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LLRF Firmware of Fermi@Elettra

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FERMI@Elettra is the soft X-ray, fourth generation light source facility at the Elettra Laboratory in Trieste, Italy. It is based on a seeded FEL, driven by a normal conducting linac that is presently expected to operate up to 1.5 GeV. To meet the requirements on phase and amplitude stabilitiy of the RF fields, state of the art technology must be adopted for the LLRF of the machine. The LLRF system is developed in the frame of a collaboration agreement between Sincrotrone Trieste and Lawrence Berkeley National Lab.
This paper describes the LLRF firmware developed for Fermi to achieve those constraints. The main characteristics of this firmware are: non-IQ demodulation of the IF inputs, CIC filtering, amplitude and phase loops, PLL loop, calibration cables loop, reference phase drift compensation, phase modulation for Sled operation, Ethernet communications and diagnostics of the system. Further developments are still foreseen like intrapulse feedback, iterative learning and real time Ethernet communications between different LLRF systems to implement a global feedback system.
This firmware has been integrated in two different hardware platforms based on FPGAs, fast ADCs and DACs: the LLRF4 Board (Spartan-3 FPGA and USB communications) and the FERMI AD Board (Virtex-5 FPGA Ethernet communications). The former board was installed to provide an "intermediate system"for the machine to perform the basic functionalities, while the latter has been specifically developed to attain the ultimate performances.

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