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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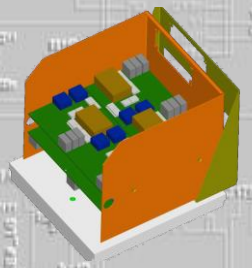
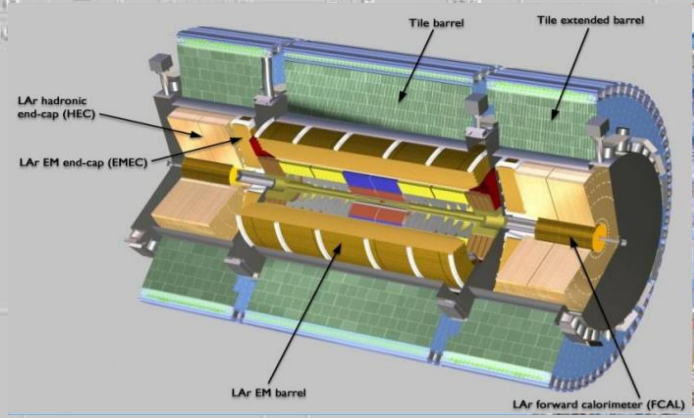
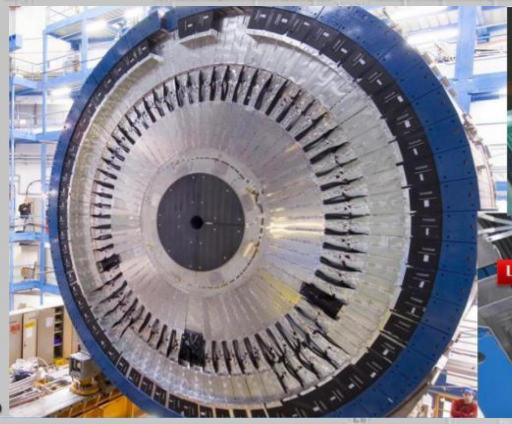
Outline

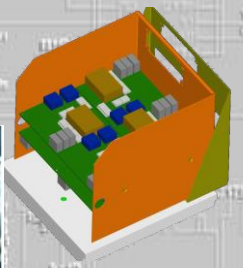


- Motivation
  - The ATLAS Tile Calorimeter (TileCal)
  - Why upgrade
- Low Voltage Power Supply (LVPS) System
  - Bricks
- Testing Mechanisms for Production
  - Burn-in station
    - Functionality
    - Test settings and outputs
    - Interface boards
      - Simulation of the PCBs
      - Validation of the PCBs
    - Control Programme - LabVIEW
- Summary

ATLAS/ TileCal



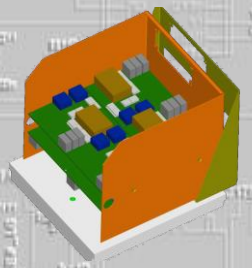




- Central hadronic calorimeter of the ATLAS experiment.
  - 4 sections – 2 central barrels in the middle and 2 extended on either side. Each divided into 64 wedge shape slices.
- TileCal samples energy of hadrons by interacting with 500 000 scintillators within the system.
- TileCal has critical role of measuring the energy and direction of showers when the particles collides with steel plates.
  - Jets, hadronic decays theta-leptons and missing transverse energy
  - Provides muon identification and inputs to the level 1 calorimeter trigger system

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

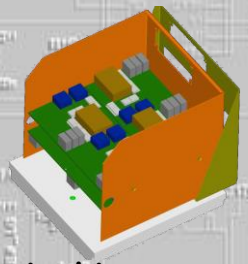
Why upgrade?

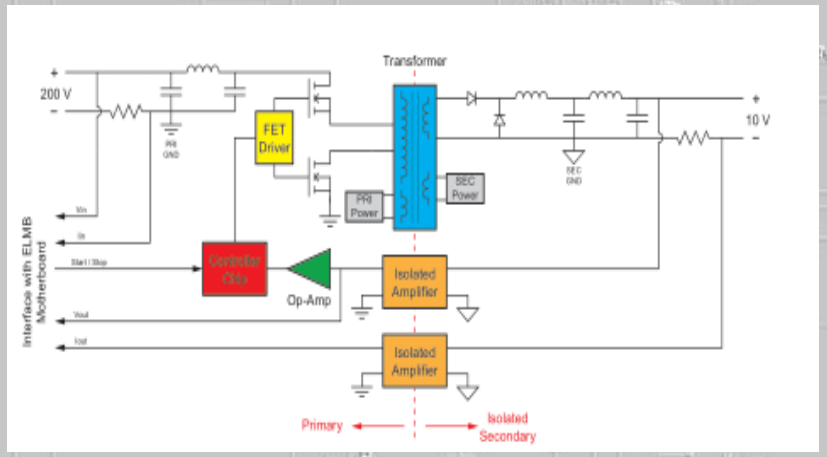


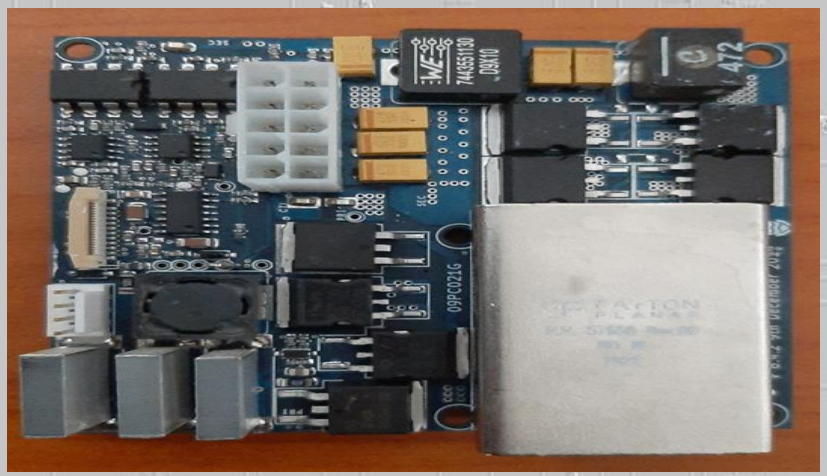
- Phase II upgrade of the ATLAS detector will increase luminosity by factor of five.
- High radiation levels and increased data processing requirements, redesign and replacement of read-out electronics is required.
- Improved reliability through redundancy and simplicity, to improve durability and reduce maintenance.
- Move away from the present single point failure in readout system.

