ATLAS TileCal LVPS Upgrade Hardware and Testing

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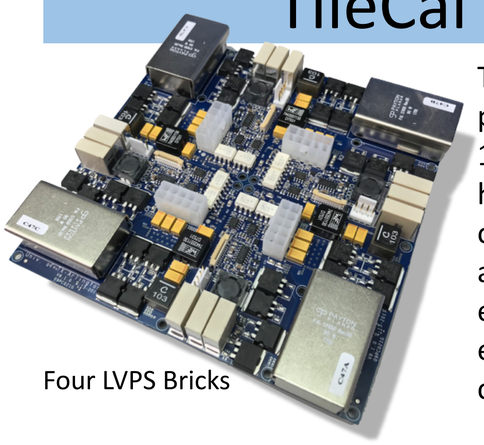
On Behalf of the ATLAS Collaboration

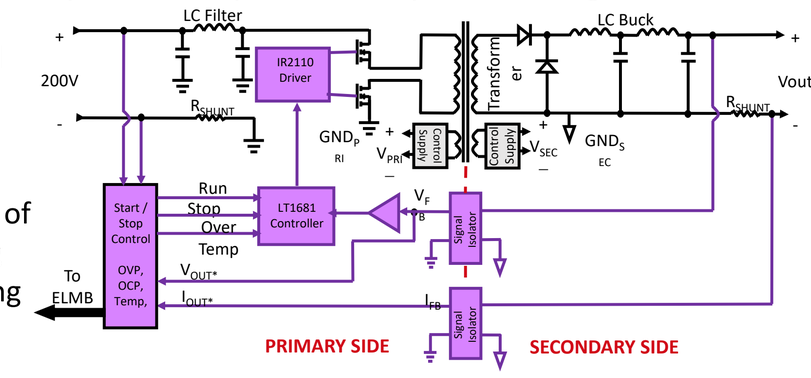
TileCal Low Voltage Power Supply



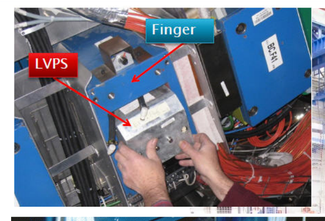
Four LVPS Bricks

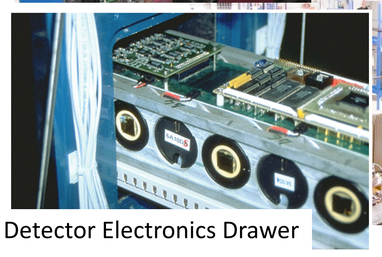
The LVPS system of each TileCal wedge consists of an array of eight nearly identical power supplies (bricks), configured in a parallel fashion. The bricks step down 200V to 10V and are nominally rated at 100W. The LVPS brick is a dual-switch, forward-type high speed switching converter operating at 300kHz. It utilizes a custom transformer operated by a LT1681 controller. 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.

The University of Texas at Arlington has been designing and producing new testing stations to ensure the reliability and quality of new TileLVPS (Low Voltage Power Supplies), also produced at UTA, which will power the next generation of upgraded hardware in the TileCal (Tile Calorimeter) system of ATLAS at CERN. UTA has produced two new types of testing stations, which build upon the previous generation of testing stations used in the initial production of the TileCal system.

