Journal of Current Research in Engineering and Science
Bi-Annual Online Journal (ISSN : 2581 - 611X)

Volume 7-Issue 1, January 2024
Paper: 72

A Multi-Output DC To DC Converter for Electric Car Application

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1. INTRODUCTION

1.1 GENERAL

The idea of employing electric power instead of fossil fuels as motive energy of vehicles is not new. Scientists and manufacturers have attempted to design an Electric Vehicle (EV) since long time ago. Robert Anderson had built the first electric carriage in 1839 and David Salomon developed an electric car using a light electric motor in 1870 . Conventional electric vehicles have a central electric motor that actuates two or all four wheels of the vehicle.

Present industry is increasingly shifting towards automation. Two principal components of today's industrial automations are programmable controllers and robots. In order to aid the tedious work and to serve the mankind, today there is a general tendency to develop an intelligent operation. However, the in-wheel motor idea first introduced in 1884 by Wellington Adams who have built and attached an electric motor directly in the vehicle's wheel through complicated gearings. Since in an in-wheel motor EV individual control of each wheel is possible; better vehicle speed, torque and acceleration control can be achieved. Using in-wheel motor technology improves drive train efficiency, dynamic stability control and safety of electric vehicles.

In modern pure electric and hybrid vehicles, battery voltages of 300- 400 V is becoming common, 600 V is gaining ground and 800 V systems are starting to emerge, all to help produce more power yet keep current flows and cabling manageable. However, these voltages do not suit all the electrical loads aboard the vehicle, so a means of converting them to lower or sometimes higher levels efficiently

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is essential. That is the role of the DC-DC converter. Also known as auxiliary power modules (APMs), they can be found in every EV or hybrid with a high voltage battery. Fundamentally, this is because direct electronic conversion between voltages is much simpler and more efficient than the indirect alternative of taking a feed from the high-voltage inverter to power a motor and belt drive for a low-voltage alternator. In functional terms there are basically two kinds of DC-DC converter – one to bring high voltages down, the other to convert between different voltages at the low end. A vehicle's main DC-DC converter typically takes a battery's voltage down to 12 V for common carloads such as headlights, window motors, pumps and so on. It also has to be adjustable, as some loads may need outputs in the 12.5 to 15.5 V range, while 42 V might be needed by power steering systems, for example. Power outputs range from 250 W to 3.5 kW, although some onboard chargers (OBCs) handle more than 6 kW; about 7.4 kW is regarded as the practical limit. Critical loads on the low-voltage side, such as steering, are driving an increase in functional safety requirements for converters, while reliability demands are also growing because vehicle OEMs want to reduce the size of the low voltage battery.

In some applications, APMs also convert a voltage upwards to help start a hybrid vehicle or provide back-up power, which requires a bidirectional capability. This type of arrangement is typically found in mild hybrids, converting between 14 and 48 Every Electronic circuit is assumed to operate some supply voltage which is usually assumed to be constant in nature.

A voltage regulator is a power electronic circuit that maintains a constant output voltage irrespective of change in load current or line voltage. Many different types of voltage regulators with a variety of control schemes are used. With the increase in circuit complexity and improved technology a more severe requirement for accurate and fast regulation is desired. This has led to need for newer and more reliable design of dc-dc converters. The dc-dc converter inputs an unregulated dc voltage input and

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outputs a constant or regulated voltage. The regulators can be mainly classified into linear and switching regulators. All regulators have a power transfer stage and a control circuitry to sense the output voltage and adjust the power transfer stage to maintain the constant output voltage. Since a feedback loop is necessary to maintain regulation, some type of compensation is required to maintain loop stability. Compensation techniques vary for different control schemes and a small signa21l analysis of system is necessary to design a stable compensation circuit. State space analysis is typically used to develop a small signal model of a converter.

1.2 BACKGROUND STUDY

Behavioural modelling is a fast, efficient, and easy manner to establish a given theory and more importantly the most efficient manner to develop a direct comparison between competing methods. The voltage control scheme is the basis for more advanced control schemes. An oracle implementation of voltage controlled buck converter is presented. Voltage control has a slow transient response due to the bandwidth limitation of the error amplifier in the feedback path. The DC-DC converter is inherently a high ripple system and to exploit this Feature current mode control was widely used for better transient response to line variation.

However, this approach depends on error amplifier speed to control load variation. In this thesis all analysis are for constant frequency control or pulse width modulation (PWM).

1.3 LITERATURE SURVEY

Shreyash.S.et al. [1], There are various types of prime mover used to drive various machines such as IC engines, turbines, motors etc. these are the mandatory parts required for functionality of any machine. Motor is most widely used prime mover considering its size and input power requirements. In this paper we will discuss on design and optimization of PMDC motor for high power to weight ratio for short duty cycle. By lowering the net resistance of armature and maximizing the net magnetic flux density we can increase the power output of motor.

