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The Embedded Local Monitor Board upgrade proposals

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The Embedded Local Monitor Board (ELMB) is a microcontroller based plug-in module with CANopen communication protocol. It has been widely used in LHC systems and experiments for slow-control and monitoring purposes, providing multiple galvanically isolated analog and digital inputs and outputs.
While these modules have shown excellent performance in the past 15 years, a replacement is necessary due to the obsolescence of spare components and much higher radiation tolerance requirements within the coming HL-LHC upgrade.
Three development paths are proposed. One fully backward compatible and two others with different concepts but with higher radiation tolerances.

Summary

The ELMB modules have been widely used in LHC systems and experiments for slow-control and monitoring purposes. Each module allows for the measurement of multiple analog voltages and interacts with other devices such as front-ends through digital signals. All connections to the local electronics or structures can be galvanically isolated and thus exclude any potential risks of creating ground loops, while being connected to local references to provide accurate measurements and settings. Communication with the control room is by means of standard CAN bus.
Three development paths are proposed. The first solution is one that is fully backward compatible. The second and third solutions make use of entirely different concepts but both allow for higher radiation tolerance in the systems.
The first development path is called ELMB2. The purpose of ELMB2 is to keep full backward compatibility with the old ELMB infrastructure. The sensitive components of the module have been replaced by ones with higher radiation tolerance and equivalent functionality. The firmware of the microcontroller has been modified in such a way as to make the module behave in the system exactly as the predecessor.
The second solution is built from a GBTx and two GBT-SCAs chip sets. Both ASICs are radiation hardened by design, and the GBT-SCA has many embedded features including ADCs, DACs, JTAG, SPI etc. In this case the system topology has to be changed to point-to-point interconnections. Communication with the control room is provided via optical links, where the back-end interface and processing units are based on the FPGA devices.
The third solution proposed is with the use of star topology, where the GBTx-based board serves a hub-like device and the FPGA-based measurements and control boards as satellites. While the satellites are housing COTS only, the SEU mitigation techniques are implemented inside FPGA firmware. The satellites and the hub are communicating via E-links and the optical link is used between the hub and the control room. This solution has a higher number of features and a higher throughput than the other two, while being able to sustain moderate radiation doses of approximately 100krad.

Authors: NICPON, Kamil Szymon (CERN); FARTHOUAT, Philippe (CERN); BOTERENBROOD, Henk (Nikhef

National institute for subatomic physics (NL)); RYJOV, Vladimir (CERN); NIKIEL, Piotr (CERN); SCHLENKER, Stefan (CERN)

Presenter: NICPON, Kamil Szymon (CERN)

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