LVPS System

Block diagram and functionality description



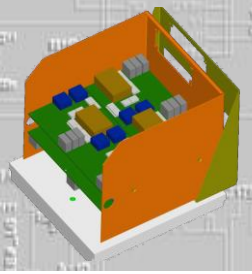


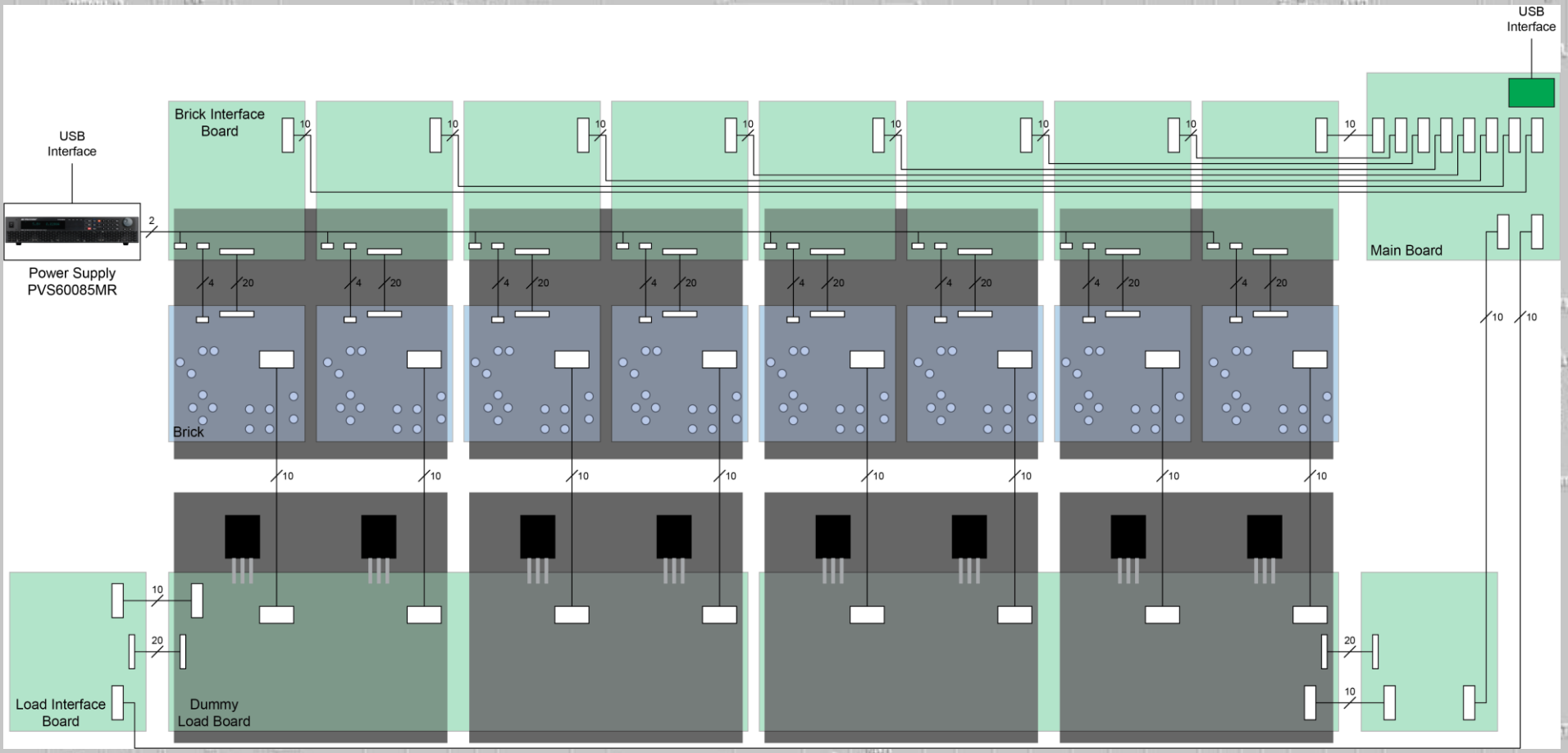


LVPS Brick V8.4.2 locally produced

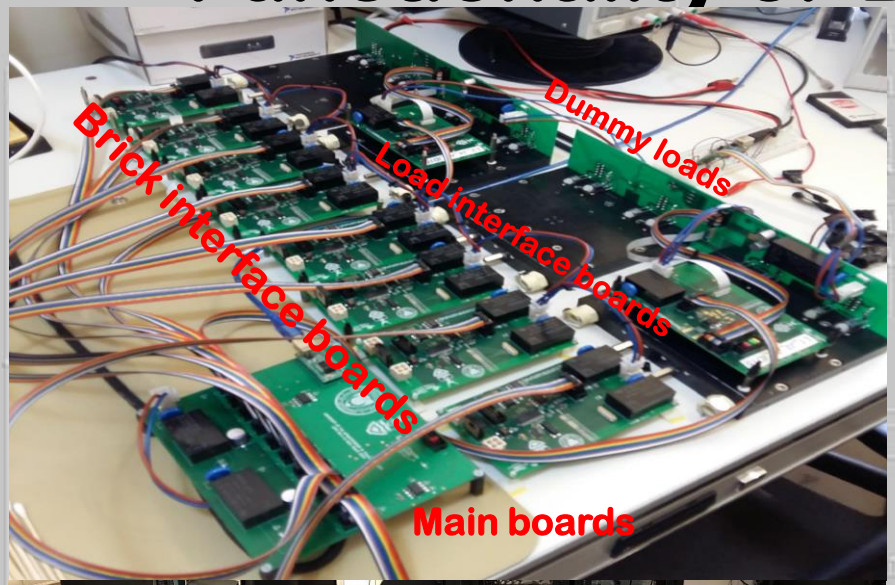
- Function: 200V DC bulk power converted to + 10v DC at 2.3A which is distributed to Point-of-Load Regulators within the Front-End electronics
- LT1681 Controller Chip: heart of design.
  - Dual transistor forward converter
  - Provides switching at 300 kHz
- FET Drivers: Drive the Field Effect transistors
  - 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

