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BATTERY MANAGEMENT SYSTEM

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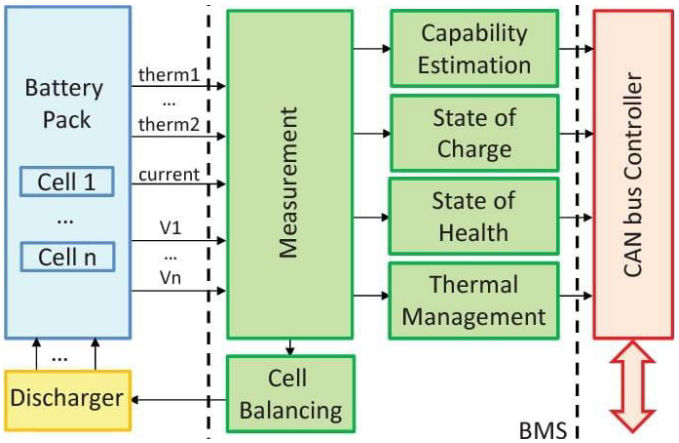
ABSTRACT:

A Battery Management System (BMS), is an electronic regulator that monitors and controls the charging and discharging of rechargeable battery to ensure it operates safely and efficiently. BMS is meant to watch the parameters related to the battery pack and its individual cells, apply the collected data to eliminate risks and optimize the battery performance. The BMS also performs many tasks including the measurement of system Voltage (V), Current (I), Temperature, the cell's state of charge (SOC), state of health (SOH), remaining useful life (RUL) parameters determination, controlling and monitoring the charge / discharge characteristics and cell balancing. For this project, 3 lithium-ion batteries are used to develop battery management for 12V . As lithium-ion battery have high value of specific energy, high energy density, high open circuit voltage, and low self-discharge.

INTRODUCTION:

BMS is an electronic system that manages a chargeable battery to make sure it operate safely and efficiently. BMS is meant to watch the parameters related to the battery pack and its individual cells, apply the collected data to eliminate risks and optimize the battery performance. Lithium -ion batteries are now mega-popular. They have found wide application in portable electronics. But unlike other sorts of batteries, for instance, lead-acid or nickel batteries, lithium-ion batteries are very demanding for the charger parameters. If you don't control the method of charging and discharging of such batteries, they're going to fail soon. The banks can swell and even explode from overcharging, and a deep discharge can explanation for battery failure. The ideal charger for lithium - ion batteries should have a stabilizing unit for voltage and current and also a voltage balancing system for banks. The voltage of the fully charged can of lithium-ion the battery is 4.2Volts. as soon because the bank has reached this voltage, the charging process should stop. We will examine a circuit that will allow charging lithium-ion can connected in series, as well as balancing them in the process of charging.

BLOCK DIAGRAM:



This is the diagram of battery management system (BMS), Primary functions of the BMS:

- Safety for overcharging and over heating
- Performance optimization
- Health monitoring and diagnosis
- Communication

Safety - Battery Management System continuous monitor parameters like temperature, voltage, current in and out of pack to make sure it's being operated in safe conditions the whole time.

Performance Optimization- Lithium-ion batteries perform best when their state of charges (SoC) is maintained between the minimum and maximum charge limits defined within the battery.

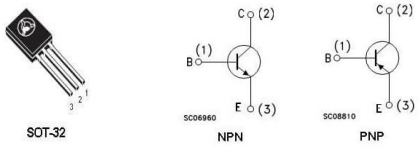
Health Monitoring and diagnosis- The BMS uses the collected data points (temperature, voltage, current, etc.) to estimate the state of charge and state of health (SoH) of the battery pack.

- **SoC-** refers to availability energy within the battery and determines how far the vehicle can go before needed to charge.
- **SoH-** measures the present condition of the battery as compared to its original capacity and indicates the battery suitability for the appliance.

Communication- BMS is liable for communicating with the ECU (Electronic Control Units) within the vehicle. Its relays the required data the parameters to the motors controller to make sure the graceful running of the vehicle.

COMPONENT USED:

- **BD 140 Transistors**

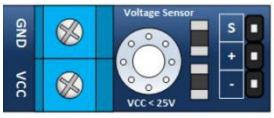


Features-Products are pre-selected in DC current gain
Application- General purpose.
Description- These epitaxial planar transistors are mounted within the SOT-32 plastic package. They are designed for audio amplifiers and drivers utilizing complementary or quasi-complementary circuits. The NPN types are the BD135 and BD139, and therefore the complementary PNP types are the BD136 and BD140.

