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CHIMERA HSDT: a modular High Speed Differential Transmitter modular system for nuclear physics signals

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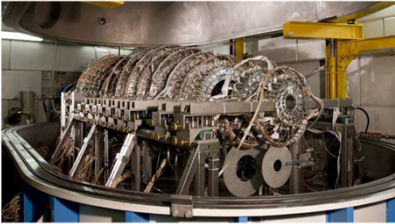
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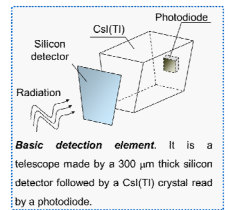
Abstract

In the framework of high-granularity multi-detectors used in nuclear physics, it is important to develop complex signal transmission architectures between the front-end electronics and the data acquisition system. We present a modular system composed of 40 HSDT-32 electronic boards (High-Speed Differential Transmitter with 32 channels), proposed for the CHIMERA detector. These compact and highly integrated units perform signal conversion from a single-ended (RSE) to a fully differential transmission system. The system improves the signal-to-noise ratio and enhances immunity to electromagnetic disturbances. The HSDT-32CH boards are designed to operate in vacuum and to be positioned as close as possible to the CHIMERA apparatus, in compliance with the installation constraints inside the scattering chamber and with effective thermal management solutions for dissipating the generated heat.



The CHIMERA Detector [1] is a multi-detector array for light charged particles and fragments operational at LNS in Catania (Italy). It is made by 1192 Si-CsI(Tl) telescopes placed in a 4 π geometry arranged in 35 Rings along the beam axis, for a total length of ~4m.

The forward 18 rings are assembled in 9 wheels covering polar angles between 1° and 30°; the remaining 17 rings covering the angular range between 31° and 176° are assembled in a sphere of 40cm of radius. The main characteristics of the detector are a systematic measurement of the **Time-of-Flight**, allowing velocity and mass determination, a **low multi-firing probability**, and the **low energy threshold**.

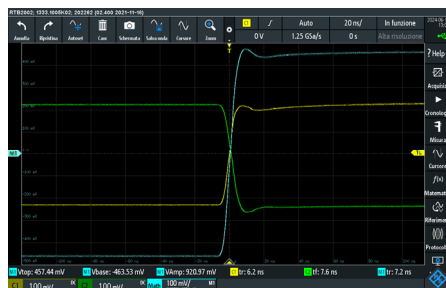
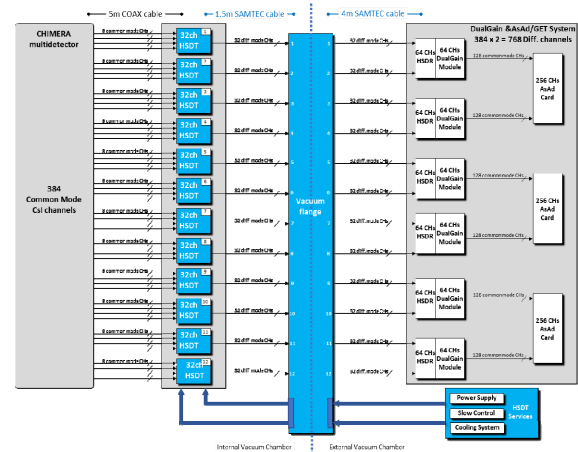
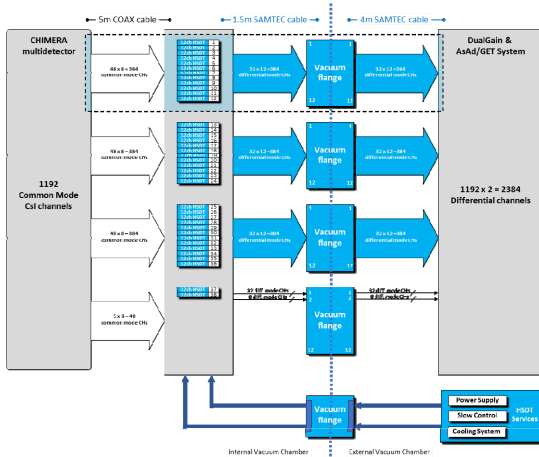


CHIMERA HSDT System Description

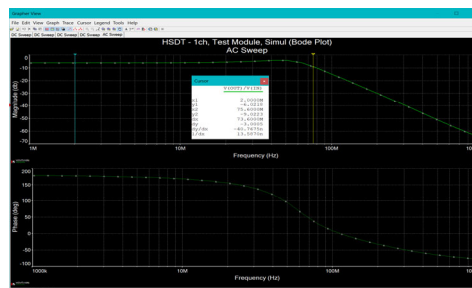
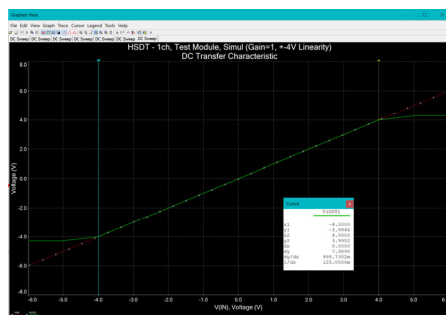
The CHIMERA HSDT System is an upgrade of the CHIMERA multidetector, aimed at enhancing signal transmission performance through the introduction of HSDT (High Speed Differential Transmitter) boards.

These boards are specifically designed to convert signals from RSE (Referenced Single Ended) to a differential configuration. This conversion is advantageous because differential signals are significantly more resistant to electromagnetic interference compared to RSE signals.

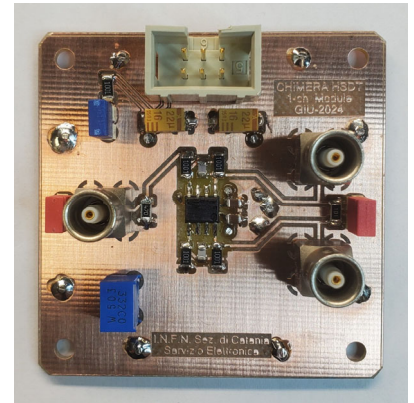
To optimize thermal management and improve the signal-to-noise ratio, the HSDT boards will be installed inside the vacuum chamber, in close proximity to the chamber walls. This placement allows for more effective heat dissipation. Additionally, the differential transmission configuration utilizes SAMTEC shielded cables with a 100 Ω impedance, which are not only more compact but also mechanically more robust than the cabling used for RSE signals. For all these reasons, it is highly recommended to minimize the length of the RSE cabling by positioning the HSDT-32CH boards as close as possible to the CHIMERA device.



The figure shows the step response measured on the amplifier module shown in the photo. The rise time is approximately 7 ns.



The figure shows the expected frequency response of the single-channel amplifier used in the HSDT System. The frequency response, measured during testing of the amplifier module shown in the photo, is 60 MHz, slightly lower than the expected 73 MHz.



CHIMERA HSDT Module Prototype

Conclusions and perspectives

The prototype has been extensively tested, and results are satisfactory. A 32-channel prototype will soon be produced to carry out full-scale testing prior to final production.

The figure shows the linearity characterization of the prototype, represented by the plot of output voltage versus input voltage.

REFERENCES

[1] Pagano A., Nucl. Phys. News Int., 22 (2012) 28