Puranmal Lahoti Government Polytechnic, Latur

Department of Electrical Engineering

Acadmic Year : 2023-24

CAPSTONE PROJECT PLANNING

Course Code : 22060

Smart EV Battery Management: Hybrid Charging & Robust Protection

Submitted By :

Sr.No.	Name of Student	Enrollment Number	Roll No.
1	Kulkarni Prasad Suresh	2100160231	38
2	Naikwade Shantanu Babruwan	2100160242	42
3	Rajmane Abhijeet Mahalingappa	2100160250	45
4	Suryakar Sanket Satish	2100160263	52
5	Markandey Atharav Vaijanath	2100160269	53
6	Pawar Aaditya Tanaji	2100160271	54
7	Nila kedar Parmeshwar	2100160246	58

Under the Guidance of :
Prof. S.K.Lokare

Puranmal Lahoti Government Polytechnic, Latur

Certificate

This is to certify that the group

1.	Kulkarni Prasad Suresh	2000160231	38
2.	Naikwade Shantanu Babruwan	2100160242	42
3.	Rajmane Abhijeet Mahalingappa	2100160250	45
4.	Suryakar Sanket Satish	2100160261	52
5.	Markendey Atharav Vaijanath	2100160269	53
6.	Pawar Aaditya Tanaji	2100160271	54
7.	Nila kedar Parmeshwar	2200160246	58

Final year student of electrical engineering has submitted a Capstone Project report on

Smart EV Battery Management: Hybrid Charging & Robust Protection

During the academic session 2023-24 in a satisfactory manner in the partial fulfilment for the requirement of Subject : CAPSTONE PROJECT PLANNING for the Diploma in Electrical Engineering

Project Guide
Prof. S. K. Lokare

HOD Electrical Engineering Department
Dr. S. B. Kulkarni

Principle
Prof. V. D. Nitnaware
(Puranmal Lahoti Government Polytechnic, Latur)
2023-24

ACKNOWLEDGEMENT

We offer sincere and hearty thanks with a deep sense of gratitude to our guide Mrs.S.K.LOKARE mam And HOD of department DR. S.B. KULAKARNI sir for their valuable direction and guidance to ours.

Project without taking care of their voluminous work. We are thankful to our principal Prof. V. D. NITNAWARE sir for this encouragement toward our project We also thankful our family and all friends for their support and encouragement toward our Project.

ABSTRACT

The abstract presents an innovative Advanced Battery Management and Hybrid Charging System designed for electric vehicles. This cutting-edge system offers robust protection mechanisms against diverse challenges, including temperature fluctuations, short circuits, high voltage, high current, and overloads. By integrating these features, the technology ensures the safety and efficiency of electric vehicle power management, contributing to the advancement of sustainable and secure transportation solution

Content page

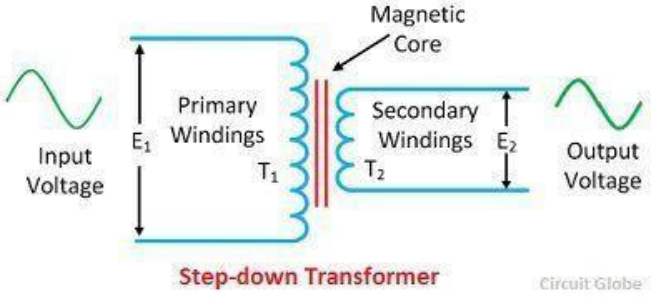
Chapter 1

Introduction

Welcome to the forefront of electric vehicle (EV) innovation, where Smart EV Battery Management takes center stage. In this cutting-edge realm, we delve into the synergy of Hybrid Charging and Robust Protection systems, revolutionizing the way we power and safeguard the next generation of electric vehicles. Join us as we explore the seamless integration of efficiency and resilience in the realm of sustainable mobility.

Step-down transformer

A step-down transformer is a type of transformer that converts the high voltage (HV) and low current from the primary side of the transformer to the low voltage (LV) and high current value on the secondary side of the transformer. The reverse of this is known as a step up transformer.



A transformer is a type of static electrical equipment that transforms electrical energy (from primary side windings) to magnetic energy (in transformer magnetic core) and again to the electrical energy (on the secondary transformer side). A step-down transformer has a wide variety of applications in electrical systems and transmission lines

When it comes to the operation voltage, the step-up transformer application can be roughly divided into two groups: LV (voltages up to 1 kV) and HV application (voltages above 1 kV). Just as transformers can step down the voltage – going from a higher primary side voltage to a lower secondary side voltage – they can also step up the voltage, going from a lower primary side voltage to a higher secondary side voltage. These are known as step-up transformers.

The transformer turns ratio (n) for a step down transformer is approximately proportional to the voltage ratio:

$$\frac{V_s}{V_p} = \frac{N_s}{N_p}$$

V_s = Secondary Voltage
V_p = Primary Voltage
N_s = Number of windings in secondary coil
N_p = Number of windings in primary coil

Where VP,S are voltages, and NP,S are the turns numbers on the primary (LV) and secondary (HV) sides respectively. The primary side of a step-down transformer (HV side) has a larger number of turns than the secondary side (LV side).
That means energy flows from the HV to the LV side. The voltage is stepped down from the primary voltage (input voltage) to the secondary voltage (output voltage).

This equation can be rearranged for the formula for the output voltage (i.e. secondary voltage). This is sometimes referred to as the step down transformer formula:

$$Vs = Ns \times Vp / Np$$

A transformer calculator can help you easily calculate the transformer turns ratio and whether the device is a step down or step up transformer.

The first LV application refers to the transformers in electronic devices. Supplying the electronic circuits requires a low voltage value (e.g. 5V, even lower values nowadays).

A step-down transformer is used to provide this low voltage value which is suitable for electronics supplying. It transforms home voltage (230/120 V) from primary to a low voltage on the secondary side which is used for electronic supplying.

If electronic devices are designed to have higher nominal power, transformers with high operating frequency are used (kHz-s). The transformers with higher nominal power value and 50/60 Hz nominal frequency would be too large and heavy. Also, the daily used battery chargers use the step-down transformer in its design.

Chapter 2

Need of battery management system

A Battery Management System (BMS) is a key factor in the safety of electric vehicles (EVs). It's a specially designed electronic regulator that monitors and controls the electronics of a battery pack or cell.

A BMS is important for a number of reasons, including:

- **Safety**

A BMS protects the user and the battery by ensuring the cell operates within its safe operating parameters. It prevents excessive current flow, which can damage the battery or other components. It also monitors the temperature of the battery to prevent overheating, which can damage the battery or cause a safety hazard.

- **Energy efficiency**

A BMS plays a pivotal role in helping EVs achieve maximum energy efficiency.

- **Battery life**

A BMS controls battery operations within the ideal range by continuously monitoring the SOC, SOH, and other crucial factors. This helps to safeguard against deep discharges and control the charge cycles to reduce capacity loss and deterioration over time.

- **Cell balancing**

A BMS takes charge of cell balancing, ensuring that all cells maintain the same state of charge. This optimization enhances energy storage capacity and extends the battery's overall lifespan.

Rectifier

A Bridge rectifier is an Alternating Current (AC) to Direct Current (DC) converter that rectifies mains AC input to DC output. Bridge Rectifiers are widely used in power supplies that provide necessary DC voltage for the electronic components or devices. They can be constructed with four or more diodes or any other controlled solid- state switches.

Depending on the load current requirements, a proper bridge rectifier is selected. Components‟ ratings and specifications, breakdown voltage, temperature ranges, transient current rating, forward current rating, mounting requirements, and other considerations are taken into account while selecting a rectifier power supply for an appropriate electronic circuit's application.

Design of Rectifier: -

It is a unidirectional device, offers a low resistance to the flow of current in one direction and high resistance to the flow of current in the opposite direction i.e., rectifier converts ac into dc.

Rectifiers are designed using element as a semiconductor diode, which can act as a closed open switch. Some of the rectifier circuits used to convert ac into de are designed in this section.

Constructions: -

The bridge rectifier construction is shown below. This circuit can be designed with four diodes namely D1, D2, D3 & D4 along with a load resistor (RL). The connection of these diodes can be done in a closed-loop pattern to convert the AC (alternating current) to DC (Direct Current) efficiently. The main benefit of this design is the lack of an exclusive center-tapped transformer. So, the size, as well as cost, will be reduced.

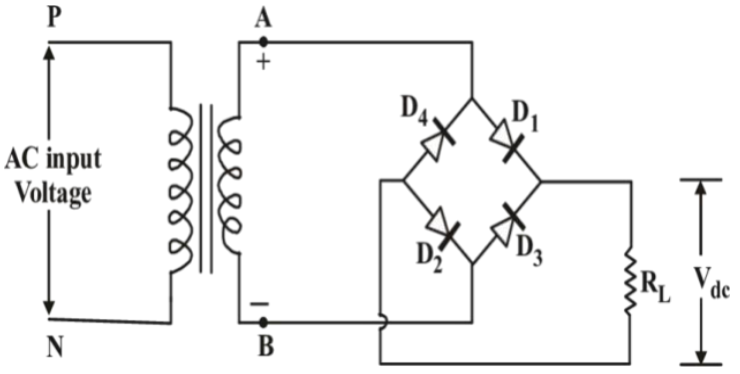
Once the input signal is applied across the two terminals like A & B then the o/p DC signal can be attained across the RL. Here load resistor is connected in between two terminals like C & D. The arrangement of two diodes can be made in such a way that the electricity will be conducted by two diodes throughout every half cycle. The pairs of diodes like D1& D3 will conduct electric current throughout the positive half cycle. Similarly, D2 & D4 diodes will conduct electric current throughout a negative half cycle.

