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The Phase 2 Global Trigger / BRIL ATCA Rear Transition Module

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For the Phase-2 Upgrade of the CMS Level-1 Trigger, a dedicated ATCA Rear Transition Module for the Serenity ATCA blade has been designed. It is intended to be used by the Phase-2 Global Trigger as well as the Beam Radiation Instrumentation and Luminousity group during operations of the CMS detector. It acts as a generic port expander for the Serenity card and is responsible for signal translation between Samtec Firefly and SFP, handling galvanic in and outputs used as clock and data lines as well as providing additional SFP connectivity.

Summary (500 words)

The GT/BRIL Rear Transition Module (RTM) is an ATCA RTM developed for the Serenity platform. It is designed to serve both, the Phase-2 Global Trigger (P2GT) and the Beam Radiation Instrumentation and Luminosity (BRIL) systems within the CMS Level-1 Trigger upgrade. This module provides additional interfaces both optical and galvanic. For BRIL, the GT/BRIL RTM is intended to receive signals from the White Rabbit machine interface in . These include an orbit trigger signal that marks the beginning of each LHC orbit, as well as a bunch clock, for each beam. In addition the RTM receives four signals from BPTX (Beam Pickup and Timing Experiment), which deliver information about the presence and timing of each beam. . For the Phase-2 Global Trigger system, the GT/BRIL RTM supports signal format conversion and connectivity expansion. It enables the conversion of signals from Firefly optical transceivers located on the Serenity card into the SFP format used by the data acquisition system. It also supports galvanic inputs via RJ-45 and SMA connectors, offering a convenient and low-cost alternative to optical links for external trigger inputs. The RTM is powered via the Zone-3 connector of the Sereniy card. Onboard DC-DC converters produce the required 3.3V and 1.8V voltages for powering optical transceivers and integrated circuits. The module uses I2C communication for configuring and monitoring the transceivers. An I2C multiplexer avoids address conflicts between multiple devices. High-speed differential data lines on the RTM are routed in a way to preserve signal integrity at data rates exceeding 10 Gbps. This is achieved through techniques such as length-matching of traces, impedance control, and backdrilling of vias. The RTM hosts eight SFP+ connectors, four of which are connected to the on board 4+4 Firefly transceiver, and four are connected to the Kria SOM located on the Serenity card. The galvanic interfaces include four RJ-45 connectors supporting differential LVDS signals designed for speeds of to 40 MHz, and seven SMA connectors, with three pairs used as clock inputs and four pairs designed for flexible signal standards, such as LVDS, LVPECL, and LVCMOS. A signal translator integrated circuit with a resistor network allows for proper signal conditioning. In addition, a dedicated testboard has been designed, offering SMA and I2C connections, along with 12V banana plug power input, for off-crate testing. The design of the GT BRIL RTM will be presented, including design choices, PCB layout challenges, as well as test results.

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