KiboCUBE

CubeSat Mission Application for the Second Round

CubeSat Name: (Name of the 1U CubeSat here)			
Organization: (Name of your organization)			
Head of the organization: Dr./Prof./Mr./Ms. FirstName Middle LASTNAME Position / profession Address Line 1 Address Line 2 **Tel.:** **Fax:** **E-mail:**		**Principal Investigator:** (point of contact) Dr./Prof./Mr./Ms. FirstName Middle LASTNAME Position / profession Address Line 1 Address Line 2 **Tel.:** **Fax:** **E-mail:**	
Version: 0.0	**Issue Date:** 07/10/2016	**Document Type:** Application	**Valid from:** (date)

Applicant's Certification

All statements in this CubeSat Mission Application are true, correct and complete.

If selected, the applicant confirms that their Organization will comply with the Terms and Conditions described in the Announcement of Opportunity[1].

Issued By:
(issuer name and signature here, usually Principal Investigator)

_____

Approved By:
(approver name and signature here, usually head of the organization)

_____

Document Change Record

Version	Date	Changed chapters	Remarks
0	(date)	document created	— (template adapted from [6])
1.0	(date)	All	First submission
1.1	(date)	4.1, 4.2	Corrections...
2.0	(date)	2-5	Major update on...

(Version 1.0 should be the first submission. Please submit an updated version to reflect any changes required by OOSA/JAXA. For small corrections, increment the subversion (e.g., 1.0, 1.1, 1.2...). Reflect major changes by incrementing the version number of the document (e.g., 2.0, 3.0...). During the duration of the project, please provide additional updates when requested: after various design and safety reviews, acceptance tests, and a pre-launch version. A final version should be submitted after the end of the project including results, outcomes, and lessons learned.)

Abstract

The abstract comes here.

[Note to applicant: Please remove instructions before submission, in this abstract section and in the rest of the template.]

General Instructions

Fill each and every section of this document with as much detail as you can, following the instructions given.

1. Please prepare the CubeSat Mission Application in accordance with the guidelines given in this template.
2. Make the descriptions in the documents specific and comprehensive utilizing charts and tables. Reference in the text all charts, figures and tables used (for example, here we refer to Table 1.1).
3. Clearly define and explain uncommon words, abbreviations and acronyms. List all acronyms in Section 8.1.
4. Indicate the equipment of the CubeSat that have already completed design/development phases in Chapter 4.
5. Write "TBD" when information is not yet available on an item.
6. Using the provided Word or LaTeX templates is encouraged. If it is not possible, the application should follow the following general format:
   i Size of paper: A4
   ii Margins: 20 mm from the edge
   iii Page number: 15 mm from the bottom edge
   iv Body font and size: Times New Roman 10-12 points
7. The total number of pages of the body of the application materials cannot exceed 40 from Introduction to References (this excludes front page, change log, abstract, index, list of figures, list of tables and annexes). If an item has many pages, put a summary in the body with a reference to the associated annex.

The CubeSat Mission Application, FULLY COMPLETED, should be sent by post, to the United Nations Office for Outer Space Affairs, Vienna International Centre, P.O. Box 500, A 1400 Vienna, Austria, in compliance with the Section 13 of the Announcement of Opportunity [1], no later than 31 March 2017. Please also e-mail the original e-file in pdf (LaTeX or WORD generated) and a scanned front page with the Applicant's Certification signatures as a pdf-file (.pdf) to hsti-kibocube@unoosa.org. Please ensure the e-file size is less than 10 MB (or split it to send by email).

NOTE: The application is only considered valid if all the information requested is provided.

Contents

List of Tables

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Introduction

1.1 CubeSat Mission Statement

1.2 CubeSat Experiment Objectives

List the objectives of the CubeSat mission, providing information in the staging of goals (minimum mission success, full mission success and secondary level objectives) and their evaluation criteria. Include also potential problems and conflicts and possible solutions to reach the above goals and explanations showing that the solutions proposed are effective (you may refer to Section 3.5.1, if included, which provides a detailed risk analysis).

A table can be provided in order to provide a good overview of the objectives. See for example Table 1.1.