V. Indragandhi.et al. [2],This paper is reported with different kinds of DC-DC converters such as epic, boost and bidirectional converters. Integrating the boost, epic, bidirectional DC-DC converters enables to identify the suitable converter for renewable energy applications with accurate power rating. The performance of non-isolated converter is assessed on the basis of these review. The solar PV conversion efficiency is low, so the converter is used to step-up/step down the voltage levels. This paper attempts to perform by examine efficiency of DC-DC converters and the voltage and current stress on the switches. A detailed review is carried out on basic PV and fuel cell based electric vehicles.

S.Shiva Kumar Chary.et al [3],The surge in the cost of fuels can be accounted as a major trigger which leads to the advent of hybrid vehicles. The hybrid electric vehicles are in the reckoning to address the dangers of the exponential increase in contamination of air and global warming associated with greenhouse gases. A vehicle that is a combination of reversible storage devices like batteries and main energy sources (oil or gas). A HEV emanates reduced emission from its IC engine when compared to a pure petrol car of the same size. In the context of Hybrid Electric Vehicle, the DC-DC power converters are the electronic devices that condition the source voltage of one level to the output voltage of another level of different DC voltage based on the application provided for the electric vehicle for charging and discharging modes.

Hyun-Wook Seong et al. [4], Describes non-isolated high step-up DC-DC converters using zero voltage switching (ZVS) boost integration technique (BIT) and their light-load frequency modulation (LLFM) control. The proposed ZVS BIT integrates a bidirectional boost converter with a series output module as a parallel-input and series-output (PISO) configuration.

Zhen Zhang et al [5], designed a bidirectional isolated DC-DC converter controlled by phase-shift and duty cycle for the fuel cell hybrid energy system is analysed and designed. The proposed topology minimizes the number of switches and their associated gate driver components by using two high frequency transformers.
which combine a half-bridge circuit and a full-bridge circuit together on the primary side. Tanmoy Bhattacharya et al., proposed a multi- power-port topology which is capable of handling multiple power sources and still maintains simplicity and features like obtaining high gain, wide load variations, lower output-current ripple, and capability of parallel-battery energy due to the modular structure. The scheme incorporates a transformer winding technique which drastically reduces the leakage inductance of the coupled inductor.

Hua Bai et al. [6],Conducted a study on bidirectional DC-DC converter in a HEV. This DC-DC converter is a high-power converter that links the high voltage battery (HV) at a lower voltage with the high voltage DC bus. The typical voltage of a battery pack is designed at 300 to 400V. The best operating voltage for a motor and inverter is around 600V. Therefore, this converter can be used to match the voltages of the battery system and the motor system. Other functions of this DC-DC converter include optimizing the operation of the power train system, reducing ripple current in the battery, and maintaining DC link voltage, hence, high power operation of the power train.

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2. EXISTING SYSTEM

2.1 INTRODUCTION

With increasing awareness towards economic and environmental concerns associated with fuel combustion in automobiles with world is focusing on the development of sustainable technologies. The transportation sector is one of the highest consumers of fossil fuels and the largest contributor of greenhouse gas (GHG) emissions in Canada with gasoline sales constituting 40% of the country total domestic petroleum sales.

The oil dependency, particularly light duty vehicles, is responsible for quarter of the total GHG emissions in the rising oil prices. Hybrid electric vehicles (HEVs) offer a fuel-efficient solution that combines an electric motor-based drivetrain with the conventional internal combustion engine (ICE) to reduce fuel consumption and vehicles emissions. These HEV benefits have prompted the automakers to develop hybrid vehicles, most of which are available in Canada today. However, consumer acceptance to hybrid vehicles remains low, mostly due to public unawareness of the performance and reliability of HEV technology as well as the high initial cost of hybrid cars. Environment-friendly alternatives and to current hybrid Canadian vehicles owners. The policies, programs, and incentives to promote sustainable transportation and to encourage the public to adopt this green technology are also discussed in detail.

2.2 EXISTING SYSTEM MODEL

A DC-to-DC converter is an electronic circuit or electromechanical device that converts a source of direct current (DC) from one voltage level to another. It is a type of electric power converter shown in Figure 2.1. Power levels range from very low (small batteries) to very high (high-voltage power transmission).Although by 1976 transistor car radio receivers did not require high voltages, some amateur radio

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operators continued to use vibrator supplies and dynamotors for mobile transceivers requiring high voltages although transistorized power supplies were available.

