ARCHITECTURE OF ELECTRIC VEHICLE

A PROJECT REPORT

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BONAFIDE CERTIFICATE

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INTERNAL EXAMINER **EXTERNAL EXAMINER**

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ABSTRACT

Electric vehicles (EVs) are a promising technology. Due to their extremely low to zero carbon emissions, low noise, high efficiency, and flexibility in grid operation and integration, electric vehicles (EVs) are a technology that holds great promise for creating a sustainable transportation industry in the future. The technologies used in electric vehicles, as well as any related energy storage and charging systems, are discussed in this chapter. There are several different electric-drive car types shown. They encompass fuel cell electric cars, hybrid electric vehicles, plug-in hybrid electric vehicles, and battery electric vehicles. We talk about the enabling technologies and the topologies for each category. Several charger and converter topologies, fresh battery technology, and various power train combinations are shown. Transport sector fuel mix diversification and energy security issues are both addressed by electrifying transportation in addition to facilitating the transition to sustainable energy. Also, this might be considered a workable method to address problems brought on by climate change. Also provided are the processes and criteria for charging as well as the relative effects of charging cars on the grid.

The entire electrical system of this four-wheeled electric vehicle is powered by a lead acid battery, including the motor, microcontroller, display, and converters. For backup, we utilized a rechargeable battery. We employed a sophisticated auditory system for indications, then we built our own aerodynamic design for the whole car to increase vehicle speed. We used a front scoop with wind fairings and an LED display to show battery life. We also used "rack and pinion" for left and right alignment.

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LIST OF ABBREVIATION

EV	Electric Vehicle
BEV	Battery Electric Vehicle
PHEV	Plug-in Hybrid Electric Vehicle
HEV	Hybrid Electric Vehicle
FCEV	Fuel Cell Electric Vehicle
ICE	Internal Combustion Engine
kWh	Kilowatt-Hour
kW	Kilowatt
kWh/100 km	Kilowatt-Hour per 100 kilometers
DCFC	Direct Current Fast Charger
AC	Alternating Current
DC	Direct Current
SOC	State of Charge
BMS	Battery Management System
OBC	On-Board Charger
kWp	Kilowatt Peak
V2G	Vehicle-to-Grid
V2H	Vehicle-to-Home
Li-ion	Lithium-ion
LiFePO4	Lithium Iron Phosphate
NCA	Nickel Cobalt Aluminium
NMC	Nickel Manganese Cobalt
LFP	Lithium Iron Phosphate
kWh/mi	Kilowatt-Hour per mile
MPG	Miles per Gallon

MPGe	Miles per Gallon equivalent
REx	Range Extender
TCO	Total Cost of Ownership
ADAS	Advanced Driver Assistance Systems
OTA	Over-The-Air updates

CHAPTER 1

ARCHITECTURE OF ELECTRIC VEHICLE

1.1 INTRODUCTION:

Electrical vehicle (EV) is based on electric power as the energy source. The main advantage is the high efficiency in power conversion through its proposition system of electric motor. Recently there has been massive research and development work reported in both academic and industry. Commercial vehicle is also available. Many countries have provided incentive to users through lower tax or tax exemption, free parking and free charging facilities. On the other hand, the hybrid electric vehicle (HEV) is an alternative.

It has been used extensive in the last few years. Nearly all the car manufacturers have at least one model in hybrid electric vehicle. This paper is to examine the recent development of electric vehicle and suggest the future development in the area. Electric vehicles (EVs) use electricity as their primary fuel or to improve the efficiency of conventional vehicle designs. EVs include all-electric vehicles, also referred to as battery electric vehicles (BEVs), and plug-in hybrid electric vehicles (PHEVs).

In colloquial references, these vehicles are called electric cars, or simply EVs, even though some of these vehicles still use liquid fuels in conjunction with electricity. EVs are known for providing instant torque and a quiet driver experience. Other types of electric-drive vehicles not covered here include hybrid electric vehicles, which are powered by a conventional engine and an electric motor that uses energy stored in a battery that is charged by regenerative braking, not by plugging in, and fuel cell electric vehicles, which use a propulsion system similar to electric vehicles, where energy stored as hydrogen is converted to electricity by the fuel cell. All-electric vehicles do not have conventional engines but are driven solely by one or more electric motors powered by energy stored in batteries.

The batteries are charged by plugging the vehicle into an electric power source and can also be charged through regenerative braking. All-electric vehicles produce no tailpipe emissions, although there are “life cycle” emissions associated with the electricity production.

All-electric vehicles typically have shorter driving ranges per charge than conventional vehicles have per tank of gasoline.

Most new BEVs are designed to travel about 100 to 400+ miles on a fully charged battery, depending on the model. For context, 90% of all U.S. household trips cover less than 100 miles. An all-electric vehicle’s range varies according to driving conditions and driving habits. Extreme temperatures tend to reduce range because energy from the battery powers climate control systems in addition to powering the motor.

1.2 TYPES OF EV:

1.2.1 BATTERY ELECTRIC VEHICLES (BEVs):

BEVs are also known as All-Electric Vehicles (AEV). Electric Vehicles using BEV technology run entirely on a battery-powered electric drivetrain. The electricity used to drive the vehicle is stored in a large battery pack which can be charged by plugging into the electricity grid. The charged battery pack then provides power to one or more electric motors to run the electric car.

COMPONENTS OF BEVs:

Electric motor, Inverter, Battery, Control Module, Drive train

WORKING:

The power for the electric motor is converted from the DC Battery to AC. As the accelerator is pressed, a signal is sent to the controller. The controller adjusts the speed of the vehicle by changing the frequency of the AC power from the inverter to the motor. The motor then connects and leads to the turning of wheels through a cog. If the brakes are pressed, or the electric car is decelerating, the motor becomes an alternator and produces power, which is sent back to the battery.

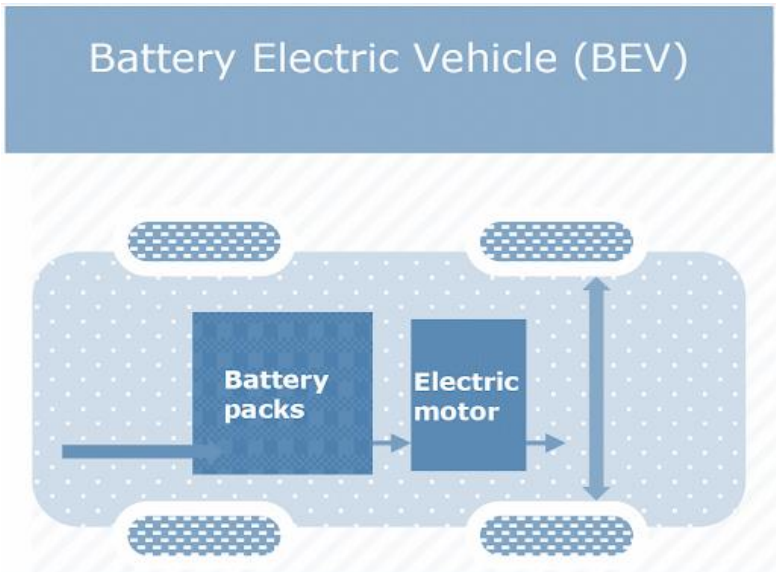


Fig 1.1 Battery Electric Vehicle

1.2.2 HYBRID ELECTRIC VEHICLE:

HEVs are also known as series hybrid or parallel hybrid. HEVs have both engine and electric motor. The engine gets energy from fuel, and the motor gets electricity from batteries. The transmission is rotated simultaneously by both engine and electric motor.

COMPOENTS OF HEVs:

Engine, Electric motor, Battery pack with controller & inverter, Fuel tank, Control module

WORKING:

The fuel tank supplies energy to the engine like a regular car. The batteries run on an electric motor. Both the engine and electric motor can turn the transmission at the same time.

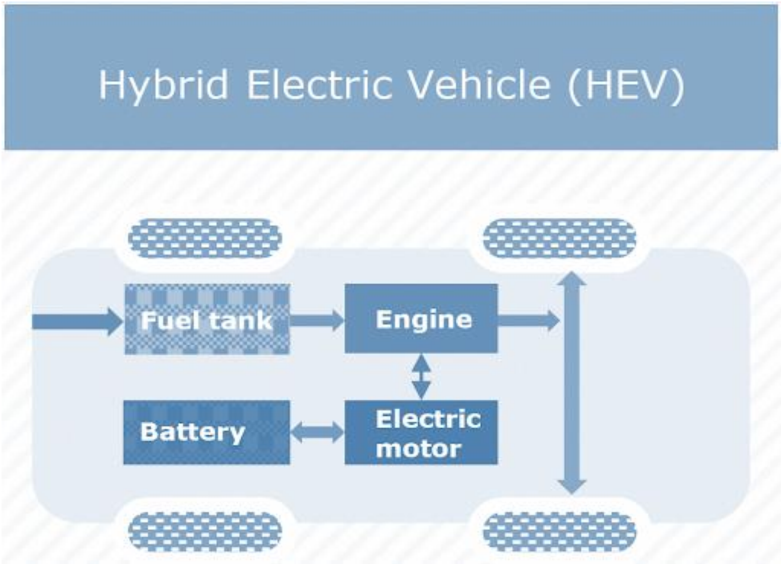


Fig 1.2 Hybrid electric vehicle

1.2.3 FUEL CELL ELECTRIC VEHICLE:

FCEVs are also known as Zero-Emission Vehicles. They employ ‘fuel cell technology’ to generate the electricity required to run the vehicle. The chemical energy of the fuel is converted directly into electric energy. To find out more about FCEVs, click below.

COPONENTS OF FCEVs:

Electric motor, Fuel-cell stack, Hydrogen storage tank, battery with converter and controller.

WORKING:

The FCEV generates the electricity required to run this vehicle on the vehicle itself.

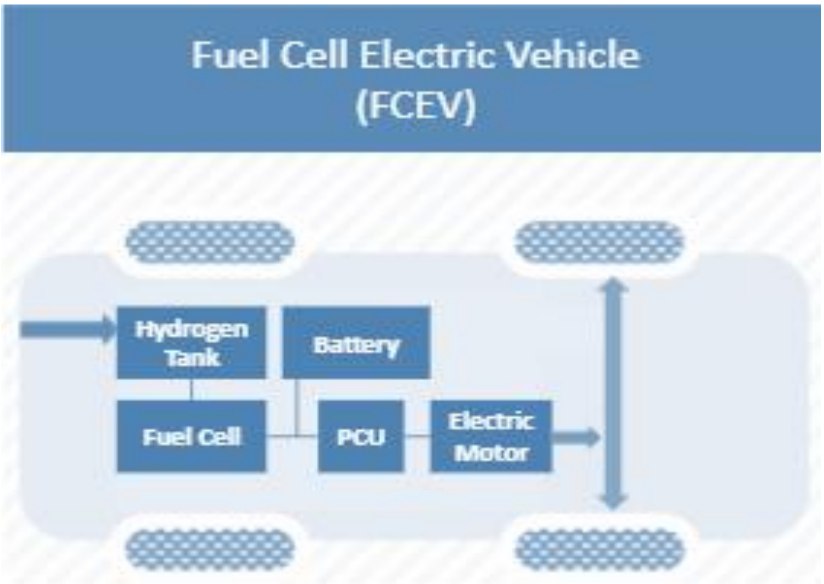


Fig 1.3 fuel cell electric vehicle

1.3 LITERATURE SURVEY:

K.W.E CHENG, et.al.,[1] This paper provides an overview of the "Recent work of electric vehicle "in the region. The paper describes the development and the comparison of different part of components. The major components in battery technology, charger design, motor, steering and braking are examined. Electrical vehicle (EV) based on electric propulsion system. No internal combustion engine is used. All the power is based on electric power as the energy source. The main advantage is the high efficiency in power conversion through its proposition system of electric motor. Recently there has been massive research and development work reported in both academic and industry. Commercial vehicle is also available.

John Farrell, et.al.,[2] has proposed a paper on "The rise of electric vehicles—2020 status and future expectations" Electric vehicles (EVs) are experiencing a rise in popularity over the past few years as the technology has matured and costs have declined, and support for clean transportation has promoted awareness, increased charging opportunities, and facilitated EV adoption. Suitably, a vast body of literature has been produced exploring various facets of EVs and their role in transportation and energy systems. EVs present numerous advantages compared to fossil-fueled internal-combustion-engine vehicles (ICEVs), inter alia: zero tailpipe emissions, no reliance on petroleum, improved fuel economy, lower maintenance, and improved driving experience (e.g., acceleration, noise reduction, and convenient home and opportunity recharging).

Sonali Goel, et.al.,[3] has done a research on "A review on barrier and challenges of electric vehicle in India and vehicle to grid optimisation" Though the use of EVs has begun, people are still depending upon fossil fuel powered vehicles. However, the EVs are facing challenges on life cycle assessment (LCA), charging, and driving range compared to the conventional fossil fuelled vehicles. The CO_2 emitted from Electric vehicle production is (59%) more than that of the ICEV. The ICEV generates 120 g/km of CO_2 emission on a tank to wheel basis, but from the point of view of the LCA, this increases to 170–180 g/km. While EV has zero emissions of CO_2 on a tank to wheel basis, we estimate that the average CO_2 is measured over the life cycle of a vehicle rather than over a vehicle. The total CO_2 emission over its full life time varies significantly depending on the power source where the vehicle is manufactured and driven.

Mohamed M,et.al.,[4] has proposed a paper on " Study of electric vehicles in India opportunities and challenges" Battery Electric Vehicles are complete electric vehicles that are powered by only electricity and do not include a petrol/diesel engine, fuel storage or exhaust pipe. They use electric motors and motor controllers for propulsion. They do not have an internal combustion engine. They charge the battery through external charging outlet and hence also known as "Plug-in Electric Vehicles (PEVs)". There are various types of BEVs such as electric cars, buses, bikes, scooters, trucks and trains. They even include fewer parts than those used for those vehicles based on internal combustion engines. They even produce fewer noises compared to their counterparts.

G Sivakumar, et.al.,[5] has proposed "Electric Vehicle" Hybrid Electric Vehicles are not pure electric vehicles since they use a combination of internal combustion engine and electric propulsion systems. These mainly include cars, buses and trucks. The latest models use technologies focusing on improving efficiencies such as regenerative brakes, which convert kinetic energy of vehicle into electric energy to charge the battery and other systems such as start-stop system, which switches off the engine at idle and restarts when needed to reduce idle emissions and motor-generator. A hybrid electric produces much less emission than those produced by pure gasoline-based hybrids improving fuel economy functioning at maximum efficiency. There are also Plug-in Hybrid Vehicles (PHEVs). They even produce fewer noises than pure hybrid vehicles.

1.4 EXISTING SYSTEM:

Electric vehicles (EVs) are becoming increasingly popular due to their low environmental impact and potential cost savings. There are currently several existing systems for electric vehicles, including:

Battery Electric Vehicles (BEVs): These vehicles run entirely on electricity stored in rechargeable batteries. BEVs have no internal combustion engine, so they emit no pollutants and require no fossil fuels.

Hybrid Electric Vehicles (HEVs): These vehicles combine an electric motor with an internal combustion engine. HEVs switch between electric power and gasoline power, depending on driving conditions.

Plug-in Hybrid Electric Vehicles (PHEVs): These vehicles are similar to HEVs, but they have a larger battery and can be charged from an external power source. PHEVs typically have a shorter electric-only range than BEVs, but they can switch to gasoline power when the battery is depleted.

Fuel Cell Electric Vehicles (FCEVs): These vehicles use a fuel cell to convert hydrogen and oxygen into electricity to power an electric motor. FCEVs emit only water vapor and have a longer range than BEVs, but hydrogen refueling infrastructure is currently limited.

Overall, these existing systems for electric vehicles offer a variety of options for consumers with different needs and preferences.

1.5 ARCHITECTURE OF ELECTRIC VEHICLE:

The term “electrical/electronic architecture” refers to the convergence of electronics hardware, network communications, software applications and wiring into one integrated system that controls an ever-increasing number of vehicle functions in the areas of vehicle control, body and security, infotainment, active safety, and other comfort, convenience, and connectivity functionality.

1.6 IMPORTANCE OF EV ARCHITECTURE:

EV architecture gives an idea of the complete cycle of the working, arrangement of the component should be placed in a sequence and while designing a vehicle, balance in performance and cost must be achieved therefore the selected architecture plays an important role.

