

Simulation, PCB and Trainer Kit Designing of Battery Voltage Level Indicator

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ABSTRACT:-

The continuous monitoring of supply voltage is required in applications like motor pumps, inverters. Analog voltmeter is a device used to measure voltage and has disadvantages as it has moving parts and is sensitive to vibrations[1]. Voltage indicator and measuring devices are small installation devices for measuring both direct and alternating voltages. They can be used for different applications like measuring current and temperature. The voltage level of the battery is indicated by the LEDs[2].

A voltage indicator uses a high impedance voltage detection circuit to sense DC voltages. The illumination of the LEDs occur when current passes through these circuits[3]. The amount of current flowing depends on the phase and ground voltages.

Battery level indicator is a project that indicates status of battery by use of LEDs. This circuit mainly uses IC LM3914 which is basically an LED controller IC. Resistors in series with LEDs are not used here because current is regulated by the IC LM3914.

INTRODUCTION:-

In mobile phones, the battery level is displayed in a dot or bar form to show the battery level. A battery level indicator circuit shows the battery level of a device from the number of LEDs that are glowing[4]. It uses ten LEDs. So for an instance, if three LEDs glow, it indicates battery capacity of 30 percent.

Unlike in mobile phones where the battery level indicator function is integrated with other functions, here only one comparator IC LM3914 does it all. The IC LM3914 divides the battery level into ten parts. This IC takes input analog voltage and drives 10 LEDs linearly according to it. In this circuit, there is no need for resistors in series with LEDs because the current is regulated by the IC.

A battery level indicator gives the indication about the battery charging or discharging state. Some batteries have high tolerance limit for overcharging and some may explode after a certain limit of charging[5]. This makes it important to disconnect the battery from charging when it reaches its maximum limit. A battery level indicator gives the visual indication of the battery state and so allows it to disconnect before overcharging and thus protecting the device. On the other hand with the use of battery level indicator, the user is instigated to charge the battery before it dies. Depending upon the state of battery there are two ways to indicate charge level, that are, the state of charge (SOC) method and another is the death of discharge (DOD) method[6]. SOC is the measure of the stored charge in the battery and DOD is the measure of the degree by which battery is getting emptied relative to the total capacity of the battery.

In this project, a battery level indicator is designed using the state of charge method. SOC of the battery can be determined by the voltage level at the terminals of the battery or by measuring the current output of the battery. For sensing the terminal voltage level, LM3914 IC is used. LM3914 is a display driver which can sense the magnitude of the analog voltage and indicate the voltage level by lighting the LEDs. The IC is designed to indicate ten voltage levels respective to a common voltage reference. For voltage indication, either LEDs or bar display can be connected to the IC. The interfacing of the IC can be done for the display of 100 steps. The internal voltage reference of the IC can range between 1.2V and 12V. The IC can allow to draw output current by an LED or bar display from 2mA to 30 mA.

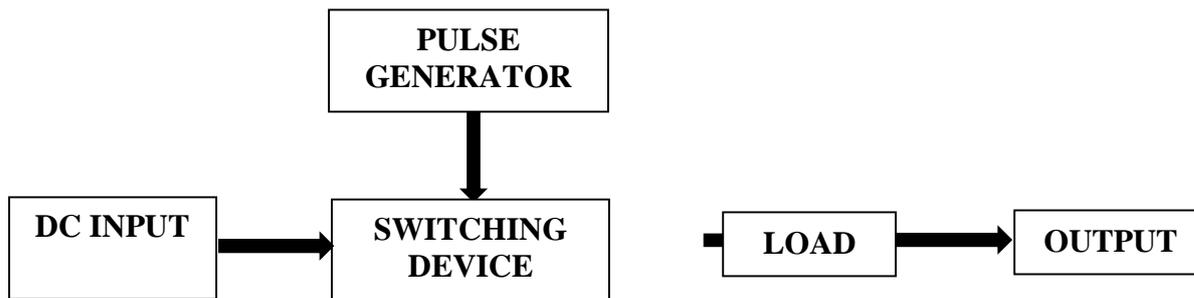
BLOCK DIAGRAM:-

Fig 1: Block diagram of Battery Voltage Level Indicator

IC LM3914 :-

IC LM3914 is the main component of the circuit. LM3914 is a monolithic integrated circuit which means all components are embedded in a single chip. It is a 18 pin IC. It senses the voltage and drives LEDs. LEDs display the voltage level in the form of a bar graph form or dot form. In bar graph form, LEDs light up in an increasing order and continuous form whereas in dot form, only one LED lights up for the corresponding voltage level[7]. For example, in bar display when the battery voltage is at 6.7V then three LEDs will light up and on the other hand, only third LED will light up in dot mode. There is no need for a resistor with LEDs as IC itself controls the LED current.

