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The readout driver (ROD) for the ATLAS liquid argon calorimeters

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Abstract

The Readout Driver (ROD) for the Liquid Argon calorimeter of the ATLAS detector is described. Each ROD module receives triggered data from 256 calorimeter cells via two fiber-optics 1.28 Gbit/s links with a 100 kHz event rate (25 kbit/event). Its principal function is to determine the precise energy and timing of the signal from discrete samples of the waveform, taken each period of the LHC clock (25 ns). In addition, it checks, histograms, and formats the digital data stream. A demonstrator system, consisting of a motherboard and several daughter-board processing units (PUs) was constructed and is currently used for tests in the lab. The design of this prototype board is presented here. The board offers maximum modularity and allows the development and testing of different PU designs based on today's leading integer and floating point DSPs.

Keywords: ATLAS; Liquid argon; ROD

1. Introduction

The Readout Driver (ROD) module is the last element in the readout chain of the calorimeters [1]. In the front-end boards (FEB), after shaping, the calorimeter signals are stored in a switched capacitor array (SCA) every 25 ns. Upon receipt of a Level 1 trigger, the samples relevant to the event are digitized (typically five samples around the pulse peak) and are transmitted to the ROD module. In the ROD module the energy E and the time T estimators for each calorimeter cell are calculated, using an *optimal filtering* technique:

$$E = \sum a_i S_i \quad \text{and} \quad ET = \sum b_i S_i$$

where the sum extends over all the samples S_i and where a_i and b_i are pre-calculated weights [2]. Since the error in the time estimator varies inversely with the amplitude, it makes sense to calculate it only if $E > E_{\text{thr}}$. In such a case a quality-of-fit parameter is calculated as well.[1] The output data are sent to the ReadOut Buffer (ROB) module, the first element in the DAQ system, while in most cases the raw data are discarded.

2. The ROD demonstrator module

In Fig. 1, a block diagram of the ROD demonstrator board is shown [3]. For the ATLAS

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[1] Most likely a simplified chi-square expression like $Q = \sum (S_i - E(g_i + g_i T))^2$, where g_i is the expected waveform normalized to unity.

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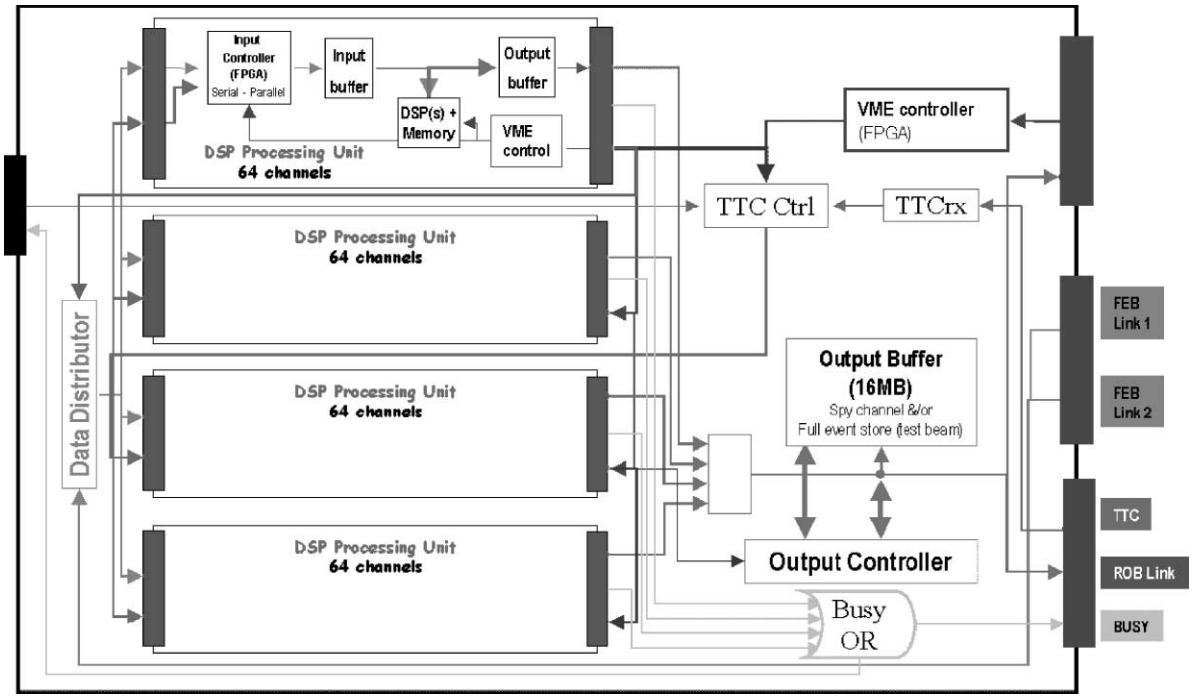

Fig. 1. Block diagram of the ROD demonstrator module.

experiment there will be about 800 ROD modules, housed in about 60 crates. Prototype boards based on the leading DSPs of the market (including the Analog Devices ADSP21160 floating point DSP, and the Texas Instruments TMS320C6202 integer DSP) were constructed and are currently under tests in the lab. Preliminary results indicate that both technologies are capable of meeting the processing power requirements: the event processing time stays within the allowed 10μs, even if for up to $\sim$ 50% of the channels the long algorithm is used. This result changes slightly when monitoring and histogramming tasks are activated, but this is subject to further optimization and parameter tuning. Despite of this very positive result, the new generation of yet more powerful DSPs foreseen in the near future will be evaluated as well. In the course of the demonstrator project the boards will be tested with real calorimeter signals in the test beam setup, as well as using ATLAS Monte Carlo data, simulating different physics channels from which important information in tuning the board parameters can be extracted. The final prototype board should be ready towards the end of 2002.

References

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