Teledyne e2v Space Quality Levels, definitions and application

Revision date :	**01/03/2022**
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Scope :	**CLIENTS - CUSTOMERS COMMERCIAL - SALES BUSINESS UNIT BMS**

Last revision approved by :

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BISSONNIER Christelle	Oui	23/11/2021
GUILLEMAIN Thomas	Oui	01/03/2022

1. DOCUMENT AMENDMENT RECORD

Author	Issue	Date	Reason for change
RENAUD Sebastien	A		Initial release
RENAUD Sebastien	A.1	01/03/2022	Template format modification

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2. SCOPE

The purpose of this document is to present the different space quality levels, to provide give definition of several space models provided by Teledyne e2v and defines the final application of these models.

These definitions are then linked to Teledyne e2v internal codifications by using a cross table in order to simplify the reading.

This document is applicable for all semiconductors products from Teledyne e2v Grenoble.

3. APPLICABLE STANDARDS

- MIL-PRF-38535: Integrated circuits manufacturing - general specification
- ESCC 9000: Integrated circuits monolithic - generic specification
- NPR 7120.8: NASA Research and Technology Program and Project Management Requirements
- NPR 7120.5: NASA Space Flight Program and Project Management Handbook
- NPR 7123.1: NASA Systems Engineering Processes and Requirements
- EEE-INST-002: Instructions for EEE Parts Selection, Screening, Qualification, and Derating
- PEM-INST-001: Instructions for Plastic Encapsulated Microcircuit (PEM) Selection, Screening, and Qualification
- ECSS-E-HB-10-02: Verification Guidelines
- ECSS-Q-ST-60: Electrical, electronic and electromechanical (EEE) components
- ECSS-Q-ST-60-13: Commercial electrical, electronic and electromechanical (EEE) components

4. INTERNALS DOCUMENTS

- BM-E : Business Manual Teledyne Teledyne e2v semiconductor
- PDx : Internal Quality system referential
- SQ 32S 214263: Commercial Part Numbers Codification Semiconductors Products
- SQ 32S 01000: Quality levels for supplied components

5. REVIEW OF INTERNAL DOCUMENTS

Internal documentation is only accessible on site. No internal documentation can be transferred outside the company to the customer.

6. ISSUE OF DOCUMENTS

Document revisions in effect on the date of the customer purchase order form a part of this document.

7. ACCRONYMS

- NASA: National Aeronautics and Space Administration
- ESA: European Space Agency
- CNES: Centre National d'Etudes Spatiales
- JAXA: Japan Aerospace Exploration Agency
- EM: Engineering Model
- EQM: Engineering Qualification Model
- FM: Flight Model
- TRL: Technology Readiness Levels
- BOM: Bill Of Materials
- QCI: Quality Conformance Inspection
- LVT: Lot Verification Testing
- GSE: Ground Support Equipment
- EEE: Electrical and Electronic Equipment
- CoC: Certificate of Compliance
- COTS: Commercial Of The Shell parts
- HiRel: High Reliability parts

8. SPACE DEFINITION AND APPLICATION

8.1 Introduction

The introduction of definitions of the different space models is recent in international standards. ESA calls these products: Models, while NASA calls them Unit. However, these models mostly reflect the same definition.
Historically, Engineering (EM or EU) and Flight (FM or FU) models are commonly used by international space agencies (ESA, NASA, JAXA...)
It was at the instigation of CNES and then of ESA that an intermediate model between EM and FM was set up.
This model is the Engineering Qualification Model or EQM. This model allows our customers to qualify their system with a lean product in terms of qualification and documentation. This model is nevertheless compatible with the Form and Function rules.
To date, there is no equivalent model at NASA. Nevertheless, Teledyne e2v has chosen to introduce the EQM model in order to respond favorably to the different demands of our space customers.

8.2 COTS versus HiRel

A COTS part is a commercial electronic component readily available and not manufactured, inspected or tested in accordance with military or space standards. This means that these parts are not directly usable for space applications. Manufacturers and customers must select and up-screen parts at space quality level to ensure reliability of parts for space use. In addition, radiation tests should be performed to verify whether selected part is able to survive in space environment. Regarding traceability, manufacturer must include this requirement to fulfill aerospace requirements.

To this other hand, HiRel part is a high reliability military or space electronic component designed, manufactured, inspected and tested according to the most stringent international military and aerospace standard. This part is able to survive in a radiative environment such as space. Full traceability is natively guaranteed for this type of parts.