Electrical Rating-

Symbol	Parameter	Value				Unit
		NPN		PNP		
		BD135	BD139	BD136	BD140	
V_{CBO}	Collector-base voltage (I_E = 0)	45	80	-45	-80	V
V_{CEO}	Collector-emitter voltage (I_B = 0)	45	80	-45	-80	V
V_{EBO}	Emitter-base voltage (I_C = 0)	5		-5		V
I_C	Collector current	1.5		-1.5		A
I_{CM}	Collector peak current	3		-3		A
I_B	Base current	0.5		-0.5		A
P_{TOT}	Total dissipation at T_C £ 25 °C	12.5				W
P_{TOT}	Total dissipation at T_{amb} £ 25 °C	1.25				W
T_{stg}	Storage temperature	-65 to 150				°C
T_j	Max. operating junction temperature	150				°C

- **Voltage Sensor**



Voltage Sensors are used for calculating the voltages of every battery and is displayed on the LCD. Voltage Sensors are interface with controller. Voltage sensors sense the voltage from the battery and this voltage value is displayed on the LCD.

Inputs

- **GND-** This is often where you connect the low side of the voltage you're measuring. Caution: This is often an equivalent electrical point as your Arduino ground.
- **VCC-** The is where you connect the high side of the voltage you're measuring.

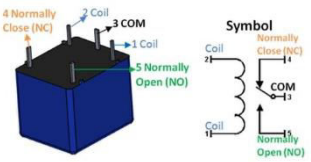
Outputs

- **S**: This connects to your Arduino analog input.
- **- (or minus)-** This connects to your Arduino ground.
- **+ (or plus)-** This is often not connected.

The Connections

- **Relay**

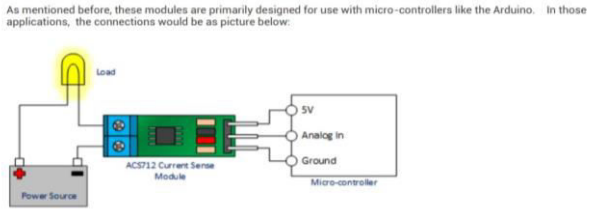
Relay in BMS is used to cut out the system from over temperature and over charging or for safety from draining battery.



- **Current Sensor**

Current sensor sense the current drawn from the battery bank and is displayed on the LCD. If the Voltage get down.

The connection-



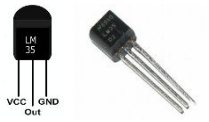
Specifications

Parameters	5A Module	20A Module	30A Module
Supply voltage (VCC)	5Vdc Nominal	5Vdc Nominal	5Vdc Nominal
Measurement Range	-5 to +5A	-20 to +20A	-30 to +30A
Voltage at 0A	VCC/2 (Nominally 2.5Vdc)	VCC/2 (Nominally 2.5Vdc)	VCC/2 (Nominally 2.5Vdc)
Scale Factor	185mV per Amp	100mV per Amp	66mVper Amp
Chip	ACS712ELC-05A	ACS712ELC-10A	ACS712ELC-30A

- **LM35 Temperature Sensor**

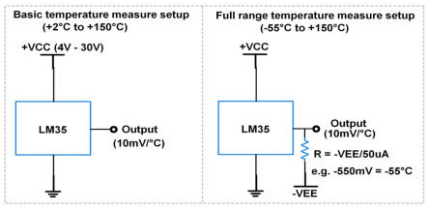
LM35 is a temperature measuring device having an analog output voltage proportional to the temperature. It provides output voltage in Centigrade (Celsius). It does not require any external calibration circuitry. the sensitivity of LM35 is 10 mV / degree Celsius. As temperature increases, output voltage also increases. It is a 3-terminal sensor want to measure surrounding temperature starting from -55 °C to 150 °C. LM35 gives temperature output which is more precise than thermistor output.

