

RedPitaya applications at the NBTF beam source SPIDER

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The RedPitaya board represents an alternative to many expensive laboratory measurement and control systems. It hosts a Zynq system composed of an ARM processor deeply integrated into a configurable FPGA, two 125MHz RF inputs and outputs and 14-bit Analog to Digital and Digital to Analog converters.

Due to its flexibility, RedPitaya has been considered for a variety of advanced diagnostic measurements at SPIDER, one of the two experiments being held at the ITER Neutral Beam Test Facility located in Padova (Italy). In particular, high-speed, event-driven data acquisition, i.e. data acquisition during a time window centered on the occurrence time of a given event, possibly repeated during the experiment, represents a common use case in data acquisition at SPIDER. Event driven data acquisition was carried out by a much more expensive commercial device and the RedPitaya solution has been considered not only for its price, but also because not all the requirements could be satisfied with the former solution. For this reason, a project was started, aiming at developing a flexible FPGA configuration capable to satisfy all the requirement, in particular the required flexibility in event definition. Events triggering acquisition can indeed be represented by external triggers, but can also be derived from input signal characteristics such as level and steepness. Moreover, external triggers can be either directly provided or derived from the Manchester encoding of real-time events in the 10 MHz timing highway signal, a signal generated by the central timing system and distributed to all systems to provide in phase clock and asynchronous triggers.

Red pitaya event driven data acquisition has also been used to provide streamed spectral measurement of RF sources. In this case, the boards receive a sequence of triggers (up to 200 Hz) and at the occurrence of every trigger it acquires a bunch of samples at high frequency (up to 125 MHz) that is then streamed to the network via the embedded Zynq CPU. FFT analysis is then performed either inline or offline to derive spectral information at every trigger time, thus implementing continuous spectral information, a measurement would otherwise have required very expensive instrumentation otherwise.

Thanks to this flexibility, RedPitaya –based data acquisition is becoming more and more used at SPIDER, and the developed solutions, including flexible DAC devices, shall also be used at RFX-mod2, the upgrade of the RFX-mod fusion experiment currently under construction in the same laboratory.

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