A Wide Dynamics Range Front-End Electronics for SiPMs using High-Speed Operational and Integration Amplifiers

16th Pisa Meeting on Advanced Detectors - La Biodola • Isola d'Elba • Italy - 26 May / 1 June, 2024

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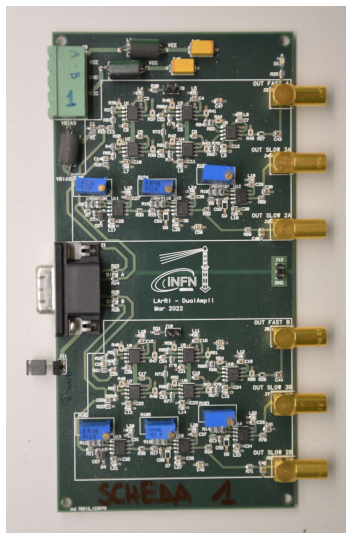
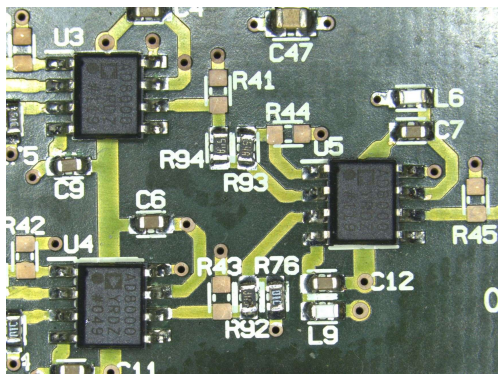


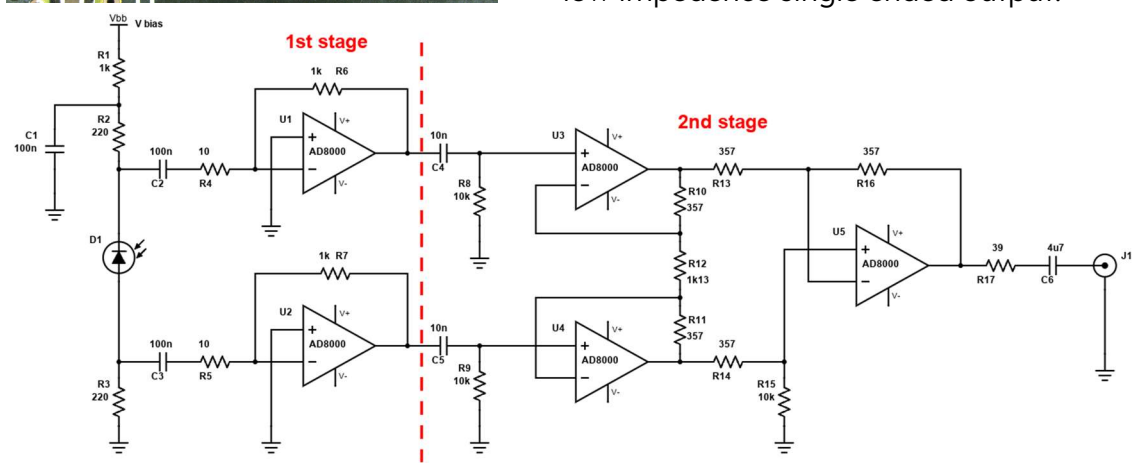
Silicon photomultipliers (SiPM) have gained popularity in particle physics due to their inherent advantages in terms of compactness, low power consumption, and high photon detection efficiency. Moreover, we have to deal with signals ranging from a few photoelectrons (PE), where we need to reconstruct the exact shape, up to thousands of PEs in short time intervals.

The design of this amplifier was conceived to handle the SiPMs signal in both cases, combining together a high-speed amplifier for precisely reconstruct the shape of the signals of a few PEs and an integrated one in which the output voltage level is directly proportional to the number of the input PEs.

