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HotLink receiver on CompactRIO for the ITER Electron Cyclotron Control System

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The ITER Electron Cyclotron (EC) System will operate at 170 GHz, aiming at pulse durations of up to 3600 seconds. It is comprised of 24 Gyrotrons and it will be used for plasma breakdown, central heating and current drive applications as well as control of magneto-hydrodynamic instabilities, making it a crucial system for the successful operation of ITER. The Gyrotrons will be powered by 12 sets of high voltage power supplies.
Fast events, such as arcs, might occur in the Gyrotrons or in the rest of the EC millimeter-wave components; a protection system capable of switching off the High Voltage Power Supplies in less than few microseconds is therefore needed. A compactRIO based solution has been developed for this purpose; it interfaces on one side to the arc detection systems and on the other side to the High Voltage Power Supplies controller, closing a protection loop which guarantees the required performances. The solution is based on commercial off-the-shelf components.
During the design of this protection system, the need to implement fast threshold detection on the electrical measurements from the High Voltage Power Supplies was identified. To this end, a custom compactRIO module has been designed and is the subject of this paper.
This module includes a HotLink receiver channel, an FPGA and two 16 bit DAC. In order to provide enough flexibility and to allow using the modules on future applications, the available PCB space has been used to house two channel 16 bit ADC and an STM32F756 MCU. The choice of the components was done on the basis of the functional requirements, of cost minimization, but also taking into account the space constraints of the compactRIO form factor and the power consumption limits, which are limited to 1.5 W per module.
The HotLink module delivers the current/voltage measurements from the power supply to the FPGA, which outputs them back in analogue format through the DAC. In parallel these measurements are also evaluated in the FPGA and all the relevant information (e.g. measurement values, system status and alarms) are made available to the compactRIO environment through its backplane.
The module can also be used with a more general configuration where the two ADCs inputs are used instead of the HotLink receiver (resulting on a significant cost reduction). In both cases, the MCU can be added as mechanism to increase the complexity of the analysis algorithms that are performed over the measured power supply signals.
The first prototype of this module is currently being developed, and the first tests are expected to be executed in late March 2016.

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