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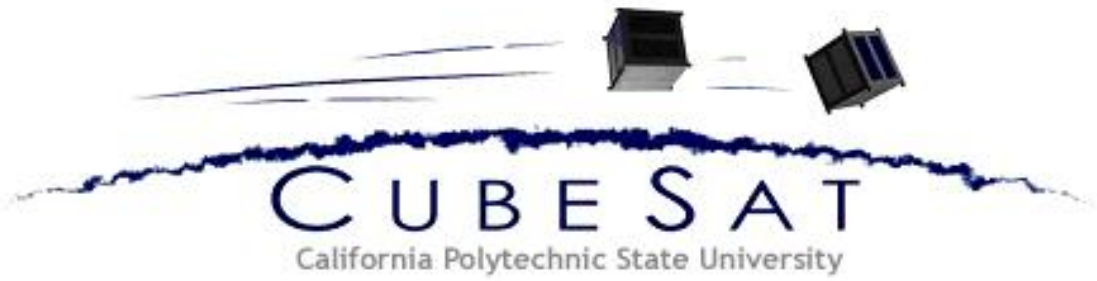
CubeSat Design Specification

(CDS)
REV 13



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.
3/30/12	12.1	Justin Carnahan	Reformatted document to improve readability, updated to include 1.5U, 2U, and 3U+. Added and modified some req.
7/12/13	13-draft	David Pignatelli	Added applicable documents section. Removed restrictions on propulsion, added guidance for propulsion systems and hazardous materials. Added magnetic field restrictions and suggestions. Cleaned Section 3.2. Added custom spring plunger specs and recommendation. Extended restrictions on inhibits. Added links to outside resources. Cleaned Section 4.
2/20/14	13	Arash Mehrparvar	Fixed page numbering, error in spring plunger thread callout, other minor edits based on external suggestions.

TABLE OF CONTENTS

List of Acronyms

AFSPCMAN	Air Force Space Command Manual
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
LSP	Lunch Services Program
LV	Launch Vehicle
MIL	Military
mm	Millimeters
NASA	National Aeronautics and Space Administration
NPR	NASA Procedural Requirements
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

Applicable Documents

The following documents form a part of this document to the extent specified herein. In the event of conflict between the documents referenced herein and the contents of this document, the contents of this document shall take precedence.

LSP Program Level P-POD and CubeSat Requirements Document (LSP-REQ-317.01)

General Environmental Verification Standard for GSFC Flight Programs and Projects (GSFC-STD-7000)

Military Standard Test Requirements for Launch, Upper-stage, and Space Vehicles (MIL-STD-1540)

Air Force Space Command Manual 91-710, Range Safety User Requirements Manual (AFSPCMAN 91-710)

Metallic Material Properties (MIL-HDBK-5)

Standard Materials and Processes Requirements for Spacecraft (NASA-STD-6016)

NASA Procedural Requirements for Limiting Orbital Debris (NPR 8715.6)

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.

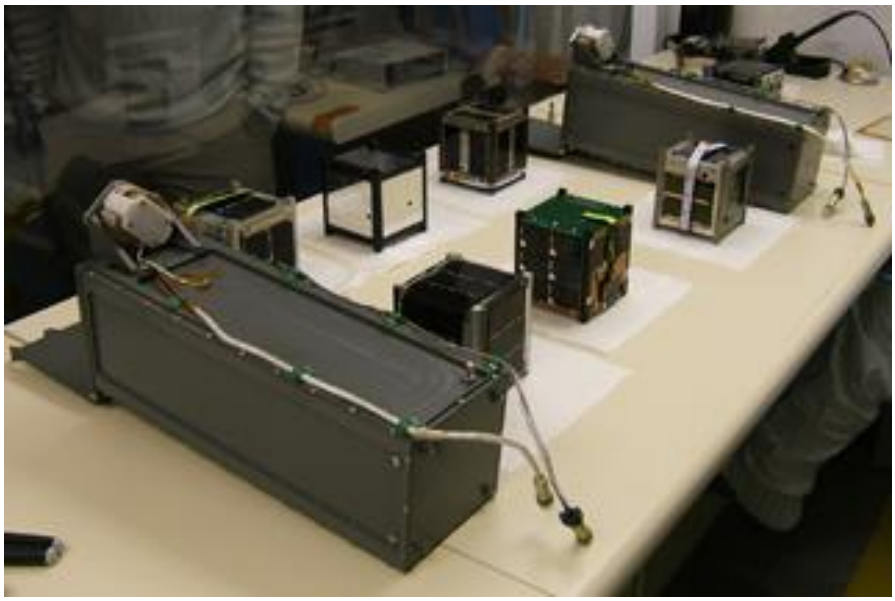


Figure 1: Six CubeSats and their deployment systems.

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 will 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://www.cubesat.org/ and waiver requests should be sent to standards@cubesat.org.

Upon completion of the DAR, the P-POD Integrator will 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, will 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.

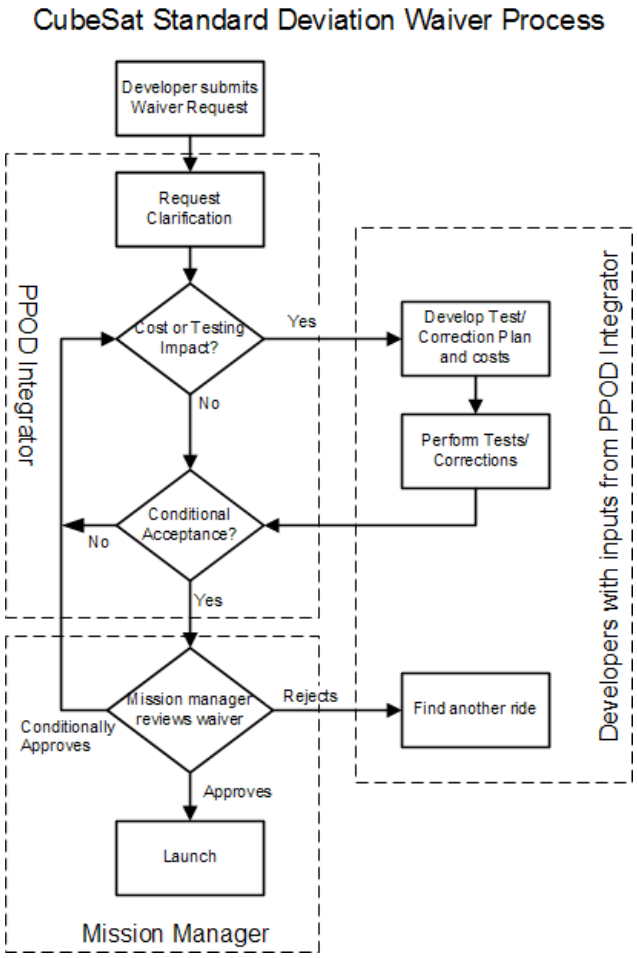


Figure 2: CubeSat Standard Deviation Wavier Process Flow Diagram

2. Poly Picosatellite Orbital Deployer

2.1 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 will 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.

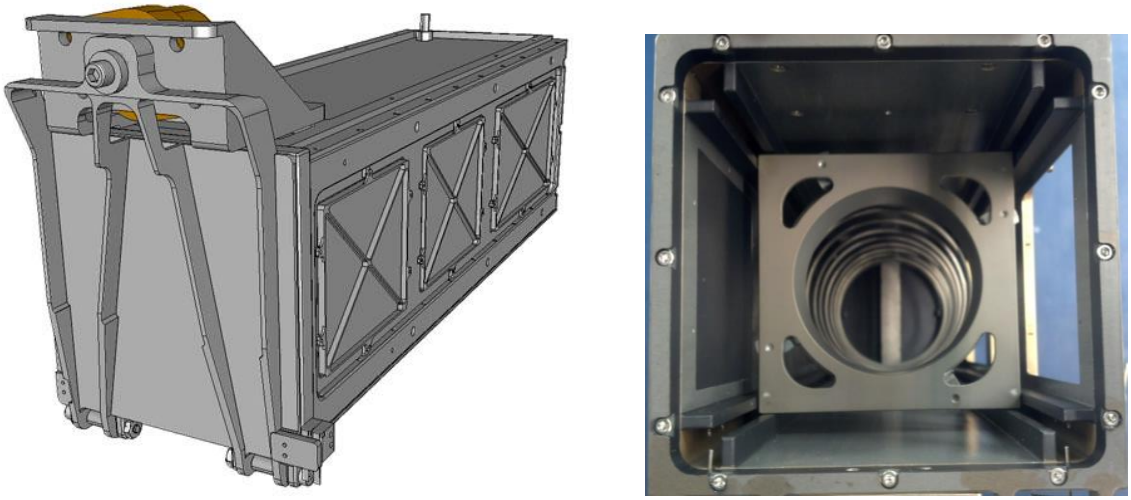


Figure 3a and 3b: Poly Picosatellite Orbital Deployer (P-POD) and cross section

3. CubeSat Specification

3.1 General Requirements

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

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

3.1.3 No pyrotechnics shall be permitted.

3.1.4 Any propulsion systems shall be designed, integrated, and tested in accordance with AFSPCMAN 91-710 Volume 3.

3.1.5 Propulsion systems shall have at least 3 inhibits to activation.

3.1.6 Total stored chemical energy will not exceed 100 Watt-Hours.

3.1.6.1 Note: Higher capacities may be permitted, but could potentially limit launch opportunities.

3.1.7 CubeSat hazardous materials shall conform to AFSPCMAN 91-710, Volume 3.

3.1.8 CubeSat materials shall satisfy the following low out-gassing criterion to prevent contamination of other spacecraft during integration, testing, and launch. A list of NASA approved low out-gassing materials can be found at: http://outgassing.nasa.gov

3.1.8.1 CubeSats materials shall have a Total Mass Loss (TML) $\leq$ 1.0 %

3.1.8.2 CubeSat materials shall have a Collected Volatile Condensable Material (CVCM) $\leq$ 0.1%

3.1.9 The latest revision of the CubeSat Design Specification will be the official version which all CubeSat developers will adhere to. The latest revision is available at http://www.cubesat.org.

3.1.9.1 Cal Poly will send updates to the CubeSat mailing list upon any changes to the specification. You can sign-up for the CubeSat mailing list here: www.cubesat.org/index.php/about-us/how-to-join

3.1.10 Note: Some launch vehicles hold requirements on magnetic field strength. Additionally, strong magnets can interfere with the separation between CubeSat spacecraft in the same P-POD. As a general guideline, it is advised to limit magnetic field outside the CubeSat static envelope to 0.5 Gauss above Earth's magnetic field.

