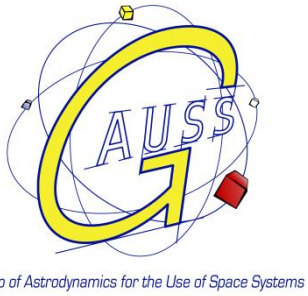

The PocketQube Standard

Issue 1

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Important Note(s): The latest version of the PocketQube Standard shall be the official version.

Contents

List of Acronyms	
TU Delft	Delft University of Technology
TML	Total Mass Loss
CVCM	Collected Volatile Condensable Material
COTS	Commercial off-the-shelf
GAUSS	Group of Astrodynamics for the Use of Space Systems
MRFOD	Morehead Rome Femtosatellite Orbital Deployer
MSU	Morehead State University
LSP	Launch Service Provider

1. Introduction

The PocketQube concept (Figure 1) was first proposed in 2009, from an idea of professor Robert J. Twiggs, as a result of a collaboration between Morehead State University (MSU) and Kentucky Space which developed some specifications with respect to this new class of spacecraft [1,2]. These specifications were stipulated in order to help universities in performing space applications using this type of platform. The PocketQubes are a cube shaped platform of 50x50 mm with a mass of no more than 250 g for which typically COTS electronics are used. The first PocketQube was launched using the MRFOD (Morehead Rome Femto Orbital Deployer) installed inside the UniSat-5 microsatellite as a result of a cooperation between Morehead State University GAUSS Srl and Kentucky Space [1,2].

1.1 Purpose

This document aims to present a PocketQube Mechanical Standard which follows from a collaboration between Alba Orbital, Delft University of Technology and GAUSS Srl. This action started due to a need to converge towards common standards and interfaces for the PocketQube platform, in order to avoid uncertainties and allow the community to grow, starting from the same, shared standard. The aim is that for the next revisions, the standard would be extended to electrical, operational and testing requirements.

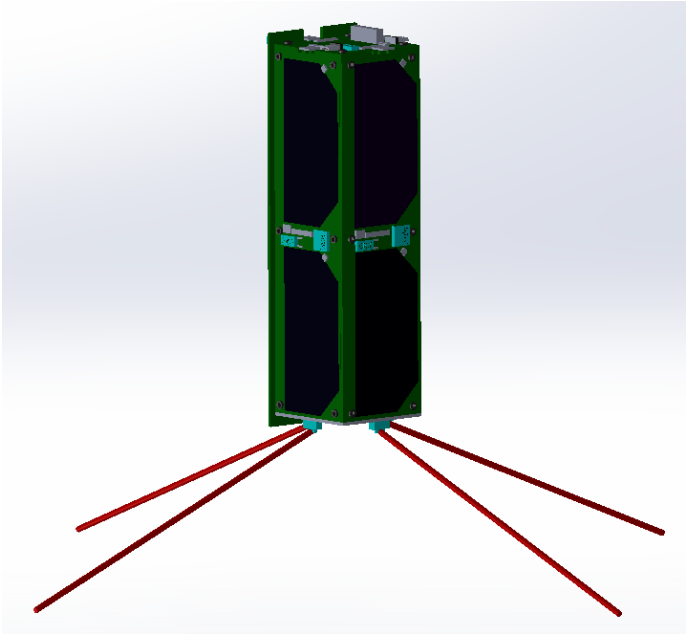


Figure 1 CAD representation of a typical PocketQube

The purpose of this standard is to facilitate the development of PocketQubes in the same way as the CubeSat Standard [3] facilitated the design and development of CubeSats in their infancy. The aim is also to enlarge the community and increase the overall access to space opportunities for this new type of satellite platform.

2. PocketQube Specification

This section presents basic general requirements that shall be applied on all PocketQubes in accordance with the Launch Service Provider as well as all mechanical dimensions.

2.1 General requirements

PQ-Gen-01: The PocketQube shall ensure no deliberate detachment of any components throughout the lifetime of the entire mission: launch, ejection and in orbit operation.
Rationale: This is a safety precaution.

PQ-Gen-02: Pyrotechnics shall not be allowed on board.
Rationale: This is a safety precaution.