- **Bridge Rectifier :- [rectifier used]**

The main advantage of the bridge rectifier is that it produces almost double the output voltage as with the case of a full-wave rectifier using a center-tapped transformer. But this circuit doesn't need a center-tapped transformer so it resembles low-cost rectifier.

The bridge rectifier circuit diagram consists of various stages of devices like a transformer, Diode Bridge, filtering, and regulators. Generally, all these blocks combination is called a regulated DC power supply that powers various electronic appliances.

The first stage of the circuit is a transformer which is a step-down type that changes the amplitude of the input voltage. Most of the electronic projects use a 230/12V transformer to step-down n the AC mains 230V to 12V AC supply.



The next stage is a diode-bridge rectifier which uses four or more diodes depending on the type of bridge rectifier. Choosing a particular diode or any other switching device for a corresponding rectifier needs some considerations of the device like Peak Inverse Voltage (PIV), forward current If, voltage ratings, etc.

It is responsible for producing unidirectional or DC current at the load by conducting a set of diodes for every half cycle of the input signal. Since the output after the diode bridge rectifiers is of pulsating nature, and for producing it as a pure DC, filtering is necessary.

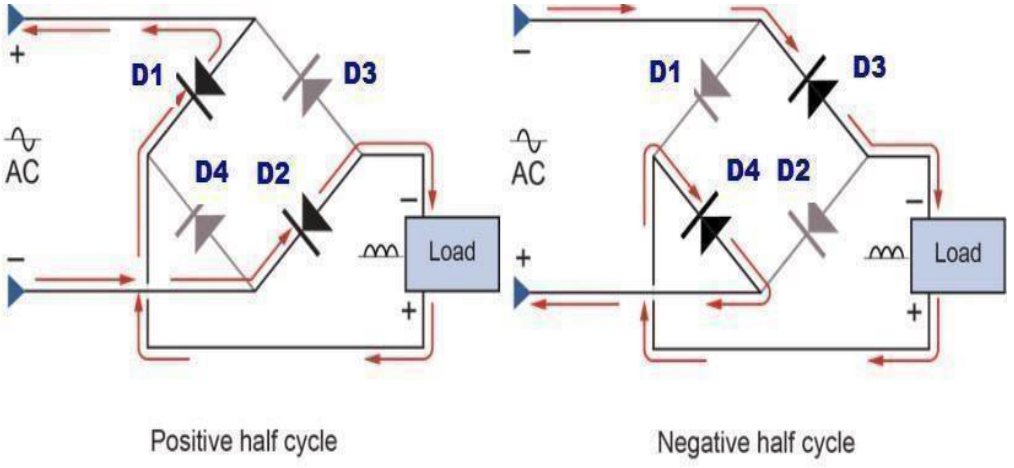
Filtering is normally performed with one or more capacitors attached across the load, as you can observe in the below figure wherein smoothing of the wave is performed. This capacitor rating also depends on the output voltage.

The last stage of this regulated DC supply is a voltage regulator that maintains the output voltage to a constant level. Suppose the microcontroller works at 5V DC, but the output after the bridge rectifier is around 16V, so to reduce this voltage, and to maintain a constant level – no matter voltage changes in the input side – a voltage regulator is necessary

Bridge Rectifier Operation: -

As we discussed above, a single-phase bridge rectifier consists of four diodes and this configuration is connected across the load. For understanding the bridge rectifier's working principle, we have to consider the below circuit for demonstration purposes.

During the Positive half cycle of the input AC waveform diodes, D1 and D2 are forward biased and D3 and D4 are reverse biased. When the voltage, more than the threshold level of the diodes D1 and D2, starts conducting – the load current starts flowing through it, as shown in the path of the red line in the diagram below.



During the negative half cycle of the input AC waveform, the diodes D3 and D4 are forward biased, and D1 and D2 are reverse biased. Load current starts flowing through the D3 and D4 diodes when these diodes start conducting as shown in the figure.

We can observe that in both cases, the load current direction is the same, i.e., up to down as shown in the figure – so unidirectional, which means DC current. Thus, by the usage of a bridge rectifier, the input AC current is converted into a DC current.

The output at the load with this bridge wave rectifier is pulsating in nature, but producing a pure DC requires an additional filter like a capacitor. The same operation is applicable for different bridge rectifiers, but in the case of controlled rectifiers thyristors triggering is necessary to drive the current to load.

To convert 12V AC to 12V DC using a bridge wave rectifier:

1. Bridge Rectifier: Typically four diodes in a bridge configuration, like 1N400X series.
2. Transformer: Steps down AC voltage to around 12V.
3. Filter Capacitor: Smoothens DC output.
4. Load: Device powered by 12V DC.

Advantage of bridge rectifier: -

- The efficiency of the bridge rectifier is higher than the efficiency of a half-wave rectifier.
- The DC output signal of the bridge rectifier is smoother than the output DC signal of a half-wave rectifier.
- In a half-wave rectifier, only half of the input AC signal is used, and the other half is blocked.

Application of Bridge Rectifier: -

- **Power rectification**: Half wave rectifier is used along with a transformer for power rectification as powering equipment
- **Signal demodulation**: Half wave rectifiers are used for demodulating the AM signals.
- **Signal demodulation**: Half wave rectifiers are used for demodulating the AM signals.

Chapter 3

Filter: -

- Filter are the circuit which removes AC component of rectifier output but allow DC component to reach the load.

- The output of rectifier is pulsating DC i.e., DC consisting of small part of AC This undesirable AC component is removed by filter circuit. It produces DC used in electronic circuit. Above fig. show the diagram of filter.

- There are three types of filter circuit
  1) Capacitor filter
  2) Choke input filter
  3) π filter or capacitor input filter

Capacitor filter

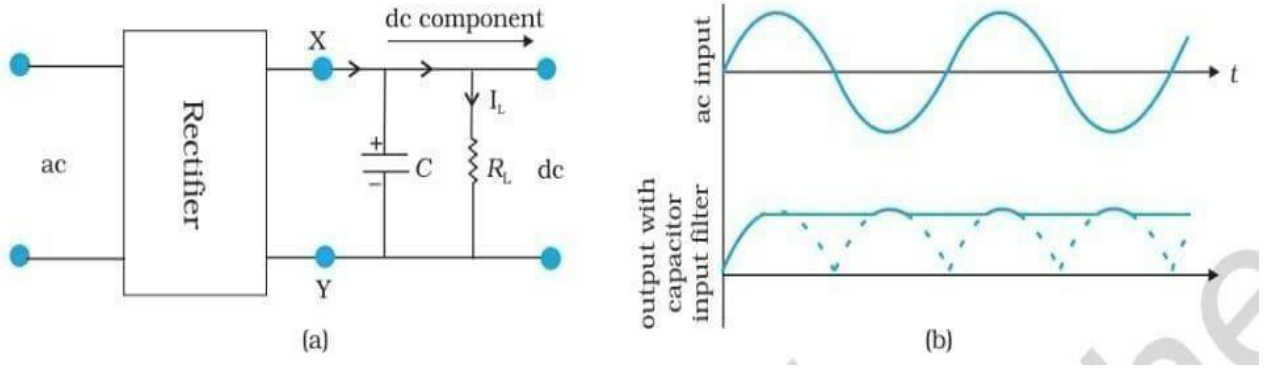


Fig. shows the capacitor filter circuit. It consists of capacitor (c) less across rectifier in parallel with RL. The rectifier output is pulsating DC

At first capacitor start to charges and charges the peak valve of rectifier voltage. At the end of the capacitor start to discharges through load and output voltage will decreases only slightly because immediately next voltage peak comes and capacitor again charges. Thus, at the output very little ripple is present. So that output is nearly pure DC as shown in above fig. (b)

capacitor-input filter is a filter circuit in which the first element is a capacitor connected in parallel with the output of the rectifier in a linear power supply. The capacitor increases the DC voltage and decreases the ripple voltage components of the output.
It is extremely popular because of low cost, small size. little weight and output characteristics and are commonly used in transistor radio battery, eliminator. Ex: - The used capacitor filter has the rating of 1000uf /25v

Operation of capacitor filter: -

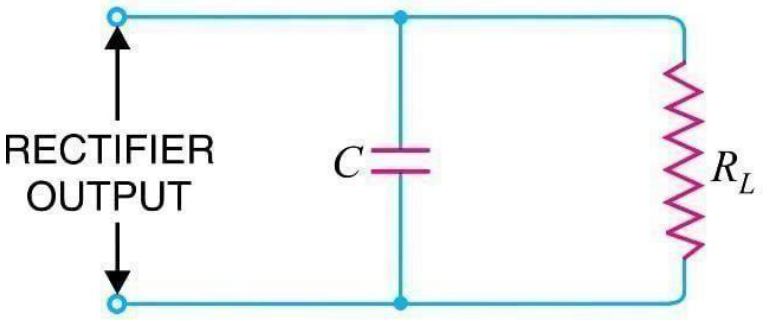
During the time the rectifier is conducting and the potential is higher than the charge across the capacitor, the capacitor will store energy from the transformer; when the output of the rectifier falls below the charge on the capacitor, the capacitor will discharge energy into the circuit. Since the rectifier conducts current only in the forward direction, any energy discharged by the capacitor will flow into the load. This results in output of a DC voltage upon which is superimposed a waveform referred to as a saw tooth wave. The saw tooth wave is a convenient linear approximation to the actual waveform, which is exponential for both charge and discharge. The crests of the saw tooth waves will be more rounded when the DC resistance of the transformer secondary is higher.

Difference of ripple factor: -

Ripple: - AC present in DC is called ripple.

Ripple factor: -It is the ratio of RMS value of AC component to the DC component in the rectifier output.

