Abstract

The Versatile Link Demonstrator Board (VLDB) is the evaluation kit for the Radiation Hard Optical Link ecosystem, which provides a 4.8 Gbps data transfer link for communication between front-end (FE) and back-end (BE) of the experiments. It gathers the Versatile Link main radiation hard custom ASICs: GBTx, GBT-SCA and VTRx/VTTx plus the FeastMP, a radiation hard in-house designed DCDC. This board is the first design allowing system-level tests of the Link with a complete interconnection of the constitutive components. The VLDB board as well as a system test example using multiple interconnected VLDBs are presented in this poster.

The VLDB and its components

The VLDB is a demo board which includes only radiation hard qualified components. These components are:

- GBTx: Gigabit Transceiver ASIC dedicated to serialization, deserialization, FEC and data and clock recovery.
- GBT-SCA: ASIC dedicated to slow control and status monitoring of the front-end modules (FE). It can handle up to 16 I2C, 8 SPI and 1 JTAG slaves, plus 32 GPIO lines, 31 ADC analog inputs and 4 DAC channels.
- VTRx/VTTx: optical transceiver/dual transmitter. The VLDB can also work with a commercial SFP+.
- FEAST MP: DCDC converters supplying 1.5V, 2.5V and 3.3V to both on-board components and VTRx/SFP+.

The VLDB can be used to:

- Be familiar with the complex set of configurations provided both by the GBTx and by the SCA.
- Characterize the radiation hard optical ecosystem, in particular focusing on the recovered clock delivered to the FE.
- Test firmware and software implementations of back-end (BE).
- Test the communication with up to 20 front-end modules via e-link/HDMI ports.
- SEU and total dose radiation tests.
- Be a reference board for the design of experiments custom boards.

Kintex 7 test setup

The first functional test setup has been designed with a KC705 reference board. This setup consists of a VLDB, the KC705 acting as back-end board, an optical link and a 5 e-link connection through HDMI cables connected to the e-link FMC.

In this configuration the FPGA is configured with the GBT-FPGA IP and a simplified Front End emulator receiving e-link data and either looping back the received e-link data or generating a pattern to be sent via e-link to the GBTx. It is thus possible to monitor the quality of the transmitted data in many configurations (GBTx as a transceiver, receiver, transmitter). This setup is also used to test a significant part of the VLDB after production.

VLDB kit

The VLDB is being distributed with several add-ons that allow the users to extract the most from the board. These are:

- USB to I²C dongle: to program and fuse the GBTx from a PC (left).
- A set of FEASTMP DC-DC to allow using either the VTRx or a commercial SFP+ as an optical transceiver (top centre).
- SCA Daughter boards: they expand SCA’s pinout for an easy connection to FE modules.
- E-link FMC board: A board that enables 5 e-link connections with an FPGA.

SCA test setups

The VLDB is equipped with an SCA, able to control more than 20 slaves with various protocols, so several connection tests can be made. In particular two test setups are being prepared:

- Cascade several VLDBs emulating a set of slave GBTx being controlled through the SCA by a single master GBTx (right picture).
- Configure a series of I2C, SPI and JTAG devices controlled over the SCA (left picture). This setup is currently under development and will be soon available for a demonstration.

In the setups the KC705 can be controlled through an Ethernet connection, allowing the user to control the SCA using the dedicated slow control field (EC bits) in the GBT frame.

The picture below depicts another example of SCA test setup. It shows a VLDB (centre) acting as a master and the two other (right) as slaves of the SCA of the first one. The master VLDB gets configured from the optical link, while the other two get their configuration from the I2C links coming from the master SCA. The slaves also get the reference clock from the GBTx of the master VLDB. The full setup is controlled by the KC705 on the left, and several slave devices not showed here can be controlled from the SCAs on the slave VLDBs.

The picture above shows an example of SCA test setup which depicts two I²C demo boards and one FPGA used as slaves from the SCA. In this setup the KC705 sends data through the EC field of the GBT serial frame. The Artix 7 FPGA can be configured through the JTAG link.

* The test setup is currently under development and the connections in this picture are voluntarily simplified.