PQ-Gen-03: Materials that can be toxic, flammable or potentially hazardous shall not be used. The use of Li-Ion batteries is exempted from this constraint, provided that there is adequate prevention against thermal runaway.
Rationale: This is a safety precaution for both the people handling the satellite and the other payloads. The launch service provider might ask for additional tests in order to prove that your system is capable of handling the thermal runaway.

PQ-Gen-04: The PocketQube shall meet the out-gassing requirement in order to prevent contamination of any other spacecraft during integration, testing and launch:

- TML ≤1.0%
- CVCM ≤0.1%

Rationale: This is a general requirement for space systems outgassing criteria as per ECSS-Q-70-02C [4].

2.2 Mechanical Requirements

PocketQubes are picosatellite platforms based on a cubic-shaped form factor (approximately 50x50x50 mm per unit) with each side one half smaller than a CubeSat (100x100x100 mm per unit). The external dimensions and features are outlined in Figure 2.

Unlike the CubeSat Standard [3] that is deployed along its long-side edges, the PocketQube uses a sliding backplate for ejection (visible in the 3D CAD in Figure 1), thus one side of the platform has slightly different dimensions as better outlined in Figure 2 and in Table 1 in the sliding backplate column.

PocketQubes external dimensions are slightly different depending on the number of units, as outlined in Table 1 for the 1P, 2P and 3P cases:

Table 1. PocketQube external dimensions and sliding backplate dimensions for different number of units:

Number of Units (P)	External dimensions without backplate (mm)	Sliding backplate dimension (mm)
1P	50x50x50	58x64x1.6
2P	50x50x114	58x128x1.6
3P	50x50x178	58x192x1.6

