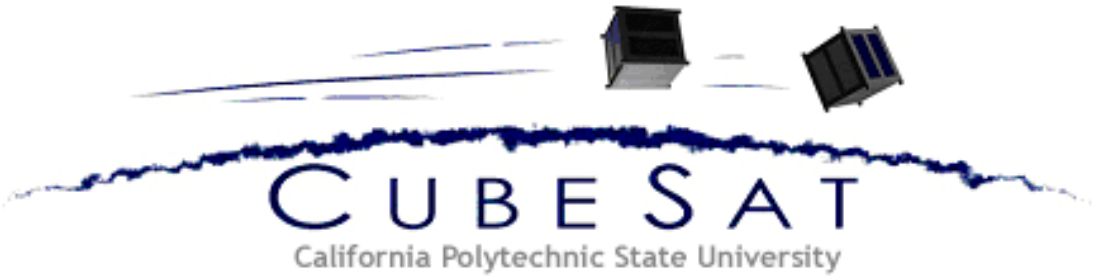
| Document Classification | |
|---|---|
| X | Public Domain |
| | ITAR Controlled |
| | Internal Only |

# CubeSat Design Specification

(CDS)



## CHANGE HISTORY LOG

| Effective Date | Revision | Author | Description of Changes |
|---|---|---|---|
| N/A | 8 | Simon Lee | N/A |
| 5/26/05 | 8.1 | Amy Hutputanasin | Formatting updated. |
| 5/15/06 | 9 | Armen Toorian | Information and presentation revised. |
| 8/2/07 | 10 | Wenschel Lan | Information updated. |
| 10/02/08 | 11 | Riki Munakata | Format, Design specification and Mk.III P-POD compatibility update. |
| 8/1/09 | 12 | Riki Munakata | Requirements update, waiver form requirements, and 3U CubeSat Specification drawing. |
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## List of Acronyms

| | |
|---|---|
| CAC | CubeSat Acceptance Checklist |
| Cal Poly | California Polytechnic State University, San Luis Obispo |
| CDS | CubeSat Design Specification |
| cm | Centimeters |
| CVCM | Collected Volatile Condensable Mass |
| DAR | Deviation Wavier Approval Request |
| FCC | Federal Communication Commission |
| GSFC | Goddard Space Flight Center |
| IARU | International Amateur Radio Union |
| kg | Kilogram |
| LV | Launch Vehicle |
| mm | Millimeters |
| mW | Milliwatt |
| NASA | National Aeronautics and Space Administration |
| P/N | Part Number |
| P-POD | Poly Picosatellite Orbital Deployer |
| RBF | Remove Before Flight |
| Rev. | Revision |
| RF | Radio Frequency |
| SLO | San Luis Obispo |
| SSDL | Space Systems Development Lab |
| STD | Standard |
| TML | Total Mass Loss |
| µm | Micrometer |

# 1. Introduction

## *1.1 Overview*

Started in 1999, the CubeSat Project began as a collaborative effort between Prof. Jordi Puig-Suari at California Polytechnic State University (Cal Poly), San Luis Obispo, and Prof. Bob Twiggs at Stanford University's Space Systems Development Laboratory (SSDL). The purpose of the project is to provide a standard for design of picosatellites to reduce cost and development time, increase accessibility to space, and sustain frequent launches. Presently, the CubeSat Project is an international collaboration of over 100 universities, high schools, and private firms developing picosatellites containing scientific, private, and government payloads. A CubeSat is a 10 cm cube with a mass of up to 1.33 kg. Developers benefit from the sharing of information within the community. If you are planning to start a CubeSat project, please contact Cal Poly. Visit the CubeSat website at http://cubesat.org for more information.