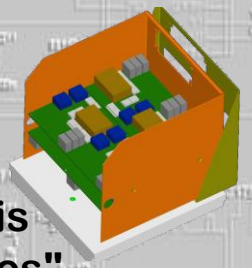
Burn-in station: Block diagram with interconnections





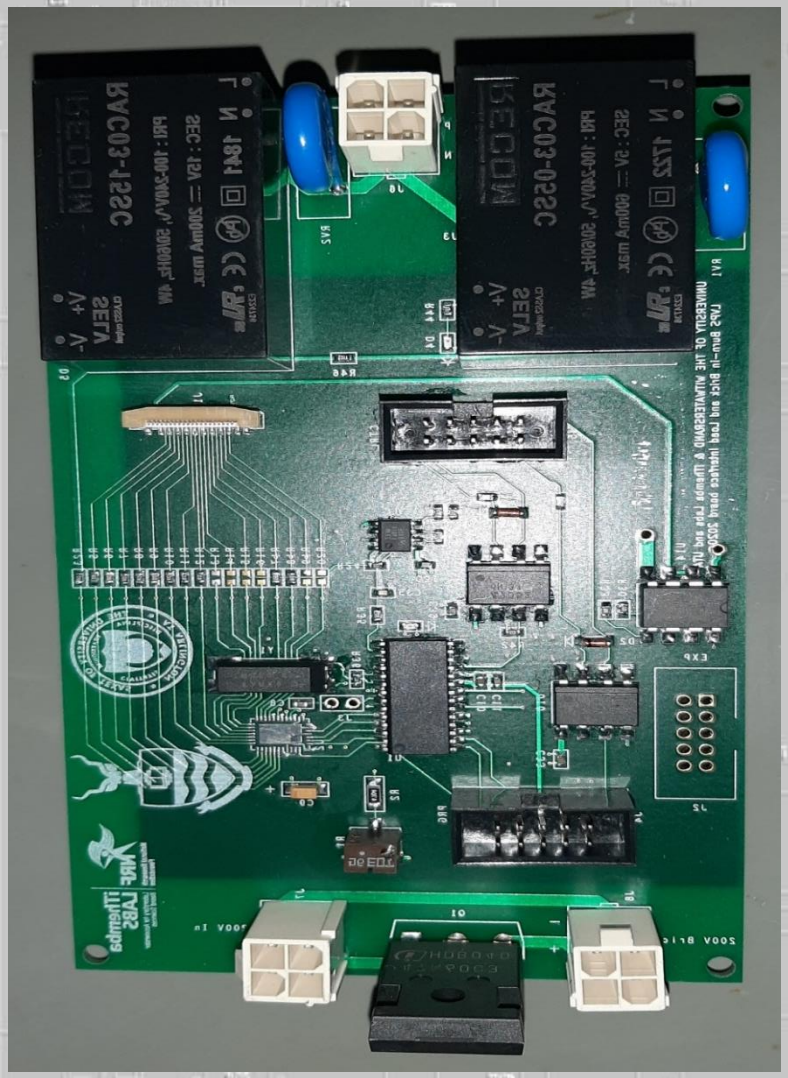
Functionality of Burn-in Station

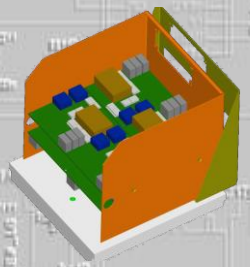




- The purpose of the burn-in process for power supplies is to weed out "infant mortalities"
  - This is to improve the reliability of the LVPS brick
- LVPS modules (bricks) are subjected to stressed environment
  - Electronic load and temperature are elevated
- Accelerated aging is performed on the bricks
  - 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