An Electrical Architecture, due to its inherent nature, allows seamless integration of various futuristic technologies. This requires special attention while designing & adopting an architecture which fulfils today’s need and allows the design to respond to tomorrow’s challenges. The future EA will enable vehicles to function faster and respond quicker to the infrastructure, which will be also more connected and smarter.

An EA drives EVs as bi-directional power flow systems to interact with smart grid and a connected infrastructure. Today’s EV platforms are evolving towards multi sensor and automated driving technologies In this journey the EA will play a key role in collaborating, securing, self-learning, self-healing and connecting to each ECU and to the master VCU and the electric vehicle architecture will have to communicate, act and control faster to get the expected outcome.

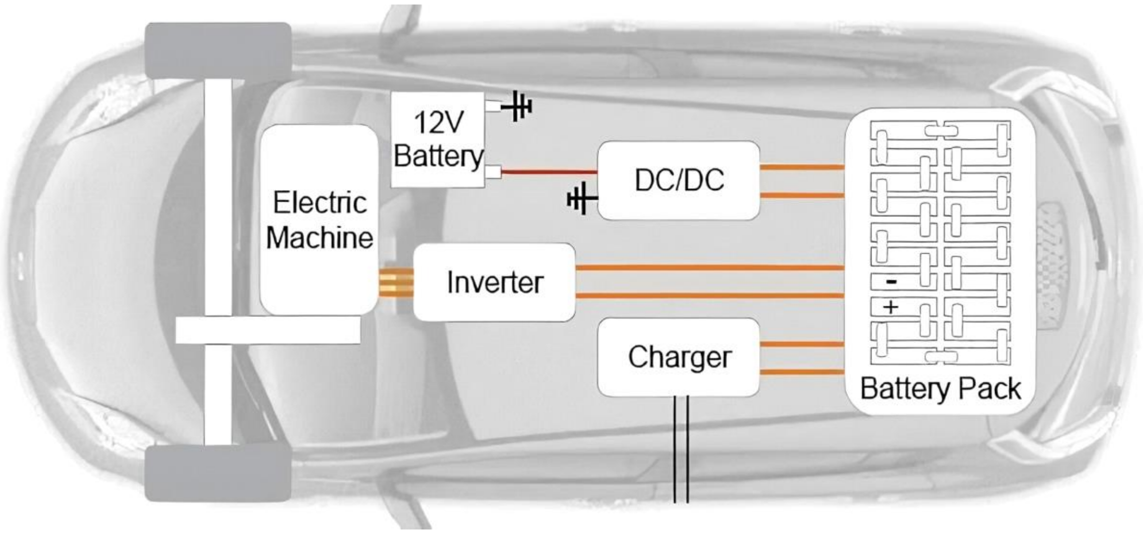


Fig 1.4 Architechture of e-vehicle

1.7 PARTS OF EV:

1.7.1 Motor:

There are a number of motors available for electric vehicle DC motors, Induction motor, DC brushless motor, Permanent magnetic synchronous motor and Switched reluctance motor.

Here we use brushless dc motor. BLDC motors have a higher torque-to-weight ratio, which is important for electric vehicles because it allows us to make the vehicle lighter while still achieving adequate torque. Because BLDC motors do not have brushes, they are more reliable because there is less equipment to deal with.

1.7.2 Charger:

A DC charger is a type of charger used in electric vehicles (EVs) to quickly charge the battery. Unlike an AC charger, which converts alternating current (AC) from the electrical grid to direct current (DC) to charge the battery, a DC charger provides direct current power directly to the battery, allowing for faster charging times.

DC chargers can charge an EV battery up to 80% in as little as 30 minutes, depending on the capacity of the battery and the charging rate of the charger. This makes them ideal for long-distance travel, as drivers can quickly charge their vehicles at charging stations along the way.

However, not all EVs are compatible with all DC chargers. Different EV models have different charging requirements, and there are different types of DC chargers with varying charging rates. It is important for EV owners to ensure that their vehicle is compatible with a specific DC charger before attempting to use it.

1.7.3 Controller:

In an electric vehicle (EV), a controller is an electronic device that manages the flow of electricity between the battery and the electric motor. The controller determines the speed, torque, and acceleration of the vehicle by controlling the amount of current flowing through the motor. It receives input from the accelerator pedal and other sensors to adjust the power output accordingly. Additionally, the controller monitors and protects the battery from damage by preventing overcharging or discharging. In regenerative braking, the controller captures the energy produced during braking and sends it back to the battery for later use. The controller plays a crucial role in optimizing the efficiency and performance of an EV.

1.7.4 Braking system:

Rear drum brakes are a type of braking system that have been used in electric vehicles (EVs) in the past. They consist of a drum-shaped brake assembly that is located inside the rear wheels of the vehicle. When the driver presses the brake pedal, a hydraulic or mechanical system forces brake shoes against the inside of the drum, creating friction and slowing the vehicle down.

While rear drum brakes are simple and effective, they have several disadvantages. They can overheat and lose effectiveness during prolonged or repeated use, and they are generally less responsive than other types of braking systems, such as disc brakes. As a result, many modern EVs use disc brakes on all four wheels for improved safety and performance.

CHAPTER 2

ELECTRICAL CAR-PERFORMANCE AND ANALYSIS OF BDLC

2.1 INTRODUCTION FOR BLDC MOTOR:

Performance analysis and testing of BLDC motors is an important aspect of motor design and development. Here are some of the key parameters that are typically analyzed and tested:

Torque and power output: The torque and power output of the motor are important performance parameters that need to be analyzed and tested. These parameters are typically measured using a dynamometer or torque sensor.

The efficiency of the motor is an important parameter that determines the overall energy efficiency of the system. This parameter is typically measured by comparing the input power to the output power of the motor.

The temperature of the motor is an important parameter that affects the performance and lifespan of the motor. The motor should be tested under different operating conditions to ensure that the temperature stays within safe limits.

The noise and vibration levels of the motor should be analyzed and tested to ensure that they meet the required standards.

The durability of the motor is an important factor that determines thelifespan of the motor. The motor should be tested under different operating conditions to ensure that it can withstand the expected wear and tear.

Overall, performance analysis and testing of BLDC motors is a crucial step in ensuring that the motor meets the required specifications and is suitable for its intended application.

2.2 MATHEMATICAL MODEL OF BLDCMOTOR

The modelled equations for the armature winding are as follows:-

$Va = Ria + L\ dia/dt$ (1)

$Vb = Rib + L\ dib/dt$ (2)

$Vc = Ric + L\ dic/dt$ (3)

Where,

L-armature self-induction in [H] R-armature resistance in [Ω]Va, Vb, Vc –terminal phase voltage in [V]

ia, ib, ic-motor input current in [A]ea, eb, ec-motor back-Emf in [V]

Back-Emf equation:-

ea=$(\theta e)\omega$ (4)

eb=$(\theta e - 2\pi/3)$ (5)

ec=$(\theta e+2\pi/3)$ (6)

Where,

Kw - back-Emf constant of one phase [V/rads-1]

Θe - rotor angle in electrical degreeω -rotor speed[rad. S-1]

Rotor angel electrical [θe] and Rotor angle mechanical [θm] are related as:-

$\theta e = P/2\theta m$ (7)

Thus the total electromagnetic torque Te in N-M can be expressed as follows:-

$Te = (eaia+ebib+ecic)/\ \omega$ (8)

The mechanical torque transferred to the motor shaft:-

$Te - Tl = Jdw/dt +$

$B\omega$ (9)Where,

Tl = load torque [N-M]

2.3 SIMULATION:

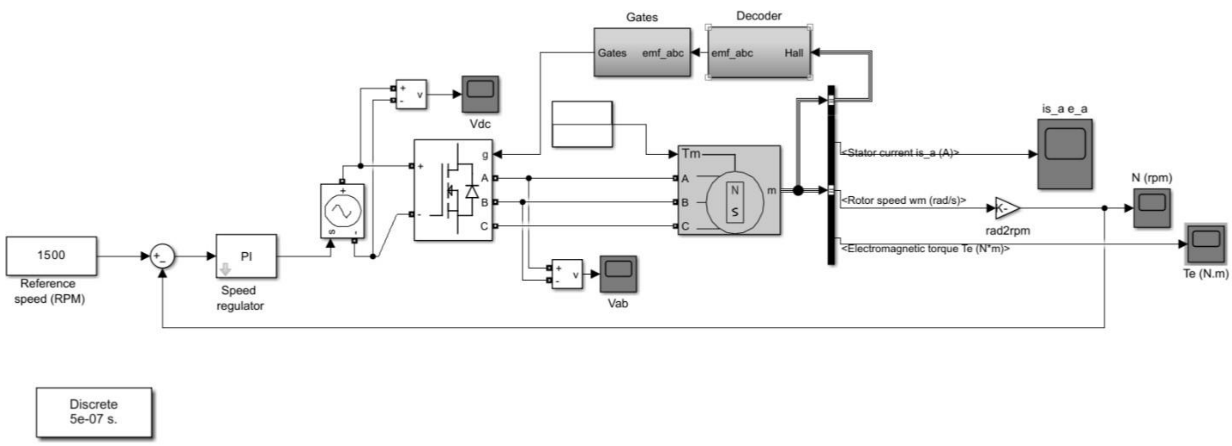
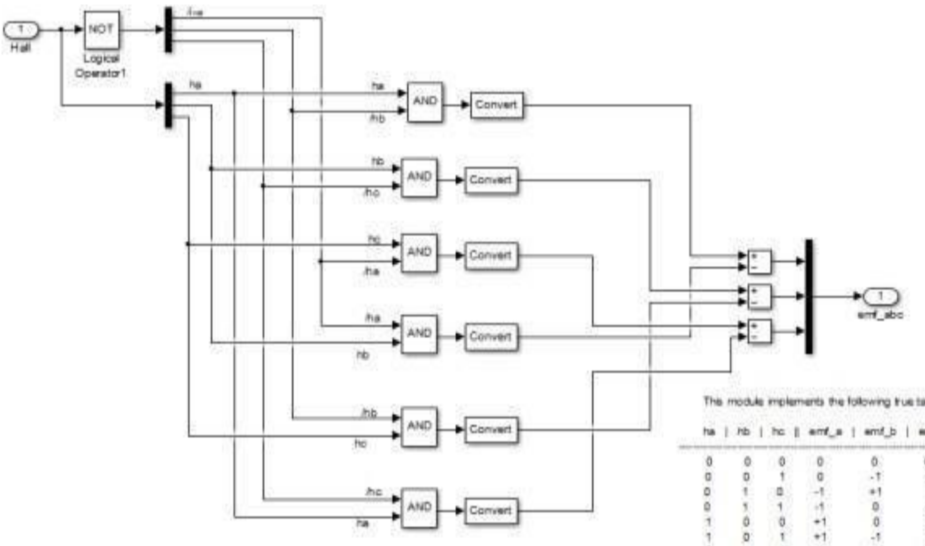


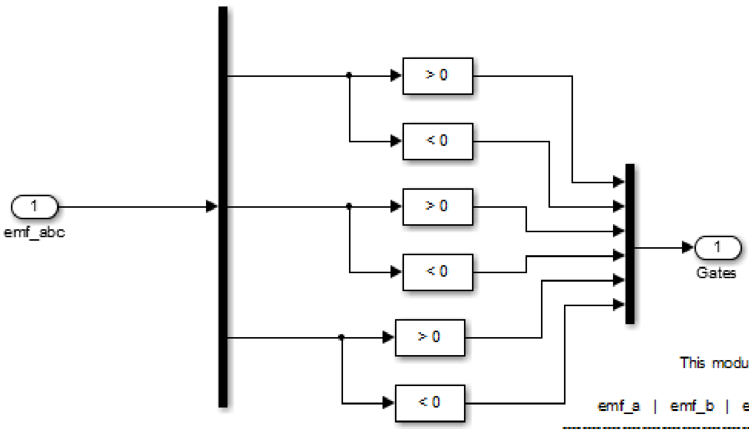
Fig. 2.1 Simulation



This module implements the following true table

ha	hb	hc	emf_a	emf_b	emf_c
0	0	0	0	0	0
0	0	1	0	-1	+1
0	1	0	-1	+1	0
0	1	1	-1	0	+1
1	0	0	+1	0	-1
1	0	1	+1	-1	0
1	1	0	0	+1	-1

Fig. 2.2 Decoder circuit



This module implements the following true table

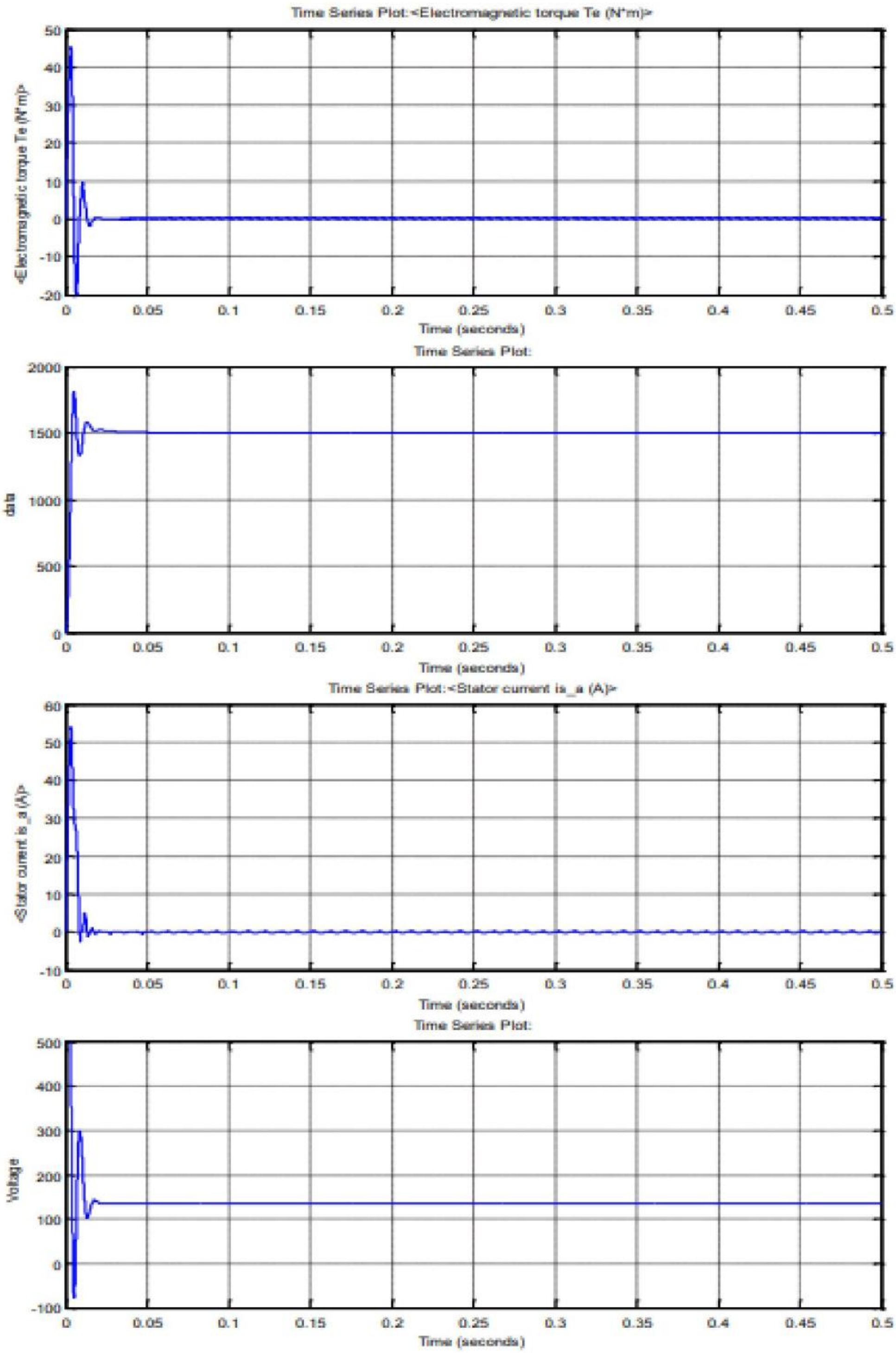
emf_a	emf_b	emf_c	Q1	Q2	Q3	Q4	Q5	Q6
0	0	0	0	0	0	0	0	0
0	-1	+1	0	0	0	1	1	0
-1	+1	0	0	1	1	0	0	0
-1	0	+1	0	1	0	0	1	0
+1	0	-1	1	0	0	0	0	1
+1	-1	0	1	0	0	1	0	0
0	+1	-1	0	0	1	0	0	1
0	0	0	0	0	0	0	0	0

