Parachute Deployment System for Experimental Rocket Avionics: Orion Deton

Ainara Gurtubay

Abstract

This portfolio presents the design and development of Orion Deton, a modular avionics subsystem created within the BiSKY Team rocketry group at the University of the Basque Country (UPV/EHU). Orion is a platform composed of seven interconnected boards that together control and monitor the flight of a rocket. Within this system, I was responsible for designing Orion Deton, the electronic module in charge of safely managing parachute deployment events, while also contributing to Orion Cameras and Orion Umbilical.

My work covered schematic design, PCB layout and routing, as well as assembly and soldering of the hardware. The system was validated through electrical, laboratory, and flight tests, confirming its robustness and reliability.

Introduction

The Orion project was created to develop a modular, scalable, and safe avionics system for university-level experimental rocketry. Each board performs a dedicated role: communications, sensors, data acquisition and storage, power supply, cameras, umbilical systems, and deployment electronics.

Within this architecture, Orion Deton is the module responsible for controlling parachute deployment and emergency cut-off events, ensuring safety, redundancy, and control through the CAN bus.

System Design

Orion Deton integrates a set of functional blocks carefully designed to fulfill its mission-critical role. At its core lies a microcontroller, the ATSAME51J20A-MU, which manages deployment logic, communication with other boards through the CAN bus, and real-time system monitoring.

Up to four independent firing channels are available, each equipped with MOSFETs, current limiters, optocouplers, and diodes that allow for robust and secure activation of CO_2 valves. Current monitoring is handled by the INA238, which provides accurate consumption data via I2C, while a TCAN1046 transceiver enables reliable communication across the avionics CAN bus. Stable voltage rails are supplied by a combination of LDO regulators and DC-DC converters, supported by resettable fuses, capacitor banks, and dedicated security switches. System health is always visible through integrated RGB status indicators.

The mission logic that Orion Deton implements is essential for parachute deployment. After apogee detection by the avionics system, the board waits for a programmed delay before firing the first detonator, which activates a CO_2 valve, pressurizing the parachute

bay and releasing the drogue parachute for a stabilized descent. If the drogue fails to deploy due to anomalies, a second detonator activates a backup CO_2 valve to ensure redundancy in the sequence.

At approximately 150 meters above ground, a third detonator activates the main parachute, allowing the rocket to land safely. To address the risk of premature deployment, Orion Deton incorporates a cut-off system: if the main parachute were to open at apogee instead of the drogue, the system can sever the cords of the main parachute, ensuring that the rocket completes its flight under the drogue alone and preventing unsafe drifts. This combination of primary, redundant, and emergency sequences makes Orion Deton one of the most critical and safety-driven components of the Orion avionics stack.

Implementation & Results

The development process began with schematic design and PCB layout in Altium Designer, with a focus on signal integrity and EMI/EMC mitigation in a four-layer board. Once the design was complete, I assembled the hardware manually, soldering both SMD and THT components. Initial tests verified power distribution, regulator performance, and continuity of ignition lines. Laboratory validation followed, with simulations of apogee detection and deployment sequences carried out over the CAN bus. These tests confirmed correct activation of each firing channel and proper redundancy management.

The system's reliability was proven in flight. Orion first flew as a payload avionics system in the team's rocket Eros during the European Rocketry Challenge (EuRoC) 2024, achieving a full mission success. Following this validation, Orion became the primary avionics platform for the rocket Valkyrie, launched in July 2025, where Orion Deton successfully managed parachute deployment throughout the mission. These achievements marked a milestone in the maturity of the avionics architecture and validated the robustness of both the hardware design and the mission logic implemented.

Conclusion

The development of Orion Deton represented a complete engineering challenge, combining electronic design, safety-critical logic, and validation under real flight conditions. The board successfully fulfills its role as a redundant and fault-tolerant parachute deployment system, seamlessly integrated into the modular Orion avionics architecture. In addition to leading the design of Orion Deton, I also contributed to other avionics modules: Orion Cameras, responsible for recording the rocket flight through integrated onboard cameras, and Orion Umbilical, which enables charging and power distribution for the avionics through a USB-C port when the rocket is fully assembled. These collaborations allowed me to gain broader experience across multiple avionics subsystems, strengthening my skills in integration and teamwork.

Throughout this project I consolidated expertise in four-layer PCB design and routing in Altium Designer, the implementation of the CAN bus, and the integration of communication protocols such as UART for camera modules, I2C and SPI for sensors and current monitors. The successful validation of Orion avionics at EuRoC 2024 and its subsequent role as the main avionics system in Valkyrie in 2025 demonstrated both technical soundness and mission reliability.

