Technical Document: Avionics and Telemetry Overview

This document details the technical setup for a rocket's flight computer and the essential pre-flight parameters.

Flight Computer (FC) Overview

A Flight Computer (FC) is the **brain of the rocket**. It reads the rocket's motion using sensors and makes decisions in real time.

The proposed architecture uses a **single ESP** to handle *all functions*:
TVC, **data collection**, **parachute ejection**, and **telemetry**.

Consolidated Components

The single ESP handles all core systems:

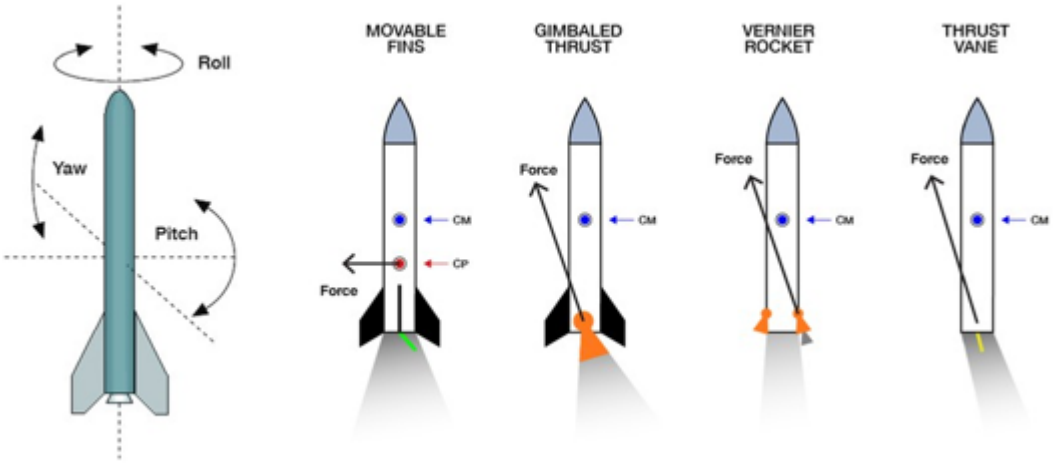
- **TVC and Stabilization**
  The ESP controls the Thrust Vector Control system using:
    - IMU Sensor: **ICM-20602** or **MPU6050**
    - Two Metal Gear Servos: **MG90S / DS929**
    - Buck Converter: (6V → 5V, adjusted for ESP requirements)
    - Servo Power Supply: **5V–6V, 2–3A**
- **Data and Ejection**
  The ESP collects data from:
    - Barometric Sensor: **BMP280**
    - Optional High-G Accelerometer: **ADXL345**
    - **Data logging**: **Micro SD Card Module** + SD Card (8–32 GB)
    - **Parachute Ejection**:
        - Micro servo

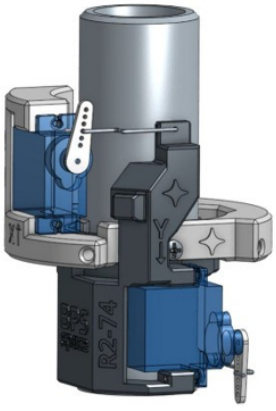
Flight Computer Basic Functions

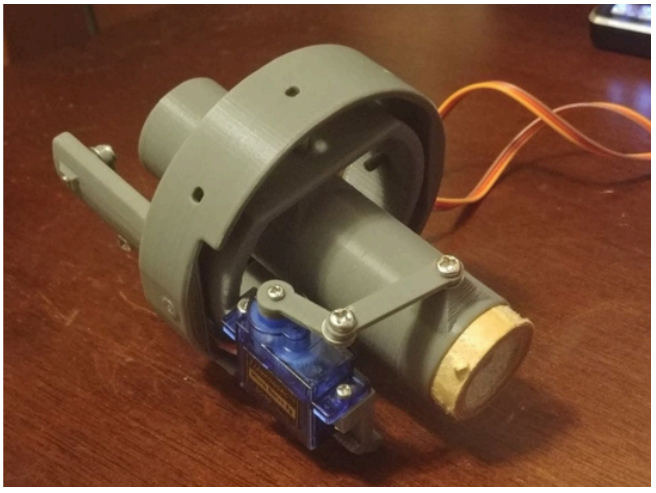
The ESP performs **four core functions**:

1. Stabilization / Thrust Vector Control (TVC)

Keeps the rocket stable and straight during boost.
It uses IMU data, calculates angles, and drives the servo motors to adjust the nozzle direction.