Fig. 2.3 Gate signal

Simulation Results:

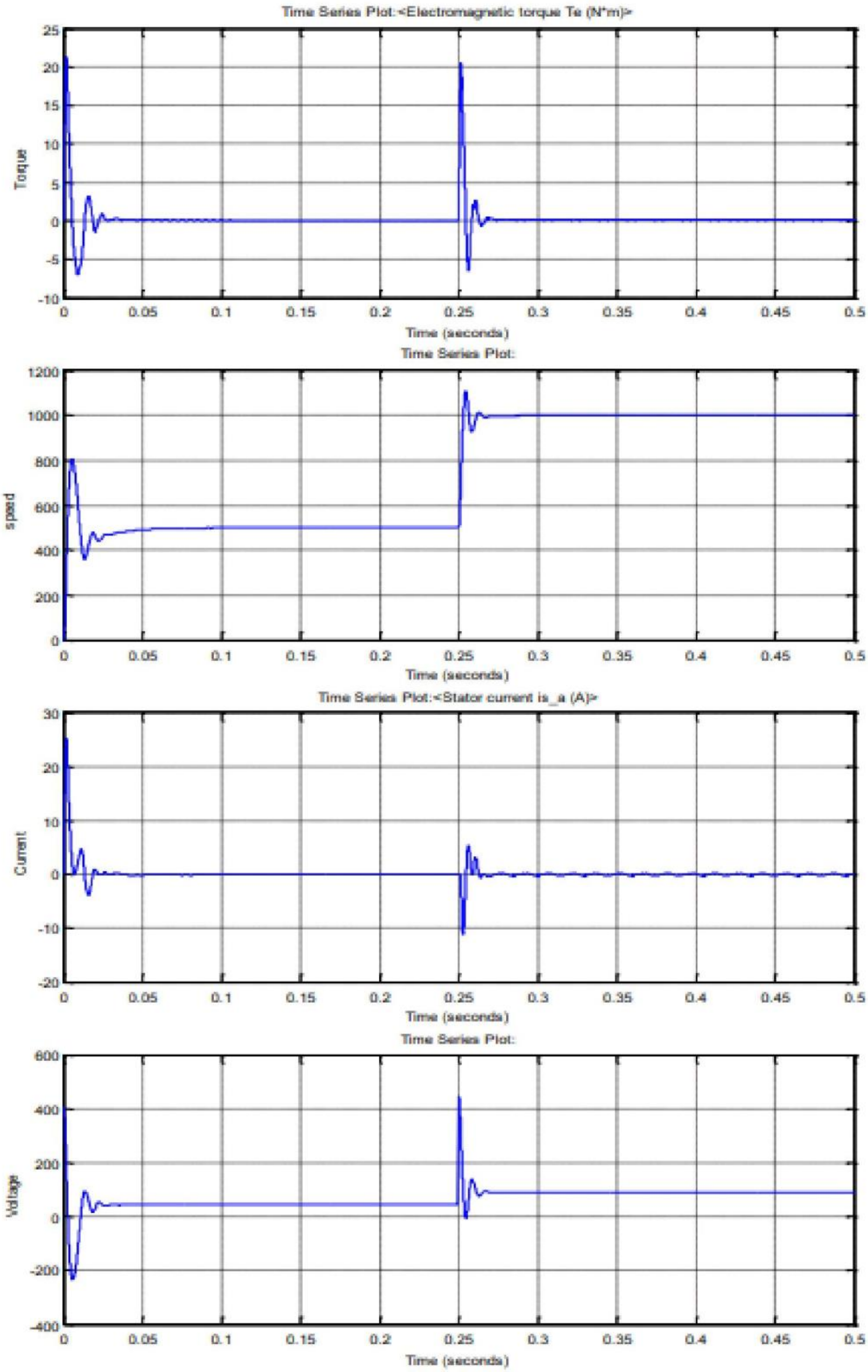
At constant condition:

Fig1:Torque vs time
Fig2:Speed vs voltage
Fig3:Stator current vs time
Fig4:Voltage vs time



At varying condition:

Fig1:Torque vs time
Fig2:Speed vs voltage
Fig3:Stator current vs time
Fig4:Voltage vs time



2.4 BLOCK DIAGRAM OF EV:

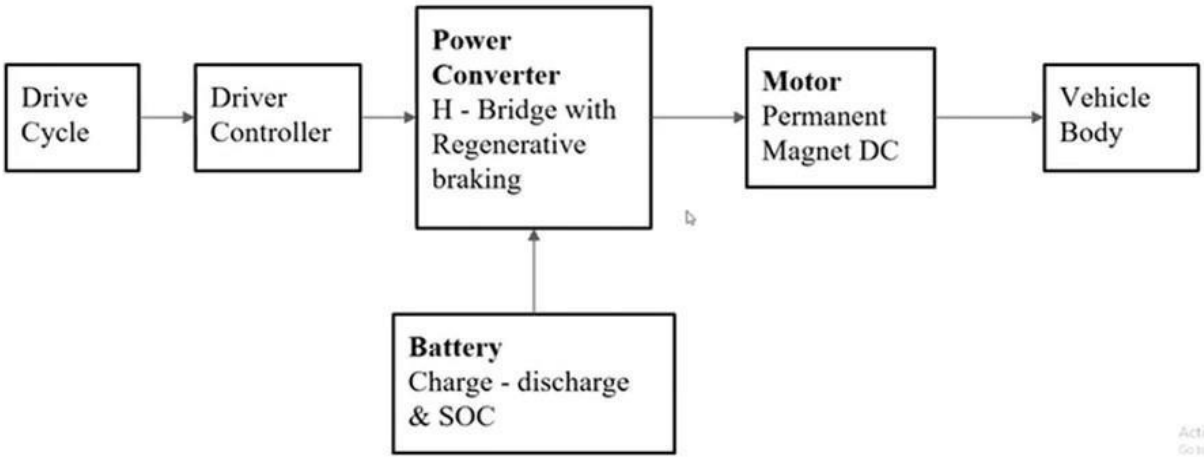


Fig 2.4 Block diagram of EV

2.5 FUNCTION OF BLDC MOTOR IN EV:

The main function of the BLDC (Brushless DC) motor used in an electric vehicle (EV) is to convert electrical energy stored in the battery into mechanical energy to drive the wheels of the vehicle.

The BLDC motor works by creating a rotating magnetic field that drives the rotor to produce torque, which in turn drives the wheels of the EV. The motor is controlled by an electronic controller, which sends signals to the motor to determine the speed and direction of the motor.

In summary, the function of the BLDC motor used in an EV is to convert electrical energy from the battery into mechanical energy to drive the wheels of the vehicle with high efficiency, high power density, and precise control.

2.5.1 Future Trends and Challenges in BLDC Motor Technology for EVs:

There is a need for even more efficient BLDC motors for EVs to increase their range and reduce their carbon footprint. New materials and design techniques are being explored to achieve this.

Improved Power Density: Increasing the power density of the BLDC motor can lead to more compact designs and higher performance. This is especially important for electric sports cars and high-performance EVs.

Advanced Control Strategies: Advanced control strategies such as sensorless control, predictive control, and model-based control can improve the performance and efficiency of BLDC motors in EVs.

Brushless DC (BLDC) motors are becoming increasingly popular in electric vehicles (EVs) due to their high efficiency, high power density, and low maintenance requirements. However, as the demand for EVs continues to grow, there are several challenges and future trends that the BLDC motor technology will need to address. Some of these challenges and trends .

Although BLDC motors are highly efficient, there is still room for improvement. Future developments in magnetic materials, advanced control algorithms, and better thermal management will lead to increased efficiency.

The power density of BLDC motors needs to be improved to meet the increasing power demands of EVs. This can be achieved through the use of high-strength magnetic materials, advanced cooling systems, and improved motor designs.

2.6 ADVANTAGES AND DISADVANTAGES OF BLDC MOTOR:

ADVANTAGES	DISADVANTAGES
Higher efficiency compared to traditional DC motors and internal combustion engines	Higher cost compared totraditional DC motors
Faster response times and smoother operation	Requires a specialized motor controller for properoperation
Precise speed and torque control	Requires sensors such asHall effect sensors or encoders for proper operation

CHAPTER 3

ELECTRICAL CAR- DESIGNING OF BATTERY PACKAGE AND MANAGEMENT SYSTEM

3.1 INTRODUCTION:

In the United States, battery electric cars charged off the dirtiest coal-dominated grid still produce less pollution than their gasoline-powered counterparts. BEVs powered by renewable energy sources like wind or solar are virtually emission-free. Not using gasoline or diesel also means that battery electric cars are significantly cheaper to fuel than conventional vehicles. Exact comparisons depend on the vehicle model and fuel prices, but driving a BEV can save drivers over $1,000 annually in gasoline money.

3.2TYPES OF BATTERY:

- Lead-Acid Batteries
- Lithium-Ion Batteries
- Nickel-Metal Hydride Batteries
- Ultracapacitors

3.2.1 Lead acid battery:

Lead-acid batteries are a type of rechargeable battery commonly used in various applications, such as automotive, marine, and backup power systems. The packaging and management of lead-acid batteries are essential to ensure their safety, performance, and longevity.

Battery packaging for lead-acid batteries typically involves the use of durable plastic or metal cases that provide physical protection to the battery cells and associated components, such as the electrodes and terminals. The packaging must be designed to withstand environmental factors, such as vibration, temperature changes, and shock, to prevent the release of hazardous materials and to provide structural support to the battery.

Fig 3.1 Lead acid battery

3.2.2 Working of lead acid battery:

The storage battery or secondary battery is such a battery where electrical energy can be stored as chemical energy and this chemical energy is then converted to electrical energy as and when required. The conversion of electrical energy into chemical energy by applying external electrical source is known as charging of battery. Whereas conversion of chemical energy into electrical energy for supplying the external load is known as discharging of secondary battery.

During charging of battery, current is passed through it which causes some chemical changes inside the battery. This chemical changes absorb energy during their formation.When the battery is connected to the external load, the chemical changes take place in reverse direction, during which the absorbed energy is released as electrical energy and supplied to the load.

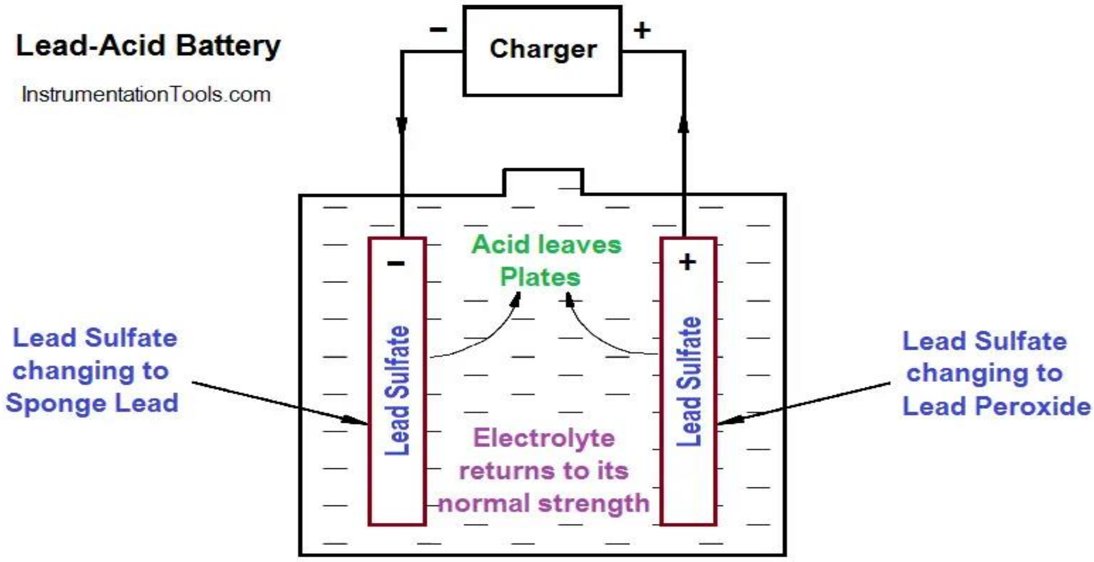


Fig 3.2 Working of lead acid battery

3.3 CHARGING:

Chemical energy is stored in the lead acid battery, which is converted into electrical energy when required. The energy conversion from chemical to electrical is known as lead acid battery charging. When the electric power gets changed to chemical energy, then this is discharging. The sulphuric acid that is present in the lead acid battery decomposes, and this is why it has to be replaced. If the battery spends a lot of time in its discharged state, then this causes a buildup of the chemical, which is not easy to remove. The lead acid batteries are usually charged using an external source of current.During the process of charging, because of chemical changes, the current passes into the battery. Any lead acid battery may use two kinds of charging methods. These are constant voltage charging or constant current changing**.**

3.4 DISCHARGING:

When the battery is in the discharged state, then the positive, as well as the negative plate, becomes lead (II) sulphate ($PbSO_4$).

Here is the Negative plate reaction:

$$Pb(s) + HSO_4^-(aq) \rightarrow PbSO_4(s) + H^+(aq) + 2e^-$$

Here is the Positive plate reaction:

$$PbO_2(s) + HSO_4^-(aq) + 3H^+(aq) + 2e^- \rightarrow PbSO_4(s) + 2H_2O(l)$$

The overall reaction occurs before combining the positive and negative reactions:

$$Pb(s) + PbO_2(s) + 2H^+(aq) + 2HSO_4^-(aq) \rightarrow 2PbSO_4(s) + 2H_2O(l)$$

3.5 SPECIFICATION:

PARAMETERS	VALUE
Internal resistance	0.032 ohms
Fully charged voltage	261.3158v
Exponential voltage zone	244.3421v
Exponential capacity zone	0.25Ah-1
Maximum capacity	78.125Ah
Nominal discharge current	15A
Capacity at nominal voltage	23.2708Ah
Nominal voltage	240v
Rated capacity	75Ah

Fig 3.3 specification of lead acid battery

3.6CIRCUIT EXPLANATION:

- The circuit mainly consists of a Bridge rectifier (if you are using AC supply stepped down to 18V), 7815 Regulator, Zener Diode, 12V Relay and a few resistors and diodes.
- The DC voltage is connected to the Vin of the 7815 and starts charging the battery through the relay and the 1Ω (5W) resistor.
- When the charging voltage of the battery reaches the tripping point i.e. 14.5V, the Zener diode starts conducting and provides enough base voltage to transistor.
- As a result, the transistor is active and its output becomes HIGH. This high signal will activate the relay and the battery is disconnected from the supply as shown in fig 1.3.

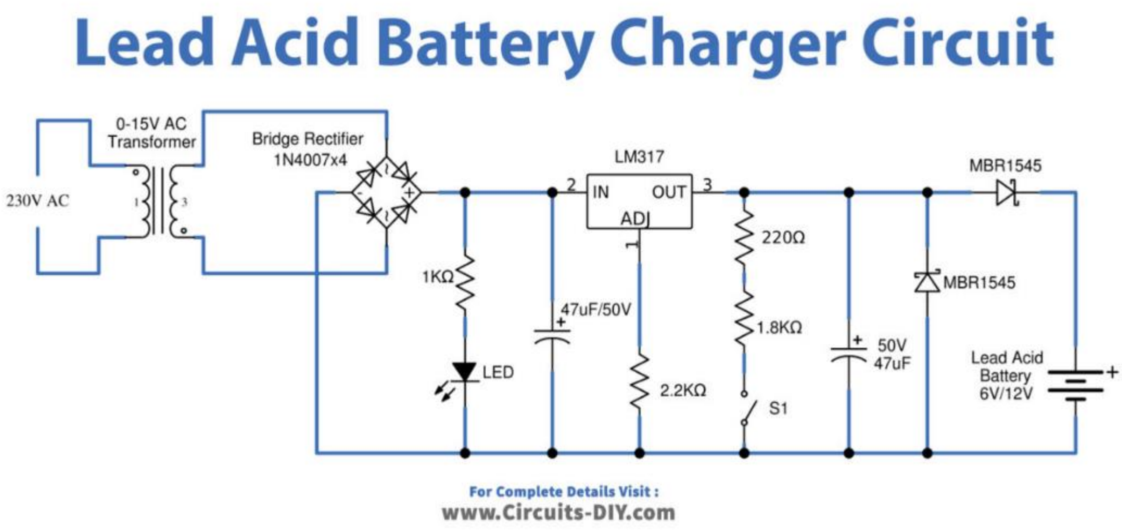


Fig 3.4 Charger circuit

3.7 BATTERY PACKAGE:

- Wear the appropriate personal protection equipment.
- Handle all returned batteries with the same responsible care as new

batteries.