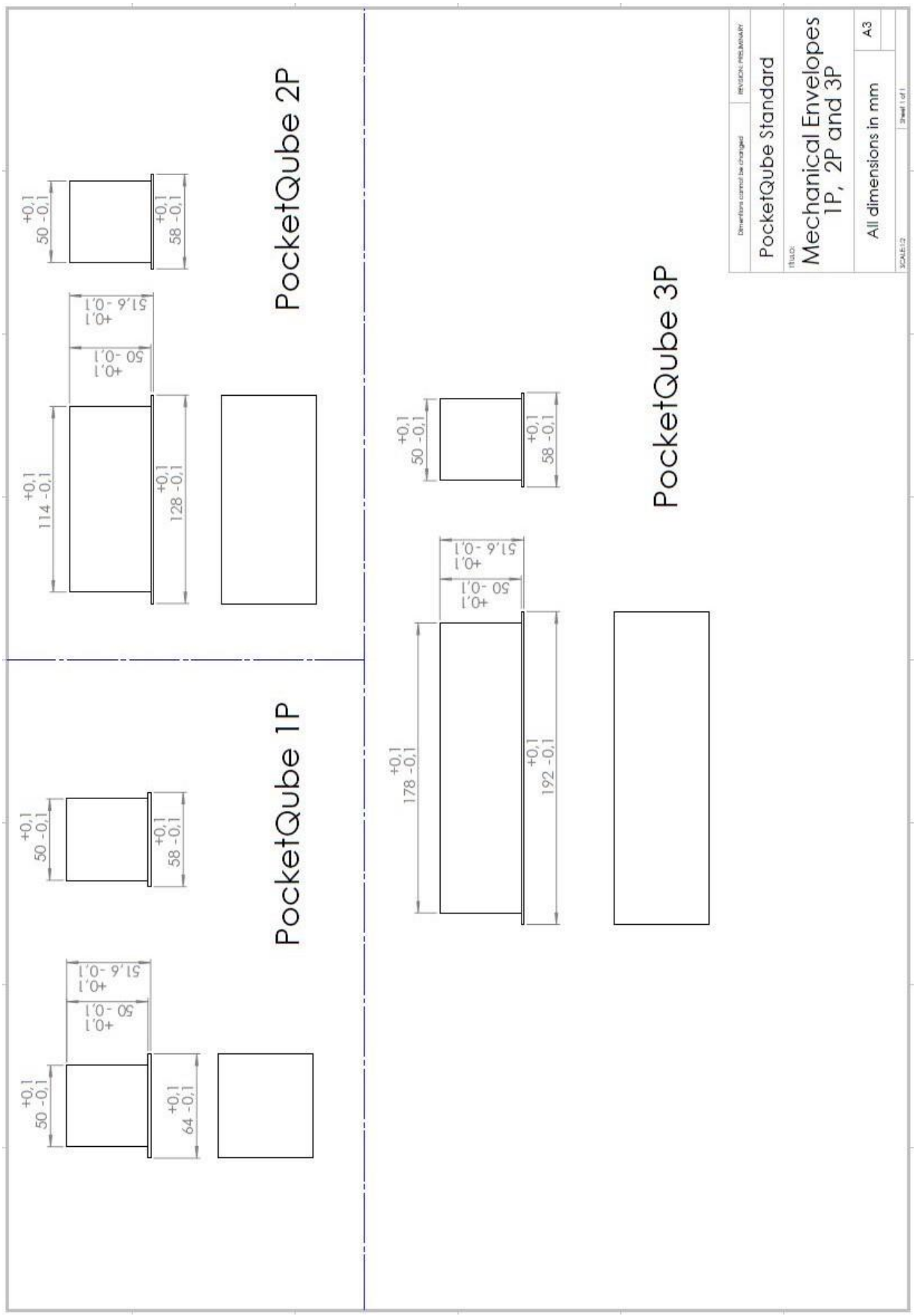


Figure 2 PocketQube Exterior Dimensions and Form Factor

2.2.1 Exterior dimensions

The axis and sides conventional nomenclature used while defining the requirements in this document are as shown in Figure 3.

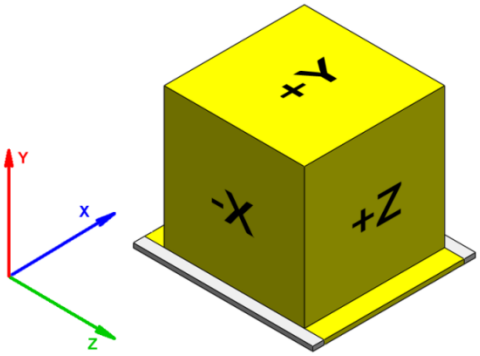


Figure 3 PocketQube Axis Specification

PQ-Mech-01: The PocketQube configuration and dimensions shall be in accordance with Figure 2.

PQ-Mech-02: A 1P PocketQube shall be 51.6±0.1 mm wide (Y dimensions as seen in Figure 2). This comprises 50.0 mm + 1.6 mm the thickness of the sliding plate.

PQ-Mech-03: A 1P PocketQube shall be 50.0±0.1 mm wide (X dimensions as seen in Figure 2) with sliding plate of 58.0±0.1 mm in the same direction.

PQ-Mech-04: A 1P PocketQube shall be 50.0±0.1 mm long (Z dimensions as seen in Figure 2) with sliding plate dimensions of 64.0 ±0.1 mm in the same direction.

PQ-Mech-05: A 2P PocketQube shall be 114.0±0.1 mm long (Z dimensions as seen in Figure 2) with sliding plate dimensions of 128.0±0.1 mm in the same direction.

PQ-Mech-06: A 3P PocketQube shall be 178.0±0.1 mm long (Z dimensions as seen in Figure 2) with sliding plate dimensions of 192.0±0.1 mm in the same direction.

PQ-Mech-07: The rail clamping dimensions shall be of 2 mm on each side of the sliding backplate as it can be seen in Figure 4 and in Figure 5. Please notice that the maximum envelope does not apply to the sliding backplate sides that are placed within the rail clamp (as seen in Figure 5).
Rationale: In order to allow the satellite to slide into the deployer, an empty area should be left for clamping.

