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FPGA-based multi-precision RF waveform measurement

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RF measurements are crucial for stabilizing the power source output and extracting beam data. As digital systems evolve, the analog-to-digital converter (ADC) now commonly reaches 16 bits and 100 MHz, enabling multi-channel low-level radio frequency (LLRF) systems to generate several gigabytes of data per second, overwhelming data storage and processing capabilities. This paper proposes a pre-processing method using Field Programmable Gate Arrays (FPGAs), which dynamically adjusts timing intervals based on operator requirements. For detailed waveform analysis, the LLRF can upload data over short time intervals with high precision. Conversely, for applications concerned with slow drift, long-time-range, low-precision data is transmitted. Thus, the total amount of uploaded data remains constant. A multi-order filter is applied to the raw data, with desired precision achieved at specific orders. The time precision ranges from 10 ns to 20 μs, while the time range spans from 20 μs to 40 ms.

Footnotes

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