- Keep batteries upright at all times. Do not tip over on side or upside down.
- Do not drop batteries. Put batteries carefully down on the pallet.
- Only lead acid batteries may be returned.
- The total height of the package must not exceed 900mm.
- Any damaged or cracked cell must be free of electrolyte and placed in a clear heavyweight polyethylene
- Plastic bag (min. 0.6mm) that is securely closed.
- All vent caps must be in place.

3.7.1 Automative batteries:

Automotive batteries must be separated into similar sizes. All batteries forming the outer rows of each layer must be of similar height. Lower height batteries can be stacked in the inner rows on each layer. All batteries must be stacked in an upright orientation so that acid is not spilled. Slip sheets must be used between the layers to minimise the potential for short circuit and post penetration. Heavy duty cardboard slip sheets are preferable to Masonite or chipboard because they are recyclable, and small spills can be absorbed and are visible. Polystyrene slip sheets are not to be used as they are difficult and costly to.Remove all battery cables or connections.

Fig 3.5 automative battery

3.7.2 STAND BY POWER BATTERY:

Standby power batteries should not be mixed with automotive batteries. Stand by power batteries should be separated into similar size groups so that they can be stacked evenly across the pallet. All batteries forming the outer rows of each layer must be of similar height. Lower height batteries can be stacked in the inner rows on each layer. Slip sheets must be used between the layers to minimise the potential for short circuit and post penetration. Heavy duty cardboard slip sheets are preferable to Masonite or chipboard because they are recyclable, and small spills can be absorbed and are visible. Polystyrene slip sheets are not to be used as they are difficult and costly to recycle (suppliers may incur an environmental disposal levy to cover the costs of disposing of any polystyrene received). Remove all battery cables or connections. Small standby power batteries can be stacked up to a maximum of 3 layers provided a maximum height of 900mm and maximum weight of 1500kg is not exceeded and stacks remain square. Large standby power batteries must only be stacked up to a maximum of 2 layers and a maximum height of 900mm and weight of 1500kg must not be exceeded.Crates and cages cause OHS and handling issues at the recycling facility and can only be used with the prior approval of the recycler.

3.8 PACKAGING AND STRAPPING:

Strapping must be high strength polypropylene, polyester or nylon plastic. The preferred strapping is 19mm wide with a combined break strength of 1500kg. Friction welding is preferred; otherwise, non-plastic clips. Strapping must be tight enough to prevent battery movement in transit. Steel strapping is not acceptable, due to the potential risk of fire from short-circuits. Automotive and standby power batteries must have one horizontal strap around each layer of batteries. Forklift and flooded standby power cells must have at least 3 horizontal straps around the load. Pallet loads must have at least 2 cross straps tying the load to the pallet.

Pallet loads must be either stretch wrapped or shrink wrapped in clear plastic to the full height of the pallet stack. The plastic wrap should not completely enclose the batteries due to the potential for gas build-up. The plastic wrap should secure the batteries to the pallet by wrapping around the pallet at least once. Plastic wrapping alone is not acceptable, except with the prior consent of the recycler.

3.9 BATTERY MANAGEMENT SYSTEM:

Battery management system (BMS) is technology dedicated to the oversight of a battery pack, which is an assembly of battery cells, electrically organized in a row x column matrix configuration to enable delivery of targeted range of voltage and current for a duration of time against expected load scenarios.

The oversight that a BMS provides usually includes:

- Monitoring the battery
- Providing battery protection
- Estimating the battery’s operational state
- Continually optimizing battery performance
- Reporting operational status to external devices

Here, the term “battery” implies the entire pack; however, the monitoring and control functions are specifically applied to individual cells, or groups of cells called modules in the overall battery pack assembly. Lead acid rechargeable cells have the highest energy density and are the standard choice for battery packs for many consumer products, from laptops to electric vehicles.

While they perform superbly, they can be rather unforgiving if operated outside a generally tight safe operating area (SOA), with outcomes ranging from compromising the battery performance to outright dangerous consequences. The BMS certainly has a challenging job description, and its overall complexity and oversight outreach may span many disciplines such as electrical, digital, control, thermal, and hydraulic.

3.9.1 Electrical management system:

Monitoring battery pack current and cell or module voltages is the road to electrical protection. The electrical SOA of any battery cell is bound by current and voltage. illustrates a typical lithium-ion cell SOA, and a well-designed BMS will protect the pack by preventing operation outside the manufacturer's cell ratings. In many cases, further derating may be applied to reside within the SOA safe zone in the interest of promoting further battery lifespan.

Lead acid battery have different current limits for charging than for discharging, and both modes can handle higher peak currents, albeit for short time periods. Battery cell manufacturers usually specify maximum continuous charging and discharging current limits, along with peak charging and discharging current limits. A BMS providing current protection will certainly apply a maximum continuous current. However, this may be preceded to account for a sudden change of load conditions; for example, an electric vehicle's abrupt acceleration.

A BMS may incorporate peak current monitoring by integrating the current and after delta time, deciding to either reduce the available current or to interrupt the pack current altogether. This allows the BMS to possess nearly instantaneous sensitivity to extreme current peaks, such as a short-circuit condition that has not caught the attention of any resident fuses, but also be forgiving to high peak demands, as long as they are not excessive for too long.

3.9.2 INTERNAL RESISTANCE:

Internal resistance Battery internal resistance does not belong to battery external parameters strictly speaking, internal resistance is one of the inherent characteristics of the battery. Most battery management systems take internal resistance parameters as auxiliary parameters for battery state estimation, but there are battery management systems in the market that rely on internal resistance as the main parameter to estimate battery SOC and SOH.

The measurement of internal resistance is a relatively complicated process, which cannot be measured directly. It is mainly measured indirectly by density method, open circuit voltage method, dc discharge method and ac method. The density method is similar to the open-circuit voltage method, and USES the external parameter - internal resistance curve to estimate the internal resistance of the battery. The dc discharge method is used to discharge the battery with instantaneous large current, and the internal resistance of the battery can only be calculated by using ohm's law combined with instantaneous pressure drop and single current, which can only be carried out offline and is not suitable for online parameter estimation.

By injecting a low-frequency ac current signal into the battery, the low-frequency voltage at both ends of the battery, the low-frequency current flowing through the battery and the phase difference between the two are measured, so as to calculate the internal resistance of the battery. The ac method requires no discharge, no static or offline operation, which avoids the impact on the safety of the equipment, and is suitable for online application.

In the battery internal resistance estimation theory, someone proposed battery equivalent circuit model, using the measured voltage and current online real-time identification of battery equivalent circuit of resistance method to estimate the battery internal resistance indirectly , its precision by equivalent circuit order time and greatly influenced by the estimation algorithm, widely applied in the battery management system .

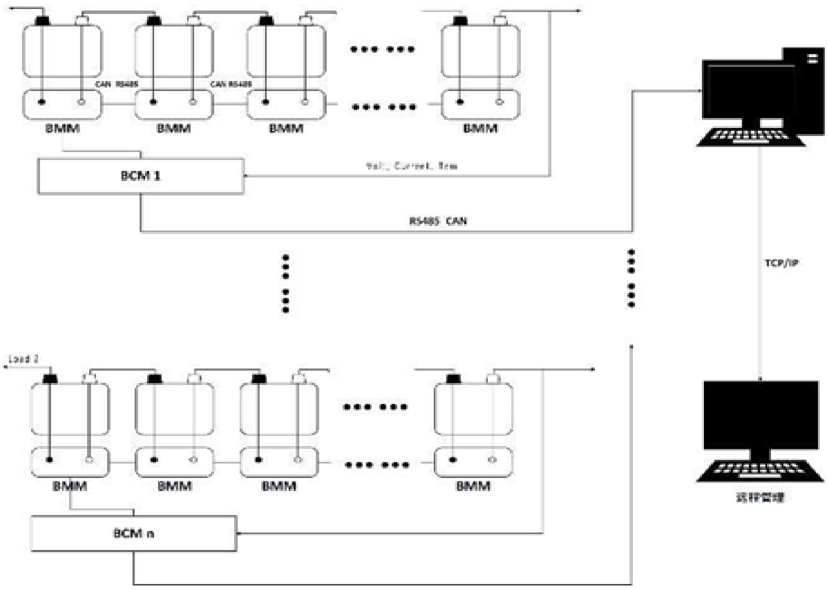


Fig 3.6 Back up for BMS

3.9.3 FUTURE SCOPE:

Battery life monitoring system has very important engineering application value and research needs. The key of battery state monitoring is real-time and accurate monitoring of battery state. The battery management system mentioned above can only be used in a fixed environment for real-time monitoring, once leaving the corresponding fixed environment, the real-time collection of parameters is lost. SOC estimation methods commonly used in engineering, such as kalman filter method, particle filter method, neural network method, etc., need prior knowledge of these algorithms, or input variables needed for online identification, all need state parameters before the battery.low-power monitoring module. At present domestic companies of monomer battery monitoring module BMM and group control unit adopts the wireless communication between BCM, brought about by the antenna power consumption is very big, this kind of situation can be optimized by strategy to solve, such as labels regularly sleep, passive awakens active tag strategy, active tag radio frequency micro energy collection, antenna power adaptive control methods .

CHAPTER 4
ELECTRICAL CAR-POWER TRAIN SYSTEM

4.1 TYPES OF ELECTRIC POWER TRAIN:

EV demand has been increasing since last few years. Electric Vehicle Powertrain is very important part of an Electric Vehicle. The electric vehicle offers new freedom in terms of electric vehicle architectures while leading to new challenges in terms of meeting all requirements.

The power train system consists of electric motor, wiring harness, converter, battery, and the controller unit. These are the main components of the power train system of electric car. A powertrain system for an electric vehicle (EV) is responsible for transferring electrical energy from the battery to the wheels, providing the necessary propulsion for the vehicle to move

As the name suggests, the powertrain provides power to the vehicle, Powertrain refers to the set of components that generate the power required to move the vehicle and deliver it to the wheels, The power train of an electric vehicle is a simpler system, comprising of far fewer components than a vehicle powered by an internal combustion engine.

An EV powertrain has 60% fewer components than the powertrain of an ICE vehicle.

The powertrain is the The Heart of the Electric Vehicle an EV's powertrain is responsible for taking energy stored in the vehicle's battery system and supplying it to the motors. The e-Powertrain powers our electric car and removes the need for an internal combustion engine

It is a lightweight, compact system that produces extremely low vibrations and generates instant torque, These elements combine to deliver a high quality, smooth and very responsive drive.

4.2 EXISTING SYSTEM:

The powertrain system of an electric vehicle (EV) generally consists of several components working together to power the vehicle.

Battery: The battery is the heart of the electric vehicle's powertrain system. It stores energy that is used to power the car's electric motor. EV batteries can vary in size and type.

Electric motor: The electric motor is the main source of power for an electric vehicle. It converts electrical energy from the battery into mechanical energy to drive the wheels. EV motors can be either AC or DC, and can vary in power and size depending on the type of vehicle.

Transmission: Some electric vehicles have a transmission to help regulate power delivery to the wheels. However, many EVs do not have a traditional transmission because electric motors can deliver maximum torque from zero RPM, eliminating the need for gears.

The converts are used in the power train system of the electric car the purpose of using this converts are converting the power for motor, suppling power for other components of the vehicle and controlling purpose of the vehicle.

On-board charger: The on-board charger allows the battery to be charged from an external power source, such as a wall outlet or a charging station. The charging rate can vary depending on the type of charger and the vehicle's battery capacity.

Overall, the powertrain system of an electric vehicle is designed to deliver efficient and clean power to the wheels, providing a smooth and quiet driving experience. With fewer moving parts compared to a traditional gasoline-powered vehicle, EV powertrains are generally more reliable and require less maintenance over time.

4.3 WHAT IS POWER TRAIN SYSTEM:

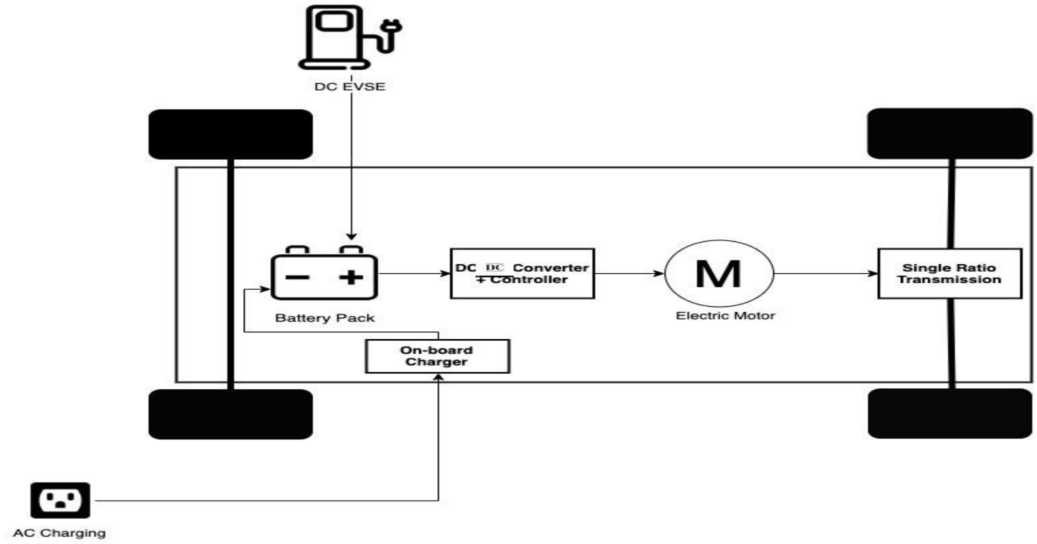


Fig 4.1 power train system

The powertrain system of an electric car is the combination of components that work together to provide power to the wheels of the vehicle. As the name suggests, the powertrain provides power to the vehicle.

It typically consists of motor, controller, converter, wiring harness and battery.

The electric motor is the main source of power for an electric car. It converts the electrical energy from the battery into mechanical energy to drive the wheels. The controller is used for suppling the power to the motor and other components of the electric car, the converter is build in with the controller the controller is a sealed type controller.

The wiring harness plays a crucial role in the powertrain system of an electric car. It is a bundle of wires and cables that connect various electrical components in the vehicle, including those in the powertrain system.

4.4 POWER TRAIN SYSTEM WORKING CYCLE:

The working cycle of the power train system is battery is gets charged by the charger. The battery powers all components and entire system of the electric car.

When the vehicle is turned on the power from the battery is supplied to the controller of the vehicle, now the controller controls and regulates the power supply from battery.

When the accelerator is pressed the controller supplies the power from the battery to the motor, now the vehicle runs in forward direction. According to the input signal the controller supplies the power to the motor and other components of the electric car.

When the battery is discharged the battery is charged by the charger which charges the battery. The charging cycle of a battery involves a process of converting electrical energy into chemical energy, which is stored in the battery for later use. Overall, the charging cycle battery is designed to deliver a steady and controlled flow of energy to the battery, allowing it to charge efficiently while minimizing the risk of overcharging or damaging the battery.

4.5 MODES OF OPERATION:

4.5.1 Forward mode:

During the forward mode the vehicle runs in forward direction. The forward drive mode which is the mode that allows the vehicle to move forward under the power of its electric motor.

The forward drive mode is engaged by pressing the accelerator pedal, which sends a signal to the vehicle's powertrain to deliver power to the electric motor. As the motor spins, it generates torque that is transmitted to the wheels, propelling the vehicle forward. Overall, the forward mode of operation in an electric car is similar to the operation of a gasoline-powered car, but with the added benefits of instant torque and quiet operation.

