The Characterization and functionality of the interface boards used on the burn-in test station for the ATLAS Tile Calorimeter Low Voltage Power Supply for phase II upgrade.

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Outline

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  ❑ The ATLAS Tile Calorimeter (TileCal)
  ❑ Why upgrade

❖ Low Voltage Power Supply (LVPS) System
  ❑ Bricks

❖ Testing Mechanisms for Production
  ❑ Burn-in station
    ➢ Functionality
    ➢ Test settings and outputs
    ➢ Interface boards
      o Simulation of the PCBs
      o Validation of the PCBs
    ➢ Control Programme - LabVIEW

❖ Summary
**ATLAS/ TileCal**

- **Central hadronic calorimeter of the ATLAS experiment.**
  - 4 sections – 2 central barrels in the middle and 2 extended on either side. Each divided into 64 azimuthal slices.

- **TileCal samples energy of hadrons by interacting with 500,000 scintillators within the system.**

- **TileCal has critical role of measuring the energy and direction of showers when the particles collides with steel plates.**
  - Jets, hadronic decays theta-leptons and missing transverse energy
  - Muon identification and provides inputs to the level 1 calorimeter trigger system

- **LVPS box are positioned within each wedge segment of TileCal, inside electronics to power all of the front end-end electronics, housed within same drawer.**
Why upgrade?

- Phase II upgrade of the ATLAS detector will increase luminosity by factor of five.

- High radiation levels and increased data processing requirements, redesign and replacement of read-out electronics is required.

- Improved reliability through redundancy and simplicity, to improve durability and reduce maintenance.

- Move away from the present single point failure in readout system.
LVPS System
Block diagram and functionality description

- Function: 200V DC bulk power converted to +10v DC at 2.3A which is distributed to Point-of-Load Regulators within the Front-End electronics

- LT1681 Controller Chip: heart of design.
  - Dual transistor forward converter
  - Proves switching at 300 kHz

- FET Drivers: Drive the Field Effect transistors
  - When conducting current flows to the primary windings of the transformer which transfers energy to the secondary windings

- Opto-Isolators: Provide voltage feedback for controlling the output voltage

- Shunt Resistor: For measuring the output current

- Protection circuitry: Over Current Protection

LVPS Brick V8.4.2 locally produced
Functionality of Burn-in Station

- The purpose of the burn-in process for power supplies is to weed out "infant mortalities"
  - This is to improve the reliability of the LVPS brick
- LVPS modules (bricks) are subjected to stressed environment
  - Electronic load and temperature are elevated
- Accelerated aging is performed on the bricks
  - To check operation life
  - To identify components which fail to perform at their maximum rated limits
- Operating parameters:
  - Runtime ~ 8 hours
  - Load at 5A with temperature up to 70°C
- LabVIEW Control Program is used to control and record parameters of the 8 bricks
Burn-in station: Block diagram with interconnections
Interface boards - brick

- Interface with each brick for control (enable, start-up) and monitoring (reading measured values)
  - Behavioral parameters measured (voltage, current and temperature)
- Receiving 200 V and providing it to the brick (switchable power)
- UART interface with the main board
- Programmable microcontroller PIC16F883
  - Programming provided through dedicated programming connector
- Local power provided through AC/DC modules RAC03-05SC and RAC03-15SC
  - 5 V and 15 V DC are generated and used locally

Courtesy of Roger
Simulation of the interface board

- Schematic diagram is used to draw up a simulation of the board using Proteus 8 software package.

- Microcontroller PIC16F883 is programmed using MPLAB XC8 and CCS complier, it transmits and sends commands to different components.

- Simulation is used to check the signal flow and functionality of the PIC
Programming of PIC16F883 Microcontroller for interface board

- Code is loaded to the compiler CCS then it get complied and the Hex file is then flashed to microcontroller using the MPLAB X IPE.

- PIC16F883 works as a multiplexer whereby it selects between several analog or digital input signals and forwards the selected input to a single output line.
Validation of the interface board

A circuitry used to validate the receive and transmit lines of the PIC

- ADC (LTC2449) - digitizes all analog input signals from a brick
Burn-in Station: LabVIEW Control Programme

Front graphical panel of the LabView program for burn-in station: shows input and output voltages, current, efficiency and temperature on each brick.
Summary

- The Burn-in station development is currently in progress with all the boards undergoing functionality test and how it is interfacing with the LabVIEW control programme.

- The testing mechanisms are essential for quality assurance to validate reliability of design and construction or manufacturing techniques of the bricks before they are shipped to CERN for further tests.

- **Wits Institute of Particle Physics** is tasked in producing about **1032** of the LVPS bricks for ATLAS Tile Calorimeter, which will power the front-end electronics of the detector.
Comments or Questions??

Kgotso, Pula, Nala!

KE A LEBOHA.
Stage 3: Point of load Regulators
Back slides

Burn-in bathtub curve for electronics failure rate
Back slides

Hierarchy of the VI’s (Virtual Instruments) for the LabVIEW control programme