The authors gratefully acknowledge the UK EPSRC (Engineering and Physical Sciences Research Council) for their financial support.

Variation of Lithium-ion cells in a module

T. L. Fantham, D. T. Gladwin

Abstract

This ongoing research project aims to measure and understand variation between cells connected in a battery module. Initial results suggests that when connected in a module, individual cell variation has little impact during the majority of a charge discharge cycle. However deviation is apparent at the extremes of SoC (State of Charge).

Motivation

There is extensive research considering individual battery cells and characterising their various parameters. However, there is little research considering cells in large strings. This is a key area of research as many applications including EV's (Electric Vehicles) and Grid connected battery storage consist of many thousands of cells connected together. Having a better understanding of this can be used to prolong the life and increase the efficiency of such a system.

Experimental Setup

The cells to be tested are in a '2 Parallel x 12 Series' (12S2P) configuration. Each parallel pair of batteries has a voltage sensor which is transmitted over CAN bus to a PC and logged every 120ms. The setup is shown in figure 1 below.

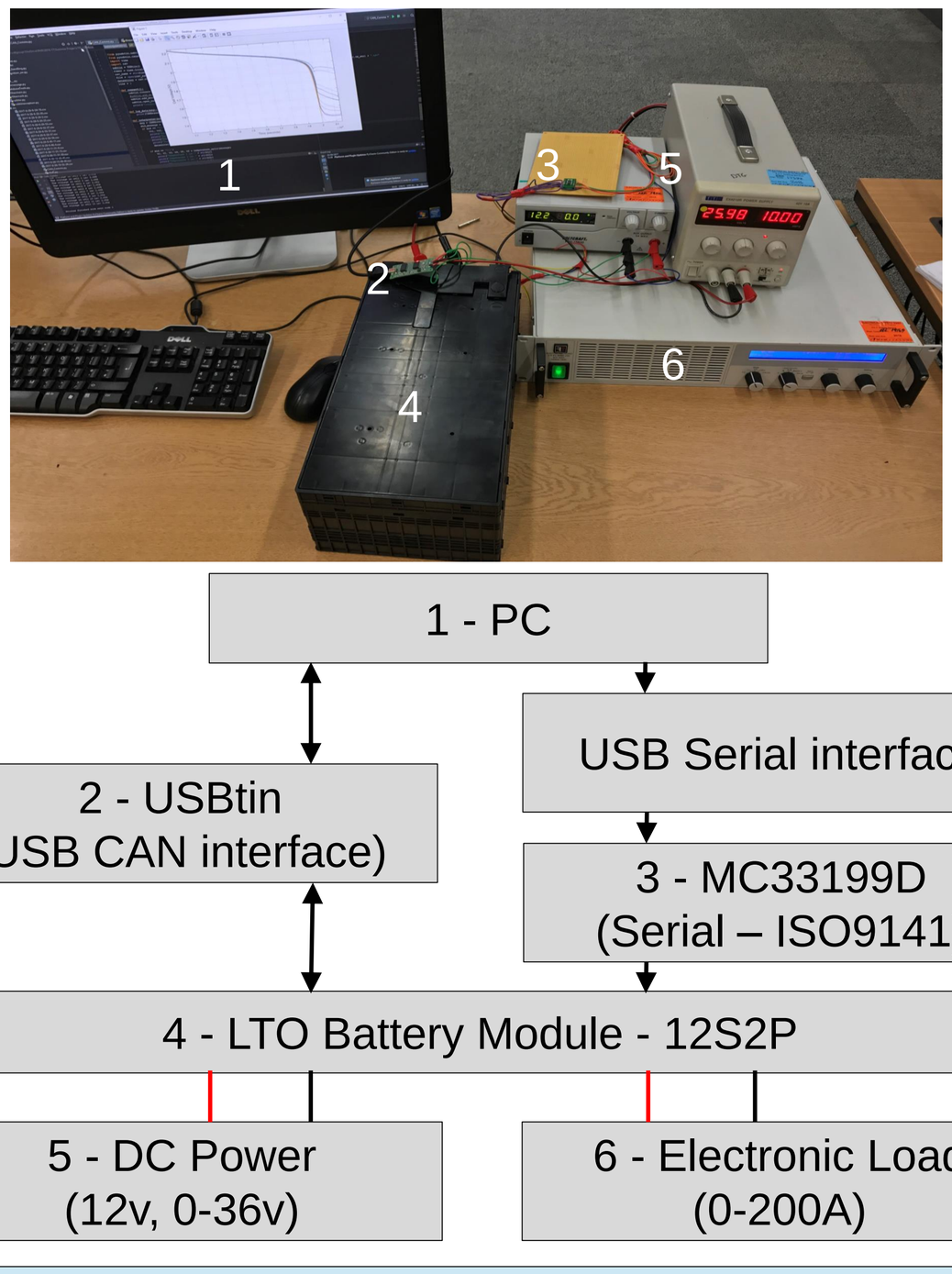

Figure 1: An image and flowchart showing the experimental lab setup

Methodology

Testing is performed using a Toshiba 40Ah SCiB (Super Charge ion Battery) Lithium-Titanate battery module. Initial testing involved performing simple charge/ discharge cycles on the module and observing the cell behaviour. This will then be scaled up to testing large strings of the modules at the Willenhall Energy Storage System (WESS) – a 2MW, 1MWh system using the same modules. This will provide data for around 1000 individual cells.

