CubeSat: LEO Shipment Tracking

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Table of Contents

Abstact……. 3
Systems ……..... 3
Power Requirements…… 4
Model…… 4
References……..…….. 6

Abstract:

The objective of this CubeSat mission proposal is to create a new form of security for customers who are using the ocean for transportation of goods. One example of such customers are cargo ships which could face issues during their journey from poor weather or changing tides. The proposed CubeSat will be used for tracking the cargo ship's travel path and ensuring that the customer's goods stay protected and on course. Additionally, customers can view pictures taken from the camera and track their cargo ship's location at any point during its journey. This service aims to provide a similar experience to that of FedEx or UPS trackers, where customers are aware of their cargo's location throughout its journey. With the use of routine pictures, the onboard cargo can be tracked to ensure ships are adhering to needed guidelines and or restrictions.

Systems:

Tables 1 through 5 include information on systems within the cubesat. The tables below include the volume of each system, the masses, operational temperatures, power consumptions, energy storage and supply voltages.

Table 1 Magnetorquer Board properties

iMTQ Magnetorquer Board						
Width	Height	Length	Mass	Temperature Range	Supply Voltage	Power Consumption
90.1 mm	17 mm	95.9 mm	196 grams	-40 to 70 C	5 V	1.1 W

Table 2 VHF uplink properties

VHF uplink/UHF downlink Full Duplex Transceiver						
Width	Height	Length	Mass	Temperature Range	Supply Voltage	Power Consumption
96 mm	15 mm	90 mm	75 grams	-20 to 60 C	6.5 to 20 V dc	0.48 W receiver, 4 W transmitter

Table 3 Raspberry SC15184 properties

Raspberry SC15184 Pi 4 Model B 2019 Quad Core 64 Bit WiFi Bluetooth				
Width	Height	Length	Mass	Consumption
2.95 in	1.1 in	3.74 in	1.59 oz	1 V, 3 A

Table 4 Electrical Power System properties

iEPS Electrical Power System						
Width	Height	Length	Mass	Temperature Range	Supply Voltage	Energy Storage
92 mm	11.34 mm	96 mm	310+/- 5 grams	-20 to 70 C	3.3 and 5 V	45 wh

Power Requirements:

Tables 5 and 6 detail the necessary power requirements needed in the cubesat. Table 5 expresses the used power per hour for each system with the cubesat. Additionally, the total and minimal necessary power required are found. These values are useful to understand how each component will run through the cubesat's orbit. Table 6 expresses the solar panels properties used on the cubesat. These details confirm all of the necessary systems will run properly and be supplied with the proper power requirements needed for the mission.

Table 5 Power Requirements

System	**Power Used per Hour (watt-hour)**
Raspberry Pi (idle)	1.2
Raspberry Pi (max usage)	5
Magnetorquer (idle)	0.175
Magnetorquer (actuation)	1.2
Uplink Transceiver (receiver only)	0.48
Uplink Transceiver (transmitter on)	4
Total (minimum)	**1.855**
Total (maximum)	**10.2**

Table 6 Solar Panel Properties

ISIS 2U Small Solar Panel				
Solar Efficiency	Power Delivered (W)	Charging Time (hrs)	Capacity (Wh)	Max Power Output (watt-hour)
0.9	4.6	3.62	22.5	37

Model:

Figures 1 and 2 below show detailed drawings of the cubesat. In figure 1, the left, right, top, and isometric view are all visible, in addition to close ups of smaller dimensional components of the cubesat. In figure 2, it shows

an exploded view of the cubesat which allows for all the necessary components to be visible. The model consists of the Raspberry Pi HQ, Raspberry Pi, Arducam 8-50 lens, CubeSat structure, solar panels, EPS Electrical Power System, S-band Antenna Patch, VHF uplink/ UHF downlink communication system, Magnetometer Board, and heat pipes. The usage of the heat pipes are to allow for all of the components within the cubesat to stay within operational temperatures while in a low earth orbit. The heatpipes will be filled with an ethylene glycol based mixture, ensuring freezing and boiling will not occur which would result in the heat pipes bursting.