Table 1.1. Experiment objectives

Objective	Nature	Priority
objective text	scientific,	primary/secondary
objective 2 text	technical etc.	or minimum/full/secondary

1.3 Team Details

List the team/research collaborators. For each organization and collaborator, provide the status of the organization (Public or Private). For any academic institution involved, please provide:

- Age of students (if applicable)
- Gender of students admitted (male only / female only / both)

1.3.1 Principal Investigator

Please provide again the contact details for the PI, who will also be the point of contact.

1.3.2 Team Members

1.4 Scientific/Technical Background

List past achievements on satellite development or subsystem development. Describe relevant past experience which can contribute to satellite development, if applicable.

2

CubeSat Requirements and Constraints

Provide a list of requirements for your CubeSat. Please include all applicable requirements from the JEM Payload Accommodation Handbook [2], from now on referred to as "the Handbook". Take as well into account applicable space debris mitigation requirements, as well as the deployment and safety standards of the ISS. The primary standards specific to the ISS are reported in the Announcement of Opportunity [1]. A few examples are here included, please expand, split or join requirements together when needed.

2.1 Mission Requirements

Please include all requirements related to your mission, from functional requirements (e.g.: The CubeSat shall be able to take pictures of cloud cover), to performance requirements (e.g.: The minimum resolution shall be XXX).

Table 2.1. Mission requirements

ID #	Requirement
MI-010	Text of first requirement. Number them in steps of 10.
MI-020	text.
MI-030	text.
MI-031	Text of a related requirement. (If a sub-requirement or related requirement is added later on, use intermediate numbers to group them in the most logical way.)
MI-040	text.
MI-100	For a complete set of requirements unrelated to the previous ones, skip to the next hundred. General rule: group them in this type of blocks for ease of reading.
MI-110	text.
MI-120	Deleted. (If a requirement is deleted or no longer applicable, indicate deleted but do not reuse the ID number. This way it is useful to track deleted requirements.)
MI-130	text.
MI-200	text.

2.2 Design Requirements

Please include also in this section all applicable and relevant design requirements from the JEM Payload Accommodation Handbook [2]. For reference only, please see as well Appendix B-1 (for 1-U CubeSats) of the CubeSat Design Specifications [4].

Table 2.2. Design requirements

ID #	Requirement
DE-010	The CubeSat size in stored configuration shall correspond to the 1U CubeSat standard (100x100x113.5 ±0.1 mm).
DE-020	The mass of the CubeSat shall be larger than 0.13 kg and less than 1.33 kg (1U)
DE-...	text.
DE-200	The ballistic coefficient of the CubeSat shall be less than 100 kg/m^2 to ensure a faster orbiting decay of the CubeSat than the ISS.
DE-210	The CubeSat minimum cross section (any cross section which can be physically or electromagnetically sighted) shall be no less than 100 cm^2 to be trackable by the Space Surveillance Network (SSN) of the United States.
DE-...	text.
DE-300	The materials and their outgassing characteristics shall meet the standard specified in the Handbook [2]. [Please expand or split into multiple requirements if applicable.]
DE-310	Any leak of toxic liquid used in battery electrolyte solutions shall be prevented.
DE-320	Any parts that may be broken by cracking shall be protected or strengthened by sealing.
DE-330	Any materials that have the potential to shatter when cracked shall be contained.
DE-...	

Regarding materials, to verify the appropriateness, all the data on the materials shall be reported to JAXA. In order to obtain necessary data of the materials, JAXA can support the outgassing test for the CubeSat.

2.3 Operational Requirements

List your operational requirements (for example tracking related, link budget related...). Please include all applicable space debris mitigation requirements, as well as the deployment and safety standards of the ISS. In general, crew access are normally limited to removing a Remove Before Flight (RBF) pin. If an astronaut is required to handle the satellite and operate it in the ISS due to features of the satellite design, crew access actions shall be planned in accordance with the conditions reported in the Announcement of Opportunity [1]. As an example, some crew access requirements have been listed in Table 2.3. Please include ONLY if applicable.

