U N I T Y

Design Specification

The *Unity program* represents a response to the increasing need of individuals and groups for easier access to Space, in order to achieve sustainable progress in their work and development of this area.

The concept itself emerged in the post-conflict region as an attempt to re-establish the cooperation of the people in the region, but this time in a completely different way, which in itself goes beyond the current mode of thinking and demands a new approach in international relations, whereby independence in creation of each participant is not jeopardized, and on the other hand there is a constant presence of the necessity of cooperation among the participants. In this way, everyone achieves both individual and group goals, and progress is inevitable.

Technically, the *Unity program* is based on CubeSat standards (**http://www.cubesat.org/**), primarily by dimensions and basic characteristics. The POD deployer carries several small satellites (*UNITYsat*) which will be delivered in Orbit. All *UNITYsat*s are connected as a single satellite (1U or 2U or 3U form factor) and they are delivered from the POD deployer in Orbit as a single satellite that splits into several small *UNITYsat*s after a certain time. The main characteristics of the *UNITYsat* are as follows:

1. The chassis of every *UNITYsat* is made by combining of anodized aluminum (6061) and 3D printed filament;
2. Basic dimensions of every *UNITYsat* are 10.0x10.0x2.5cm (height can be 1.25cm for Version 2);
3. User/developer defines payload of its own *UNITYsat* with respect of the standards defined in this document;

The price is formed on the one *UNITYsat*: *development kit + launch service*. Although the volume of the one *UNITYsat* is 250 cm3, the same rules (rights and obligations) are valid as for large satellites. The user/developer can put all the basic subsystems and payload in its own *UNITYsat* if meets the defined standards. Testing of each *UNITYsat* before the launching process is mandatory and this is also defined by mentioned standards.

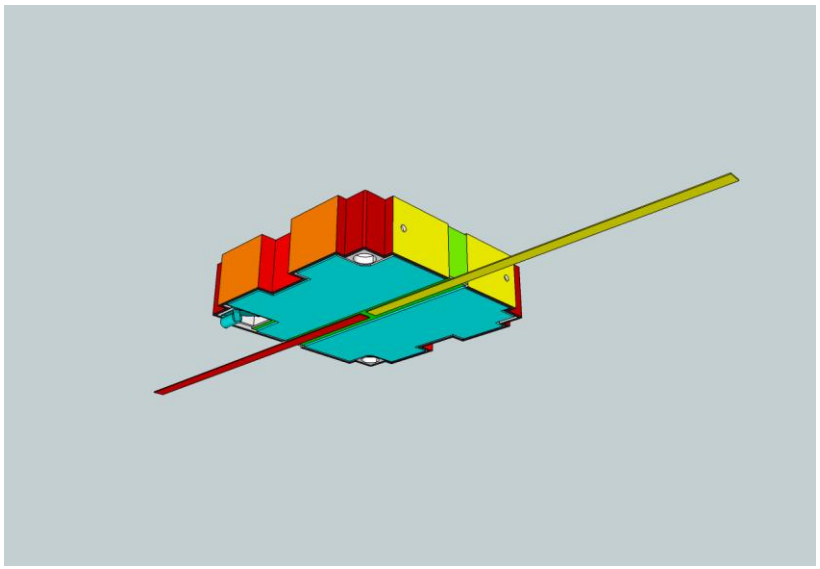
3.1. Each *UNITYsat* is sorted one on the other.

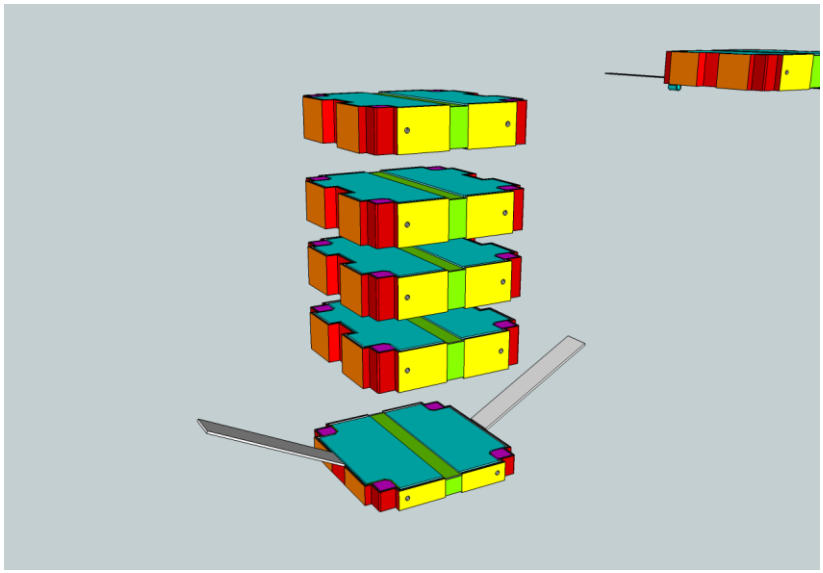
3.2. The RBF must be on designated side of the *UNITYsat* (yellow side) in the form of switch, that must not exceed the external dimension of the designated side, i.e. it must be in the same plane (file: UNITY**.skp**).