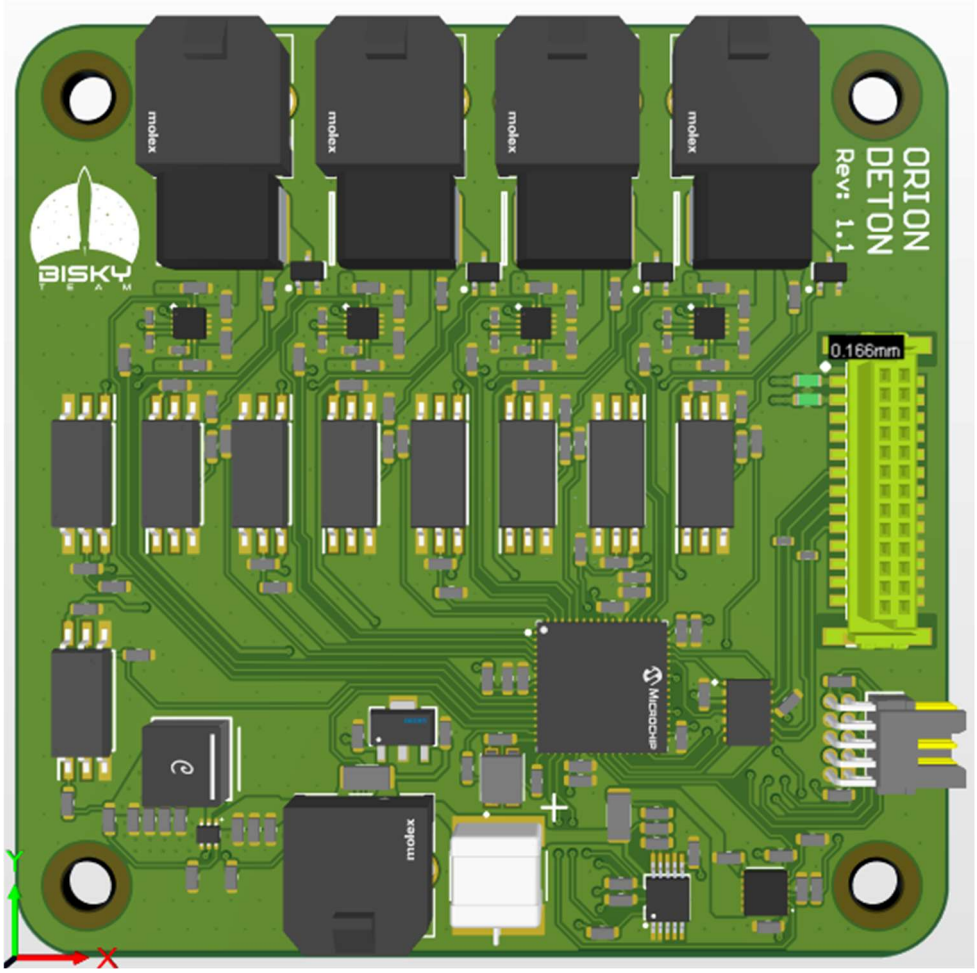

Figure 1. 3D render of the Orion Deton PCB, top view.

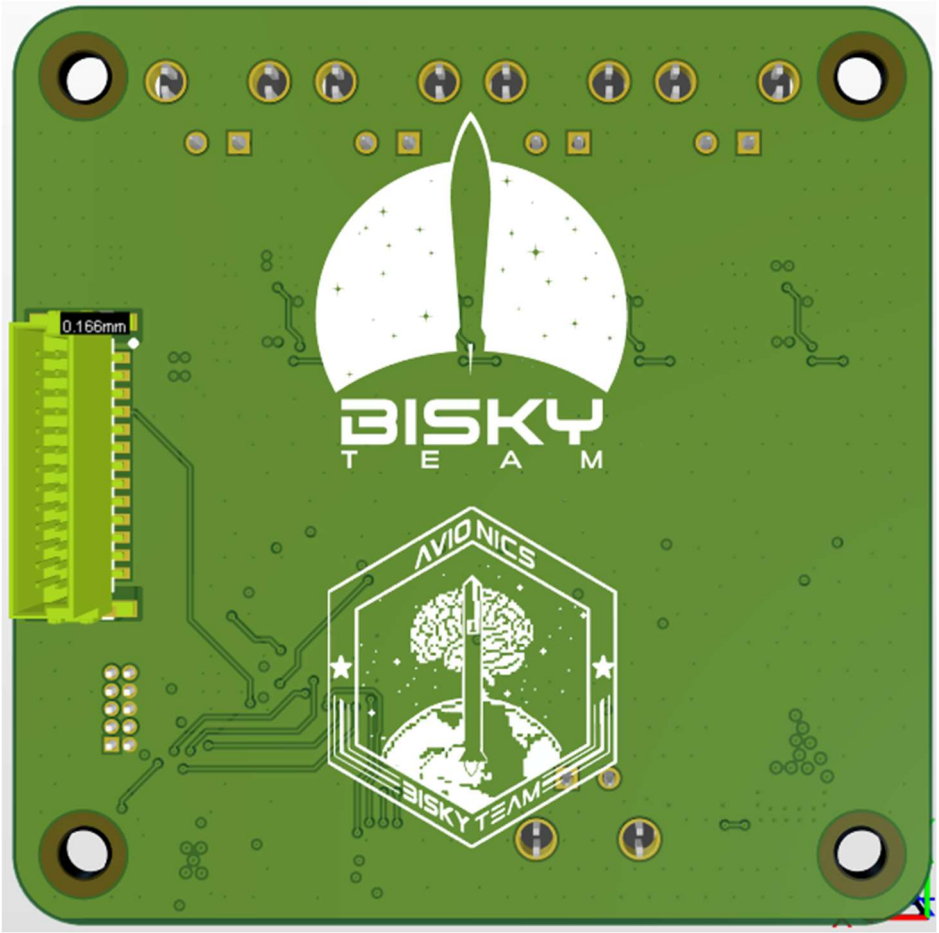

Figure 2. 3D render of the Orion Deton PCB, bottom view.