A new test-bench design and performance testing of an individual Low Voltage Power Supply for the ATLAS Tile Calorimeter front-end electronics

ICCPA Poster Session, CERN, 05 October 2020

Tile Calorimeter of the ATLAS detector

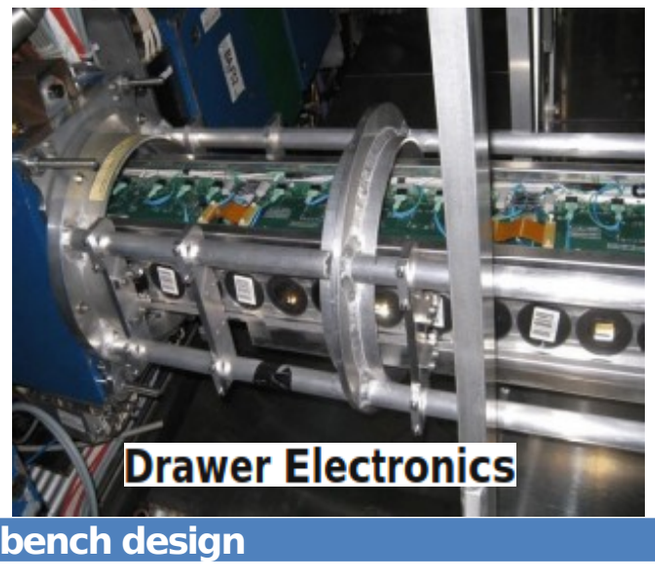
The LHC accelerator will be upgraded to deliver an instantaneous luminosity up to 7.5×10^{34} cm^{-2} s^{-1}. A major replacement of the on- and off detector electronics is required. The Hadronic Calorimeter is constructed from inactive (Fe) and active scintillator material where the energy of hadrons interact mostly with the inactive (Fe) material within the system. TileCal consists of 4 sections, each comprising of 64 modules and is divided into three sections along the beam length. The girder is welded (Fe) material with windows for the scintillator tiles and inside there is empty space for the movable drawer where the PMT's and front-end electronics are positioned. In front of the module is finger creating creating a magnetic shield for the LVPS box which houses the (Low Voltage Power Supply) LVPS to power the detector front-end electronics.