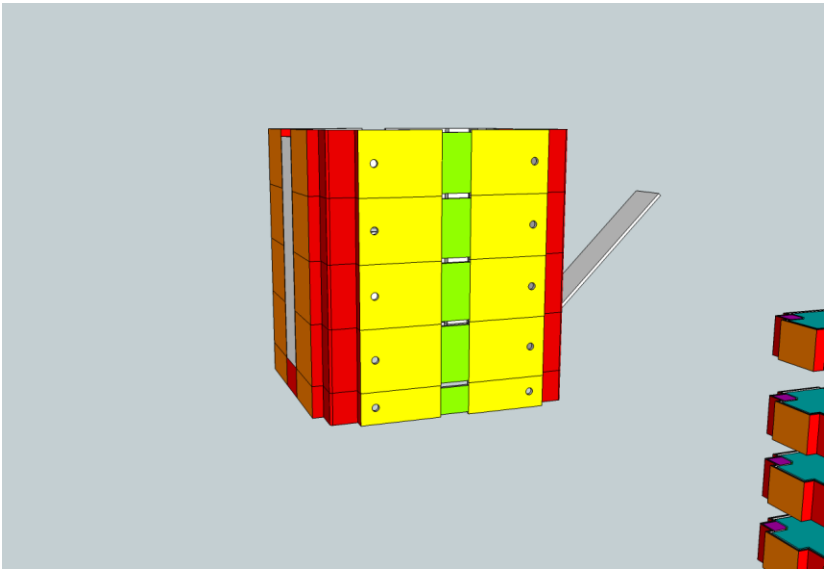
3.3. RBF is a mandatory part of each *UNITYsat* regardless of whether the user/developer has chosen to power its own *UNITYsat* only from batteries or uses and the Solar Cells.

3.4. Batteries may be full charged during launching, but the user/developer must provide a place (port) on a designated (yellow surface in **UNITY.skp**) side of *UNITYsat* for external battery charging and diagnostics if desired. External battery charging and diagnostics **will not be allowed** after placing *UNITYsat* in POD deployer!

3.5. Each user/developer creates its own NiChrome switch as an independent part of the *UNITYsat*, following the instructions obtained from CSPD&TSC or by purchasing it on the market also following the aforementioned instructions. Since that the name and idea of the entire program is *UNITY*, by publicly random selection method will be selected two NiChrome switches that will be implemented in the system as the main switches for separation of all *UNITYsat*s. Both NiChrome switches are at the same time and the main and the backup switches. Each NiChrome switch is activated immediately after the deployment from the POD deployer, and that is the moment when the countdown starts (about 15 minutes) until the NiChrome wires are heated and release mechanism enable separation of *UNITYsat*s.







- *UNITYsat* with basic dimensions -

Defined Standards for *UNITYsat*

1. General Requirements

1. All parts shall remain attached to the *UNITYsat* during launch, ejection and operation. No additional space debris shall be created.
2. Pyrotechnics shall not be permitted.
3. No pressure vessels shall be permitted.
4. No hazardous materials shall be used on a *UNITYsat*. If you are not sure if a material is considered hazardous contact us.
5. *UNITYsat* materials shall satisfy the following low out-gassing criterion to prevent contamination of other spacecraft during integration, testing, and launch.

   Note 1:
   A list of NASA approved low out-gassing materials can be found at: http://outgassing.nasa.gov
6. The latest revision of the *UNITYsat* Define Standards shall be the official version (http://2comnet.info/komsat/en/unity-program/), which all *UNITYsat* users/developers shall adhere to.

2. *UNITYsat* Mechanical Requirements

The *UNITYsat* in basis is not a square shape. The form defines the limitations in POD deployer.
File **UNITY.skp** represents a technical drawing of *UNITYsat*'s. General features of all *UNITYsat*'s include:

2.1 Exterior Dimensions

2.1.1 The *UNITYsat* shall use the coordinate system as defined in file **UNITY.skp**. The –Z face (bottom surface of the thinnest satellite with white holders and dipole antenna attached in **UNITY.skp**) will be inserted first into the POD Deployer.

