भारतीय मानक

Indian Standard

IS 18891 : 2024
ISO 17770 : 2017

अंतरिक्ष पद्धतियां — घन उपग्रह (क्यूबसैट)

Space Systems — Cube Satellites (CubeSats)

ICS 49.140

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Air and Space Vehicles Sectional Committee, TED 14

NATIONAL FOREWORD

This Indian Standard which is identical to ISO 17770 : 2017 ‘Space systems — Cube satellites (CubeSats)’ issued by International Organization for Standardization (ISO) was adopted by the Bureau of Indian Standards on the recommendations of Air and Space Vehicles Sectional Committee and approval of the Transport Engineering Division Council.

The text of ISO standard has been approved as suitable for publication as an Indian Standard without deviations. Certain terminologies and conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words ‘International Standard’ appear referring to this standard, they should be read as ‘Indian Standard’; and

b) Comma (,) has been used as a decimal marker, while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to certain International Standard for which Indian Standard also exists. The corresponding Indian Standard, which is to be substituted in its respective place, is listed below along with its degree of equivalence for the edition indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
ISO 14620-1 Space systems — Safety requirements — Part 1: System safety	IS 18328 (Part 1) : 2023/ISO 14620-1: 2018 Space systems — Safety requirements: Part 1 System safety	Identical

The Committee has reviewed the provisions of following International Standard referred in this adopted standard and has decided that it is acceptable for use in conjunction with this standard:

International Standard	*Title*
ISO 24113	Space systems — Space debris mitigation requirements

Attention is drawn to the possibility that some of the elements of this standard may be the subject of patent rights. The Bureau of Indian Standards shall not be held responsible for identifying any or all such patent rights.

This standard also makes a reference to the BIS certification marking of the product, details of which is given in National Annex A.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 2022 ‘Rules for rounding off numerical values (*second revision*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Contents

Page

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.

Indian Standard

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.

