A

Project Report

On

# Satellite Design for CANSAT2021

*Submitted in partial fulfilment of the*

*requirement for the award of the*

*Degree of*

**BACHELOR OF TECHNOLOGY**

In

**ELECTRONICS AND COMMUNICATION ENGINEERING**

By

**RAJ MISHRA (18021030153)**
**PRAKHAR SHUKLA (18021030143)**
**UZAIR AHMAD SARDAR (18021030163)**

*Under the Guidance of*

**Dr. Baibaswata Mohapatra**
(Professor & Dean)

GALGOTIAS UNIVERSITY

**DEPARTMENT OF ELECTRICAL, ELECTRONICS AND COMMUNICATION ENGINEERING**
**May, 2022**

## DECLARATION

We declare that the project presented in this report titled, "**Satellite design for CANSAT2021**", submitted to the Department of Electrical, Electronics and Communication Engineering, Galgotias University, Greater Noida, for the Bachelor of Technology in Electronics and Communication Engineering is our original work. We have not plagiarized unless cited or the same report has not submitted anywhere for the award of any other degree. We understand that any violation of the above will be cause for disciplinary action by the university against us as per the University rule.

**Place: Greater Noida**

**Date: 28th May, 2022**

**Signature of the Students**

<u>**PRAKHAR SHUKLA**</u>

PRAKHAR SHUKLA (18021030143)

<u>**RAJ MISHRA**</u>

RAJ MISHRA (18021030153)

<u>**UZAIR AHMAD SARDAR**</u>

UZAIR AHMAD SARDAR (18021030163)

**Department of Electrical, Electronics and Communication Engineering**

## CERTIFICATE

This is to certify that the project titled “Satellite Design for CANSAT2021’’ is the bona fide work carried out by Prakhar Shukla, Raj Mishra and Uzair Ahmad Sardar, during the academic year 2018-22. We approve this project for submission in partial fulfilment of the requirements for the award of the degree of Bachelor of Technology in Electronics and Communication Engineering, Galgotias University.

Dr. B. Mohapatra

(Project Guide(s))

**The Project is Satisfactory/Unsatisfactory.**

Internal Examiner (s)

External Examiner

Approved by

Dean

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# ABSTRACT

This project aims to design a miniature satellite while keeping within the guidelines provided for CANSAT Competition 2021. This model exhibits some of the basic functioning of an actual satellite including the real time telemetry, receiving commands, performing some basic tasks and collect information from its surroundings. The effectiveness of this satellite relies on economical, physical and technical factors. It demonstrates complete working of a man-made satellite including carrying an objective oriented payload and it's separate functioning. Since it is a model, to ensure its proper functioning and robustness, it will be launched to a height of 725m with the help of a rocket.

The proposed system provides an elegant design for a model rocket that demonstrates all the basic functioning of a satellite. It uses Teensy 4.0 as main control unit (MCU) for all the separate sections of the satellite. Teensy is compact but powerful with fast boot. It will help the system to regain functionality in case of power loss. It manages all the different software states in a particular order. Servo motor provides the mobility to release the parachute, payloads and bottom latch of the container.

CanSat keeps a track of temperature throughout the launch. MCP9808 is a high precision temperature sensor. Also, majority of the operations are dependent on altitude, so we used BMP280 high precision pressure sensor to calculate the altitude. All the data is sent and received on each node using xbee radios. Nodes are Ground station, Container, Science payload 1 and Science payload 2.

Ground station has two teams one for operating system and second to retrieve the satellite from landing site.

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## GLOSSARY

| | |
|---|---|
| GPS | Global Positioning System |
| UAV | Unmanned Aerial Vehicle |
| MCU | Main Control Unit |
| GCS | Ground Control System |
| CDH | Communication and Data Handling |
| SP1 | Science Payload 1 |
| SP2 | Science Payload 2 |