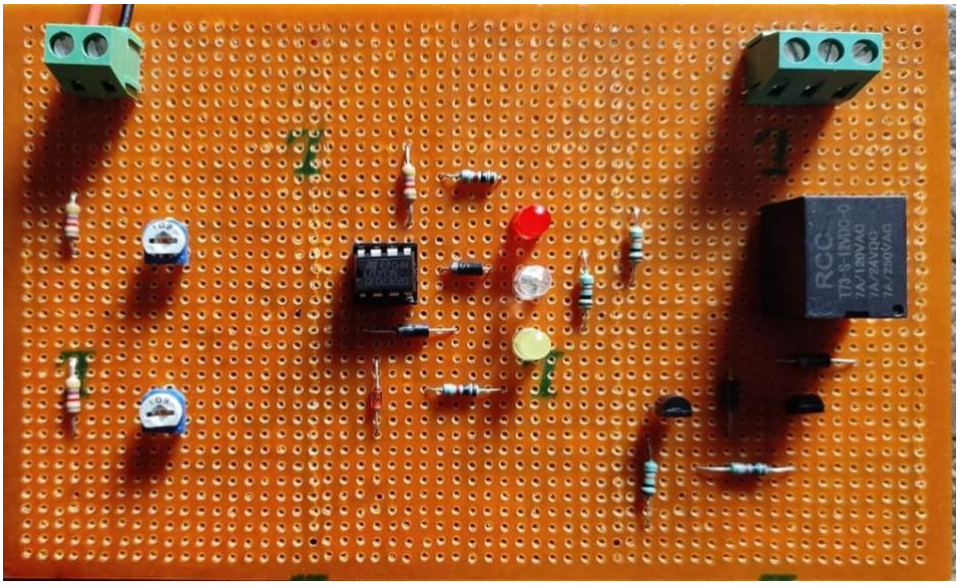
Design of capacitor filter: -

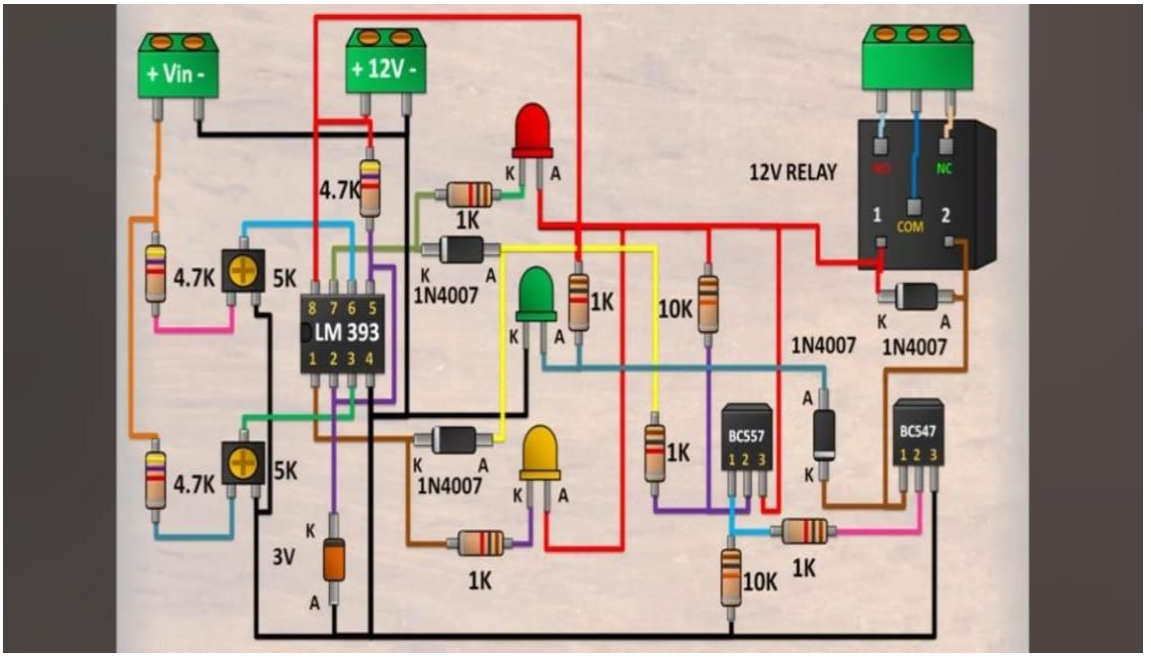


Chapter 4

Protection modules : -

- **Over voltage and low voltage module**





Description :

The aim of this kit is to develop a low voltage and high voltage tripping mechanism to protect the load from damage. The fluctuation in AC mains supply is frequent Sensitive electronic devices in these conditions can get easily damaged. It is preferable to have a tripping mechanism to protect the load.

This Over voltage/under voltage electrical appliance protector system will trip the load in the event of the input voltage falling below/above a set value. Two comparators are used as window comparators formed out of one quad comparator IC. This delivers an error output if the input voltage to them crosses the range beyond the voltage window. A relay is then operated to cut off the load for safety reasons.

Specifications –

Operating temperature -10 to130°C
7A/12v DC
7A/125vA

- **Lithium-ion Battery**

A LIB is an electrochemical device that stores/delivers electrical energy through a reversible intercalation reaction in which Li+ ions are shuttled between two dissimilar electrode materials separated by the Li+ ion conducting electrolyte solution. From: Journal of Power Sources, 2021.

- **Why lithium-ion battery?**

Lithium-ion batteries have several advantages over lead-acid batteries, including:

- **Charging time**

Lithium-ion batteries can charge faster than lead-acid batteries, which can take more than 10 hours to charge. Depending on the size of the battery, lithium-ion batteries can take as little as a few minutes to charge.

- **Efficiency**

Lithium-ion batteries are typically 95% efficient, while lead-acid batteries are only 80-85% efficient. This means lithium-ion batteries charge faster and have a more effective battery capacity.

- **life**

Lithium-ion batteries have a ten time longer cycle life than lead-acid batteries. This means lithium-ion batteries cost less per cycle and need to be replaced less often.

- **Eco-friendliness**

Lithium-ion batteries contain fewer toxic heavy metals than lead-acid batteries.