Pin description-

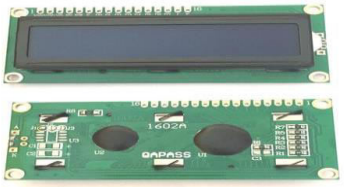


- **VCC-** Supply Voltage(4-30V)
- **Out-** It gives analog output voltage which is proportional to the temperature (in °C).
- **GND-** Ground

Application Setup

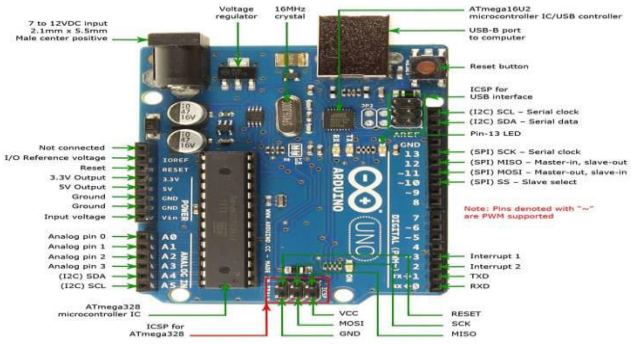


- **16×2 LCD Module**



Operating Voltage is 4.7V to 5.3V. Current consumption is 1mA without backlight. Alphanumeric LCD display module, meaning can display alphabets and numbers. Consists of two rows and every row can print 16 characters. Each character is build by a 5×8 pixel box. Can work on both 8-bit and 4-bit mode. It can also display any custom generated characters Available in Green and Blue Backlight.

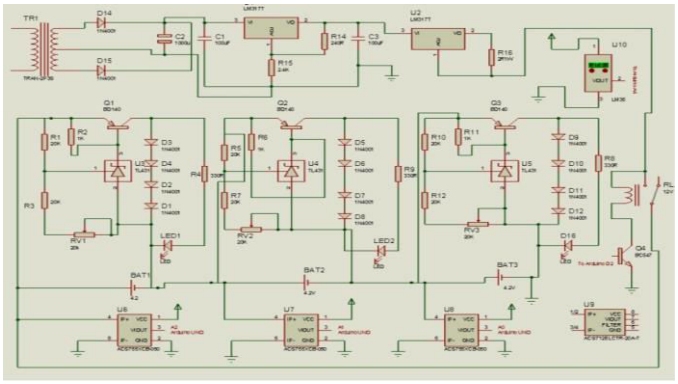
- **Arduino UNO**



ARDUINO UNO is the Controller used for calculating the parameters like voltages, current, temperature, State of charge , State of health of the Lithium - ion batteries. ARDUINO Uno also used for safety of the batteries if the charges of the batteries goes to minimum or maximum size.

SYSTEM DESIGN:

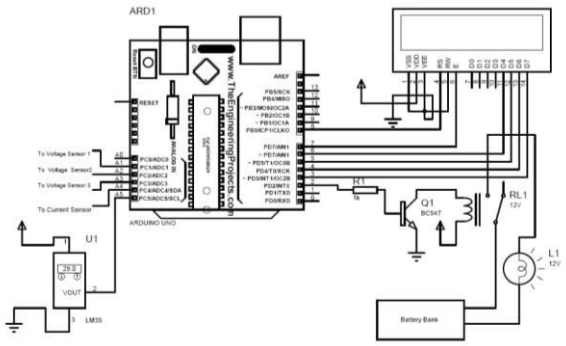
- **System Circuit Diagram**



SYSTEM WORKING

This is our Battery Management System (BMS) board for 3 numbers of Li-ion Batteries connected serial. We've designed Power supply of 12 volt, 1A by using LM317 IC, for charging BMS system. The voltage from the power supply unit is firstly stabilized by the linear stabilizer LM317 and set the voltage for 12 V, and on the second chip the current stabilization process is realized, then comes within the balancing board. The charge current is stabilized and depends on the worth of the resistor R16. There's a ZENER diode which is TL431 which opens when a particular voltage is reached on the battery and extinguishes everything unnecessary. transistor BD140 is employed; at a given voltage an influence transistor is opened. There are diodes within the collector circuit, which is employed to make the equivalent of the load. The board features a tuning resistor to regulate the circuit for the specified cut out voltage. The LED indicator is employed on the collector circuit of the transistor will glow when the transistor is open, it indicating that the charging process is complete. When the voltage of the battery is reached at 4.2 the LED will glow. If the voltage of the battery is below 4.2 LED won't glow that indicates that the battery remains charging. If the voltage of the battery goes below 3.0 volt then it is possibility that battery can be dead. So, we set the cut off voltage at 3.0 volt then battery won't go below 3.0 volt and therefore the battery is continuously charging. To sense voltage of batteries, three voltage sensors are used for every battery.