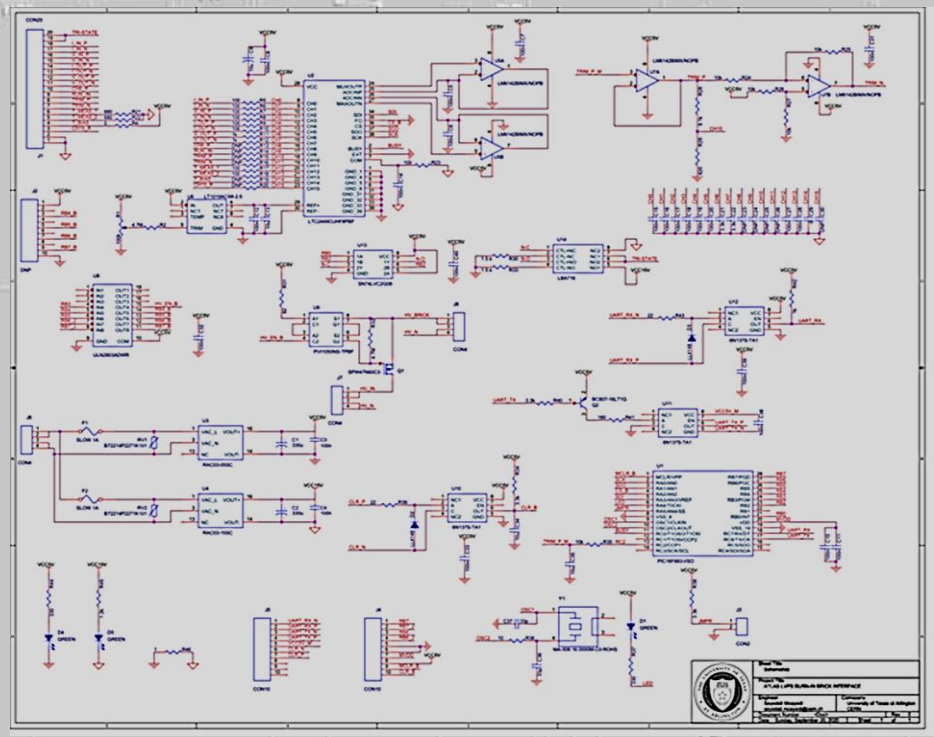
Interface boards - brick

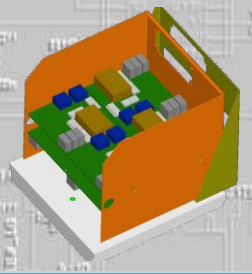


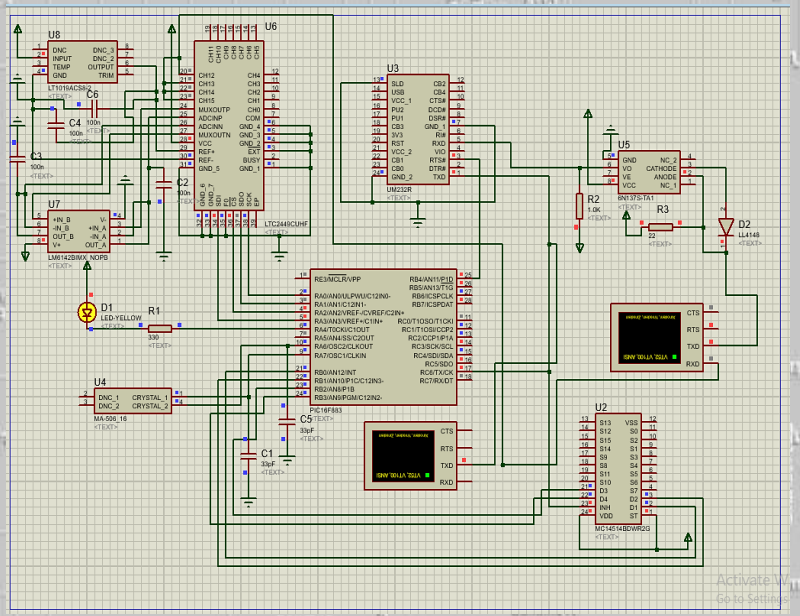


- Interface with each brick for control (enable, start-up) and monitoring (reading measured values)
  - Behavioral parameters measured (voltage, current and temperature)
- Receiving 200 V and providing it to the brick (switchable power)
- UART interface with the main board
- Programmable microcontroller 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