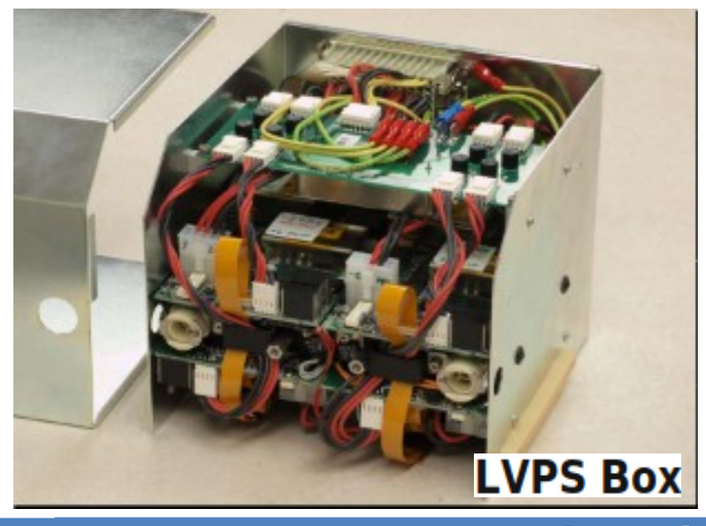

End of Long Barrel

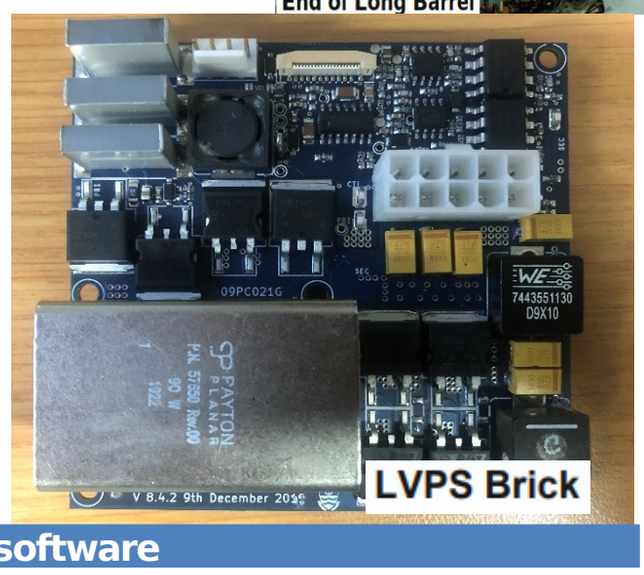
LVPS (Low Voltage Power Supply)


Detector Section

The LVPS system of each TileCal module consists of an array of eight identical power supplies (bricks), configured in a parallel fashion. The LVPS bricks step down 200V to 10V and are nominally rated at 100W. The combination of the harsh operating environment and high reliability necessitated the custom design of a switching power supply. The environment of which LVPS is located in must remain radiation hardened to single-event upsets as well as total dose accumulated over several years. LVPS also contains custom designed magnetic components to operate reliably within a magnetic field. Wits and UTA have produced a new type of testing station, which build upon the previous generation of testing stations used in the initial production of the TileCal system.

