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Solar Operated Battery Management System using IoT

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Abstract: *Electric vehicles are set to be the dominant form of transportation in the near future and Lithium-based rechargeable battery packs have been widely adopted in them. Battery packs need to be constantly monitored and managed in order to maintain the safety, efficiency and reliability of the overall electric vehicle system. A battery management system consists of a battery fuel gauge, optimal charging algorithm, and cell/thermal balancing circuitry. It uses three non-invasive measurements from the battery, voltage, current and temperature, in order to estimate crucial states and parameters of the battery system, such as battery impedance, battery capacity, state of charge, state of health, power fade, and remaining useful life. These estimates are important for the proper functioning of optimal charging algorithms, charge and thermal balancing strategies, and battery safety mechanisms. Approach to robust battery management consists of accurate characterization, robust estimation of battery states and parameters, and optimal battery control strategies. This paper describes some recent approaches developed by the authors towards developing a robust battery management system.*

Keywords: Battery Management Systems; Battery Fuel Gauge; State of Charge; State of Health; Power Fade; Capacity Fade; Robust Estimation; Predictive Control.

I. INTRODUCTION

BMS means different things to different people. To some it is simply Battery Monitoring, keeping a check on the key operational parameters during charging and discharging such as voltages and currents and the battery internal and ambient temperature. The monitoring circuits would normally provide inputs to protection devices which would generate alarms or disconnect the battery from the load or charger should any of the parameters become out of limits. For the power or plant engineer responsible for standby power whose battery is the last line of defense against a power blackout or a telecommunications network outage BMS means Battery Management Systems. Such systems encompass not only the monitoring and protection of the battery but also methods for keeping it ready to deliver full power when called upon and methods for prolonging its life. This includes everything from controlling the charging regime to planned maintenance. For the automotive engineer the Battery Management System is a component of a much more complex fast acting Energy Management System and must interface with other on-board systems such as engine management, climate controls, and communications and safety systems.

There are thus many varieties of BMS. The battery fuel status indicator is a common feature of the battery supported handheld devices The battery fuel measurement is achieved by measuring the discharging and charging currents in real time. The discharging current is the current coming out from the battery and the charging current is the current flowing into the battery. The fuel used (mAH) and the fuel remaining (mAH) are calculated by tracking the discharging and charging currents over time. The fuel used is the total discharged current over time and the remaining fuel is simply the subtraction of the fuel used from the fully charged fuel. Energy which comes from natural resources such as sunlight, wind, rain, geothermal heat etc. is called renewable energy. Renewable energy resources are inexhaustible, clean as compared with conventional resources. About 16% of global final energy consumption comes from renewable resources. Solar Photovoltaic energy has many advantages like clean green energy, free and abundant, environment friendly, low operation and maintenance cost, etc. and hence the demand is increased.

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Many types of Photovoltaic power conversion systems have been developed including the grid-connected system for reducing the power from the utility and the standalone system for providing the load power without the utility. In case of stand-alone system is usage, batteries are required for energy storage. Electricity generations of solar panels are strongly related with solar radiation intensity. However, the intensity is not stable. Therefore, charge efficiency is a very important topic in solar systems. Charge controllers are designed to improve charge efficiency and safety.

The primary function of a charge controller is to protect the battery from overcharge and over discharge in a stand-alone photovoltaic system. In developing countries like India, the demand for power is increasing and there are scheduled power outages. Photovoltaic being intermittent in nature, energy storing devices such as batteries are integrated into the system to meet the dynamic power demands. A photovoltaic system implemented in houses involves two power sources (photovoltaic and utility), a power sink (load) and a power source/sink (battery), and hence a Power Flow Management system (PMS) is required to balance the power flow among these sources. A PMS has been used to control the operation of the bidirectional converter in Grid Connected photovoltaic systems.

