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Digital Readout Board for CMS and TOTEM Precision Proton Spectrometer Timing Upgrade Project

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For the CMS and TOTEM Precision Proton Spectrometer Project, a digital readout board was designed to take front-end data of the Diamond Detectors and Quartz Timing Cherenkov Detectors, reformat the data timing packets, and transmit them to the CMS and TOTEM data acquisition systems through optical data links. This board is capable of having HPTDC or SAMPIC mezzanines for high-resolution timing measurement of the leading and trailing edges in the hit pulses with the resolution of 10 - 20 ps.

Summary

The FPGA-based digital readout board is designed for the Precision Proton Spectrometer Timing Readout project along with the TOTEM Timing Upgrade project. The board is capable of data readout from two HPTDC mezzanine (each containing four HPTDC time to digital converter chips) or two SAMPIC time to digital converter mezzanine through different extensions. Data is then sent to the CMS data acquisition system using four 400 Mbit/s optical links implemented by the four-channel Pixel Optohybrid (POH), and to TOTEM data acquisition system via two optical links. One CCU25 chips has been mounted on the board to benefit from the maximum capability of this chip by having four parallel 8-bit, one master JTAG and at most sixteen I2C channels for controlling the board as well as programming the FPGA and communicating with the DAQ system. The selected Rad-Hard FPGA is a SmartFusion2 M2S150-FC1152 from Microsemi Co.

Data readout of the HPTDC mezzanine is done through dedicated 80 Mbit/s LVTTTL serial lines without trigger recovery, and dedicated 32-bit LVTTTL parallel ports with trigger recovery. The four HPTDC chips on the mezzanine board form a token ring which is controlled by the main SmartFusion2 FPGA on the readout board. For the beam test purposes, USB and FieldBus expansions are also implemented on the board using the QuickUSB and FieldBus components. Data readout from the mezzanines and board programming would be possible by these extensions through a special data protocol which is defined in the main firmware.

For the transmitting readout data from the SAMPIC mezzanine to TOTEM data acquisition system, two GOH optical links has been added to this readout board due to TOTEM DAQ requirements. For the configuration purposes, the SAMPIC mezzanine FPGAs are programmed by the SmartFusion2 FPGA.

The dedicated clock distribution systems will be used to synchronise the detectors installed on both sides in the tunnel at 220 m from CMS interaction point.

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