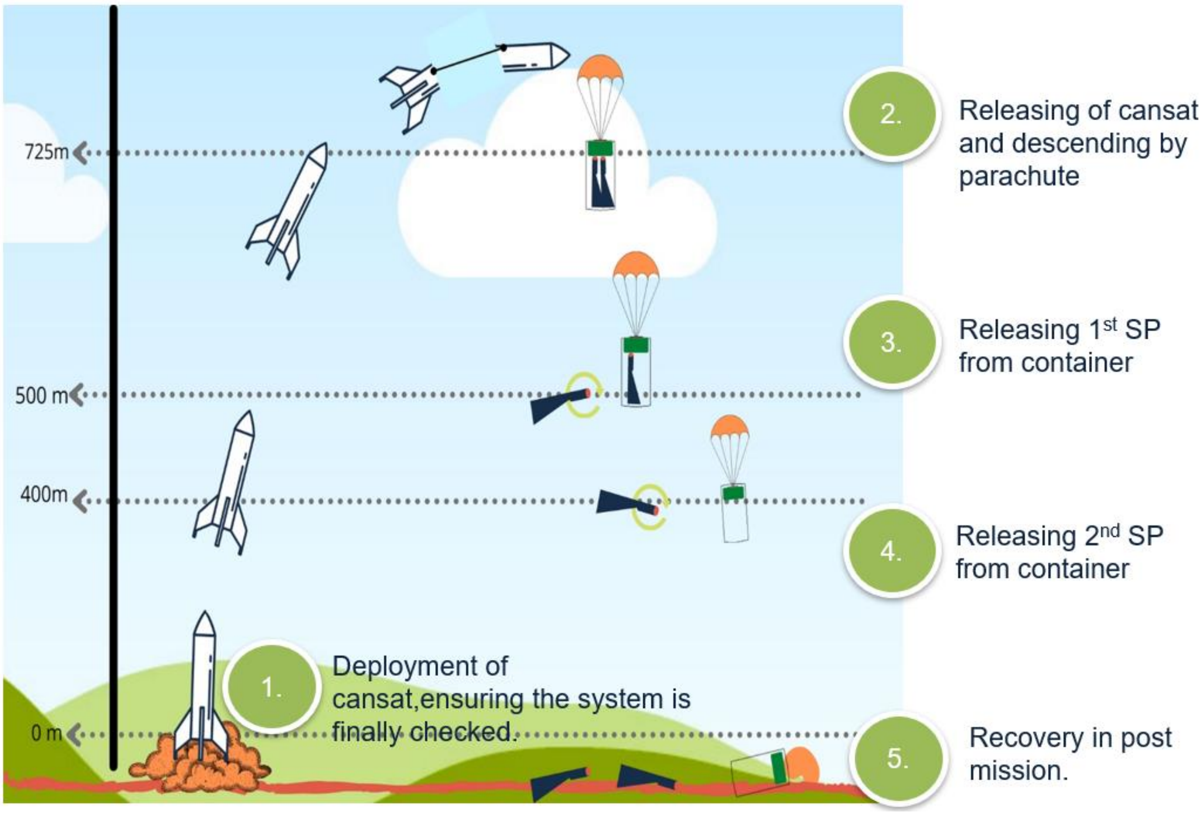
# 1. INTRODUCTION

CanSat challenge is organised by AAS and sponsored by NASA in order to increase awareness about space research, education and possibilities from a very initial stage of education.

A satellite is anything that has mass and orbits round a massive body like planet or star. Satellites are either natural like moon or man-made which are launched into space using rocket. Mostly they are used for either communication or Global Positioning System. Satellites can collect a large amount of data, very quickly due to large area exposure of the Earth. They also increase our reach into space exploration and wider our understanding of space. Satellites also have numerous applications in surveillance [3].

CanSat is a design-manufacture and launch competition. It helps teams to experience the life cycle of an aerospace system. It mimics a standard aerospace program on a miniature scale. All the aspects of such a program are embedded into the development process of CanSat. It consists of various stages from preliminary design review to post mission review. Requirements of this model are majorly dependent on telemetry, communications and autonomous operations [2].

This CanSat comprises of a container and two similar payloads. All three of these have telemetric abilities, well established communication among themselves as well as ground station. During launch both payloads are encapsulated within main container. Both payloads and container have separate electronic circuits to assist automation and facilitate wireless communication among them. Circuit majorly consists of sensors, actuators, microcontrollers, storage and power supply. All the data collected is transmitted in real-time to ground station for further interpretation and appropriate representation while also storing it onboard in a MicroSD card. Main container also contains a GPS module in order to keep track of its position in terms of latitude and longitude. An audio beacon is also installed in the container to make it easy to relocate its position on the ground [1].




1. System Concept of Operations

The main objective of this paper is to release a satellite, "CANSAT" at a height of 725m containing two payloads, which have to be released mid-air at certain levels separately. A parachute will be deployed from the container to control its dissent. However major challenge is to land the payloads safely without using parachutes. We will discuss the same in detail in this paper. This article will also discuss the physical designs and technical competencies of this satellite.

There are various criteria that a satellite needs to fulfil in order to be considered a satellite. Few basic ones are communication, telemetry, robustness, autonomous, gathering, processing and storing data.

The telemetry will be received by Ground Station. Ground station comprises of an antenna, and a personal computer. That computer has a GUI (Graphical User Interface) application that formats and displays the data received from the CanSat. All the data is represented with help of proper graphics, tables and graphs. This application also provides an interface to send commands to the CanSat in the format instructed by competition authorities.

The physical structure is designed within the constraints of the directives. We have used light materials to reduce its weight. Structure of the container and payloads is designed in a way to allow shock absorption up to 30Gs without compromising the integrity of the structure. Materials are also heat resistant up to 60℃.

# 2. LITERATURE SURVEY

CanSat module (payloads and container) are not heavier than 600 grams +/- 10 grams. Container is cylindrical in shape with dimensions 125 mm diameter x 400 mm length.

The module is secured in an unmanned aerial vehicle (UAV). It is released from a height of about 725 m. The deployment is violent and uncontrolled. From there CanSat descent at a rate of 15 m/s. At 500 m, first payload is released from where payload descent at a rate less than 20 m/s using a maple seed mechanism which is discussed later in detail. At 400 m, second payload is released same as first one. Telemetry of payloads is transmitted to container which transmits it to ground station incorporated with its own telemetry. Whole descent, including release of payloads is recorded with a camera at the base of container and stored in the MicroSD card onboard [1].

## *2.1 Objectives*

Objectives as per the directives from CanSat 2021:

- Objective: Main objective is to descent the CanSat, consisting of a container and two payloads safely to ground level. It should relay a telemetry of its own with the telemetry of payloads.
- Bonus Objective: Container carries a video camera at the bottom, pointing to ground. It captures the release and descent of payloads.
- External Objective: To spread awareness regarding satellite communication [1].

## 2.2 Overview

Cansat consists of a container and two autorotating maple seed science payloads. The container contains electronics to release the autorotating maple seed science payloads and relay data from the payload to a ground station. The Cansat is launched to an altitude ranging 670 meters to 725 meters above the launch site and deployed near apogee (peak altitude). The CanSat container must protect the science payloads from damage during the launch and deployment. Once the CanSat is deployed from the rocket, the CanSat descends using a parachute at a descent rate of 15 m/s. At 500 meters, the container releases one autorotating maple seed science payload. At 400 meters, the container releases the second autorotating maple seed science payload. The container relays all telemetry sent from the science payloads until the container lands. The container also incorporates its own telemetry along with the autorotating maple seed science payload telemetry. The container transmits using the team ID as its net ID. The autorotating maple seed science payloads descends after being released and spin rapidly enough so its descent rate is less than 20 m/s. The science payload transmits telemetry once a second and include air pressure and air temperature. The science payloads transmit for five minutes after being released and use the team ID plus 5 as its net ID.

## 2.3 Telemetry

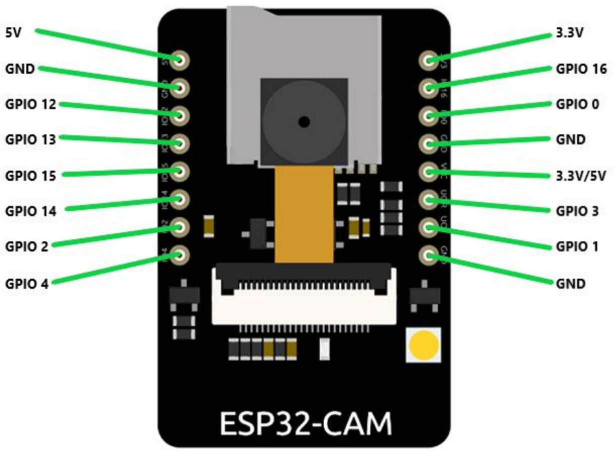
Upon receiving of the telemetry activation command (CX ON), the CanSat container collects the required telemetry at a one Hz sample rate, and transmit the telemetry data in the ASCII format shown below. Each telemetry field is delimited by a comma, and each telemetry transmission is concluded by a carriage return character. In addition, each Science Payload transmit telemetry data to the Container for relay to the ground station. The transmission rate for Science Payload to Container is also 1Hz. Transmissions do not need to be synchronized.