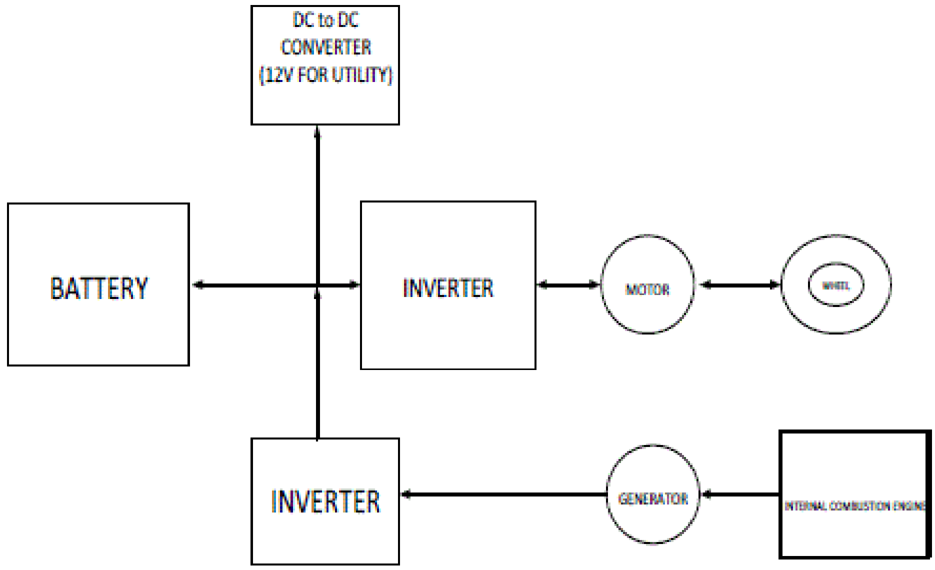

Fig 2.1 Block diagram of DC to DC converter

Electric Vehicle (EV) sales have grown dramatically. The first mass-produced EV, the EV1, sported a range of 70 to 100 miles, while a base-model Tesla Model 3 has a range of 264 miles for similar costs. Improvements in total range and lifetime of EV's is mostly responsible for this massive increase in popularity. The output voltage is measured through potential transformer connected. The potential transformer output is amplified and then given to analog to digital converter. That digital output is processed in microcontroller. It will check the set voltage over output voltage and produce the PWM pulse according to that.

A standard DC-DC converter will contain a switching device, an inductor, and input and output capacitors. In an isolated device, a transformer will typically be included as the method of galvanic isolation. The two main ways of improving EV

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range is through system efficiency and improved battery technology. System efficiency improvements are mostly due to the use and improvement of power electronics systems within the vehicle. Power electronics refers to the use of switching electronics for power conversion and distribution. The Figure 2.1 shows the simple form of DC to DC converter.

2.3 PROBLEMS OF EXISTING SYSTEM

- Isolated DC-DC converter has more energy transformer on condition of the barrier.
- The output of isolated converter is organized as positive or negative. Switching converters are prone to noise.
- They are expensive.
- Choppers are inadequate due to unsteady voltage and current supply.

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3 PROPOSED SYSTEM

3.1 INTRODUCTION

A DC-to-DC converter is an electronic circuit or electromechanical device that converts a source of direct current (DC) from one voltage level to another. It is a type of electric power converter. Power levels range from very low (small batteries) to very high (high-voltage power transmission).Although by 1976 transistor car radio receivers did not require high voltages, some amateur radio operators continued to use vibrator supplies and dynamotors for mobile transceivers requiring high voltages although transistorized power supplies were available.

DC –DC converters are power electronic circuits that convert a dc voltage to a different voltage level. There are different types of conversion method such as electronic, linear, switched mode, magnetic, capacitive. Unstable or improper voltage supplies leads to characteristics degradation and even malfunction .To prevent this, a DC to DC converter is needed to stabilize the voltage. A device that stabilizes the voltage using a DC -DC converter is referred as a voltage regulator.

These are electronic devices that are used whenever change of DC electrical power from one voltage level to another is needed. Generically speaking the use of a switch or switches for the purpose of power conversion can be regarded as an SMPS. From now onwards whenever we mention DC-DC converters we shall address them with respect to SMPS.

A few applications of interest of DC-DC converters are where 5V DC on a personal computer motherboard must be stepped down to 3V, 2V or less for one of the latest CPU chips; where 1.5V from a single cell must be stepped up to 5V or more, to operate electronic circuitry.

In all of these applications, we want to change the DC energy from one voltage level to another, while wasting as little as possible in the process. In other words, we want to perform the conversion with the highest possible efficiency.

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DC-DC Converters are needed because unlike AC, DC can't simply be stepped up or down using a transformer. In many ways, a DC-DC converter is the DC equivalent of a transformer. They essentially just change the input energy into a different impedance level. So whatever the output voltage level, the output power all comes from the input; there is no energy manufactured inside the converter. Quite the contrary, in fact some is inevitably used up by the converter circuitry and components, in doing their job. The Figure 3.1 shows the advanced model of Multiple DC to DC converter.