4.5.2 Reverse mode:

During the reverse mode the vehicle runs in reverse direction. The reverse mode is engaged when the reverse switch is pressed.

In an electric car reverse mode the mode of operation where the electric motor drives the wheels in the opposite direction of the forward mode, allowing the vehicle to move backwards.

When the reverse mode is activated, the power electronics system in the electric car will change the direction of the current flow to the electric motor, causing it to spin in the opposite direction. The controller in the power electronics system adjusts the speed and torque of the motor in the reverse mode to ensure smooth and safe operation. The electric motor in the reverse mode typically operates at a lower speed and torque compared to the forward mode, to ensure precise and controlled movements.

During the reverse mode of operation, the controller turns on the reverse light and reverse horn to indicate that the vehicle is running in reverse direction.

4.6 SIMULATION EXPLANATION:

Simulation of the powertrain system of an electric car involves using computer software to model the behavior and performance of the various components of the system, including the battery pack, electric motor, and power electronics.

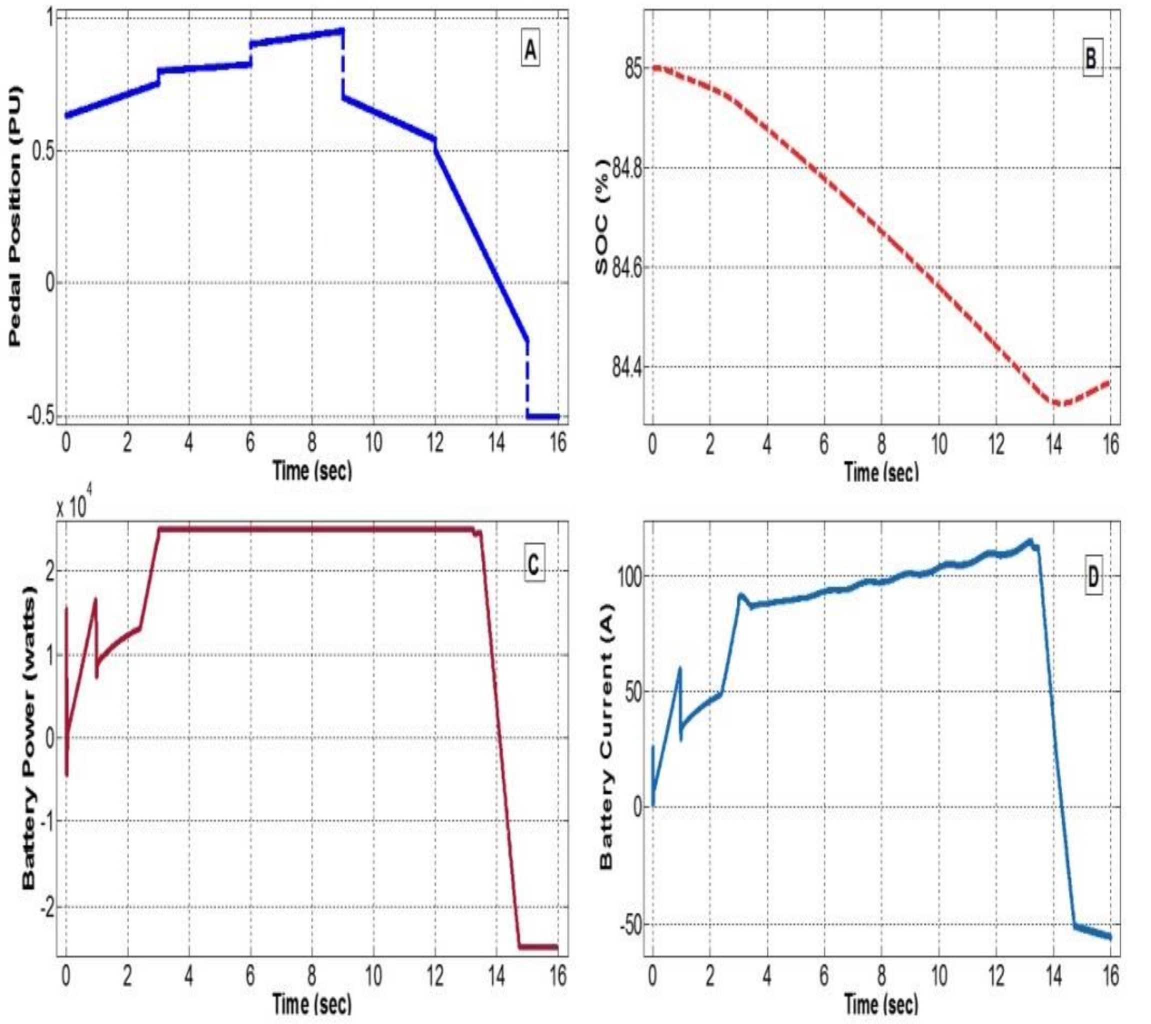


Fig 4.2 simulation of power train system

The simulation waveform (b) shows the battery state of charge from the simulation we can clearly see that the battery charge is decreasing when the time is increasing, when the time increases the state of charge in battery decreases . this one shows the draining of the battery when it is usage.

The third simulation waveform (c) shows the battery power with the time as we can see in this simulation during starting time the power from the battery is at its peak and then the power gradually decreases when the time is increasing.

The fourth simulation waveform (d) shows the battery current in relation to the time as we can see the battery current gradually increases when the increases and it peaks after some seconds this is due to limiting the starting current.

From the simulation graph (e) we see that the drive torque is high at the starting point of the time this is due to the high starting torque of the motor, after some seconds the torque is gradually decreasing and remains constant, this high starting torque also helps to propel the vehicle from stand still position.

4.7 HARDWARE DESIGN:

4.7.1 Components:

Fig 4.3 BLDC motor

Fig 4.4 Controller DC-DC Converter

Fig 4.5 Wiring harness

Fig 4.6 Battery

4.7.2 BLDC motor:

- The BLDC motor power rating is 48V 1200 watts
- The purpose of the motor in an electric vehicle (EV) is to convert electrical energy stored in the battery into mechanical energy that can be used to power the vehicle's wheels and propel it forward.
- The motor provides two modes of operation like
- Forward motoring
- Reverse motoring

Overall, the motor is a crucial component of an electric vehicle, enabling it to run on electricity, produce zero emissions, and offer a smooth and efficient driving experience.

4.7.3 Controller, DC TO DC converter:

- The controller is a 24-tube sinewave type controller
- The controller in an electric car is to manage the flow of electrical energy from the battery to the motor, ensuring efficient use of the battery's energy and controlling the motor's speed and torque.
- The controller used for the controlling operation of the electric car. It provides controlling operations like forward motoring, reverse motoring.
- The DC-TO-DC converter is built in with the controller unit.
- This controller is sealed type unit.

4.7.4 Wiring harness:

- The wiring harness used is 13 mm we well
- The wiring harness in an electric car is to connect the various electrical components of the car's powertrain system, including the battery, motor, controller, and other systems, with each other and with the car's electrical system.
- The wiring harness provides a reliable and organized way to transmit power and signals between different parts of the vehicle, ensuring that they work together seamlessly and safely.

4.7.5 Battery:

- The battery which powers the system is a 48 V 26 Ah lead acid battery.
- The battery in an electric car is to store electrical energy that is used to power the car's motor and other electrical systems.

- The battery is the primary source of energy for an electric car, and it provides the power needed to propel the vehicle and operate various components.
- The battery is like the "fuel tank" of an electric car, providing the energy needed to keep the car running.

CHAPTER 5

ELECTRICAL CAR- DC TO DC CONVERTER

5.1 INTRODUCTION FOR DC-TO-DC CONVERTER:

DC-to-DC converters are an integral part of any modern-day electric vehicle’s power electronic circuits (PECs). converter has been designed to control the speed of a DC motor for electric vehicle application. In automotive applications, they are an essential intermediary between systems of different voltage levels throughout the vehicle. The transistor gate drive circuit was designed to provide the maximum isolation between the power and the control circuits.

DC-to-DC converters are devices that temporarily store electrical energy for the purpose of converting direct current (DC) from one voltage level to another. In electric vehicles which use a DC motor, actually running the motor can use up to three times the voltage provided by the battery. With the help of the right converter, we can bridge this gap without having to resort to a larger, prohibitively-heavy battery.

The main dc-dc converter changes dc power from an on-board high voltage battery into lower dc voltages to power headlights, interior lights, wiper and window motors, fans, pumps and many other systems within electric vehicles (EV).

5.2 LITERATURE REVIEW:

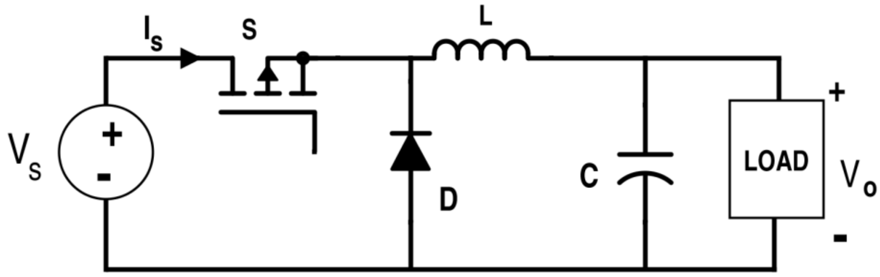
In many industrial applications, it is required to convert a fixed-voltage dc source into a variable-voltage dc source. A dc-dc converter converts directly from dc to dc and is simply known as a dc converter. A dc converter can be considered as dc equivalent to an ac transformer with continuously variable turns ratio. Like transformer, it can be used to step down or step up a dc voltage source.

Dc converters widely used for traction motor in electric automobiles, trolley cars, marine hoists, and forklift trucks. They provide smooth acceleration control, high efficiency, and fast dynamic response. Dc converter can be used in regenerative braking of dc motor to return energy bake into the supply, and this feature results in energy 5 saving for transportation system with frequent stop and also is used, in dc voltage regulation.

5.3 PROPOSED SYSTEM:

The block diagram of a DC-to-DC converter consists of an input voltage source, a switching device, an inductor, a transformer or capacitor, and an output voltage load. The switching device is used to switch the input voltage source on and off at high frequencies. The inductor is used to store energy when the switching device is on and release it when it's off. The transformer or capacitor is used to step up or step down the voltage level.

5.4 Circuit Diagram:



5.5 Simulation Model:

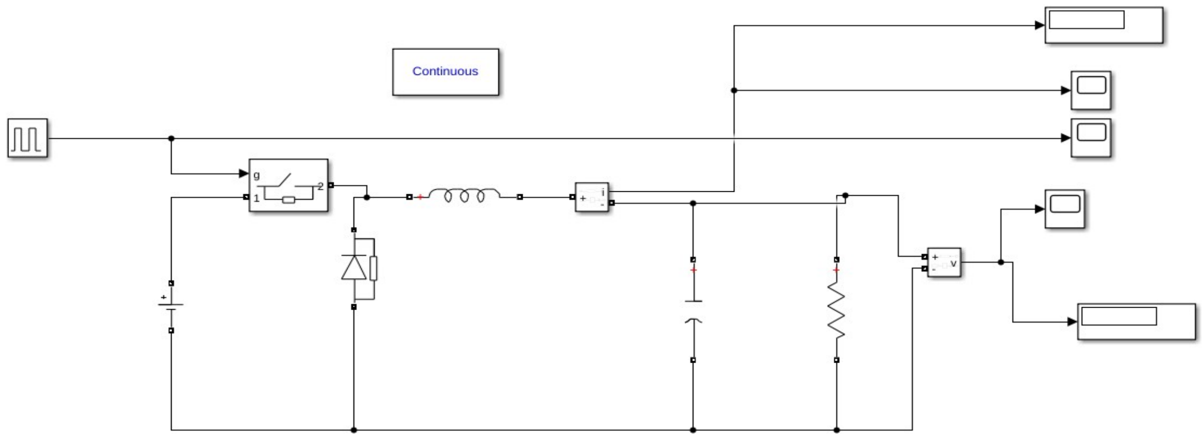
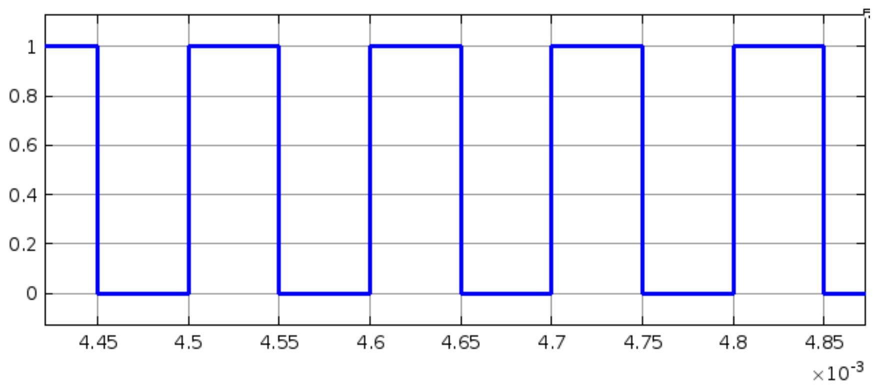


Fig 5.2 dc to dc converter

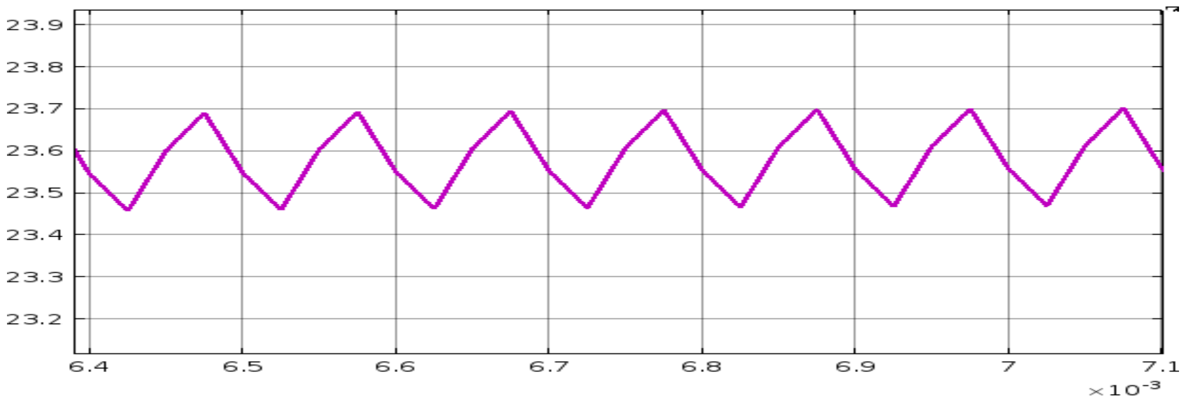
5.6 Design Parameters:

R	10 (H)	**Amplitude**	1
L	10e-3(F)	**Period(secs)**	0.0001
C	6.25e-6(ohms)	**Pulse Width(% of period)**	50

5.7 HARDWARE:



The Hardware of the DC-to-DC converter is very simple. The inductor in the input resistance has an unexpected variation in the input current. If the switch is kept as high (on), then the inductor feeds the energy from the input and stores the energy in the form of magnetic energy. If the switch is kept as **low (off),** it discharges the energy. Here, the output of the capacitor is assumed as **high** that is sufficient for the time constant of an **RC circuit** on the output side. The huge time constant is compared with the switching period and made sure that the steady-state is a constant output voltage.



ADVANTAGES:

- DC/DC converters play a key role in helping one choose the voltage variation of the devices and in controlling the power flow in each of the devices used in the EV powertrain.
- Battery space can be reduced by reducing or increasing the available input voltage.
- They are also considered as an important source of electromagnetic interference and have undesirable effects on electric networks.

CHAPTER 6

ELECTRICAL CAR- CHARGING SYSTEM

6.1 INTRODUCTION FOR CHARGING SYSTEM:

Electric charging systems are becoming increasingly popular as more people adopt electric vehicles (EVs) as a mode of transportation. An electric charging system is a network of charging stations that provide electric energy to EVs, allowing them to operate without the need for traditional gasoline or diesel fuel. The charging process involves plugging the EV into the charging station and allowing the battery to recharge, usually taking anywhere from a few minutes to several hours, depending on the type of charging station and the capacity of the EV battery.