**2.4 Payload Surveillance using ESP32 cam**

An ESP32 CAM with independent power source and storage is fixed at the bottom of the container. All the proceedings since the deployment of cansat from UAV are recorded and stored onboard. Main objective for the camera is to record the release and descent of both autorotating science payloads, Fig. 2.

ESP32-CAM costs around $10. This module has OV2640 camera and GPIOs to connect to peripherals. It incorporates a microSD card slot that stores all the data collected during flight.

- The smallest 802.11b/g/n Wi-Fi BT SoC module
- Low power 32-bit CPU, can also serve the application processor
- Up to 160MHz clock speed, summary computing power up to 600 DMIPS
- Built-in 520 KB SRAM, external 4MPSRAM
- Supports UART/SPI/I2C/PWM/ADC/DAC
- Support image Wi-FI upload
- Support for serial port local and remote firmware upgrades (FOTA)

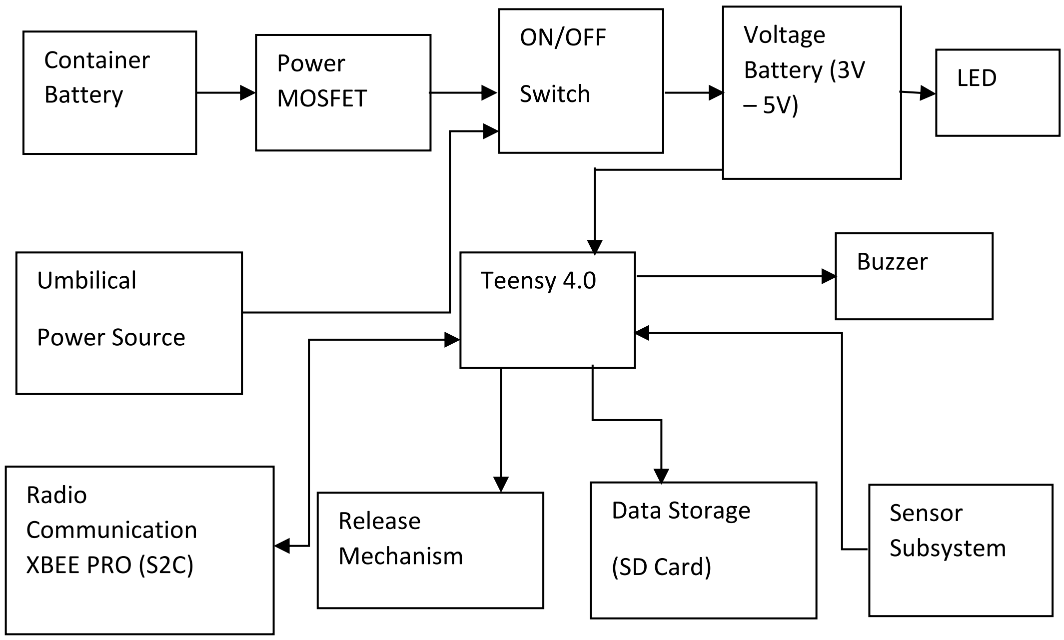



2. ESP32 CAM

# 3. SATELLITE DESIGN

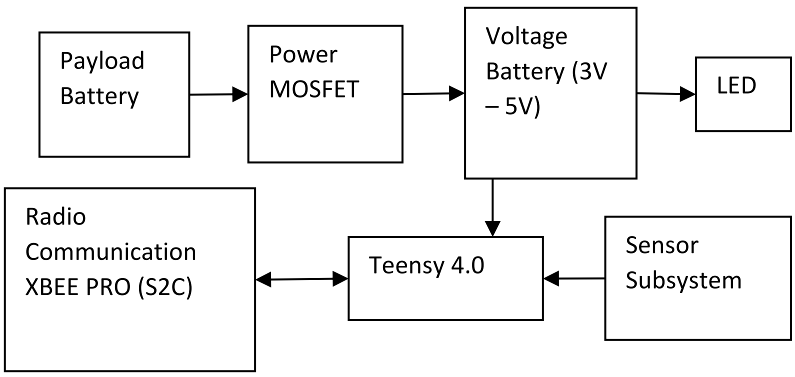
## *3.1 Block Diagram*

Fig. 3 shows the block diagram for proposed container design for CanSat 2021 that comprises of Teensy 4.0 that acts as MCU, Power supply, Communication peripherals, Storage, GPS and a sensor subsystem including sensors concerning all the required data fields. It also incorporates a release mechanism for both the payloads that is governed and controlled by MCU. Both payloads are hooked in and released with the motion of a servo motor.




4. Container Electrical Block Diagram

Both payloads incorporate similar circuitry and designs. However, number of data fields are considerably less than container. MCU for both the payloads is Teensy 4.0 with Power supply, communication peripherals, storage and a sensor subsystem.




5. Payload Electrical Block Diagram

### *3.2 Electrical Subsystem*

Electrical subsystem of the CanSat deals with the power supply to all components of the circuitry, telemetry, descent and sensors. It comprises of a central decision-making unit, which is a microcontroller, sensors, actuators, storage unit, battery, etc [2].

Battery used to fulfil the requirements of the electrical subsystem is Li-ion battery as per the directives of the competition. Batteries used for power supply in container and payload are "Panasonic NCR18650PF". It is a 3.6 volt, 3400 mAh. It is a light weight, compact battery with thin cross section which allows it to fit in the wing axle of the payload. Microcontroller used is Teensy4.0, which requires input voltage of 3.3volt and all the sensors are capable of functioning under 3 volt. SD card reader and transmitter/receiver module requires 3.3 volt to operate, Fig. 9.