8.3 Definition of environments

8.3.1 Laboratory Environment

An environment that does not address in any manner the environment to be encountered by the system, subsystem, or component (hardware or software) during its intended operation tests in a laboratory environment are solely for the purpose of demonstrating the underlying principles of technical performance (functions) and functional debugging without accounting for environmental requirements of final system.

8.3.2 Relevant Environment

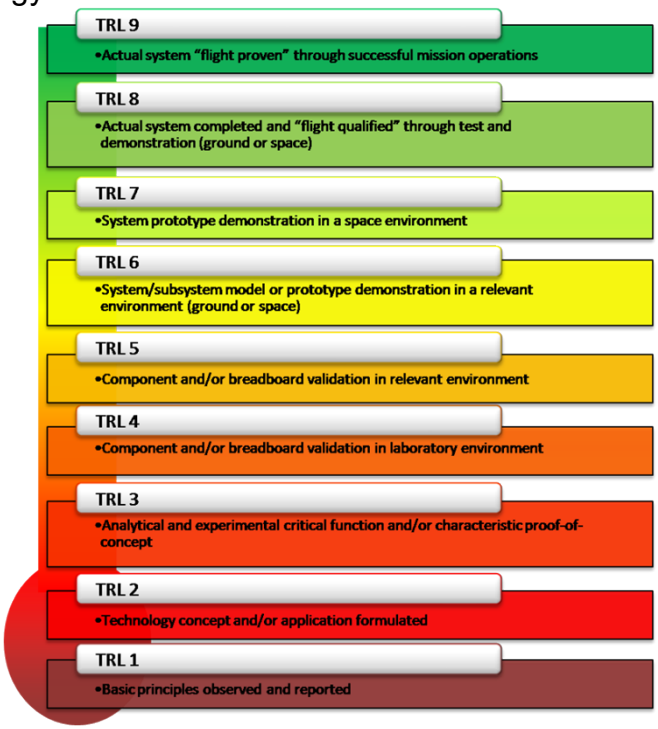
Not all systems, subsystems, and/or components need to be operated in the operational environment in order to satisfactorily address performance margin requirements.
Consequently, the relevant environment is the specific subset of the operational environment that is required to demonstrate critical "at risk" aspects of the final product performance in an operational environment. It is an environment that focuses specifically on "stressing" the technology in question.

8.3.3 Operational Environment

The environment in which the final product will be operated. In the case of space flight hardware/software, it is space. In the case of ground-based or airborne systems that are not directed toward space flight, it will be the environments defined by the scope of operations. For software, the environment will be defined by the operational platform.

8.4 Definition of Technology Readiness Level

Technology Readiness Levels (TRL) are a type of grading measurement system used to assess the maturity level of a particular technology.
Each technology project is evaluated against the parameters for each technology level and is then assigned a TRL rating based on the projects progress.
There are nine technology readiness levels. TRL 1 is the lowest and TRL 9 is the highest.



8.5 Definition

The following paragraphs give the definitions of the different models for Teledyne e2v products.
For each product, our certificate of compliance defines the model. The model is defined by shortened definition defines hereafter. This shortened definition is made by limiting the number of characters in order to simplify the incoming inspection of our products.

8.5.1 Engineering Model (EM)

Engineering Models (EMs) are flight representative in form, fit and function, without high reliability EEE components.

The Engineering Models are used for functional qualification and are built and tested so as to establish confidence that the design will function in the expected environments.

EMs can also be used for final validation of test facilities and Ground Support Equipment (GSE) with related procedures.

Subject to change without any notification.
No space screening is applied, these parts are delivered without initial and lot qualification (QCI/LVT).
This model is not qualified for Flight.

8.5.2 Engineering Model CoC definition

Eng. Model,may be subject to change,intended for functional evaluation,not flight-qualified.Refer to NE60S220869 for definition

8.5.3 Engineering Qualification Model (EQM)

Engineering Qualification Models fully reflect the design of the end product but do not go through the full flight model screening and qualification.

The Engineering Qualification Model are used for functional performance qualification and EMC testing. The EQMs may also be used for environmental testing if the Customer accepts the risk that the parts has not gone through the full flight model screening and qualification.

The Engineering Qualified Model has passed our initial qualification and parts are screened according to Teledyne e2v internal flow.

Parts are delivered without lot qualification (QCI/LVT).
This model is not qualified for Flight.

8.5.4 Engineering Qualification Model CoC definition

EQM, reflects End product,may be used for environmental testing, not flight-qualified.Refer to NE60S220869 for definition

8.5.5 Flight Model (FM)

Flight Model is the flight end product. It is subjected to formal functional and environmental acceptance testing.