1)PIC18F4520:

It is an 8-bit enhanced flash PIC microcontroller that comes with nano Watt technology and is based on RISC architecture. Many electronic applications house this controller and cover wide areas ranging from home appliances, industrial automation, and security system and enduser products. This microcontroller has made a renowned place in the market and becomes a major concern for university students for designing their projects, setting them free from the use of a plethora of components for a specific purpose, as this controller comes with inbuilt peripheral with the ability to perform multiple functions on a single chip.

Fig 1: PIC18F4520 Micro Controller

2)16*2 LCD Display:

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical. Easily programmable have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.

A 16x2 LCD means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD. A command is an instruction given to LCD to do a predefined task like initializing it, clearing its screen, setting the cursor position, controlling display etc. The data register stores the data to be displayed on the LCD. The data is the ASCII value of the character to be displayed on the LCD. Click to learn more about internal structure of a LCD. The purpose of using 16x2 LCD in our project is to display all the parameters of electricity meter and is connected to the port 0 of ARM micro-controller.

FEATURES:

•16x2 matrix
•Low power operation support: 2.7 to 5.5V.
•Duty cycle: 1/16
•Connector for standard 0.1-pitch pin headers.

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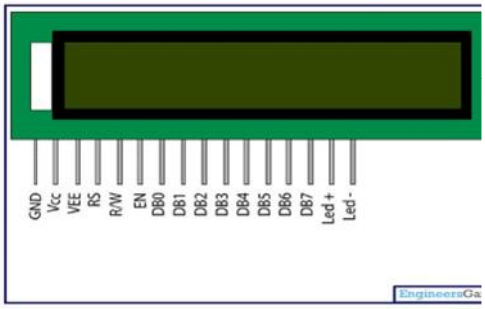

Fig 2: 16*2 LCD Display

3) VOLTAGE REGULATOR:

The LM78XX/LM78XXA series of three-terminal positive regulators are available in the TO-220/DPAK package and with several fixed output voltages, making them useful in a Wide range of applications. Each type employs internal current limiting, thermal shutdown and safe operating area protection, making it essentially indestructible. If adequate heat sinking is provided, they can deliver over 1A output Current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltages and currents.

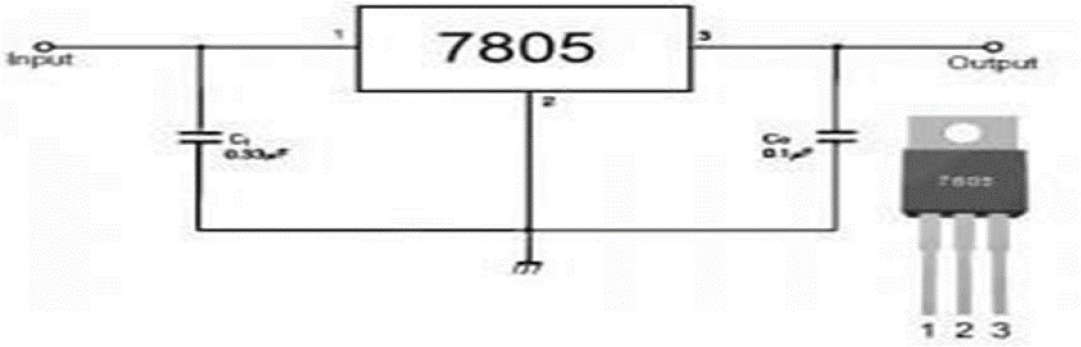

Fig 3. Voltage Regulator Diagram

FEATURES:

•Output Current up to 1A.
•Output Voltages of 5, 6, 8, 9, 10, 12, 15, 18, 24V.
•Thermal Overload Protection.
•Short Circuit Protection.
•Output Transistor Safe Operating Area Protection

4) SOLAR PANEL:

Photovoltaic solar panels absorb sunlight as a source of energy to generate direct current electricity. A photovoltaic (PV) module is a packaged, connected assembly of photovoltaic solar cells available in different voltages and wattages. Photovoltaic modules constitute the photovoltaic array of a photovoltaic system that generates and supplies solar electricity in commercial and residential applications. One of the essential components of the solar charging system is the solar panel. A solar panel is a device that is designed to absorb sunlight to generate electricity or heating power. It is the component that helps collect energy from direct sunlight and then converts it into electricity. There are several types of solar panels. The three most common types are Monocrystalline cells, polycrystalline cells and amorphous or thin-film solar cell. It is essential to understand the basic features including the watts, cost and space you require before you decide the one to pick.

