Introduction

- A new field-programmable gate array (FPGA)-based time-to-digital converter (TDC) with a wide dynamic range greater than 20 ms has been developed to monitor the timing of various pulsed devices in the trigger timing distribution system of the KEKB injector linac.
- The development of the new trigger timing distribution system started in 2004 to realize top-up injections for both the previous KEKB and PF rings based on the new control system.
- The required specifications of the TDC were realized on the basis of the complex timing systems in large accelerator complexes.

Basic specifications designed for the FPGA-based TDC

- FPGA: XILINX Spartan-6 (XC6SLX75, DCM 250MHz)
- External clock: EPSON TG-5501CA, 50MHz
- Gigabit ethernet based on SITCP is embedded

Multisampling technique in the time duration measurement

- Based on the multisampling technique, the accuracies were 2.6 ns (rms) and less than 1 ns (rms) within the dynamic ranges of 20 ms and 7.5 ms, respectively.
- The various nonlinear effects were improved by implementing high-precision external clock with a built-in temperature-compensated crystal oscillator.

Characteristics evaluations of the TDC module

- The various nonlinear effects were improved by implementing high-precision external clock with a built-in temperature-compensated crystal oscillator.

Conclusion

- We have successfully fabricated and tested a new VME/FPGA-based TDC with a wide dynamic range greater than 20−ms and a resolution of 1 ns.
- The required specifications of the TDC were realized on the basis of the suitable design with a high-precision temperature-compensated external clock with an accuracy of 0.13 ppm.
- The results are fully sufficient for monitoring the trigger timing distribution system of the injector linac. The developed TDC could be applied to further complex timing systems in large accelerator complexes.