Development of new high speed data acquisition system prototype for SOI pixel detector using 10 Gb Ethernet SiTCP

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Introduction

SOI pixel detector (SOIPIX)

10GbE SiTCP data acquisition system

Plan of data acquisition system production board

Prototype of data acquisition system

Prototype DAQ system was developed on KC705 FPGA board.

10GbE SiTCP is a network processor IP (Intellectual Property) core that can be implemented in an FPGA.

- Developed by Tomohisa Uchida (KEK ESYS), and currently developed and supported by Bee Beans Technologies.
- Small circuit size(3000 Slice), simple FPGA like (close to specification maximum transfer speed caused by Hardware-based implementation and easy to customize).

Prototype of data acquisition system

- Present system using 1GbE SiTCP, and it is not enough for advanced experiments (high framerate, large area etc.)

Experimental results

Setup

From upstream side → From downstream side

Tests for prototype DAQ system were done at KEK Photon Factory BL-14A and BL-14B.

- X-ray beam (12keV monochromatic) was injected from backside of SOIPIX detector and was intercepted by an X-ray chopper with a duty ratio of 50%.

Conclusion

- SOI pixel detector's new DAQ system based on 10GbE SiTCP is now under developed.
- Prototype DAQ system was developed on KC705 FPGA board.
- Prototype system was tested with SOI pixel detector (INTPIX4NA) at KEK PhotonFactory BL-14A and BL-14B.
- 10GbE SiTCP result shows no fluctuation caused by instability of transfer rate in 682 Mbps average data traffic situation.
- 10GbE SiTCP shows stable framerate at 350 fps (average data traffic is 2.4 Gbps).
- These results were the initial result of X-ray imaging data taken by 10GbE SiTCP.

10GbE SiTCP shows stable framerate even in higher(>1GbE) transfer rate condition.

Condition of Test 1.

- Exposure time : 200 us/frames , Analog output settling wait time : 240 ns/pix 
- Frame to frame period (Starting edge to edge) : 10 ms (Triggered by 100 Hz clock) , Average data traffic : 682 Mbps 
- (If one frame’s data transfer wasn’t completed in 10 ms, next frame’s period will extended to 20 ms or 30 ms.)

Condition of Test 2.

- Exposure time : 80ns/pix 
- Frame to frame period (Starting edge to edge) : 2.828 ms , Average data traffic : 2.4 Gbps 
- (If one frame’s data transfer wasn’t completed in 2.828 ms, next frame’s period will shows longer time)

Condition of Test 3.

- Exposure time : 80ns/pix 
- Frame to frame period (Starting edge to edge) : 2.828 ms , Average data traffic : 2.4 Gbps

You can see the movie data from below link or right QR code. (Dropbox link valid until 2021/05/31.)
https://www.dropbox.com/s/9fhv06qofwnqkx1/201122_14A_I4NA_XG_350fps_Run00003.mp4

10GbE SiTCP was advanced to Beta release and now you can try!
Go to https://github.com/BeeBeansTechnologies/SiTCP_XG_Netlist_for_Kintex7 
or Scan right QR code.