The Electric components for container are given in Table 1, [2].

| **Component** | **Type** | **Container (C)/ Payload (P)** |
|---|---|---|
| Battery | To power up the main system | C, P |
| GPS | Tracks the position of the container | C |
| 3.3V-5V Voltage regulator | To regulate voltage supply | C, P |
| Microcontroller Teensy4.0 | To receive, process and transmit the data from the sensors | C, P |
| Sensors | To collect data | C, P |
| Camera | To record the proceedings | C |
| Radio Communications | To establish communication between container, payloads and ground station. | C, P |
| LED | Power indicator | C, P |
| Buzzer | Beacon | C |
| Servo | For opening parachute and payload release mechanism. | C |

Table 1. Components of Container and Payloads

*a) Battery:* CanSat required an uninterrupted power source which is light and compact. We selected a Li-ion battery, “Panasonic NCR18650PF”, with 3.6 V and 3400 mAh capacitanceas shown in Table 2. Also, it is very compact with diameter of 18.50mm and height of 65.30mm, Fig .5.


6. Panasonic NCR18650PF battery

| | |
|---|---|
| Capacity | 2900 mAh |
| Output Voltage | 3.7 VDC |
| Max Discharge rate | 10A |
| Charging Time | 4hrs/ 100mA |
| Discharge Rate | 3C |
| Length | 66 mm |
| Width | 19 mm |
| Weight | 48 gm |

Table 2. Specifications of power supply

### *3.3 Sensor Subsystem*

Container has to gather the sensory data for the following fields.

- Altitude
- Temperature
- Voltage
- GPS Time, GPS Latitude, GPS Longitude, GPS Altitude, GPS satellites
- Camera

Sensors are chosen while keeping few but very specific parameters in mind like weight and dimensions. As there are constraint on the size and weight of CanSat, sensors were to be light and compact while maintaining the accuracy of the readings. Power consumption is also one of the major factors that was considered while selection due to limited availability and space for batteries.

We are using a pressure to calculate the Altitude of the container using formula

$$H = 44330 * [1 - (P/p^0) ^\wedge (1/5.255) ] \qquad (1)$$

Where,

H = altitude (m)

P = measured pressure from the sensor

$p^0$ = reference pressure at sea level

Models and types of sensors are given in Table 3 with reference to their data requirement.

| **Data** | **Type** | **Sensor** | **Voltage(V) /Current(uA)** |
|---|---|---|---|
| Altitude | Pressure | BMP280 | 1.8-3.6V /1uA |
| Temperature | Temperature | MCP9808 | 2.7-5.5V /200uA |
| Voltage | Voltage | Onboard ADC + Series resistor + Voltage divider | Nominal |
| GPS Time, Altitude, Latitude, Longitude, Satellites | GPS | Ublox NEO M8N | 0.5-3.6V /40mA |
| Camera | Camera | ESP32 CAM | 5V /6-6.7mA |

Table 3. Sensors selected for each container

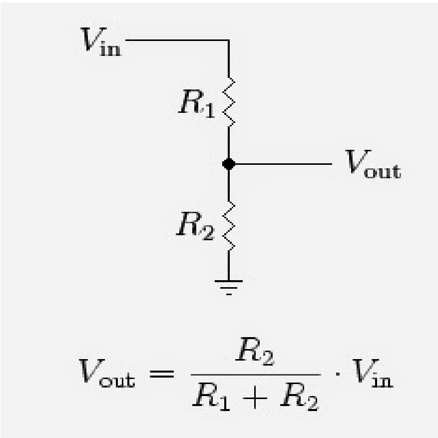
- Altitude Sensor: For calculating we have used BMP280 high precision pressure sensor.

7. BMP280

- Temperature Sensor: For temperature data field we have used adafruit MCP9808 high precision temperature sensor.


8. MCP9808

- Voltage Sensor: For sensing voltage in the circuit, we have used a combination of Onboard ADC, Series resistor and Voltage Divider.




9. Voltage Sensor

Payload has similar sensor subsystem design as container with few exceptions. Following fields of data is covered by payloads.

- Altitude
- Temperature
- Rotation Rate

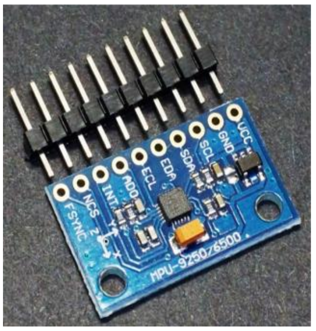
Dimension of sensors are very significant when it comes to payloads as the size of PCB capsule is very compact to facilitate the maple seed like aerodynamics.

Models and types of sensors for payloads are given in Table 4 with reference to their data requirement.

| **Data** | **Type** | **Sensor** | **Voltage(V) /Current(uA)** |
|---|---|---|---|
| Altitude | Pressure | BMP280 | 1.8-3.6V /1uA |
| Temperature | Temperature | MCP9808 | 2.7-5.5V /200uA |
| Rotation rate | Gyroscope | MPU9250 | 2.4-3.7V /9.3uA |

Table 4. Sensors selected for each payload

- Rotation Rate Sensor: For sensing the rate of rotation of payloads we are using gyroscope on MPU9250 module.




10. MPU9250

### *3.4 Ground Control System (GCS)*

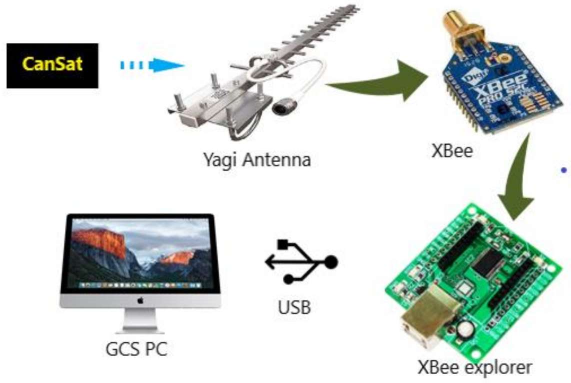
CanSat transmits real-time telemetry and supports several remote operations. Ground station is designed to receive, analyse, process and present data while also directing the certain operation of CanSat remotely. For this kind of communication between payloads, container and ground control system we are using Xbee radios with 5dBi Antennas for CanSat and 15 dBi, yagi antenna for ground station [4].

