NASA-STD-8739.11 Tutorial

Overview

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Acronyms [*modify as needed*]

AEC	Automotive Electronics Council
COTS	Commercial-Off-The-Shelf
Cpk	Process Capability Index
DLA	Defense Logistics Agency
DoD	Department of Defense
DPPM	Defective Parts Per Million
EEEE	Electrical, Electronic, Electromechanical, Electro-Optical
EOL	End-Of-Line
ETW	Electronics Technology Workshop
FIT	Failure-In-Time
FMEA	Failure Mode and Effects Analysis
GSFC	Goddard Space Flight Center
IL	In-Line
ILPM	Industry Leading Parts Manufacturer
JEDEC	Joint Electron Device Engineering Council

MEAL	Mission Environment, Application, and Lifetime
MIL-SPEC	Military Specification
NASA	National Aeronautics and Space Administration
NEPP	NASA Electronic Parts & Packaging (Program)
NESC	NASA Engineering & Safety Center
NSC	NASA Safety Center
PPAP	Production Part Approval Process
PSW	Part Submission Warrant
QML	Qualified Manufacturers List
QPL	Qualified Product List
RHA	Radiation Hardness Assurance
SMA	Safety and Mission Assurance
SMD	Standard Microcircuit Drawing
SME	Subject Matter Expert
SPC	Statistical Process Control

Purpose

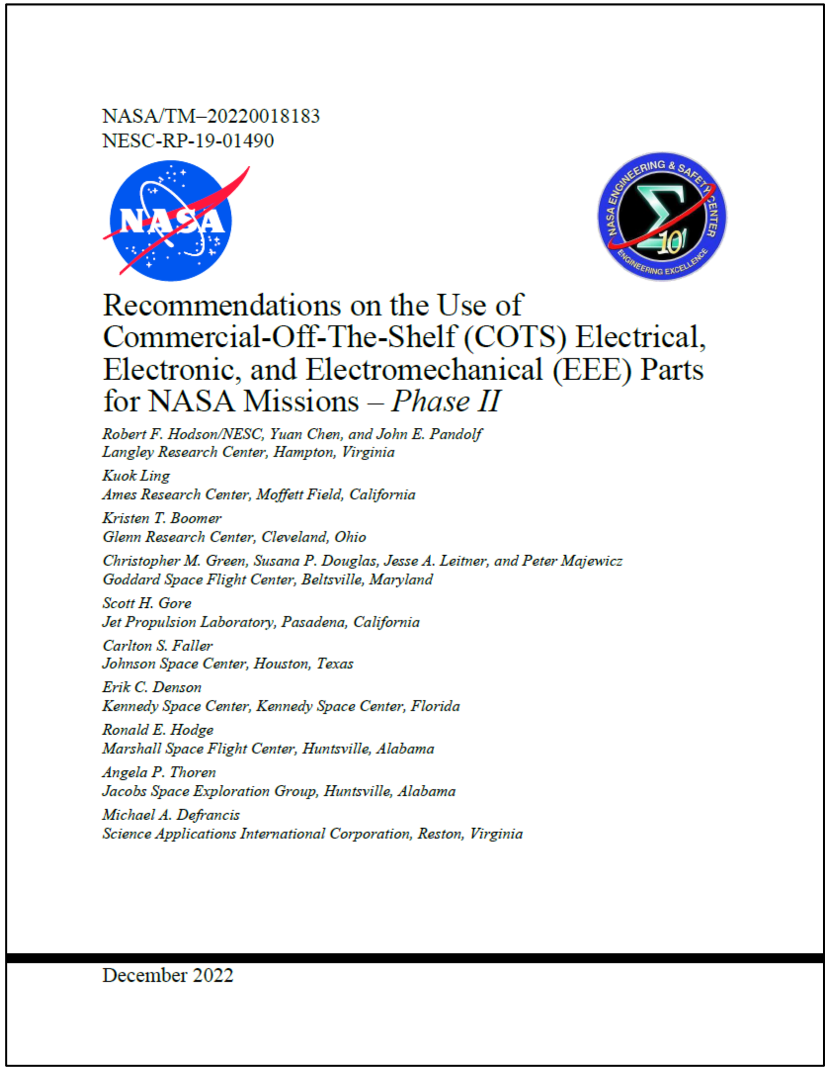
- Establish baseline criteria for selection, screening, lot acceptance testing, and derating of quad-E parts
- Establishes the baseline assurance requirements needed to meet four assurance levels of quad-E parts
  - Identifies electrical and environmental tests in the form of screening and lot acceptance tests
  - Inspections in the form of destructive physical analysis or pre-cap visual inspections
- Does not attempt to adequately cover radiation effects of EEEE parts.