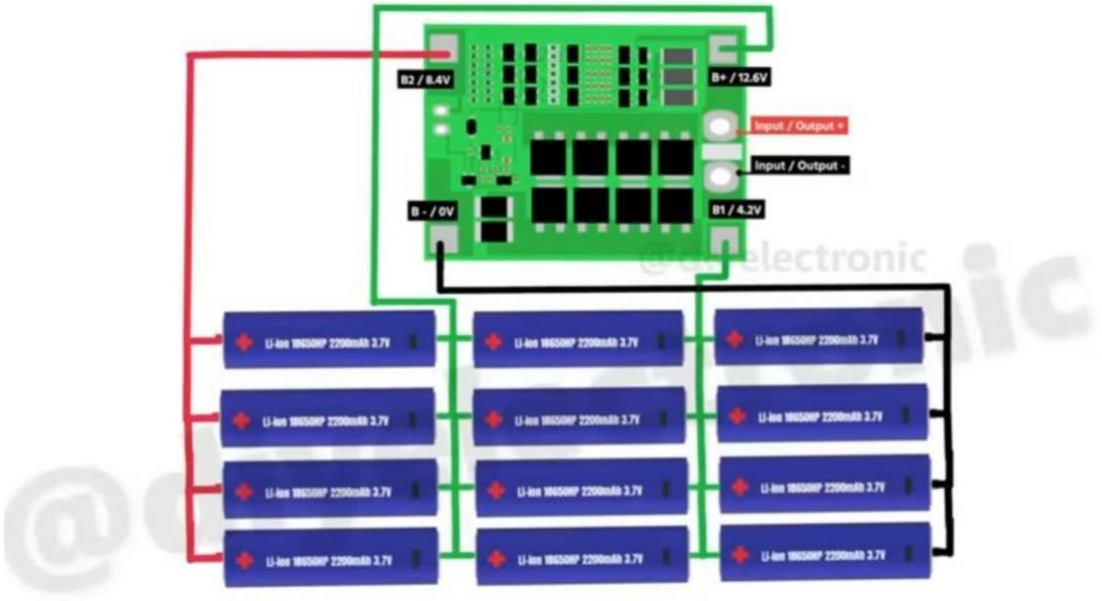
- **Maintenance**

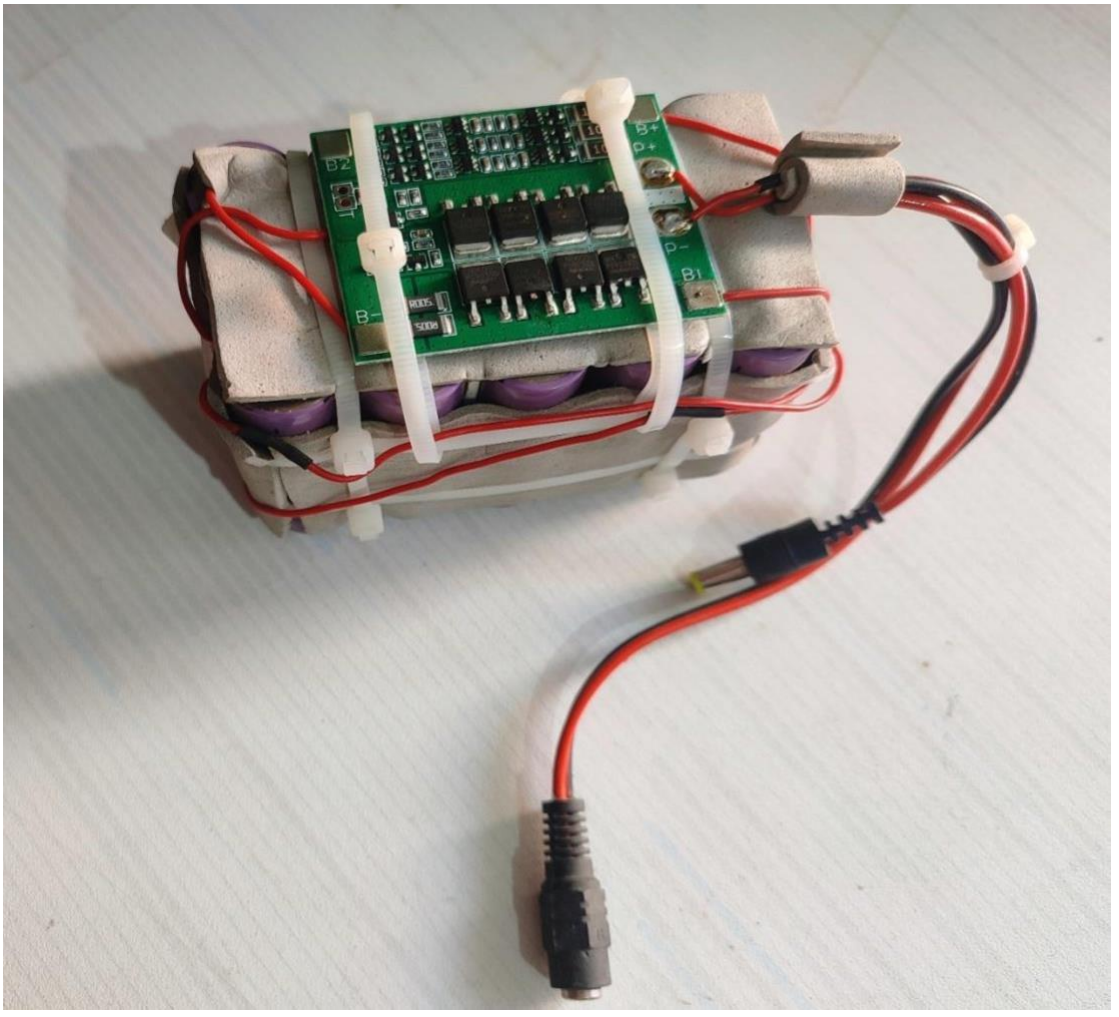
Lithium-ion batteries are low maintenance and have a low self-discharge rate

- **Infrastructure cost**

Lead-acid batteries release gas while charging, so they must be charged in a dedicated area. This requires additional space and incurs the cost of gas disposal.

- **Schematic diagram of 12v lithium ion battery pack**





Battery pack with BMS [Battery management system]

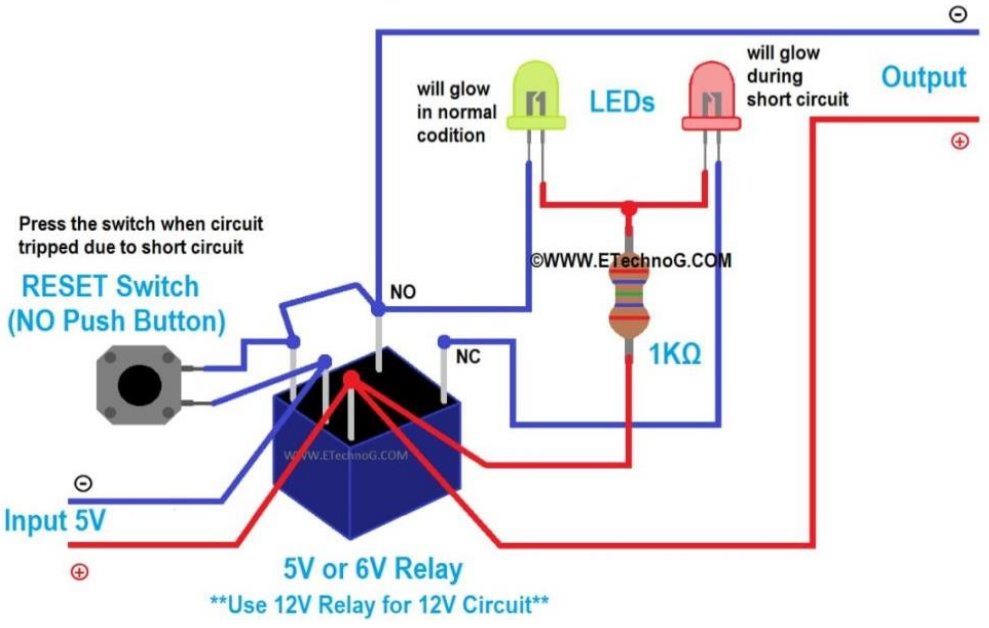
- **Short circuit and overload protection circuit :-**

We are going to see the circuit diagram for a simple homemade Overload Protection and Short Circuit Protection system. You can use this circuit with a 6V DC or 12V DC power supply. This circuit is best suitable for use with batteries. Overload and Short circuits can result in overheating, venting, sparks, explosions, or fires of the batteries. So this circuit will work as a safeguard for your batteries.

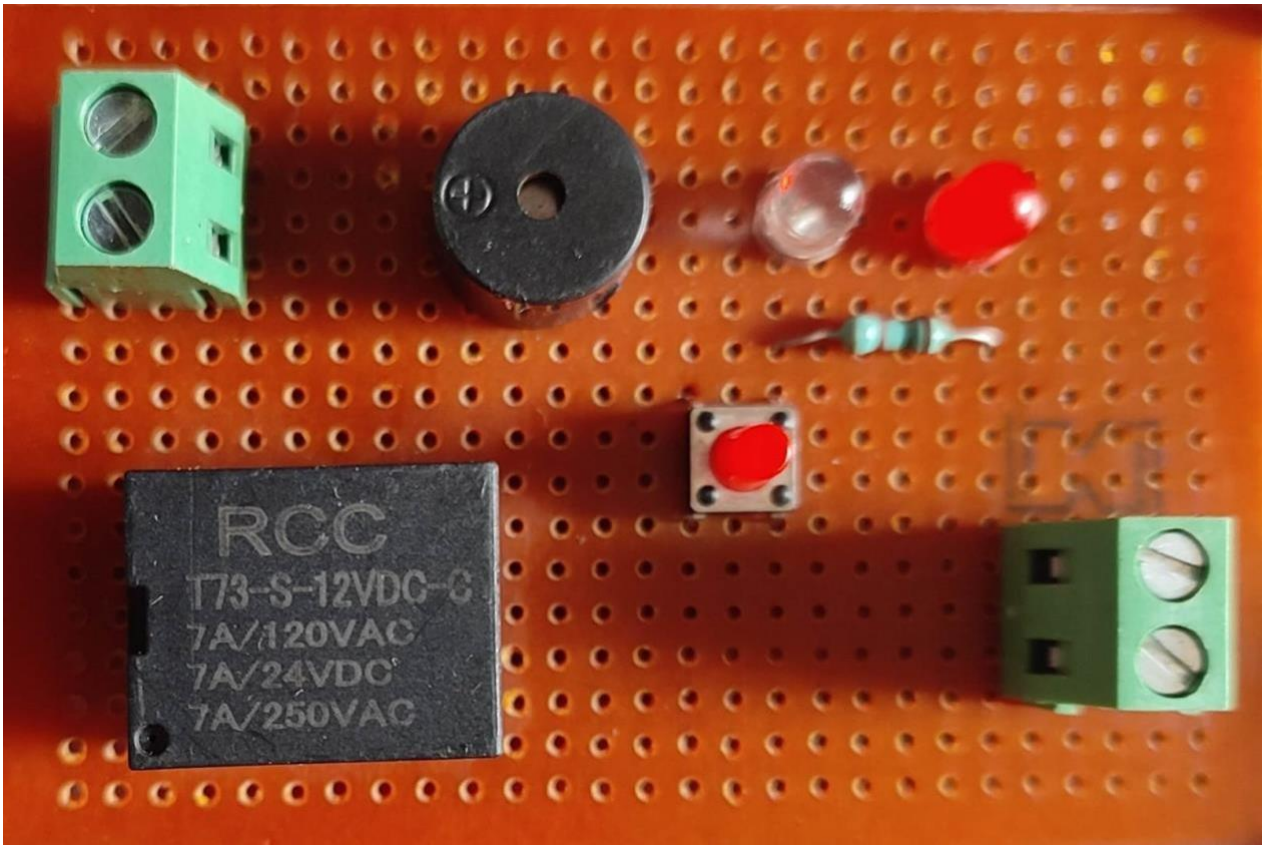
Basically, we have built this circuit using a Relay with some components. Overload and short circuit protection circuits using relays can be used in various applications to ensure the safety and proper functioning of electrical systems.

For example, in vehicles, these circuits can be used to protect various electrical components, such as headlights, windshield wipers, and power windows, from overload or short-circuit conditions. This prevents damage to both the vehicle's electrical system and the components themselves. For small solar power systems or off-grid setups, where 6V to 12V batteries are commonly used, protection circuits with relays can prevent damage due to overload or short circuit events caused by varying sunlight conditions or system malfunctions. Devices such as audio amplifiers, small motors, and lighting systems that operate within the 6V to 12V range can benefit from these protection circuits.

Figure.01: Simple Short Circuit Protection Circuit Diagram



- **Circuit diagram and actual circuit**



Operation and Working Principle :-

First of all, connect the load to the output terminals. Now, when you connect the power source to the input the

Red led will glow and the load will not get any power supply. In this case, you have to press the Reset Switch. Once you press the Reset Switch the green LED will turn On and the load will get the power supply. Now, if there is any short circuit happening at the output or load side the Red Light will be turned ON and the load will be disconnected from the power supply. After removing the short circuit, again you need to press the Reset switch to work the circuit again.

The working principle of this circuit is very simple. Actually, the relay coil is connected in series between the Power source and load. So when the short circuit fault occurs, a high current flow through the relay coil, and it gets energized. Once the relay coil energies it changes its contacts that interrupt the current flow between the Power source and the load. Thus the power source got protected from the short circuit fault.