3.1.11 The CubeSat shall be designed to accommodate ascent venting per ventable volume/area < 2000 inches.

3.2 CubeSat Mechanical Requirements

CubeSats are cube shaped picosatellites with dimensions and features outlined in the CubeSat Specification Drawing (Appendix B). The PPOD coordinate system is shown below in Figure 4 for reference. General features of all CubeSats include:

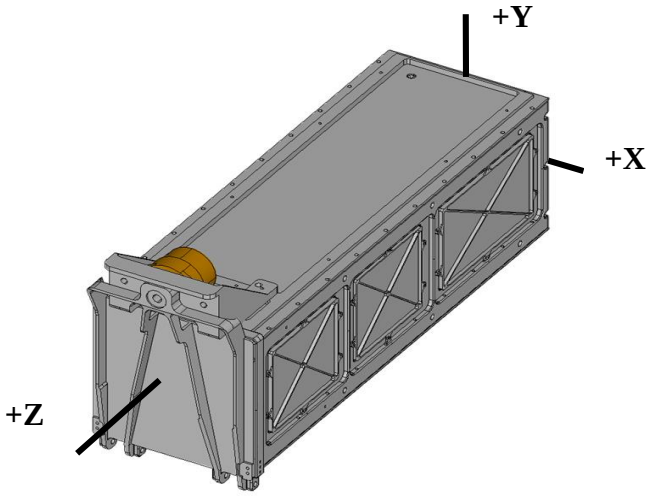


Figure 4: PPOD Coordinate System

3.2.1 The CubeSat shall use the coordinate system as defined in Appendix B for the appropriate size. The CubeSat coordinate system will match the P-POD coordinate system while integrated into the P-POD. The origin of the CubeSat coordinate system is located at the geometric center of the CubeSat.

3.2.1.1 The CubeSat configuration and physical dimensions shall be per the appropriate section of Appendix B.

3.2.1.2 The extra volume available for 3U+ CubeSats is shown in Figure 6.

3.2.2 The –Z face of the CubeSat will be inserted first into the P-POD.

3.2.3 No components on the green and yellow shaded sides shall exceed 6.5 mm normal to the surface.

3.2.3.1 When completing a CubeSat Acceptance Checklist (CAC), protrusions will be measured from the plane of the rails.

3.2.4 Deployables shall be constrained by the CubeSat, not the P-POD.

3.2.5 Rails shall have a minimum width of 8.5mm.

3.2.6 Rails will have a surface roughness less than 1.6 µm.

3.2.7 The edges of the rails will be rounded to a radius of at least 1 mm

3.2.8 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 6).

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

3.2.10 The maximum mass of a 1U CubeSat shall be 1.33 kg.

3.2.10.1 Note: Larger masses may be evaluated on a mission to mission basis.

3.2.11 The maximum mass of a 1.5U CubeSat shall be 2.00 kg.

3.2.11.1 Note: Larger masses may be evaluated on a mission to mission basis.

3.2.12 The maximum mass of a 2U CubeSat shall be 2.66 kg.

3.2.12.1 Note: Larger masses may be evaluated on a mission to mission basis.

3.2.13 The maximum mass of a 3U CubeSat shall be 4.00 kg.

3.2.13.1 Note: Larger masses may be evaluated on a mission to mission basis.

3.2.14 The CubeSat center of gravity shall be located within 2 cm from its geometric center in the X and Y direction.

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

3.2.14.2 The 1.5U CubeSat center of gravity shall be located within 3 cm from its geometric center in the Z direction.

3.2.14.3 The 2U CubeSat center of gravity shall be located within 4.5 cm from its geometric center in the Z direction.

3.2.14.4 3U and 3U+ CubeSats' center of gravity shall be located within 7 cm from its geometric center in the Z direction.

3.2.15 Aluminum 7075, 6061, 5005, and/or 5052 will be used for both the main CubeSat structure and the rails.

3.2.15.1 If other materials are used the developer will submit a DAR and adhere to the waiver process.

3.2.16 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.

3.2.17 The 1U, 1.5U, and 2U CubeSats shall use separation springs to ensure adequate separation.

3.2.17.1 Note: Recommended separation spring specifications are shown below in Table 1. **These are a custom part available through Cal Poly. Contact cubesat@gmail.com in order to obtain these separation springs.**

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

3.2.17.3 The 1U, 1.5U, and 2U CubeSat separation spring will be centered on the end of the standoff on the CubeSat's –Z face as per Figure 7.

3.2.17.4 Separation springs are not required for 3U CubeSats.

Table 1: CubeSat Separation Spring Characteristics

Characteristics	***Value***
Plunger Material	*Stainless Steel*
End Force Initial/Final	*0.14 lbs. / 0.9 lbs.*
Throw Length	*0.16 inches minimum above the standoff surface*
Thread Pitch	*8-36 UNF-2B*

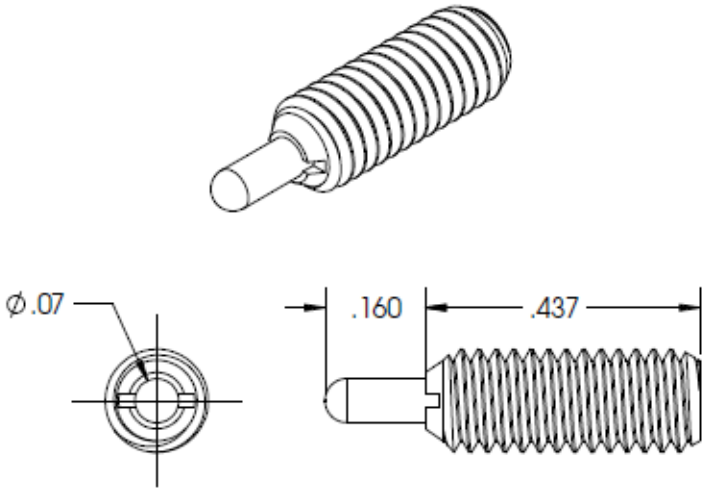


Figure 5: Custom Spec Spring Plunger (Separation Spring)

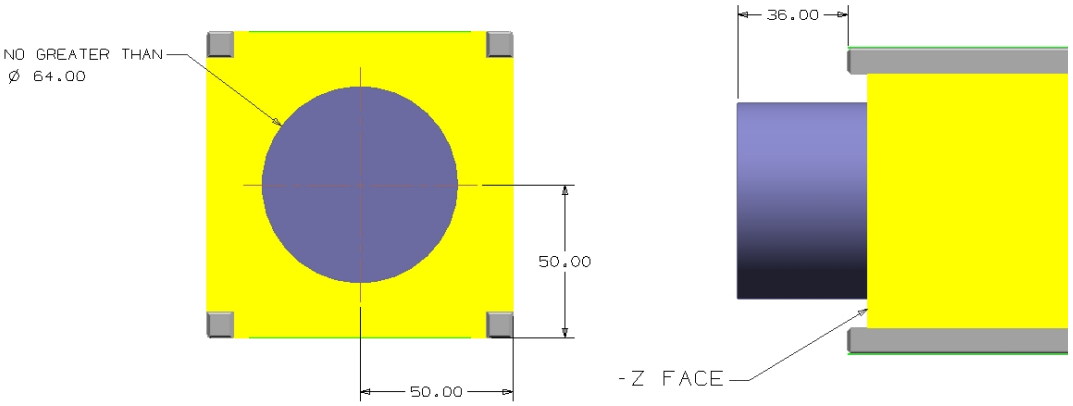


Figure 6: 3U+ Extra Volume ("Tuna Can")

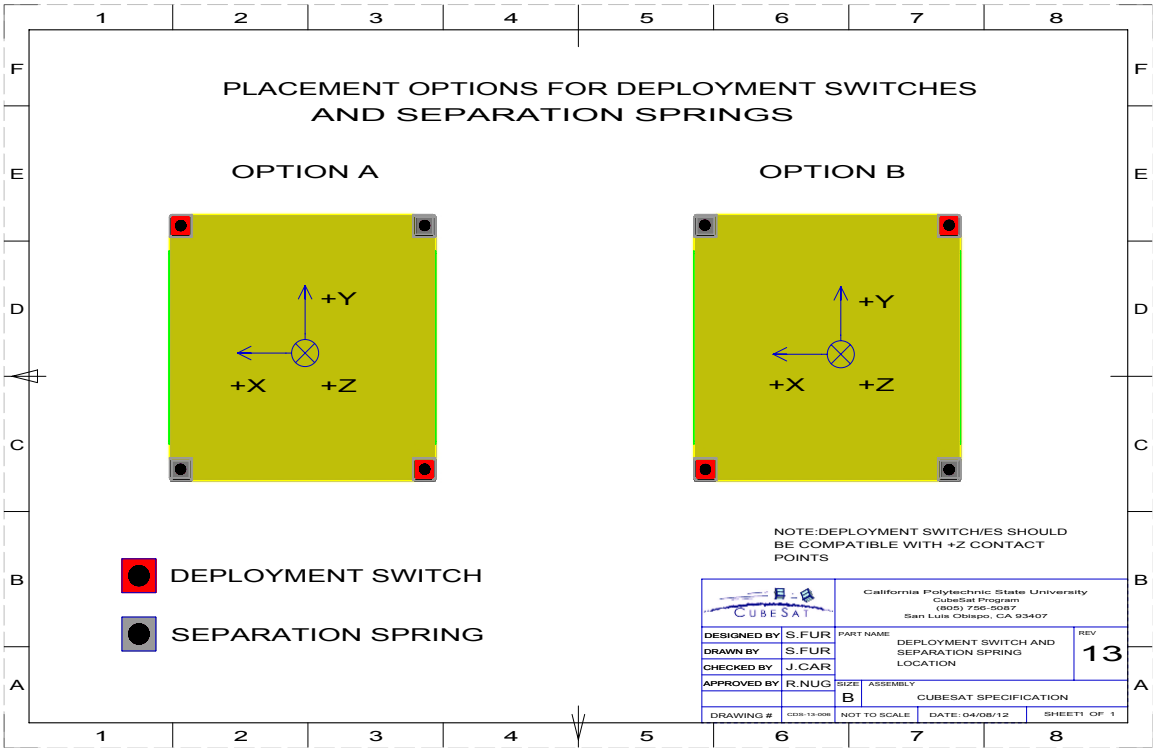


Figure 7: Deployment Switches and Separation Spring Locations

3.3 Electrical Requirements

Electronic systems will be designed with the following safety features.

3.3.1 The CubeSat power system shall be at a power off state to prevent CubeSat from activating any powered functions while integrated in the P-POD from the time of delivery to the LV through on-orbit deployment. CubeSat powered function include the variety of subsystems such as Command and Data Handling (C&DH), RF Communication, Attitude Determine and Control (ADC), deployable mechanism actuation. CubeSat power systems include all battery assemblies, solar cells, and coin cell batteries.

3.3.2 The CubeSat shall have, at a minimum, one deployment switch on a rail standoff, per Figure 7.

3.3.3 In the actuated state, the CubeSat deployment switch shall electrically disconnect the power system from the powered functions; this includes real time clocks (RTC).

3.3.4 The deployment switch shall be in the actuated state at all times while integrated in the P-POD.

3.3.4.1 In the actuated state, the CubeSat deployment switch will be at or below the level of the standoff.

3.3.5 If the CubeSat deployment switch toggles from the actuated state and back, the transmission and deployable timers shall reset to t=0.

3.3.6 The RBF pin and all CubeSat umbilical connectors shall be within the designated Access Port locations, green shaded areas shown in Appendix B.