GCS is divided into two parts.

- Hardware
- Software

*GCS Hardware:* Hardware at ground control consist of a 15dBi yagi antenna with a Xbee radio interfaced with the ground station system (laptop/desktop) using a Xbee explorer module, Fig. 10.

Yagi Antenna has a frequency range of 2.4-2.5 GHz and gain of 15dBi. It has a maximum input power of 100 Watt. It can operate in high temperature like 60°C.We are using Xbee pro S2C radios with 2.4GHz frequency and 3.6volt supply voltage as end-point transmitters. Transmission rate is 1Hz.




11. GCS Hardware configuration

*2. Software:* GCS uses XCTU software to calibrate Xbee radios. A simple graphical user interface (GUI) is designed to plot and represent the data received in real-time at ground station. Most of the software packages are commercial off the shelf (COTS) [4].

Major software(s) for designing the GUI are NodeJS, React, Python3.8, XCTU. To plot real time graphs, libraries like matplotlib has been used. It records the data and saves it on local server. It also allows you to download a .csv file of the data received.

Transmitted telemetry is in form of a comma separated string. All the data values are added into a string with commas between them and transmitted to ground station. As per directives a string format has been provided. Table 5 shows the data fields of container and payloads in sequential order. Telemetric information is received for every second and every four second telemetric information of payloads is received.

| **Data Fields** | **Description** | **Container (C) /Payloads (P)** |
|---|---|---|
| TEAM_ID | Team identification | C, P |

| Data Fields | Description | Container (C) /Payloads (P) |
| --- | --- | --- |
| MISSION_TIME | Time in UTC format | C, P |
| PACKET_COUNT | Count of transmitted packages | C, P |
| PACKET_TYPE | ‘C’ for container telemetry and ‘SP1’ and ‘SP2’ for payloads | C, P |
| MODE | Two modes are available, “Flight” and “Simulation” | C |
| SP1_RELEASED | Status of payload1 | C |
| SP2_RELEASED | Status of payload2 | C |
| ALTITUDE | Altitude | C, P |
| TEMP | Temperature | C, P |
| VOLTAGE | Voltage of the power bus | C |
| GPS_TIME | Time via GPS receiver, in UTC format | C |
| GPS_LATITUDE | Latitude via GPS receiver | C |
| GPS_LONGITUDE | Longitude via GPS receiver | C |
| GPS_ALTITUDE | Altitude via GPS receiver | C |

| **Data Fields** | **Description** | **Container (C) /Payloads (P)** |
|---|---|---|
| GPS_SATS | Number of GPS satellites being tracked by the receiver | C |
| SOFTWARE_STATE | Operating state of software | C |
| SP1_PACKET_COUNT | Count of transmitted packages from payload1 | C |
| SP2_PACKET_COUNT | Count of transmitted packages from payload2 | C |
| CMD_ECHO | Last received command | C |
| SP_ROTATION_RATE | Rotation rate of the payload | P |

Table 5. Container and Payloads telemetry fields

### *3.5 Communication and Data Handling (CDH)*

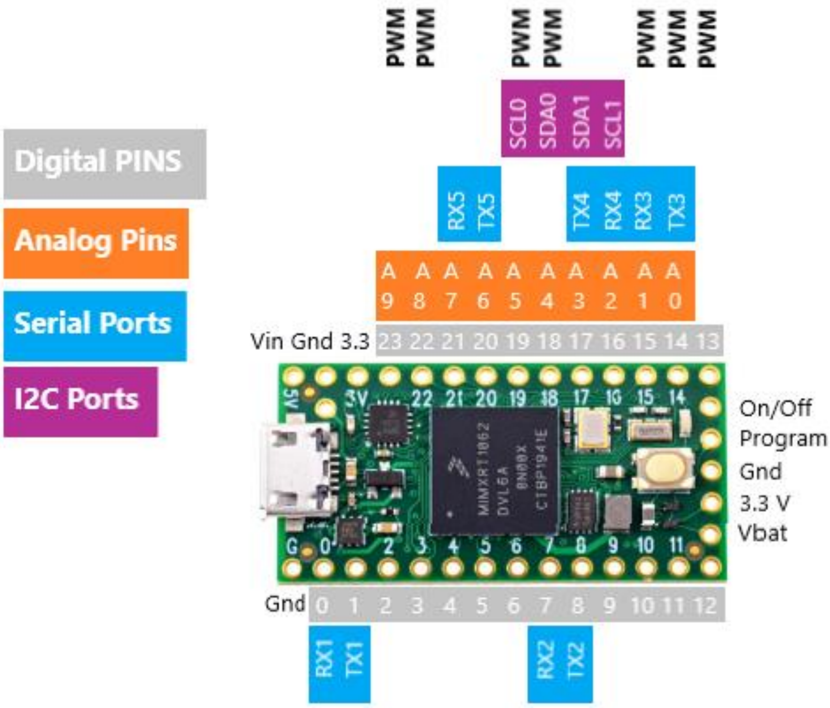
CDH of CanSat oversee the flow of data and commands while processing and presenting it to the ground station. CDH majorly comprise of four constituents.

- Microcontroller
- Commands
- Flight Software (FSW)

*Microcontroller:* Container and both payloads have Teensy4.0 as their central decision-making unit. Teensy 4.0 has an ARM Cortex-M7 processor at 600MHz, and a NXP iMXRT1062 chip. Teensy 4.0 is small and compact in size, and retains compatibility with most of the pin functions. Teensy 4.0 provides support for dynamic clock scaling. Unlike most of the microcontrollers, Teensy 4.0 hardware and Teensyduino's software support for Arduino timing functions are designed to allow dynamically speed changes. If a coin cell is connected to VBAT, Teensy 4.0's RTC also continues to keep track of date & time while the power is off which is essential for the CanSat. The ARM Cortex-M7 brings many powerful CPU features to a true real-time microcontroller platform.

| | |
|---|---|
| Processor | ARM Cortex-M7 at 600MHz |
| RAM | 1024K RAM |
| Flash | 2048K Flash (64K reserved for recovery & EEPROM emulation) |
| USB ports | 2 USB ports, both 480MBit/sec |
| $I^2C$ | 3 $I^2C$, all with 4 byte FIFO |
| SPI | 3 SPI, all with 16 word FIFO |
| Serial | 7 Serial, all with 4 byte FIFO |
| PWM pins | 31 pins |
| Digital pins | 40 pins (interrupt capable) |
| Analog pins | 14 pins |
| RTC | For date and time |