This model is qualified for Flight.

8.6 Model definition

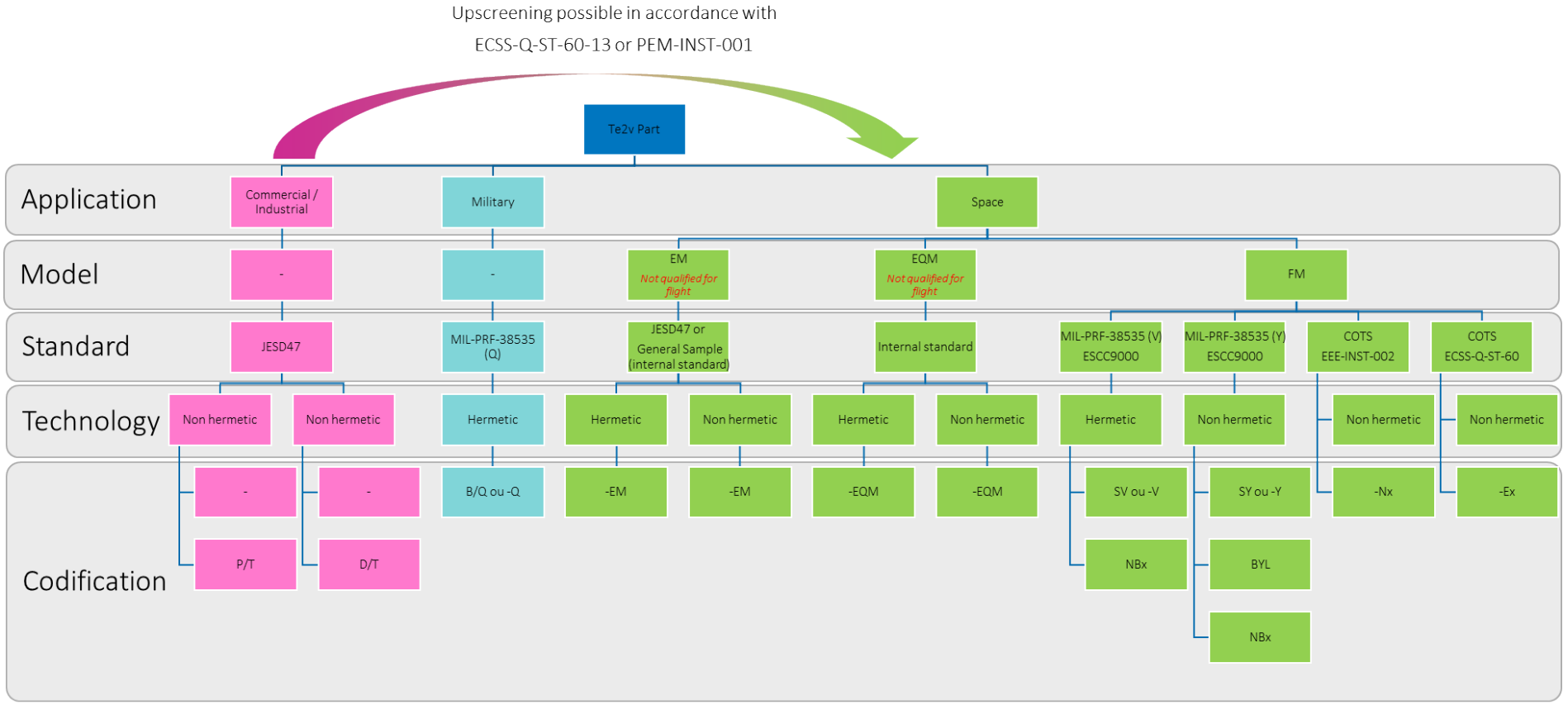
8.6.1 Summary table

Table below summarizes the definition of models for assessing technology maturity and identify activities that should be accomplished.

Model	Purpose	Performance / function	Form & Fit / Scaling	Environmental requirements	Pedigree (materials, parts, traceability	TRL
EM	Finalize detailed design	Meet performance/function requirements in a limited range of temperature	Representative at the time of design	Meet laboratory or relevant environmental requirements	Not required	4/5
EQM	Qualify design	Meet performance/function requirements in complete range of temperature	Representative at the time of design	Meet operational environmental requirements	Not required, but may be	7
FM	Final product	Meet performance/function requirements	Respect all aspect	Meet operational environmental requirements	Full	8/9

8.7 Cross table between Teledyne e2v part codification and Model

This cross table summarizes the links between customer applications, internal codification of our products and performed quality levels.



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