Contribution ID: **8** Type: **Poster**

Isolated USB Programmer for LpGBT (UPL) for the ATLAS-HGTD upgrade

Tuesday, 21 September 2021 17:20 (3 minutes)

The CERN developed radiation-tolerant data transmission chip lpGBT will be used on the peripheral electronics board (PEB) of High Granularity Timing Detector (HGTD) in ATLAS. In order to configure the lpGBT on the PEB, we designed a dedicated isolated USB programmer. Compared with the 2 existing lpGBT configuration toolkits, piGBT and CERN USB-I2C dongle, the programmer has very good cross-platform compatibility, electrical isolation performance and compact dimensions, which make it a better choice for PEB configuration.

Summary (500 words)

The increase of pileup will be one of the main challenges in the High-Luminosity LHC. Therefore, a High-Granularity Timing Detector (HGTD) has been proposed for the ATLAS Phase-II upgrade to mitigate the pileup effects caused by the increasing luminosity of proton-proton collision. The collisions that are very close in space but well separated in time can be distinguished with the high precision timing information provided by HGTD.

The Peripheral Electronics Boards (PEB) are located at the peripheral area of HGTD, and serve as a data transmission bridge between the front-end detector modules and DAQ system, the luminosity system as well as the detector control system. The CERN developed radiation-tolerant data transmission ASIC lpGBT plays a very important role in the data transmission of the PEB.

We designed a dedicated isolated USB programmer, which will be used to configure the lpGBT on PEB in the future. The motive of this design is that the 2 existing lpGBT configuration tools, piGBT and CERN USB-I2C dongle, are not suitable for the configuration of the lpGBT on PEB. For example, the piGBT has large size while the CERN USB-I2C dongle is platform-dependent and no GPIOs available. Moreover, neither of them considered electrical isolation, which is required for PEB configuration.

This design uses the FT232H ASIC chip, which can do the conversion between USB protocol and I2C protocol. Following the FT232H ASIC chip, an I2C isolator is used to electrically isolate the I2C signals from the host side and detector side. Then a GPIO expander and a level shifter can extend more GPIO ports and shift the 3.3 voltage level to lpGBT voltage level respectively. The power supply is also isolated with a power isolator. And the board has only 1 power source, which is the 5V voltage from USB. In addition, a dedicated connector is used, which can match with the connector on PEB.

Therefore, the programmer board has the characteristic of electrical isolation for both signal and power supply. The PEB under configuration would not be interfered by the host side since there are no direct electrical connection between the 2 sides. For example, the high surge voltage from the host side doesn't affect the PEB as well as electrical noises. Another feature of the board is good cross-platform compatibility. The FT232H ASIC chip provides multi-platform supported USB driver, which can work on the operating systems such as Mac OS, Linux, Windows7/8/10, Windows XP, and so on. Moreover, many programming languages such as C++, C#, Python, etc, can be used to control the USB driver.

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Session Classification: Posters Programmable Logic, Design Tools and Methods

Track Classification: Programmable Logic, Design Tools and Methods