LED Board Upgrade for Mobidick4 testing bench

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**Abstract.** Reviewing the architecture of the MobiDick4 system, this is used in the development of a test bench which will be used for the readout and control electronics of the Tile Calorimeter. Emphasis on the LED Board

1. Introduction

The LHC is the world’s largest particle accelerator. It is the single most complex experimental facility in the history of mankind. Confirmed the discovery of the Higgs Boson March of 2013 which was detected by two of its detectors, namely ATLAS and CMS

ATLAS is one of two detectors at the LHC to have found the Higgs Boson. It is the largest detector on site and is the general purpose detector which consists of concentric cylinders. Namely being the Inner detector, Calorimeters and Muon produced Spectrometers

At the LHC, the ATLAS detector is the largest of all the detectors on site and is used as the general purpose detector. It consists of concentric cylinders namely being the Inner Detector, Calorimeters and Muon produced spectrometers.

The detectors are complementary of each other. The function of the inner detector tracks the trajectories of the particles precisely, the calorimeters measure the energy of the easily stopped particles and the muon system makes additional measurements of highly penetrating muons. The magnet systems bend charged in the inner detector and the Muon Spectrometer, allowing their momenta to be measured.

 The Tile calorimeters in the detectors are superdrawers used to measure the energy and trajectory of the particles produced in the proton-proton collisions happening in the inner detector. It measures those properties by using signals, boosted light pulses, into photo multiplier tubes.

Inside the superdrawers are front end electronics which process the signals. During the shutdown there will be a consolidation integrity check on the electronics which will be carried out by the MobiDick4 system.

The MobiDick4 system is the new upgraded version of the MobiDick. It includes many state-of-the-art daughter boards each of which provide different functionality to the motherboard. This combination allows for fifteen different tests that can be performed on the super drawers

1. Motivation

The University of the Witwatersrand was tasked with upgrading two of the several daughter boards on the MobiDick4. Namely being the High Voltage card and the LED board. The board which I have upgraded is the LED board. What was previously wrong with the board was that it was made 10 years ago and as a consequence of that the board is now old technology. Some of the parts on the board has been discontinued thus it’s extremely hard to replace and currently there are better ways to achieve the same kind of end result as the current design. It simply cannot keep up with the current technology of the detector. Therefore an upgraded is a necessity.

1. LED Board Specifications

The LED Board was originally designed by Romeo Bonnefoy.

The trigger input has a TTL pulse of 100ns and the frequency is limited by a monostable. The small led on the board blinks according to the trigger input.

• Input voltages:

o +5V at 80mA

o -12V at 250mA

o +24V at 100mA

• Input trigger:

o +3.3V (TTL) Level provided by the motherboard is used to fire the output voltage for a LED pulser

• Decoupled control input: Optocoupler model ISO721 is required

The board uses a component called a monostable to generate a signal that will be split in two, to feed two separate branches of a shaping circuit. Monostables are just vibrators that have two states, one being stable and the other one conditional to the input signal you provide. This monostable is powered by the +5V. The input signal to the monostable is filtered by a circuit that avoids input signals with higher frequencies than 1 kHz. The input signal to the board comes from the MobiDick4 base ML507 motherboard, this being a 3.3V 100ns width almost square pulse. After the monostable, the output signal is split into two branches. Each one uses the 24V to produce a pulse of 20V of very narrow width (20ns) which is ultimately output through the lemo connectors.

The purpose of the board is to produce -20V 20ns width almost square pulses out of a control signal that is 3.3V.

These 20V when applied inversed to a conventional LED, thus -20V, will produce a very bright pulse of light that is almost identical to the light produced by particles that traverse the scintillator tiles of which the Tile calorimeter is made, thus recreating an actual event. These pulses are focused on the photo-multiplier tubes of the Tile read-out electronics, which are ultimately read-out digitally by another component of MobiDick4. What we see in the end is a set of samples that conform to a pulse (output of the photo-multiplier), the amplitude of which is proportional to the energy of the photons fed to the photo-multiplier.

1. Production

Schematics

The PDF files had to be captured in electronic format. The program used to capture the schematics of the board is called OrCad Capture CIS. This program basically makes logical connections between each of the components. After the logical connections have been made, a netlist of the components is compiled and thus the logical connections are transferred to a program where you can place the components to a physical layout. The diagram below depicts the conversion of the MC10198 MultiVibrator component from PDF to Orcad Capture.

Figure 1: Conversion of MultiVibrator component from PDF to Electronic Format

Component Layout

After laying out the logical connections between each of the components on the board. The schematics are exported into a designer called Orcad PCB Editor which is basically the program which designs the actual physical layout of the board.

This is done by the following steps:

* Set up board geometry
* Place each board in efficient manner
* Set up ground plane

Factors one needs to keep in mind of:

* Package dimensions
* Route width
* Current
* Mounting locations
1. Conclusion

A complete redesign of the board with several components replaced with a single component. A single board shall be produced and tested and if successful the LED Board will be put into production