Charging for electric systems can take different forms depending on the location and the owner of the charging station. Some charging stations may offer free charging to attract customers or incentivize the use of EVs. However, many charging stations charge a fee for the use of their services, either by time or energy consumed. This fee can vary depending on factors such as the location, the type of charging station, the time of day, and the amount of energy used. Charging fees may also include membership fees for access to certain charging networks or exclusive charging privileges.

6.2 TYPES OF CHARGING SYSTEM FOR EV:

6.2.1 Charging system based on household outlet:

It is the simplest and most basic type of charging system, and it uses a standard 120-volt AC household outlet. Level 1 charging can provide up to 2-5 miles of range per hour of charging, and it is suitable for vehicles with smaller battery capacities or for overnight charging.

Components:

EV battery, charging cable, and outlet.

Working:

When the EV is connected to the household outlet, the charging cable's one end is plugged into the vehicle's charging port, and the other end is plugged into the household outlet. The electricity flows from the outlet to the charging cable and then into the vehicle's battery.

The charging process starts with the vehicle's battery management system (BMS) communicating with the charger to determine the battery's current state of charge and how much charging is required. The BMS also monitors the battery's temperature, voltage, and current during the charging process to ensure safe and efficient charging.

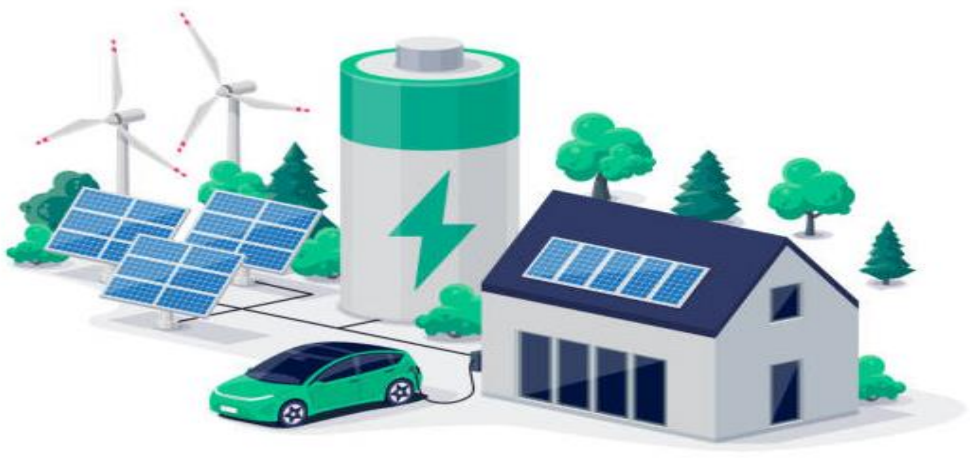


Fig 6.1 Household outlet

6.2.2 Charging system based on 240-volt ac supply:

This type of charging system uses a 240-volt AC power supply, which provides faster charging than Level 1. Level 2 charging can provide up to 10-60 miles of range per hour of charging, depending on the vehicle and the charging station. Level 2 charging stations are commonly found in public charging stations and at home, but they require installation of special equipment by a professional electrician.

Components:

EV battery, charging station, charging cable, and power supply.

Working:

The Level 2 charging station provides a 240-volt AC power supply, which is converted by the charging station's onboard charger to the DC power required by the vehicle's battery. The charging rate of Level 2 charging is faster than Level 1 charging, and it can provide up to 10-60 miles of range per hour of charging, depending on the vehicle and the charging station.

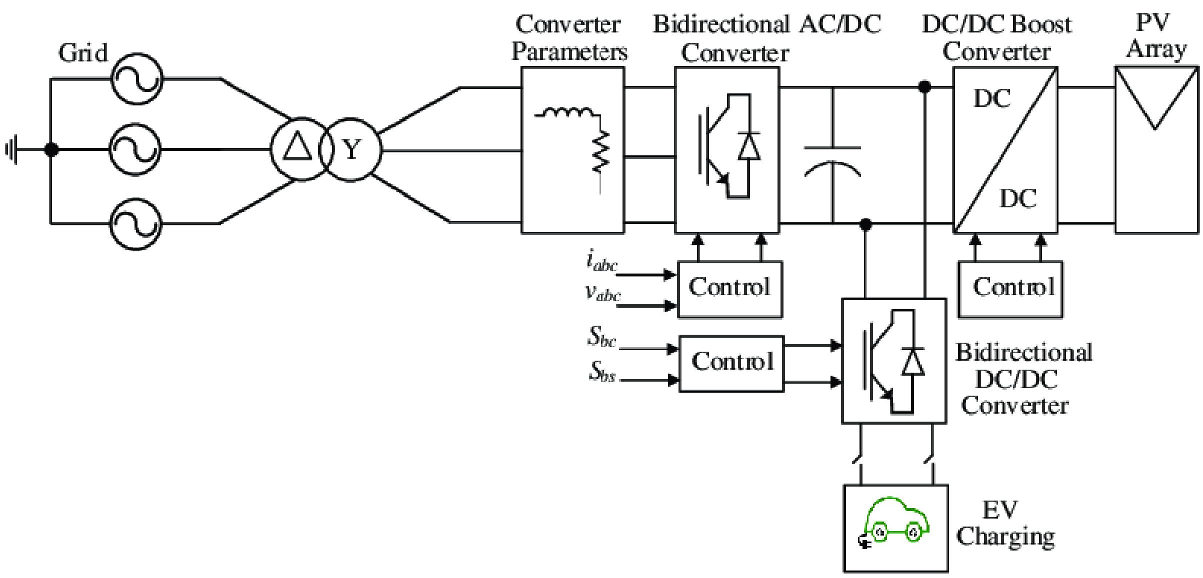


Fig 6.2 Block diagram for charging

6.2.3 Dc fast charging:

This type of charging system is designed for rapid charging of electric vehicles. Level 3 charging stations use a 480-volt DC power supply, which can provide up to 80% charge in 20-30 minutes. Level 3 charging stations are typically found in commercial or public areas and are less common at homes due to their high cost.

Components:

EV battery, charging station, charging cable, and power supply.

Working:

The DC fast charging station provides a high-voltage DC power supply, which bypasses the vehicle's onboard charger and directly charges the battery with DC power. The charging rate of DC fast charging is the fastest of all charging levels, and it can provide up to 80% charge in 20-30 minutes, depending on the vehicle and the charging station.

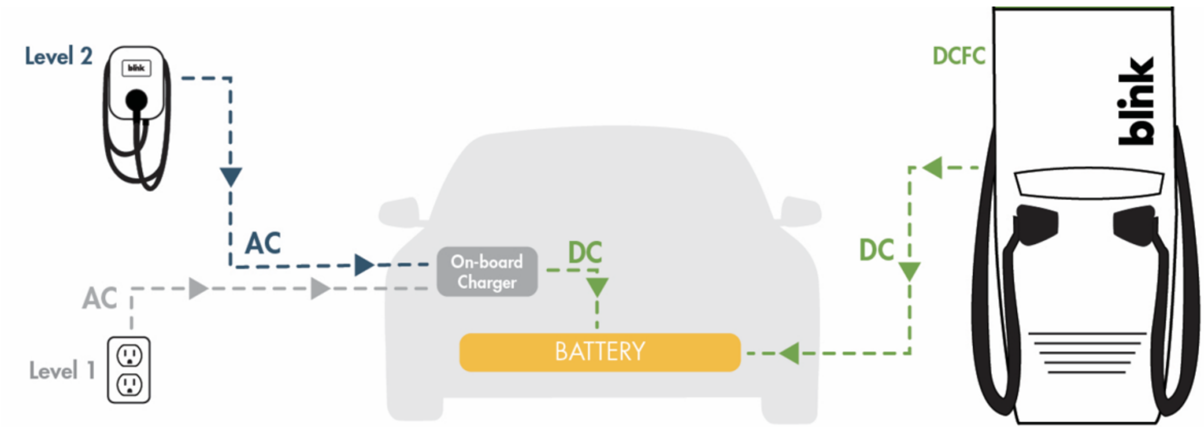


Fig 6.3 dc fast charging

6.3 CHARGING INFRASTRUCTURE FOR E VEHICLE:

The charging infrastructure for electric vehicles (EVs) is an essential component of the EV ecosystem. EVs require access to charging stations to recharge their batteries, and a reliable and convenient charging network is necessary to enable widespread adoption of EVs.

Charging infrastructure is a network of charging stations and connectors that allow electric vehicle (EV) drivers to recharge their vehicles. The infrastructure can be divided into different levels based on charging speed and voltage, with Level 1 being the slowest and Level 3 (DC fast charging) being the fastest. EVs use different types of connectors depending on the charging level and region, and charging stations can be located in various public locations such as parking lots, shopping canters, and gas stations. Charging networks operate groups of charging stations, and accessibility features such as clear signage and audio cues should be considered for all EV drivers. The expansion and improvement of charging infrastructure are essential for the continued growth and widespread adoption of EVs.

6.3.1 Electric vehicle supply equipment:

Electric vehicle supply equipment (EVSE) refers to the infrastructure used to charge electric vehicles. It includes the charging station, the connector, and any associated software and hardware needed to facilitate the charging process. The EVSE technology is constantly evolving, and new charging technologies are being developed, such as wireless charging, bidirectional charging, and ultra-fast charging. As the adoption of electric vehicles continues to grow, so too will the demand for EVSE, and it is essential to have a robust charging infrastructure in place to support this transition to electric mobility.

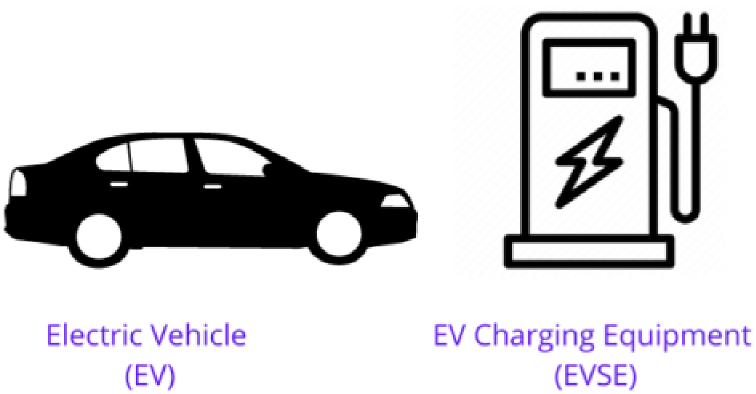


Fig 6.4 EVSE system

6.3.2 Public charging station:

Public charging stations for electric vehicles (EVs) are an essential component of the EV charging infrastructure, as they provide EV drivers with a convenient and accessible place to charge their vehicles while on the go. These charging stations can be found in various locations such as shopping malls, airports, public parking lots, and on-street parking spots.

The installation and management of public charging stations are usually done by a charging network operator (CNO) who provides the charging infrastructure and manages the billing and payment process. Some CNOs offer subscription-based charging plans, while others allow users to pay for charging on a per-use basis.

In conclusion, public charging stations are crucial to the adoption and growth of electric vehicles, as they provide EV drivers with a reliable and convenient way to charge their vehicles while away from home. The installation of more public charging stations is essential to support the transition to electric mobility and to reduce range anxiety among EV drivers.

6.3.3 Battery charging station:

A battery charging station for electric vehicles (EVs) is an infrastructure used to charge the vehicle's battery. These charging stations can be installed at homes, workplaces, or public locations, DC fast charging stations are the fastest charging option and use direct current (DC) to charge an EV's battery.

They can provide up to 350 kW of power and can charge an EV's battery to 80% capacity in as little as 20-30 minutes. DC fast charging stations are commonly found along highways and other major travel routes. As the demand for electric mobility continues to grow, the installation of more charging stations, including DC fast charging stations, is necessary to support long-distance travel and reduce range anxiety among EV drivers.

Fig 6.5 charging station

6.3.4 Captive charging station:

A captive charging station for an electric vehicle refers to a charging station that is owned and operated by a specific business or organization, typically for use by its employees or customers. Captive charging stations can be installed in various locations, such as office buildings, parking garages, or retail centers, and are intended to provide convenient charging options for electric vehicle owners who spend time at those locations.

Installing a captive charging station can provide several benefits for a business, such as attracting electric vehicle owners as customers or employees, improving the company's sustainability credentials, and potentially generating revenue from charging fees.

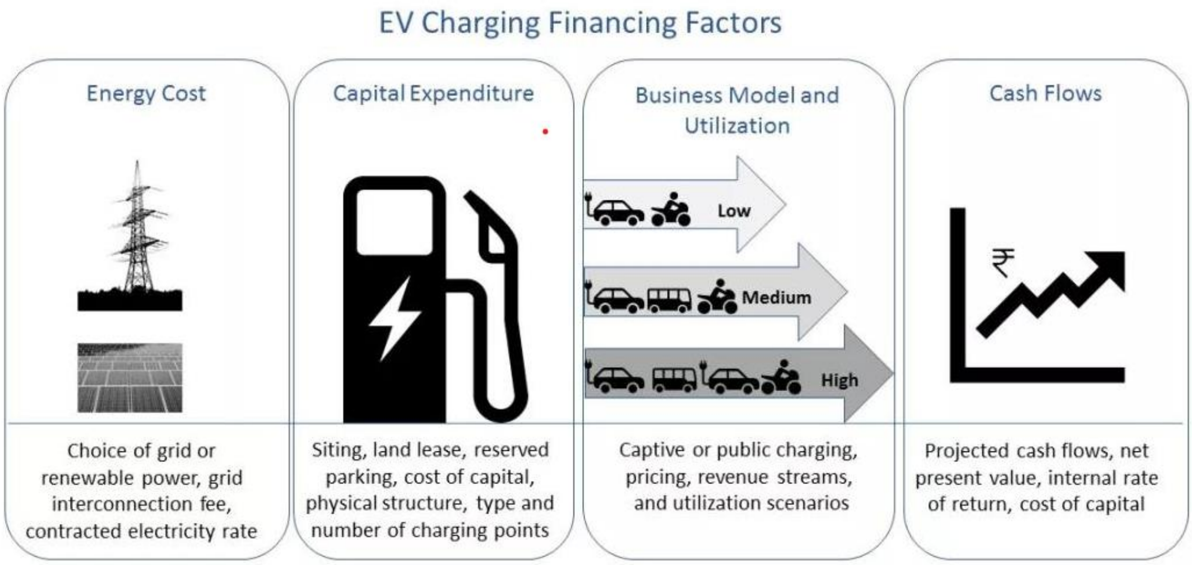


Fig 6.6 EV charging financing factors

6.4 KEY FUNCTION OF THE BMS IN E VEHICLE:

6.4.1 SOC estimation:

The BMS estimates the current state of charge of the battery pack based on the current and voltage measurements. State of Charge (SOC) estimation is a critical aspect of electric vehicle (EV) battery management, as it provides information about the remaining charge in the battery. SOC estimation is typically based on the measurement of the battery's voltage, current, and temperature, along with advanced algorithms that consider factors such as battery aging and degradation.

6.4.2 SOH estimation:

The BMS estimates the state of health of the battery pack based on the historical data and the current usage patterns. SOH estimation is typically based on the measurement of the battery's internal resistance, capacity, and other parameters, along with advanced algorithms that consider factors such as temperature, usage patterns, and aging. There are different methods for SOH estimation, including electrochemical impedance spectroscopy, model-based approaches, and data-driven methods.

6.4.3 Thermal management:

The BMS monitors the temperature of the battery pack and activates the cooling or heating system as needed to maintain the optimal temperature range. Thermal management in EVs typically involves a combination of active and passive cooling systems, which use liquid or air to dissipate heat generated by the battery and motor. Active cooling systems use pumps and heat exchangers to circulate coolant through the battery and motor, while passive systems rely on natural convection or radiation to dissipate heat.

6.4.4 Balancing:

The BMS ensures that the cells within the battery pack are balanced, meaning that they have the same state of charge, to prevent overcharging or undercharging of individual cells. Balancing is typically achieved through a battery management system (BMS), which monitors the voltage and current of each cell and ensures that they are charged and discharged evenly. BMS may use different balancing methods, including passive balancing, active balancing, and hybrid balancing.

6.4.5 Protection:

The BMS provides protection to the battery pack against overcharging, over-discharging, short-circuiting, and other types of faults. Protection systems in EVs typically include a range of sensors, circuits, and algorithms that monitor the vehicle's performance and respond to potential threats.

