parts families, DPA is not required.**

# Destructive Physical Analysis (DPA) – 5 (Class 2)

**Non-space qualified parts : on 3 samples per lot/date code for as a minimum:**

1. **Oscillators**
2. **Relays**
3. **Commercial parts (see ECSS-Q-ST-60-13Crev1)**

# Destructive Physical Analysis (DPA) – 6 (Class 3)

**Non-space qualified parts: on 3 samples per lot/date code for as a minimum:**

1. **Relays**
2. **Commercial parts (see ECSS-Q-ST-60-13Crev1)**

# Relifing -1

**When components from a supplier's or parts procurement agent's stock are used, the following criteria shall be met:**

1. **The parts are stored according to the minimum conditions,**
2. **The minimum overall requirements (including screening) are in accordance with the project requirements,**
3. **The lot/date code homogeneity and traceability can be demonstrated,**
4. **The EEE parts documentation is available and the content is acceptable in accordance with the project requirements (including radiation data, if necessary),**
5. **There are no open NCR's and no unresolved alerts with respect to their date code.**

**For components meeting the above criteria, and which have a lot / date code exceeding the period defined in ECSS-Q-ST-60-14 clause 5, the relifing procedure ECSS-Q-ST-60-14rev1corr1 shall apply.**

**Note: ECSS-Q-ST-60-14Crev1c1 also contains requirements for storage**

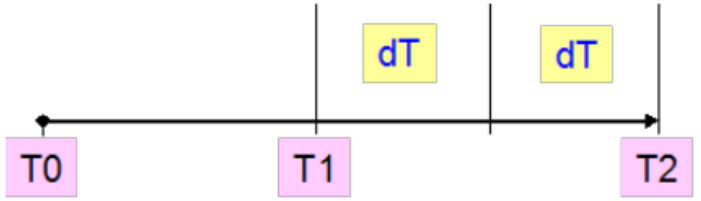
# Relifing -2 (ECSS-Q-ST-60-14Crevcorr1)

**Relifing applies after 7 years of storage and, if successful, validates the parts for for another 4 years. Can be repeated once. After 15 years of storage parts are deemed unfit for flight. Note:**

- **First relife does not need to happen before 7 years, don't perform until needed!**
- **Cut-off date is at assembly**
- **What to do in relife differs between Class 1&2 and Class 3**

**Table 5-1: Timing parameters**

| T1 | T2 | dT |
|---|---|---|
| 7 years | 15 years | 4 years |




| | |
|---|---|
| T0 | Original date code |
| T1 | Maximum allowed storage period from T0 with no relifing control |
| T2 | Maximum duration between the original date code of part and its mounting |
| dT | Maximum allowed storage period after a relifing control which can be repeated once |

ECSS-Q-ST-60-14C Rev. 1 Corrigendum 1
2 March 2020

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## Space product assurance

**Relifing procedure – EEE components**

ECSS Secretariat
ESA-ESTEC
Requirements & Standards Division
Noordwijk, The Netherlands

# Relifing -3 (ECSS-Q-ST-60-14Crevcorr1 Class 1&2)

**Requires relife on all component families**

- **External visual inspection on 100% or sample**
- **Electrical test for most families, 100% or sample**
- **Seal test 100% for cavity devices**
- **Specific test for some families, e g charge/discharge and burn-in for tantalum capacitors**

| | External Visual Inspection | ELECTRICAL (6.1.1o) | SEAL (6.1.1e) | SPECIFIC TESTS |
|---|---|---|---|---|
| resistors, high precision, fixed, metal foil (RNC90, ...) | sampling | 100 % | no | no |
| resistors, network, thick and thin film | sampling | 100 % | no | no |
| resistors, current sensing (RLV, ...) | sampling | 100 % | no | no |
| resistors, power, fixed, wirewound (RWR, ...) | sampling | sampling | no | no |
| resistors, power, fixed, wirewound, chassis mounted (RER, ...) | sampling | sampling | no | no |
| resistors, precision, fixed, wirewound (RBR, ...) | sampling | 100 % | no | no |
| resistors, fixed, film, high voltage (RHV, ...) | sampling | sampling | no | no |
| resistors, fixed, thick and thin film, chip | sampling | 100 % | no | no |
| switches, electromechanical | 100 % | 100 % | 100 % | no |
| switches, thermostatic | 100 % | 100 % | 100 % | no |
| thermistors | 100 % | 100 % | no | no |
| transformers | sampling | 100 % | no | no |
| transistors | 100 % | sampling | 100 % | no |
| transistors, microwave | 100 % | sampling | 100 % | no |
| wires and cables, low frequency | sampling (6.1.1n) | no | no | no |
| cables, coaxial, radio frequency | sampling (6.1.1n) | no | no | no |
| hybrids | 100 % | 100 % (6.1.1l) | 100 % | no |
| surface acoustic waves | 100 % | 100 % | 100 % | no |
| charge coupled devices | 100 % | 100 % (6.1.1l) | 100 % | no |
| opto discrete devices (photodiodes, LED, phototransistors, optocouplers, ...) | 100 % | 100 % | 100 % | no |
| HV cable assembly | 100 % | 100 % | no | no |
| cable assembly | 100 % | 100 % (6.1.1p) | no | no |

