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BATTERY LEVEL MONITORING

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ABSTRACT

Battery has become an important source of carrying the electricity portably. The battery has lot of dilemma in performance i.e. sulphation, Reverse charging, grid corrosion. We have developed a model for a 12v, 7Ah battery which can indicate the charge present in the battery, Voltage across the battery, current withdrawn from the battery, A precise value of how much hours does the battery can withstand for the given load for the charge present in the battery and also indicates the hours the battery can withstand in full charge of the battery. It also indicates when does the battery has to be charged it gives an indication for charging and charges automatically when the battery level reaches certain level below. Thus it helps in monitoring the performance of battery and avoids deep discharging thus improving the battery life.

KEYWORDS—*Battery, Arduino, Failure, Charging, Lead acid, Microcontroller, Monitoring*

I. INTRODUCTION

Rechargeable battery is an electrochemical device which converts electrical energy to chemical energy during charging and converts chemical energy to electrical energy during discharging. Rechargeable battery plays important role hence it is employed in almost every field [1]. Lead acid battery offers lowest self-discharge than any other battery. Nowadays, Lead acid battery is widely used because of the longest life cycle. Accurate battery information such as state-of-charge (SOC), current and voltage are vital for circuit designer to manage the energy consumption of battery-powered system. Moreover, handling on battery is necessary to avoid battery from overcharged or over-discharged [2]. All over the world, there are many kinds of portable devices and common point of these devices is “having a battery”. All manufacturers try to make devices run with low current and try to make battery life longer. Although there are many parameters affecting the battery run-time, software management has an important role in battery management. Knowledge about the remaining energy of the battery provides how much long does the battery withstands with the energy. In order to make battery last longer, microcontroller gives up some data thus do not undertake the deep discharge on the low remaining energy of the battery. So, battery management makes devices comfortable and useful. Battery management will start with knowing battery behavior. So source voltage is certain but current flow fluctuates in time. Due to current alternating, computed remaining battery energy changes instantly. In the following sections we will see about parameters for Battery Monitoring, Calculations for battery management system, Schematic and the results obtained.

II. VOLTAGE AND CURRENT MONITORING

Voltage and current measurement is one of the key parameters for the Battery Management System (BMS). There are other parameters for the BMS i.e. Temperature, Internal resistance of battery etc. For voltage measurement we have used Voltage divider circuit and for current measurement ACS712 Current sensor is used, In addition to the parameters for a particular load we have calculated the Estimation time of the battery for current charge and for full charge. The parameters which are measured as analog sent to the microcontroller and values are displayed in LCD (Liquid Crystal Display).

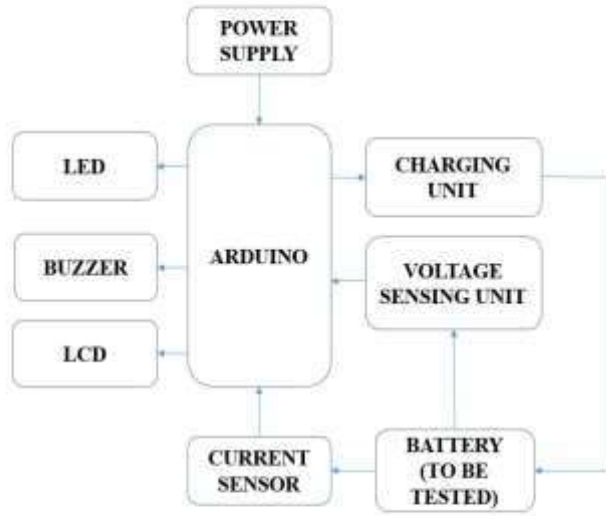

Fig.1.Block Diagram of Battery level monitoring.

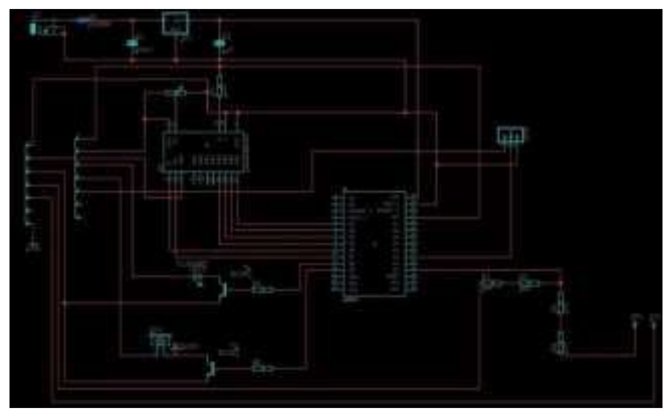

Fig.2.Schematic Diagram.

A. BCI STANDARDS

According to Battery Council International (BCI) based on the voltage available in the battery the charge of the battery can be predicted. The bellow Table I shows the values of the Open circuit voltages of different types of batteries and its corresponding state of charge [8] based on these values our system is build.

Table I: BCI standard of Lead acid batteries.