Table 2.3. Operational requirements

ID #	Requirement
OP-010	Once deployed from Kibo, the separation of the CubeSat from the centre of ISS shall be larger than 200 m after the first orbit.
OP-...	text.
OP-100	The CubeSat shall be able to remain in storage at a JAXA facility for a duration of six to twelve months from the time of delivery to JAXA to the deployment from Kibo.

continued on next page

Table 2.3. Operational requirements – continued from previous page

ID #	Requirement
OP-110	The CubeSat shall not require the provision of electrical power during the transport of the CubeSat to and the deployment of the CubeSat from Kibo.
OP-120	[The CubeSat shall be compliant with the Electromagnetic Compatibility requirements of the ISS. Please include all applicable and expand into multiple requirements if applicable.]
OP-...	
OP-200	Safety features shall be put into place to protect astronauts from inadvertent contact with any sharp edges of the CubeSat.
OP-210	The CubeSat shall not be taken out of the Satellite Install Case, but shall be accessed from the access window.
OP-220	[The CubeSat design shall be compliant with the requirements of surface touch temperature of the ISS for crew contact. Please include details and expand only if applicable.]
OP-...	

2.4 Constraints

[if applicable]

3

Project Planning

Charts (e.g., Gantt charts) and graphs can be utilized for the description if needed. The following points should be confirmed in this section and its subsections:

- That manpower required to implement the plan is secured.
- That the project applicant is capable of performing the tasks according to the schedule and achieve results within their demonstrated experience and qualifications.
- That the support organizations involved in the plan can fulfil their tasks according to a detailed and adequate division of work and responsibility among the main actors.

3.1 Implementation Structure

3.2 Schedule

Indicate the timeline of the design, purchase, production and test plan per each model such as Breadboard Model (BBM), Engineering Model (EM), Structure/Thermal Model (STM), and Flight Model (FM), if applicable. Include plans for safety reviews for each phase and a final compatibility review of the Flight Model.

3.2.1 Desired launch date and deployment date

- Specify the desired date for launch and deployment (MM/YYYY) along with the reasons.
- Indicate the time required to develop and deliver the satellite to JAXA after being designated as the Selected Entity.

3.3 Resources and Financial Plan

- Provide a detailed financial plan to implement the project with material procurement cost, facility rental fees accrued for development of the CubeSat system, subsystem, and ground systems at a rough estimate.
- Confirm that you have secured all the funds necessary to design, develop and test the CubeSat, including the cost of delivering the satellite to JAXA and of visiting JAXA facility when required (for example, for the safety review). Attach a document as annex to certify the confirmation, if any.
- You may refer to any involvement of your Government to support the proposed CubeSat mission on relevant areas such as science and technology, economics and/or education programmes.

3.3.1 Manpower

3.3.2 Budget

3.3.3 External support

3.4 Outreach Approach

Outreach/Public relations/Capacity-building aspects

- Explain how the results of the development and operation of the CubeSat could be maintained, disseminated and developed.
- Describe the plan for educational promotion and capacity-building activities in your institution as well as in your country and abroad through this programme.
- Describe the plan for public events in your institution as well as in your country when your CubeSat is deployed from Kibo.

Link also to Annex A, where a list of outreach and media coverage events during the project will be provided in subsequent versions of the document.

[If you considered the additional sub-items should be included in the Project Planning (for example, Risk Analysis, Reliability Analysis, Maintainability), please describe below.]

3.5 Supplementary Notes

3.5.1 (Not a Mandatory Section) Risk Analysis

This section is not mandatory, but is included here as an example of additional sub-items that the applicant may want to submit.

If desired, conduct a risk analysis on each action/timeline and indicate reasonable plans to implement the concrete measures and solutions to maintain the timeline of the CubeSat manufacturing and the safety of the mission. Try to reduce all risks, either in probability for it to occur or in their severity, to acceptable risks (for an example of a risk index table, see Figure 3.1).

