BATTERY MANAGEMENT SYSTEM

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1 INTRODUCTION

The battery management system is imperative to the management and monitoring of the lithium ion battery pack. The BMS technology is known as the brain behind the battery pack and plays a crucial role of making sure each element of the pack operates within its safe operating area (protection), monitoring the state of health of the battery, data transmission, performance and charge rates to ensure the battery life is prolonged.

Recent research shows that the wired battery management systems can be very complex because of lots of cabling within the system. Again, the cables can fail and incur a lot of cost. Wireless battery management system has proven to be more efficient and has demonstrated a lot of advantages over the wired system. Although there has been some progress made by researchers in advancing this technology, the WBMS is still yet to be fully realized in a lot of its applications.

2 PROJECT OBJECTIVES

- Design, build and test a cost effective, less efficient, non-smart wired battery management system which is capable of charging a 3S battery pack, protect it from overvoltage, balance the batteries, and limit the charging current.
- Provide a cost analysis for the prototype.

3 PROJECT DESCRIPTION

A basic prototype of a wired battery management system is built which performs the following functions;

- **Charge the lithium-ion battery.**
- **Limit the charging current.**
- **Perform battery balancing.**

The lithium-ion battery usually has a nominal voltage of 3.7V and about 4.2V when fully charged. This wired battery management system is designed to charge a 3S battery pack of lithium-ion cells individually having different internal structures. Thus, one cell will charge faster than the other due to different discharge rates or internal resistances.

The BD140 transistor is connected in series with the four (4) 1N4007 diodes. A TL431 zener reference diode is connected to the base of the transistor. This connection is purposely for the TL431 zener reference diode to open at a voltage value which is 4.2V when the lithium-ion battery is fully charged. At this instance, when the BD140 transistor is active, the charging current will bypass the battery and go through the four (4) 1N4007 diodes connected in series with the transistor. This power will be wasted on the diodes hence the circuit is less efficient. Also, this charging current will light up the LED to indicate full charge. The reference pin of the TL431 zener is connected to the 20k potentiometer hence by adjusting the potentiometer value to the 4.2V, the charging process stops at that voltage value. By this process, passive cell balancing is achieved while charging the 3S battery pack.

Lastly, by connecting two (2) LM317 regulators, one in current mode where the current limit is set by a resistance value. The Vref of the LM317 is 1.25V. Thus the charging current is given by;

Charging Current (I) = $\frac{ReferenceVoltage(Vref)}{ResistorValue(Res)}$

The second LM317 regulator is on voltage control mode. By this connection, no matter the input voltage, the voltage that goes to the 3S battery is 4.2 by 3 which is 12.6V.

Testing and Results

A power adapter is used to convert the AC power to 12V DC. This 12V DC is fed to the input of a DC-DC boost converter which steps-up the voltage to a 16V DC and further feds it to the circuit.This 16V is used to power the circuit. The voltage limit is set to 12.6V and the charging current 600mA. The three (3) Li-ion batteries will be charging but at different rates. The three (3) LEDs turn on consecutively at different time intervals indicating full charge.

4 CIRCUIT DIAGRAM

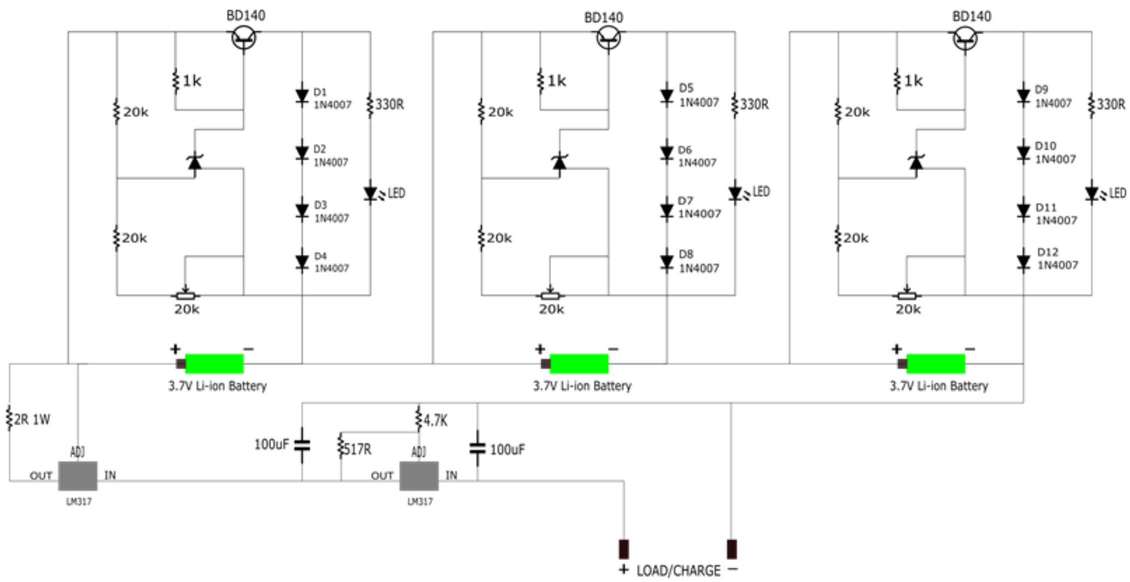

Figure 1: shows the schematic diagram of the battery management system.

5 ITEM LIST

ITEM	QUANTITY
1S Lithium-ion battery	3
TL431 Zenner	3
BD140 PNP Transistor	3
1N4007 Diode	12
LM317 Regulator	2
LED 5mm	3
Resistor Kit	1
20K Potentiometer	3
2R 1W Resistor	2
Battery Holder	1
Power Adapter	1
100uF Capacitor	2
Perfboard	1
Connecting wires	1

Table 1: List of components used and the number required.

