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Mission Complete: Ireland’s First EIRSAT-1 Satellite

Gamma-Ray Detection with Silicon Photomultipliers

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Summary

Application: Aerospace

Location: Ireland

Contracting Agency/Customer: University College Dublin

Product Used: J-Series SiPMs

Overview

The Educational Irish Research Satellite-1 (EIRSAT-1), Ireland's very first satellite, has successfully completed a pioneering mission and made a significant mark in the nation's space industry. Started with a proposal submitted to the European Space Agency's (ESA) *Fly Your Satellite!* Program in 2017, this project was developed by students and faculty from University College Dublin (UCD).

EIRSAT-1 is a double-unit (2U) CubeSat spacecraft equipped with two experimental payloads, a Gamma-ray module (GMOD) and an ENBIO module (EMOD), as well as a wave-based control (WBC) system for magnetic attitude control, and antenna deployment module (ADM) for communications. These major subsystems were all designed and manufactured at UCD.

After more than six years of building and rigorous testing, EIRSAT-1 was launched at the Vandenberg Space Force Base in California, aboard a Falcon 9 SpaceX rocket on December 1, 2023. The satellite carried out three experiments in low Earth orbit and transmitted data back to its command center at UCD.

Mission

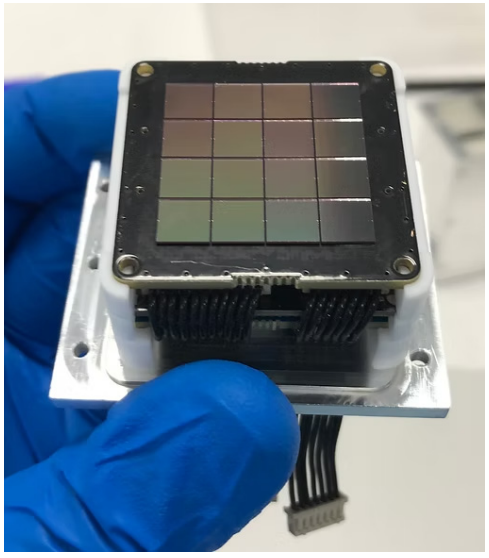
The primary objective of EIRSAT-1 was to provide comprehensive training and education for students in all major aspects of satellite development, space science and engineering. The UCD team had to build the spacecraft using both bespoke and commercial off-the-shelf components, go through extensive testing and validation to ensure resilience in the harsh space environment, and launch the satellite and collect data. The main goal of the GMOD of EIRSAT-1 is to trigger

on gamma-ray bursts (GRBs) in real-time and rapidly report to the scientific community. GMOD would provide important data on the behavior in space of the novel technologies it uses, paving the way for other space missions. The project helped foster collaborations not previously seen before across academia, industry and the ESA.

Challenge

The GMOD utilizes an array of silicon photomultipliers (SiPMs), developed by the **onsemi** team based in Cork, Ireland, to detect gamma-rays from both cosmic and atmospheric phenomena. The objective of the primary payload was to perform real-time detection of deep space electromagnetic explosions, or gamma-ray bursts (GRBs), and report them back to the UCD. At the early development of the EIRSAT-1 project, it was decided to adopt a modular CubeSat configuration, leveraging standardized, compact, and low-cost cubic unit. Each CubeSat unit measures 10 cm x 10 cm x 10 cm and is scalable depending on the mission. The entire EIRSAT-1 is a two-unit CubeSat spacecraft measuring only 10 cm x 10 cm x 20 cm. Gamma-ray instruments for astrophysics need sensitive, compact, robust, low-voltage light detectors. Traditional photo-multiplier tubes (PMTs) are sensitive but cannot be miniaturized to a CubeSat scale. All the subsystems were required to be CubeSat compatible and underwent extensive pre-launch testing.

Solution



Source/Credit: David Murphy/University College Dublin

Figure 1. SiPM Array in GMOD Module

The Silicon Photomultipliers (SiPMs) used in EIRSAT-1 were acquired by UCD team as off-the-shelf sensing element from **onsemi**. From the very early days of the project, **onsemi** team provided tremendous support by educating the UCD team about the sensors and their operations requirements, as well as developing proposals for ESA. The UCD team then built its own custom instrument around the SiPMs for GMOD.

This light signal is detected by an array of 16 SiPMs. The SiPMs convert the light created by the gamma-ray when it impinges on a scintillating material into an electrical signal. These signals are digitized by a specially designed SiPM readout application-specific integrated circuit before they can be processed by onboard computers and transmitted back to UCD. The SiPM is revolutionizing in-situ and remote sensing of gamma-rays in space by removing the need for conventional photomultiplier tubes that are typically very bulky, fragile and require high voltages to operate. Within the precious real estate of a CubeSat, the miniature size (from 3 mm to 6 mm) and thickness of the SiPM is another reason why it was selected for GMOD.

GMOD underwent extensive vibration testing on its own as well as part of the CubeSat to ensure reliability during the launch. It was also tested repeatedly in a thermal vacuum chamber, simulating the operational environment in low Earth orbit. Silicon photomultipliers like those used in GMOD were irradiated by high-energy protons to assess long-term performance in space.

Result

EIRSAT-1 sent its final beacons on September 4, 2025, officially completing its two-year journey in space before deorbiting, then burning up upon re-entry of Earth’s atmosphere. Two versions of EIRSAT-1 were built: the Flight Model which was launched completing its mission, and the Environmental Qualification Model which remains at UCD for educational and development purposes. During the mission, GMOD detected 10 cosmological GRBs and two solar flares, contributing to scientific knowledge and understanding about the universe.

EIRSAT-1 represents not just Ireland’s first satellite; it was Ireland’s first space mission. This small satellite is a major step for the UCD team to prove its ability to develop, launch and operate a spacecraft, and a giant leap for Ireland as a spacefaring nation. The legacy of EIRSAT-1 carries on at UCD, inspiring further space research and preparing the next generation workforce for industry.

REVISION HISTORY

Revision	Description of Changes	Date
0	Initial document release.	11/14/2025

ADDITIONAL INFORMATION

TECHNICAL PUBLICATIONS:
Technical Library: www.onsemi.com/design/resources/technical−documentation
onsemi Website: www.onsemi.com

ONLINE SUPPORT: www.onsemi.com/support
For additional information, please contact your local Sales Representative at www.onsemi.com/support/sales

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