Simulation of the interface board

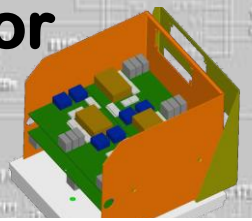


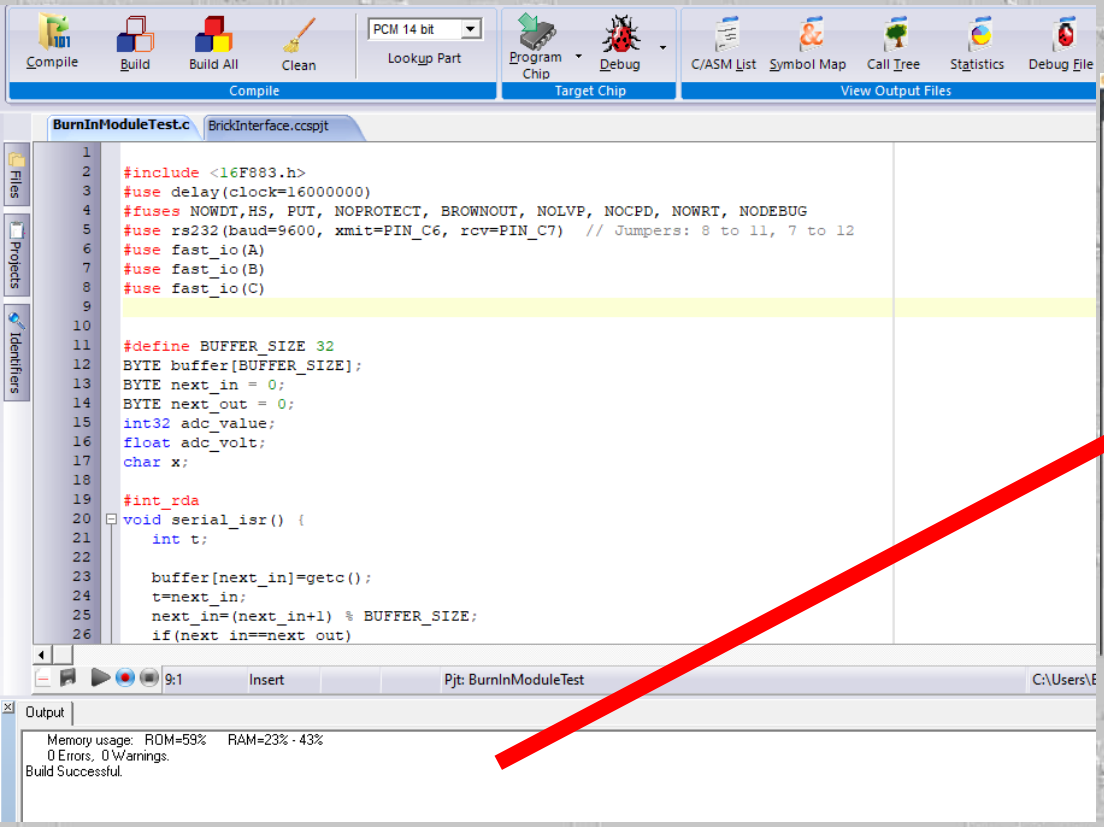


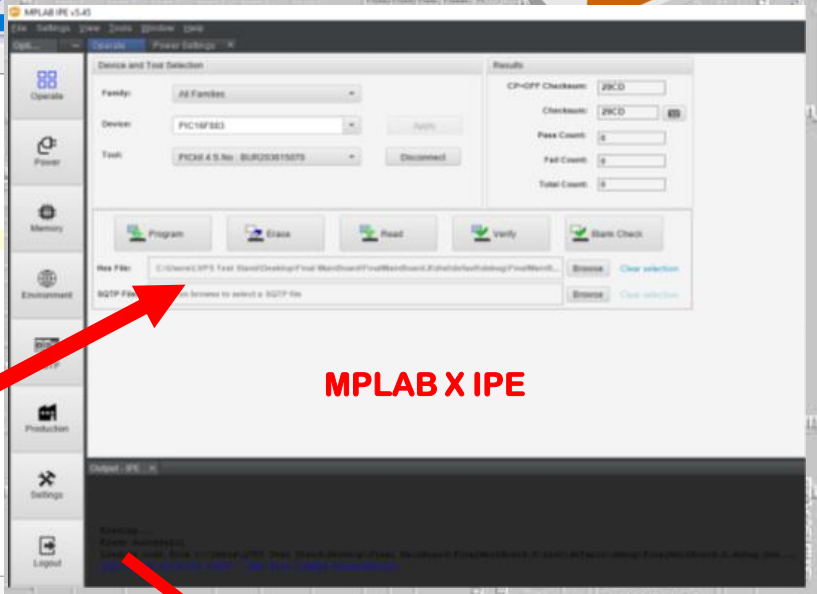


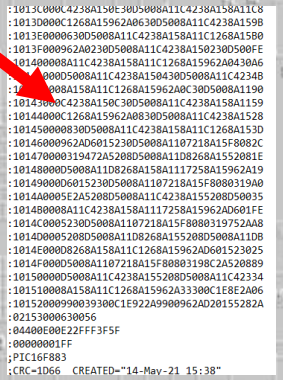
- Schematic diagram is used to draw up a simulation of the board using Proteus 8 software package.
- Microcontroller PIC16F883 is programmed using MPLAB XC8 and CCS complier, it transmits and sends commands to different components.
- Simulation is used to check the signal flow and functionality of the PIC

Programming of PIC16F883 Microcontroller for interface board









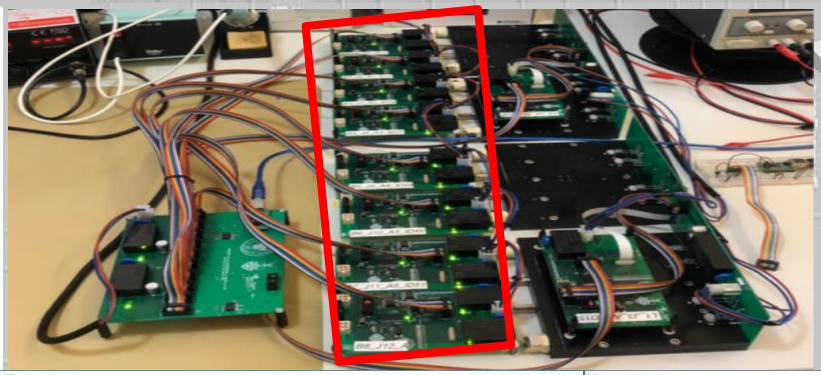
- Code is loaded to the compiler CCS then it get complied and the Hex file is then flashed to microcontroller using the MPLAB X IPE.
- PIC16F883 works as a multiplexer whereby it selects between several analog or digital input signals and forwards the selected input to a single output line