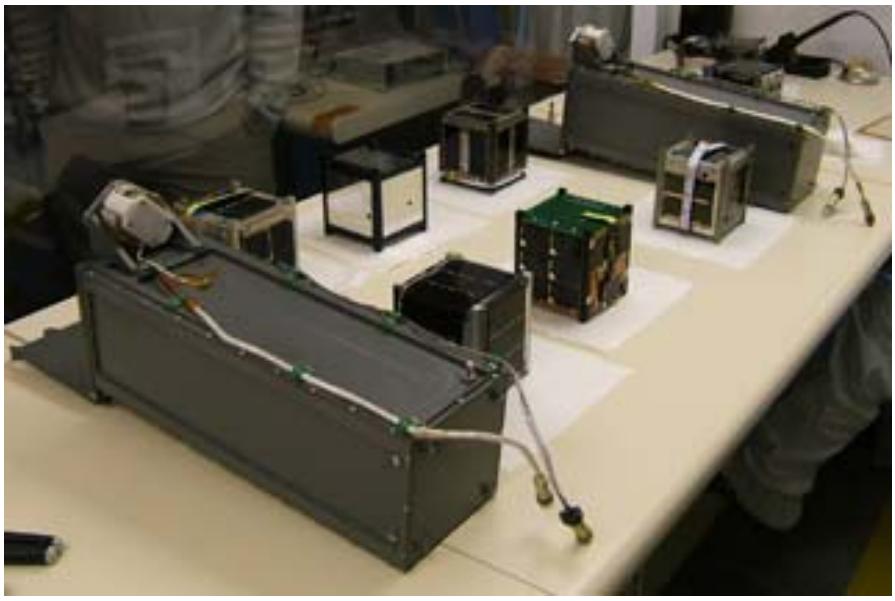

**Figure 1: Six CubeSats and their deployment systems.**

## *1.2 Purpose*

The primary mission of the CubeSat Program is to provide access to space for small payloads. The primary responsibility of Cal Poly, as the developer of the Poly Picosatellite Orbital Deployer (P-POD), is to ensure the safety of the CubeSat and protect the launch vehicle (LV), primary payload, and other CubeSats. CubeSat developers should play an active role in ensuring the safety and success of CubeSat missions by implementing good engineering practice, testing, and verification of their systems. Failures of CubeSats, the P-POD, or interface hardware can damage the LV or a primary payload and put the entire CubeSat Program in jeopardy. As part of the CubeSat Community, all participants have an obligation to ensure safe operation of their systems and to meet the design and minimum testing requirements outlined in this document. Requirements in this document may be superseded by launch provider requirements.

## *1.3 Waiver Process*

Developers shall fill out a "Deviation Waiver Approval Request (DAR)" (see appendix A) if their CubeSat is in violation of any requirements in sections 2 or 3. The waiver process is intended to be quick and easy. The intent is to help facilitate communication and explicit documentation between CubeSat developers, P-POD integrators, range safety personnel, and launch vehicle providers. This will help to better identify and address any issues that may arise prior to integration and launch. The DAR can be found at http://cubesat.atl.calpoly.edu/pages/documents/developers.php and waiver requests should be sent to standards@cubesat.org.

Upon completion of the DAR, the P-POD Integrator shall review the request, resolve any questions, and determine if there are any additional tests, analyses or costs to support the waiver. If so, the Developer, with inputs from the P-POD Integrator, shall write a Test Plan and perform the tests before the waiver is conditionally accepted by the P-POD Integrator. Waivers can only be conditionally accepted by the P-POD Integrator until a launch has been identified for the CubeSat. Once a launch has been identified, the waiver becomes mission specific and passes to the launch vehicle Mission Manager for review. The launch vehicle Mission Manager has the final say on acceptance of the waiver, and the Mission Manager may require more corrections and/or testing to be performed before approving the waiver. Developers should realize that each waiver submitted reduces the chances of finding a suitable launch opportunity.

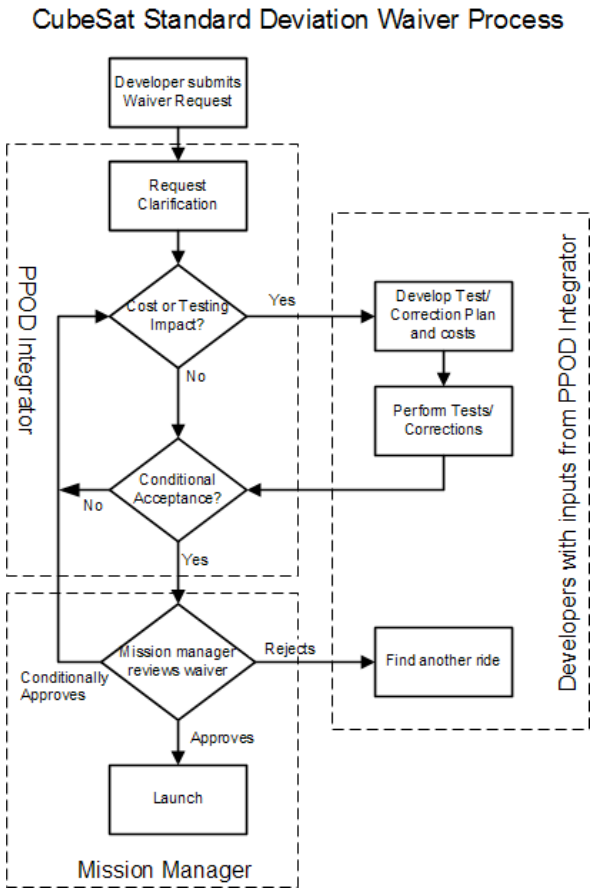


**Figure 2: CubeSat Standard Deviation Wavier Process Flow Diagram**

# Poly Picosatellite Orbital Deployer

## *1.4 Interface*

The Poly Picosatellite Orbital Deployer (P-POD) is Cal Poly's standardized CubeSat deployment system. It is capable of carrying three standard CubeSats and serves as the interface between the CubeSats and LV. The P-POD is a rectangular box with a door and a spring mechanism. Once the release mechanism of the P-POD is actuated by a deployment signal sent from the LV, a set of torsion springs at the door hinge force the door open and the CubeSats are deployed by the main spring gliding on its rails and the P-PODs rails (P-POD rails are shown in Figure 3b). The P-POD is made up of anodized aluminum. CubeSats slide along a series of rails during ejection into orbit. CubeSats shall be compatible with the P-POD to ensure safety and success of the mission, by meeting the requirements outlined in this document. The P-POD is backward compatible, and any CubeSat developed within the design specification of CDS rev. 9 and later, will not have compatibility issues. Developers are encouraged to design to the most current CDS to take full advantage of the P-POD features.