**Extract only**

# Relifing - 4 (ECSS-Q-ST-60-14Crevcorr1 Class 3)

**Requires relife activities only on a subset of families for Class 3:**

Table 7-1: Control parameters and detailed application of categories for Class 3 programmes

| Component family | External Visual Inspection | ELECTRICAL | SPECIFIC TESTS |
|---|---|---|---|
| capacitors, glass (CYR, …) | 100 % | 100 % | no |
| capacitors, chip, solid tantalum (TAJ, T495, CWR11, …) | sampling | 100 % | yes (see 7.1.1e) |
| capacitors, leaded, solid tantalum (CSR, …) | sampling | 100 % | Yes (see 7.1.1e) |
| capacitors, leaded, non solid (tantalum,(CLR79, …) | 100 % | 100 % | yes (see 7.1.1f) |
| through-hole components using glass beads | 100% | no | No |
| opto discrete devices (photodiodes, LED, phototransistors, optocouplers, …) | 100 % | 100 % | No |
| Hybrids | 100 % | 100 % (see 7.1.1g) | No |
| oscillators (hybrids) | 100 % | 100 % | No |
| commercial active components | 100% | sampling (see 7.1.1g) | No |

# Relifing - 5 (ECSS-Q-ST-60-14Crevcorr1)

## All three classes

**In case of 100 % test any batch of components shall be declared as not conform when failing the following "pass" conditions:**

1. **lot size < 100 parts: 0 defect allowed**
2. **lot size > 100 parts: 1 defect allowed**

**Electrical testing**
**A subset of DC parameters, as given in the Table of room temperature electrical measurements of the relevant procurement specification, ESCC or equivalent, shall be selected, submitted to customer's approval and then measured.**

**For VLSI, hybrids and CCD, when electrical test is not practicable because of test program or product complexity, the validation may be transferred to use step such as functional tests or programming stages**

# Manufacturer's data documentation deliveries

**The manufacturer's CoC shall be delivered to the parts procurer.**

**Any other data (i.e. LAT or LVT, QCI or TCI), defined in the applicable procurement documents, shall be available at the manufacturer's facilities or delivered to the parts' procurer in line with the purchase order.**

**For non qualified parts, the parts procurer shall store the documentation for a minimum of 15 years after receiption of the components.**

**NOTE For qualified parts, the documentation storage period is under the responsibility of the manufacturer and the qualifying authority.**

**However not always meeting 15 years**

# Handling and Storage

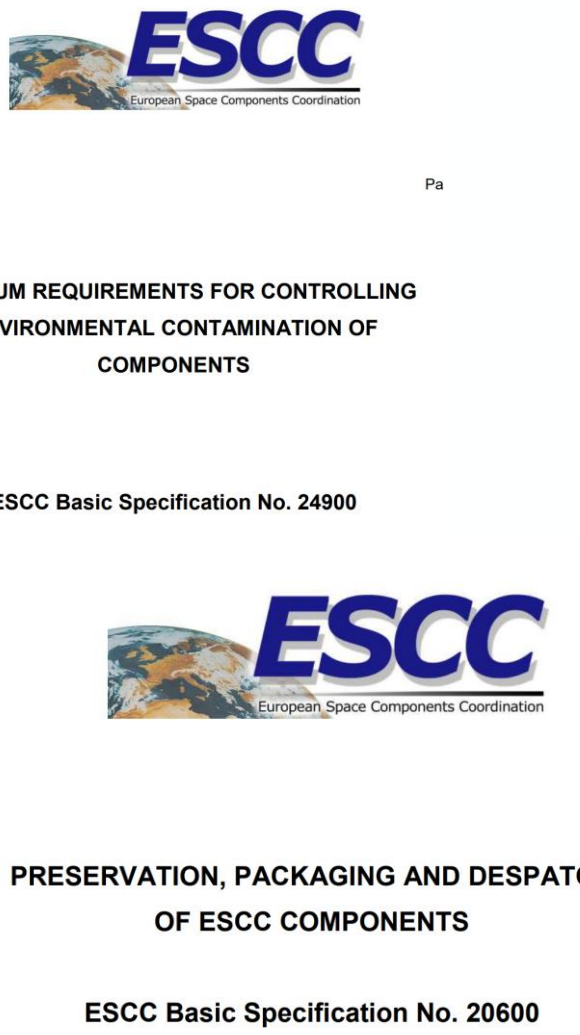
**The supplier shall establish and implement procedures for handling and storage of components in order to prevent possible degradation.**