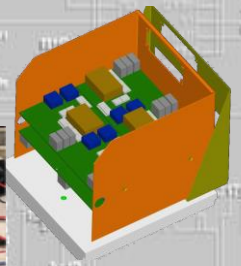
Hex file flashed on the PIC16F883

Validation of the interface board

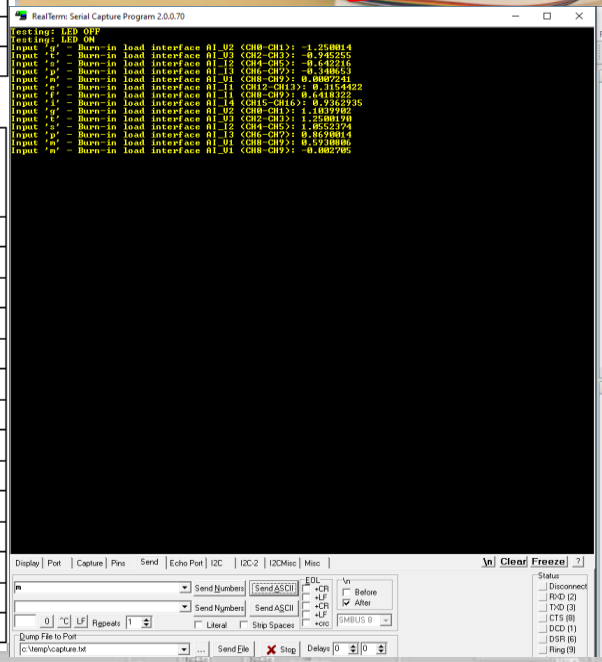
ASCII Character	FUNCTION
1	Brick 10V ON
2	Brick 10V OFF
3	Brick 200V ON
4	Brick 200V OFF
r	Brick Start (Run_IN)
o	Brick Stop (Run_IN)
g	Read brick input current (ADC)
i	Read brick output current (ADC)
t	Read brick input voltage (ADC)
p	Read brick output voltage (ADC)
e	Set brick temp 1 (ADC)
f	Set brick temp 2 (ADC)
q	Read back address

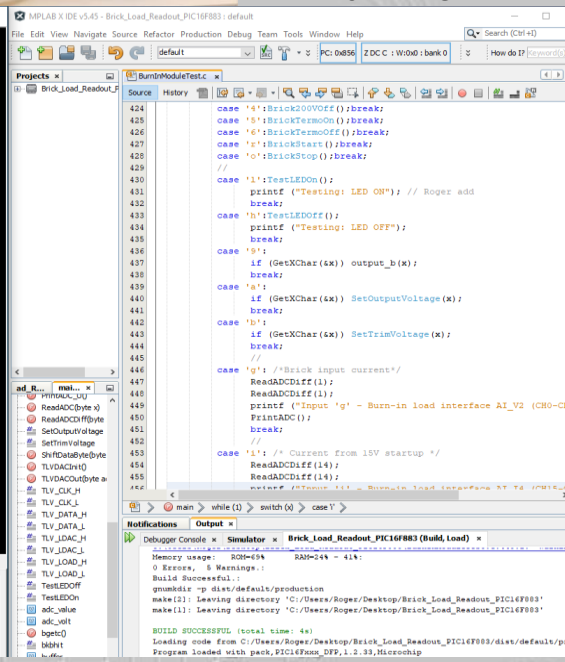
ASCII Input Characters	ADC channels with positions	OUTPUT (Voltage and Current)
g	CH0-CH1	-1.250014 V
t	CH2-CH3	-0.945255 V
s	CH4-CH5	-0.642216 A
p	CH6-CH7	-0.340653 A
m	CH8-CH9	0.0007241 V
e	CH12-CH13	0.3154422 A
f	CH8-CH9	0.6418322 A
i	CH15-CH16	0.9362935 A
g	CH0-CH1	1.1039902 V
t	CH2-CH3	1.2500190 V
s	CH4-CH5	1.0552374 A
p	CH6-CH7	0.8690014 A
m	CH8-CH9	0.5930806 V
m	CH8-CH9	-0.002705 V