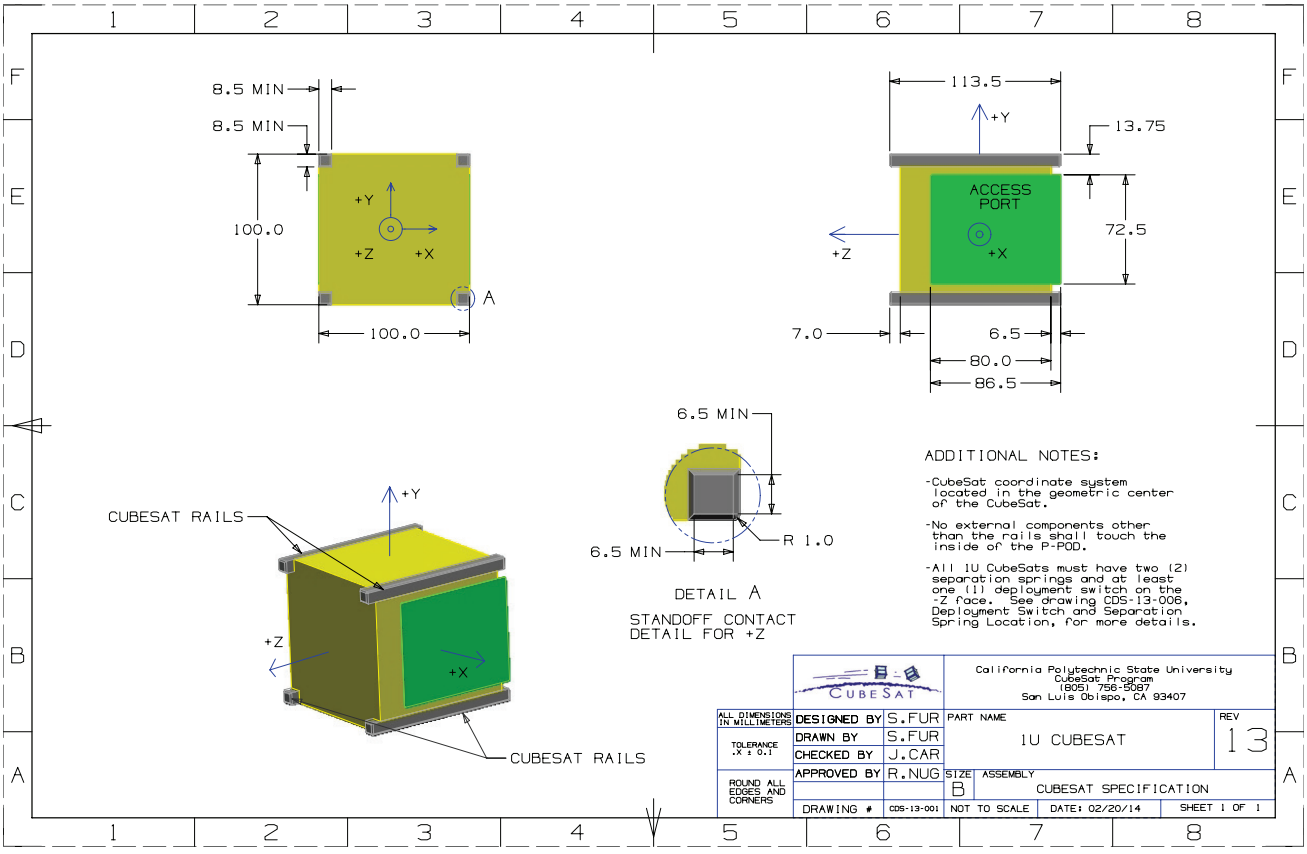

Figure 1 — Single CubeSat

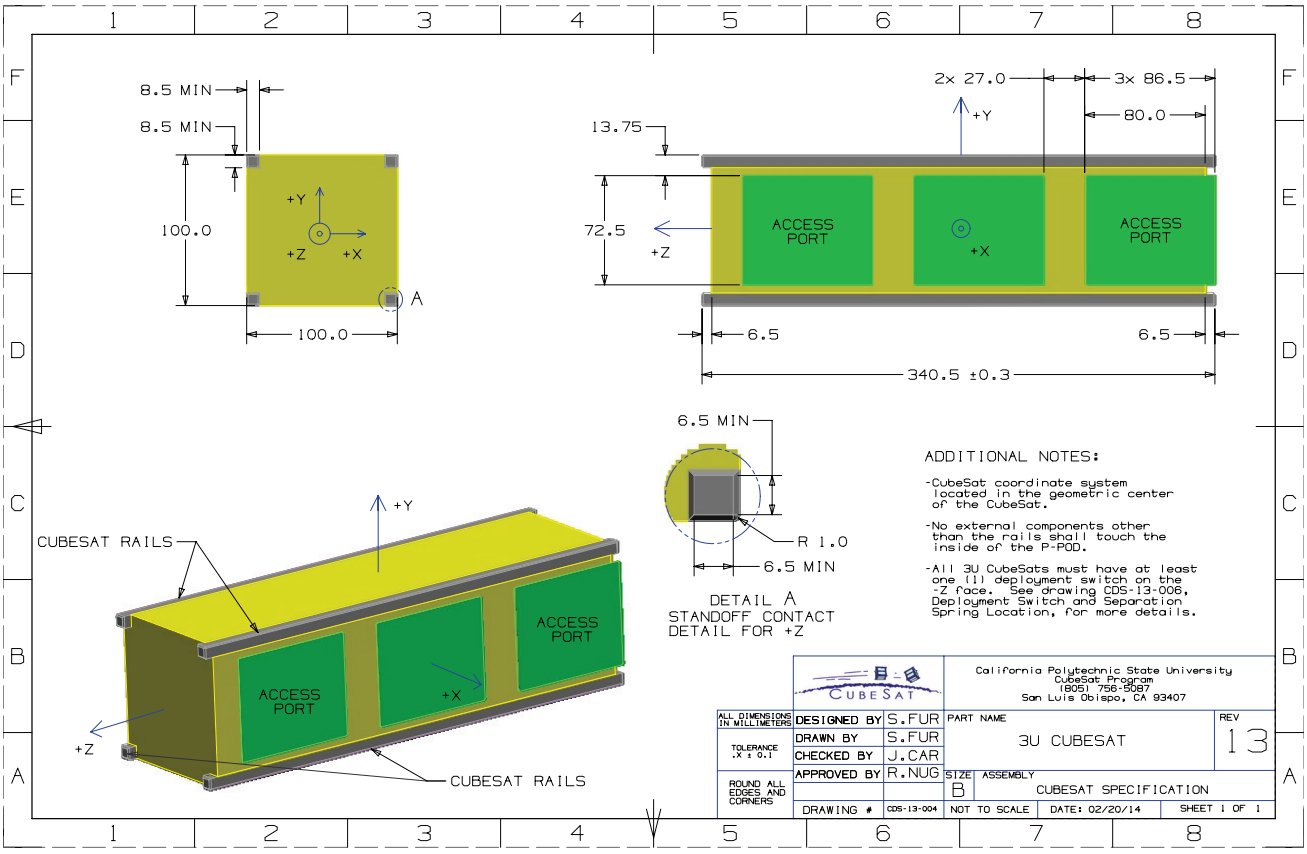

Figure 2 — Triple CubeSat

5.2.11 The edges of the rails shall be rounded to a radius of at least 1 mm.

5.2.12 The ends of the rails on the +Z face shall have a minimum surface area of 6,5 mm × 6,5 mm contact area for neighbouring CubeSat rails (as per Figure 1).

5.2.13 At least 75 % of the rail shall be in contact with the Deployer rails. 25 % of the rails may be recessed and no part of the rails shall exceed the requirement.

5.3 CubeSat mechanical requirements: Mass

5.3.1 Each single CubeSat shall not exceed 1,33 kg.

5.3.2 Each triple CubeSat shall not exceed 4,00 kg.

5.3.3 The CubeSat centre of gravity shall be located within a sphere of 2 cm from its geometric centre in the X and Y direction.

5.3.3.1 The 1U CubeSat centre of gravity shall be located within 2 cm from its geometric centre in the Z direction.

5.3.3.2 The 3U CubeSat centre of gravity shall be located within 7 cm from its geometric centre in the Z direction.

5.4 CubeSat mechanical requirements: Materials

5.4.1 The main CubeSat structure and the rails shall be made from aluminium materials in Table 1. Reference [2] contains other national designations for these materials.

Table 1 — Equivalent designations for allowed material

ASTM/EN AW	GOST	ISO
7075	1950/V95	AlZn5.5MgCu
6061	1330/AD33	AlMg1SiCu
5052	AMg	AlMg2.5
5005	1510/AMg1	AlMg1

5.4.2 The CubeSat rails and standoff, which contact the Deployer rails and adjacent CubeSat standoffs, shall be hard anodized aluminium to prevent any cold welding within the Deployer.

5.4.3 The CubeSat shall use separation springs with characteristics defined in Table 2 on the designated rail standoff. The separation springs provide relative separation between CubeSats after deployment from the Deployer.

Table 2 — Separation spring characteristics

Characteristics	Value
Plunger Material	Stainless Steel
End Force Initial/Final	2,224 N/6,672 N