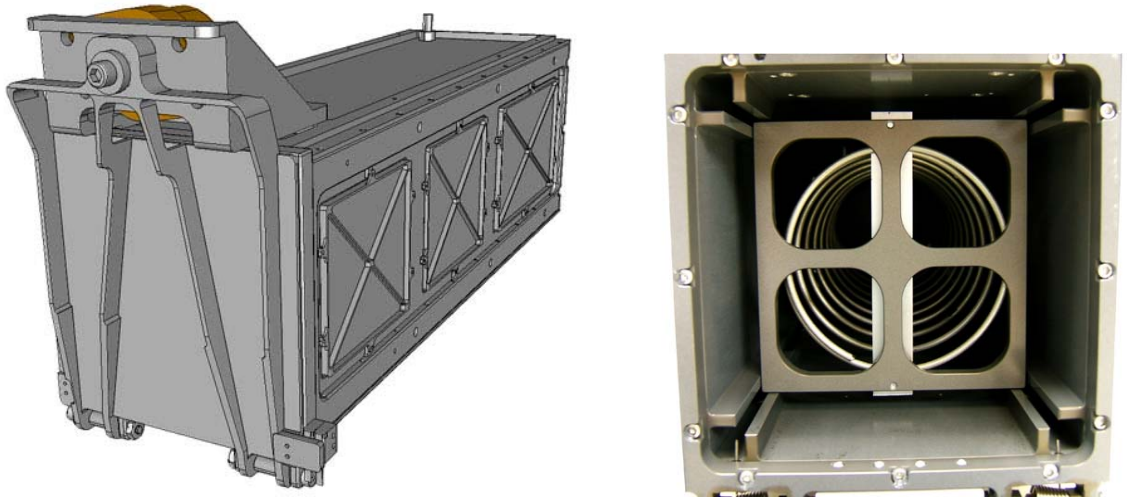

**Figure 3a and 3b: Poly Picosatellite Orbital Deployer (P-POD) and cross section**

# 2. CubeSat Specification

## *2.1 General Requirements*

2.1.1 CubeSats which incorporate any deviation from the CDS shall submit a DAR and adhere to the waiver process (see Section 1.3 and Appendix A).

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

2.1.3 Pyrotechnics shall not be permitted.

2.1.4 No pressure vessels over 1.2 standard atmosphere shall be permitted.

2.1.4.1 Pressure vessels shall have a factor of safety no less than 4.

2.1.5 Total stored chemical energy shall not exceed 100 Watt-Hours.

2.1.6 No hazardous materials shall be used on a CubeSat. Please contact us if you are unsure if a material is considered hazardous.

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

2.1.7.1 Total Mass Loss (TML) shall be $\leq$ 1.0 %

2.1.7.2 Collected Volatile Condensable Material (CVCM) shall be $\leq$ 0.1%

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

2.1.8 The latest revision of the CubeSat Design Specification shall be the official version (http://cubesat.calpoly.edu/pages/documents/developers.php), which all CubeSat developers shall adhere to.

2.1.8.1 Cal Poly shall send updates to the CubeSat mailing list upon any changes to the specification. You can sign-up for the CubeSat mailing list here: http://atl.calpoly.edu/mailman/listinfo/cubesat

## *2.2 CubeSat Mechanical Requirements*

CubeSats are cube shaped picosatellites with a nominal length of 100 mm per side. Dimensions and features are outlined in the CubeSat Specification Drawing (Figure 5). General features of all CubeSats include:

2.2.1 **Exterior Dimensions**

2.2.2 The CubeSat shall use the coordinate system as defined in Figure 5. The –Z face of the CubeSat will be inserted first into the P-POD.

2.2.3 The CubeSat configuration and physical dimensions shall be per Figure 5.

2.2.4 The CubeSat shall be 100.0$\pm$0.1 mm wide (X and Y dimensions per Figure 5).

2.2.5 A single CubeSat shall be 113.5$\pm$0.1 mm tall (Z dimension per Figure 5).

2.2.5.1 A Triple CubeSat shall be 340.5$\pm$0.3 mm tall (Z dimension per Appendix C).

2.2.6 All components shall not exceed 6.5 mm normal to the surface of the 100.0 mm cube (the green and yellow shaded sides in Figure 5).

2.2.7 Exterior CubeSat components shall not contact the interior surface of the P-POD, other than the designated CubeSat rails.

2.2.8 Deployables shall be constrained by the CubeSat. The P-POD rails and walls shall not to be used to constrain deployables.

2.2.9 Rails shall have a minimum width of 8.5mm.

2.2.10 The rails shall not have a surface roughness greater than 1.6 µm.

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

2.2.12 The ends of the rails on the +Z face shall have a minimum surface area of 6.5 mm x 6.5 mm contact area for neighboring CubeSat rails (as per Figure 5).

2.2.13 At least 75% of the rail shall be in contact with the P-POD rails. 25% of the rails may be recessed and no part of the rails shall exceed the specification.

2.2.13.1 For single CubeSats this means at least 85.1 mm of rail contact.

2.2.13.2 For triple CubeSats this means at least 255.4 mm rail contact.

2.2.14 **Mass**

2.2.15 Each single CubeSat shall not exceed 1.33 kg mass.

2.2.16 Each triple CubeSat shall not exceed 4.0 kg mass.

2.2.17 The CubeSat center of gravity shall be located within a sphere of 2 cm from its geometric center.

2.2.18 **Materials**

2.2.19 Aluminum 7075 or 6061 shall be used for both the main CubeSat structure and the rails. If other materials are used the developer shall submit a DAR and adhere to the waiver process.

