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Space systems — Cube satellites (CubeSats)

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Contents

Page

Foreword

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This document was prepared by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 14, *Space systems and operations*.

Introduction

Recent years have seen an increase in the number of student satellites developed at universities around the world. To date, most university satellites require several years to develop and significant financial resources, making them prohibitive for small programs. New technological developments in small low-power electronics make smaller, lower-cost satellites feasible.

The CubeSat program has developed a picosatellite standard that significantly reduces the cost and development time of picosatellites with a specific form factor. In addition, CubeSats can serve as platforms for in-space experimentation, as well as a means of space-qualifying future small-satellite hardware.

The CubeSat Standard is an evolution of the picosatellites developed for Stanford's OPAL mission. CubeSats are constrained to a 100 mm cube (not including deployment interface rails) with a mass of one kilogram or less. Led by Stanford University's Space Systems Development Lab (SSDL), the CubeSat project is developed jointly by universities and industry worldwide. Within this international community CubeSat developments at the California Polytechnic State University (CalPoly) have been twofold: first, develop the standardized launcher-interface/deployer mechanism for CubeSats, and second, demonstrate the feasibility of developing a working CubeSat using low-cost, commercial off-the-shelf components. The project involves a multidisciplinary team of software, aerospace, manufacturing, electrical, and mechanical engineering undergraduate students.

In recent years, more sophisticated capabilities have been demonstrated in CubeSats by major space corporations and major space customers. CubeSat concepts for inclusion in Mars exploration are in development. Entire companies have been established to solely support the global CubeSat marketplace.

Space systems — Cube satellites (CubeSats)

1 Scope

This document addresses CubeSats, CubeSat Deployer and related verification of assurance/quality terms and metrics.

This document defines a unique class of picosatellite, the CubeSat. CubeSats are ideal as space development projects for universities around the world. In addition to their significant role in educating space scientists and engineers, CubeSats provide a low-cost platform for testing and space qualification of the next generation of small payloads in space. A key component of the project is the development of a standard CubeSat Deployer.

This Deployer is capable of releasing a number of CubeSats as secondary payloads on a wide range of launchers. The standard Deployer requires all CubeSats to conform to common physical requirements, and share a standard Deployer interface. CubeSat development time and cost can be significantly reduced by the development of standards that are shared by a large number of spacecraft.

Normative control of the CubeSat design, qualification and acceptance testing is generally applied from other small satellite specific standards with the exception of CubeSat/Deployer launch environment test.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 14620-1, *Space systems — Safety requirements — Part 1: System safety*

ISO 24113, *Space systems — Space debris mitigation requirements*

3 Terms and definitions

3.1
CubeSat
picosatellite measuring 100 mm cubic and weighing 1,33 kg or less

Note 1 to entry: Variations on the basic form factor are also considered CubeSats.

3.2
deployer
encloses CubeSats within a confined volume with a lid at one side that closes the ejection port during the launch phase

Note 1 to entry: It is capable of carrying one or multiple standard CubeSats and serves as the interface between the CubeSats and launch vehicle.

3.3
P-POD
Poly Picosatellite Orbital Deployer
example of a CubeSat Deployer

Note 1 to entry: In recognition of the original design by the California Polytechnic State University – Cal Poly.

Note 2 to entry: The P-POD is Cal Poly's standardized CubeSat deployment system. It is capable of carrying three standard CubeSats.

3.4
single CubeSat
single 100 mm CubeSat

Note 1 to entry: Singe CubeSat is also described as “1U”.

3.5
triple CubeSat
common three CubeSat configuration, where it is three CubeSats long connected along the longitudinal axis

Note 1 to entry: Triple CubeSat is also described as “3U”.

4 Abbreviated terms

CVCM	Collected Volatile Condensable Mass
FCC	Federal Communication Commission
IARU	International Amateur Radio Union
LV	Launch Vehicle
P/N	Part Number
P-POD	Poly Picosatellite Orbital Deployer
RBF	Remove Before Flight
RF	Radio Frequency
STD	Standard
TML	Total Mass Loss
U	Used with a number [e.g. 1U (see 3.4), 3U (see 3.5)] to denote CubeSat units

5 CubeSat requirements

5.1 General requirements

5.1.1 All parts shall remain attached to the CubeSat during the launch phase, ejection, and operation to ensure safety (see ISO 14620-1). No additional space debris shall be created (see ISO 24113).

5.1.2 Pyrotechnics shall not be permitted.

5.1.3 Propulsion systems shall have at least three inhibits to activation.

5.1.4 Total stored chemical energy shall not exceed 100 Watt-hours.

5.1.5 CubeSat materials shall satisfy the following out-gassing criterion to prevent contamination of other spacecraft during integration, testing and launch.

NOTE A list of NASA approved out-gassing materials can be found at http://outgassing.nasa.gov.

5.1.5.1 Total Mass Loss (TML) shall be <1,0 %.

5.1.5.2 Collected Volatile Condensable Material (CVCM) shall be <0,1 %.

5.1.6 The CubeSat shall be designed to accommodate ascent venting per ventable volume/area <50 800 mm (Note: derived from 2000 inches).

5.2 CubeSat mechanical requirements: External dimensions

5.2.1 The CubeSat shall use the coordinate system as defined in Figure 1 for single CubeSat, and Figure 2 for triple CubeSat.

5.2.2 The Z-face of the CubeSat will be inserted first into the Deployer.

5.2.3 The single CubeSat configuration and physical dimensions shall be per Figure 1, the triple CubeSat per Figure 2.

5.2.4 The CubeSat shall be 100,0 mm ± 0,1 mm wide (X and Y dimensions per Figure 1).

5.2.5 A single CubeSat shall be 113,5 mm ± 0,1 mm tall (Z dimension per Figure 1).

5.2.5.1 A triple CubeSat shall be 340,5 mm ± 0,3 mm tall (Z dimension per Figure 2).

5.2.6 All components shall not exceed 6,5 mm normal to the surface of the 100,0 mm cube.

5.2.7 Exterior CubeSat components shall not contact the interior surface of the Deployer other than the designated CubeSat rails.

5.2.8 Deployable items shall be constrained by the CubeSat. The Deployer rails and walls shall not be used to constrain deployable items.

5.2.9 The rails shall have a minimum width of 8,5 mm.

5.2.10 The rails shall have a surface roughness less than 1,6 µm.