



AEROSPACE RECOMMENDED PRACTICE

ARP7495™

Issued

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Methods to Address Specific Issues Related to COTS Electronic Components in Airborne Electronic Hardware

RATIONALE

Use of commercial-off-the-shelf (COTS) electronic components is a necessity for airborne electronic hardware (AEH) in aerospace systems; but most COTS components are not designed or intended for long-life, safety-critical, or rugged-environment applications such as AEH. This presents challenges for the design, production, support, and certification of AEH systems. Although COTS hardware can have significant impacts on aerospace electronic system design, reliability assessment, quality, testing, production or support, there is no currently-agreed-upon method to assess those impacts in the certification process. This document describes an aerospace industry consensus process to do so, with respect to 12 specific COTS-related issues, as described in DOT/FAA/TC-16/57. For each of the 12 issues, this document contains (1) a brief description of the issue, (2) aerospace industry consensus processes to assure that the issue has been addressed adequately in the system design, and (3) acceptable artifacts to verify that the issue has been addressed adequately in the system design.

INTRODUCTION

This Aerospace Recommended Practice (ARP - see Definitions) describes practices that may support design and airworthiness assessment of AEH containing COTS electrical, electronic, and electromechanical (EEE) components, hereinafter called COTS components. It identifies and addresses COTS hardware issues that can impact airworthiness.

This ARP is based on industry best practices for use of COTS components in AEH; it does not distinguish among complexity levels of components, or assurance levels of hardware.

This document describes artifacts, based on aerospace industry standards, that may be used as evidence that the specific COTS component issues, defined in this document, have been addressed in the system design.

1. SCOPE

This ARP is not a certification document; it contains no certification requirements beyond those already contained in existing certification documents. The purpose of this ARP is to provide more detailed descriptions of the 12 hardware-related COTS issues listed in Appendix B, and to provide recommendations on existing practices, processes, and methods to address them. This ARP also describes artifacts that may be used as evidence that the issues have been addressed. The recommended practices and artifacts may be used to facilitate communication between, for example, the provider and the user of the avionics systems into which COTS components are integrated, or between the applicant for certification and the certification body.

This ARP does not claim that the recommended practices and artifacts described in this ARP are the only acceptable ones. They are, however, used widely today, and merit serious consideration where applicable in the avionics system design and certification processes.

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COTS components, by definition, typically have not been designed specifically for the aerospace applications or environments in which they will be used. In many cases, the design data for COTS components is limited or not available, compromising the ability of the integrator of the COTS components into aerospace systems to fully assess their functions and failure modes, and consequently their impact on the system performance (intended and unintended) and safety. Nevertheless, the organization that integrates COTS components into avionics systems is responsible to assure that the system is functional and airworthy.

The avionics system design and development process, therefore, needs to take into account the use of COTS components, and the evidence and artifacts that are produced and used to demonstrate that the implementation satisfies the allocated requirements and provides the level of confidence, consistent with airworthiness requirements.

Various methods may be considered to accomplish the above, broad categories of which include (but are not limited to):

- Design and conduct additional tests and analyses of the COTS component, beyond those conducted by its supplier, to assure that the COTS component will perform its allocated function reliably in its application;
- Modify the avionics system design to reduce operating and environmental stresses on the COTS component;
- Modify the avionics system design to provide assurance the system will perform its allocated function reliably, even if the COTS component were to fail;
- Modify the avionics system operating and maintenance practices to prevent premature failure of the avionics system; and
- Any additional practices needed by the application.