2.2.20 The CubeSat rails and standoff, which contact the P-POD rails and adjacent CubeSat standoffs, shall be hard anodized aluminum to prevent any cold welding within the P-POD.

2.2.21 The CubeSat shall use separation springs (Figure 4) with characteristics defined in Table 1 on the designated rail standoff. Separation springs with characteristics can be found using McMaster Carr P/N 84985A76. The separation springs provide relative separation between CubeSats after deployment from the P-POD.

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

2.2.21.2 The throw length of the separation spring shall be a minimum of 0.05 inches above the standoff surface.

2.2.21.3 Separation springs are not required for 3U CubeSats.

**Table 1: CubeSat Separation Spring Characteristics**

| **Characteristics** | ***Value*** |
|---|---|
| Plunger Material | *Stainless Steel* |
| End Force Initial/Final | *0.5 lbs. / 1.5 lbs.* |
| Throw Length | *0.05 inches minimum above the standoff surface* |

**Figure 4: Spring Plunger**

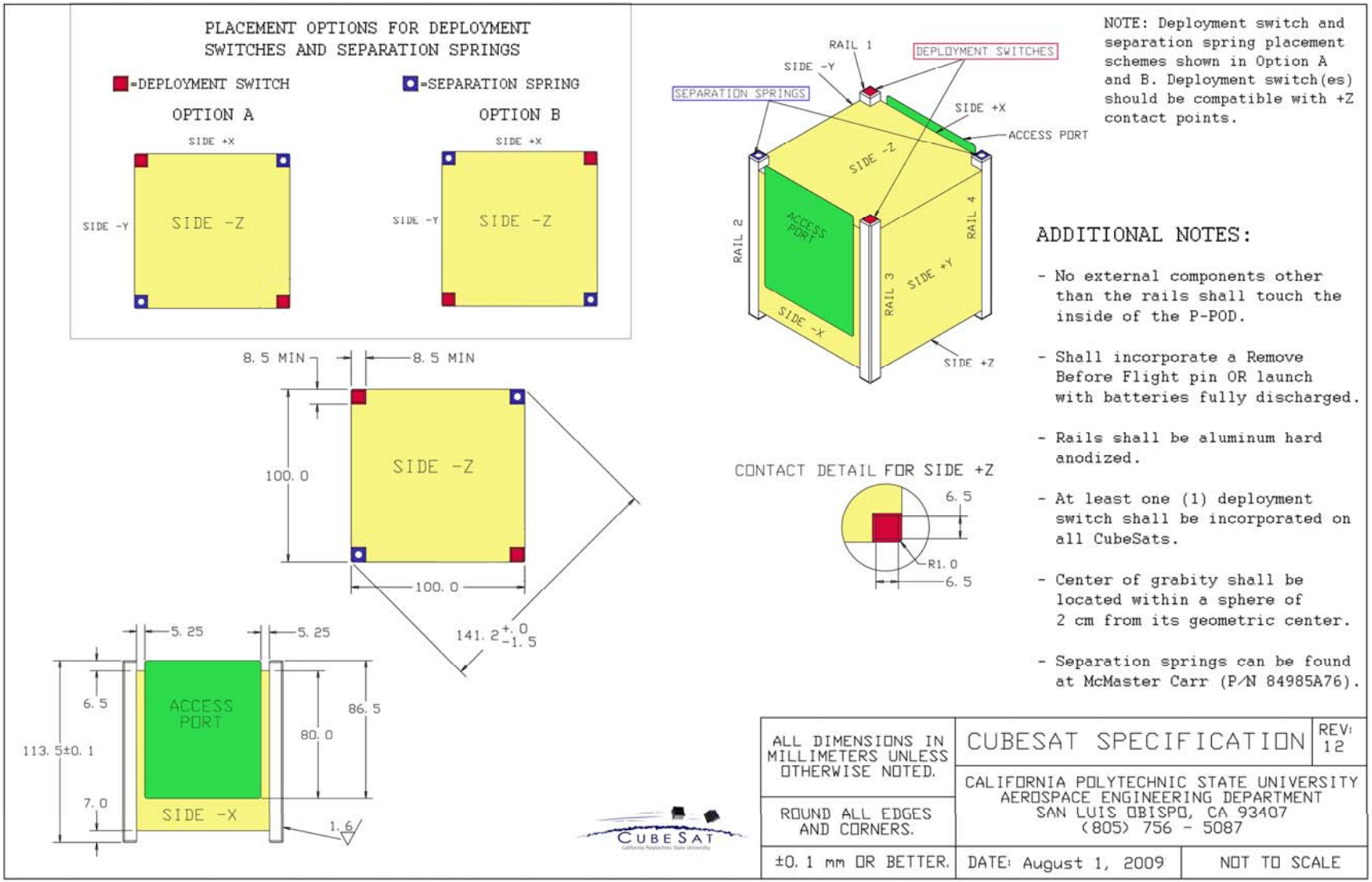


**Figure 5: CubeSat Design Specification Drawing**

## *2.3 Electrical Requirements*

Electronic systems shall be designed with the following safety features.

2.3.1 No electronics shall be active during launch to prevent any electrical or RF interference with the launch vehicle and primary payloads. CubeSats with batteries shall be fully deactivated during launch or launch with discharged batteries.