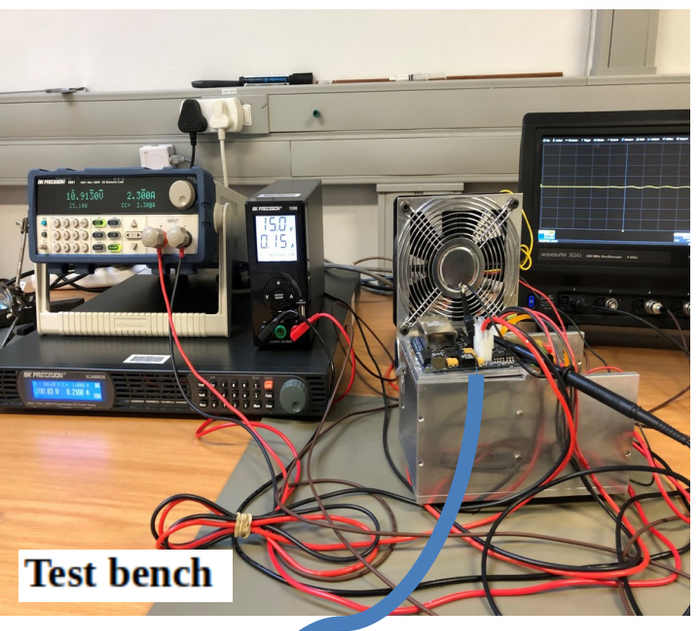

Drawer Electronics

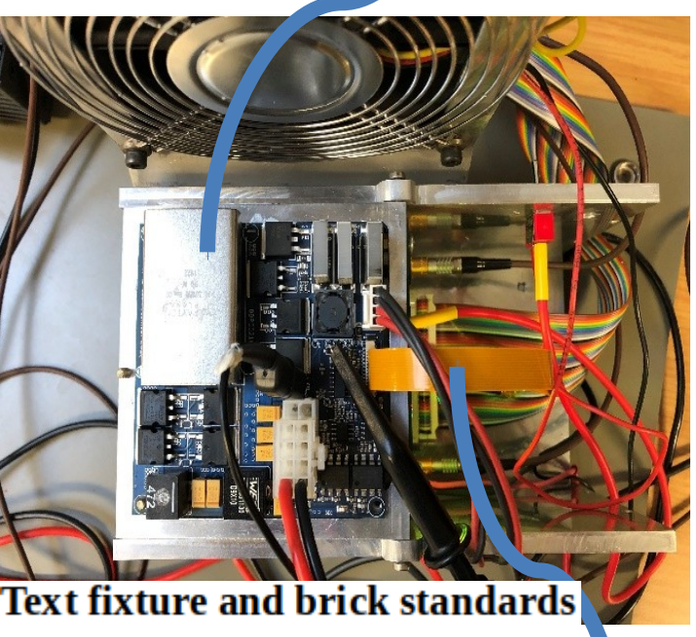

LVPS Box

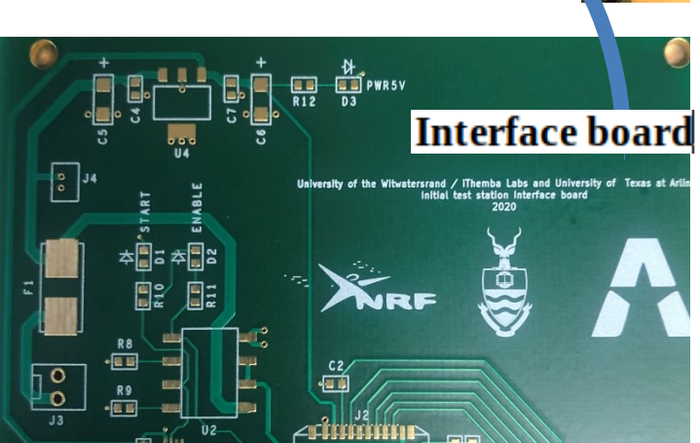


LVPS Brick

Test bench design


Test bench


Text fixture and brick standards

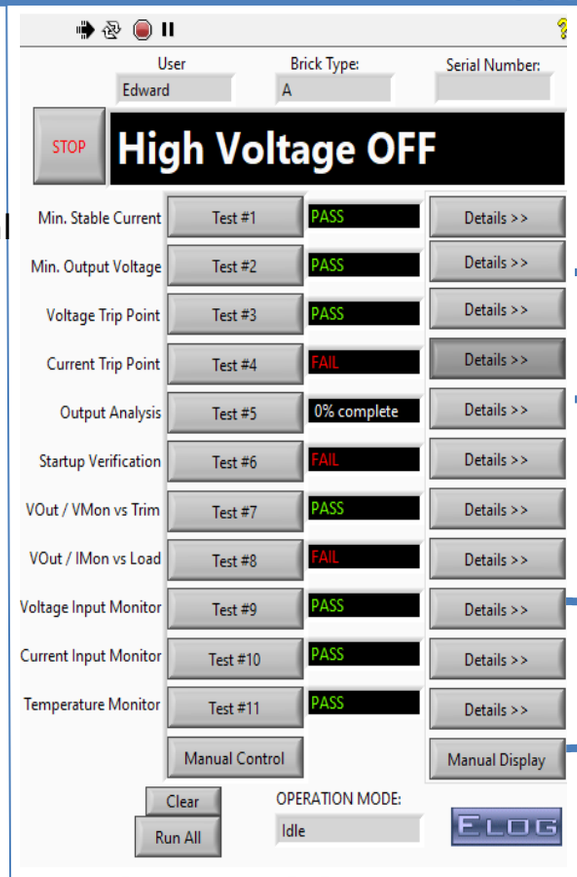


Interface board

The full composition of the test bench

- The test bench is based on a computer controlling and reading out several commercial equipment which perform the tests; a metal case that acts as brick support and provides the interface to the computer and the ground connections
- The test bench which tests brick individually includes the development of a interface PCB.
- Once successfully set up the **test bench** will quantifies a multitude of **performance** metrics of a LVPS brick.
- Tri-state signal which in normal conditions would be coming from the Auxboard through the ELMB mother board to start the brick, keep it on, or shut it down done from the interface board.
- The design of a test fixture interface board modified to include tri-state functionality and monitoring signals
- The data is acquired primarily through a data acquisition card SCB-68 connected to a peripheral component interface (PCI)
- The data acquisition card can digitize eight channels contemporaneously and has in/ out registers.