Throw Length	1,27 mm minimum above the standoff surface

5.4.4 The compressed springs shall be at or below the level of the standoff.

5.4.5 Separation springs shall not be required for Triple (3U) CubeSats.

5.5 Electrical requirements

Electrical requirements shall be designed with the following safety features:

5.5.1 The CubeSat power system shall be at a power off state to prevent CubeSat from activating any powered functions while integrated in the Deployer from the time of delivery to the launch vehicle through on-orbit deployment.

5.5.2 The CubeSat shall include, at a minimum, one deployment switch on the designated rail standoff (shown in Figure 1) to completely turn off satellite power once actuated. In the actuated state, the deployment switch shall be centred at or below the level of standoff.

5.5.2.1 All systems shall be turned off before the integration into Deployer and stay off until the ejection, including any real-time clocks.

5.5.3 To allow for CubeSat diagnostics and battery charging after the CubeSats have been integrated into the Deployer all CubeSat umbilical connectors shall be within the designated Access Port locations, as shown in Figure 1.

5.5.3.1 Triple CubeSats shall use the designated Access Port locations as shown in Figure 2.

5.5.4 The CubeSat shall include a Remove Before Flight (RBF) pin.

5.5.4.1 The RBF pin shall be removed from the CubeSat after integration into the Deployer.

5.5.4.2 The RBF pin shall be accessible from the Access Port location, areas shown in Figure 1.

5.5.4.2.1 Triple CubeSats shall locate their RBF pin in one of the three designated Access Port locations shown in Figure 2.

5.5.4.3 The RBF pin shall cut power to the satellite once it is inserted into the satellite.

5.5.4.4 The RBF pin shall not protrude more than 6.5 mm from the rails when it is fully inserted into the satellite.

5.5.5 CubeSats shall incorporate battery circuit protection for charging/discharging to avoid unbalanced cell conditions.