Arduino:-

Arduino is an open source software and hardware component which designs microcontroller kits for making digital devices and interactive objects that can sense and control objects in the physical and digital world[8]. Arduino boards are able to read inputs like light on a sensor, a finger on a button, or a Twitter message and turn it into an output for activating a motor, turning on an LED, or publishing something online. The board can be used by sending a set of instructions to the microcontroller on the board. The Arduino programming language and the Arduino Software (IDE), based on Processing are used to do so[9]. A program for Arduino hardware may be written in any programming language with compilers that produce binary machine code for the target processor.

Programming done for the working of the project

```

#include <LiquidCrystal.h>
LiquidCrystal lcd(2, 3, 4, 5, 6, 7);
int analogInput = 0;
float vout = 0.0;
float vin = 0.0;
float R1 = 100000.0; // resistance of R1 (100K)
float R2 = 10000.0; // resistance of R2 (10K)
int value = 0;
int a[5] = {};
void setup()
{
  Serial.begin(9600);
  pinMode(analogInput, INPUT);
  lcd.begin(16, 2);
  lcd.setCursor(2, 0);
  lcd.print("DC VOLTMETER");

```

```

lcd.setCursor(0, 1);
lcd.print("GROUP-K");
delay(3000);
lcd.clear();
}
void loop()
{
  lcd.print("DC Voltmeter");
  // read the value at analog input
  value = analogRead(analogInput);
  vout = (value * 5) / 1024.0;
  vin = vout / (R2 / (R1 + R2));
  Serial.println(vin);
  if (vin < 0.09)
  {
    vin = 0.0;
  }
  lcd.setCursor(0, 1);
  lcd.print("Voltage V :");
  lcd.print(vin);
  delay(3000);
  lcd.clear();
}

```

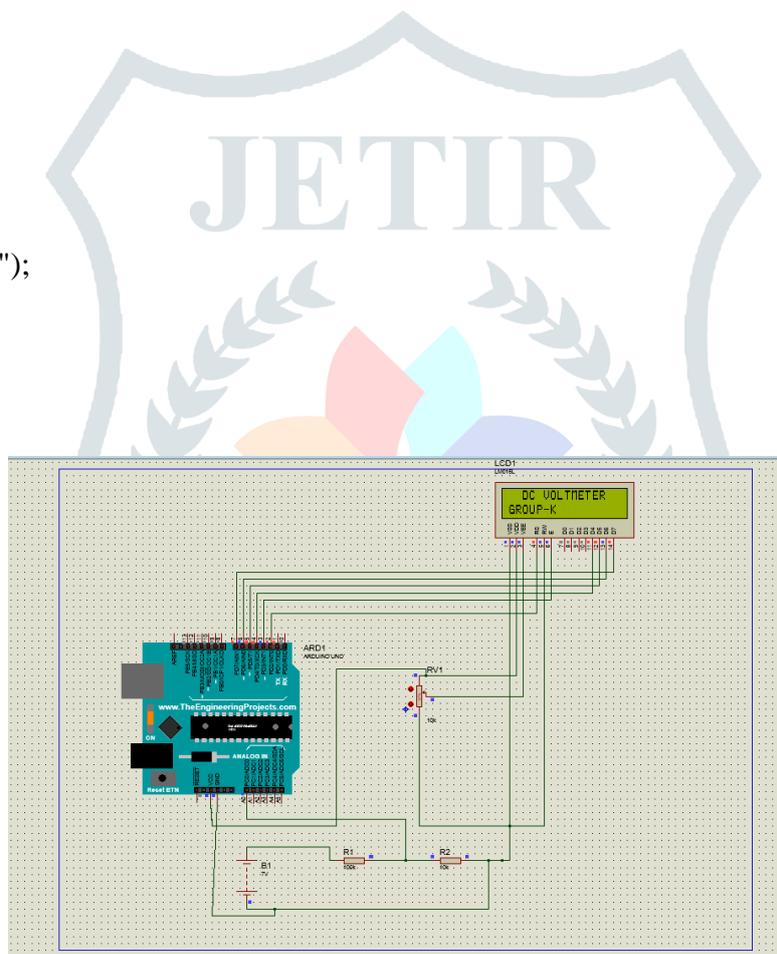


Fig 2: Overview of the Arduino software

Proteus Software

The simulation of the circuit is done on Proteus software. It is a design software developed by Lab center Electronics for electronic circuit simulation, schematic capture and also PCB design. Its design is simple and user friendly which makes it a popular software[10]. Proteus is commonly used for digital simulations such as microcontrollers and microprocessors which can simulate LED, LDR and USB Communication[11]. It also has the ability to simulate the interaction between software running on a microcontroller and any analog or digital electronics connected to it. The specifications of the components used in building the circuit can be varied by the study of the graph generated by this software. It helps in generating accurate results.