**NOTE For guidance, refer to the basic specification ESCC 20600.**

**On request, handling and storage procedures shall be sent to the customer for review.**

**As a minimum, the following areas shall be covered:**

1. **Control of the environment in accordance with ESCC Basic Specification No. 24900.**
2. **Measures and facilities to segregate and protect components during receiving inspection, storage, and delivery to manufacturing.**
3. **Control measures to ensure that electrostatic discharge susceptible components are identified and handled only by trained personnel using anti static packaging and tools.**



# Non-Conformances and Failures

**Any observed deviation (failures, malfunctions, deficiencies and defects) of EEE components from requirements as laid down in applicable specifications, procedures and drawings shall be controlled by the nonconformance control system.**

**The nonconformance control system shall handle all non-conformances occurring on EEE components during:**

1. **Manufacture (if available), screening and acceptance tests,**
2. **Incoming inspection,**
3. **Integration and test of equipment,**
4. **Storage and handling.**

**For ESCC qualified components the supplier shall apply the ESCC basic specification no 22800.**

ESCC European Space Components Coordination

**ESCC NON-CONFORMANCE**

**CONTROL SYSTEM**

**ESCC Basic Specification No. 22800**

NB does not replace project NCR

# Class 1 : QA – Alerts

**The supplier shall take into account all received alerts, errata sheets from international alert systems, from manufacturers or sent by the customer and shall validate that there are no alerts related to the intended applications and the recommendations of alerts were taken into account.**

**If alerts become available at a later stage, the supplier shall analyse the alerts, analyse the project risk and propose an action plan for customer approval.**

**The supplier shall initiate and distribute within the project notifications for all major problems arising on EEE parts during procurement, incoming inspection or during all levels of equipment manufacturing or testing, which are of general concern.**

**Class 1 only**

**The major Alert Systems are the US GIDEP and ESA Alert both secure the detailed alert information in a private domain.**

**Other organisations, and companies, also maintain alert systems with strict access control.**

**The rules for the ESA Alert system are in the public domain https://alerts.esa.int**

# Class 1 : QA – Traceability and Lot Homogeneity

**The traceability of all components shall be maintained during manufacturing, testing, through incoming, storage, and installation at the procurer and user of the component**

**In any case, the traceability requirements imposed by the supplier on the EEE parts manufacturer or distributor shall allow managing the adequacy of the tests performed by the supplier (i.e. evaluation, lot validation, any additional test or inspection).**

**The traceability of EEE parts during installation in equipment, shall be ensured by the supplier through maintaining the traceability to the manufacturer's lot/date code.**

**If the as built DCL has not yet been delivered, the supplier shall be able to provide this information (part type actually installed with its relevant lot/date code number) within one week.**

**Note: Different formulation in class 3 as ABDCL is not required**

**Lot homogeneity is a key requirement for sampling tests!**

# Specific Components; ASIC and one-time-programmable

- **ECSS-Q-ST-60-02 shall apply.**

  **Note: This standard is in update, not included in this presentation**

- **PAD shall make reference to programming procedure and acceptance of programmed parts**
- **One time programmable components shall be submitted to a post-programming sequence**

  **Note: this does normally not mean a post programming burn-in which is only applied in following case:**

  "For one time programmable FPGA and PROM without a clear and defined heritage, a post-programming burn-in shall be applied, in conformance with ESCC9000 subclause 8.16, for a minimum duration of 160 h.
  NOTE FPGA and PROM with defined heritage are documented in these reports: ESCC REP 010 and ESCC REP011, available on https://escies.org. "

# Specific Components; ASIC and one-time-programmable

The supplier shall prepare a post-programming procedure for customer's approval, depending on part types.