3.3.6.1 Note: All diagnostics and battery charging within the P-POD will be done while the deployment switch is depressed.

3.3.7 The CubeSat shall include an RBF pin.

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

3.3.7.2 The RBF pin shall be removed from the CubeSat after integration into the P-POD.

3.3.7.3 The RBF pin shall protrude no more than 6.5 mm from the rails when it is fully inserted into the satellite.

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

3.3.9 The CubeSat shall be designed to meet at least one of the following requirements to prohibit inadvertent radio frequency (RF) transmission. The use of three independent inhibits is highly recommended and can reduce required documentation and analysis.

An inhibit is a physical device between a power source and a hazard. A timer is not considered an independent inhibit.

3.3.9.1 The CubeSat will have one RF inhibit and RF power output of no greater than 1.5W at the transmitting antenna's RF input.

3.3.9.2 The CubeSat will have two independent RF inhibits

3.4 Operational Requirements

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

3.4.1 Operators will obtain and provide documentation of proper licenses for use of radio frequencies.

3.4.1.1 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.

3.4.2 CubeSats will comply with their country's radio license agreements and restrictions.

3.4.3 CubeSats mission design and hardware shall be in accordance with NPR 8715.6 to limit orbital debris.

3.4.3.1 Any CubeSat component shall re-enter with energy less than 15 Joules.

3.4.3.2 Developers will obtain and provide documentation of approval of an orbital debris mitigation plan from the FCC (or NOAA if imager is present).

3.4.3.2.1 Note: To view FCC amateur radio regulations, go to http://www.arrl.org/part-97-amateur-radio

3.4.3.3 Note: Analysis can be conducted to satisfy the above with NASA DAS, available at http://orbitaldebris.jsc.nasa.gov/mitigate/das.html

3.4.4 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.

3.4.5 No CubeSats shall generate or transmit any signal from the time of integration into the P-POD through 45 minutes after on-orbit deployment from the P-POD. However, the CubeSat can be powered on following deployment form the P-POD.

3.4.6 Private entities (non-U.S. Government) under the jurisdiction or control of the United States who propose to operate a remote sensing space system (satellite) may need to have a license as required by U.S. law. For more information visit http://www.nesdis.noaa.gov/CRSRA/licenseHome.html. Click on the Application Process link under the Applying for a License drop down section to begin the process.

3.4.7 Cal Poly will conduct a minimum of one fit check in which developer hardware will be inspected and integrated into the P-POD or TestPOD. A final fit check will be conducted prior to launch. The CubeSat Acceptance Checklist (CAC) will be used to verify compliance of the specification (Found in the appendix of this document or online at http://cubesat.org/index.php/documents/developers).

4. Testing Requirements

Testing will be performed to meet all launch provider requirements as well as any additional testing requirements deemed necessary to ensure the safety of the CubeSats, P-POD, and the primary mission. If the launch vehicle environment is unknown, The General Environmental Verification Standard (GEVS, GSFC-STD-7000) and MIL-STD-1540 can be used to derive testing requirements. GSFC-STD-7000 and MIL-STD-1540 are useful references when defining testing environments and requirements, however the test levels defined in GSFC-STD-7000 and MIL-STD-1540 are not guaranteed to encompass or satisfy all LV testing environments. Test requirements and levels that are not generated by the launch provider or P-POD Integrator are considered to be unofficial. The launch provider testing requirements will supersede testing environments from any other source. The P-POD will be tested in a similar fashion to ensure the safety and workmanship before integration with the CubeSats. At the very minimum, all CubeSats will undergo the following tests.

4.1 Random Vibration

Random vibration testing shall be performed as defined by the launch provider

4.2 Thermal Vacuum Bakeout

Thermal vacuum bakeout shall be performed to ensure proper outgassing of components. The test specification will be outlined by the launch provider.

4.3 Shock Testing

Shock testing shall be performed as defined by the launch provider.

4.4 Visual Inspection

Visual inspection of the CubeSat and measurement of critical areas will be performed per the appropriate CAC (Appendix C).

4.5 CubeSat Testing Philosophy

The CubeSat shall be subjected to either a qualification or protoflight testing as defined in the CubeSat Testing Flow Diagram, shown in Figure 88. The test levels and durations will be supplied by the launch provider or P-POD integrator.

4.5.1 Qualification

Qualification testing is performed on an engineering unit hardware that is identical to the flight model CubeSat. Qualification levels will be determined by the launch vehicle provider or P-POD integrator. Both MIL-STD-1540 and LSP-REQ-317.01 are used as guides in determining testing levels. The flight model will then be tested to Acceptance levels in a TestPOD then integrated into the flight P-POD for a final acceptance/workmanship random vibration test. **Additional testing may be required if modifications or changes are made to the CubeSats after qualification testing.**

4.5.2 Protoflight

Protoflight testing is performed on the flight model CubeSat. Protoflight levels will be determined by the launch vehicle provider or P-POD integrator. Both MIL-STD-1540 and LSP-REQ-317.01 are used as guides in determining testing levels. The flight model will be tested to Protoflight levels in a TestPOD then integrated into the flight P-POD for a final acceptance/workmanship random vibration test. The flight CubeSat **SHALL NOT** be disassembled or modified after protoflight testing. Disassembly of hardware after protoflight testing will require the developer to submit a DAR and adhere to the waiver process prior to disassembly. **Additional testing will be required if modifications or changes are made to the CubeSats after protoflight testing.**

4.5.3 Acceptance

After delivery and integration of the CubeSat into the P-POD, additional testing will be performed with the integrated system. This test ensures proper integration of the CubeSat into the P-POD. Additionally, any unknown, harmful interactions between CubeSats may be discovered during acceptance testing. The P-POD Integrator will coordinate and perform acceptance testing. Acceptance levels will be determined by the launch vehicle provider or P-POD integrator. Both MIL-STD-1540 and LSP-REQ-317.01 are used as guides in determining testing levels. 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.

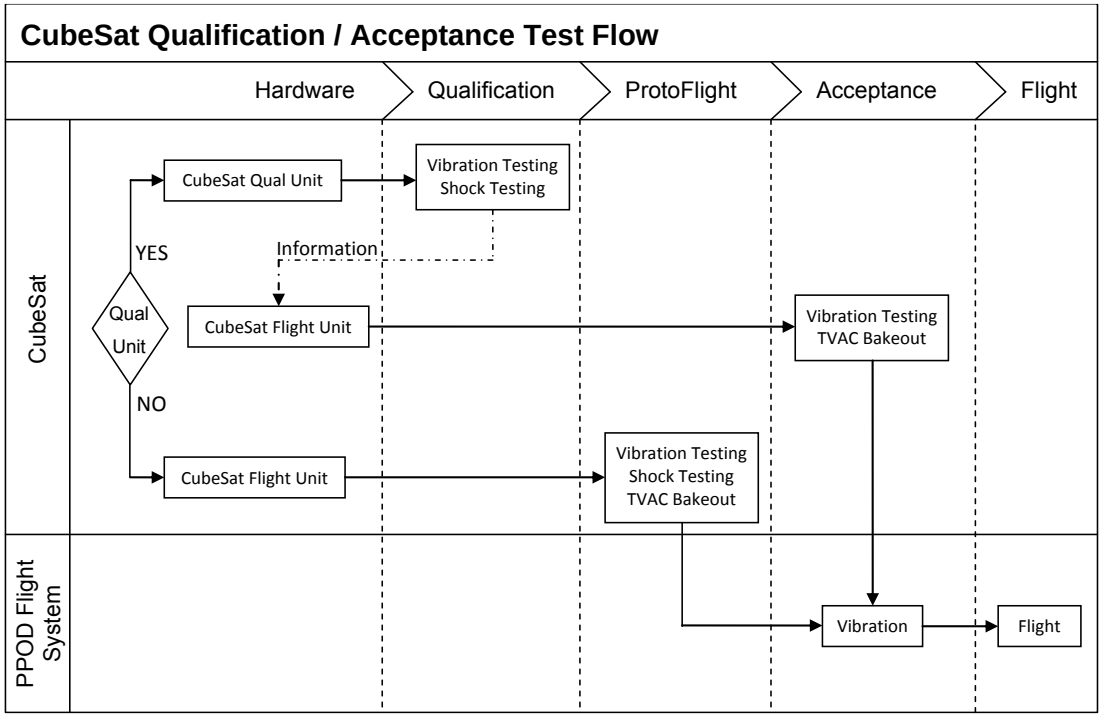


Figure 8: CubeSat General Testing Flow Diagram

5. Contacts

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Appendix A:
Waiver 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 ☐ DIMENSIONS or MASS ☐ STRUCTURE ☐ ELECTRICAL ☐ OPERATIONS ☐ TESTING ☐ 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

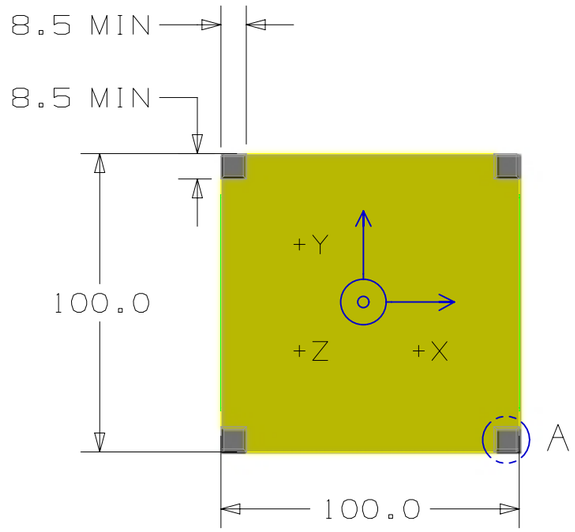
15. APPROVAL CONDITIONS

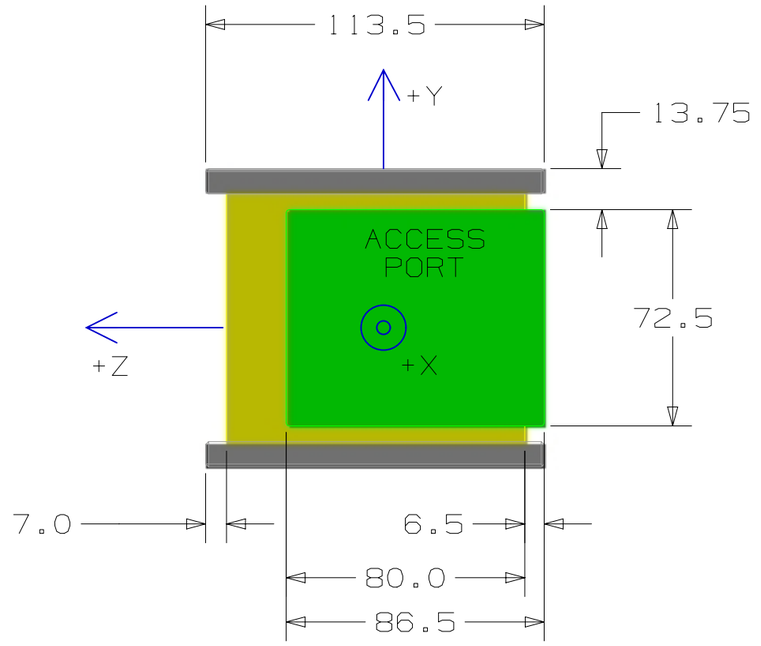
1. MISSION NAME:	DEVIATION WAIVER APPROVAL REQUEST CONTINUATION PAGE	2. DAR NO.	3. DATE:

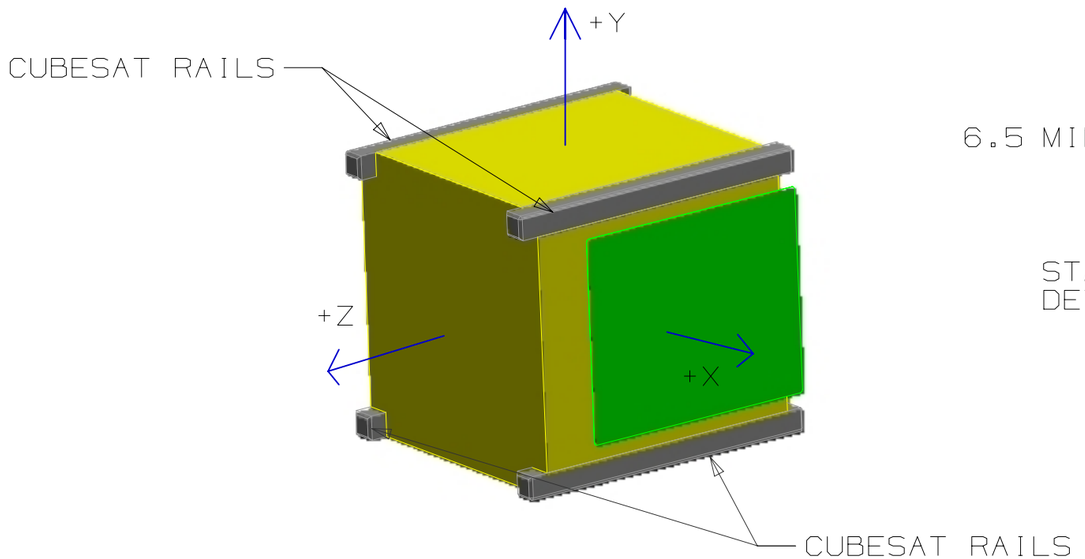
16. CONTINUATION (indicate item or block number):

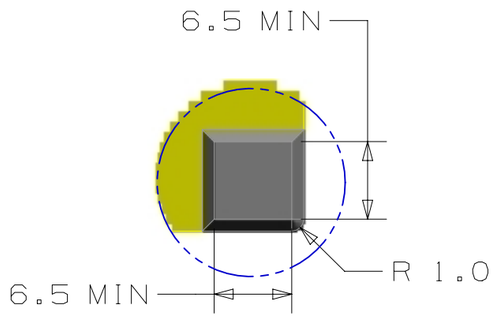
Appendix B:
1U, 1.5U, 2U, 3U, and 3U+
CubeSat Specification Drawing

Section 1
1U CubeSat Design Specification Drawing









DETAIL A

STANDOFF CONTACT
DETAIL FOR +Z

ADDITIONAL NOTES:

-CubeSat coordinate system located in the geometric center of the CubeSat.

-No external components other than the rails shall touch the inside of the P-POD.

-All 1U CubeSats must have two (2) separation springs and at least one (1) deployment switch on the -Z face. See drawing CDS-13-006, Deployment Switch and Separation Spring Location, for more details.

CUBESAT

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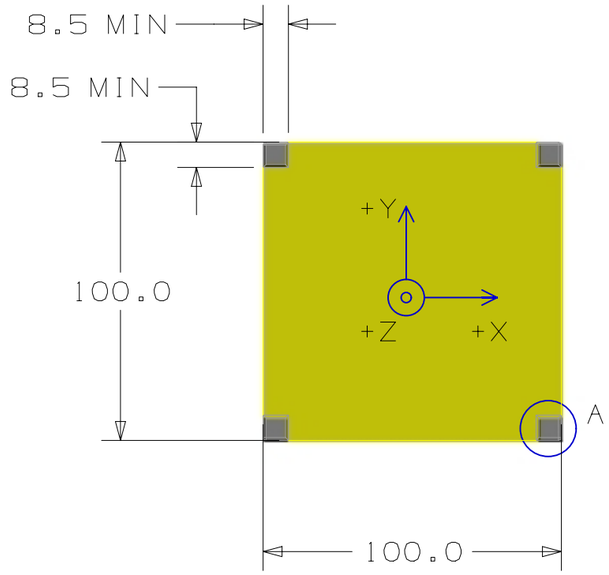
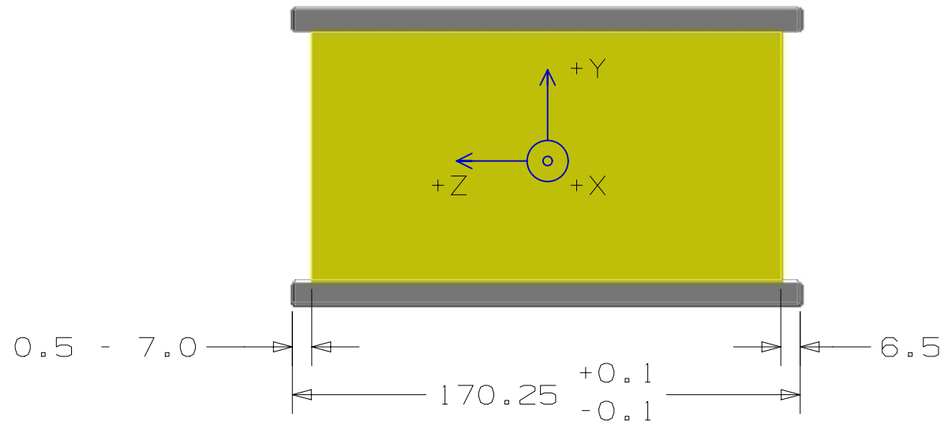
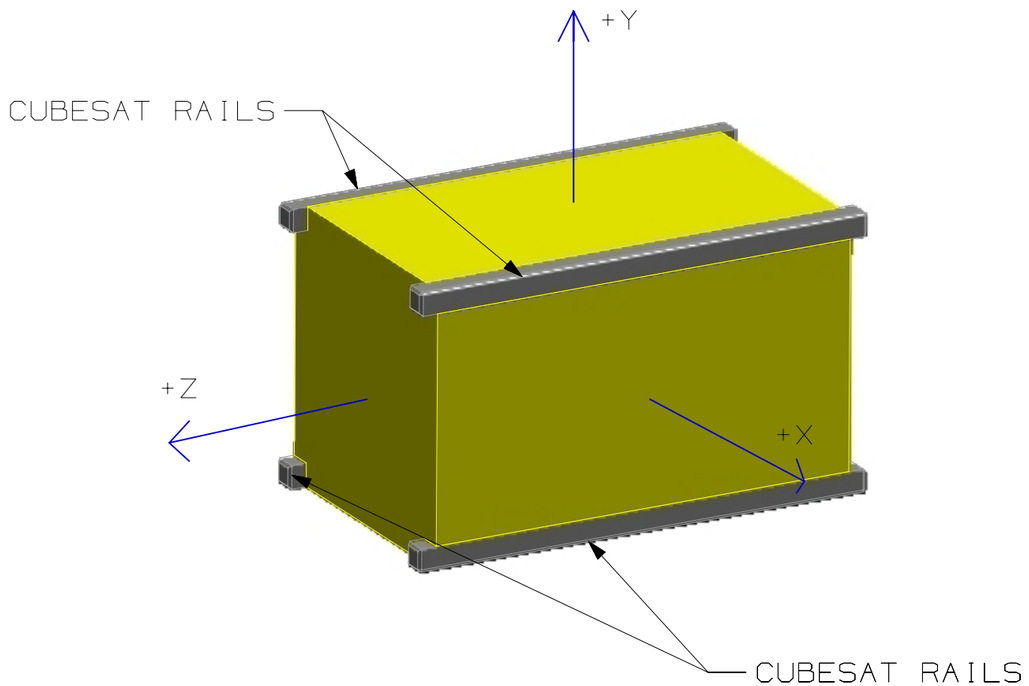
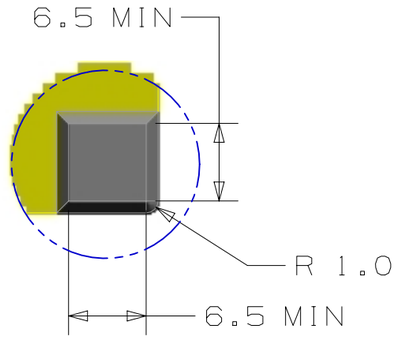
ALL DIMENSIONS IN MILLIMETERS	DESIGNED BY	S.FUR	PART NAME: 1U CUBESAT	REV: 13
TOLERANCE .X ± 0.1	DRAWN BY	S.FUR		
	CHECKED BY	J.CAR		
ROUND ALL EDGES AND CORNERS	APPROVED BY	R.NUG	SIZE: B	ASSEMBLY: CUBESAT SPECIFICATION
	DRAWING #	CDS-13-001	NOT TO SCALE	DATE: 04/05/12 — SHEET 1 OF 1

Section 2
1.5U CubeSat Design Specification Drawing









DETAIL A

STANDOFF CONTACT DETAIL FOR +Z

ADDITIONAL NOTES:

-CubeSat coordinate system located in the geometric center of the CubeSat.

-No external components other than the rails shall touch the inside of the P-POD.

-All 1.5U CubeSats must have two (2) separation springs and at least one (1) deployment switch on the -Z face. See drawing CDS-13-006, Deployment Switch and Separation Spring Location, for more details.