The High Speed Amplifier

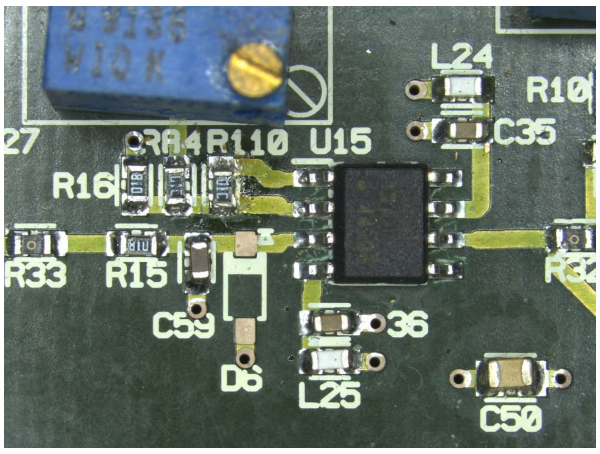


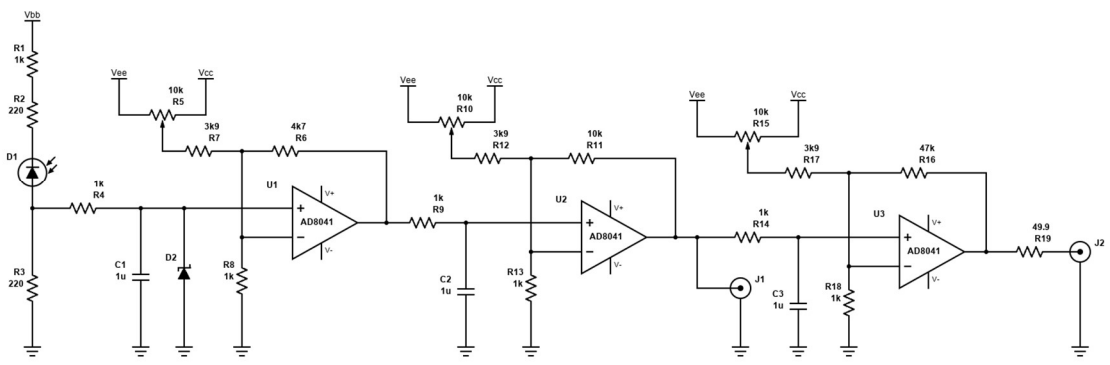
- The signal is picked up at the SiPM in differential way by a R-C net in order to block the bias voltage and to adapt the input impedence.
- The first stage is designed to have a gain of 100V/V in inverting configuration.
- The second stage is a 3 OpAmp Instrument Amplifier designed to convert the signal from differential to a low impedence single ended output.



The Integration Amplifier

- The SiPM signal is sent in parallel to the integrated amplifier.
- Three stages of incremental gain: 5, 10, 50 V/V; Outputs available on 2nd and 3rd stages.
- Offset regulation by trimmer in each stages.
- Output levels are directly proportional to the PE's number detected.

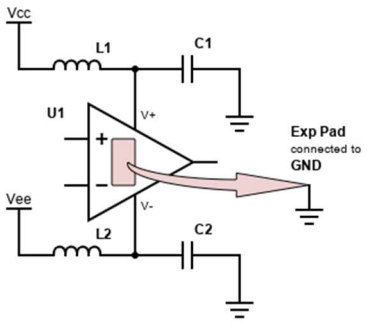


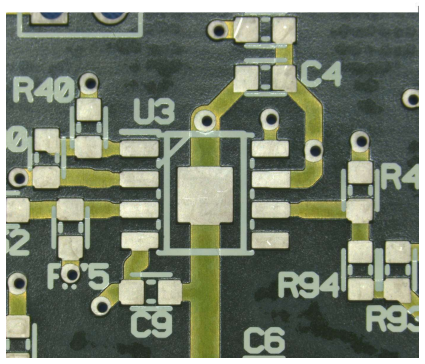


Power Connections

Special care is required in the design of the printed circuit board (PCB) to handle the high-speed signals.

- Dual Power of each op-amp is provided by individual L-C filters
- Ground is not directly connected to the GND internal plane, but with a dedicated top layer route
- Internal ground planes is splitted indipendently for each channel





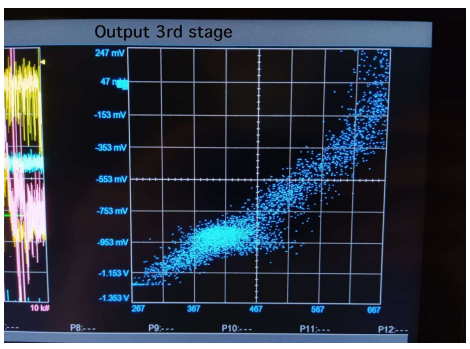
Installations and Performed Tests - LArRI

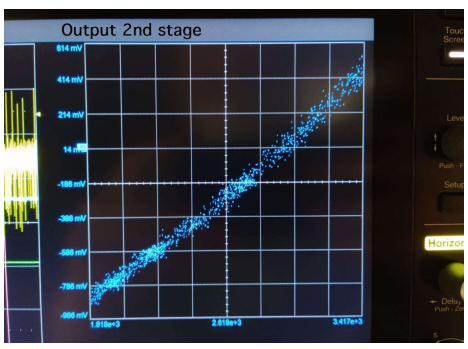
Two of these boards have been employed successfully in LArRI: a new setup for **L**iquid **Ar**gon **R**efractive **I**ndex measurement, built at the physics department of UNIGE and INFN sezione di Genova.

Inside a cryostat four SiPMs Hamamatsu (S13370-3075CN UV-sensitive 3x3 mm^2) are mounted on a movable stand.

The two boards, placed outside the cryostat at room temperature, route the bias voltage to the SiPMs and integrate their current signals (τ ~= 100 ms). Signals are then acquired with a Teledyne Lecroy scope in a 100 ms time windows, at typically rates of 2-10 Hz.

The images below show the output Voltage at the 2nd and 3rd stages (y-axis) as a function of the number of events (x-axis) counted by the Teledyne Lecroy HDO6104A-MS.





For more informations about LArRI setup and results see:
POSTER #467 LArRI: a new setup for Liquid Argon Refractive index measurement (bianca.bottino@ge.infn.it)

Future Works

Two of these boards will be employed in ARTIC (**AR**gon **T**est **I**nfrastru**C**ture), a criogenic facility installed in the DIFILab, a laboratory of the Physics Department of University of Genova, in order to perform measurements on scintillation light in liquid argon.