NOTE This includes, if applicable:

- electrical test conditions, - note most often at unit/board level
- programming conditions and equipment,
- programming software version qualified by the supplier,
- burn-in conditions,
- additional screening tests, and
- specific marking after programming.

The lot acceptance procedure, as defined in clause x.3.5, shall be performed on devices coming from the flight lot/date code and programmed on the same kind of hardware tools and compatible software.

In case of several designs based on the same lot of blank parts, the lot acceptance procedure, as defined in clause, x.3.5, may be limited to one representative flight programmed design.

**These requirements never imposed on space level parts.**

# Specific Components; Hybrids

ECSS-Q-ST-60-05C Rev. 1
6 March 2009

Selection and validation of the hybrids manufacturers shall conform to clauses 5 and 6 of ECSS-Q-ST-60-05.

Design of hybrids shall conform to clause 7 of ECSS-Q-ST-60-05.

The hybrids shall be procured in accordance with the specifications listed in Table 7-1/2/3.

NOTE:

- ECSS-Q-ST-60-05Crev1 can only be used when procuring from European manufacturer fully familiar with it and preferably listed in ESCC PROCESS CAPABILITY APPROVAL LIST (PCAL), see escies.org)
- There are now also ESCC specifications for hybrids

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**Space product assurance**

**Generic procurement requirements for hybrids**

# Specific Components; Hybrids

## Microwave monolithic integrated circuit

Design, selection, procurement and use of the microwave monolithic integrated circuits shall be performed in conformance with the requirements from ECSS-Q-ST-60-12.

## Connectors

For connectors with removable contacts, contacts shall be procured from the same manufacturer as the connector in which they are mounted.

# ECSS-Q-ST-60-13C

COMMERCIAL COMPONENTS COTS

# ECSS-Q-ST-60-13Crev1

Follows ECSS-Q-ST-60 and defines applicable, not applicable, new and modified requirements.

It also contains 3 classes.

In last revision some passive part families were added, now includes requirements for

- Ceramic capacitors chips
- Solid electrolyte tantalum capacitors chips
- Discrete parts (transistors, diodes, optocouplers)
- Fuses
- Magnetic parts
- Microcircuits
- Resistors chips
- Thermistors

Can also be used as guideline for other families on case by case basis

Special recognition for AEC-Q qualified parts

**Warning: it is not easy to interpret!**
**Very short summary for required tests:**

**Evaluation**
- Always required but extent dependent on Class and AECQ status

**Screening**
- Extent dependent on Class and AECQ status
- Always required in Class 1
- When applicable some screening steps apply in all cases; as an example PIND

**LAT**
- Extent dependent on Class and AECQ status
- Note – when evaluation is done on FM lot can cover LAT

| | | |
|---|---|---|
| | **4.3.2 Procurement specification** | |
| 4.3.2a | The supplier shall procure EEE components according to controlled specifications.<br>NOTE It can be procurer's in-house specification, a manufacturer's drawing or a datasheet as a minimum. | Modified |
| 4.3.2b | | Not applicable |
| 4.3.2c | | Not applicable |
| 4.3.2d | | Not applicable |
| 4.3.2e | | Applicable |
| 4.3.2f | | Applicable |
| 4.3.2g | | Applicable |
| 4.3.2h | If additional requirements to the manufacturer are identified by the supplier, they shall be specified in the procurement specification, in conformance with DRD from Annex C. | New |
| | **4.3.3. Screening requirements** | |
| 4.3.3a | | Applicable |
| 4.3.3b | | Applicable |
| 4.3.3c | | Applicable |
| 4.3.3d | For commercial parts, screening tests shall be performed in accordance with:<br>1. Table 8–1 for ceramic capacitors chips,<br>2. Table 8–2 for solid electrolyte tantalum capacitors chips<br>3. Table 8–3 for discrete parts (diodes, transistors, optocouplers)<br>4. Table 8–4 for fuses<br>5. Table 8–5 for magnetic parts<br>6. Table 8–6 for microcircuits<br>7. Table 8–7 for resistors<br>8. Table 8–8 for thermistors | Modified |
| 4.3.3e | | Deleted |
| 4.3.3f | | Applicable |