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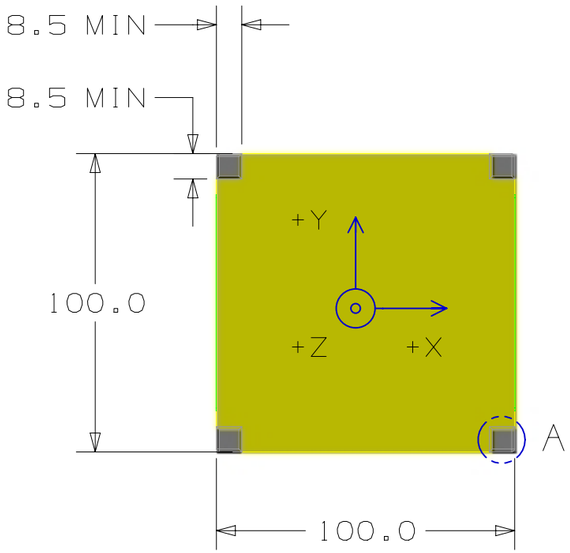
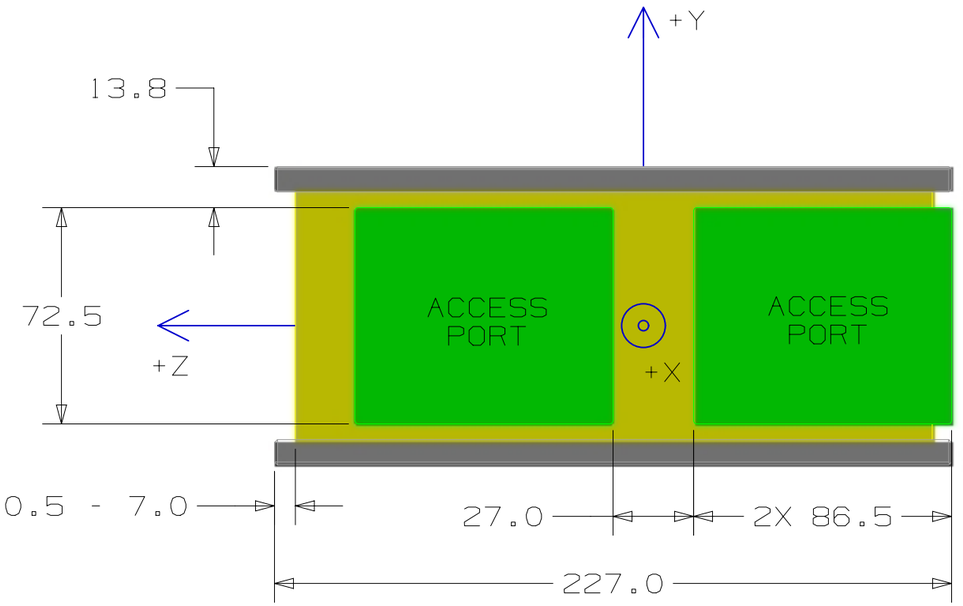
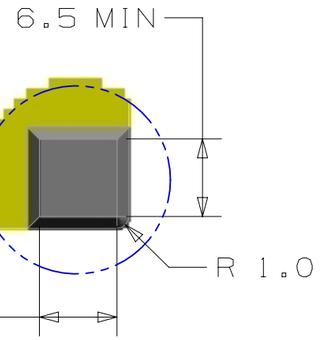
ALL DIMENSIONS IN MILLIMETERS	DESIGNED BY	S.FUR	PART NAME: 1.5U CUBESAT	REV: 13
TOLERANCE .X ± 0.1	DRAWN BY	S.FUR		
	CHECKED BY	J.CAR		
ROUND ALL EDGES AND CORNERS	APPROVED BY	R.NUG	SIZE: B	ASSEMBLY: CUBESAT SPECIFICATION
	DRAWING #	CDS-13-002	NOT TO SCALE	DATE: 04/03/12

Section 3
2U CubeSat Design Specification Drawing

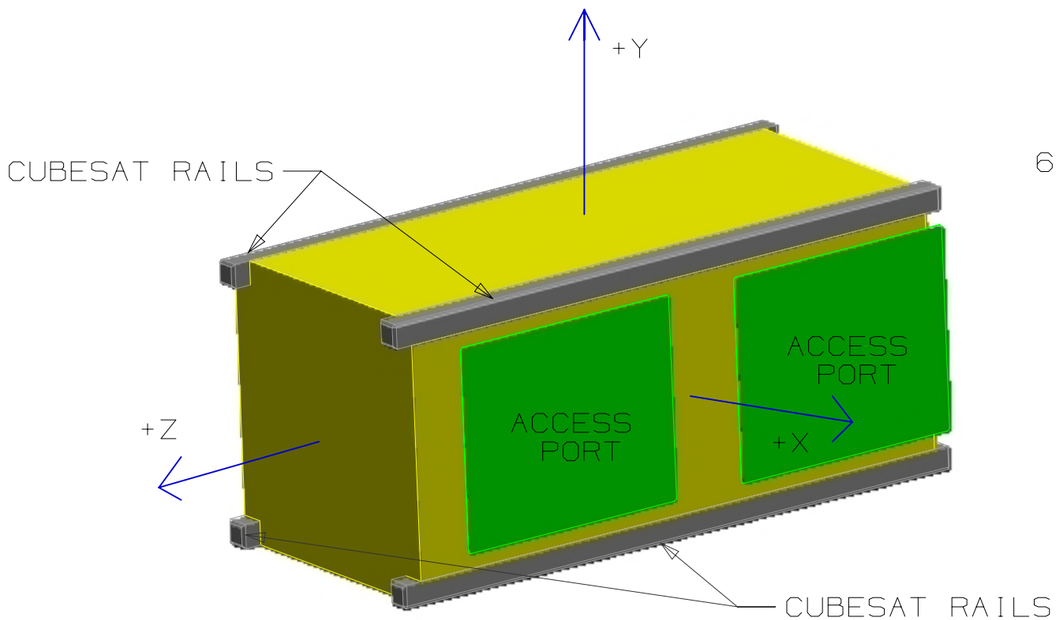






DETAIL A

STANDOFF CONTACT DETAIL FOR +Z

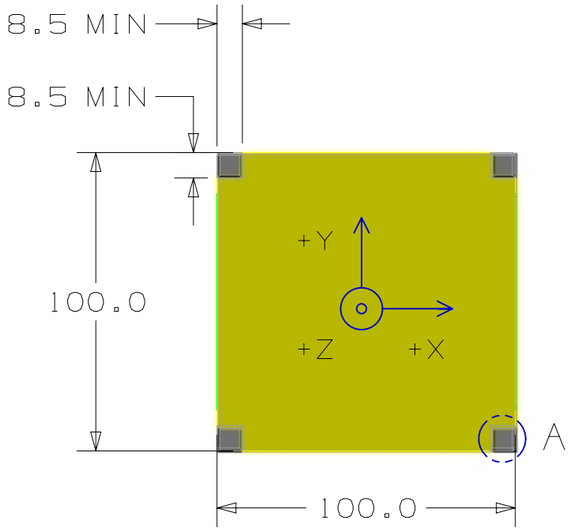


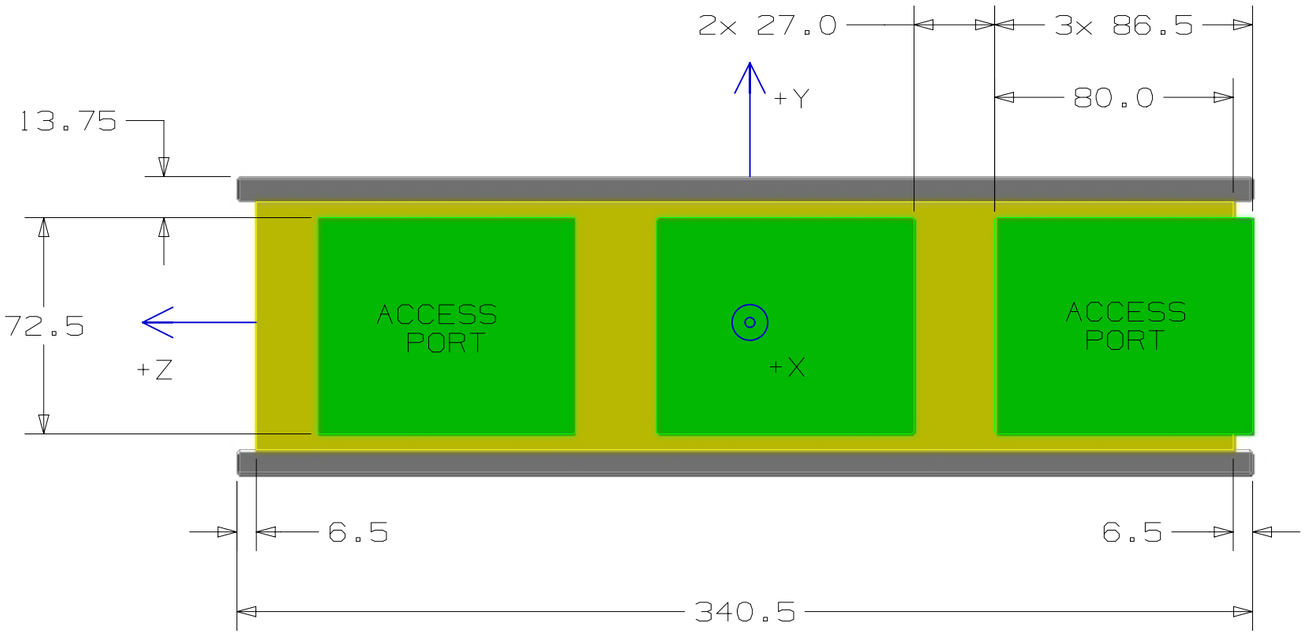
ADDITIONAL NOTES:

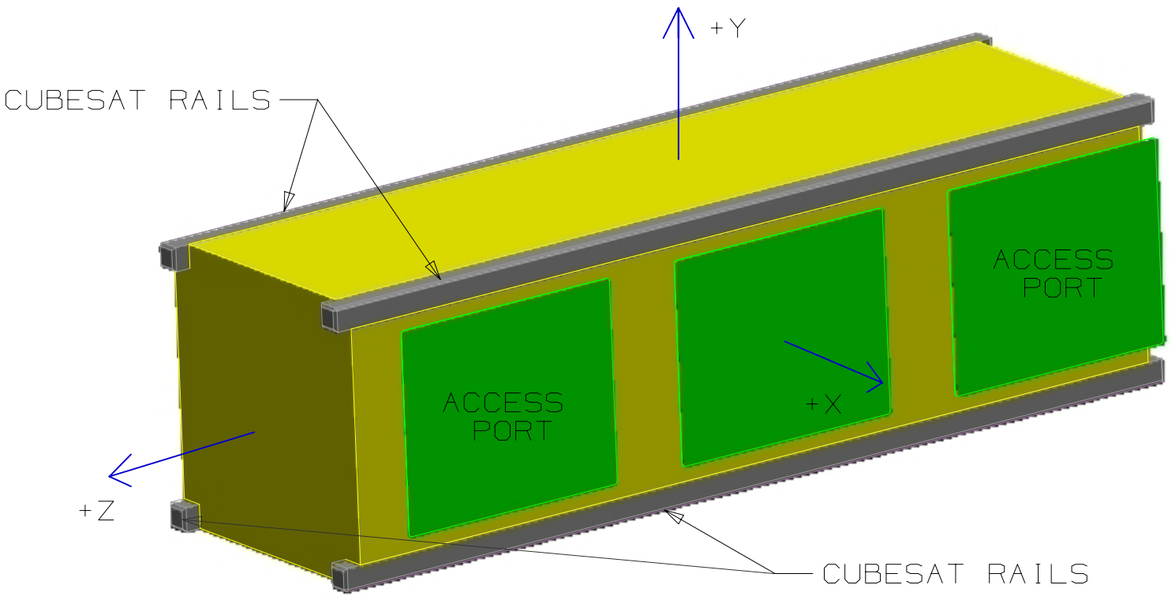
- CubeSat coordinate system located in the geometric center of the CubeSat.
- No external components other than the rails shall touch the inside of the P-POD.
- All 2U CubeSats must have two (2) separation springs and at least one (1) deployment switch on the -Z face. See drawing CDS-13-006, Deployment Switch and Separation Spring Location, for more details.