History

- Based on the EEE-INST-002, *Instructions for EEE Parts Selection, Screening, Qualification, and Derating*
  - GSFC document (used by other Centers)
  - 3 Quality Levels
  - 18 Device Specific Sections
  - Technology specific electrical testing (outdated)
  - Last update 2003
- Science Mission Directorate Policy: SMD Standard Mission Assurance Requirements For Payload Classification D
  - SMD encourages and empowers small mission project teams to take higher programmatic and technical risks when the potential for high scientific return at low cost has a fair likelihood of being achieved...
  - The Developer shall document and implement a Parts Control Plan. Per NASA-STD-8739.10, Level 4 or Commercial-Off-The-Shelf (COTS) parts may be used without additional screening.

COTS Utilization

NASA Engineering and Safety Center Recommendations on the Use of COTS EEE Parts for NASA Missions



NASA/TM–20220018183
NESC-RP-19-01490

Recommendations on the Use of Commercial-Off-The-Shelf (COTS) Electrical, Electronic, and Electromechanical (EEE) Parts for NASA Missions – *Phase II*

Robert F. Hodson/NESC, Yuan Chen, and John E. Pandolf
Langley Research Center, Hampton, Virginia

Kuok Ling
Ames Research Center, Moffett Field, California

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Goddard Space Flight Center, Beltsville, Maryland

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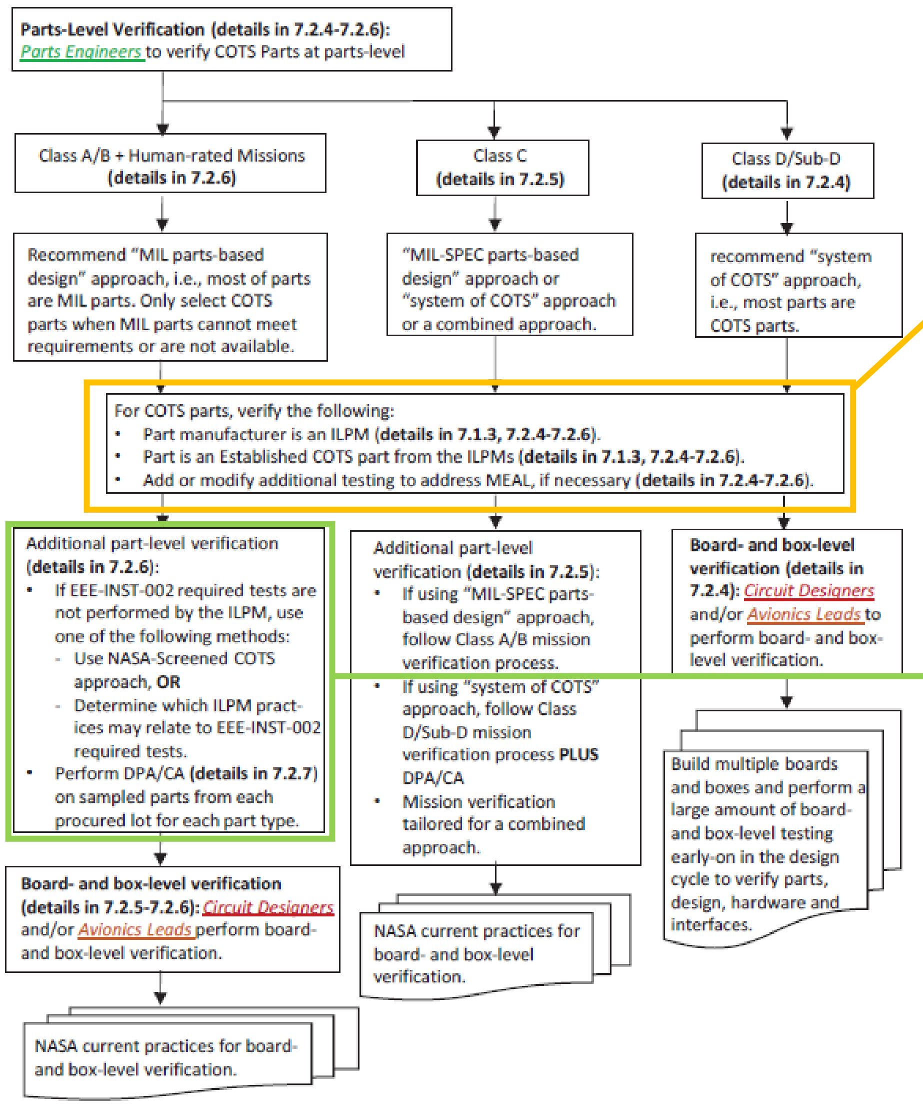
EEE Parts Assessment Flow Using the ILPM Process