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Solar charge controllers' primary function is to manage power, but it may offer additional capabilities including load control and lighting. Thus, when the solar charge controller receives the solar supply, it then regulates the electricity and current directed to the batteries to ensure proper battery charging occurs.

Fig 4: Solar Panel

5)TEMPERATURE SENSORS:

The LM35 is one kind of commonly used temperature sensor that can be used to measure temperature with an electrical o/p comparative to the temperature (in °C). It can measure temperature more correctly compare with a thermistor. This sensor generates a high output voltage than thermocouples and may not need that the output voltage is amplified. The LM35 has an output voltage that is proportional to the Celsius temperature. The scale factor is .01V/°C. The LM35-series devices are precision integrated-circuit temperature sensors, with an output voltage linearly proportional to the Centigrade temperature. The LM35 device has an advantage over linear temperature sensors calibrated in Kelvin, as the user is not required to subtract a large constant voltage from the output to obtain convenient Centigrade scaling. The LM35 device does not require any external calibration or trimming to provide typical accuracies of ± ¼ °C at room temperature and ± ¾ °C, over a full −55°C to 150°C temperature range.

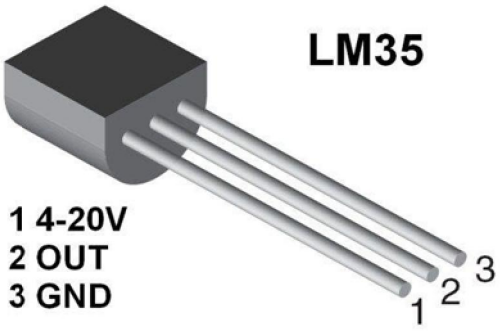

Fig 5: Lm35 Temperature Sensor

6)RELAY:

A relay is electrically operated switch. Many relays use an electromagnet to operate a switching mechanism mechanically, but other operating principles are also used. Relays are used where it is necessary to control a circuit by a low-power signal (with complete electrical isolation between control and controlled circuits), or where several circuits must be controlled by one signal. A relay is an electrically operated switch. Current flowing through the coil of the relay creates a magnetic field which attracts a lever and changes the switch contacts. The coil current can be on or off so relays have two switch positions and most have double throw (changeover) switch contacts as shown in the diagram.

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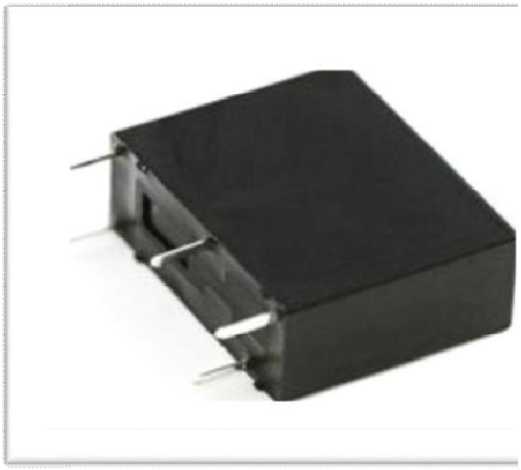

Fig 6: Relay

Normally Open (NO): Contacts connect the circuit when the relay is activated, the circuit is disconnected when the relay is inactive. Normally Closed (NC): Contacts disconnect the circuit when the relay is activated, the circuit is connected when the relay is inactive. Change Over (CO): It's the common contact. Coil: It's the electromagnet coil inside relay. Coil rating: It's the Voltage at which the coil gets fully activated. Some alsohave coil resistance mentioned on them. Relay coil voltage rated 6V and 12V are the most commonly available. The figure shows a relay with its coil and switch contacts. You can see a lever on the left being attracted by magnetism when the coil is switched on. This lever moves the switch contacts.