3.2 PROPOSED SYSTEM

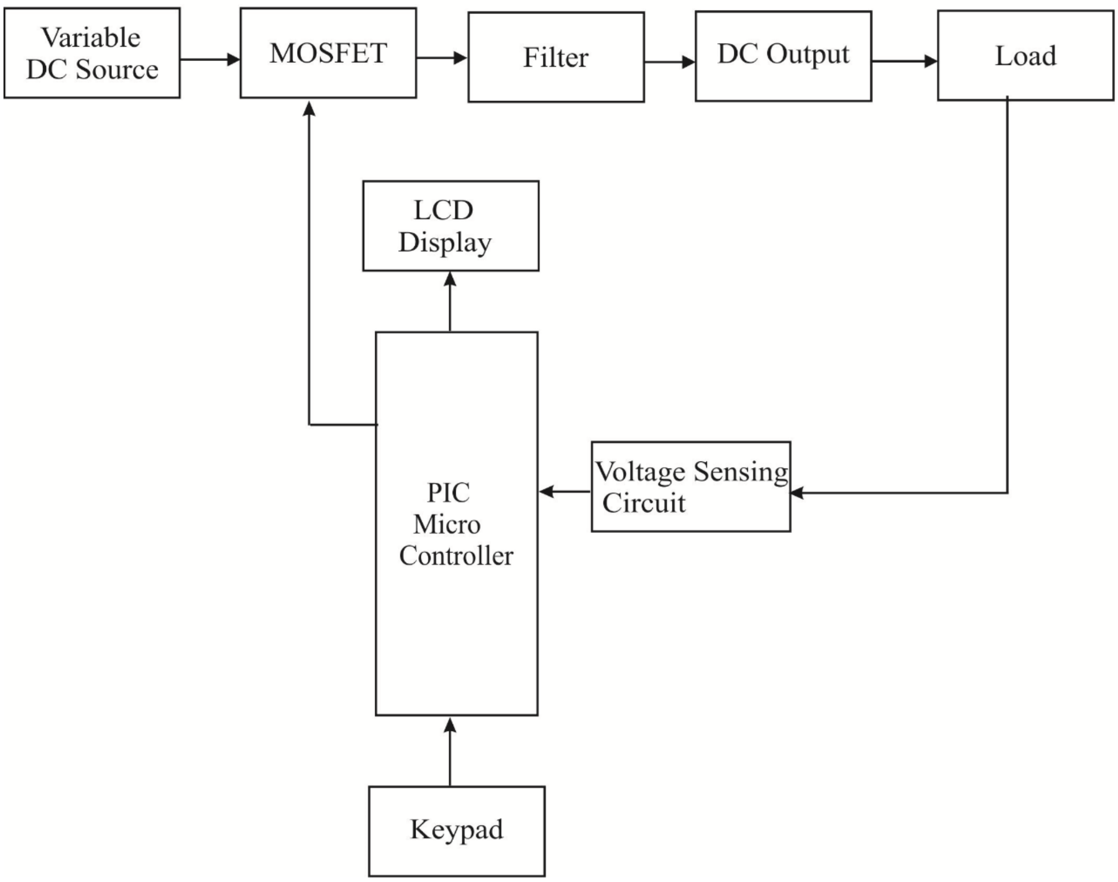

Figure 3.1 Block Diagram of Multiple DC to DC Converter.

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The proposed system "Multiple DC to DC Converter" is designed and developed to accomplish the various tasks in an adverse environment of an industry shown in figure 3.1. The intelligent machine is loaded with several units such as Input Volt Source, LCD, microcontroller, and alarm which synchronously work with the help of a start-of-the-art PIC microcontroller. This project is an owe to the technical advancement. This prototype system can be applied effectively and efficiently in an expanded dimension to fit for the requirement of industrial, research and commercial applications.

Microcontroller is the heart of the device which handles all the sub devices connected across it. We have used as microcontroller. It has flash type reprogrammable memory. It has some peripheral devices to play this project perform. It also provides sufficient power to inbuilt peripheral devices. We need not give individually to all devices. The peripheral devices also activates as low power operation mode. These are the advantages are appearing here.

The batteries of a Battery Electric Vehicle (BEV) typically output several hundred volts of Direct Current (DC). However, the electric components inside the vehicle vary in their voltage requirements, with most running on a much lower voltage. This includes the radio, dashboard readouts, air conditioning, and in-built computers and displays. A DC-to-DC converter is a category of power converters, which converts a DC source from one voltage level to another. It can be unidirectional, which transfers power only in one direction, or bidirectional, which can transfer power in either direction. Moreover, a DCDC converter is a critical component in the architecture of a BEV, where it is used to convert power from the high voltage (HV) bus to the 12V Low Voltage (LV) bus to charge the LV battery and power the onboard electric devices.

Battery electric vehicles have multiple architectural variations, and figure 1 shows a simplified block diagram of one of this architecture. Here, an HV bus,

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supplied by the large battery, drives the electric powertrain. Most of the components are bidirectional, allowing power to go from the battery to the inverter, which rotates the motor and moves it (traction drive).When decelerating, the vehicle's momentum turns the motor, which is now acting as a generator, drives power back through the inverter, and charges the battery (regenerative braking). Here, the DC-DC converter is the device that converts higher voltage DC power from the traction battery pack to the lower-voltage DC power needed to run vehicle accessories and recharge the auxiliary battery.

3.3 TYPES OF DC-DC CONVERTER

There are different kinds of DC-DC converters. A variety of the converter names are included here,

- The BUCK converter
- The BOOST converter
- The BUCK-BOOST converter

3.3.1 Buck Converter

Buck Converter is a type of chopper circuit that is designed to perform step-down conversion of the applied dc input signal. In the case of buck converters, the fixed dc input signal is changed into another dc signal at the output which is of lower value shown in figure 3.2. This means it is designed to produce a dc signal as its output that possesses a lower magnitude than the applied input. It is sometimes called Step-down DC to DC Converter or Step-down Chopper or Buck Regulator.