2. Data Logging

Records parameters including:

- Acceleration
- Altitude
- Orientation
- Temperature
- Velocity

All data is saved to an SD card for post-flight analysis.

3. Event Triggering

Detects **apogee** (highest point) and triggers the **parachute deployment** system.

4. Telemetry

Sends live flight data to the ground using the **LoRa module**.

Parachute System

The ESP detects apogee and initiates parachute release.

Apogee Detection Method

1. Read altitude from the barometer.

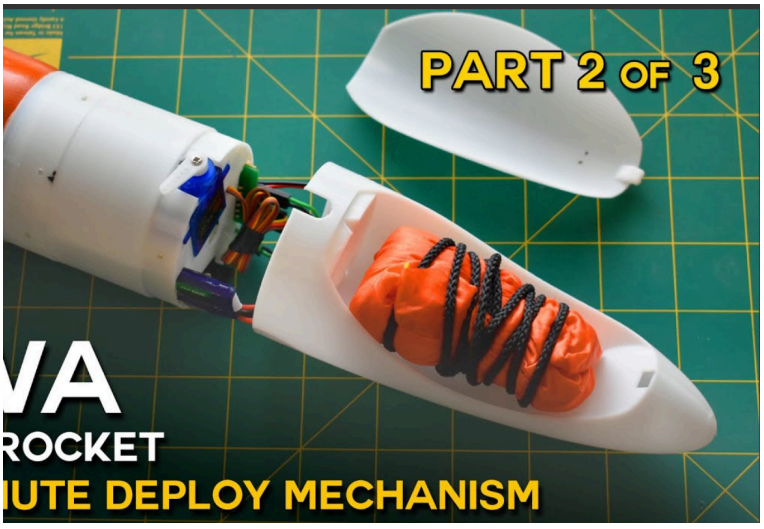
2. If altitude **decreases for 5 consecutive readings**, the ESP confirms that the rocket is falling.

3. The parachute deployment mechanism is fired.

Parachute Deployment Methods

Options include:

- **Servo-based door release**



LoRa Telemetry (Air-to-Ground Communication)

Telemetry sends live data from the rocket to the ground during flight.
The **LoRa SX1278** module (Ra-02) is selected.

Key Specifications

- **Long Range:** 3–5 km with small antennas
- **Noise Immunity:** Very high
- **Power:** Low power consumption
- **Stability:** Works even if the rocket spins or rotates

Benefits for Testing

- **TVC Verification:**
  Live angle readings show if the stabilization loop is performing correctly.

- **Failure Detection:**
  Detect servo stall, battery drop, sudden spin, or other mid-flight anomalies.

- **Performance Analysis:**
  Helps validate:

  - Thrust curve
  - Angle behavior
  - Apogee point
  - Servo response
  - Flight stability

Reference Links

- Thrust-Vector Control Mount (design team):
  https://youtu.be/KJJ0bbHzJx8

- Reference video (using Nano):
  https://youtu.be/MYdrzulL2zY

- Parachute ejection mechanism:
  https://youtube.com/shorts/HQN6HNjEQvc

- Parachute ejection mechanism (full video): https://youtu.be/COkh5ykzC3Y

Parameter need to check before flight

Motor testing
Structural testing
Avionics (electronics) testing
Safety testing

1. MOTOR / THRUST TESTING PARAMETERS

- **Peak Thrust (N)**

  Maximum force your motor produces.

- **Average Thrust (N)**

  Needed for stability calculation and simulation.

- **Burn Time (seconds)**

  How long the motor produces thrust.

- **Pressure Build-up**

  Check if nozzle gets clogged or pressure spikes.

- **Thrust Curve**

  Plot: Thrust vs Time → needed for flight simulation.

- **Total Impulse (Ns)**

  Tells the motor class (A, B, C, D, etc.) Formulae Integral of thrust over time

- **Pre-ignition safety**

  Check if propellant burns smoothly during ignition.

Component needed

- Load Cell (50 kg or 100 kg)
- Load Cell Amplifier (HX711)

Reference:

https://youtube.com/shorts/xvaB1OYGh7c?si=hh4LE6Wpibh1NK8G