Applications of Relays:

Control a high-voltage circuit with a low-voltage signal, as in some types of modems or audio amplifiers. Control a high-current circuit with a low-current signal, as in the starter solenoid of an automobile.Detect and isolate faults on transmission and distribution lines by opening and closing circuit breakers.

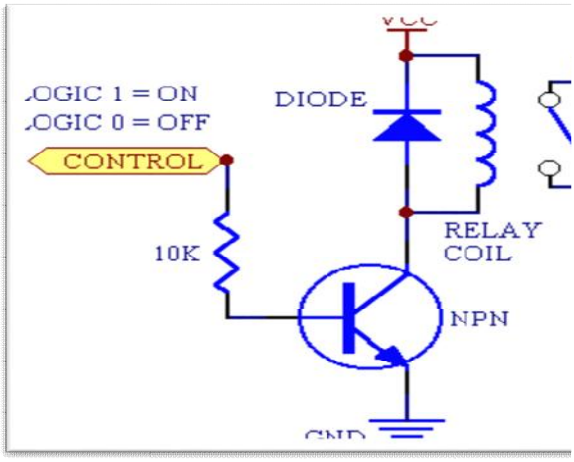

Fig 7: Relay

7)BUZZER:

A buzzer or beeper is an audio signal device,which may be mechanical, electromechanical, or piezoelectric. Typical uses of buzzers and beepers include alarm devices, timers and confirmation of user input such as a mouse click or keystroke. If embedded system is misplaced from dashboard, the IR sensor becomes active. The signal is sent to ARM micro controller to ring the buzzer. It is connected to the port pin P0.21 via jumper J10 of micro controller.

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Fig 8: Buzzer

8)RESISTER:

Resistor is a two-terminal electronic component designed to oppose an electric current by producing a voltage drop between its terminals in proportion to the current, that is, in accordance with Ohm's lawV = IR. Resistors are used as part of electrical networks and electronic circuits. They are extremely commonplace in most electronic equipment. Practical resistors can be made of various compounds and films, as well as resistance wire (wire made of a high-resistivity alloy, such as nickel/chrome).

9)GSM:

This GSM modem has a SIM800A chip and RS232 interface while enables easy connection with the computer or laptop using the USB to Serial connector or to the microcontroller using the RS232 to TTL converter. Once you connect the SIM800 modem using the USB to RS232 connector, you need to find the correct COM port from the Device Manger of the USB to Serial Adapter. Then you can open Putty or any other terminal software and open a connection to that COM port at 9600 baud rate, which is the default baud rate of this modem.Once a serial connection is open through the computer or your microcontroller you can start sending the AT commands. When you send AT commands for example: "AT\r" you should receive back a reply from the SIM800 modem saying "OK" or other response depending on the command send.

SIM800 is a complete Quad-band GSM/GPRS solution in a LGA type which can be embedded in the customer applications. SIM800H support Quad-band 850/900/1800/1900MHz, it can transmit Voice, SMS and data information with low power consumption. With tiny size of 15.8*17.8*2.4 mm, it can fit into slim and compact demands of customer design. Featuring and Embedded AT, it allows total cost savings and fast time-to-mar for customer applications.

Fig 9: GSM Module

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10)BATTERY:

12V 2Ah Rechargeable Lead Acid Battery is normally use for robots in competition. Wired or Wireless Robots runs for a long time with high speed with this type of battery. Seal Lead Acid (SLA) Rechargeable battery is the most common general-purpose battery. Low cost, robust and less maintenance required are the advantages of SLA. But it is considered heavy weight for certain robotic application. To charge SLA batteries, you can use any general DC power supply as long as it provides the correct voltage to your battery.