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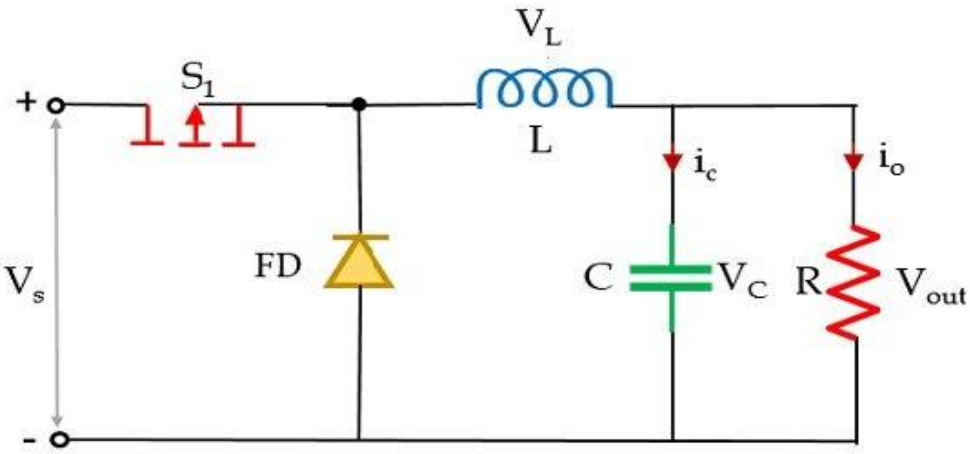

Figure 3.2 Buck Converter

In the above figure 3.2 shows the circuit of Buck converter, it is clearly shown that along with the power electronics solid-state device which acts as a switch for the circuit, there is another switch in the circuit which is a freewheeling diode. The combination of these two switches forms a connection with a low-pass LC filter in order to reduce current or voltage ripples. This helps in generating regulated dc output. A pure resistor is connected across this whole arrangement that acts as a load of the circuit.

A buck converter or step-down converter is a DC-to-DC converter which steps down voltage (while stepping up current) from its input (supply) to its output (load).The Buck-Boost or Inverting regulator takes a DC input voltage and produces a DC output voltage that is opposite in polarity to the input. The negative output voltage can be either larger or smaller in magnitude than the input voltage.

VsLDTs=VoL(1−D)Ts.

The principle of operation of a converter is based on the switch mode action of its switches. Commutations of the switches generate very fast current and/or voltage transients so that the transient behaviour of the sources is fundamental for

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converter design. There are a number of benefits to using multiphase buck converters, such as

- Higher efficiency from lower transitional losses.
- Lower output ripple voltage.
- Better transient performance.
- Lower ripple-current-rating requirements for the input capacitor.

3.3.2 Boost Converter

Boost Converters sometimes, also known as step-up choppers are the type of chopper circuits that provides such an output voltage that is more than the supplied input voltage shown in figure 3.3. In the case of boost converters, the dc to dc conversion takes place in a way that the circuit provides a high magnitude of output voltage than the magnitude of the supply input. It is given the name 'boost' because the obtained output voltage is higher than the input voltage. Previously, we have seen another type of chopper circuit i.e., buck converter. Buck converters generate an output voltage that is lower than the supplied input. So, we can say, boost converters are the ones that perform a reverse operation of the buck converter. Due to the type of operation performed by boost converters, these are referred to as step-up choppers.

It is to be noted here that since the product of voltage and current results in power then with the increase in the output voltage, the output current through the circuit will automatically decrease. In chopper circuits, power MOSET, BJT, IGBT, etc. are used as switches while the thyristors are not used for such purposes and the reason for the same is that an external commutation circuit is needed in order to commutate the device. The Figure 3.3 shows the circuit of Boost converter.

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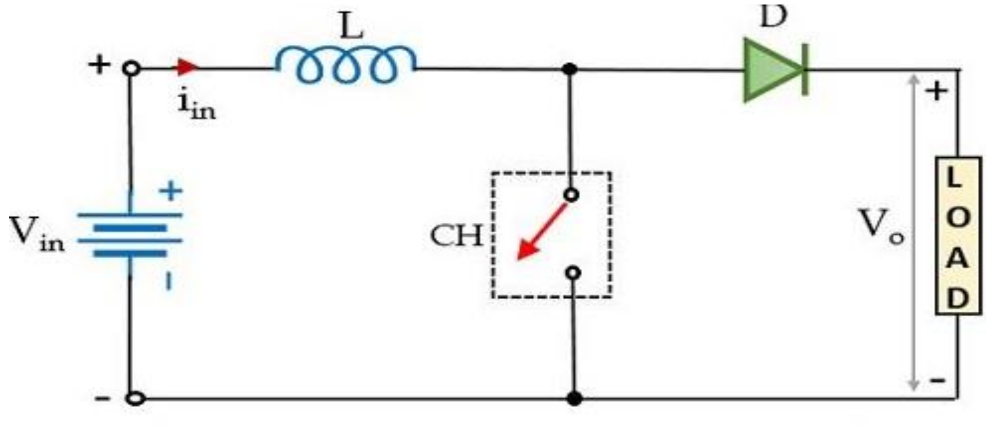

Figure 3.3 Boost Converter

The circuit here is an elementary form of step-up chopper which necessarily requires a large inductor L in series connection with the voltage source. The whole circuit arrangement operates in a way that it helps in maintaining a regulated dc signal at the output. Let us understand how the given circuit operates in order to provide an increased dc signal at the load.It is given the name 'boost' because the obtained output voltage is higher than the input voltage.

$$Vout/Vin = 1/(1-D),$$

Where, $0 \le D \le 100\%$.