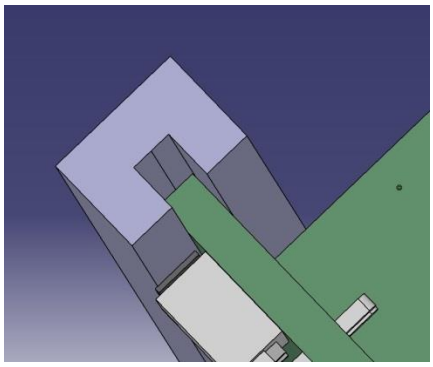


Figure 4 Sliding backplate rail clamping

PQ-Mech-08: The envelope around the PocketQube shall be no more than 7 mm for components. For appendages and deployables, maximum 10 mm is allowed if the Launch Service Provider can adapt to this requirement (as shown in Figure 5, in which the area of maximum appendages envelope is hashed differently). This procedure implies completing the waiver form attached in Annexe 1, which also includes a table and drawing with the relevant dimensions that cannot be exceeded.
Rationale: The envelope is 7 mm, however the waiver of 10 mm maximum envelope was accepted for the PocketQubes that have deployables (panels, GPS antennas, etc) assuming a Launch Service Provider can allow a bigger envelope.

PQ-Mech-09: All deployable components shall be constrained by the PocketQube and not by the deployer.

PQ-Mech-10: The minimum contact surface of the PocketQube backplate shall be 21.5 mm from both sides on the Z+ axis, as seen in Figure 6, the red area.
Rationale: Contact surface means either between satellite and pusher plate or between two satellites assuming they are stacked upon each other. This contact surface is required in order to make sure the kill switches are pressed.

PQ-Mech-11: The contact surface between the PocketQube and pusher plate or between two stacked PocketQubes shall be as outlined in Figure 7.

PQ-Mech-12: All PocketQubes shall use at least two kill switches to keep the satellite offline while in deployer.
Rationale: This is a safety precaution to assure the satellite is turned off while in the deployer.

PQ-Mech-13: The PocketQube kill switches shall make contact with the deployer rail or with another PocketQube (see green and blue surfaces from Figure 6).

PQ-Mech-14: Kill switches shall be located only on Z- axis. There are two different possible placement areas:

a) In the lateral side of the satellite within 20 mm from the Z- faces and touching the deployment rails (as shown in Figure 6, lateral green area);
b) Aligned with the sliding backplate in Z- face and in contact with the PocketQube below or the pusher plate (as shown in Figure 6, blue area).

PQ-Mech-15: The kill switches (Figure 6) shall not obstruct ejection of the satellite from the deployer.

Rationale: Depending on the direction of the kill switches force, pressure against deployment can be an issue.