6 COST

Below is a quote on the components required for this project;

INVENT ELECTRONICS LTD

Plot 18, Block 7, Ayeduase New Site, Kumasi

TEL:+233553479020

Receipt

To

Buyer: Kofi Annan					
Shipping Address: .... Ghana					
Phone Number: +233 204 203 405					
	Date:2022-02-03				

Item No.	Item	Part No/Description	Unit Price(GHS)	Qty	Amount(GHS)
1	1S Li-Ion battery		GHS20.00	3	GHS60.00
2	TL431 zenner		GHS1.50	3	GHS4.50
3	BD140 PNP transistor		GHS2.00	3	GHS6.00
4	1N4007 diode		GHS0.30	12	GHS3.60
5	LM317 regulator		GHS5.00	2	GHS10.00
6	LED 5mm		GHS0.50	3	GHS1.50
7	Resistor KIT		GHS25.00	1	GHS25.00
8	20K potentiometer		GHS2.00	3	GHS6.00
9	2R 1W resistor		GHS1.00	2	GHS2.00
10	Battery Holder		GHS10.00	1	GHS50.00
11	Power Adapter		GHS45.00	1	GHS45.00
12	Capacitor		GHS1.00	2	GHS2.00
13	Perfboard		GHS5.00	1	GHS5.00
14	Connecting Wires		GHS10.00	1	GHS10.00
	Total				**GHS230.60**

Eric Heckford Bryan

Figure 2: shows the prices of each component

7 PROTOTYPE

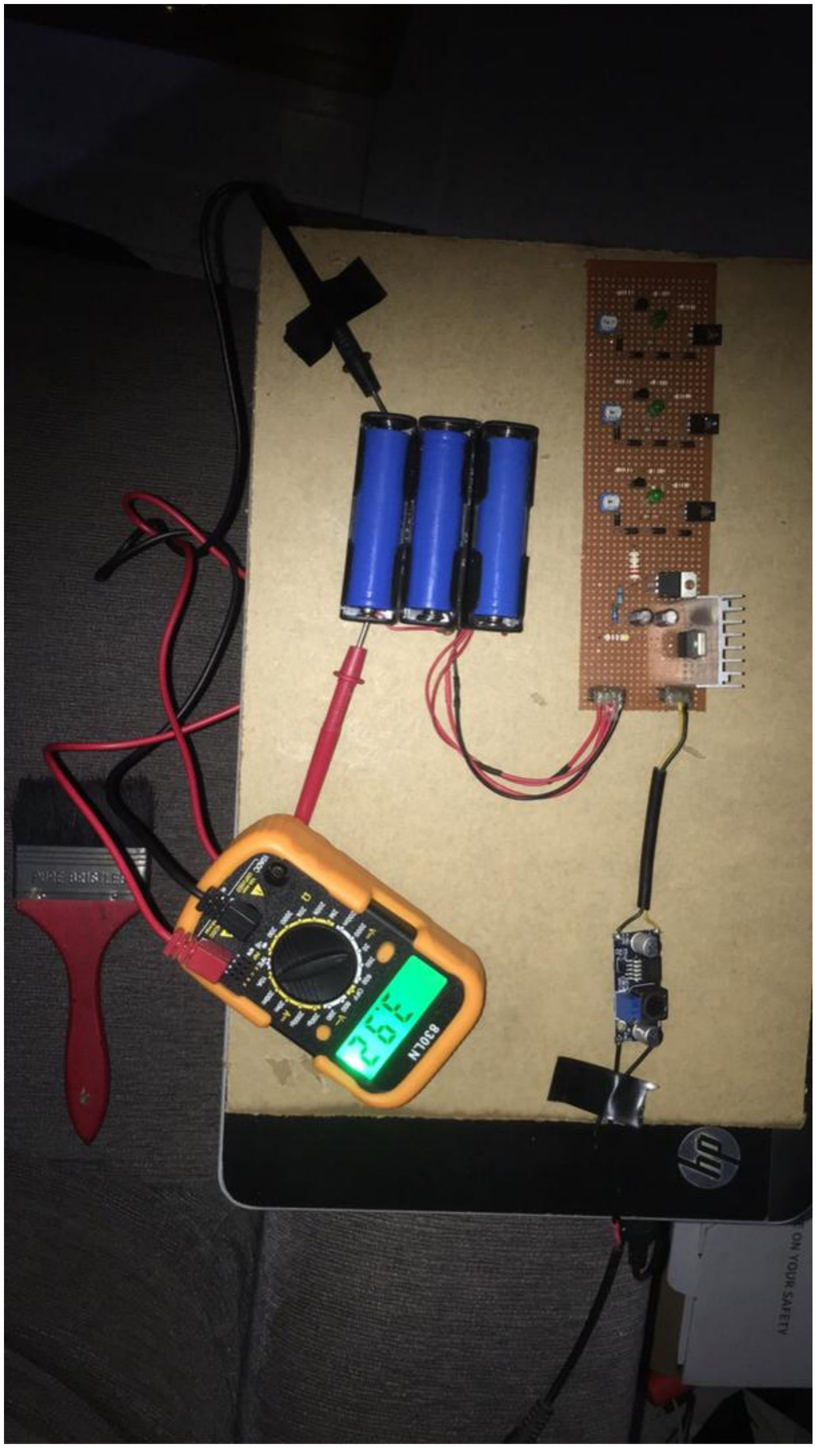

Figure 3: shows the prototype of the BMS system