Connection Procedure :-

1. The positive terminal of the power source is to be connected to the coil 2 terminal of the relay coil and the same is used as the positive output terminal.
2. The negative terminal of the power source is to be connected to the common terminal of the relay.
3. The push button switch should be connected between the common terminal and the coil 1 terminal of the Relay Coil
4. Also, connect this coil 1 terminal to the NO terminal.
5. Now connect the positive terminal of both LEDS and finally connect to the positive terminal of the power Source or the coil 2 terminal of the relay in series with a 1 Kilo-ohm resistor.
6. Connect the negative terminal of the Green LED to the NO terminal and connect the negative terminal of The Red LED to the NC terminal.
7. Also, use the NC terminal as the negative out.

- **Alcohol Sensor Module – MQ3**

Overview:

This module is made using Alcohol Gas Sensor MQ3. It is a low cost semiconductor sensor which can detect the presence of alcohol gases at concentrations from 0.05 mg/L to 10 mg/L. The sensitive material used for this sensor is SnO2, whose conductivity is lower in clean air. Its conductivity increases as the concentration of alcohol gases increases. It has high sensitivity to alcohol and has a good resistance to disturbances due to smoke, vapor and gasoline. This module provides both digital and analog outputs. MQ3 alcohol sensor module can be easily interfaced with Microcontrollers, Arduino Boards and Raspberry Pi etc.

➢ TECHINAL SPECATION :

1. Concentration – 0.05 mg/L ~ 10 mg/L Alcohol
2. Operating Voltage – 5V ±0.1
3. Current Consumption – 150mA
4. Operation Temperature : -10°C ~ 70°C

➢ PIN OUT:

1. VCC – Input Power Supply
2. GND – Supply Ground
3. DO – Digital Output
4. AO – Analog Output

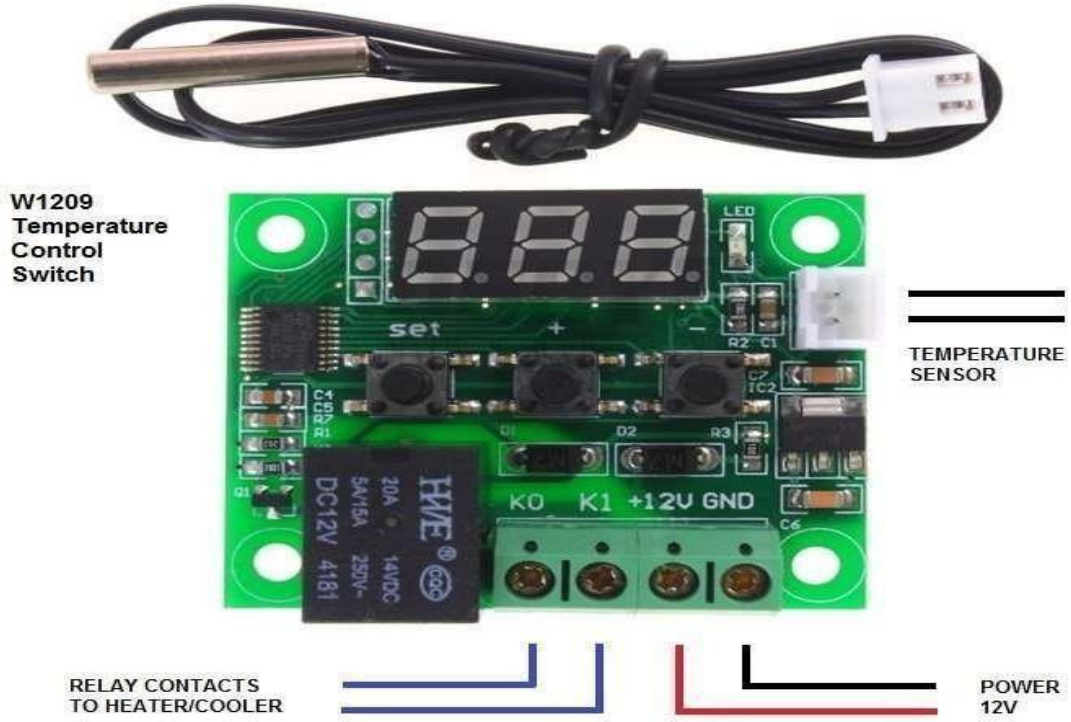
➢ APPLICATION:

1. Vehicle Alcohol Detector
2. Portable Alcohol Detector

➢ Key Features:

1. 5V operation
2. Simple to use
3. LEDs for output and power
4. Output sensitivity adjustable
5. Analog output 0V to 5V
6. Digital output 0V or 5V
7. Low Cost
8. Fast Response
9. Stable and Long Life
10. Good Sensitivity to Alcohol Gas
11. Both Digital and Analog Outputs
12. On-board LED Indicator

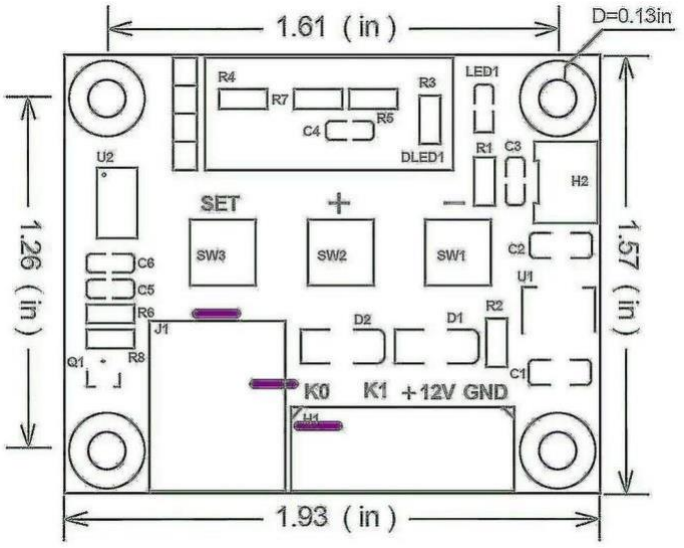
- **W1209 Temperature Control Switch**



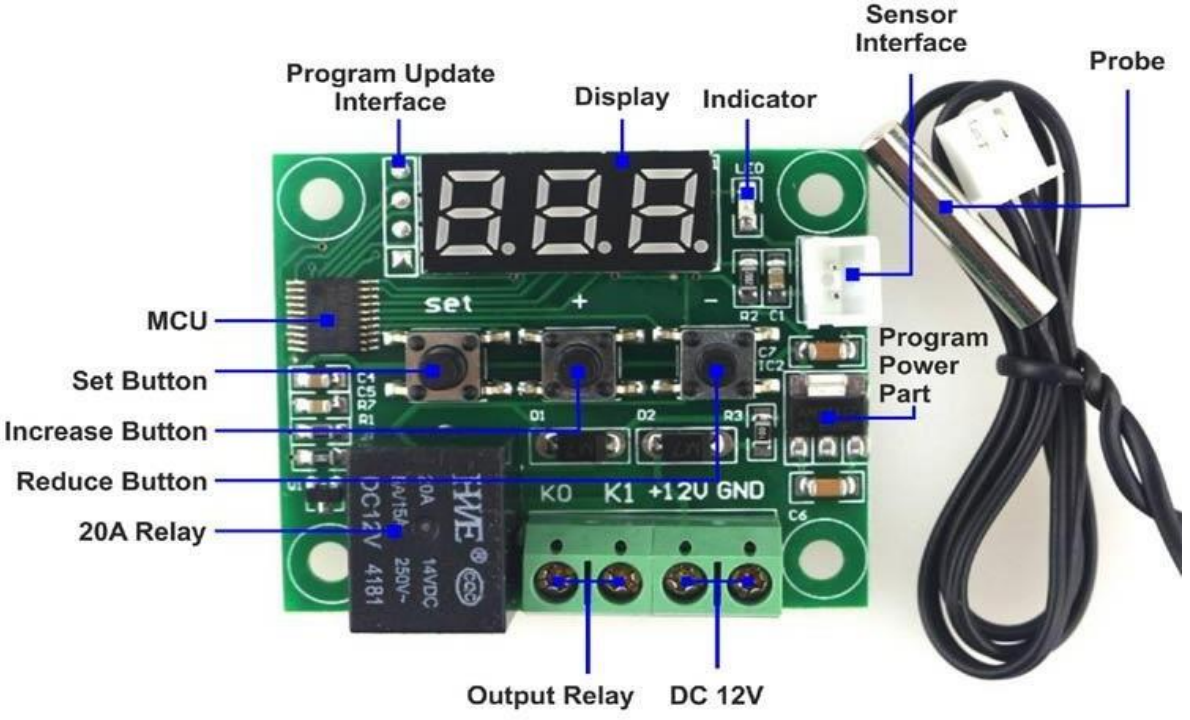
DESCRIPTION:

The W1209 is an incredibly low cost yet highly functional thermostat controller. With this module you can intelligently control power to most types of electrical device based on the temperature sensed by the included high accuracy NTC temperature sensor. Although this module has an embedded microcontroller no programming knowledge is required. 3 tactile switches allow for configuring various parameters including on & off trigger temperatures. The on board relay can switch up to a maximum of 240V AC at 5A or 14V DC at 10A. The current temperature is displayed in degrees Centigrade via its 3 digit seven segment display and the current relay state by an on board LED.

Size chart is as follows-



Following figure shows the various components used in this circuit.