2.3.2 The CubeSat shall include at least one deployment switch on the designated rail standoff (shown in Figure 5) to completely turn off satellite power once actuated. In the actuated state, the deployment switch shall be centered at or below the level of the standoff.

2.3.2.1 All systems shall be turned off, including real time clocks.

2.3.3 To allow for CubeSat diagnostics and battery charging after the CubeSats have been integrated into the P-POD all CubeSat umbilical connectors shall be within the designated Access Port locations, green shaded areas shown in Figure 5.

2.3.3.1 Triple CubeSats shall use the designated Access Port locations (green shaded areas) show in Appendix C.

2.3.3.2 Note: CubeSat deployment switch shall be depressed while inside the P-POD. All diagnostics and battery charging shall be done while the deployment switch is depressed.

2.3.4 The CubeSat shall include a Remove Before Flight (RBF) pin or launch with batteries fully discharged. The RBF pin shall be removed from the CubeSat after integration into the P-POD.

2.3.4.1 The RBF pin shall be accessible from the Access Port location, green shaded areas shown in Figure 5.

2.3.4.1.1 Triple CubeSats shall locate their RBF pin in one of the 3 designated Access Port locations (green shaded areas) show in Appendix C.

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

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

## *2.4 Operational Requirements*

CubeSats shall meet certain requirements pertaining to integration and operation to meet legal obligations and ensure safety of other CubeSats.

2.4.1 CubeSats with batteries shall have the capability to receive a transmitter shutdown command, as per Federal Communications Commission (FCC) regulation.

2.4.2 All deployables such as booms, antennas, and solar panels shall wait to deploy a minimum of 30 minutes after the CubeSat's deployment switch(es) are activated from P-POD ejection.

2.4.3 RF transmitters greater than 1 mW shall wait to transmit a minimum of 30 minutes after the CubeSat's deployment switch(es) are activated from P-POD ejection.

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

2.4.4.1 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.

2.4.5 The orbital decay lifetime of the CubeSats shall be less than 25 years after end of mission life.

2.4.5.1 Developers shall obtain and provide documentation of approval of an orbital debris mitigation plan from the FCC or local agency.

2.4.6 Cal Poly shall conduct a minimum of one fit check in which developer hardware shall be inspected and integrated into the P-POD. A final fit check shall be conducted prior to launch. The CubeSat Acceptance Checklist (CAC) shall be used to verify compliance of the specification (Appendix B for single CubeSats and Appendix D for triple CubeSats).

# 3. Testing Requirements

Testing shall be performed to meet all launch provider requirements as well as any additional testing requirements deemed necessary to ensure the safety of the CubeSats and the P-POD. If launch vehicle environment is unknown, GSFC-STD-7000 (http://standards.gsfc.nasa.gov/gsfc-std/gsfc-std-7000.pdf) shall be used to derive testing requirements. GSFC-STD-7000 is a useful reference when defining testing environments, however the test levels defined in GSFC-STD-7000 are not guaranteed to encompass or satisfy all LV testing environments. Test plans that are not generated by the launch provider or P-POD Integrator are considered to be unofficial. Requirements derived in this document may be superseded by launch provider requirements. All flight hardware shall undergo protoflight and acceptance testing. The P-PODs shall be tested in a similar fashion to ensure the safety and workmanship before integration with the CubeSats. At the very minimum, all CubeSats shall undergo the following tests.

## *3.1 Random Vibration*

Random vibration testing shall be performed as defined by LV provider, or if unknown, GSFC-STD-7000.

## *3.2 Thermal Vacuum Bakeout*

Thermal vacuum bakeout shall be performed to ensure proper outgassing of components. The test cycle and duration will be outlined by LV provider, or if unknown, GSFC-STD-7000.

## *3.3 Visual Inspection*

Visual inspection of the CubeSat and measurement of critical areas shall be performed per the 1U CAC (Appendix B) or 3U CAC (Appendix D) as appropriate.

## *3.4 Qualification*

CubeSats may be required to survive qualification testing as outlined by the LV provider. If LV environments are unknown, GSFC-STD-7000 (NASA GEVS). Qualification testing will be performed at developer facilities. In some circumstances, Cal Poly can assist developers in finding testing facilities or provide testing for the developers. **Additional**

**testing may be required if modifications or changes are made to the CubeSats after qualification testing.**

### *3.5 Protoflight*

All CubeSats shall survive protoflight testing as outlined by the LV provider. If LV environments are unknown, GSFC-STD-7000. Protoflight testing will be performed at developer facilities. In some circumstances, Cal Poly can assist developers in finding testing facilities or provide testing for the developers. CubeSats **SHALL NOT** be disassembled or modified after protoflight testing. Disassembly of hardware after protoflight testing shall require the developer to submit a DAR and adhere to the waiver process prior to disassembly. **Additional testing shall be required if modifications or changes are made to the CubeSats after protoflight testing.**

### *3.6 Acceptance*

After delivery and integration of the CubeSats into the P-POD, additional testing shall be performed with the integrated system. This test ensures proper integration of the CubeSats into the P-POD. Additionally, any unknown, harmful interactions between CubeSats may be discovered during acceptance testing. The P-POD Integrator shall coordinate and perform acceptance testing. After acceptance testing, developers may perform diagnostics through the designated P-POD diagnostic ports, and visual inspection of the system shall be performed by the P-POD Integrator. The P-POD **SHALL NOT** be deintegrated at this point. If a CubeSat failure is discovered, a decision to deintegrate the P-POD will be made by the developers, in that P-POD, and the P-POD Integrator based on safety concerns. The developer is responsible for any additional testing required due to corrective modifications to deintegrated P-PODs and CubeSats.