Due to the operating principle of step-up choppers, these find applications in the regenerative braking of dc motors. Along with this, these are used in various consumer electronics, battery power systems, power amplifier circuits, power factor correction circuits, automotive equipment, etc. The boost converter is used to "step-up" an input voltage to some higher level, required by a load. This unique capability is achieved by storing energy in an inductor and releasing it to the load at a higher voltage.

3.3.3 Buck-Boost Converter

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A buck or step-down converter is a DC/DC switch mode power supply that is intended to buck (or lower) the input voltage of an unregulated DC supply to a stabilized lower output voltage shown in figure 3.4. Buck converters are, especially compared to traditional voltage regulators, widely valued for their extremely high efficiencies which can easily exceed 95%. The below simplified circuit diagram shows how current flows through the circuit during a switching event of a buck converter. Buck-boost converters offer a more efficient solution with fewer, smaller external components. They are able to both step-up or step-down voltages using this minimal number of components while also offering a lower operating duty cycle and higher efficiency across a wide range of input and output voltages.

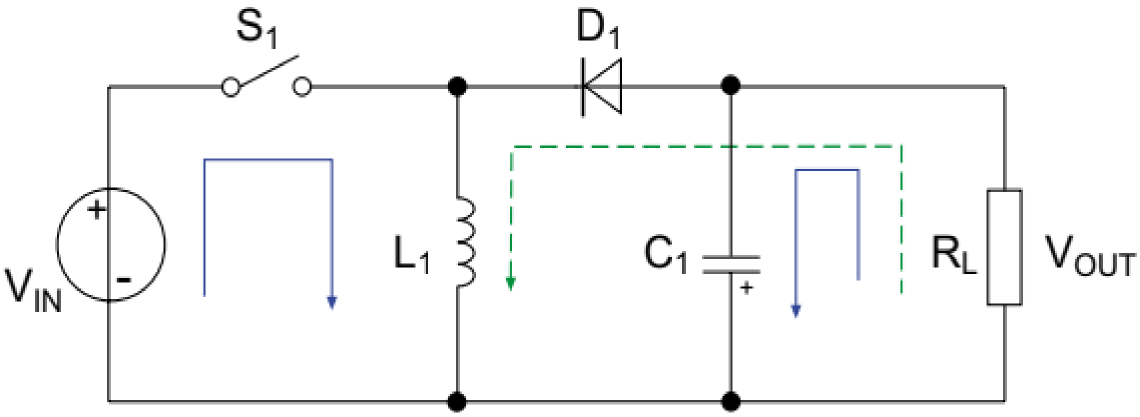

Figure 3.4 Buck-Boost Converter

A buck-boost boost converter can supply a regulated DC output from a power source delivering a voltage either below or above the regulated output voltage. The Figure 3.4 shows the circuit of Buck-Boost converter. A buck-boost converter circuit combines elements of both a buck converter and a boost converter, however they are often larger in footprint than either alternative. The below simplified circuit diagram shows a typical flow of current during a switching event through a buck-boost converter. As you may have noticed in the circuit diagram, V out is actually negative with respect to the supply potential, which can complicate certain designs.

Buck-boost converters also require more expensive components as they need to withstand both high Vin max voltage and high input current at Vin min, but they are useful in many applications. A very common use of buck-boost converters are for high power LED lighting where, for example, lead-acid batteries supply a nominal 9-14V to a constant 12V LED load.

dQ = DTs*Io,

since the capacitor current does not go below zero

Vo = Vs*D/(1-D) Io = Vo/R

dQ = D*Ts*Io dVcb = dQ/C print (if 'The output voltage ripple of the boost converter is {1000*dVcb:. 3f} mV. ') The output voltage ripple of the buck converter is 3.750 mV.

The buck–boost converter is a type of DC-to-DC converter that has an output voltage magnitude that is either greater than or less than the input voltage magnitude. It is equivalent to a flyback converter using a single inductor instead of a transformer. Two different topologies are called buck–boost converter. A buck-boost converter produces a DC output voltage that can be either bigger or smaller in magnitude than its DC input voltage. As its name suggests, it combines the functions of a buck converter(used for DC voltage step-down) and a boost converter (used for DC voltage step-up). A Buck-Boost converter transforms a positive DC voltage at the input to a negative DC voltage at the output.

The circuit operation depends on the conduction state of the MOSFET: On-state: The current through the inductor increases and the diode is in blocking state. USB on the go, point of load converters for PCs and laptops, Battery Chargers, Quad Copters, Solar Chargers, and power audio amplifiers.