5.5.6 The CubeSat shall be designed to meet at least one of the following requirements to prohibit inadvertent radio frequency (RF) transmission. An inhibit is a physical device between a power source and a hazard. A timer is not considered an independent inhibit.

5.5.6.1 The CubeSat shall have one RF inhibit and RF power output of no greater than 1,5 W at the transmitting antenna's RF input.

5.5.6.2 The CubeSat shall have two independent RF inhibits.

5.6 Operational requirements

CubeSats need to meet requirements pertaining to integration and operation to meet legal obligations and ensure safety of other CubeSats. Additionally, LV and primary spacecraft may impose or allow

different safety requirements due to unique vehicle configurations. CubeSat standard requirements may be superseded by higher priority legal, LV or primary spacecraft requirements.

5.6.1 CubeSats mission design and hardware shall be in accordance with ISO 24113 to limit orbital debris.

5.6.2 All deployable items such as booms, antennas, and solar panels shall wait to deploy a minimum of 30 min after the CubeSat's deployments switches are activated from Deployer ejection.

5.6.3 No CubeSats shall generate or transmit any signal from the time of integration into the Deployer through 45 min after on-orbit deployment from the Deployer.

5.6.4 Operators shall obtain and provide documentation of proper licenses for use of frequencies.

5.6.4.1 For amateur frequency use, this requires proof of frequency coordination by the International Amateur Radio Union (IARU). Applications can be found at www.iaru.org.

6 Interface to the launch vehicle: The CubeSat Deployer

6.1 Enclosure

The Deployer shall enclose CubeSats with a contained volume during the launch phase and a lidded ejection port at one side.

6.2 Interface

The Deployer shall have the ability to interface with a variety of launch vehicles with minimum modifications and with no changes to the CubeSat standard requirements.

6.3 Mass

The mass of the Deployer shall be minimized.

6.4 Modularity

The Deployer shall incorporate a modular design that allows different numbers of CubeSats to be launched on any given mission.

6.5 Parts attachment

All parts shall remain attached to the Deployer during the launch phase, ejection, and operation. No additional space debris shall be created.

6.6 Release from the Deployer

The CubeSats shall be released from the Deployer with no induced spin or lateral velocity relative to the ejection vector to ensure a low probability of collision with the launch vehicle or other CubeSats.

7 CubeSat and Deployer assurance/quality verification

7.1 General

CubeSat requirements verification in this clause is required by the launch provider, at a minimum. Usually verification will include verification that the CubeSat will fit on the launch vehicle, survive the space environment and the launch environment. As is common with other spacecraft, some of

these tests may be performed on a qualification unit, with the remainder on the flight unit. Whatever verification is performed on the CubeSat flight unit, the Deployer must protect the launch vehicle and primary payload from any mechanical, electrical or electromagnetic interference from the CubeSats even in the event of a catastrophic CubeSat failure.

7.2 Random vibration

Random Vibration Testing shall be done on the CubeSat and done on the CubeSat and Deployer after integration to verify requirements as stated by the launch provider.

7.3 Thermal/Vacuum bakeout

As with spacecraft in general bakeout (thermal/vacuum) needs to be performed to ensure outgassing of CubeSat components to a level consistent with CubeSat, the launch vehicle and primary payload non-volatile residue limits. A thermal/vacuum bakeout test shall be performed on the CubeSat to verify requirements as stated by the launch provider.

7.4 Shock

Shock testing shall be done on the CubeSat to verify requirements as stated by the launch provider.

7.5 Visual inspection

Visual inspection of the CubeSat and measurement of critical areas shall be performed.

Bibliography

[1] ISO 16454, *Space systems — Structural design — Stress analysis requirements*

[2] *Worldwide Guide to Equivalent Nonferrous Metals and Alloys*. ASTM International, Fourth Edition, 2001

NATIONAL ANNEX A

(*National Foreword*)

A-1 BIS CERTIFICATION MARKING

The product(s) conforming to the requirements of this standard may be certified as per the conformity assessment schemes under the provisions of the *Bureau of Indian Standards Act*, 2016 and the Rules and Regulations framed thereunder, and the products may be marked with the Standard Mark.

Bureau of Indian Standards

BIS is a statutory institution established under the *Bureau of Indian Standards Act*, 2016 to promote harmonious development of the activities of standardization, marking and quality certification of goods and attending to connected matters in the country.

Copyright

Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the website-www.bis.gov.in or www.standardsbis.in.

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Amendments Issued Since Publication

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