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Multidetector Embedded Readout Interface for Timepix3

Timepix3 [1] was developed within the Medipix3 Collaboration at CERN as the successor of the widely used Timepix detector. The chip showed good performance in various domains –3D track reconstruction [2, 3], radiation monitoring in particle physics experiments such as ATLAS or MoEDAL [4, 5]. Readout electronic systems were designed, e.g. SPIDR [6], ADVADAQ[7] and Katherine[8] with interfaces based on Gigabit Ethernet, 10G Ethernet or USB 3.0.

The Katherine readout was used in a lot of applications and projects. However, after several years of using, new demands on such device arose. Therefore, the new generation (designation "Ultimate Edition") of Katherine readout has been developed. It is introduced in this contribution.

A key feature of the upgraded version is the native support for more Timepix3 detectors. The device implements a pair of VHDCI connectors that allows to connect two standard CERN chipboards immediately (see Fig.1). However, the input data lines of the device could work independently, it means that through a reduction board up to 8 detectors can be connected. For example, one of aim application is the support of a quad detector geometry (four Timepix3 detectors with common sensor).
The new device offers wider possibilities of connectivity: Besides the Gigabit Ethernet used in the older device, a USB 3.0 interface was implemented as well. In case of USB, the user can use this fast interface for data rate around 40 Mhit/s at shorter distances between computer and readout device. On the other hand, the Gigabit Ethernet makes it possible to use remote control and several devices in the local area network (LAN). In this case the speed is limited to 14 Mhit/s.

Another upgrade is related to the bias voltage supply for the sensors. Thick silicon sensors, CdTe, CZT, or GaAs sensors require higher reverse bias voltage. Two independent high voltage power supplies are on the board. Each of them can provide a voltage in range from -1kV to +1kV additionally providing a leakage current measurement.

The experience obtained by using the previous version of the device, mainly in more complex measurement chain, showed us that one of the most important features of the readout device is the possibility of easy integration into bigger experimental readout chains. Therefore, advanced readout devices should offer an easy way of synchronization using one or more external trigger signals or feeding an external clock. The new Katherine device implements one input for external clock (also can be used as general input) and other three I/O signals for triggering or other purposes. The SMA connectors are used for these I/O signals with optional 50ohm termination (controlled by software). The device synchronization (demonstration –time differences between two layers of Timepix3 are shown in Fig.2) is solved in several layers. Firstly, clocks for detectors are synchronized and phase matched. The device implements a coarse soft Time-to-digital convertor (TDC) with a resolution of 4 ns for the measurement of delays. Then, there is a set of hardware TDCs with a precision of 50 ps used to get accurate synchronization. Lastly, the RAM memory of the device was extended to 2GB, in line with the dual ARM A9 processor it gives user good chance to implement enhanced data pre-processing directly in the hardware.

[1] Poikela, T., et al. Timepix3: a 65K channel hybrid pixel readout chip with simultaneous ToA/ToT and sparse readout. Journal of instrumentation, 2014, 9.05: C05013.B.
[2] Bergmann, B., et al. 3D track reconstruction capability of a silicon hybrid active pixel detector. The European Physical Journal C, 2017, 77.6: 1-9.
[3] Bergmann, B., et al. 3D reconstruction of particle tracks in a 2 mm thick CdTe hybrid pixel detector. The European Physical Journal C, 2019, 79.2: 1-12.
[4] Burian, P., et al. Timepix3 detector network at ATLAS experiment. Journal of Instrumentation, 2018, 13.11:

C11024.
[5] Bergmann, B., et al. Relative luminosity measurement with Timepix3 in ATLAS. Journal of Instrumentation, 2020, 15.01: C01039.
[6] Van der Heijden, B., et al. SPIDR, a general-purpose readout system for pixel ASICs. Journal of Instrumentation, 2017, 12.02: C02040. Visser, J., et al. SPIDR: a read-out system for Medipix3 & Timepix3. Journal of Instrumentation, 2015, 10.12: C12028.
[7] Turecek, D.; Jakubek, J.; Soukup, P. USB 3.0 readout and time-walk correction method for Timepix3 detector. Journal of Instrumentation, 2016, 11.12: C12065.
[8] Burian, P., et al. Katherine: Ethernet embedded readout interface for timepix3. Journal of Instrumentation, 2017, 12.11: C11001.

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