# ECSS-Q-ST-60-13Crev1

**Indeed not easy to interpret!**

Table 8–6: Procurement test table for microcircuits

| Microcircuits | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Automotive grade | Class 1 | Class 2 | Class 3 | Category | Test type | Sample size | Test Procedure | Specific Test condition | Note |
| AEC-Q grd 0/1 | X | X | X | Evaluation | Radiation evaluation | | i.a.w. ECSS-Q-ST-60-15 | | |
| AEC-Q grd 0/1 | X | X | X | Evaluation | Construction Analysis | 5 | i.a.w. Annex H + outgassing | | Note (d) |
| AEC-Q grd 0/1 | X | | | Evaluation | Life Test 2000h | 15 | TM from Table 8-9 | 2000h LT | Note (a) |
| AEC-Q grd 0/1 | X | X | X | Screening | Hermeticity | all | TM from Table 8-10 and 8-13 | | for hermetic parts |
| AEC-Q grd 0/1 | X | X | X | Screening | PIND test | all | TM from Table 8-10 and 8-13 | | for parts with cavity |
| AEC-Q grd 0/1 | X | | | Screening | Complete screening | all | TM from Table 8-10 | 240h burn-in | Note (b) |
| AEC-Q grd 0/1 | X | X | X | LAT | RVT | | i.a.w. ECSS-Q-ST-60-15 | | |
| AEC-Q grd 0/1 | X | X | X | LAT | Construction Analysis | 5 | i.a.w. Annex H | | |
| AEC-Q grd 0/1 | X | X | | LAT | Life test 1000h | 15 | TM from Table 8-11 and 8-14 | 1000h LT | Note (c) |
| No | X | X | X | Evaluation | Radiation evaluation | | i.a.w. ECSS-Q-ST-60-15 | | |
| No | X | X | X | Evaluation | Construction Analysis | 5 | i.a.w. Annex H + outgassing | | Note (d) |
| No | X | X | | Evaluation | Complete Evaluation | see tables | TM from Table 8-9 and 8-12 | | Note (a) |
| No | X | X | X | Screening | Hermeticity | all | TM from Table 8-10 and 8-13 | | for hermetic parts |
| No | X | X | X | Screening | PIND test | all | TM from Table 8-10 and 8-13 | | for parts with cavity |
| No | X | X | | Screening | Complete screening | all | TM from Table 8-10 and 8-13 | 240/168h duration in class 1/2 | Note (b) in class 2 |
| No | X | X | X | LAT | RVT | | i.a.w. ECSS-Q-ST-60-15 | | |
| No | X | X | X | LAT | Construction Analysis | 5 | i.a.w. Annex H | | |

68



| Microcircuits | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Automotive grade | Class 1 | Class 2 | Class 3 | Category | Test type | Sample size | Test Procedure | Specific Test condition | Note |
| No | X | X | X | LAT | Complete LAT | see tables | TM from Table 8-11, 8-14 and 8-15 | Life test duration 1000h | Note (c) in class 3 |

# ECSS-Q-ST-60-13Crev1

Justification document replaces PAD and requests much more extensive data. A non-exhaustive list includes:

- General information; part number, manufacturer, package, AEC-Q, data sheet, internal qualification, manufacturer traceability, Tg, MSL level ….
- Supporting data on previous lot including radiation data and quality & reliability data from tests of previous lots.
- Evaluation Plan
- Tests to be performed on FM lot; screening/LAT/RVT plans.
- Traceability (date code/trace code, assembly and wafer plant, diffusion lot and die revision

It is understood that not all required information is available for all parts.

# Who deals with ECSS-Q-ST-60 in ESA?

- The standard is part of the ECSS series maintained by ESA, TEC-Q Department, TEC-QES Section.
- The Product Assurance Section (TEC-QQM) refers to the standard when defining PARD.
- The Components Technology Section (TEC-EDC) provides service to ESA projects w.r.t. the implementation of the requirements.
- The Requirement and Standard Section (TEC-QES) and the Components Section (TEC-EDC) supports the preparation of the Q-ST-60 standard and its Level 2 ancillary documents.
- The Radiation Hardness Assurance and Component Analysis section (TEC-QEC) develops and maintains standards for RHA and retains tests capability necessary to conduct tests and inspections as required by Q-60

# References

www.esa.int

www.ECSS.nl

https://escies.org contains among others

European Preferred Parts List, ESCC QPL/QML
ESCC specifications, Radiation Effects Database, ESCCON Proceedings, Technology and EEE components information, links

https://esarad.esa.int

https://landandmaritimeapps.dla.mil/programs/milspec/DocSearch.aspx

US-MIL specs and Qualifications

https://nepp.nasa.gov/ NASA Electronic Parts and Packaging website

http://radhome.gsfc.nasa.gov/top.htm NASA Radiation home page

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