Fig 10: Battery

Features:

- Rechargeable
- Recyclable
- No Memory Effect
- Able to use for most of the 12V controllers, motors or any other appliances Specification:
- Voltage: 12V
- Capacity: 2Ah
- Size: 98mm x 43mm x 52 mm
- Weight: 0.450kg
- Package Includes:
- 1 x 12V 1.2Ah Rechargeable Lead Acid Battery

II.CONCLUSION

Open circuit voltage modelling: It is demonstrated how careful modelling and optimization can result in parameters that are applicable to a wide range of temperatures. The need for careful modelling is demonstrated using scaling, a strategy, when ignored, results in up to 90% higher SOC errors. Battery impedance estimation: Battery impedance changes with temperature and other battery states; real-time impedance estimation is required for effective battery management. In this paper, we summarize a real time approach to battery impedance estimation. Battery capacity estimation: Accurate knowledge battery capacity is crucial for all aspects of a battery management system. Adaptive strategies for universal battery management: newer versions of batteries come in slightly different chemical compositions. How to develop a battery management system that can stay relevant with ever changing battery types? This paper offers a glimpse into futuristic solutions based on probabilistic data and information fusion.

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REFERENCES

[1] Mohd Helmy Abd Wahab et al, "IoT-Based Battery Monitoring System for Electric Vehicle", International Journal of Engineering &Technology (2018).
[2] M Ramesh Kumar et al, "Battery Monitoring System using IoT", International Journal of Scientific Development and Research (2018).
[3] N Harish et al, "IOT Based Battery Management System", International Journal of Applied Engineering Research (2018).
[4] Pande, A.S, K. Bhadane et al., "A Comprising Study on Modernization of Electric Vehicle Subsystems, Challenges, Opportunities and strategies for its Further Development," 2021 4th Biennial International Conference on Nascent Technologies in Engineering (ICNTE), NaviMumbai, India, 2021, pp. 1-9, doi: 10.1109/ICNTE51185.2021.9487757.
[5] Pande, A.S., Soni, B.P. &Bhadane, K.V. "Electrical Models for EV's Batteries: An Overview and Mathematical Design of RC Network." J. Inst. Eng. India Ser. B 104, 533–547 (2023). https://doi.org/10.1007/s40031-022-00852-1.
[6] Arvind S Pande, K Bhadane, Bhanu P Soni, Mukherjee A "Batteries: Classification and Review of Electric Circuit Models for Electric Vehicle" iciemsc@uem.edu.in, Conference, 2021, pp1-16.
[7] A. Pande and R. Munie, "Fast Output Sampling Feedback with Two Delayed Inputs for MIMO System," 2018 International Conference on Advances in Communication and Computing Technology (ICACCT), Sangamner, India, 2018, pp. 74-78, doi: 10.1109/ICACCT.2018.8529391.
[8] Rodrigue, J.P.; Comtois, C.; Slack, B. The Geography of Transport Systems; Taylor & Francis: New York, NY, USA, 2016.
[9] Plett, G.L. Battery Management Systems, Volume I: Battery Modeling; Artech House: Norwood, MA, USA, 2015.
[10] Plett, G.L. Battery Management Systems, Volume II: Equivalent-Circuit Methods; Artech House: Norwood, MA, USA, 2015.
[11] Thomas, K.E.; Newman, J.; Darling, R.M. Mathematical modeling of lithium batteries. In Advances in Lithium-Ion Batteries; Springer: Boston, MA, USA, 2002; pp. 345–392.
[12] Abada, S.; Marlair, G.; Lecocq, A.; Petit, M.; Sauvant-Moynot, V.; Huet, F. Safety focused modeling of lithium-ion batteries: A review. J. Power Sources 2016, 306, 178–192. [CrossRef]
[13] Taylor, W.; Krithivasan, G.; Nelson, J.J. System safety and ISO 26262 compliance for automotive lithium-ion batteries. In Proceedings of the 2012 IEEE Symposium on Product Compliance Engineering Proceedings, Portland, OR, USA, 5–7 November 2012; pp. 1–6.