- **System Arduino UNO Controller Side**



Voltage sensors are connected to the ARDUINO UNO which then displayed the voltage of the battery on display screen (LCD Board). The current sensor reads the current from the battery bank when the load is applied to the system. Current sensor also connected to the ARDUINO UNO which then display the present of the battery on interface of display screen also as on LCD Board. We connected the LED panel as a load to the System. To read the temperature of Battery Bank, sensor LM35 is used. Temperature sensor is about on one among the batteries and connected to the ARDUINO UNO which then displayed the voltage of the battery on interface of display screen also as on LCD Board. If the temperature of the battery is exceeding above 50 degree Centigrade it displays "Over Temperature Indicated" on interface of display screen. We used relay, when Over Temperature is detected then relay stop the charging from power supply. It avoids overheating and explosion of the battery and therefore the system. So, by using these sensors we calculate the various parameters of the Battery and directly displayed on interface of display screen also as on LCD.

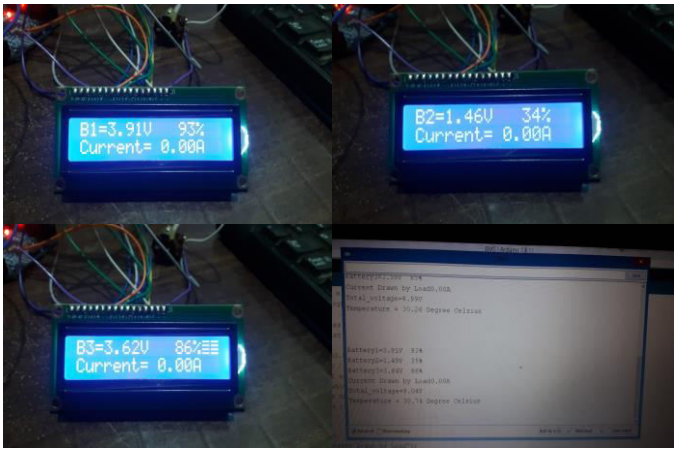
SOFTWARE USED:

- ARDUINO IDE (Integrated Development Environment).
- Proteus Software for circuit schematic.
- Express PCB for PCB circuit design and layout.
- Serial Port display for output results of all parameters.

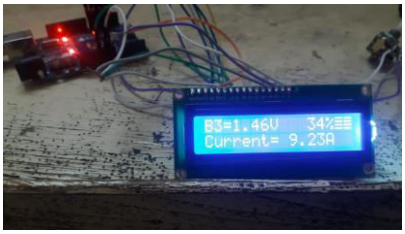
CONCLUSION AND RESULT:

BMS is essential element for the battery to perform inspection, monitoring, control, supervision, balance and diagnostic in order to not just keep the cells secure state but to collect data that have the likelihood evaluate how the battery behave with time.

At No-Load



At Load



On the monitor (LCD Board) and interface display showing all real time status of all the parameters at NO-LOAD and at LOAD CONDITION – voltage, current, temperature, state of charge, state of health of every individual cells. And it's shown that our Battery management system (BMS) works perfectly.

APPLICATIONS OF BMS:

- Electrical Car vehicle charging system.
- Laptop Charging System.
- On board Drone Charging system and warning.
- Vacuum cleaner.
- solar power led.
- Solar / Wind Energy Storage Systems.
- Battery Backup Systems.

ADVANTAGES OF BATTERY MANAGEMENT SYSTEM:

- A **BMS** enhances the lifetime of the battery cells.
- This is an efficient system to live and control the cell's voltage.
- It provides stability and reliability.
- It ensures the security of the battery pack, especially large format **lithium-ion batteries**.
- It controls the temperature.
- It monitors the battery cells constantly to avoid the occurrence of failure or explosion.

FUTURE SCOPE:

- Lamp-post charging
- Electrified roads
- On-Board chargers and charging stations
- Consumer Electronics
- Military and defense
- Medical and Healthcare
- Telecommunication.

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