Acquisition and Control Module for the DAMIC-M Experiment

Mircea Bogdan*, Marc Dhellot**, Daniel Florin***, Romain Gaior**, Lounes IDDIR**, Ben Kilminster***
Antoine Letessier-Selvon**, Sravan Mungavalasa*, Paolo Privitera*, Achim Vollhardt***
The University of Chicago*, LPNHE**, University of Zurich***

Introduction

We introduce a new Acquisition and Control Module (ACM), designed for the DAMIC-M (DArk Matter In CCDs at Modane) experiment.
The experiment aims to detect dark matter that generates eV-scale ionization events in the 670 μm substrate of the CCD. Using a floating gate amplifier for repetitive non-destructive charge measurements, the DAMIC-M detector is able to count single electrons with eV-scale resolution. One Acquisition and Control Module incorporates all power, bias and clock generators required to control four CCDs, as well as four 18-Bit, 15Msps ADC channels. ACM functionality is managed by a powerful Intel Arria V FPGA, allowing for remote configuration of all parameters. This 6U VME form factor module was designed to work independently, or inside a traditional VME crate. The board can interface via two 6Gbps SFP optical links and one Gigabit Ethernet Port on the front panel, as well as via the VME64 back plane. Multiple module synchronization with simultaneous sampling is made possible with four LVDS signals via an auxiliary front panel RJ45 connector. The DAMIC-M experiment will run 50 Acquisition and Control Modules, installed at the Laboratoire Souterrain de Modane in France. .

Electronic Chain

The Ethernet controlled ACM provides all the CCD required clocks and biases and receives the video signals, which are pre-amplified by a Front-End board. Figure 1 shows all the elements in the electronic chain being tested, during the prototyping stage.

Figure1. CCD control and readout electronic chain.

Connection between the CCDs and the Front-End board is done with a specially designed 2-Layer, 1.5m long, radiopure Flex PCB. From there to the ACM, radiopurity of material is not critical and communication is done with individually shielded cables.

The ACMs are standard 6U VME boards. In order to maximize the noise performance, all power voltages connected to the crate come from linear supplies. Figure 2 shows the first ACM fabricated and tested in Chicago.
In this setup, full VME control is possible, but it's not employed. The crate is used only for the chassis and power connections, while all module control and data acquisition are done via the front panel. Up to 20 ACMs can be installed in one crate.

Figure 2. Prototype ACM board inside VME crate with linear power supplies.

Conclusions

Figure 3 presents one of the four ACM prototypes, that have been manufactured and tested so far.
One module provides all the voltages and clocks required to control four CCDs and also incorporates the DAQ for the corresponding video signals.
Depending on the application, readout can be done via VME or the Ethernet ports.
In small applications, this module can also run on a single 12V supply, with the use of a mezzanine card.

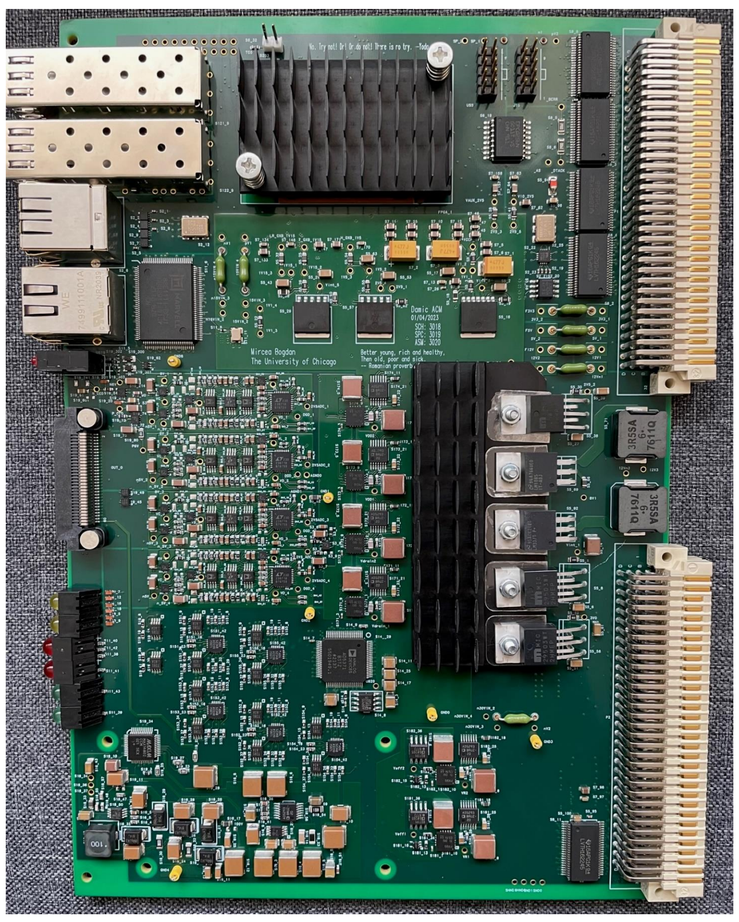

Figure 3. Prototype ACM board

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