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Front-End Electronic for Miniaturized LIDAR Signal Conditioning

Santiago Andrés Velasco, Joaquín Rivas Abalo, Ignacio Arruego Rodríguez, Gustavo Vázquez Yáñez, Saturnino Montalvo Chacón, Esteban Muñoz García, Alberto Martín Ortega, Juan José Jiménez Martín, Elisa García Menéndez, and Alberto Moya Señas
Instituto Nacional de Técnica Aeroespacial (INTA)

The Miniaturized LIDAR for MARS Atmospheric Research (MiLi) project falls within the European Union funding program called Horizon Europe [1]. Within this general framework, the project being presented is classified under cluster 4 - Digital, Industry, and Space [2]. The investment in the different projects within this fourth point pursues the idea of global leadership of the European industry in key areas, through the development of competitive and trustworthy technologies. This sets the foundation for a competitive, digital, sustainable, and circular industry that allows for progress and innovation in global societal challenges.

The use of LIDAR in characterizing the Earth's atmosphere is widespread. These instruments use laser light to study the size and density of aerosol particles, making it logical to consider this solution to examine Martian aerosols (atmospheric dust and ice clouds). However, such instruments are typically large, heavy, and consume significant amounts of energy, making their use aboard planetary exploration modules a complex challenge. Designing and developing a miniaturized, low-power LIDAR for atmospheric research on Mars, which demonstrates the feasibility of a future characterization mission and increases the TRL level of the new technology developed, are the main objectives of the project [3].

One of the key aspects in a LIDAR instrument is the design of the receiver circuit for the emitted laser pulse, as it is responsible for both receiving the signal and carrying out its subsequent processing and transmission. In this project we explore the possibility of capturing the pulses through Si-PMT (Silicon Photomultipliers) known as MPPC (Multi-pixel Photon Counter). The proposed design has a dual functionality, as measurements will not only be taken at the time of laser pulse emission but also when it is off, this will allow for an exact characterization of the so-called dark pulses (electrical signals produced by the photodetectors in the absence of incident light). Understanding and characterizing them is of great importance since they directly affect the sensitivity and precision of the measurements carried out.

The design presented is based on an innovative solution that addressed the problem detailed as one of the main objectives: instrument compactness. In this, different signal distribution techniques, gain adaptation, EMI mitigation, as well as transmission of signals obtained from photodetectors over long distances are employed.