USB on the go,

- Point of load converters for PCs and laptops.

- Battery Chargers and Quad Copters.
- Solar Chargers and power audio amplifiers.

3.3 WORKING AND OPERATION

Designing a new multi-output DC-DC converter for electric vehicles requires a thorough understanding of the power requirements of the vehicle's various subsystems, as well as knowledge of the latest power electronics technologies and trends. Here are some general guidelines that may be useful in the design process. These applications include battery chargers, MOSFET, Rectifier circuit, potential transformer and microcontroller, variable DC sources. Microcontroller is programmed for maintaining the output level to set point voltage. This may get through producing a PWM in microcontroller. The width of the pulse is varied over output voltage getting. We can change the output voltage by keypad connected to microcontroller. The output voltage is measured through potential transformer connected. The potential transformer output is amplified and then given to analog to digital converter.

That digital output is processed in microcontroller. It will check the set voltage over output voltage and produce the PWM pulse according to that. This pulse is given to MOSFET. In MOSFET circuit, we turn on the MOSFET according to pulse ON period. It will produce dc output which is given to rectifier circuit. Then the rectified DC voltage is taken as output. Here we can get multiple of output. Determine the power requirements the Identify the various electrical subsystems in the electric vehicle, such as the battery, motor, lighting, and auxiliary systems, and estimate their power requirements. This will help you determine the total power output of the DC-DC converter and the number of outputs required.

Select the appropriate topology There are many different DC-DC converter topologies to choose from, such as buck, boost, buck-boost, and SEPIC. Select the

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topology that best meets the power requirements of the electric vehicle and provides the necessary voltage regulation and current control.

Choose the components Select the appropriate components for the DC-DC converter, such as MOSFETs, diodes, inductors, capacitors, and transformers. Choose components with high efficiency, low cost, and small size to maximize the performance and minimize the size of the converter.

Implement control and protection circuits Implement control and protection circuits to ensure the safe and reliable operation of the DC-DC converter. Control circuits can include pulse width modulation (PWM) controllers and feedback loops to regulate the output voltage and current, while protection circuits can include overcurrent, overvoltage, and thermal protection.

Test and validate the design Once the design is complete, test and validate the performance of the DC-DC converter under various load conditions and environmental conditions. This will help ensure that the converter meets the design specifications and is suitable for use in electric vehicles.

Overall, designing a new multi-output DC-DC converter for electric vehicles is a complex process that requires careful planning, component selection, and testing. By following these general guidelines and working with experienced power electronics engineers, you can develop a high-performance, reliable, and efficient DC-DC converter that meets the power requirements of modern electric vehicles.

3.4 BLOCK DIAGRAM

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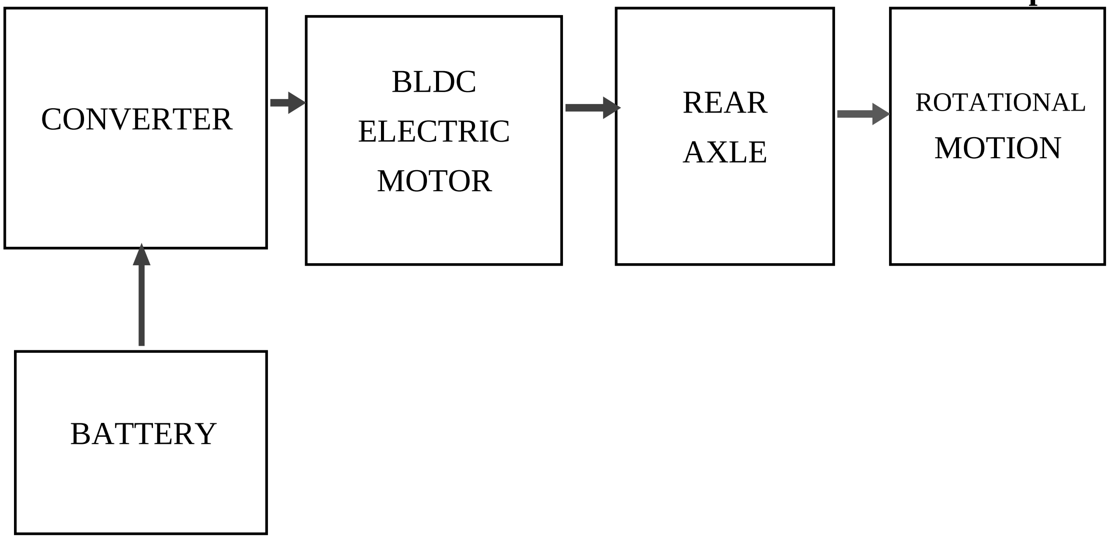

Figure:3.7 Block Diagram for Electric Car

The battery pack is the source of electrical energy in the electric vehicle, and it stores energy for the vehicle to run. It is typically made up of several battery modules connected in series or parallel. The converter is responsible for converting DC voltage from the battery pack to AC voltage that can be used by the BLDC motor. It is also responsible for regulating the voltage and current going to the motor. The Brushless DC (BLDC) motor is a type of electric motor that is widely used in electric vehicles. It converts electrical energy from the battery pack into rotational energy to drive the vehicle. The BLDC motor is more efficient and reliable than traditional brushed DC motors and has a longer lifespan. The Figure 3.7 shows the Block Diagram of Electric car.