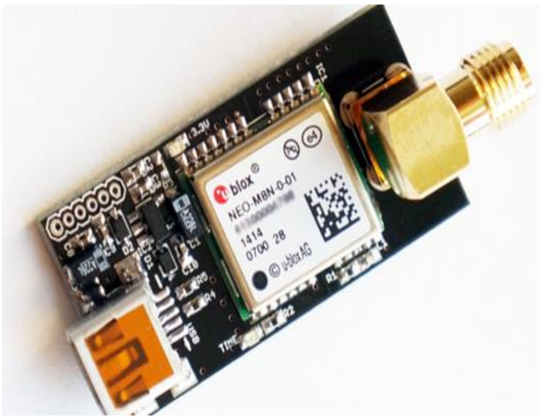
Table 6. Specifications of Teensy 4.0




12. Teensy 4.0 Pinout, [7]

*b) GPS:* The Global Positioning System is a navigation device which is satellite-based that offers region and time data. The gadget is openly available to everybody with a Global Positioning System receiver and cleared line of sight to at the minimum four GPS satellites. A Global Positioning System receiver computes its role by exactly schedule the GPS satellites to send alerts. At the moment GPS is widely used and additionally has become a fundamental section of smartphones.

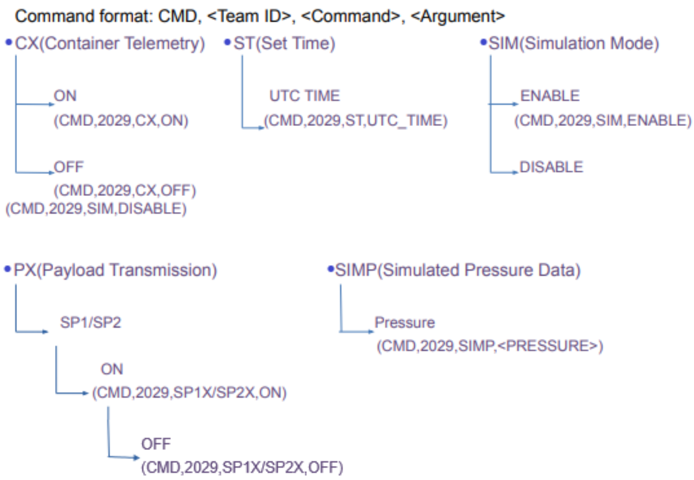
For CanSat we have used u-blox NEO-M8N module. CanSat records Latitude, Longitude, Time, number of satellites and Altitude using this module.




*13.* U-blox NEO M8N GPS

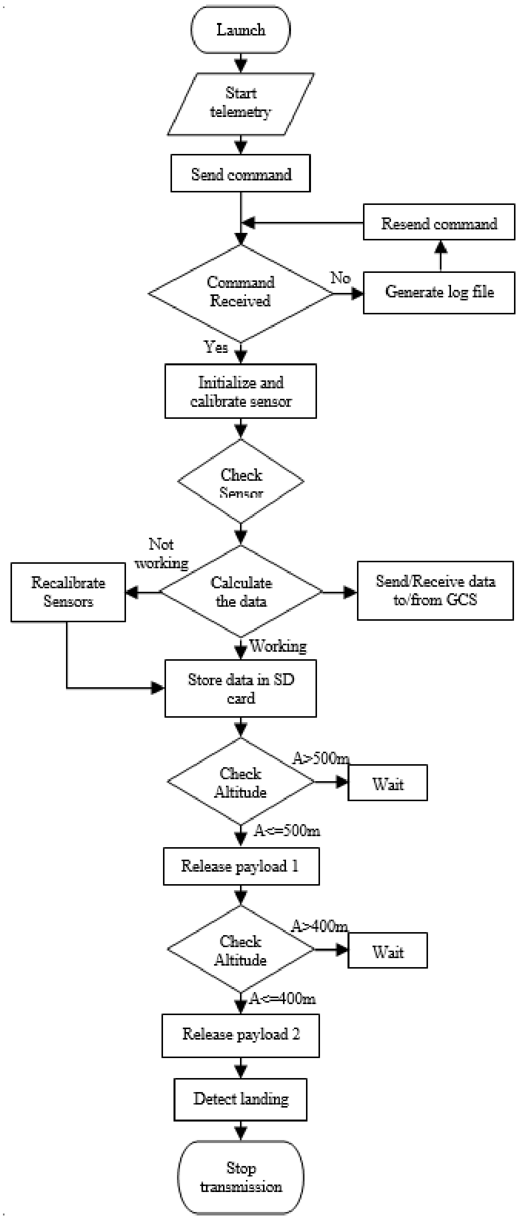
*Commands:* Commands from ground station are sent to container for certain operations such as turning on/off the telemetry, setting time or switching between “Simulation” and “Flight” mode [1]. Commands are relayed to payloads from container itself. The format for command is predefined as per the directives, Fig. 12.

As mentioned above CanSat can switch between “Flight” and “Simulation" mode. In Simulation mode all the sensors stop collecting the data. Using a csv file of pressure values provided by the organizers, we feed fake pressure data to CanSat. This helps in testing the various altitude-based operations.