CUBESAT	California Polytechnic State University CubeSat Program (805) 756-5087 San Luis Obispo, CA 93407			
ALL DIMENSIONS IN MILLIMETERS	DESIGNED BY	S.FUR	PART NAME: 2U CUBESAT	REV: 13
TOLERANCE .X ± 0.1	DRAWN BY	S.FUR		
	CHECKED BY	J.CAR		
ROUND ALL EDGES AND CORNERS	APPROVED BY	R.NUG	SIZE: B	ASSEMBLY: CUBESAT SPECIFICATION
	DRAWING #	CDS-13-003	NOT TO SCALE	DATE: 04/05/12 — SHEET 1 OF 1

Section 4
3U CubeSat Design Specification Drawing







DETAIL A
STANDOFF CONTACT
DETAIL FOR +Z

ADDITIONAL NOTES:

- CubeSat coordinate system located in the geometric center of the CubeSat.
- No external components other than the rails shall touch the inside of the P-POD.
- All 3U CubeSats must have at least one (1) deployment switch on the -Z face. See drawing CDS-13-006, Deployment Switch and Separation Spring Location, for more details.

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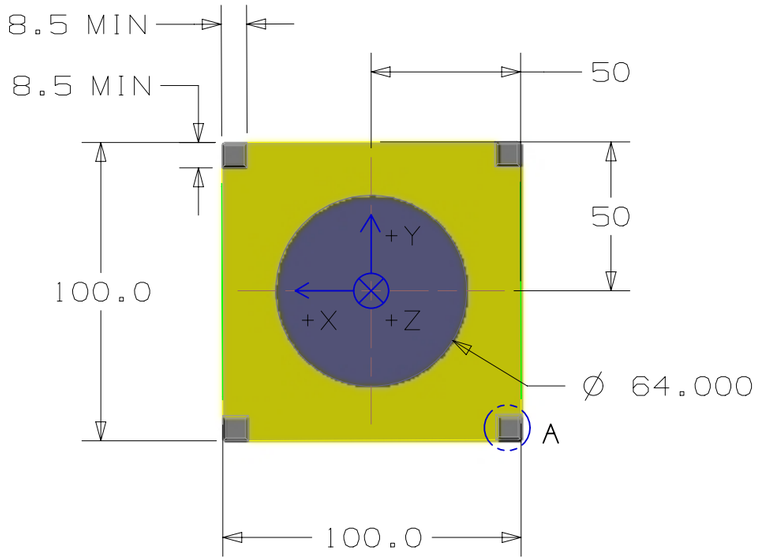
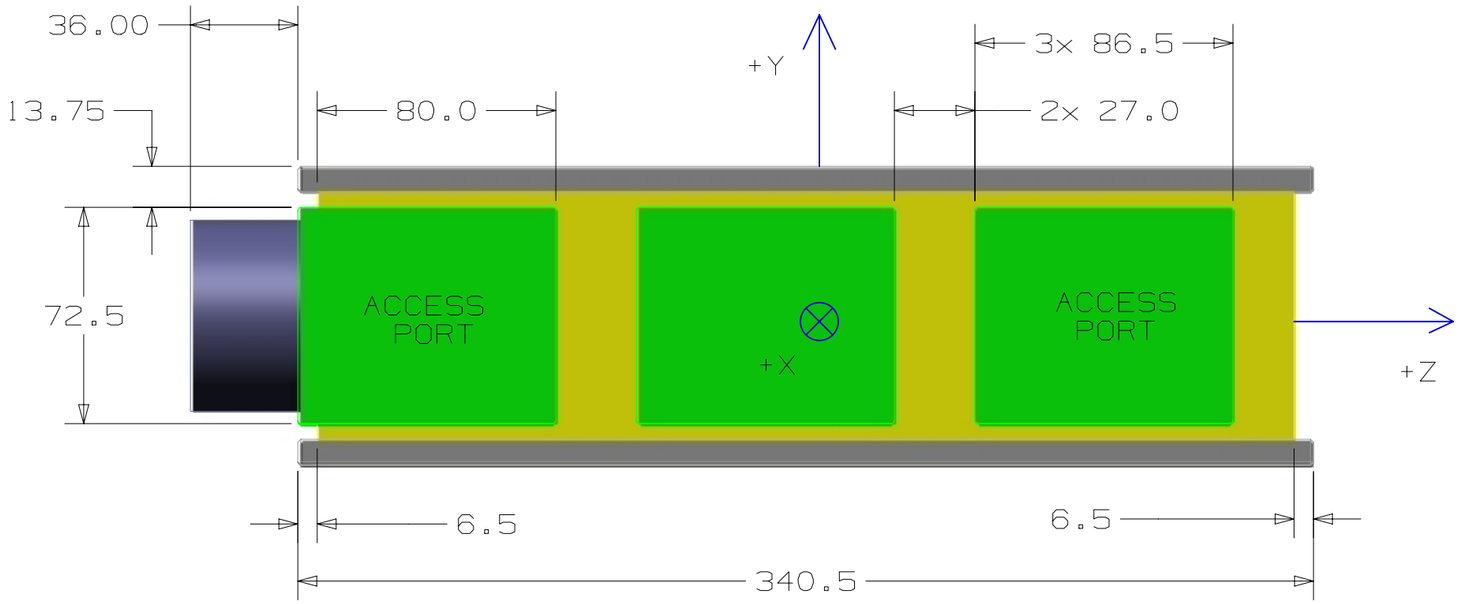
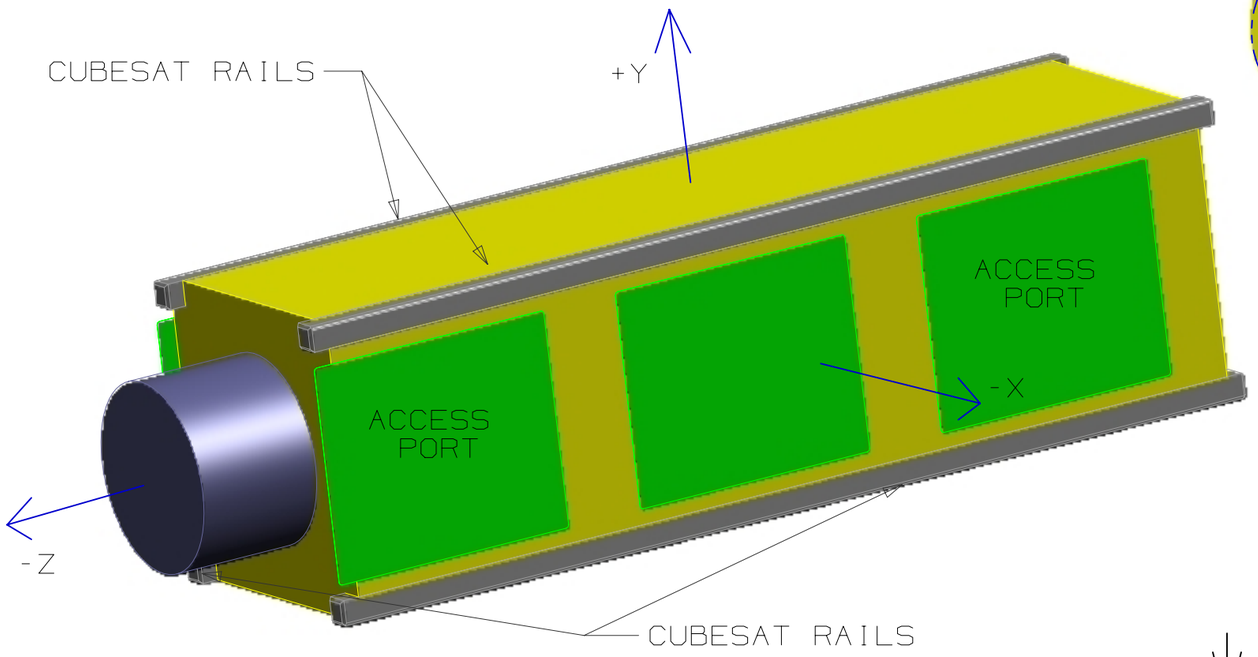
ALL DIMENSIONS IN MILLIMETERS	DESIGNED BY	S.FUR
	DRAWN BY	S.FUR
TOLERANCE .X ± 0.1	CHECKED BY	J.CAR
	APPROVED BY	R.NUG
ROUND ALL EDGES AND CORNERS		
	DRAWING #	CDS-13-004

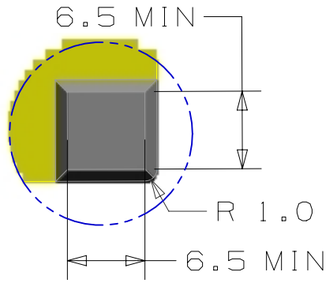
PART NAME: 3U CUBESAT
REV: 13
SIZE: B
ASSEMBLY: CUBESAT SPECIFICATION
NOT TO SCALE | DATE: 04/03/12 | SHEET 1 OF 1

Section 5
3U+ CubeSat Design Specification Drawing









DETAIL A
STANDOFF CONTACT
DETAIL FOR -Z

ADDITIONAL NOTES:

-CubeSat coordinate system located in the geometric center of the CubeSat.

-No external components other than the rails shall touch the inside of the P-POD.

-All 3U+ CubeSats must have at least one (1) deployment switch on the -Z face. See drawing CDS-13-006, Deployment Switch and Separation Spring Location, for more details.

