Contribution ID: **160** Type: **Oral**

Overview of the production and qualification tests of the lpGBT

Wednesday 4 October 2023 09:20 (20 minutes)

The Low-Power Gigabit Transceiver (lpGBT) is a radiation-tolerant ASIC used in high-energy physics experiments for multipurpose high-speed bidirectional serial links. Almost 200,000 chips have been tested with a production test system capable of exercising the majority of the ASIC functionality to ensure its correct operation.
Furthermore, specific individual qualification tests were carried out beyond the production tester limits, including radiation, multi-drop bus topology, inter-chip communication through different types of electrical links and jitter characterization.
In this paper, an overview of the production and qualification tests is given together with their results demonstrating the robustness and flexibility of the lpGBT.

Summary (500 words)

The Low-Power Gigabit Transceiver (lpGBT) is a radiation-tolerant ASIC that is used to implement multipurpose high speed bidirectional optical links for high-energy physics experiments and in particular for the HL-LHC upgrades of ATLAS and CMS. It provides a single bidirectional link to be used simultaneously for data readout, trigger data, timing, experiment control and monitoring.

The lpGBT has many diverse features that must be tested before its delivery to ensure its correct operation. Almost 200'000 chips have been produced and tested in Q4 2022 and Q1 2023, which represents an unprecedented production volume of ASICs for the high-energy physics community. During the production testing, each chip went through an optimised process limited to thirty seconds during which all I/O connectivity and internal functions were tested. This testing process was done at three different supply voltages and both ambient and cold (-30 ℃) temperatures and allowed, in addition, to assign and fuse chip serial numbers and perform analogue calibration of the ASICs.

Nevertheless, a few complex functions could not be included in the test sequence due to the constraints imposed by production testing, in particular time and cost, and the form factor of the test system. For instance, the tester only houses one lpGBT and an FPGA emulating both the back-end and front-end electronics which, in reality, will be extremely diverse.
Hence several additional tests representing the many use-cases were performed on several samples, such as the communication of the lpGBT with other ASICs through different types of available electrical links. The characterisation of the jitter performance of the lpGBT required a relatively complex setup which could not be included in the production tests. Therefore, it was also part of the additional qualification campaign and was performed with different configurations and environments. Finally, the lpGBT has been extensively qualified under various types of radiation over several test campaigns. Complimentary to tests of tolerance to total-ionising-dose, it was also tested stand-alone with heavy ions and as part of an ecosystem (including the VTRx+ transceiver [1] and the bPol2V5 [2] and bPol12V [3] radiation tolerant DCDC convertors) in a neutron beam.

Conclusions from this extensive qualification programme formed the basis of recommendations for the diverse users in the HL-LHC community and these will be presented together with the main results from production testing.

[1] The VTRx+, an Optical Link Module for Data Transmission at HL-LHC, J. Troska et Al., DOI 10.22323/1.313.0048
[2] 2.5V step-down DCDCs: a radiation-hard solution for power conversion, G. Ripamonti et Al., DOI 10.22323/1.370.0071
[3] The bPOL12V DCDC converter for HL-LHC trackers: towards production readiness, F. Faccio et Al., DOI 10.22323/1.370.0070

Author: HERNANDEZ MONTESINOS, Daniel (CERN)

Co-authors: PORRET, David (CERN); WYLLIE, Ken (CERN); RODRIGUES SIMOES MOREIRA, Paulo (CERN); VICENTE LEITAO, Pedro (CERN); HAZELL, Philippa (CERN); BARON, Sophie (CERN); BIEREIGEL, Stefan (CERN); KULIS, Szymon (CERN)

Presenter: HERNANDEZ MONTESINOS, Daniel (CERN)

Session Classification: Production, Testing and Reliability

Track Classification: Production, Testing and Reliability