14. Container command format

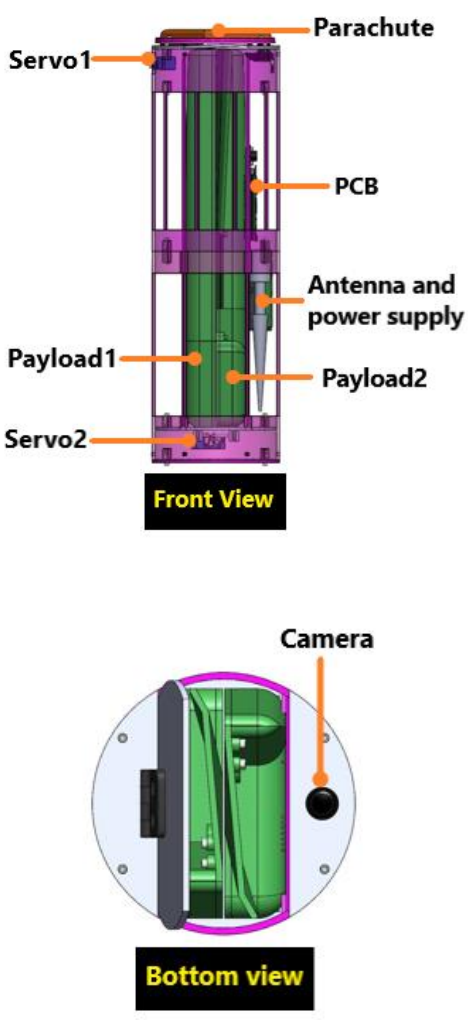
*Flight Software (FSW):* Microcontrollers in Container and Payloads are programmed to manage the operations from launch to the landing of CanSat. Once the CanSat is ejected telemetry is started [6]. FSW ensures that commands are received and operations are successfully executed. All the data is logged onboard. Sensors are calibrated and data collected is transmitted to ground station. Both payloads are released based on altitude. Payload1 is released at 500m and payload2 is released at 400m. On landing a buzzer is activated as beacon, Fig. 16.




15. FSW Architecture

### *3.6 Mechanical Subsystem*

*Container:* Mechanical aspects of container are designed to incorporate both payloads and electrical subsystem while maintaining the integrity of the structure. Prime objective here is to protect the payloads and components inside the container, Fig. 1. Structure of the container has to be robust enough in order to withstand the violent shocks, vibrations and excessive heat. Our design withstands the environmental tests.



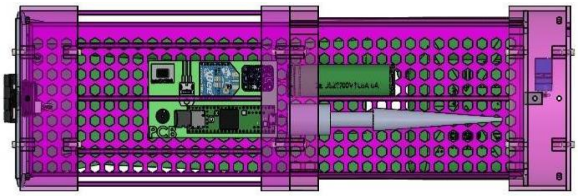

16. Container showing the side and bottom view with different orientation

It has four major components:

- Hexagonal mesh (for mounting purpose)

- Parachute release mechanism
- Payload release mechanism
- Outer Container

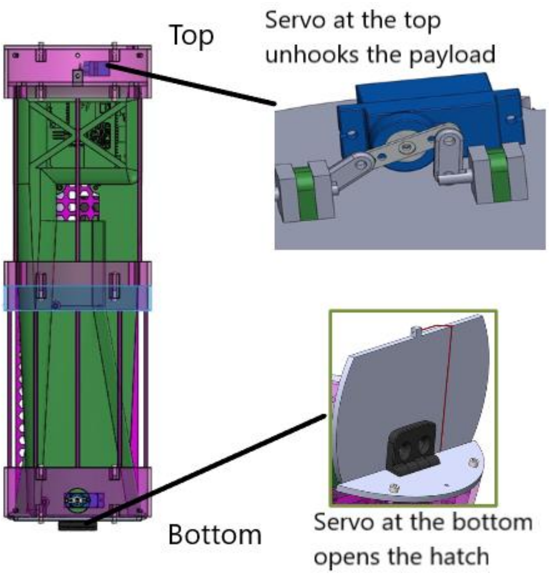
*Hexagonal mesh:* Container has two hexagonal mesh walls made of ABS material, separating payloads from PCB and other components as shown in Fig.1. Hexagonal structure helps in absorbing the shocks and vibrations, Fig. 2. This mesh compartmentalizes the container which makes it easier to organise the components and separate the sensitive components from each other.



17. Hexagonal Mesh where PCB is mounted

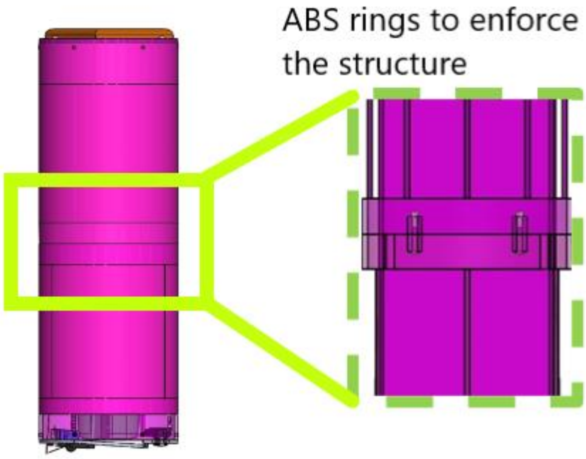
*Parachute release mechanism:* The parachute is folded and fixed to the top of the container with the help of a thin covering. As the UAV deploys the CanSat due to air drag the covering is removed and parachute opens up reducing the speed of the descent [2].

*Payload release mechanism:* A servo motor is fixed at the bottom, as well as top of the container. The motor at the bottom opens up the hatch at the bottom to release the payloads. Payloads are hooked at the top of the container on the inside. The second servo controls the deployment of the payloads. The location of servos is demonstrated in Fig. 3.




18. Payload release mechanism

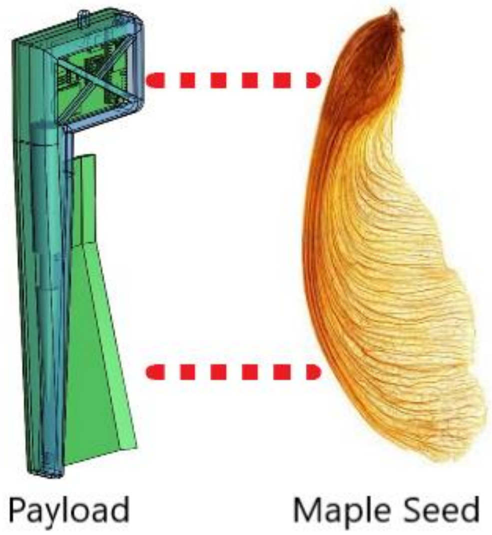
*Outer Container:* Container's outer structure is made of the same material as the internal mesh which is ABS. It is sturdy and protects the internal components from atmospheric conditions and any kind of physical challenges [5]. ABS rings are used to enforce the outer covering of the container, Fig. 4.