Approximate state-of-charge	Open circuit voltage			
	2V	6V	8V	12V
100%	2.10	6.32	8.43	12.65
75%	2.08	6.22	8.30	12.45
50%	2.04	6.12	8.16	12.24
25%	2.01	6.03	8.04	12.06
0%	1.98	5.95	7.72	11.89

B. ACS712 Current Sensor

The ACS712 provides economical and precise solutions for AC or DC current sensing in industrial, commercial, and communications systems. Typical applications include motor control, load detection, switched-mode power supplies, and over current fault protection. The device consists of a precise, low-offset, linear Hall sensor circuit with a copper conduction path located near the surface of the die. Applied current flowing through this copper conduction path generates a magnetic field which is sensed by the integrated Hall IC and converted into a proportional voltage. Device accuracy is optimized through the close proximity of the magnetic signal to the Hall transducer. A precise, proportional voltage is provided by the low-offset, chopper-stabilized BiCMOS Hall IC, which is programmed for accuracy after packaging. The output of the device has a positive slope when an increasing current flows through the primary copper conduction path (from pins 1 and 2, to pins 3), which is the path used for current sensing. The internal resistance of this conductive path is 1.2 mΩ typical, providing low power loss. The thickness of the copper conductor allows survival of the device at up to 5× overcurrent conditions. The terminals of the conductive path are electrically isolated from the sensor leads (pins 5 through 8). This allows the ACS712 current sensor to be used in applications requiring electrical isolation without the use of opto-isolators or other costly isolation techniques. This has been selected for our project for its sensing range 0-20A and for its operating voltage which is 5v so that it can be interfaced easily.

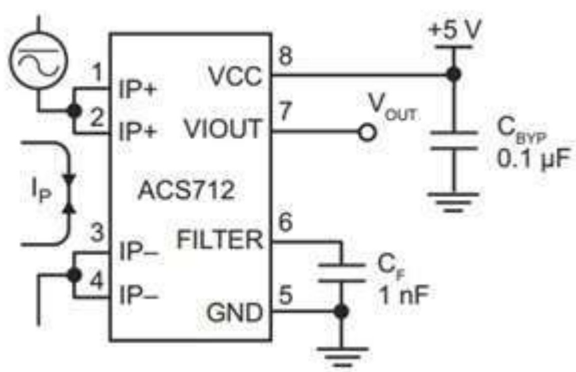

Fig. 3 ASC712 Application.

C. Voltage Divider circuit

Voltage divider circuit which consists of resistors connected in series. One end of this series connection is connected to the voltage to be measured (Vm) and the other end to the ground. A voltage (V1) proportional to the measured voltage will appear at the junction of resistors. This junction can then be connected to the analog pin of the Arduino (A0). The voltage can be found out using the below formula.

$$V_1 = V_m * (R_2 / (R_1+R_2)) \qquad (1)$$

The Resistor values obtained from the derivation are R1=96.5K Ω, R2=44K Ω respectively.

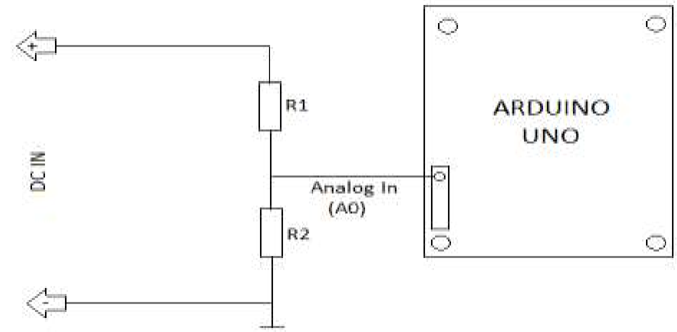

Fig. 4 Voltage divider circuit with Arduino Microcontroller.

D. Estimation Time of Battery

We are using a battery of 7Ah which means it can deliver 7 ampere current for an hour. With this the amount of current discharged from the battery is calculated by using ACS712 current sensor module the value is divided,

Estimation time=7/current value (2)

Thus it gives number of hours the battery can withstand with full charge.

For Estimation of time with current charge the Estimation time is multiplied with SOC.

III. LCD, ACS712 AND CHARGING MODULE

For the system, three main interfacing is necessary. LCD is used to display the Parameters for Battery level in real time. As above discussed the ACS712 is necessary for measuring the current drawn from the battery and the charging module is essential for the preventing deep discharging.

A. LCD

A Liquid Crystal display is a matrix display. In the system we use a 16x2 display which can display 16 characters and in two lines. The data shall be sent in parallel communication. There are three control pins that need to be configured before sending the data for display [7]. The Register Select (RS) is used to select the mode of data send as character or instruction. Instructions are used to clear the LCD, set the cursor, selecting the line, etc. It is done by making RS=0. The character to be displayed shall be send by making the RS=1. The RW is used to either read or write data to the LCD. To display data, the RW is to be set in write mode, i.e. RW=1. For each data to pass, the enable (EN) has to be changed from 0 to 1. Further, a 5V supply is to be provided to the VCC.