2.1.2 The *UNITYsat* configuration and physical dimensions shall be per **UNITY.skp**.

2.1.3 The *UNITYsat* shall be 109.0±0.1 mm wide (X dimensions per **UNITY.skp**).

2.1.4 The *UNITYsat* shall be 109.0±0.1 mm wide (Y dimensions per **UNITY.skp**).

2.1.5 A single *UNITYsat* (basic dimension) shall be **maximum** 25.0 mm tall (Z dimension per **UNITY.skp**), including antennas and Solar cells (if exist).

2.1.5.1 **Note 2:** Users/developers should keep in mind that external structure (Anodized aluminum) of the *UNITYsat* will be delivered to each user/developer after additional purchase of structure. It is a prerequisite for participation in the program! In this way deviations in the external dimensions will be prevented.
The internal/core structure which holds electronics can be 3D printed (ABS filament). User/developer can design the internal/core structure as it likes, but with respect of the Defined Standards in this document.
Note 3*: In the **UNITY.skp** is given only an example of internal/core structure and changes are allowed!*

2.1.5.2 Users/developers can change everything in internal/core structure in **UNITY.skp** (wall thickness, bottom and cover thickness, to add inside what they need etc.) except the total height (24 mm) of the internal/core structure, holes for Spring Plungers, Main switch, and Antenna paths (green line on the Top and the Bottom). An integral part of total height must be and the thickness of Solar Cells and Antennas. This means that the **UNITY.skp** file serves only as an initial design that can be changed as needed.

2.1.5.3 Pink squares on the Top are places for separation between two *UNITYsat*s by Spring Plungers and because of that, pink squares must be covered with e.g. anodized aluminum (for example user/developer can 3D print those pink squares with entire internal/core structure and after that use small parts of thin anodized aluminum for covering. After covering, pink

squares can reach the maximum height of the *UNITYsat* i.e. to be aligned with the external structure height as it shown in **UNITY.skp**). User/developer should make the holes in internal/core structure for Spring Plungers as it shown in **UNITY.skp** and as explained in **2.3.2** part. 3D printing of the holes is allowed as it shown in **UNITY.skp**.

2.1.5.4 Users/developers that are interested in *2UNITYsat*, *3UNITYsat etc.* form factors will receive special additional instructions!

2.1.6 All *UNITYsat* parts/components may NOT contact the interior surface of the POD Deployer.

2.1.7 Yellow sides of *UNITYsat* are designated area for RBF switch, battery recharge and electronics diagnostic ports. On these sides screws for connecting external and internal/core structures are allowed. User/developer can put additional Solar cells or something else on these sides, but must not exceed an additional 2 mm.

2.1.8 User/developer can put additional Solar cells or something else on Orange sides of *UNITYsat*, but must not exceed an additional 2 mm. On these sides screws for connecting external and internal/core structures are also allowed.

2.1.9 Red colored places of *UNITYsat* represents rails and work in these places is NOT allowed!

2.1.10 Blue surfaces on the Top and the Bottom sides of *UNITYsat* represents designated places to which placement of the Solar cells is permitted. These places are limited by the Green line for the Antenna path and the external structure of the *UNITYsat*.

2.2 Mass

2.2.1 Each single *UNITYsat* (basic dimension) shall not exceed 215g mass.

2.2.2 *2UNITYsat* shall not exceed 430g mass, *3UNITYsat* shall not exceed 645g mass etc.

2.3 Materials

2.3.1 For external structure material is Anodized aluminum (6061). For internal/core structure material ABS (3D printing filament) could be used.

2.3.2 The *UNITYsat* shall use separation springs with characteristics defined in **Table 1** on the designated place (white holes at the Bottom side in **UNITY.skp**). Separation springs with characteristics can be found using McMaster Carr P/N 84985A76. The separation springs provide relative separation between *UNITYsat*s after deployment from the POD Deployer and splitting.

2.3.2.1 The compressed separation springs shall be at the level of the bottom side of the external structure (black surface in **UNITY.skp**) of *UNITYsat*.

2.3.2.2 The throw length of the separation spring shall be a minimum of 0.05 inches above the bottom side of the external structure (black surface in **UNITY.skp**).

Table 1: *UNITYsat* 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

Spring Plunger

3. Electrical Requirements

Electronic systems shall be designed with the following safety features:

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

4.2 The *UNITYsat* shall include deployment switch on the designated place (Blue switch on the Bottom side in **UNITY.skp**) to completely turn off satellite power once actuated. In the actuated state, the deployment switch shall be centered at the level of the bottom side of external structure (black surface in **UNITY.skp**).

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

4.2.2 The *UNITYsat* diagnostics and battery charging after the *UNITYsat* have been integrated into the POD Deployer are not allowed.

Note: *All diagnostics and battery charging shall be done while the UNITYsat deployment switch is depressed.*

4.3 The *UNITYsat* shall include a Remove Before Flight (RBF) switch. The RBF switch shall be ON after *UNITYsat* integration into the POD Deployer.