Parts-Level Verification (details in 7.2.4-7.2.6):
Parts Engineers to verify COTS Parts at parts-level

Class A/B + Human-rated Missions **(details in 7.2.6)**

Class C **(details in 7.2.5)**

Class D/Sub-D **(details in 7.2.4)**

Recommend "MIL parts-based design" approach, i.e., most of parts are MIL parts. Only select COTS parts when MIL parts cannot meet requirements or are not available.

"MIL-SPEC parts-based design" approach or "system of COTS" approach or a combined approach.

recommend "system of COTS" approach, i.e., most parts are COTS parts.

For COTS parts, verify the following:
- Part manufacturer is an ILPM (**details in 7.1.3, 7.2.4-7.2.6**).
- Part is an Established COTS part from the ILPMs (**details in 7.1.3, 7.2.4-7.2.6**).
- Add or modify additional testing to address MEAL, if necessary (**details in 7.2.4-7.2.6**).

Additional part-level verification **(details in 7.2.6)**:
- If EEE-INST-002 required tests are not performed by the ILPM, use one of the following methods:
  - Use NASA-Screened COTS approach, **OR**
  - Determine which ILPM practices may relate to EEE-INST-002 required tests.
- Perform DPA/CA **(details in 7.2.7)** on sampled parts from each procured lot for each part type.

Additional part-level verification **(details in 7.2.5)**:
- If using "MIL-SPEC parts-based design" approach, follow Class A/B mission verification process.
- If using "system of COTS" approach, follow Class D/Sub-D mission verification process **PLUS** DPA/CA
- Mission verification tailored for a combined approach.

Board- and box-level verification (details in 7.2.4): Circuit Designers and/or Avionics Leads to perform board- and box-level verification.

Build multiple boards and boxes and perform a large amount of board- and box-level testing early-on in the design cycle to verify parts, design, hardware and interfaces.

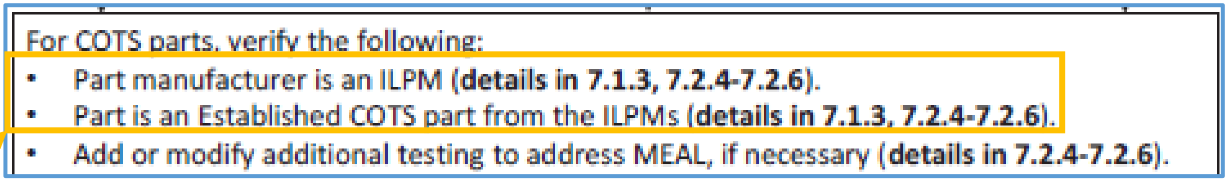
Board- and box-level verification (details in 7.2.5-7.2.6): Circuit Designers and/or Avionics Leads perform board- and box-level verification.

NASA current practices for board- and box-level verification.

NASA current practices for board- and box-level verification.

Figure 7.2-2. NESC Recommendations on Part-level Verification

NEPP ILPM Pathfinder activities are targeted here.