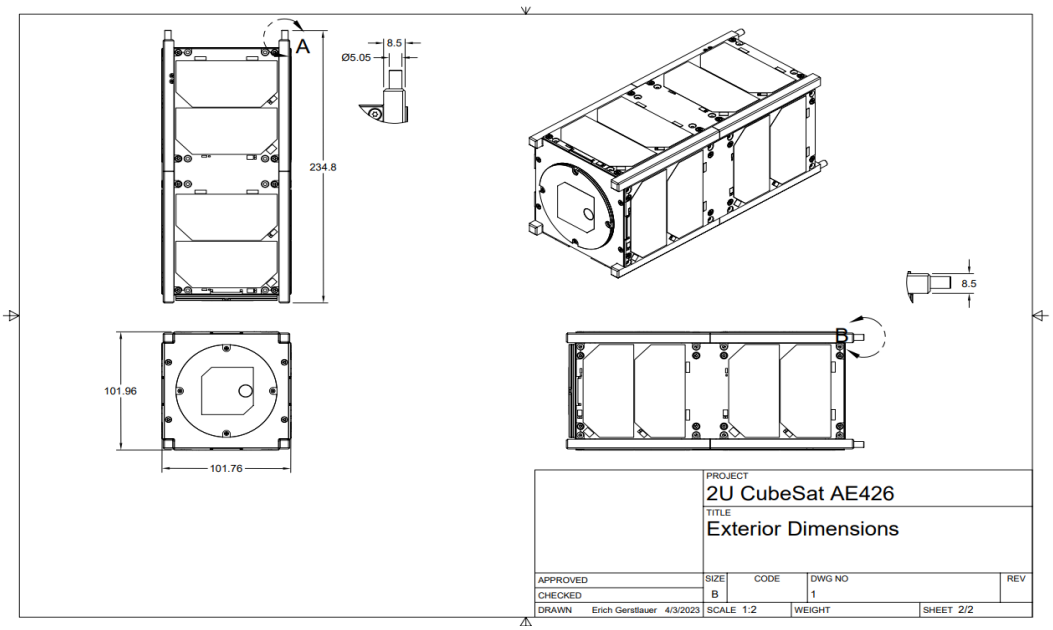

Fig. 1 Exterior Dimensions

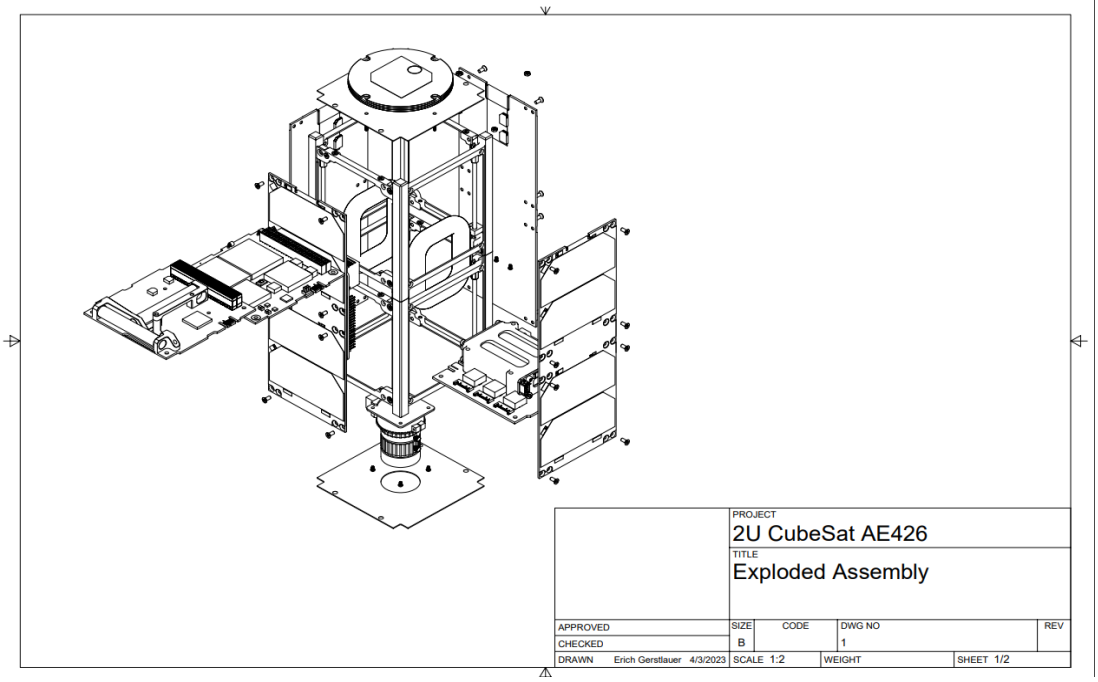

Fig. 2 Exploded Assembly

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