# 4. Contacts

**Cal Poly - San Luis Obispo**
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(805) 756-2376 fax
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Roland Coelho
Program Manager
(805) 756-5087
(805) 756-5165 fax
rcoelho@calpoly.edu

*Student Contacts*
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(805) 756-5165 fax
cubesat@gmail.com

**SRI International**
Dr. Scott Williams, Program Manager
Engineering Systems Division
(650) 859-5057
(650) 859-3919 fax
scott.williams@sri.com

# Appendix A:
# Waiver Form

Submit Form



# CubeSat Design Specification
# Deviation Waiver Approval Request (DAR)

Date: August 1, 2009 Rev. 12

CubeSat Developers only fill out sections 1 through 9 and 15(optional). Email to: standards@cubesat.org

| 1. MISSION NAME: | 2. DAR NUMBER: | 3. DATE: |
|---|---|---|
| 4. INITATOR | 5. INITIATING ORGANIZATION: | |

| 6. SPECIFIED REQUIREMENTS NUMBERS: | 7. JUSTIFICATION FOR DAR: | 8. WAIVER TYPE<br>☐ DIMENSIONS or MASS<br>☐ STRUCTURE<br>☐ ELECTRICAL<br>☐ OPERATIONS<br>☐ TESTING<br>☐ OTHER |
|---|---|---|

**9. DESCRIPTION OF DEPARTURE FROM REQUIREMENTS:**

**10. CSEP DISPOSITION:**
☐ ACCEPTED
☐ REJECTED
☐ CONDITIONALLY ACCEPTED

**11. ACCEPT/REJECT JUSTIFICATION:**

| CSEP AUTHORIZED REP. | SIGNATURE | ORGANIZATION | DATE |
|---|---|---|---|

**12. ACCEPTANCE CONDITIONS**

**13. LAUNCH VEHICLE INTEGRATOR APPROVAL AUTHORITY:**
☐ APPROVED
☐ DISAPPROVED
☐ CONDITIONALLY APPROVED

**14. LVI APPROVAL/DISAPPROVAL JUSTIFICATION:**

| LVI AUTHORIZED REP. | SIGNATURE | ORGANIZATION | DATE |
|---|---|---|---|

**15. APPROVAL CONDITIONS**

| 1. MISSION NAME: | DEVIATION WAIVER APPROVAL REQUEST CONTINUATION PAGE | 2. DAR NO. | 3. DATE: |
|---|---|---|---|

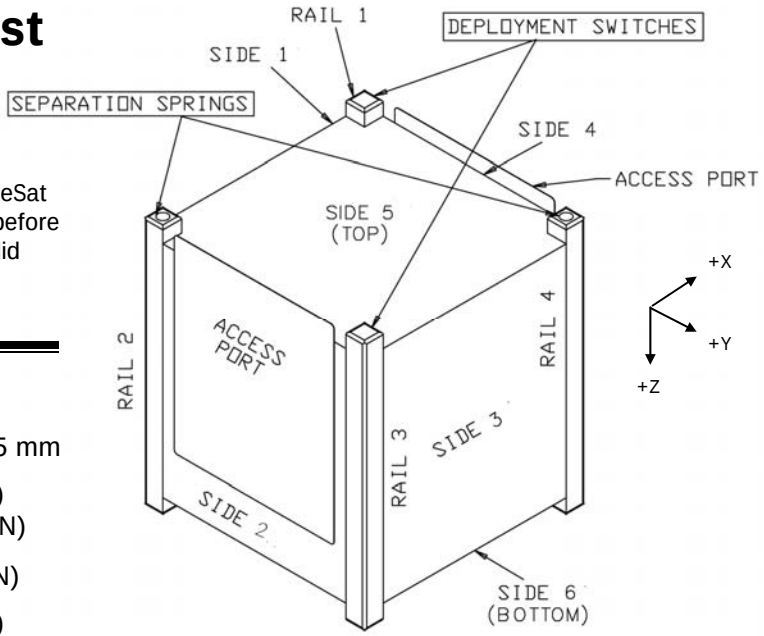
**16. CONTINUATION (indicate item or block number):**

# Appendix B:
# 1U CubeSat Acceptance Checklist

# CubeSat Acceptance Checklist

Revision: 12
Revision Date: August 1, 2009
Author: Riki Munakata

This document is intended to be used concurrently with the CubeSat Integration Procedure (CIP) and should be used by developers before and after each testing phase to verify the CubeSat dimensions did not change.