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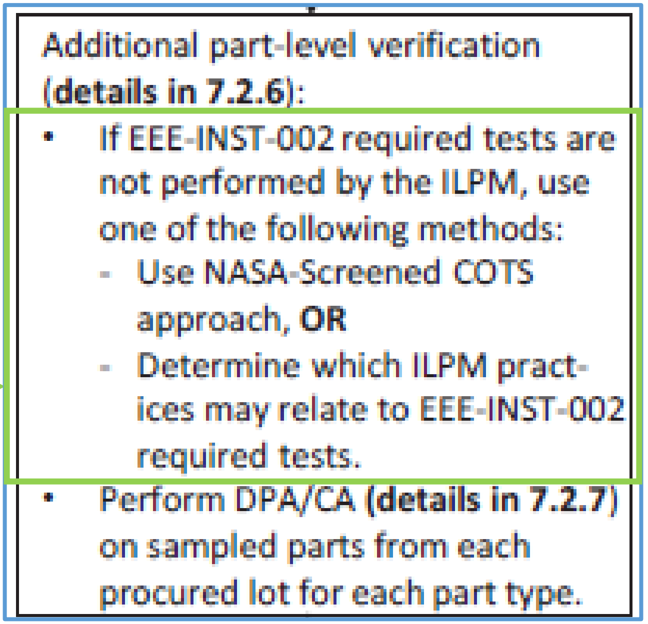

Additional part-level verification **(details in 7.2.6)**:
- If EEE-INST-002 required tests are not performed by the ILPM, use one of the following methods:
  - Use NASA-Screened COTS approach, **OR**
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- Perform DPA/CA **(details in 7.2.7)** on sampled parts from each procured lot for each part type.

Implementation of ILPM Established COTS part usage in a mission is project-driven for now. Executing at an agency-level is best.

NASA-STD-8739.11

- NASA Standard – Applicable to NASA Headquarters, Centers, JPL, contractors,... IAW contracts...
- 4 Assurance Levels
- 24 Device Specific Sections
- Includes MIL-Spec Plastic Encapsulated Classes
- Does not include technology specific electrical testing
- Lot Acceptance Testing vice Qualification
- No Screening Tests for AL 4
- No LAT Testing for AL 3 & 4

Sections (new in red)

LIST OF SECTIONS

Notes from adjudication of comments

- Evident of meticulous review
- Over 900 comments
- Not adding tests to raise “Class B” to “Class B+”
  - X-ray, PIND
- Not limiting method of hermetic testing.
- Includes reference to ILPM requirements
- Adding an option row for AEC-Q qualified devices for different data elements from manufacturer

NASA-STD-8739.11 AEC-Q Plan

New update to separate automotive (AEC-Q) parts from other commercial parts to specify a different set of requirements for resistors, capacitors, and plastic-encapsulated semiconductors/ICs

Guidance is needed for projects and parts engineers to understand how to implement this new methodology