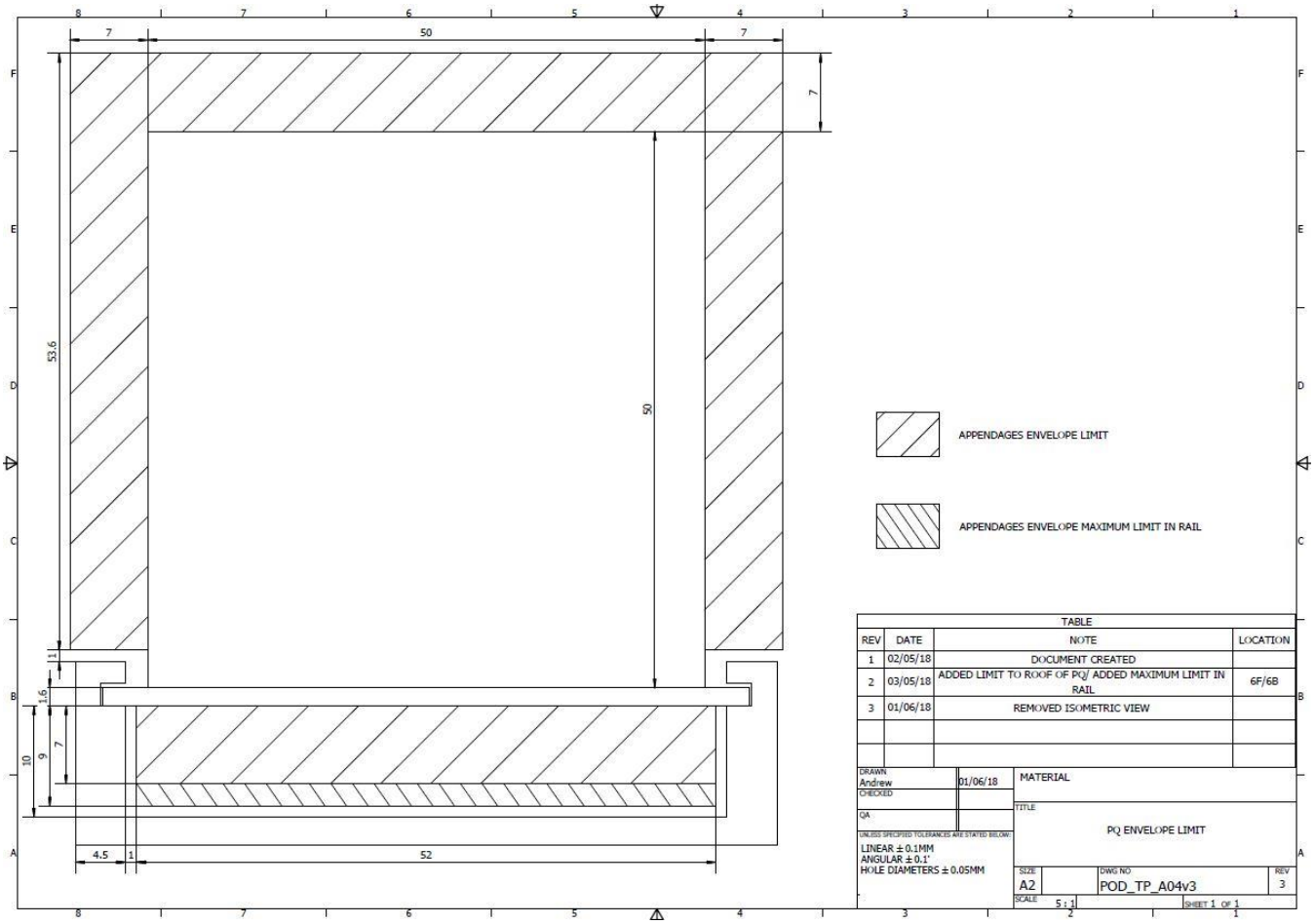


Figure 5 Components Envelope and Allowable Additional Envelope for Deployables

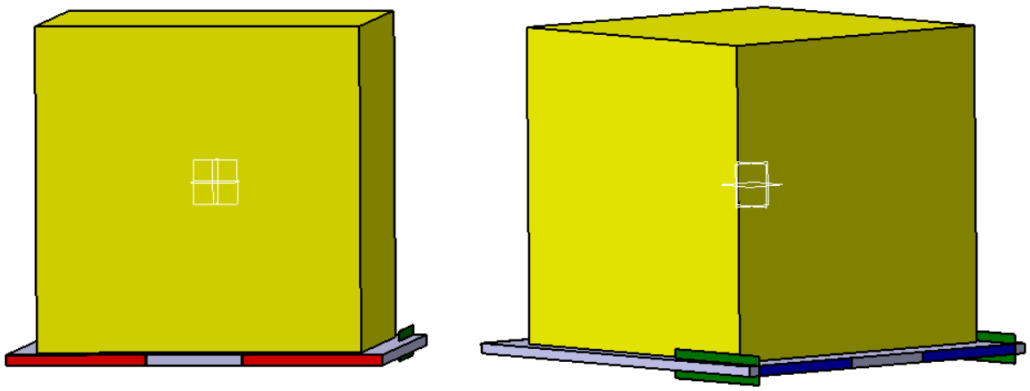


Figure 6 Contact Surface (red) Kill Switches location (green) options

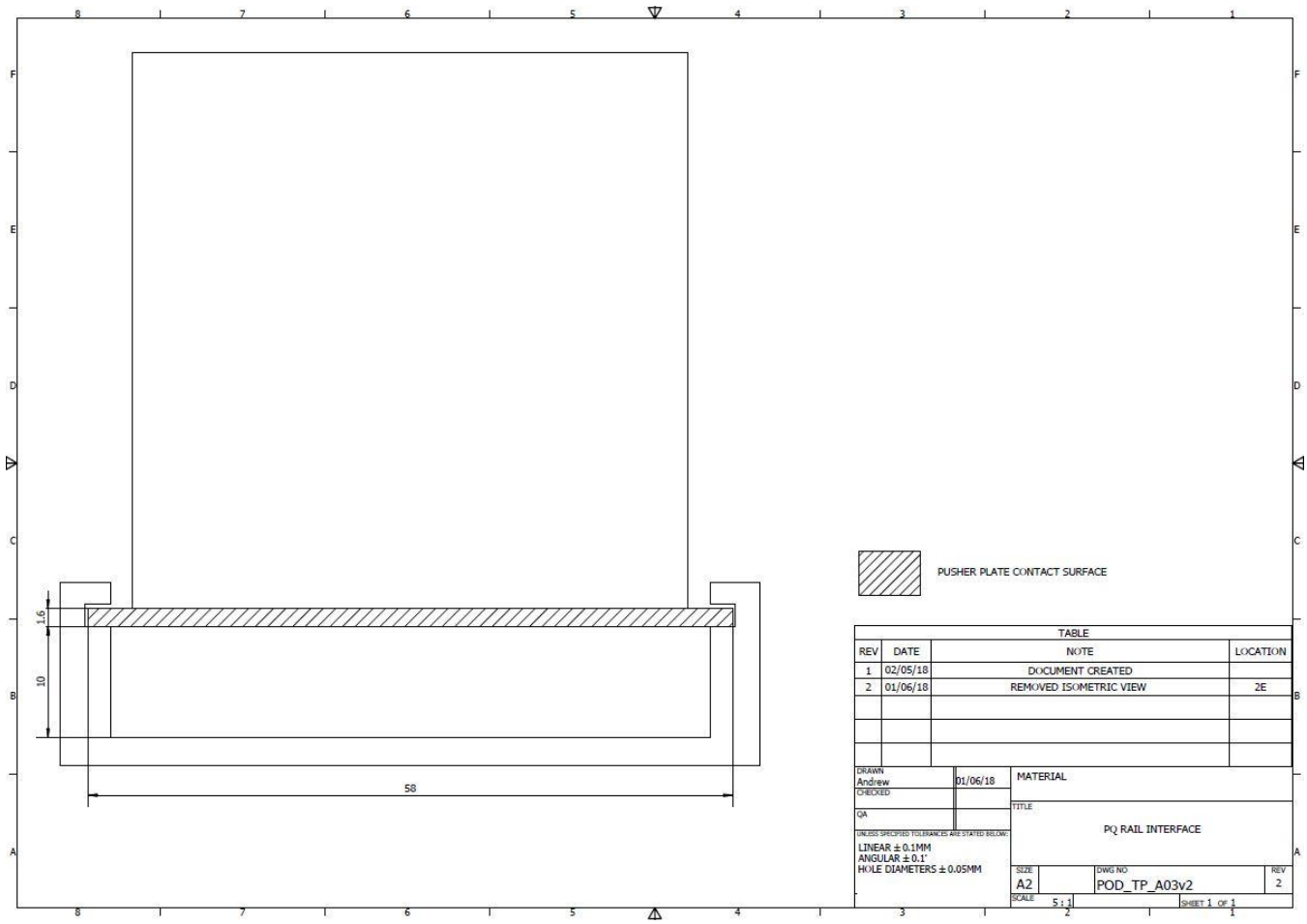


Figure 7 Contact surface (hashed area)

2.2.2 Mass

PQ-Mass-01: Each PocketQube unit (1P) shall not exceed 250 g mass.

PQ-Mass-02: Each 2P PocketQube shall not exceed 500 g mass.

PQ-Mass-03: Each 3P PocketQube shall not exceed 750 g mass.

Rationale: 1P PocketQube represents in volume one-eighth of a CubeSat. Due to the higher density of subsystems in a PocketQube, 1P shall not exceed 250 g.

PQ-Mass-04: The centre of mass of the PocketQube shall not exceed 1 cm from its geometric centre in stowed position.

Rationale: This requirement ensures the launch is safe and not jamming other payloads preventing clashes that might cause a debris.

2.2.3 Materials

PQ-Mat-01: Any structural material used for the PocketQube shall be able to withstand all required environmental tests.