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ALL DIMENSIONS IN MILLIMETERS	DESIGNED BY	S.FUR	PART NAME: 3U+ CUBESAT — REV: 13
TOLERANCE .X ± 0.1	DRAWN BY	S.FUR	
	CHECKED BY	J.CAR	
ROUND ALL EDGES AND CORNERS	APPROVED BY	R.NUG	SIZE: B — ASSEMBLY: CUBESAT SPECIFICATION
	DRAWING #	CDS-13-005	NOT TO SCALE — DATE: 04/05/11 — SHEET 1 OF 1

Appendix C:
1U, 1.5U, 2U, 3U, and 3U+
CubeSat Acceptance Checklist

Section 1
1U CubeSat Acceptance Checklist

1U CubeSat Acceptance Checklist

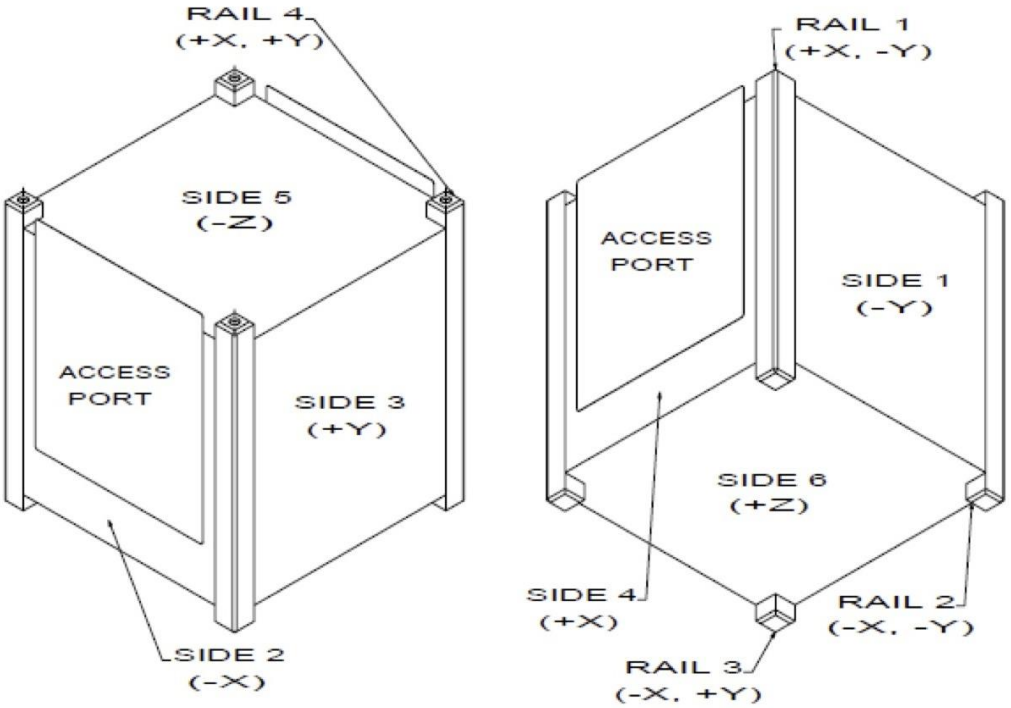
Project: Date/Time: Engineers:

Organization: Location:

Satellite Name: Satellite S/N:

Mass ($1.0^{+0.5}_{-0.2}\,kg$)	_____	**RBF Pin** (≤6.5mm)	_____
Spring Plungers (Depressed)	Functional Y / N Flush with Standoff Y / N	**Rails Anodized**	Y / N
Deployment Switches (Depressed)	Functional Y / N Flush with Standoff Y / N	**Deployables Constrained**	Y / N

Mark on the diagram the locations of the RBF pin, connectors, deployables, and any envelope violations.



Authorized By:

IT #1: _____

IT #2: _____

Passed: **Y** / **N**

List Item	As Measured				Required
Width [x-y]	Side 1 (-Y)	Side 2 (-X)	Side 3 (+Y)	Side 4 (+X)	
+Z	_____	_____	_____	_____	$100.0^{+0.1}_{-0.1}\,mm$
Middle	_____	_____	_____	_____	$100.0^{+0.1}_{-0.1}\,mm$
-Z	_____	_____	_____	_____	$100.0^{+0.1}_{-0.1}\,mm$
Height [x-y]	Rail 1 (+X, -Y)	Rail 2 (-X, -Y)	Rail 3 (-X, +Y)	Rail 4 (+X,+Y)	
	_____	_____	_____	_____	$113.5 \pm 0.5mm$
	Rail 1 (+X, -Y) length x width	Rail 2 (-X, -Y) length x width	Rail 3 (-X, +Y) length x width	Rail 4 (+X, +Y) length x width	
+Z Standoffs	____ x ____	____ x ____	____ x ____	____ x ____	$\geq 6.5mm$
-Z Standoffs	____ x ____	____ x ____	____ x ____	____ x ____	$\geq 6.5mm$

Protrusions	Side 1 (-Y)	Side 2 (-X)	Side 3 (+Y)	Side 4 (+X)	Side 5 (-Z)	Side 6 (+Z)	
	_____	_____	_____	_____	_____	_____	$\leq 6.5mm$

Section 2
1.5U CubeSat Acceptance Checklist

1.5U CubeSat Acceptance Checklist

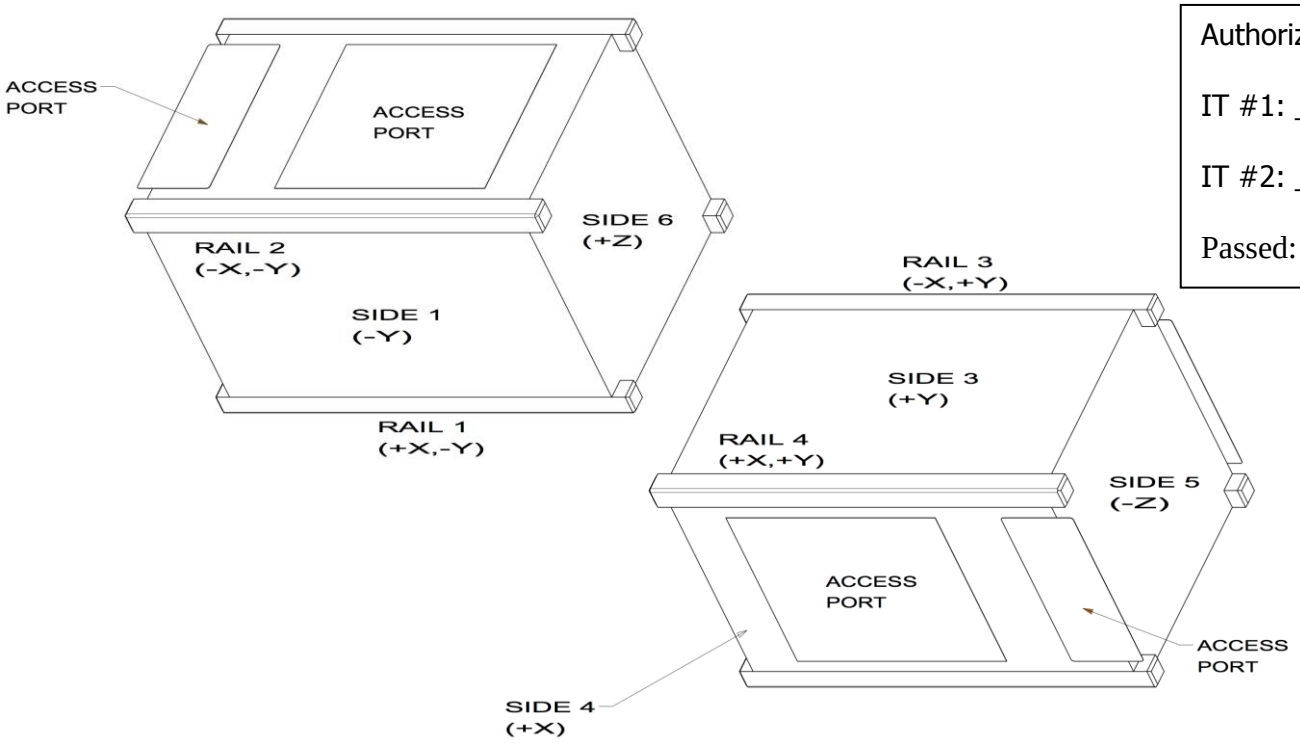
Project: Date/Time: Engineers:

Organization: Location:

Satellite Name: Satellite S/N:

Mass ($1.5^{+0.7}_{-0.3} kg$)	_____	**RBF Pin** (≤6.5mm)	_____
Spring Plungers (Depressed)	Functional Y / N Flush with Standoff Y / N	**Rails Anodized**	Y / N
Deployment Switches (Depressed)	Functional Y / N Flush with Standoff Y / N	**Deployables Constrained**	Y / N

Mark on the diagram the locations of the RBF pin, connectors, deployables, and any envelope violations.



Authorized By:

IT #1: _____

IT #2: _____

Passed: **Y** / **N**

List Item	As Measured				Required
Width [x-y]	Side 1 (-Y)	Side 2 (-X)	Side 3 (+Y)	Side 4 (+X)	
+Z	_____	_____	_____	_____	$100.0^{+0.1}_{-0.1} mm$
Middle	_____	_____	_____	_____	$100.0^{+0.1}_{-0.1} mm$
-Z	_____	_____	_____	_____	$100.0^{+0.1}_{-0.1} mm$
Height [x-y]	Rail 1 (+X, -Y)	Rail 2 (-X, -Y)	Rail 3 (-X, +Y)	Rail 4 (+X,+Y)	
	_____	_____	_____	_____	$170.2 \pm 0.7 mm$
	Rail 1 (+X, -Y) length x width	Rail 2 (-X, -Y) length x width	Rail 3 (-X, +Y) length x width	Rail 4 (+X, +Y) length x width	
+Z Standoffs	____ x ____	____ x ____	____ x ____	____ x ____	$\geq 6.5mm$
-Z Standoffs	____ x ____	____ x ____	____ x ____	____ x ____	$\geq 6.5mm$

Protrusions	Side 1 (-Y)	Side 2 (-X)	Side 3 (+Y)	Side 4 (+X)	Side 5 (-Z)	Side 6 (+Z)	
	_____	_____	_____	_____	_____	_____	$\leq 6.5mm$

Section 3
2U CubeSat Acceptance Checklist

2U CubeSat Acceptance Checklist

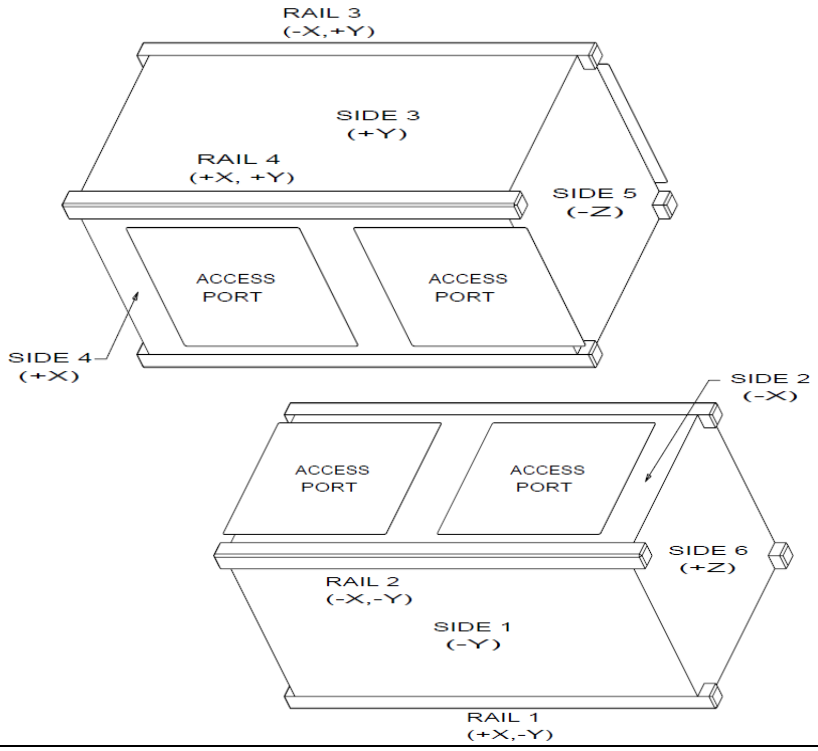
Project: Date/Time: Engineers:

Organization: Location:

Satellite Name: Satellite S/N:

Mass ($2.0^{+0.7}_{-0.4} kg$)	_____	**RBF Pin** (≤6.5mm)	_____
Spring Plungers (Depressed)	Functional Y / N Flush with Standoff Y / N	**Rails Anodized**	Y / N
Deployment Switches (Depressed)	Functional Y / N Flush with Standoff Y / N	**Deployables Constrained**	Y / N

Mark on the diagram the locations of the RBF pin, connectors, deployables, and any envelope violations.



