Digital Signal Processing for Bunched Beam Intensity Measurements

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ABSTRACT Intensity measurements of bunched beams are typically based on ACcoupled toroidal transformers (toroid) or broadband resistive wall current monitors (RWCM). Read-out technologies based on an

125MHz 14-bit 8 Channel Digitizer



FPGA Signal Processing

- Configurable timing scheme, beam Sync pulse as trigger
- Calculations for all channel performed in parallel





in-house designed 8 channel VME digitizer board are presented. This paper gives an overview of the entire measurement system, discusses the hardware and performance of the 125 MS/s digitizer, and provides details on the FPGA-based digital signal processing. We present the different FPGA algorithms, applied for single- and multi-bunch beam intensity measurements in proton and electron linacs.





- In-house designed, 6U VME board, sampling rate up to 125MSPS
- 8 analog input channels, selectable AC/DC coupling
- Programmable clock distribution circuit, smart triggering scheme
- Onboard FPGA chip, DDR2 SDRAM, Flash memory





The integrator uses trapezoidal instead of rectangular integration to account for possible change in pulse current.



FPGA Firmware Implementation (at the instant k=8193):



Baseline Correction





To ensure the beam intensity remains close to pre-determined levels, beam intensity monitors with magnetically-coupled toroidal pickups are used as a non-interceptive method to measure the total transferred intensity in the transport lines at FNAL.



The toroidal pickup follows basic transformer theory. Passing

Simplified digitizer hardware diagram

FPGA Firmware Structure



The firmware contains I/O interfaces including the LVDS receiver, VME bus driver, memory interface, serial interface, etc. as well as application specific algorithms. The connection between the design blocks was developed using the SOPC tool provided by Altera.

Baseline corrected data is also saved to the memory. Decimation

can be configured from software as well.



A buffer records the variation of the baseline/pulse. When input samples exceed the recorded range by a predetermined threshold, the edge is detected.

System Installation

Measurement Screenshots

through the center of the toroid, the beam forms a single-turn primary coil of the transformer. The induced voltage is measured across a burden resistor which terminated the secondary coil.





Preamp and VME based electronics



Digitizer testing program screenshot

Control system user end read out

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