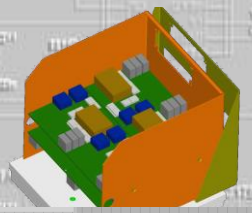
Courtesy of Roger

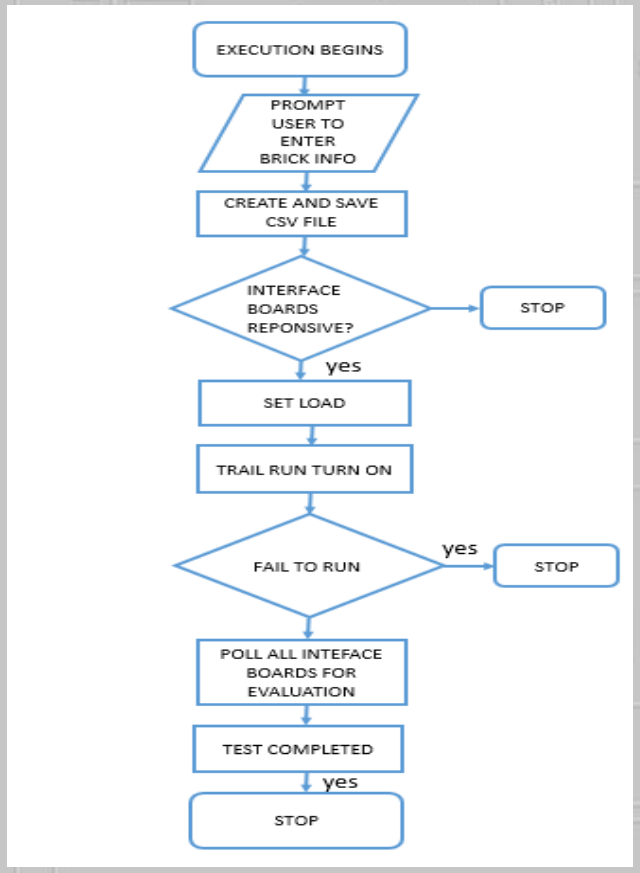




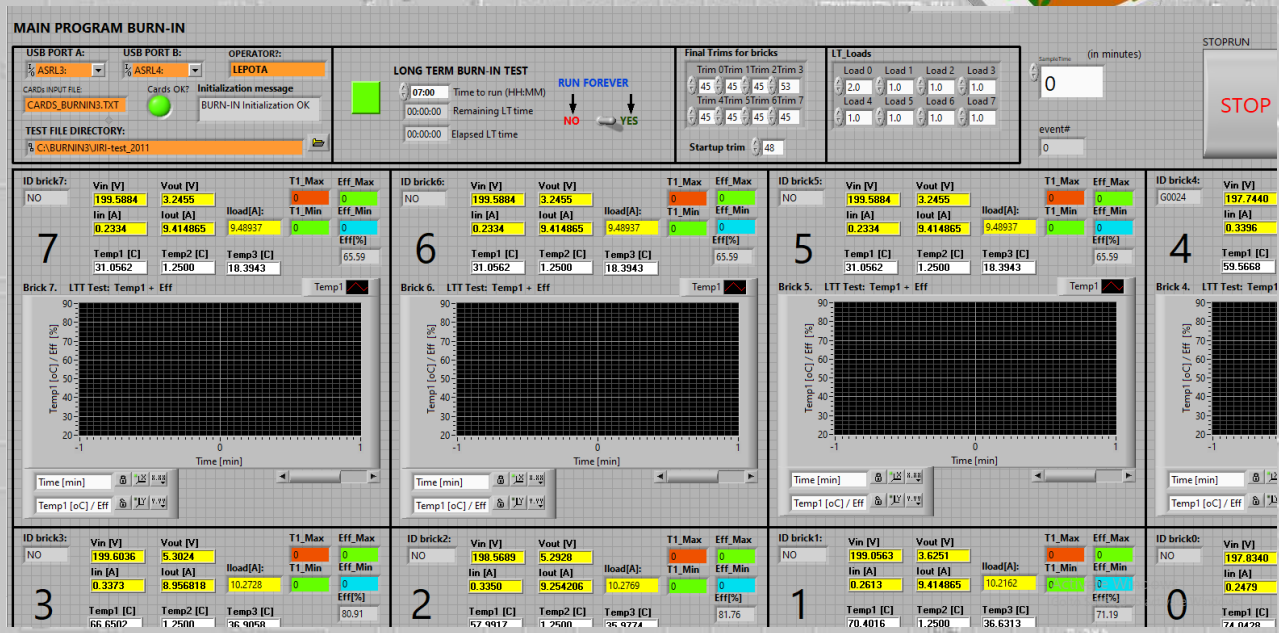
- A circuitry used to validate the receive and transmit lines of the PIC
- ADC (LTC2449) - digitizes all analog input signals from a brick

Burn-in Station: LabVIEW Control Programme



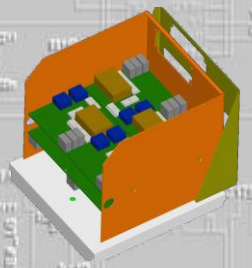


LabView execution diagram

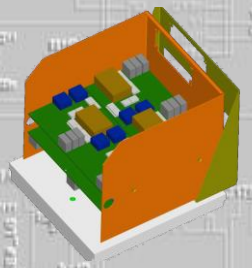


Front graphical panel of the LabView program for burn-in station: shows input and output voltages, current, efficiency and temperature on each brick.

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.



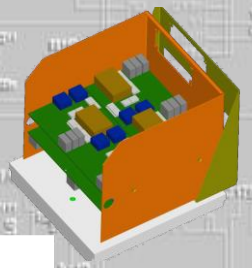
Comments or Questions??

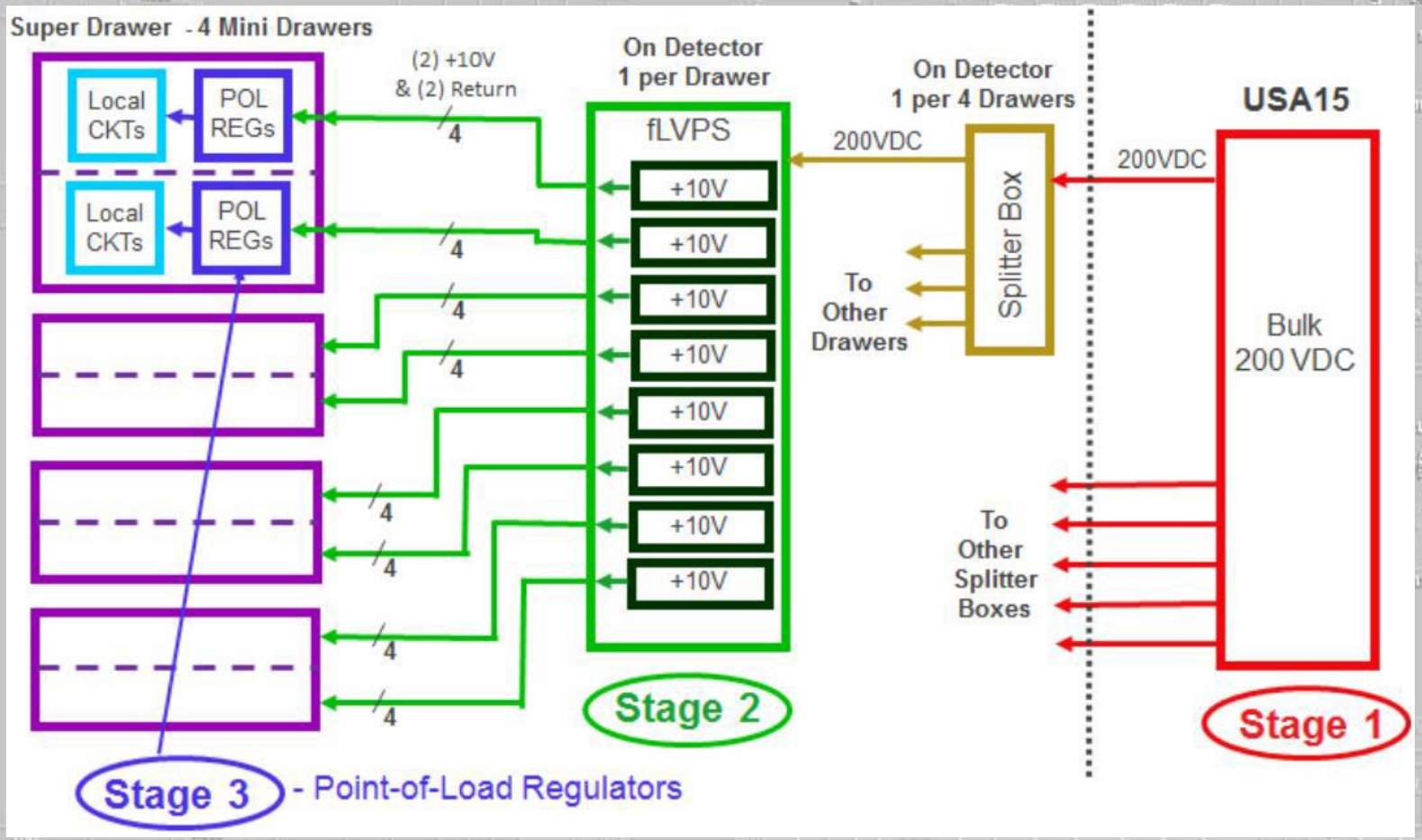
Kgotso, Pula, Nala!