Authorized By:

IT #1: _____

IT #2: _____

Passed: **Y** / **N**

List Item	As Measured				Required
Width [x-y]	Side 1 (-Y)	Side 2 (-X)	Side 3 (+Y)	Side 4 (+X)	
+Z	_____	_____	_____	_____	$100.0^{+0.1}_{-0.1} mm$
Middle	_____	_____	_____	_____	$100.0^{+0.1}_{-0.1} mm$
-Z	_____	_____	_____	_____	$100.0^{+0.1}_{-0.1} mm$
Height [x-y]	Rail 1 (+X, -Y)	Rail 2 (-X, -Y)	Rail 3 (-X, +Y)	Rail 4 (+X,+Y)	
	_____	_____	_____	_____	$227.0 \pm 1.0 mm$
	Rail 1 (+X, -Y) length x width	Rail 2 (-X, -Y) length x width	Rail 3 (-X, +Y) length x width	Rail 4 (+X, +Y) length x width	
+Z Standoffs	____ x ____	____ x ____	____ x ____	____ x ____	$\geq 6.5 mm$
-Z Standoffs	____ x ____	____ x ____	____ x ____	____ x ____	$\geq 6.5 mm$

Protrusions	Side 1 (-Y)	Side 2 (-X)	Side 3 (+Y)	Side 4 (+X)	Side 5 (-Z)	Side 6 (+Z)	
	_____	_____	_____	_____	_____	_____	$\leq 6.5 mm$

Section 4
3U CubeSat Acceptance Checklist

3U CubeSat Acceptance Checklist

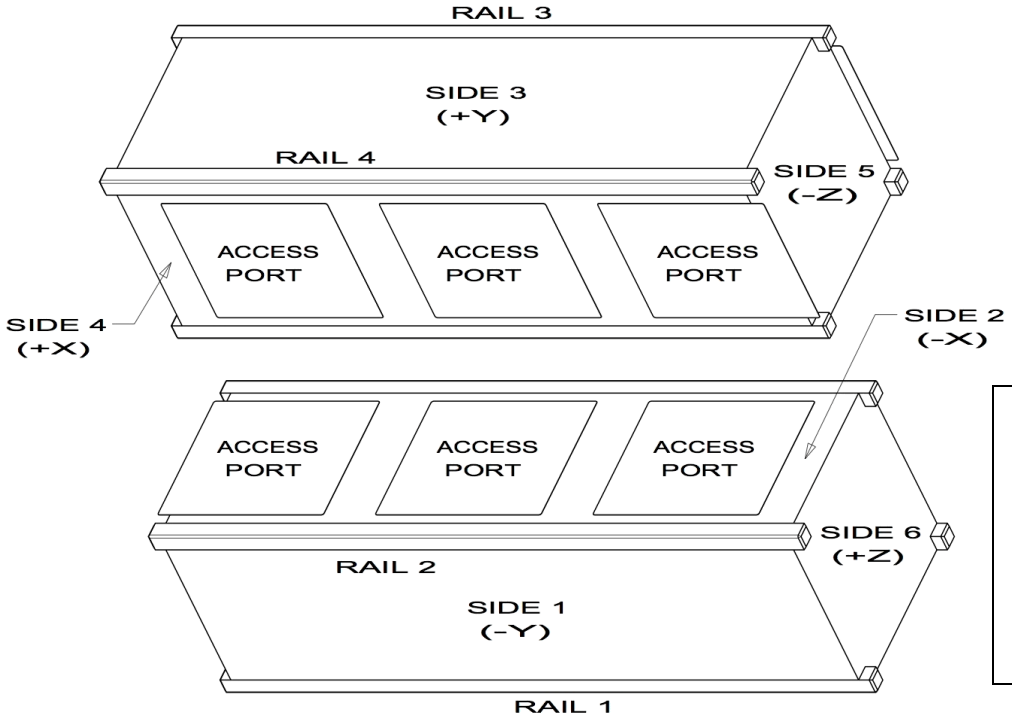
Project: Date/Time: Engineers:

Organization: Location:

Satellite Name: Satellite S/N:

Mass (< 4 kg)	_____	**RBF Pin** (≤6.5mm)	_____
Spring Plungers (Depressed)	Functional Y / N Flush with Standoff Y / N	**Rails Anodized**	Y / N
Deployment Switches (Depressed)	Functional Y / N Flush with Standoff Y / N	**Deployables Constrained**	Y / N

Mark on the diagram the locations of the RBF pin, connectors, deployables, 3U+ Protrusion, and any envelope violations.



Authorized By:

IT #1: _____

IT #2: _____

Passed: **Y** / **N**

3U+ Volume

Length (Z): _____ $\leq 36mm$

Diameter: _____ $\leq 64mm$

3U+ Centered: **Y** / **N**

List Item	As Measured						Required
Width [x-y]	Side 1 (-Y)	Side 2 (-X)	Side 3 (+Y)	Side 4 (+X)			
+Z	_____	_____	_____	_____			$100.0^{+0.1}_{-0.1} mm$
Middle	_____	_____	_____	_____			$100.0^{+0.1}_{-0.1} mm$
-Z	_____	_____	_____	_____			$100.0^{+0.1}_{-0.1} mm$
Height [x-y]	Rail 1 (+X, -Y)	Rail 2 (-X, -Y)	Rail 3 (-X, +Y)	Rail 4 (+X,+Y)			
	_____	_____	_____	_____			$340.5 \pm 1.5mm$
	Rail 1 (+X, -Y) length x width	Rail 2 (-X, -Y) length x width	Rail 3 (-X, +Y) length x width	Rail 4 (+X, +Y) length x width			
+Z Standoffs	____ x ____	____ x ____	____ x ____	____ x ____			$\geq 6.5mm$
-Z Standoffs	____ x ____	____ x ____	____ x ____	____ x ____			$\geq 6.5mm$
Protrusions	Side 1 (-Y)	Side 2 (-X)	Side 3 (+Y)	Side 4 (+X)	Side 5 (-Z)	Side 6 (+Z)	
	_____	_____	_____	_____	_____	_____	$\leq 6.5mm$

Section 5
3U+ CubeSat Acceptance Checklist

3U+ CubeSat Acceptance Checklist

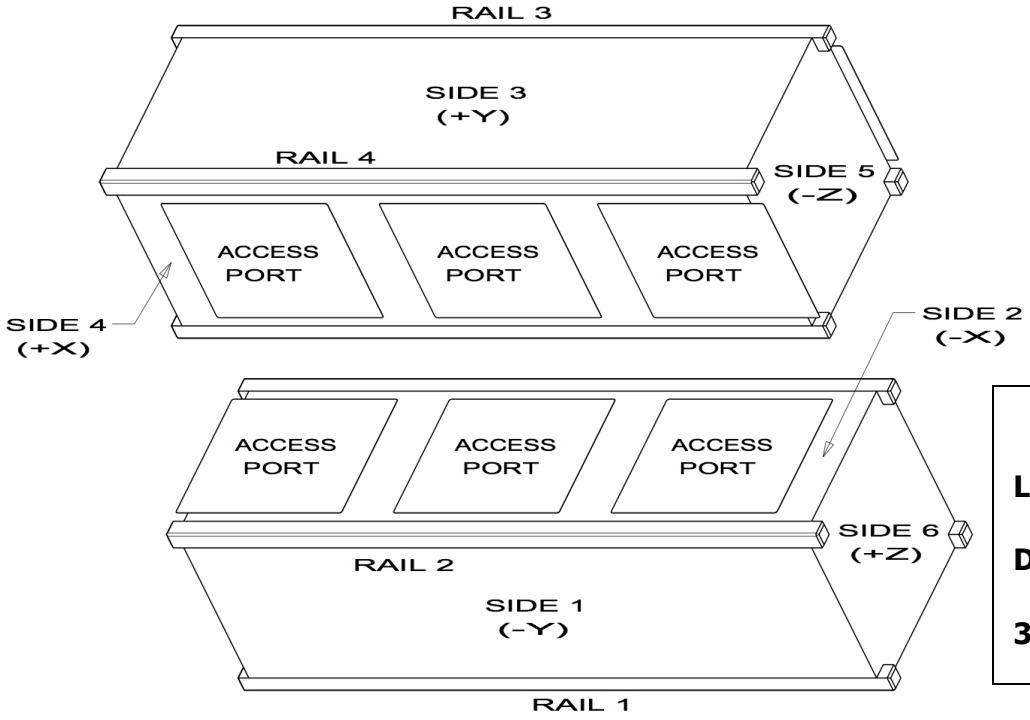
Project: Date/Time: Engineers:

Organization: Location:

Satellite Name: Satellite S/N:

Mass (< 4 kg)	_____	**RBF Pin** (≤6.5mm)	_____
Spring Plungers (Depressed)	Functional Y / N Flush with Standoff Y / N	**Rails Anodized**	Y / N
Deployment Switches (Depressed)	Functional Y / N Flush with Standoff Y / N	**Deployables Constrained**	Y / N

Mark on the diagram the locations of the RBF pin, connectors, deployables, 3U+ protrusions, and any envelope violations.



Authorized By:

IT #1: _____

IT #2: _____

Passed: **Y** / **N**

3U+ Volume

Length (Z): _____ $\leq 36mm$

Diameter: _____ $\leq 64mm$

3U+ Centered: **Y** / **N**

List Item	As Measured				Required
Width [x-y]	Side 1 (-Y)	Side 2 (-X)	Side 3 (+Y)	Side 4 (+X)	
+Z	_____	_____	_____	_____	$100.0^{+0.1}_{-0.1}mm$
Middle	_____	_____	_____	_____	$100.0^{+0.1}_{-0.1}mm$
-Z	_____	_____	_____	_____	$100.0^{+0.1}_{-0.1}mm$
Height [x-y]	Rail 1 (+X, -Y)	Rail 2 (-X, -Y)	Rail 3 (-X, +Y)	Rail 4 (+X,+Y)	
	_____	_____	_____	_____	$340.5 \pm 1.5mm$
	Rail 1 (+X, -Y) length x width	Rail 2 (-X, -Y) length x width	Rail 3 (-X, +Y) length x width	Rail 4 (+X, +Y) length x width	
+Z Standoffs	____ x ____	____ x ____	____ x ____	____ x ____	$\geq 6.5mm$
-Z Standoffs	____ x ____	____ x ____	____ x ____	____ x ____	$\geq 6.5mm$

Protrusions	Side 1 (-Y)	Side 2 (-X)	Side 3 (+Y)	Side 4 (+X)	Side 5 (-Z)	Side 6 (+Z)	
	_____	_____	_____	_____	_____	_____	$\leq 6.5mm$