Probability / likelihood	**Risk Index: Combination of Severity and Likelihood**				
E	Low	Medium	High	Very High	Very High
D	Low	Low	Medium	High	Very High
C	Very Low	Low	Low	Medium	High
B	Very Low	Very Low	Low	Low	Medium
A	Very Low	Very Low	Very Low	Very Low	Low
	1	2	3	4	5 **Severity**

Fig. 3.1. Risk index. Adapted from [5]

The format or structure of the risk analysis is not mandatory. This section provides an example based on ECSS Standards [5], please modify according to your needs. In this example format, a risk register table details all foreseen risks (see Table 3.1). This table may include from technical to personnel risk (e.g., lack of manpower for certain phases...). The table also includes any action planned to reduce risks.

The following shorthands are used in the example format:

For the risk ID:

- **TC** technical/implementation (example TC-010, TC-020...)
- **MS** mission (operational performance)
- **SF** safety
- **VE** vehicle
- **PE** personnel
- **EN** environmental

For the probability or likelihood **P**:

- **A** Minimum – Almost impossible to occur
- **B** Low – Small chance to occur
- **C** Medium – Reasonable chance to occur
- **D** High – Quite likely to occur
- **E** Maximum – Certain to occur, maybe more than once

For the severity **S**:

- **1** Negligible – Minimal or no impact
- **2** Significant – Leads to reduced experiment performance
- **3** Major – Leads to failure of subsystem or loss of flight data
- **4** Critical – Leads to experiment failure or creates minor health hazards
- **5** Catastrophic – Leads to termination of the programme, damage to the vehicle or injury to personnel

Table 3.1. Risk Register

ID	Risk and consequences	P	S	P × S	Action(s)
number	description	A	3	very low	—
number	description	E	1	low	—
number	description	B	5	medium	—
number	description	D	4	high	—

4

CubeSat Specifications and Detailed Description

Indicate the specifications and the design per subsystem according to the grouping as follows:

4.1 CubeSat Setup and Overall System

Include (you can use graphs and tables for some items such as Table 4.1):

- 3D view.
- External dimensions: the size of protruding objects should be also indicated, if there are any.
- Mass: not only the total mass of the CubeSat, but the mass distribution among the satellite. subsystems and CubeSat mission payload should also be indicated.
- System block diagram and list of components.
- Structural analysis.
- Payload profiles.
- Subsystem analysis (structure, thermal, power, communication, data processing, attitude and payload). See Sections 4.3 to 4.9.

Table 4.1. CubeSat main specifications

[Please refer to the Handbook [2] and comply with the specifications]

Parameter	Values	Units
mass	[1U: less than 1.33]	kg
dimensions	[1U: 100×100×113.5]	mm
dimensions (deployed)		cm
ballistic coefficient		kg/m^2
expected COG position		—

4.1.1 CubeSat Components

Include a list of components produced or purchased. Components in the system block diagram are detailed per satellite subsystem. Based on this grouping, the subsystems will be summarized in the list of components as produced or purchased.

Please indicate one of the following for each item:

- Purchased item (Developed product),
- Purchased item (Proven product that has space-flight performance),
- In-house produced item (Developed), or
- In-house produced item (Proven).

4.2 CubeSat Interfaces

Please refer to JEM [2] and the AO [1]. Include a schematic of the interfaces.

4.2.1 Mechanical

4.2.2 Electrical

4.2.3 Radio-frequencies

4.2.4 Thermal

4.3 Structural and Mechanical Subsystem Design

Design for primary structure, mechanisms such as deployment of solar panels and antenna, equipment layout plans, separation mechanism, and materials for primary structure

4.4 Thermal Subsystem Design

List of components and control system

4.5 Power Subsystem Design

List of components, schematic of the electronics, and control system

4.6 Communication Subsystem Design and Ground Support Equipment

List of components, frequency, and satellite ground stations

4.7 Data Processing Subsystem Design

List of components, CPU, data compression method, data recorder, and multiplexing schematics

4.8 Attitude and Orbit Control Subsystem Design

List of components, attitude control methods, orbit control methods, and control accuracy

4.9 Payload

List of components for the payload of the CubeSat mission

4.10 Additional technical features of the CubeSat

Include existence or non-existence of hazardous materials such as toxic gas or flammable materials, and specifications of unique equipment.