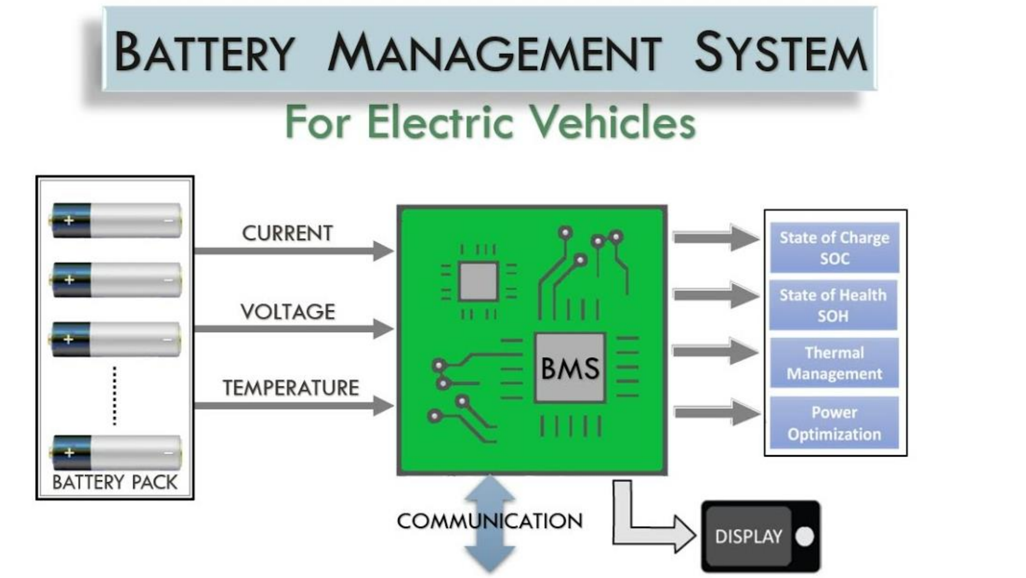


Fig 6.7 BLOCK DIAGRAM FOR BMS

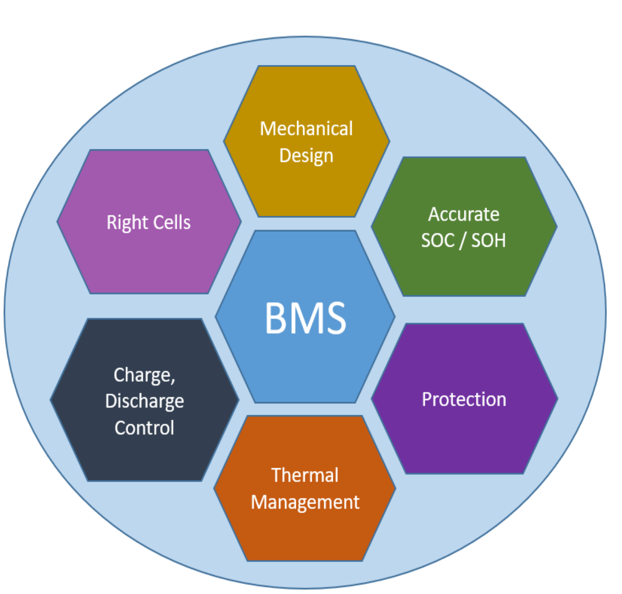


Fig 6.8 BMS system flow chart

CHAPTER 7

ELECTRICAL CAR- OPERATION OF LIGHTS BY VOICE COMMANDS

7.1 OVERVIEW OF AUDIO SYSTEM:

The traditional way of controlling car lights is by using physical switches. However, the use of voice commands to control car lights is becoming increasingly popular due to its convenience and accessibility. The project aims to provide a solution that allows users to control car lights without the need for physical switches. The system utilizes the Arduino Uno microcontroller, Elechouse V3 Module for voice recognition, and 24V Dual Channel Relay for controlling the car lights.

The traditional way of controlling car lights is by using physical switches. However, the use of voice commands to control car lights is becoming increasingly popular due to its convenience and accessibility. The project aims to provide a solution that allows users to control car lights without the need for physical switches. The system utilizes the Arduino Uno microcontroller, Elechouse V3 Module for voice recognition, and 24V Dual Channel Relay for controlling the car lights. The utilization of voice acknowledgment framework does not exclusively need voice source yet in addition ready to be utilized for autonomous voice source. Current commercial signaling system uses a mechanical turn switch in the form of moving the switch in required direction to switch on the turn indicator.

7.2 WORKING OF MANUAL TURN INDICATORS:

The conventional turn indicator present in most of the vehicles is a fully manual controlled system. The system requires the driver to move the turn switch in accordance to the direction of the required turn (upwards for a left turn and downwards for a right turn). This system sometimes might delay the indication of a driver to activate the turn signal. Most drivers do not activate the turn signal because there is a necessity to remove their hands from the steering wheel to switch on the indicator. For less experienced drivers, this method is even more difficult. The wiring of a conventional turn indicator is made as follows. At the point when no blinker is chosen, both brake lights will get control when the brake pedal is pushed.

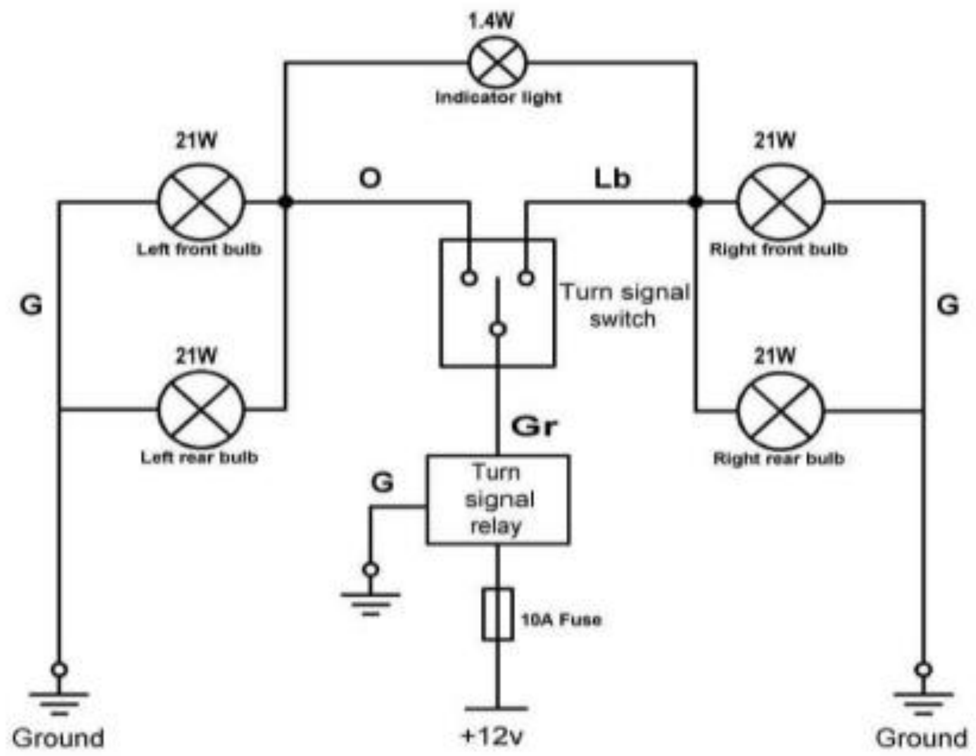


Fig 7.1 The schematic of the existing circuit diagram right/left indicator

7.3 PROPOSED SYSTEM:

The proposed system intends to accomplish automation of vehicle signaling system, and totally evacuate PROPOSED SYSTEM the manual control of the turn switch indicator. The framework fundamentally comprises of three principle segments, an Arduino UNO, voice recognition module compatible with the Arduino and an Arduino itself. An microphone regularly utilized in the PC framework is utilized as a voice sensor to record the assistant's voice. The recorded voice is handled in the voice module which will separate the directions for left and right turns. The perceived word is then utilized as contribution to the Arduino which will thus actuate the required indicator which is available in the vehicle. The Arduino Uno microcontroller is the main control unit that receives voice commands from the driver and sends signals to the Elechouse V3 module to activate the corresponding turn indicator. The Elechouse V3 module is a voice recognition module that recognizes specific voice commands and converts them into digital signals that the Arduino Uno can understand. The 24V dual channel relay is a switching device that turns on and off the car's turn indicators.

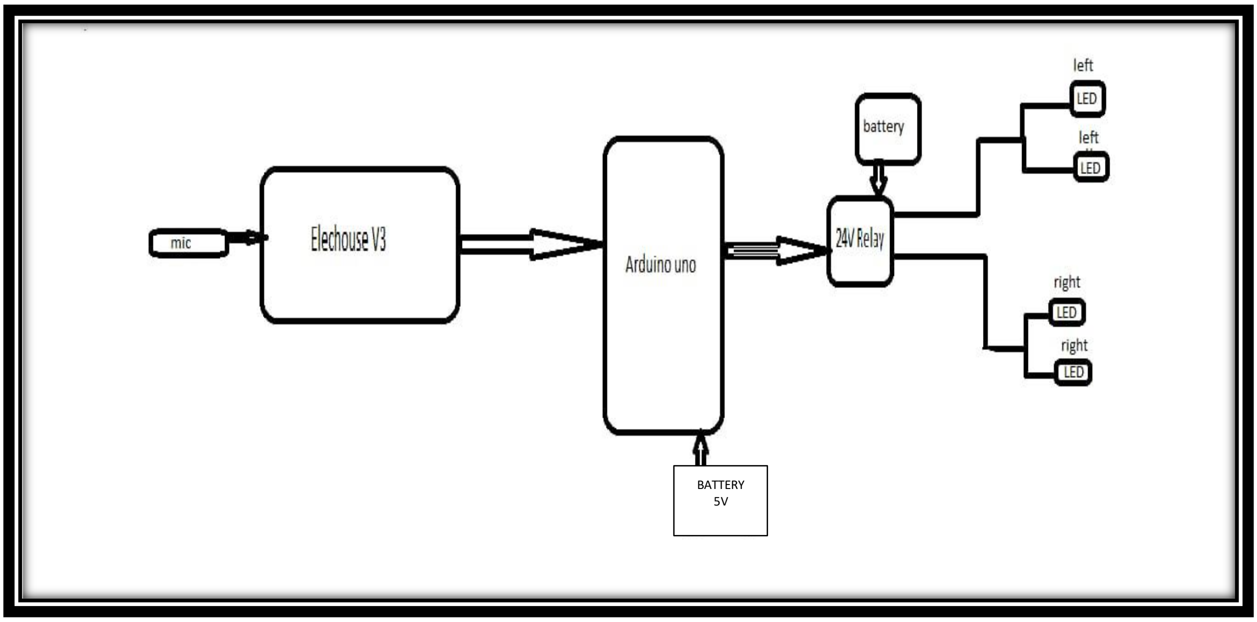


Fig 7.2 shows the block diagram of the proposed system

7.4 Elechouse V3 to Arduino UNO

The Elechouse V3 module is a voice recognition mTable odule that can recognize up to 15 voice commands. The module is easy to use and can be easily integrated with the Arduino Uno microcontroller. In this section, we will discuss how the Arduino Uno pins are used with the Elechouse V3 module.The Elechouse V3 module communicates with the Arduino Uno microcontroller through the serial port. The module has a TTL-level serial interface, which means it uses digital signals to communicate with the Arduino Uno. To use the module with the Arduino Uno, we need to connect the module to the Arduino Uno using four wires: power, ground, TX , and RX .The Elechouse V3 module requires a 5V power supply, which can be obtained from the Arduino Uno's 5V pin. Connect the VCC pin of the Elechouse V3 module to 5V pin of the Arduino Uno.

- Connect the GND pin of the Elechouse V3 module to GND pin of the Arduino Uno.
- Connect the RXD pin of the Elechouse V3 module to pin 0 of the Arduino Uno.

Elechouse V3 Module	Arduino Uno
VCC	5V
RX	0
TX	1
GND	GND

Table 4.1 Connecting pins from Elechouse V3 to Arduino UNO

7.5 ARDUINO UNO TO 24V DUAL CHANNEL RELAY:

The Arduino Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz quartz crystal, a USB connection, and a power jack. In this project, we will be using the digital input/output pins to control the 24V dual-channel relay.The digital input/output pins on the Arduino Uno can be configured as either input or output. When configured as input, the pins can detect the state of a connected sensor or switch. When configured as output, the pins can drive a connected LED, motor, or other device.The digital input/output pins are labeled D0 through D13 on the Arduino Uno. The pins D0 and D1 are also used for serial communication with other devices.

- VCC: This pin is connected to the power supply. It can accept a voltage range of 5V to 12V.
- GND: This pin is connected to the ground of the circuit.
- IN1: This pin is connected to the digital output pin of the Arduino Uno. It controls the first channel of the relay.
- IN2: This pin is also connected to the digital output pin of the Arduino Uno. It controls the second channel of the relay.
- COM: This pin is the common pin of the relay. It is connected to the negative terminal of the turn indicator.
- NO: This pin is the normally open pin of the relay. It is connected to the positive terminal of the turn indicator

- Connections between Arduino Uno and 24V Dual-Channel Relay:
- To control the turn indicators of the car using the Arduino Uno and the 24V dual-channel relay, we need to make the following connections:
- Connect the VCC pin of the 24V dual-channel relay to the 5V pin of the Arduino Uno.

- Connect the GND pin of the 24V dual-channel relay to the GND pin of the Arduino Uno.

Arduino UNO Pins	24V Dual Channel Relay
5V	VCC
GND	GND
Pin4	IN1
Pin5	IN2

Table 4.2 Connecting pins from Arduino UNO to 24V Dual relay

7.6 COMPONENTS USED:

- Arduino UNO ATmega328P
- Elechouse V3
- 24V Dual Channel Relay
- 3.6mm Microphone

7.7 PROGRAM

CHAPTER 8

ELECTRICAL CAR- MECHANICAL AND AERODYNAMICS DESIGN

8.1 INTRODUCTION:

An automotive differential is a mechanism that is commonly found in most vehicles with two or more driven wheels. It is designed to allow the wheels to rotate at different speeds while still receiving power from the engine, enabling smooth turning and improved traction.

The differential is usually located between the drive wheels, and it works by distributing torque between the wheels while allowing them to rotate at different speeds. When a vehicle turns, the inside wheel travels a shorter distance than the outside wheel, and the differential compensates for this by allowing the inside wheel to rotate at a slower speed than the outside wheel. This prevents the wheels from slipping and ensures a smooth and safe turn.

fig 8.1 differential of electrical vehicle

8.2 TYPES OF DIFFERENTIALS IN ELECTRICAL VEHICLE

There are several types of differentials used in electric cars, which are similar to those used in conventional gasoline-powered cars.

- Open Differential , Limited-Slip Differential(LSD) , Electronic Differential , Torque Vectoring Differential , Dual Motor Differential.

8.3 CONSTRUCTION:

The construction of a differential in an electric car is similar to that of a differential in a conventional gasoline-powered car, with some differences due to the absence of a transmission and internal combustion engine.

The differential in an electric car is typically located between the two electric motors, which are located on the front and rear axles of the car. The differential housing consists of a casing that contains the ring gear and pinion gear set, along with bearings and seals to support and lubricate the gears.

The pinion gear is mounted on the electric motor shaft and meshes with the ring gear, which is attached to the differential carrier. The differential carrier supports the side gears that engage with the drive axles, which are responsible for transmitting torque to the wheels.

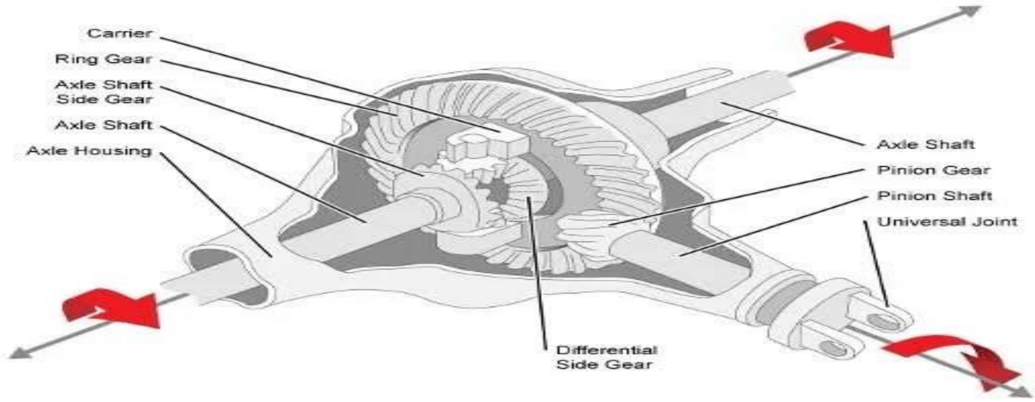


fig 8.2 Working of differential of electrical vehicle

8.4 WORKING OF DIFFERENTIAL:

In an electric car, the differential plays a crucial role in transmitting power from the electric motor to the wheels. The differential is a mechanical device that allows the wheels on an axle to rotate at different speeds while still receiving power from the motor.