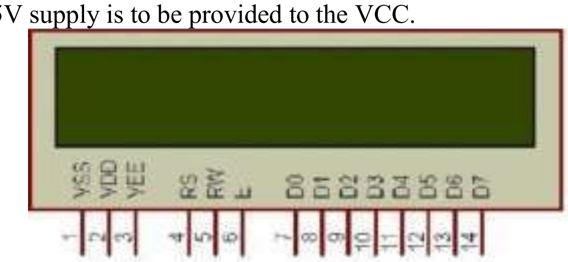

Fig. 5 Pin diagram of LCD display.

B. ACS712 Current Sensor Module

The ACS712 Current sensor module is used because of the following salient features, Low-noise analog signal path, 5 μs output rise time in response to step input current, 80 kHz bandwidth, Total output error 1.5% at TA = 25°C, 1.2 mΩ internal conductor resistance, 5.0 V single supply operation, 66 to 185 mV/A output sensitivity, Output voltage proportional to AC or DC currents.

Fig. 6 ACS712 Current Sensor Module.

C. Charging module

The charging module is fed with the input of 230V AC supply which will be rectified to 13-14V DC supply which is the charging voltage for the 12V, 6 cell battery which we are testing. A 5V Relay which is controlled by microcontroller is connected to the output of the charging module. As the voltage reaches below a set voltage the charging circuit is turned ON. This module has built in relay for automatic control and cheap.

Fig. 7 12V charging module.

IV. RESULTS AND CONCLUSION

The system measures the voltage and current of battery and displays it on a display as in Fig. 9, Fig. 10, Fig. 11, and Fig. 12. This helps in monitoring the battery and knowing the battery level helps us to use the battery based on it, the estimation time of the battery help to identify the duration time with which the battery can withstand helps to use the battery accordingly. The automatic charging helps to avoid problems on deep discharging and thus improving battery life and performance.

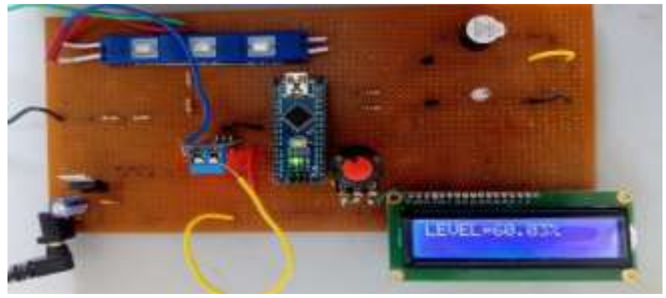

Fig. 8 Battery level in percentage.

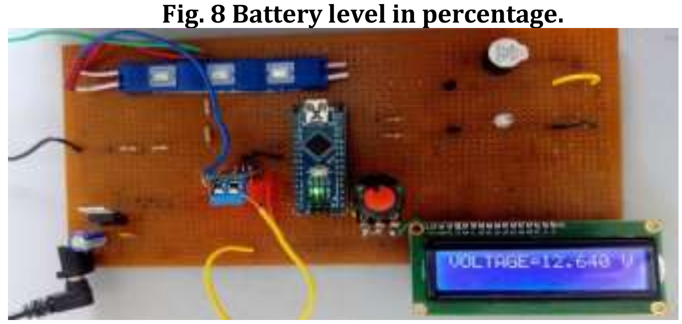

Fig.9 Battery OCV in Volts.

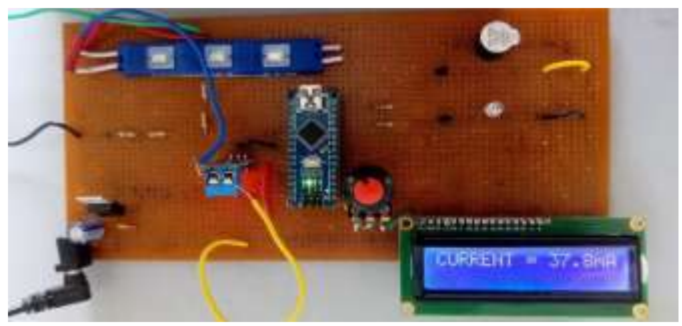

Fig.10 Current drawn from the battery for load.

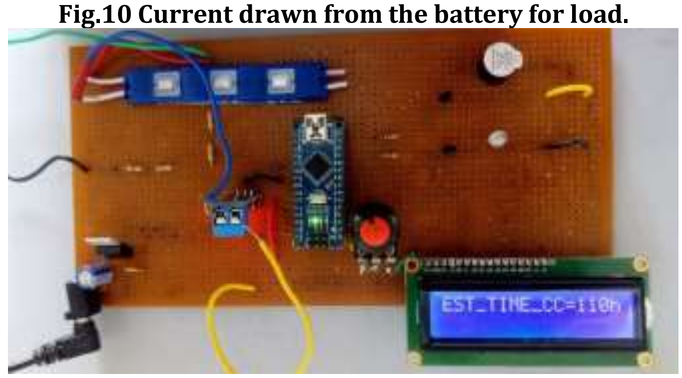

Fig.11 Charge estimation in Battery.

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