KE A LEBOHA.

Back slides

Stage 3: Point of load Regulators





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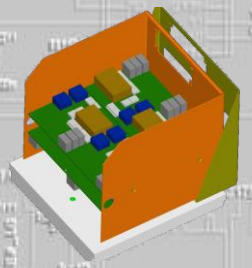
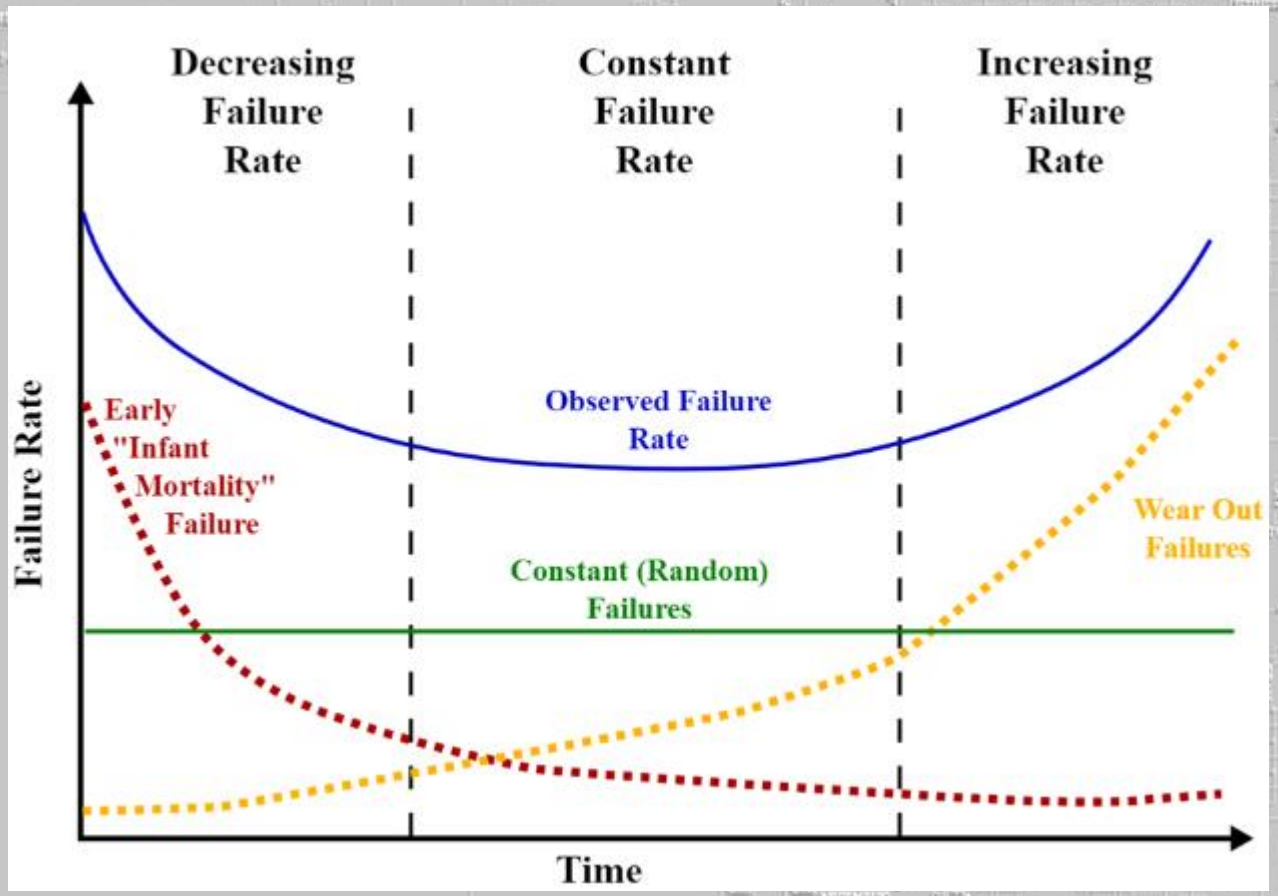
Burn-in bathtub curve for electronics failure rate





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