SPECIFICATION:

Temperature Control Range: -50 ~ 110 C Resolution at -9.9 to 99.9: 0.1 C
Resolution at all other temperatures: 1 C Measurement Accuracy: 0.1 C
Control Accuracy: 0.1 C Refresh Rate: 0.5 Seconds Input Power (DC): 12V
Measuring Inputs: NTC (10K 0.5%) Waterproof Sensor: 0.5M
Output: 1 Channel Relay Output, Capacity: 10A
Power Consumption Static Current: <=35mA Current: <=65mA
Environmental Requirements
Temperature: -10 ~ 60 C
Humidity: 20-85%
Dimensions 48mm x 40mm x 14mm

Settings Chart

Long press the "SET" button to activate the menu.
Code Description Range Default Value P0 Heat C/H C
P1 Backlash Set 0.1-15 2
P2 Upper Limit 110 110
P3 Lower Limit -50 -50
P4 Correction -7.0 ~ 7.0 0
P5 Delay Start Time 0-10 mins 0
P6 High Temperature Alarm 0-110 OFF
Long pressing +- will reset all values to their default

Displaying the current temperature:

The thermostat will display the current temperature in oC by default. When in any other mode making no input for approximately 5 seconds will cause the thermostat to return to this default display.

Setting the trigger temperature:

To set the trigger temperature press the button marked 'SET'. The seven segment display will flash. You can now set a trigger temperature (in oC) using the '+' and '-' buttons in 0.1 degree increments. If no buttons are pressed for approximately 2 seconds the trigger temperature will be stored and the display will return back to the current temperature.

Setting the parameters:
To set any parameter first long press the 'SET' button for at least 5 seconds. The seven segment display should now display 'P0'. This represents parameter P0. Pressing the '+' or '-' buttons will cycle though the various parameters (P0 to P6). Pressing the 'SET' button whilst any of there parameters are displayed will allow you to change the value for that parameter using the '+' and '-' buttons (see below). When finished setting a parameter press the set button to exit that option. If no buttons are pressed for approximately 5 seconds the thermostat will exit the parameter options and will return back to the default temperature display.

Setting the cooling or heating parameter P0:
The parameter P0 has two settings, C and H. When set to C (default) the relay will energize when the temperature is reached. Use this setting if connecting to an air-conditioning system. When set to H the relay will de-energize when the temperature is reached. Use this setting if controlling a heating device.

Setting the hysteresis parameter P1:
This sets how much change in temperature must occur before the relay will change state. For example if set to the default 2oC and the trigger temperature has been set to 25oC, it will not de-energize until the temperature falls back below 23oC. Setting this hysteresis helps stop the thermostat from continually triggering when the temperature drifts around the trip temperature.

Setting the upper limit of the thermostat parameter P2:
This parameter limits the maximum trigger temperature that can be set. It can be used as a safety to stop an excessively high trigger temperature from accidentally being set by the user.

Setting the lower limit of the thermostat parameter P3:
This parameter limits the minimum trigger temperature that can be set. It can be used as a safety to stop an excessively low trigger temperature from accidentally being set by the user.

Setting temperature offset correction parameter P4:
Should you find there is a difference between the displayed temperature and the actual temperature (for instance if the temperature probe is on a long run of cable) you can make minor corrections to the temperature reading with this parameter.

Setting the trigger delay parameter P5:

This parameter allows for delaying switching of the relay when the trigger temperature has be reached. The parameter can be set in one minute increments up to a maximum of 10 minutes.

Setting the high temperature alarm parameter P6:

Setting a value for this parameter will cause the relay to switch off when the temperature reaches this setting. The seven segment display will also show '---' to indicate an alarm condition. The relay will not re-energize until the temperature falls below this value. The default setting is OFF.

- **Charger Control Module Model: XH-M603 –**

Description:

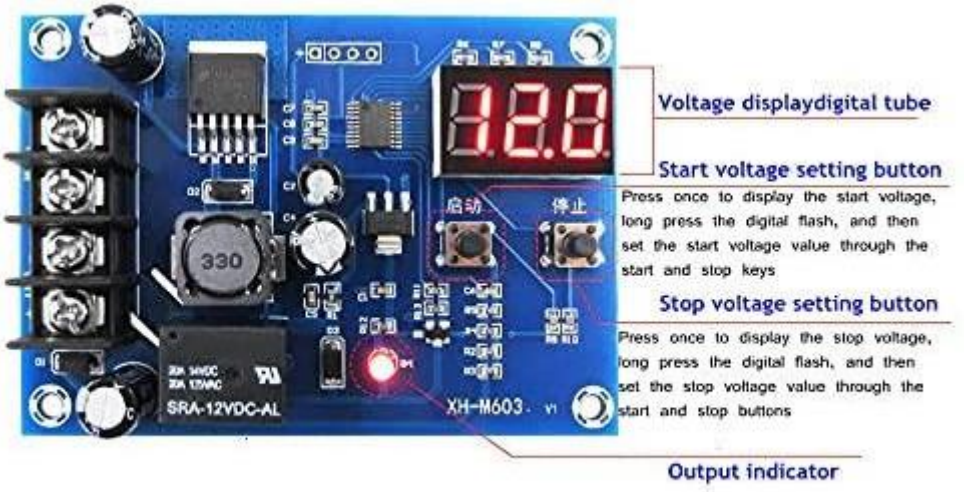
This product is suitable for 6-60V battery charge control, can be set free to start charging voltage and stop charging voltage! In the EN input charger 660V voltage, in the battery terminal, for example, set 12V start 15V stop when the voltage is less than 12V when the relay is closed to the charger charging Voltage to the battery, when the voltage Charging is greater than 15V Relay off to stop charging, can be Used in household chargers, solar, Wind turbines.

The XH-M603 is a battery charge controller module that works with storage batteries that have a voltage range of 12-24V. It can work with various types of batteries

Specification:-

a. Input voltage: DC 10-30V
b. Control current: 20A (Max)
c. Output type: Direct output
d. Voltage reading accuracy: ± 0.1V
e. Dimensions: 55 x 82 mm/2.1 x 3.2 in
f. Display precision: 0.1V
g. Control precision: 0.1V
h. Voltage tolerance: ±0.1V

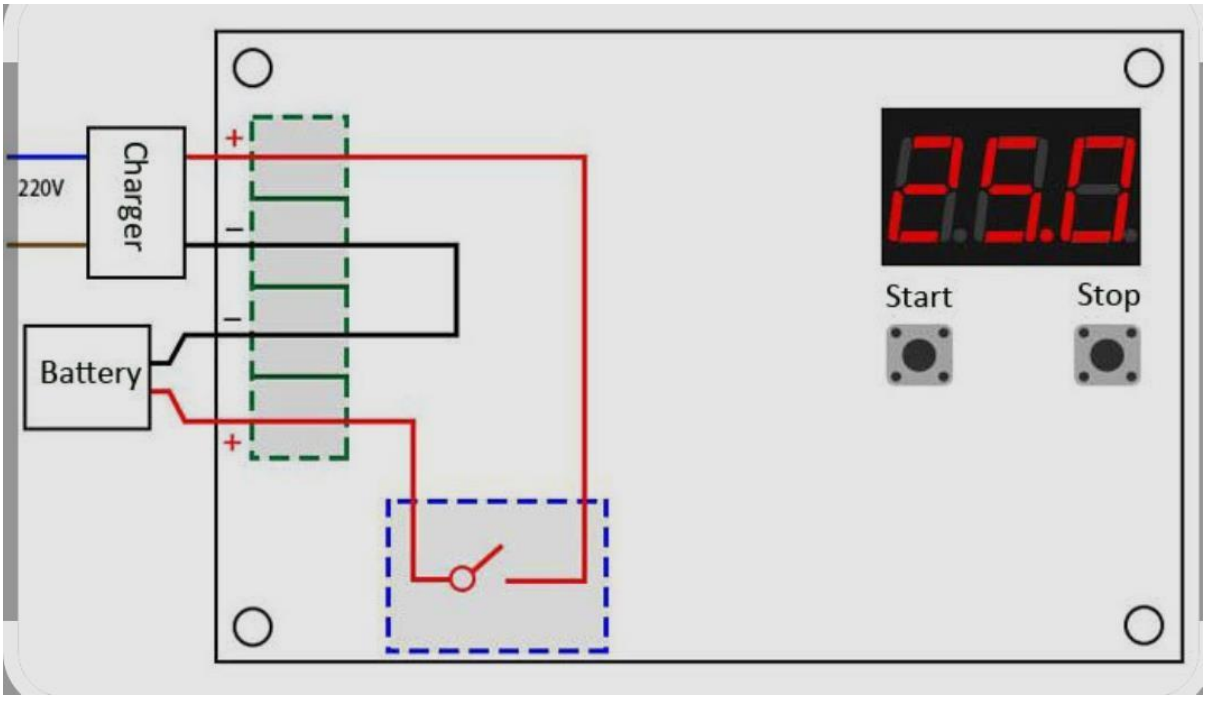
Physical Specifications:



Using Method:

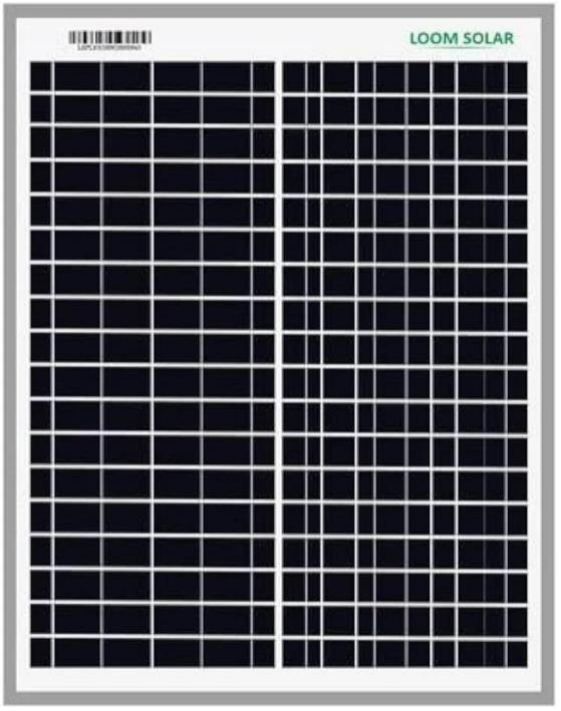
In the context of the voltage value, the start button plays role of Up-adjust action, stop button plays the role of Down-adjust action.