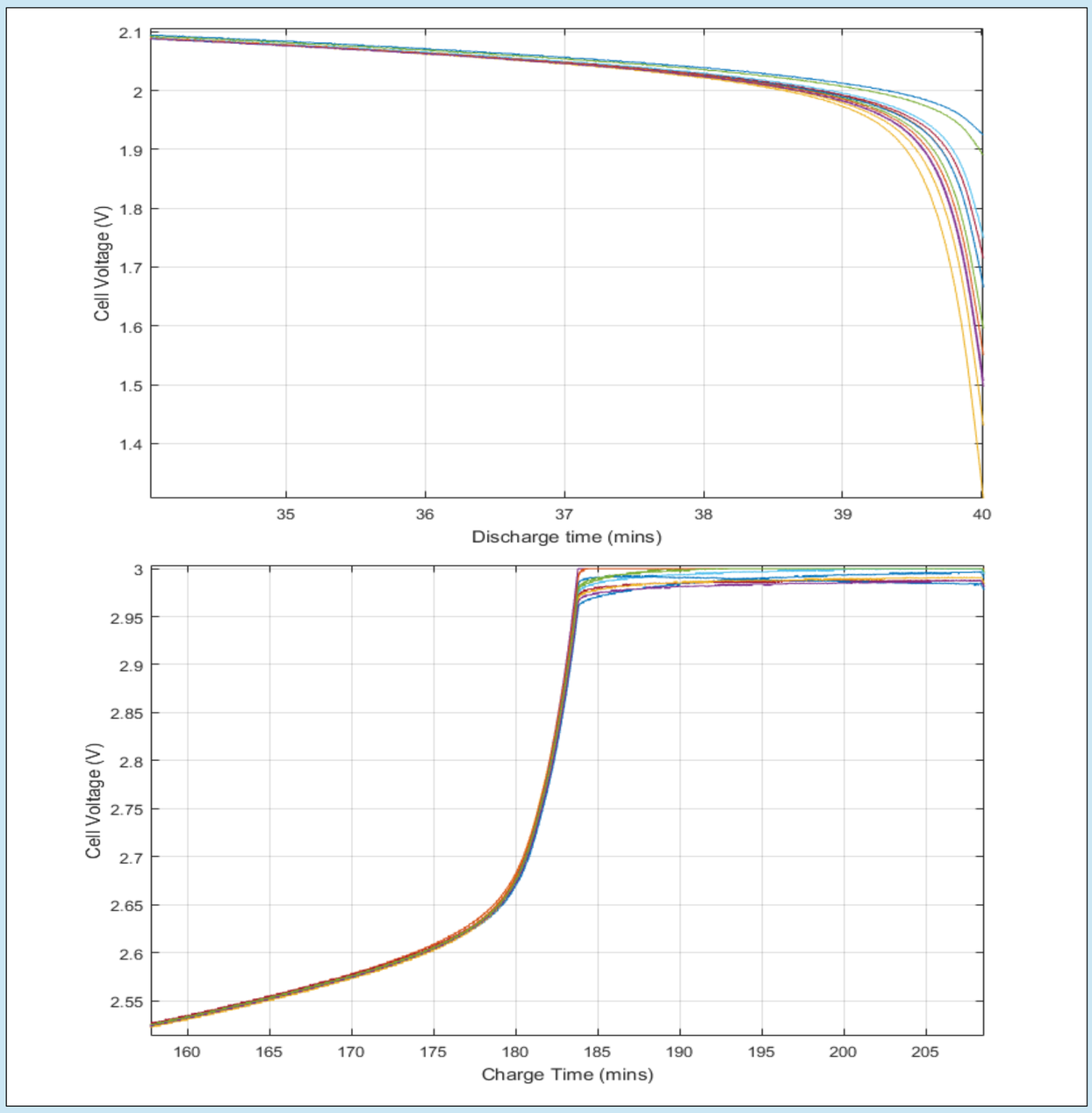

Figure 2: Results from charging (1/4C) and discharging (2C) the SCiB Module, scaled to show cell deviations

Results

Results from charge and discharge in figure 2 shows that during the majority of the cycle, there is <5mv deviation. However during charge near 100% SoC there is ~40mv deviation and during discharge near 0% SoC there is over 600mv deviation between the strongest and weakest cells. It was found that when brought away from those extremes of SoC, the cell voltages would converge with no external balancing.

Future Work

Experimental techniques will be developed to cycle the modules in such a way as to produce the most useful data, before testing at WESS on larger strings. This will likely take the form of aggressive cycling to accelerate battery ageing and pulse charging to characterise cells in a module through observing transient behaviour. Similar work can then be performed on different battery types using the same techniques to develop module models.