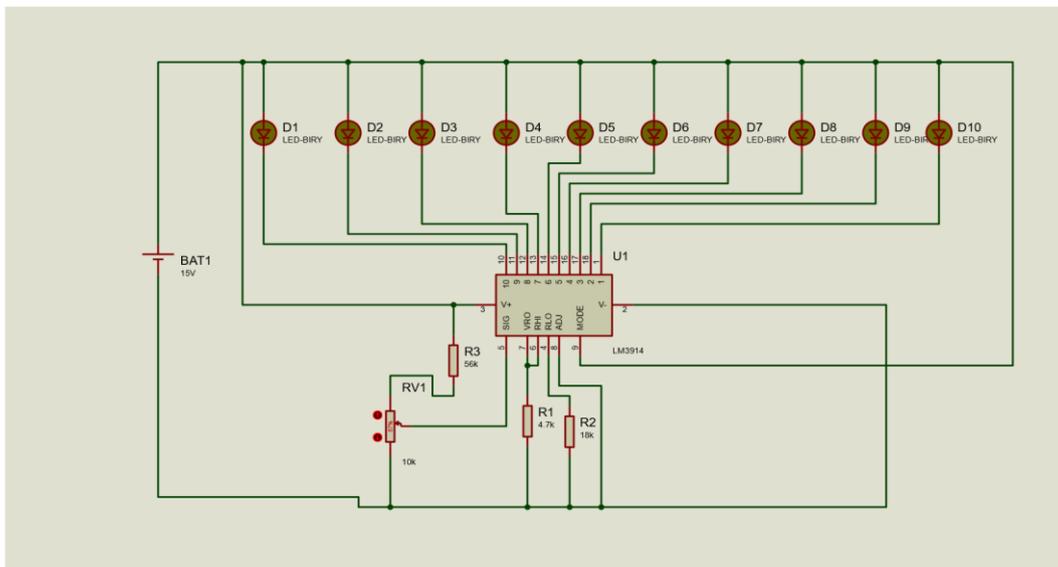


Fig 3: Simulation on the PROTEUS software

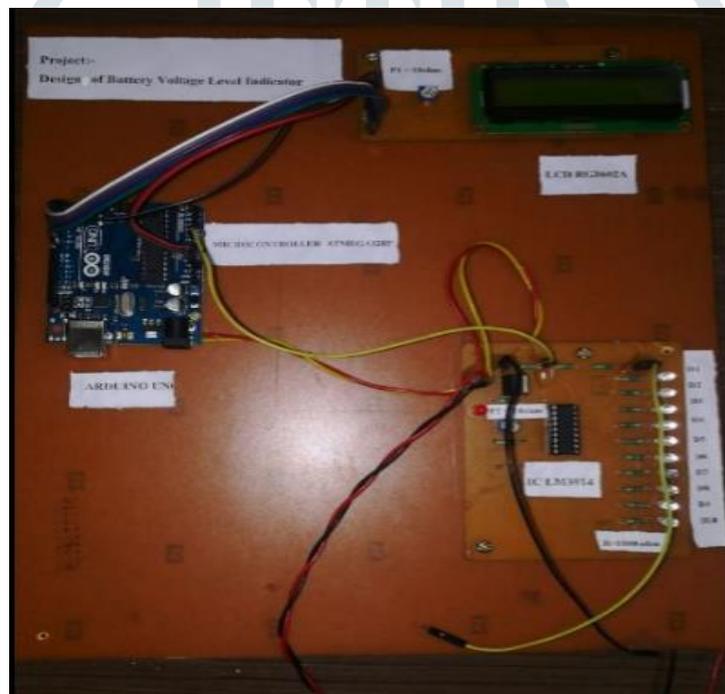


Fig 4: Overview of the hardware of the project

CONCLUSION:-

The aim of the project was to design and build a system that would indicate the rechargeable battery capacity level. During the study on batteries, many recommendations surfaced, which are not only helpful to the users but to the manufacturers as well. The outcome of the project, met the objective target but with room for improvement. The system is expected to help in planning with the batteries to avoid unnecessary malfunction of devices and avoid wastage by throwing away batteries which are still useful. Proper charging through the use of smart chargers and the understanding of how different rates of charging and discharging affect batteries covered in this project is also an important aspect. The results from the project encourage proper use of batteries, improved battery management and conservation of energy with the help of the system. The entire functionality of the circuit is handled by the LM3914 IC. The IC is designed to operate as a battery level indicator which is attached with some additional components to meet the required results.

Future Scope:-

This project has a great scope of future enhancement and implementation. With some modifications and addition of advanced components, it could be used for several different purposes in the future.

The circuit is optimized for monitoring charged 12V battery systems. So it is like an analog voltmeter which continuously measures or monitors the state of the battery and display the result by glowing the LEDs of different colors. The display can be made digital which will further increase the user interface. It will eventually affect the cost. The cost will also increase. If the circuit was designed to monitor the car battery, it will prove to be very handy as we will be able to attach the circuit on the car dash.

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