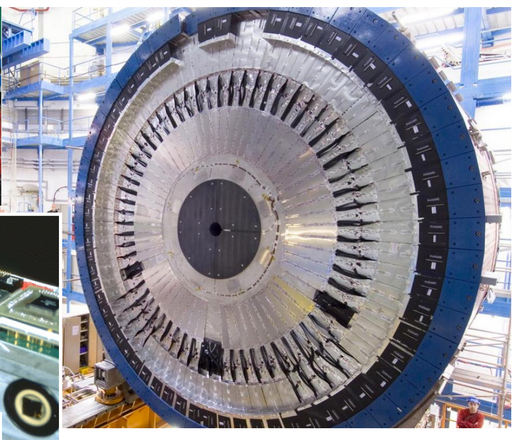


TileCal of ATLAS





Detector Electronics Drawer

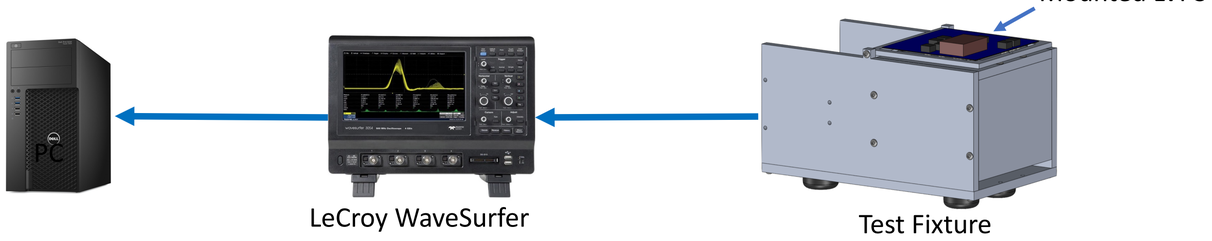


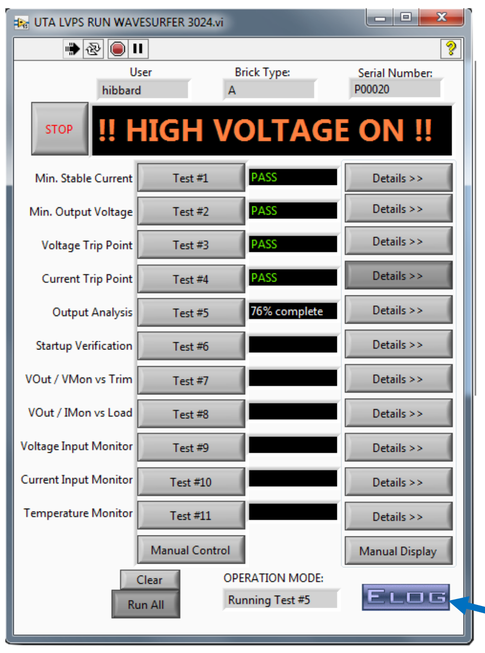
LVPS is apart of the Tile Hadronic Calorimeter of ATLAS. TileCal samples the energy of hadrons as they interact with 500,000 scintillator tiles within the system. TileCal consists of 4 sections, each comprising of 64 wedge-like segments and is divided into three sections along the beam length. LVPS is positioned within a drawer of TileCal, which also houses the detector electronics it powers.

LVPS Production

Test Station

The Initial test station, called just the 'Test Station' quantifies a multitude of performance metrics of a LVPS brick. Custom PC based software was synthesized to perform the tests and graphically display and record onto file these performance metrics. Eleven separate tests in total completes these tasks, each communicating with several lab instrumentation devices. A few notable metrics we are measuring are the system clock and its jitter. Excessive clock jitter in LVPS can affect system stability and derate the working range of the system duty cycle. This station also verifies protection circuitry of LVPS, to guard against over temperature, over current and over voltage.





Custom PC Software

Testing Program Subsets

1. Min. Stable Current
2. Min. Output Voltage
3. Output Over Voltage Trip Point
4. Output Over Current Trip Point

Set of tests validates fail-safe features of the Bricks.

5. Output Analysis (more metrics)
6. Startup Verification (turn-on delay)
7. Vout / Vmon vs Trim
   (feedback signal: slope, offset, linearity)
8. Vout / Imon vs Load
   (feedback signal: slope, offset, linearity)

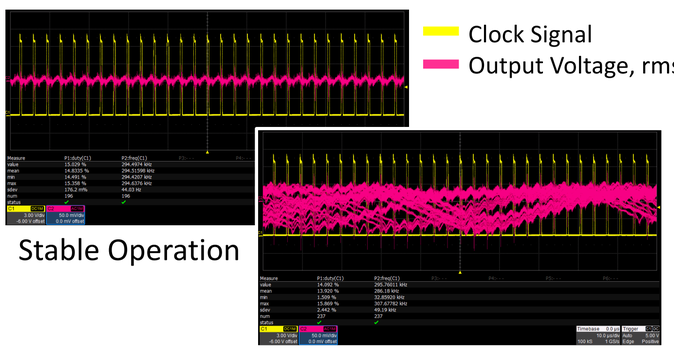
Validates LT1681 controller feedback signals.

9. Input Voltage Monitor
10. Input Current Monitor
11. Temperature Measurements

Validates feedback signals used for remote monitor.

A new entry is automatically submitted to 'ELOG' to record test results

Test #1: 'Min. Stable Current'

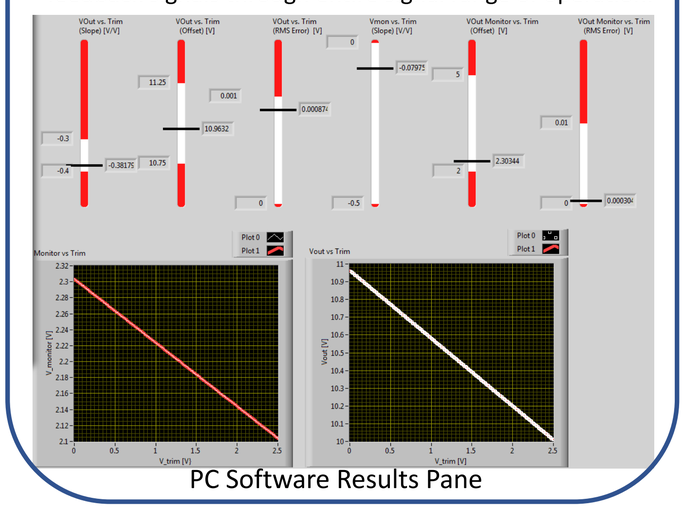


Stable Operation

Unstable Operation

Test #7: 'Vout/Vmon vs Trim'