PQ-Mat-02: Recommended materials for the baseplate are: FR4, Aluminium (7075,6061,6065,6082) as described in [5].

PQ-Mat-03: Potential metallic materials used for the PocketQube that are in contact with the deployer and standoffs shall be hard anodized.

Rationale: All aluminium materials specified in requirement PQ-Mat-02 that are in contact with the deployer shall be hard anodized in order to prevent cold welding.

PQ-Mat-04: For any other materials which are not specified in requirement PQ-Mat-02, the PocketQube developer shall contact the Launch Service Provider.

2.3 Electrical Requirements

To be continued in the 2nd issue. For information with respect to the electrical requirements, please contact your LSP.

2.4 Operational Requirements

To be continued in the 2nd issue. For information with respect to the operational requirements, please contact your LSP.

2.5 Testing Requirements

To be continued in the 2nd issue. For information with respect to the testing requirements, please contact your LSP.

3. Annexe 1

The PocketQube envelope waiver form

Contact _____

Contact email _____

Contact phone _____

Company/Organisation _____

PocketQube satellite _____

I acknowledge and accept that the appendages and deployable mechanisms exceed the 7 mm envelope limit which is specified in the PocketQube standard. I understand that our appendages and deployables must not exceed the 10 mm limit which is a requirement for deployers with larger envelopes.

I agree to disclose the details of the appendages and deployable mechanisms of the satellite to the launch provider in order to determine the suitability of our satellite for integrating into the <INSERT POD NAME> deployer.

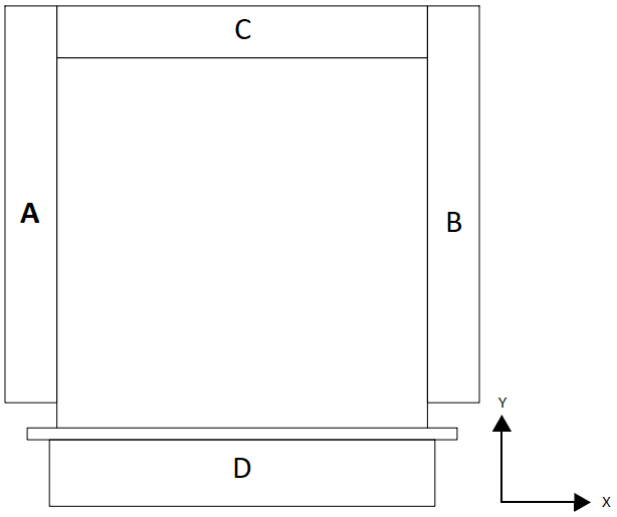
Signature: _____ Date:_____/_____/_____

Print Name: _____

Refer to the figure and table below for the maximum envelope of the appendages mechanisms. If you require assistance in defining the interface between the PocketQube and the POD, contact your deployer provider.

Mechanical standard maximum envelope			Maximum envelope for larger PODs (intended for PocketQubes that require a larger envelope as per req. no PQ-Mech-08)	
Location	Max X (mm)	Max Y (mm)	Max X (mm)	Max Y (mm)
A	7	53.6	10	53.6
B	7	53.6	10	53.6
C	50	7	50	7
D	54	7	54	9

Mechanical limits:



4. References

[1] “Small Launch Platforms for Microsatellites” – Cappelletti, Chantal and Battistini, Simone and Graziani, Filippo; Advances in Space Research;

[2] Cappelletti, C., 2018. Femto, pico, nano: overview of new satellite standards and applications. In: Advances in Astronautical Sciences, Proceedings of the 4th IAA Conference on University Satellite Missions and CubeSat Workshop, vol. 163, pp. 503–510;

[3] CubeSat Design Specification (CDS) revision 9, 3rd of June 2004;

[4] ECSS-Q-70-02C, 15th of November 2008 – Space Product Assurance, Thermal vacuum outgassing test for screening of space materials;

[5] ECSS-Q-ST-70-36C, 6th of March 2009 – Space Product Assurance, Material selection for controlling stress-corrosion cracking.

5. Contacts

For any additional questions with respect to the standard, please contact one of the following people:

Table 2. Contacts:

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