The 12 issues addressed in this ARP are likely to be relevant for the foreseeable future; however, it also is likely that additional issues will emerge, as COTS component technology continues to progress, and as avionics system reliance on their use continues to increase.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AIR6219	Development of Atmospheric Neutron Single Event Effects Analysis for Use in Safety Assessments
ARP4754	Guidelines for Development of Civil Aircraft and Systems
ARP5890	Guidelines for Preparing Reliability Assessment Plans for Electronic Engine Controls
ARP6338	Process for Assessment and Mitigation of Early Wearout of Life-Limited Microcircuits
ARP6379	Processes for Application-Specific Qualification of Electrical, Electronic, and Electromechanical Parts and Sub-Assemblies for Use in Aerospace, Defense, and High Performance Systems
AS5553	Counterfeit Electronic Parts; Avoidance, Detection, Mitigation, and Disposition

EIA-4899	Standard for Preparing an Electronic Components, Management Plan
EIA-933	Standard for Preparing a COTS Assembly Management Plan
GEIA-STD-0005-1	Performance Standard for Aerospace and High Performance Electronic Systems Containing Lead-free Solder
GEIA-STD-0008	Derating of Electronic Components
GEIA-STD-0009	Reliability Program Standard for Systems Design, Development, and Manufacturing
SAE J3168	Reliability Physics Analysis of Electrical, Electronic, and Electromechanical Equipment, Modules, and Components
SAE STD-0016	Standard for Preparing a DMSMS Management Plan

2.1.2 EUROCAE Publications

Available from EUROCAE Secretariat, 102 rue Etienne Dolet, 92240 Malakoff, France, Tel: +33 1 40 92 79 30, www.eurocae.net.

EUROCAE ED-80	An Application Guidelines to Redesign/Re-Engineering Airborne Electronic Hardware (also refer to RTCA DO-254)
EUROCAE ED-124	Integrated Modular Avionics (IMA) Development Guidance and Certification Considerations (also refer to RTCA DO-297)

2.1.3 FAA Publications

Available from Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591, Tel: 866-835-5322, www.faa.gov.

DOT/FAA/TC-16/57	Commercial Off-The-Shelf Airborne Electronics Hardware Issues and Emerging Solutions; Authority for Expenditure No. 75 Report (originally published as the final report of Aerospace Vehicle Systems Institute (AVSI) project 75) September 2017
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2.1.4 IEC Publications

Available from IEC Central Office, 3, rue de Varembe, P.O. Box 131, CH-1211 Geneva 20, Switzerland, Tel: +41 22 919 02 11, www.iec.ch.

IEC 62402	Obsolescence Management
IEC 62239-1	Process Management for Avionics – Management Plan - Part 1: Preparation and Maintenance of an Electronic Components Management Plan
IEC TS 62239-2	Process Management for Avionics – Management Plan - Part 2: Preparation and Maintenance of an Electronic COTS Assembly Management Plan
IEC TR 62240-1	Process Management for Avionics - Electronic Components Capability in Operation - Part 1: Temperature Upgrading
IEC TR 62240-2	Process Management for Avionics - Electronic Components Capability in Operation - Part 2: Semiconductor Microcircuit Lifetime

IEC 62396 series on atmospheric radiation. This series includes eight IEC standards that comprehensively address the issue of atmospheric radiation.

IEC TR 62396-7	Process Management for Avionics - Atmospheric Radiation Effects - Part 7: Management of Single Event Effects (SEE) Analysis Process in Avionics Design
IEC TS 62647-1	Process Management for Avionics - Aerospace and Defence Electronic Systems Containing Lead-free Solder - Part 1: Preparation for a Lead-free Control Plan
IEC 62668-1	Process Management for Avionics - Counterfeit Prevention - Part 1: Avoiding the Use of Counterfeit, Fraudulent and Recycled Electronic Components

2.1.5 IEEE Publications

Available from IEEE Operations Center, 445 and 501 Hoes Lane, Piscataway, NJ 08854-4141, Tel: 732-981-0060, www.ieee.org.

IEEE 1413	A Standard for Reliability Predictions
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2.1.6 JEDEC Publications

JEDEC JEP 149	Application Thermal Derating Methodologies
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2.1.7 RTCA Publications

Available from RTCA, Inc., 1150 18th Street, NW, Suite 910, Washington, DC 20036, Tel: 202-833-9339, www.rtca.org.