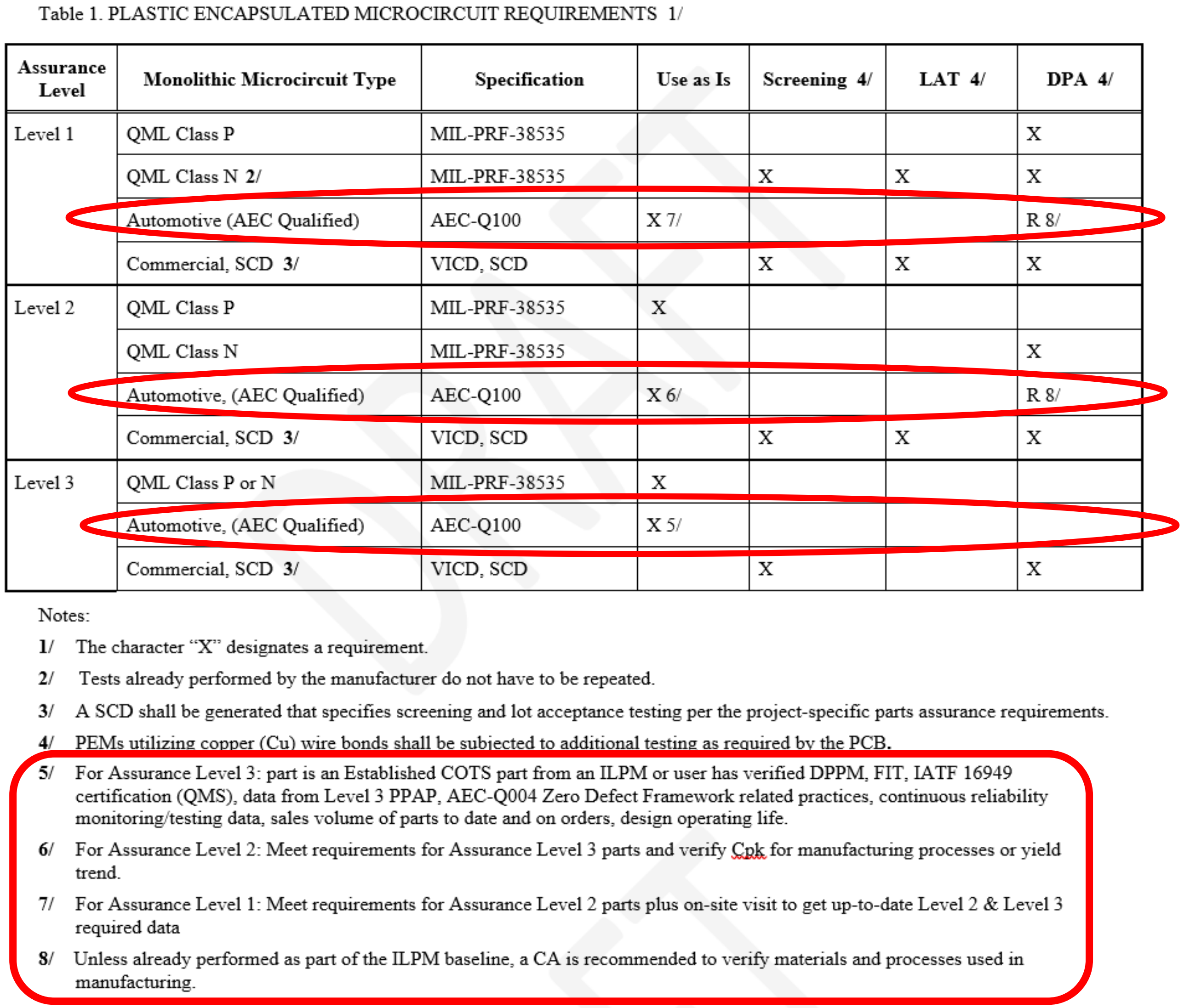

Table 1. PLASTIC ENCAPSULATED MICROCIRCUIT REQUIREMENTS 1/

Assurance Level	Monolithic Microcircuit Type	Specification	Use as Is	Screening 4/	LAT 4/	DPA 4/
Level 1	QML Class P	MIL-PRF-38535				X
	QML Class N 2/	MIL-PRF-38535		X	X	X
	Automotive (AEC Qualified)	AEC-Q100	X 7/			R 8/
	Commercial, SCD 3/	VICD, SCD		X	X	X
Level 2	QML Class P	MIL-PRF-38535	X			
	QML Class N	MIL-PRF-38535				X
	Automotive, (AEC Qualified)	AEC-Q100	X 6/			R 8/
	Commercial, SCD 3/	VICD, SCD		X	X	X
Level 3	QML Class P or N	MIL-PRF-38535	X			
	Automotive, (AEC Qualified)	AEC-Q100	X 5/			
	Commercial, SCD 3/	VICD, SCD		X		X

Notes:

1/ The character "X" designates a requirement.

2/ Tests already performed by the manufacturer do not have to be repeated.

3/ A SCD shall be generated that specifies screening and lot acceptance testing per the project-specific parts assurance requirements.

4/ PEMs utilizing copper (Cu) wire bonds shall be subjected to additional testing as required by the PCB.

5/ For Assurance Level 3: part is an Established COTS part from an ILPM or user has verified DPPM, FIT, IATF 16949 certification (QMS), data from Level 3 PPAP, AEC-Q004 Zero Defect Framework related practices, continuous reliability monitoring/testing data, sales volume of parts to date and on orders, design operating life.

6/ For Assurance Level 2: Meet requirements for Assurance Level 3 parts and verify Cpk for manufacturing processes or yield trend.

7/ For Assurance Level 1: Meet requirements for Assurance Level 2 parts plus on-site visit to get up-to-date Level 2 & Level 3 required data

8/ Unless already performed as part of the ILPM baseline, a CA is recommended to verify materials and processes used in manufacturing.

Send email to address below for questions

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