The differential consists of a housing containing gears that mesh with the ring gear attached to the drive shaft. The pinion gear is mounted on the end of the motor shaft and meshes with the ring gear. As the motor turns, it rotates the pinion gear, which in turn rotates the ring gear and the differential housing.

Inside the differential housing, there are two side gears, one for each wheel. These side gears mesh with the differential pinions, which allow them to rotate independently of each other. When the car is traveling in a straight line, the differential pinions rotate at the same speed, and the side gears rotate at the same speed as the ring gear, which rotates at the same speed as the motor.

When the car turns, the outside wheel travels a greater distance than the inside wheel. This means that the outside wheel needs to rotate faster to maintain traction and prevent skidding. The differential allows this by allowing the side gear on the outside wheel to rotate faster than the side gear on the inside wheel. This is achieved by the differential pinions rotating at different speeds, which allows the side gears to rotate at different speeds as well.

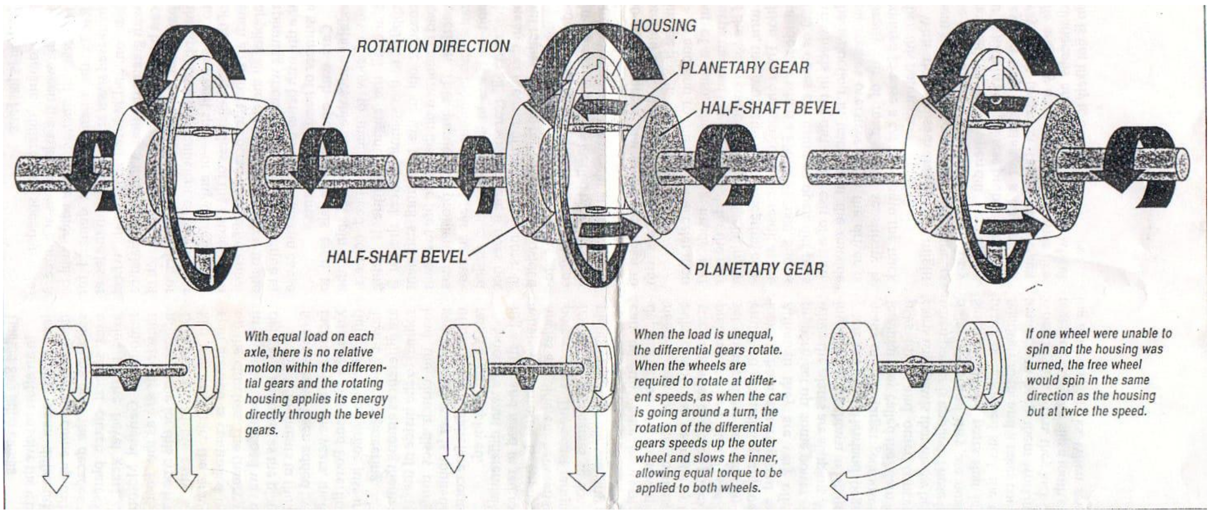


fig 8.3 working model of differential

8.5 BENEFITS OF DIFFERENTIAL:

- Improved handling and stability when turning.
- Reduced tire wear and stress on drivetrain components.
- Better traction and acceleration on uneven surfaces.
- Increased efficiency and range of electric motor.

- More precise control of power delivery to each wheel.
- Enhanced safety and stability in slippery conditions.
- Reduced risk of vehicle damage or failure.

8.6 RACK AND PINION:

Rack and pinion is a steering system used in many modern cars, including electric cars. The system consists of two main components: the rack and the pinion.

The rack is a long, flat metal bar with teeth along its length. The pinion is a small gear that meshes with the teeth on the rack. The pinion is attached to the steering wheel and as the driver turns the wheel, the pinion rotates and moves the rack left or right.

fig 8.4 Model of Rack and Pinion

8.6.1 TYPES OF RACK AND PINION:

There are several types of rack and pinion systems that can be used in electric cars, depending on the specific design and requirements of the vehicle. Here are a few examples:

Power-assisted rack and pinion: This is a common type of system used in electric cars, which combines a hydraulic or electric power steering pump with a traditional rack and pinion setup. The power assist helps to reduce the effort required to turn the steering wheel, making it easier for drivers to control the vehicle.

Electric power steering rack and pinion: In this type of system, the rack and pinion is powered by an electric motor, rather than a hydraulic pump. This can help to improve efficiency and reduce maintenance requirements, since there are no fluids to leak or replace.

Dual-pinion electric power steering: Some electric cars may use a dual-pinion setup, which includes two small pinions on the steering rack instead of one large one. This can provide more precise and responsive steering, as well as improved energy efficiency.

8.7 WORKING OF RACK AND PINION:

Rack and pinion is a type of mechanical mechanism that is used to translate rotary motion into linear motion. It consists of a gear, called a pinion, that meshes with a flat bar with teeth, called a rack.

When the pinion gear is rotated, it causes the rack to move in a straight line. This linear motion can be used to perform work, such as turning wheels or moving machinery.

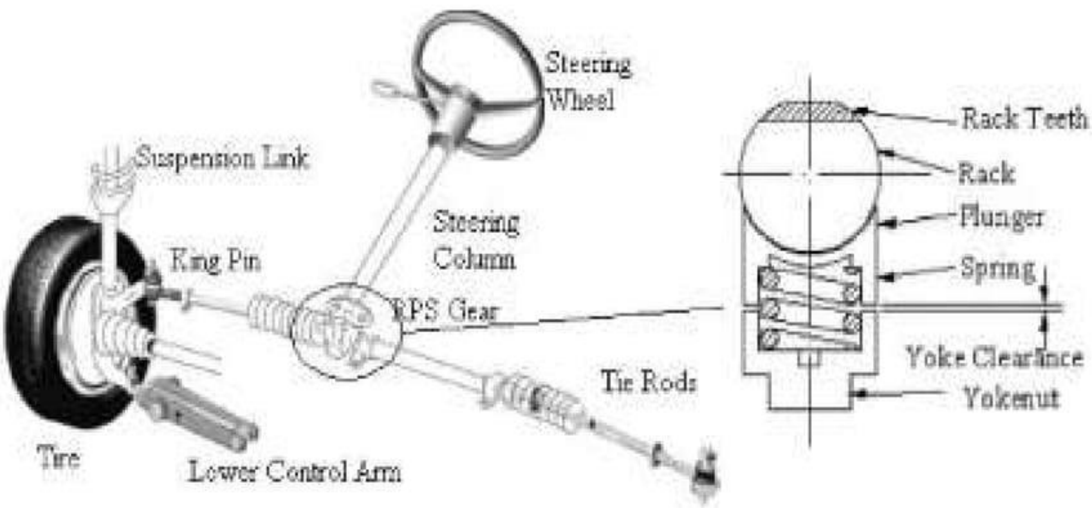


fig 8.5 Working of Rack and Pinion with streering

The rack and pinion mechanism is commonly used in steering systems of automobiles and other vehicles. In a car's steering system, the pinion gear is attached to the steering shaft, which is turned by the driver. The rack is attached to the vehicle's front wheels and moves them left or right, depending on the direction the driver turns the steering wheel.

8.8 STEERING RATIO:

The steering ratio of an e-car with a rack and pinion steering system depends on various factors such as the vehicle's design, weight, and intended use. However, a typical steering ratio for an e-car with a rack and pinion system would be around 15:1.

This means that for every 15 degrees of rotation of the steering wheel, the front wheels of the e-car will turn by one degree. A lower steering ratio will result in a more responsive and quicker steering feel, while a higher ratio will provide a slower and more stable feel. The specific ratio chosen for an e-car will depend on the manufacturer's design preferences and intended use of the vehicle.

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8.8.1 Advantages:

- Efficiency
- Precise control
- Compact design
- Low maintenance
- Smooth operation.

8.9 AERODYNAMIC IN ELECTRIC VEHICLE:

\Aerodynamics play a crucial role in the performance and efficiency of electric vehicles. As with any vehicle, reducing drag and improving airflow can lead to a more efficient use of energy and increased range.

One way that electric vehicles can improve aerodynamics is by reducing the amount of air resistance that the vehicle encounters. This can be accomplished through design changes such as smoothing out the vehicle's body shape, reducing the size of the vehicle's frontal area, and incorporating features such as aerodynamic mirrors and wheels.

Another way that aerodynamics can be improved is through the use of active aerodynamic systems. For example, some electric vehicles use active grille shutters that can automatically open and close to regulate airflow to the engine compartment, reducing drag when the engine doesn't need as much cooling. Another active aerodynamic system is the use of air curtains, which can help reduce turbulence and drag by directing air around the vehicle in a more efficient manner.

Finally, electric vehicles can also benefit from improved underbody aerodynamics. By smoothing out the underbody and adding aerodynamic features such as underbody panels and diffusers, airflow can be better managed, reducing turbulence and drag and improving overall efficiency.

8.9.1 FRONT SCOOP :

In electric vehicles, front scoops are less common than in traditional internal combustion engine vehicles. This is because electric vehicles don't require as much air flow for combustion as combustion engine vehicles. However, there are still some instances where a front scoop can be beneficial for an electric vehicle.One possible application of a front scoop in an electric vehicle is for cooling the battery. Electric vehicle batteries can generate a significant amount of heat during operation, which can A front scoop can help direct air flow to the battery compartment, which can help cool the batteries and improve their performance and longevity.

Another use for a front scoop in an electric vehicle is to improve the vehicle's aerodynamics. While electric vehicles don't have an exhaust system or transmission that needs to be cooled, they still benefit from improved aerodynamics to reduce drag and improve efficiency.

A front scoop can be designed to direct air around the vehicle in a more efficient manner, reducing drag and improving the vehicle's overall range .It's also worth noting that some electric vehicles use a front scoop for aesthetic purposes. Electric supercars, for example, may use a front scoop to enhance their aggressive and sporty appearance be carefully aggressive and sporty appearance.

In summary, while a front scoop is less common in electric vehicles than in combustion engine vehicles, there are still situations where it can be beneficial.

Whether it's to cool the battery and motor in high-performance applications, improve aerodynamics, or simply for aesthetic purposes, a front scoop can play a role in the design and performance of an electric vehicle.

8.9.2 WIND FAIRINGS:

Wind fairings are also beneficial for electric vehicles, as they can help improve the vehicle's aerodynamics and reduce wind resistance. While electric vehicles do not have a traditional engine and exhaust system that requires cooling, they still benefit from improved aerodynamics to reduce drag and increase their overall range.

Wind fairings can be especially beneficial for electric SUVs and crossovers, which tend to have a larger frontal area and higher center of gravity than smaller passenger cars. By reducing wind resistance, wind fairings can help improve the stability of these vehicles at high speeds and increase their overall efficiency.

In addition to their aerodynamic benefits, wind fairings can also help reduce wind noise in electric vehicles, creating a quieter and more comfortable driving experience for passengers.

Overall, wind fairings are a simple and effective way to improve the aerodynamics and efficiency of electric vehicles, helping to maximize their range and performance while providing a more comfortable and enjoyable driving experience for passengers.

CHAPTER 9

RESULT

V

V

V

9.2 LIMITATIONS AND FUTURE SCOPES:

- **LIMITED RANGE**: EVs have a limited range compared to gasoline-powered vehicles, and this range can be further reduced by factors such as weather conditions, driving style, and terrain.
- **CHARGING INFRASTRUCTURE**: The availability of charging stations is still limited, especially in rural and remote areas, which can be a barrier for EV adoption.
- **BATTERY PRODUCTION AND DISPOSAL**: The production and disposal of batteries used in EVs can have environmental impacts, including resource depletion and pollution.
- **COST**: EVs are typically more expensive than traditional vehicles, although this cost is expected to decrease as production increases and technology improves.
- **PERFORMANCE**: EVs may not have the same level of performance as gasoline-powered vehicles, particularly in terms of acceleration and top speed.

9.3 FUTURE SCOPES:

BATTERY TECHNOLOGY: The development of more advanced batteries that offer higher energy density and faster charging times could greatly enhance the performance and range of EVs. **Lithium-ion battery technology is superior to lead-acid** due to its reliability and efficiency, among other attributes.

MOTOR: PMDC motor do not require field winding, thus, they do not have field circuit copper loss. PMDC motors have higher efficiency as compared to conventional DC motors. Due to low torque repulsion, **PMSM gets higher and**

smooth torque with higher efficiency and low noise than BLDC. PMSM has a higher power density, which will help in reducing the size of the motor.

STEERING SYSTEM: Four-wheel steering means all wheels steer. It helps to increase the stability at higher speeds and also helps to make quicker lane changes even if the vehicle is towing. Advanced four wheel steering systems are capable of turning the rear wheels in opposing directions, which can help in difficult braking conditions.

REGENERATIVE BRAKING SYSTEM: Regenerative braking systems (RBSs) are a type of kinetic energy recovery system. It captures the kinetic energy from braking and converts it into the electrical power that charges the vehicle's high voltage battery.

CHARGING INFRASTRUCTURE: The expansion of charging infrastructure, including the deployment of fast-charging stations and wireless charging technology, could make EVs more practical for long-distance travel.

RENEWABLE ENERGY: The growth of renewable energy sources, such as wind and solar power, could provide an increasingly clean and sustainable source of energy for charging EVs.

AUTONOMOUS DRIVING: The development of autonomous driving technology could make EVs more convenient and practical for consumers, especially in urban areas where traffic congestion is a major issue.

VEHICLE-TO-GRID TECHNOLOGY: The integration of EVs into the power grid through vehicle-to-grid technology could enable them to function as a mobile battery storage system, helping to balance the electricity grid and reduce demand during peak periods.

CONCLUSION:

In conclusion, electric vehicles (EVs) are becoming increasingly popular due to their environmental benefits, reduced operating costs, and improved performance. As battery technology continues to improve, the driving range of EVs is increasing, making them a viable option for many drivers. Additionally, as more charging infrastructure is installed, the inconvenience of charging an EV is becoming less of an issue. However, the higher upfront cost of EVs compared to traditional gas-powered vehicles remains a barrier for many consumers. Despite this, the long-term savings on fuel and maintenance costs can make EVs a financially sensible choice for some. Overall, the transition to electric vehicles is a promising development in the effort to reduce greenhouse gas emissions and mitigate climate change.

Electric vehicles are a promising solution to reducing greenhouse gas emissions and mitigating climate change, as they produce zero emissions at the tailpipe and can be powered by renewable energy sources.

Despite the higher upfront cost of electric vehicles, they offer long-term savings on fuel and maintenance costs, making them a financially sensible choice for some consumers.

The driving range of electric vehicles is increasing as battery technology improves, and the installation of more charging infrastructure is making them a more convenient option for drivers.

The adoption of electric vehicles is growing rapidly, driven by government incentives, consumer demand, and technological advancements.

Electric vehicles offer a superior driving experience compared to traditional gas-powered vehicles, with instant torque and quiet operation, making them an appealing option for performance-minded drivers.

The high upfront cost of electric vehicles remains a barrier for many consumers, but the long-term savings on fuel and maintenance costs can make them a financially sensible choice for some.

The environmental benefits of electric vehicles are significant, but the production and disposal of batteries can have negative environmental impacts that must be addressed.

Electric vehicles can help to reduce our dependence on imported oil and increase energy security.

The development of autonomous electric vehicles has the potential to revolutionize the way we think about transportation, making it safer, more efficient, and more sustainable.

Electric vehicles are a rapidly evolving technology, and ongoing research and development is essential to ensure that they continue to improve and become more widely adopted.

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