4.3.1 The RBF switch shall be accessible from the Access Port location (yellow surface in **UNITY.skp**).

4.3.2 The RBF switch shall cut all power to the *UNITYsat* once it is OFF.

4.4 Batteries may be full charged during launching, but the user/developer must provide a place (port) on a designated (yellow surface in **UNITY.skp**) side of *UNITYsat* for external battery charging and diagnostics if desired. External battery charging and diagnostics **will not be allowed** after placing *UNITYsat* in POD Deployer!

4.5 An example of setting the Antenna and bending method will be performed live through the Workshop during the development process (example of dipole antenna 17.3cm x 2). This example is extremely important because based on it must be set up and bend and the Antenna(s) with other dimensions. The contact between the Antenna and the interior side of the POD Deployer is NOT allowed!

4.6 Deploying of Antennas and/or Solar cells etc. are allowed only by using Timer Switch (e.g. NiChrome timer switch) which countdown is triggered by separation of *UNITYsat*s after ejection from the POD Deployer in Orbit and splitting. The Timer countdown must last at least 15 minutes before deploying of Antennas and/or Solar cells.

4. Operational Requirements

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

4.1 Deploying of Antennas and/or Solar cells etc. are allowed only by using Timer Switch (e.g. NiChrome timer switch) which countdown is triggered by separation of *UNITYsat*s after ejection from the POD Deployer in Orbit and splitting. The Timer countdown must last at least 15 minutes before deploying of Antennas and/or Solar cells.

4.2 Users/developers shall obtain and provide documentation of proper licenses for use of frequencies.

4.2.1 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.

4.3 Instead of using of *UNITYsat* Acceptance Checklist (*UNITYsat*AC) CSPD&TSC shall conduct a minimum of one fit check in which user/developer hardware shall be inspected. A final fit check shall be conducted prior to launch.

5. Testing Requirements

Testing shall be performed to meet all requirements deemed necessary to ensure the safety of the *UNITYsat*s and the POD Deployer. Test plans that are not generated by the CSPD&TSC 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. At the very minimum, all *UNITYsat*s shall undergo the following tests.

5.1 Random Vibration

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

5.2 Thermal Vacuum Bakeout

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

5.3 Visual Inspection

Visual inspection of the *UNITYsat* and measurement of critical areas shall be performed both by user/developer and by CSPD&TSC.

5.4 Qualification

*UNITYsat*s may be required to survive qualification testing as outlined by the CSPD&TSC and/or LV provider. If are unknown, GSFC-STD-7000 (NASA GEVS). Qualification testing will be performed at developer facilities. In some circumstances, CSPD&TSC 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** ***UNITYsat*s after qualification testing.**

5.5 Protoflight

All *UNITYsat*s shall survive protoflight testing as outlined by the CSPD&TSC and/or LV provider. If are unknown, GSFC-STD-7000. Protoflight testing will be performed at developer facilities. In some circumstances, CSPD&TSC can assist developers in finding testing facilities or provide testing for the developers. *UNITYsat*s **SHALL NOT** be disassembled or modified after protoflight testing. **Additional testing shall be required if modifications or changes are made to the** ***UNITYsat*s after protoflight testing.**

5.6 Acceptance (depends in first place of LV provider / could be subject of changes)

After delivery and integration of the *UNITYsat*s into the POD Deployer, additional testing shall be performed with the integrated system. This test ensures proper integration of the *UNITYsat*s into the POD Deployer. Additionally, any unknown, harmful interactions between *UNITYsat*s may be discovered during acceptance testing. The POD Deployer Integrator shall coordinate and perform acceptance testing. After acceptance testing, the *UNITYsat*s will be removed from POD Deployer to perform diagnostics through the designated *UNITYsat* diagnostic ports and then again integrated into the POD Deployer to repeat the process one more time. Visual inspection of the system shall be performed by the POD Deployer Integrator. The POD Deployer **SHALL NOT** be deintegrated at this point.

6. Responsibilities

CSPD&TSC responsibilities are to deliver purchased *development kit* to users/developers, to integrate the users/developers *UNITYsat*s and users/developers NiChrome switches in one single satellite and to all together place into POD Deployer, to enable launch (through its LV provider partner) at a contracted price once capacity of POD Deployer is full, to ensure the safety of the POD Deployer and protect the launch vehicle (LV), primary payload, and other Satellites.

Responsibility for deploying *UNITYsat*s in Orbit is on LV provider.

Responsibility for functionality of the release mechanism for separation of *UNITYsat*s is on users/developers, as well as functionality of the *UNITYsat*s

7. 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.

- Cal Poly CubeSat Design Specifications Document (www.cubesat.org)
- 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)
- Procedural Requirements for Limiting Orbital Debris (NPR 8715.6)

8. Contact

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