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Design and implementation of a high-precision time to digital converter based on ZYNQ 7000

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Time measurement technology is widely used in modern nuclear physics and particle physics experiments, aerospace and laser ranging etc. As its core technology, time to digital converter (TDC) is increasingly important. This paper presents a high-resolution TDC implemented in Xilinx ZYNQ 7000 device with a new encoder. This design introduces a novel pipeline-multiplexer encoder that realises 'bubble_proof' by using a coarse-fine counter method based on the FPGA carry chain. In comparison to the conventional Wallace tree encoder, the proposed design exhibits reduced hardware and area requirements, as well as a shorter critical path. Additionally, the propagation delay time per delay cell (bin width) is dependent on the temperature and power supply voltage of the hardware circuit, automatic calibration of the ARM is necessary to ensure optimal performance. The resolution of differential nonlinearity (DNL) and integral nonlinearity (INL) is approximately 11ps. Gaussian fitting indicates that the precision of this system is within 50ps, which is in accordance with the desired design specification.

Footnotes

Funding Agency

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Yes

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