| List Item | Actual | Required |
|---|---|---|
| Mass | _____ | $\leq 1330g$ |
| Remove Before Flight | _____ | Protrudes $\leq$ 6.5 mm |
| Spring Plungers | _____ | Option (A/B) Functional (Y/N) |
| Rails | _____ | Anodized (Y/N) |
| Deployment Switches | _____ | Option (A/B) Functional (Y/N) |
| **Width [x-y], Top** | | |
| Side 1 | _____ | $100.0 \pm 0.1mm$ |
| Side 2 | _____ | $100.0 \pm 0.1mm$ |
| Side 3 | _____ | $100.0 \pm 0.1mm$ |
| Side 4 | _____ | $100.0 \pm 0.1mm$ |
| **Width [x-y], Middle** | | |
| Side 1 | _____ | $100.0 \pm 0.1mm$ |
| Side 2 | _____ | $100.0 \pm 0.1mm$ |
| Side 3 | _____ | $100.0 \pm 0.1mm$ |
| Side 4 | _____ | $100.0 \pm 0.1mm$ |
| **Width [x-y], Bottom** | | |
| Side 1 | _____ | $100.0 \pm 0.1mm$ |
| Side 2 | _____ | $100.0 \pm 0.1mm$ |
| Side 3 | _____ | $100.0 \pm 0.1mm$ |
| Side 4 | _____ | $100.0 \pm 0.1mm$ |

| List Item | Actual | Required |
|---|---|---|
| **Height [z]** | | |
| Rail 1 | _____ | $113.5 \pm 0.1mm$ |
| Rail 2 | _____ | $113.5 \pm 0.1mm$ |
| Rail 3 | _____ | $113.5 \pm 0.1mm$ |
| Rail 4 | _____ | $113.5 \pm 0.1mm$ |
| **Diagonal [x-y]** | | |
| Top 1&3 | _____ | $141.2^{+0}_{-1.5}\,mm$ |
| Top 2&4 | _____ | $141.2^{+0}_{-1.5}\,mm$ |
| Bottom 1&3 | _____ | $141.2^{+0}_{-1.5}\,mm$ |
| Bottom 2&4 | _____ | $141.2^{+0}_{-1.5}\,mm$ |
| **Protrusions** | | |
| Side 1 | _____ | $6.5 + 0.0mm$ |
| Side 2 | _____ | $6.5 + 0.0mm$ |
| Side 3 | _____ | $6.5 + 0.0mm$ |
| Side 4 | _____ | $6.5 + 0.0mm$ |
| Side 5 | _____ | $6.5 + 0.0mm$ |
| Side 6 | _____ | $6.5 + 0.0mm$ |

Authorized By:

IT #1: _____

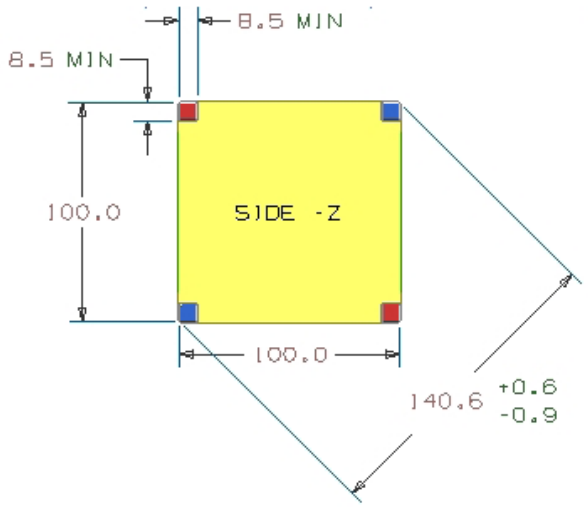
IT #2: _____

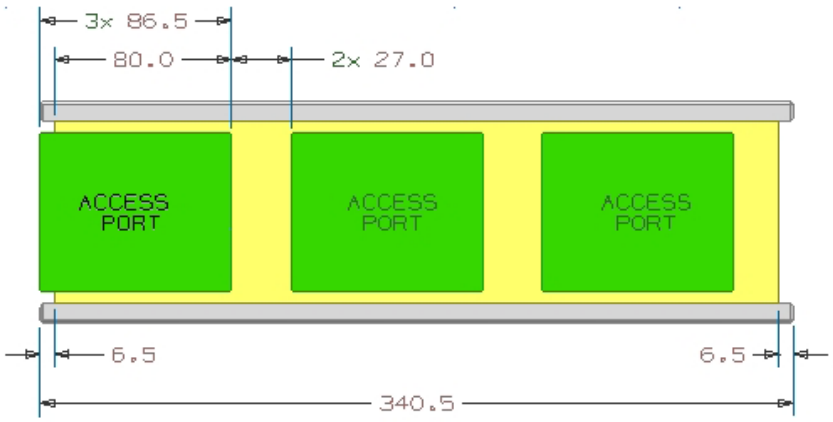
Testing Info:

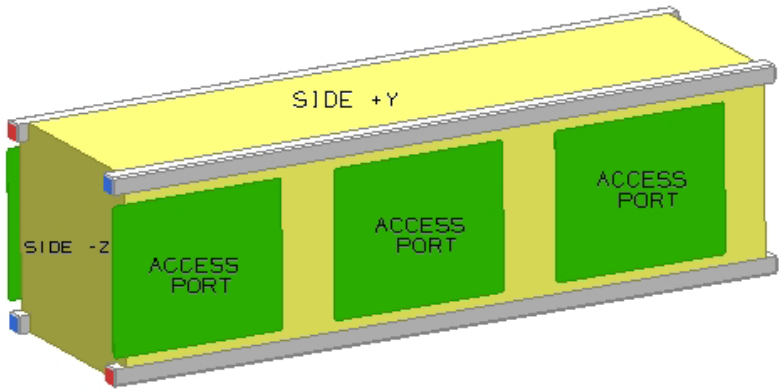
Date: _____

Passed: **Y / N**

# Appendix C:
# 3U CubeSat Specification Drawing




CUBESAT

California Polytechnic State University
CubeSat Program
(805) 756-5087
San Luis Obispo, CA 93407

| | | |
|---|---|---|
| ALL DIMENSIONS IN INCHES | DESIGNED BY | R.MUN |
| TOLERANCES .XX± .01 .XXX± .002 ANGULAR ± .5° | DRAWN BY | R.MUN |
| | CHECKED BY | N/A |
| MATERIAL | APPROVED BY | R.MUN |

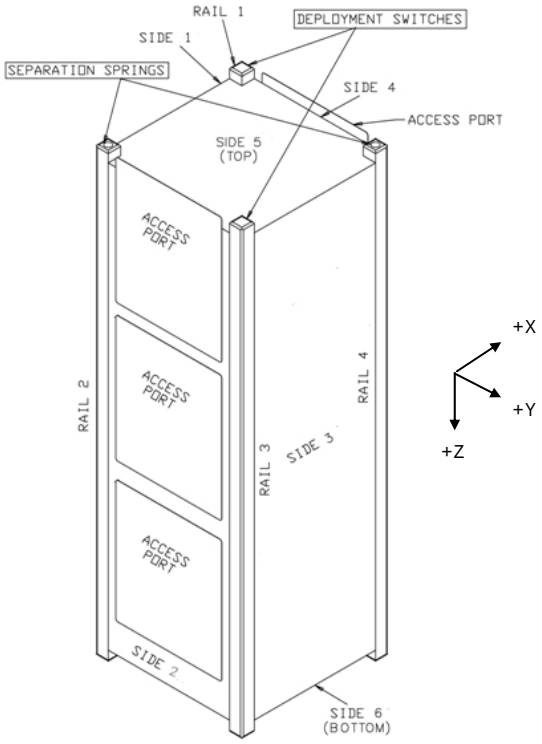
PART NAME: 3U CUBESAT SPECIFICATION
REV: 12
SIZE: B
ASSEMBLY: P-POD MK. III - R
SCALE 1:1 | DATE: 04/17/09 | SHEET 1 OF 1

# Appendix D:
# 3U CubeSat Acceptance Checklist

# CubeSat Acceptance Checklist

Revision: 12
Revision Date: August 1, 2009
Author: Riki Munakata

This document is intended to be used concurrently with the CubeSat Integration Procedure (CIP) and should be used by developers before and after each testing phase to verify the CubeSat dimensions did not change.




| List Item | Actual | Required |
|---|---|---|
| Mass | | $\leq 4000g$ |
| Remove Before Flight | | Protrudes $\leq$ 6.5 mm |
| Spring Plungers | | Option (A/B)<br>Functional (Y/N) |
| Rails | | Anodized (Y/N) |
| Deployment Switches | | Option (A/B)<br>Functional (Y/N) |
| **Width [x-y], Top** | | |
| Side 1 | | $100.0 \pm 0.1mm$ |
| Side 2 | | $100.0 \pm 0.1mm$ |
| Side 3 | | $100.0 \pm 0.1mm$ |
| Side 4 | | $100.0 \pm 0.1mm$ |
| **Width [x-y], Middle** | | |
| Side 1 | | $100.0 \pm 0.1mm$ |
| Side 2 | | $100.0 \pm 0.1mm$ |
| Side 3 | | $100.0 \pm 0.1mm$ |
| Side 4 | | $100.0 \pm 0.1mm$ |
| **Width [x-y], Bottom** | | |
| Side 1 | | $100.0 \pm 0.1mm$ |
| Side 2 | | $100.0 \pm 0.1mm$ |
| Side 3 | | $100.0 \pm 0.1mm$ |
| Side 4 | | $100.0 \pm 0.1mm$ |

| List Item | Actual | Required |
|---|---|---|
| **Height [z]** | | |
| Rail 1 | | $340.5 \pm 0.3mm$ |
| Rail 2 | | $340.5 \pm 0.3mm$ |
| Rail 3 | | $340.5 \pm 0.3mm$ |
| Rail 4 | | $340.5 \pm 0.3mm$ |
| **Diagonal [x-y]** | | |
| Top 1&3 | | $141.2^{+0}_{-1.5}\,mm$ |
| Top 2&4 | | $141.2^{+0}_{-1.5}\,mm$ |
| Bottom 1&3 | | $141.2^{+0}_{-1.5}\,mm$ |
| Bottom 2&4 | | $141.2^{+0}_{-1.5}\,mm$ |
| **Protrusions** | | |
| Side 1 | | $6.5 + 0.0mm$ |
| Side 2 | | $6.5 + 0.0mm$ |
| Side 3 | | $6.5 + 0.0mm$ |
| Side 4 | | $6.5 + 0.0mm$ |
| Side 5 | | $6.5 + 0.0mm$ |
| Side 6 | | $6.5 + 0.0mm$ |

| Authorized By: | Testing Info: |
|---|---|
| IT #1: _____ | Date: _____ |
| IT #2: _____ | Passed: **Y / N** |