Indicate the features, performances, and solutions towards development in detail including charts and diagrams.

4.11 Novelty, progressiveness, uniqueness and possible evolution

Versatility of the CubeSat system, progressiveness and possible evolution of the CubeSat with comprehensive descriptions.

5

CubeSat Verification

Include a verification plan for the CubeSat and a safety review schedule.

This plan should refer to Chapter 4.2.2. “Safety Design Guidelines” (for testing of the CubeSat), and Chapter 5.4. “Safety Review and Design Review” (for schedule), and Verification matrix in Appendix C of the JEM Payload Accommodation Handbook [2].

5.1 Verification Matrix

[The verification matrix lists all still applicable requirements identified by their ID number -refer to Chapter 2-, with the type of verification that is used for that requirement, the test(s) that are use for verification, and the status. It is to be used for verification purposes. All requirements need to be verified by at least one test -or inspection/review/analysis procedure-, and all test need to verify at least one requirement.]

Table 5.1 shows the verification matrix. The following legend applies for the column **V** (verification):

- **A** verification by analysis
- **I** verification by inspection
- **R** verification by review of design
- **T** Verification by test

Table 5.1. Verification matrix

[Please refer to the Handbook [2] and comply with the specifications]

ID #	Requirement text	V	Test #	Status
MI-010	text	T	2, 3, 10...	TBD
...	text	...	#, #,...	TBD
MI-...	text	A/I/R/T	#	TBD
...	text	...	#	TBD
DE-010	The CubeSat size in stored configuration shall correspond to the 1U CubeSat standard (100x100x113.5 ±0.1 mm).	I, R, T	10	TBD
...	text	I	#	TBD

If verification by test (T) is selected, please provide in column 4 which tests apply as in the example for DE-010.

5.2 Verification Plan

Include a verification plan for the CubeSat with facilities to be used.

- As listed above, verification methods are Analysis, Inspection, Review of design and Testing.
- Indicate the plans for verification such as electric and environmental tests on each model (BBM, EM, STM, and FM).
- For the electric tests, indicate the schedule for testing, not only for individual component tests but also for subsystem tests (including check out test for the interfaces among components), and system level tests (including End-to-End communication test) along with the preparation plan of the customized test equipment if required.
- For the environmental tests, indicate schedule and owner of the facilities for thermal cycle test, vacuum test, thermal vacuum test, vibration test, and shock test.

Provide a list and description of all test procedures (electric, vacuum, vibration...) planned to date following a template similar to that provided in Table 5.2.

Table 5.2. Test procedure #01: XXX (example)

Test #	01
Test type/name	...
Test facility	...
Tested item	...
Test level/procedure	...
Test campaign duration	...
Test campaign date	...
Requirements verified	XX,XX,XX
Test status	To be performed, passed, failed...

Table 5.3. Test procedure #10 [example number]: Integration Test (example)

Test #	10
Test type/name	Integration test
Test facility	...
Tested item	...
Test level/procedure	...
Test campaign duration	...
Test campaign date	...
Requirements verified	DE-010, DE-020,..
Test status	...

5.3 Verification Results

For later and final versions of the document, provide results, otherwise, leave empty.

6

Operations Planning and Preparation

6.1 Ground segment operation plan

Indicate a plan for the ground station operation and maintenance differentiating between new implementation, maintenance or utilization of existing facilities. This plan includes not only telemetry command operation facility but mission data processing facilities.

6.2 Frequency license plan

- Provide a plan for international frequency coordination to obtain a frequency license in compliance with the ITU regulations (including planned process, schedule and status).
- Provide a plan for obtaining a frequency license in compliance with the regulations in your country (including planned process, schedule and status). Provide evidence, such as the draft Advance Publication Information, if you have already started the licensing process.
- Indicate any foreseen obstacles for obtaining the license.

Please refer to the Guidelines on Space Object Registration and Frequency Management for Small and Very Small Satellites [3].

6.3 Space object registration

Indicate your intention and provide a plan to register your CubeSat in the United Nations Register of Objects Launched into Outer Space. Please refer once again to the Guidelines on Space Object Registration and Frequency Management for Small and Very Small Satellites [3].