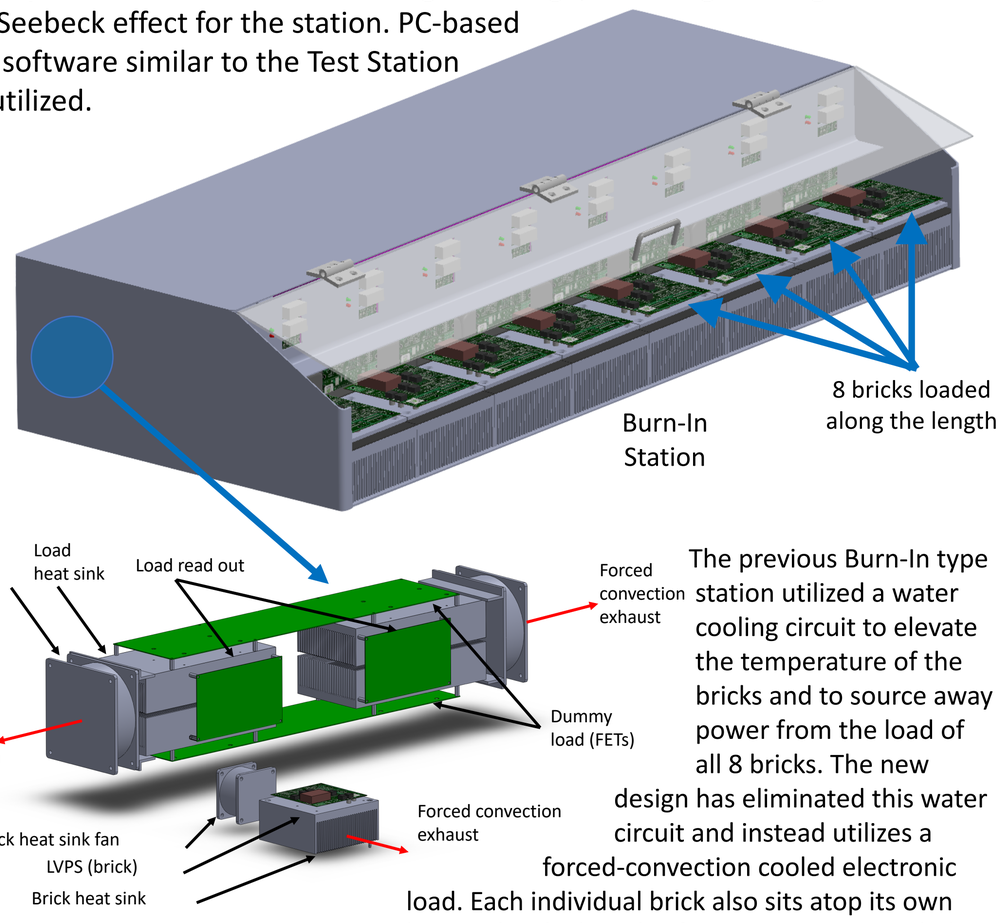
Validates quality (linearity, slope, offset) of LT1681 feedback signals through entire signal range of operation.



PC Software Results Pane

Burn-In Station

The Burn-In Station performs an endurance type test. Here, a LVPS is subjected to a stressed environment where the load and temperature are both elevated. In this environment the expected operational life of the brick is reduced, which serves as an indicator of how long the bricks will last under the normal environment in the detector. This will allow us to identify any components which fail to perform at their maximum rated limits. Different thermal systems were considered during the design, including utilizing the Peltier-Seebeck effect for the station. PC-based control software similar to the Test Station is also utilized.



The previous Burn-In type station utilized a water cooling circuit to elevate the temperature of the bricks and to source away power from the load of all 8 bricks. The new design has eliminated this water circuit and instead utilizes a forced-convection cooled electronic load. Each individual brick also sits atop its own heat sink, which is also force-convection cooled, to regulate the temperature individually of each brick.

An alternative solution to the thermal management of the individual bricks in the new Burn-In station was also explored utilizing the Peltier-Seebeck effect, also called the thermoelect effect. Thermoelectric tiles were chosen which were capable of either sourcing or sinking heat to or away from the individual LVPS bricks to enable a wider temperature range of extended testing. This feature was ultimately not necessary in the final design.

Optional Thermo-Electric Configuration