RTCA DO-160	Environmental Conditions and Test Procedures for Airborne Equipment
RTCA DO-254	An Application Guidelines to Redesign/Re-Engineering Airborne Electronic Hardware (also refer to EUROCAE ED-80)
RTCA DO-297	Integrated Modular Avionics (IMA) Development Guidance and Certification Considerations

2.1.8 U.S. Government Publications

Copies of these documents are available online at <https://quicksearch.dla.mil>.

MIL-HDBK-338	Military Handbook: Electronic Reliability Design Handbook
MIL-HDBK-454	Military Handbook: General Guidelines for Electronic Equipment
MIL-STD-3018	Department of Defense Standard Practice: Parts Management

2.2 Definitions

ACCREDITED THIRD PARTY: A nationally- or regionally-recognized organization that is competent to test and certify that another organization's products or processes are compliant to specific requirements, behave ethically, and employ suitable quality assurance.

ARTIFACT: An item produced for the purpose of verifying that a given issue has been addressed in an AEH system design.

AEROSPACE RECOMMENDED PRACTICES (ARP): Documentations of practice, procedures, and technology that are intended as guides to standard engineering practices; may be of a more general nature or propound data that have not yet gained broad acceptance (SAE definition).

COTS ASSEMBLY: An EEE assembly developed by a supplier for multiple customers, whose design, qualification, and configuration are controlled by the supplier's or an industry specification (example: an electronic printed wiring assembly).

COTS COMPONENT (*as used in this document*): An EEE piece part, sub-assembly, or assembly¹.

COTS COMPONENT INTEGRATOR: The organization that integrates a COTS component into an AEH system.

COTS PIECE PART: An EEE device that cannot be disassembled, and still maintain its design or function.

COTS SUB-ASSEMBLY: A smaller EEE assembly that may be integrated into a larger assembly (Example: a hybrid integrated circuit that is mounted on a printed wiring assembly).

2.3 Abbreviations

AEH	Airborne Electronic Hardware
CAMP	COTS Assembly Management Plan
CMOS	Complementary Metal Oxide Semiconductor
COTS	Commercial-Off-The-Shelf
ECMP	Electronic Component Management Plan
EEE	Electrical, Electronic, Electro-Mechanical
LLM	Life-Limited Microcircuits
SEE	Single Event Effects
VME	Virtual Machine Environment

3. APPLICABILITY

This ARP is applicable primarily to evaluating the likelihood of occurrence, and the effects, of failure mechanisms in COTS EEE components, that result from degradation of material properties or accumulated damage, sufficient to impact the functional outputs of the system over its expected lifetime. It is intended to aid in providing system-level information about the use of COTS components, to support the design and airworthiness of the given system. It is intended for use in airborne electronic hardware, and it also may be used in other electronic systems in the aerospace, defense, automotive, and other high performance (ADHP) applications.

4. BACKGROUND

Use of COTS components in AEH is a necessity for aerospace vehicle design, development production, and support, but most COTS components are not designed or intended for long-life, safety-critical, or rugged-environment applications such as AEH. This presents challenges for the design, development, production, and certification of AEH systems.

To identify, document, and address the challenges, the Aerospace Vehicle Systems Institute (AVSI) conducted a project, designated as Authority for Expenditure (AFE) project 75, to (1) define critical issues related to COTS components in AEH; and, for each issue, (2) discuss its relationship to airborne system design, development, safety, and certification, (3) assess existing industry activity and resources to address it, (4) describe the technology weakness or deficiency, (5) describe the process weakness or deficiency, and (6) recommend desired outcomes. The results of this project are detailed in document number DOT/FAA/TC-16/57 (see References).

¹ It is acknowledged that the term “component” can have many meanings, according to the context of its use; and that there is no generally accepted definition that can be used in all contexts. Thus, the definition here may be limited to this and similar documents.