6.4 End of life procedures of the CubeSat on orbit

Operations for the end of transmission, method for cutting off the battery charge lines, and for deorbiting the satellite within 25 years (after the launch).

6.5 Safety risks during operations

6.6 ISS operations planning and interfaces

List any operations and checks required during storage and deployment from ISS. They should take into account requirements and constraints listed in Chapter 2, and the CubeSat interfaces described in Section 4.2

[Include additional sections as needed, such as... (remove unnecessary sections).]

6.7 Post-flight activities

7

Data Analysis and Results

7.1 Data analysis plan

7.2 Results

(leave empty until final version)

7.3 Lessons learned

(leave empty until final version)

8

Abbreviations and References

8.1 Abbreviations

AIT	Assembly, Integration and Testing
a.k.a.	also known as
AL	Airlock
AO	Announcement of Opportunity
API	Advance Publication Information
asap	as soon as possible
BBM	Breadboard Model
BSTI	Basic Space Technology Initiative
CDR	Critical Design Review
CDS	CubeSat Design Specification
COG	Centre of Gravity
EAT	Experiment Acceptance Test
EAR	Experiment Acceptance Review
ECSS	European Cooperation for Space Standardization
EIT	Electrical Interface Test
EM	Engineering Model
FAR	Flight Acceptance Review
FM	Flight Model
FST	Flight Simulation Test
FRP	Flight Requirement Plan
FRR	Flight Readiness Review
GPU	Ground Power Unit
GSE	Ground Support Equipment
HK	House Keeping
HSTI	Human Space Technology Initiative
HTV	H-II B Transfer Vehicle
H/W	Hardware
IC	Integrated circuit
ICD	Interface Control Document
IDE	Integrated Development Environment
I/F	Interface
IGA	Inter-Governmental Agreement

IPR	Integration Progress Review
ISS	International Space Station
ITU	International Telecommunication Union
JAXA	Japan Aerospace eXploration Agency
JEM	Japanese Experiment Module, a.k.a. Kibo
Kibo	ISS Japanese Experiment Module, a.k.a. JEM
LED	Light-Emitting Diode
LO	Lift Off
LT	Local Time
LOS	Line of Sight
MFH	Mission Flight Handbook
n.a.	not applicable / not available
OOSA	Office for Outer Space Affairs
PCB	Printed Circuit Board
PDR	Preliminary Design Review
PI	Principal Investigator
PST	Payload System Test
RBF	Remove Before Flight
RF	Radio Frequency
SSN	Space Surveillance Network
STM	Structure/Thermal Model
S/W	Software
TBC	To Be Confirmed
TBD	To Be Determined
TKSC	Tsukuba Space Center
UN	United Nations
USB	Universal Serial Bus
WBS	Work Breakdown Structure
1U	1-Unit (CubeSat)

...

8.2 References

The first three entries are to be considered Applicable Documents and they supersede any other reference document in case of conflict. [Please list in this section any additional document or report you have cited in your application. Please remove extra items below if not used (they are just examples).]

[1] *Announcement of Opportunity: United Nations/Japan Cooperation Programme on CubeSat Deployment from the International Space Station (ISS) Japanese Experiment Module (Kibo) "KiboCUBE".* OOSA/JAXA, second edition, 2016.

[2] *JEM Payload Accommodation Handbook Vol. 8 - Small Satellite Deployment Interface Control Document, JX-ESPC-101133-B, Rev. B.* Japan Aerospace Exploration Agency (JAXA), 2015.

[3] *Guidance on Space Object Registration and Frequency Management for Small and Very Small Satellites.* OOSA/ITU, 2015.

[4] *CubeSat Design Specification (CDS), Rev. 13.* The CubeSat Program, Cal Poly SLO, 2013.

[5] *Space Project Management, Risk Management, ECSS-M-ST-80C.* European Cooperation for Space Standardization ECSS, 2008.

[6] T. Plüss. *REXUS/BEXUS Student Experiment Documentation LaTeX Template.* kooltek.net, 2015.

ANNEXES

A

Outreach and Media Coverage

B

Additional Technical Information