1. **Start Startup Voltage**: In normal display voltage state, press the button to display start charging Voltage; long press for 3 s the digital tube flashes; you can start or stop button to set start voltage Charging value.
2. **Set Off Voltage**: In normal display voltage state, press the button to display charging voltage Stop; long press the button for 3 s the digital tube flashes; you can start or stop button to stop set Charge voltage value.
3. **Factory reset:** in power on the state press the start / stop button at the same time, digital



tube Displays 888; that represents factory reset settings

Solar panel



Brand	Loom Solar
Product Dimensions	45L x 35W x 2.2H Centimeters
Item Weight	2.24 Kilograms
Efficiency	High Efficiency
Connector Type	plug in
Maximum Voltage	12 Volts
Maximum Power	20 Watts
Manufacturer	Loom Solar
Country of Origin	India
Item model number	LS20W
Product Dimensions	45 x 35 x 2.2 cm; 2.24 kg
ASIN	B07JVX4PZT

A solar panel works by absorbing sunlight and converting it into electricity or heat. Here's how:

1. Sunlight activates the panels
2. The cells produce electrical current
3. The electrical energy is converted
4. The converted electricity powers your home
5. A net meter measures usage

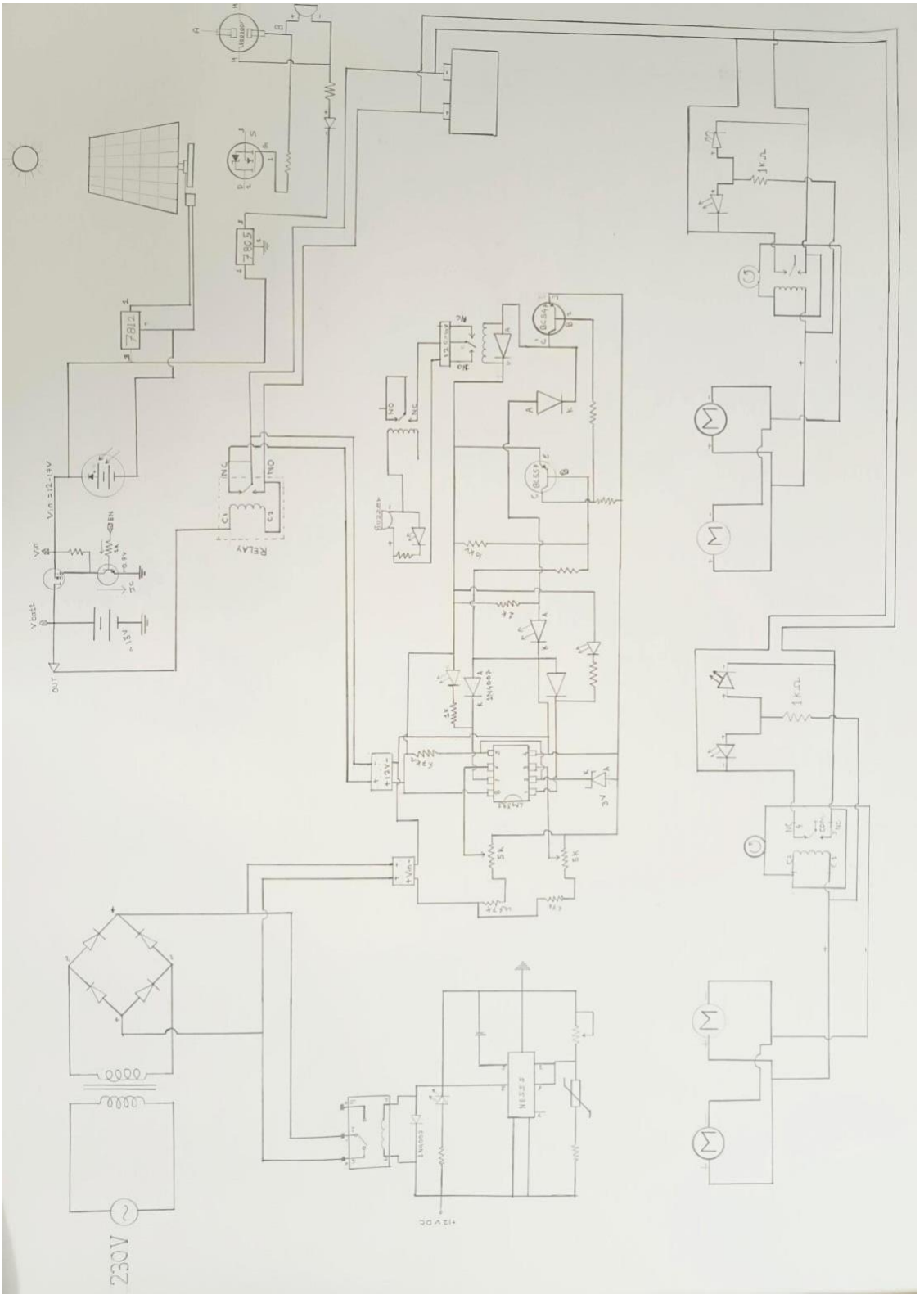
DC motor (12V)

A 12V DC motor operates on a 12-volt direct
current power supply and is used in diverse applications like automotive systems and robotics.
It comes in brushed and brushless types, with the latter offering higher efficiency.
These motors provide torque for mechanical work, and their speed can be controlled through voltage adjustment or electronic speed controllers.
Considerations include proper voltage matching, heat dissipation, and maintenance based on the specific motor type.

- **Working**

A DC motor, or electric motor, works by converting electrical power into mechanical rotation. When an electric current passes through a conductor placed in a magnetic field, a force acts on the conductor, causing it to move and obtain mech