Control software



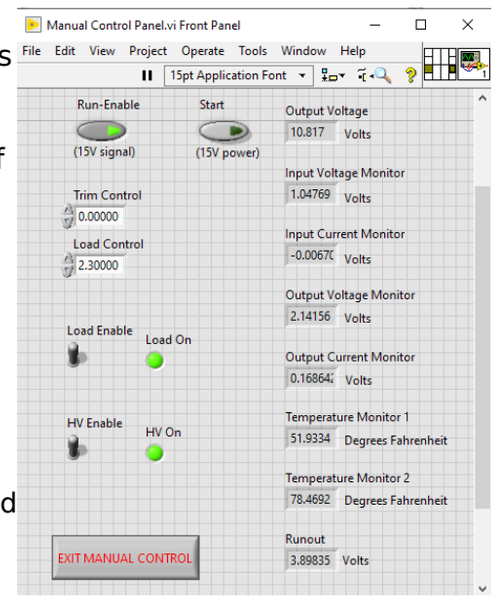
Custom PC Software

In the control software we check that the main functions and parameters of the bricks are correct. The required parameters are 3σ around the nominal value for all test except the over voltage and over current protections, for these tests the requirement is set by quality 3σ assurance procedures

Set of tests validates fail-safe features of the Bricks

Validates LT1681 controller feedback signals

Validates feedback signals used for remote monitor



Manual control feature, allows you to monitor all I/O, enable HV and load to debug any electrical inconsistencies

Performance testing of latest v8.4.2 LVPS brick

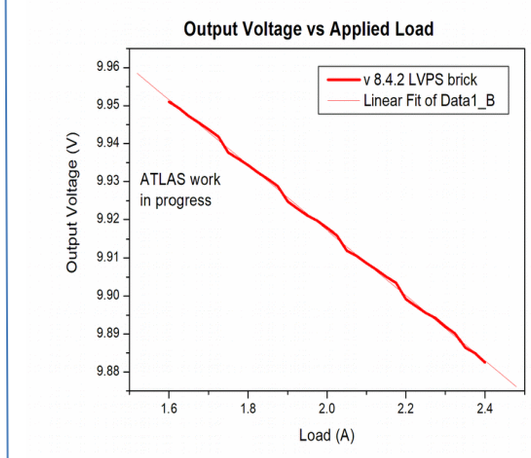


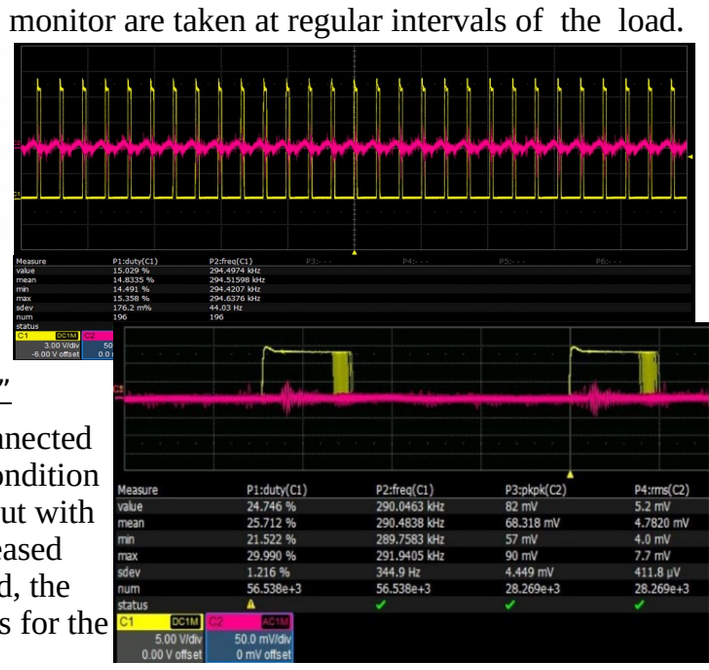
Figure 1: The test measures the slope and offset of the plot, the slope depends on the individual brick feedback signals..

Test #1: "Minimum Stable Current"

- To determine this value the brick is connected to the nominal load value and in this condition the clock output from LT1681 is read out with the oscilloscope. The load is then decreased until missing clock cycles are registered, the load value is recorded. Permitted values for the test depends on the brick.

Test #8: Signal Feedback Analysis

- This test checks the correct functioning of the monitor circuit of output current. The brick is started at minimum output voltage, the load is then increased up to 80% of trip point. Output of the out monitor are taken at regular intervals of the load.



Edward Nkadimeng[1,2], on behalf of the ATLAS TileCal Collaboration

1. University of the Witwatersrand, 2. Institute for Collider Particle Physics