19. Outer schematic of container with ABS rings for strength

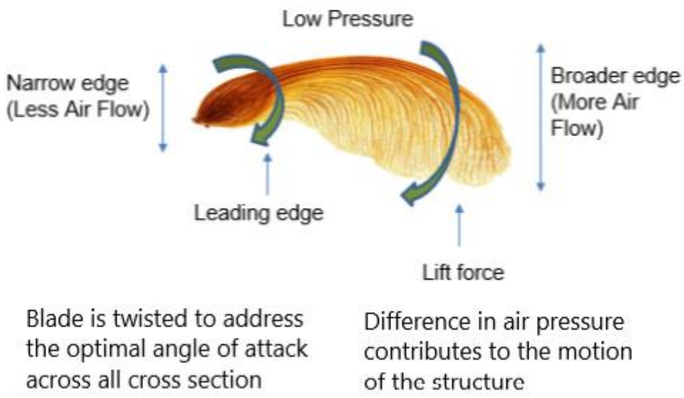
*Payloads:* The major challenge was to design the payloads as their descent mechanism is not a parachute but its maple seed design. As shown in Fig. 4, payloads physical structure is inspired by maple seed to duplicate its descent mechanism, Fig. 5.

This is a autorotating payload, where rotation is result of its maple seed structure. It rotates at a high speed which creates a hovering kind of motion, ultimately reducing the velocity of its descent to the ground.




20. Payload with reference to maple seed structure

The precise equilibrium between gravity and inertia are responsible for its unique motion. During a vertical descent, the vertical force component and gravity on payload is balanced in a manner to allow a steady descent, Fig. 6.

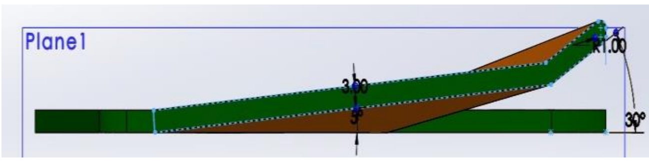



21. Maple seed mechanism

This payload design is mainly composed of three portions.

- Wing frame
- Wing Axle
- PCB capsule

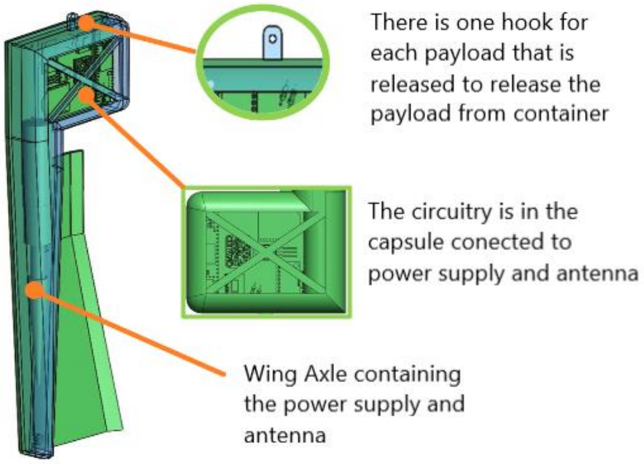
*Wing frame:* Wing frame of the payload has wing pattern made in the base part as shown in Fig. 6. Wing is designed to duplicate the motion of a maple seed leaf. Wing is kept light and thin. Wing frame has a angle of attack of 10 degrees in order to increase the lift force, Fig. 7.




22. Schematic of the wing pattern

*Wing Axle:*  Axle of the wing gives a rigid support to the wing frame as well as contains batteries and antenna that sustains the electrical subsystem in the payload, Fig. 7.

*PCB capsule:* PCB capsule is a capsule attached at the base of the wing that acts as the heavy seed part in maple seed. It also encloses a PCB within, containing all the sensors and components required for operations as shown in Fig.7. This PCB majorly contributes to the weight of capsule. At the opposite end of the capsule there is a hook for servo, which connects to the payload release mechanism of container.




23. Payload wing axle, capsule and servo hook

# 4. RESULT AND DISCUSSION

### *4.1 Launch and CanSat Release*

Launch was done using a UAV at the altitude ranging 670 meters to 725 meters from ground level. At that instant CANSAT is released from UAV. Parachute opens instantly as it is packed outside the container and starts the descent at the rate of 15 m/s.

### *4.2 Descent and Payload Release*

Container starts collecting data and real time telemetry to GCS. Descending to 500 meters, the container will release 'SP1'. SP1 starts collecting and transmitting data to container, which in turn forwards it to GCS. At 400 meters SP2 is released and follows the same procedure as SP1.

Descent rate for both payloads is 20 m/s.

### *4.3 Landing*

As soon as both payloads and container touches ground and altitude is zero, telemetry stops and a beacon goes off. A recovery team gets to the location to collect the payloads and container.

### *4.4 Ground Control and Data Delivery*

On ground a GCS is setup in order to receive, store, format and present data. Data can be downloaded from there in CSV format. Data is presented using an interactive window.

It also allows to send commands to container, initiating certain operations.

# 5. CONCLUSION AND FUTURE SCOPE

## *5.1 Conclusion*

In this project, we designed a miniature satellite to demonstrate the functioning and all the subsystems of an aeronautical mission. It fulfils all the requirements of the competition. It is launched to the height of about 650-725m using a UAV. Its descent starts using a parachute CanSat is containing two payloads within it. First payload is released at 500m and its telemetry is started, while the second payload is released at 400m. Meanwhile container and both payloads keep collecting and transmitting data to ground station. Release of payloads and descent is recorded using a camera at the base of container and saved onboard. Both the payloads are designed to mimic the aerodynamics of a maple seed and serve as autorotating payloads. All the data received by ground station is presented in an interactive interface. It also allows to download data as a csv file.

It also incorporated a camera to record the release and descent of the payloads. Ultimately this satellite followed the mechanical, electrical and software development of a real-world satellite. It allowed a detailed experimentation and learning experience for fresh minds, who wants to explore the field of satellite communications.

## *5.2 Future Scope*

It can be further developed to receive and transmit data to a larger range. Moreover, complex data can be collected by interfacing different kind of sensors. It will enhance the knowledge of aerospace and aeronautics on a more basic level with hands on approach. This satellite can be further enhanced with more versatile payloads that can contribute solutions to areas like agriculture, traffic management, surveillance, etc.

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