Circuit diagram of Smart EV Battery Management :-



Block diagram of Smart EV Battery Management :-

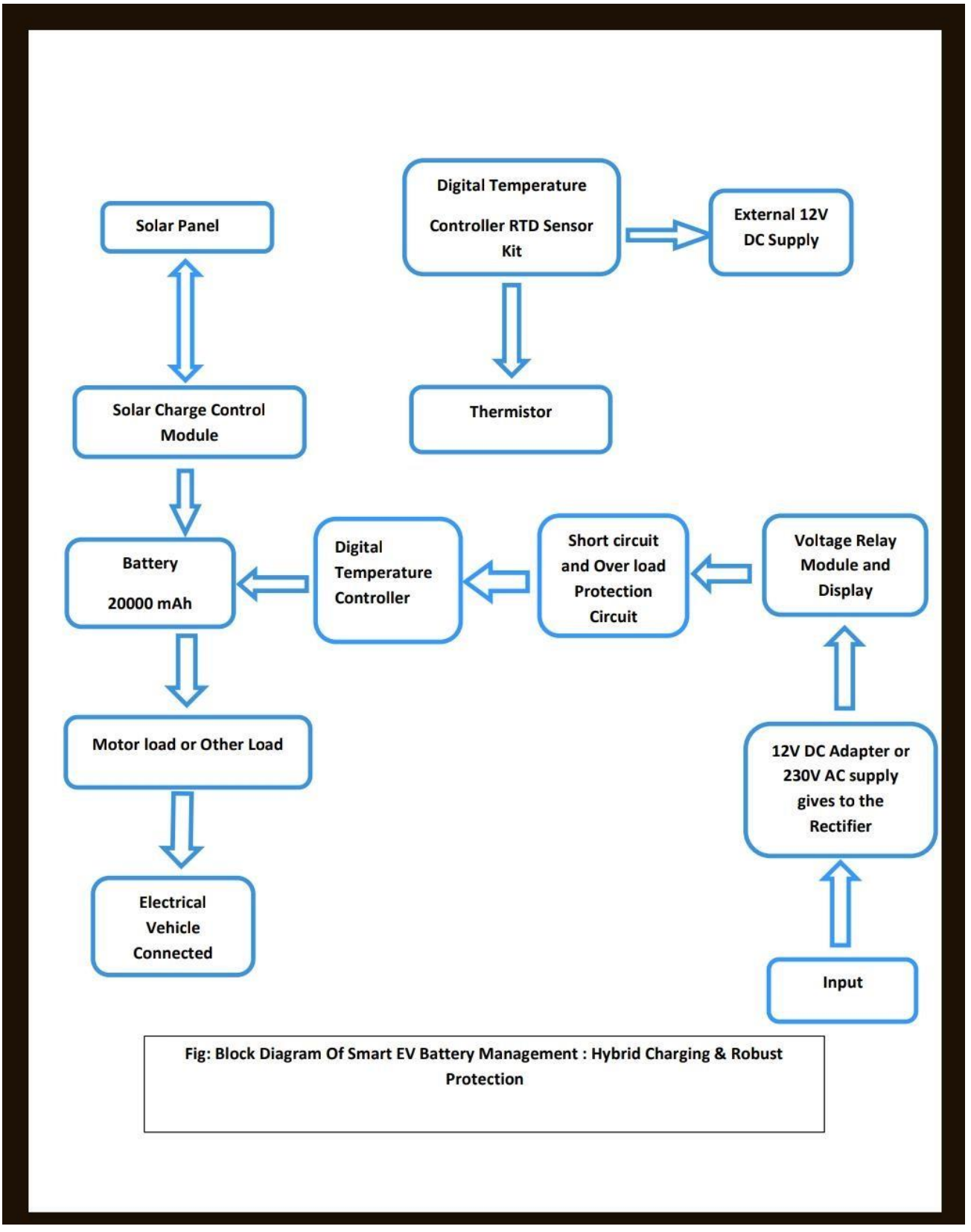
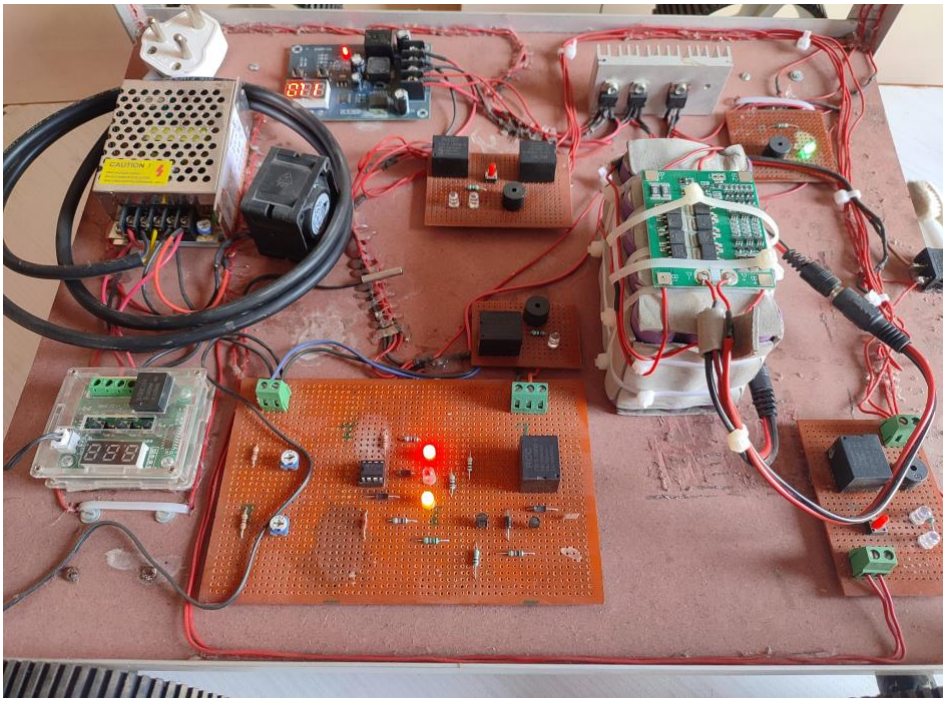
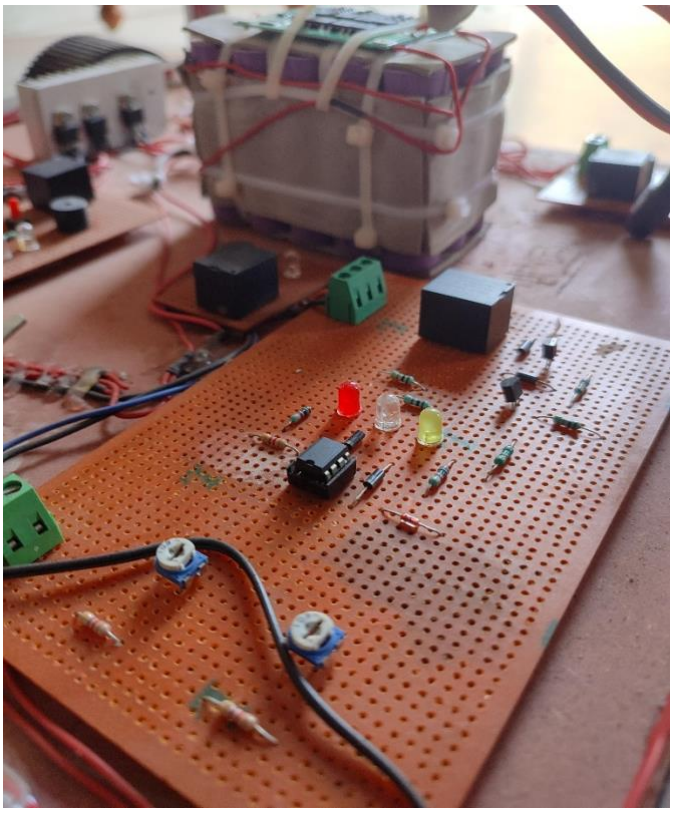


Fig: Block Diagram Of Smart EV Battery Management : Hybrid Charging & Robust Protection

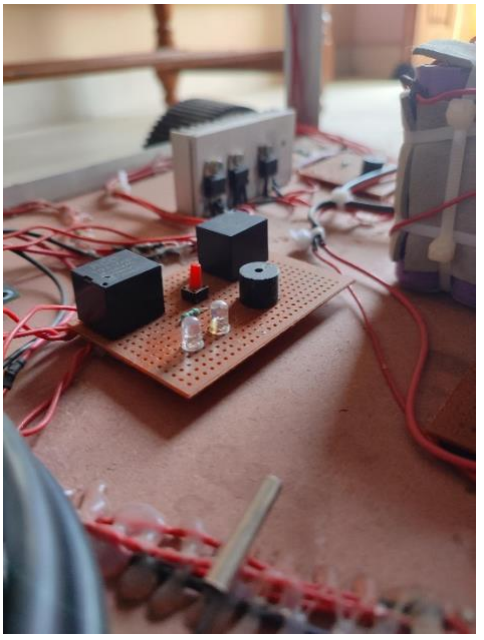
- **Photograph of smart EV battery management system.**

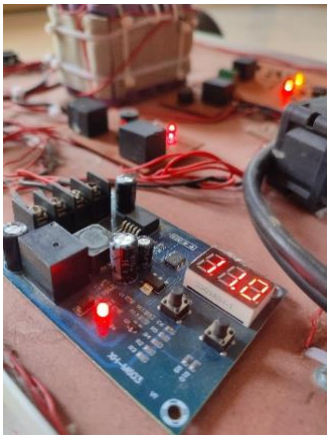


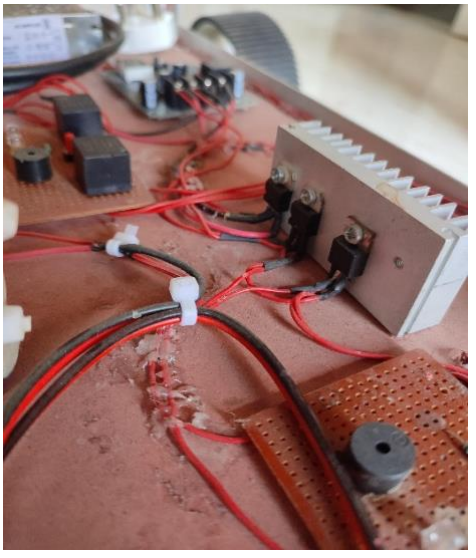
- **High & low voltage circuit**

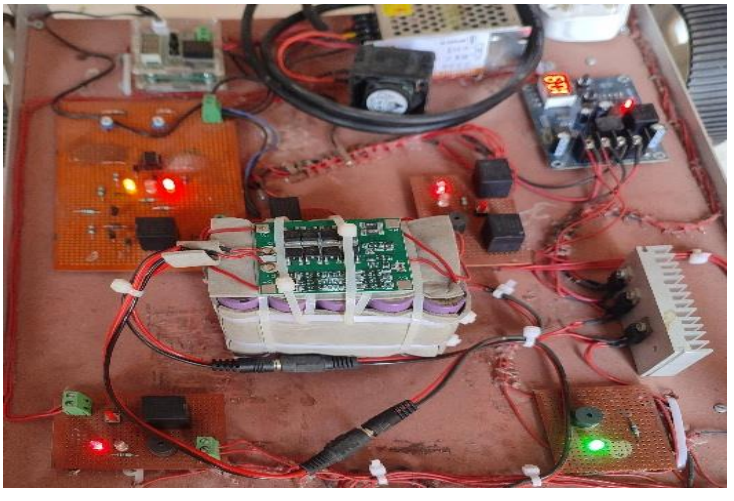


short circuit protection circuit









- **Total expenses and costing**

Sr.No	Name of material used	Specifications	Cost
1.	Step-down transformer	V-Tech 12-0-12v, AC 230v 50 Hz	290/-
2.	Bridge rectifier	Amp-2. IN4007 AC to DC	155/-
3.	Low and high voltage module	0-12v dc	300/-
4.	Solar panel	20w,1.6amp, 12v DC	1150/-
5.	Temperature sensor module	Ap-Tech W1209	346/-
6.	Charge controller module	XH-M604, De 6-60v	663/-
7.	Alcohol sensor circuit	MQ-3	197/-
8.	Battery	Lithium-ion battery (14.8V,12A)	750/-
9.	Connecting wires	Single strand	200/-
10.	Geared Motor	12v,2mp Dc	600/-
11.	Chassis (Main Body)	Aluminium, wooden board	1260/-
12.	Robot car wheels	70mm*40mm	399/-
13.	MOSFET, Heatsink	7805, 7812, IRF540N	180/-
14.	SCOP circuit	7amp, 12v dc	220/-
15.	Over voltage alarm circuit	7amp, 12v dc	69/-
16.	Motor clamp	Metal alloy	200/-
17.	Other expenses like (hot glue, screws, etc.)	-	500/-
		Total cost =	**7496/-**

References: -

Sr.No	Reference book / website / notes	Author
1.	Principle of electrical and electronics engineering	V.K. MEHTA
2.	Electronic and radio-engineering	M.L. GUPTA
3.	Electrical technology volume-2 (AC and DC machine)	B.L. THERAJA
4.	Power Electronics	Dr.P.S. BIMBHRA
5.	https://www.etechnog.com/2023/08/simple-overload-and-short-circuit.html?m=1	Internet
6.	https://www.circuitlab.com/	Internet