The rear axle rotational system is responsible for transferring the rotational energy from the BLDC motor to the wheels. It includes components such as the differential, drive shaft, and wheel hub. Overall, the block diagram of an EV in 2023 is relatively simple compared to traditional gasoline-powered vehicles, with fewer mechanical

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components and more electrical components. This simplicity not only makes EVs more efficient and reliable but also easier to maintain and repair.

4 RESULT ANS DISCUSSION

Electric vehicles typically have a high-voltage battery pack that powers an electric motor. The voltage of the battery pack is usually much higher than the voltage required by the vehicle's electrical system, so a DC-DC converter is used to step down the voltage and provide power to the vehicle's various components. Multiple DC-DC converters can be used in electric vehicles to provide different voltage levels to different components. In terms of the use of multiple DC-DC converters in electric vehicles in 2023, it is difficult to predict with certainty. However, it is likely that as electric vehicles become more widespread and sophisticated, the use of multiple DC-DC converters will become more common. This is because different components will require different voltage levels, and using multiple converters can help to optimize the efficiency of the overall system. Specification of the Project is shown in Table 4.1

Battery type	Lithium ion
Battery capacity	72V,100Amps
Motor type	BLDC
Motor capacity	3 KW
Controller type	Sine wave
Electric motor drive mileage	60kmpc
Battery charging duration	4hrs
Maximum Speed by Electric Drive Mode	60kmph
Car weight	700 kg
Pulling capacity	250kg

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Ground clearance	180mm

Table : 4.1 Specification of The Project

5 CONCLUSION

The application of DC-DC converters in electric vehicles is vital for ensuring efficient power delivery and management within the vehicle's electrical system. With the increasing demand for more electric vehicles and the need for extended driving ranges, the use of advanced DC-DC converters will become more prevalent in the coming years. This will drive innovation and advances in power electronics to provide more efficient, compact, and affordable solutions. Overall, the future of DC-DC converters in electric vehicles looks promising, and we expect significant advancements in this technology by 2023. there are several reliable DC to DC converters available in the market for electric vehicles in 2023. These converters include brands such as Vicor, Delta Electronics, Infineon, TDK-Lambda, and CUI Inc. The selection of a DC-to-DC converter will depend on the specific requirements of the electric vehicle, including input voltage range, power requirements, and size constraints. Consulting with an expert in the field can help ensure the most suitable converter is selected for the application.

Looking to the future, the DC-to-DC converters for electric vehicles in 2024 and beyond will continue to focus on improving efficiency, reducing size and weight, and increasing power density. The integration with other power electronics components, GaN and SiC technology, wireless power transfer, and energy storage are among the areas of development we can expect to see. With ongoing advancements in power electronics technology, the future of DC-to-DC converters for electric vehicles is promising.

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6. FUTURE SCOPE

- Integration with other power electronics components: DC to DC converters can be integrated with other components such as inverters, battery chargers, and motor controllers to reduce the overall size and weight of the vehicle's power electronics system.
- Gallium Nitride (GaN) technology: GaN technology is gaining popularity in the power electronics industry due to its high efficiency and high switching speed. DC to DC converters using GaN technology can be smaller and lighter than traditional converters, while still maintaining high efficiency.
- Silicon Carbide (SiC) technology: SiC technology is another promising option for DC to DC converters. SiC-based converters can operate at higher temperatures and have higher power density than traditional converters.
- Wireless power transfer: Wireless power transfer technology is still in its early stages, but it has the potential to eliminate the need for a physical connection between the vehicle's charging system and the charging infrastructure. This could lead to the development of wireless DC to DC converters.
- Energy storage: Energy storage systems, such as supercapacitors and batteries, are becoming more advanced and could be integrated with DC to DC converters to provide additional energy storage and improve the overall efficiency of the vehicle's power electronics system.

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[8] Vicor DC-DC Converters: Vicor is a well-known brand in the power electronics industry and offers a range of high-performance DC-DC converters suitable for electric vehicles. Their products are highly efficient and have a wide input voltage range.

[9] Delta Electronics DC-DC Converters: Delta Electronics is another well-known brand that offers a range of DC-DC converters for electric vehicles. Their products are designed to be highly efficient and reliable, and they have a wide input voltage range.

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[10] TDK-Lambda DC-DC Converters: TDK-Lambda offers a range of DC-DC converters for electric vehicles that are designed to be highly efficient and have a wide input voltage range. Their products are known for their reliability and longevity.

[11] Infineon DC-DC Converters: Infineon is a leading manufacturer of power electronics components and offers a range of DC-DC converters for electric vehicles. Their products are known for their high efficiency and reliability.

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Journal of Current Research in Engineering and Science
Bi-Annual Online Journal (ISSN : 2581 - 611X)

Volume 7-Issue 1, January 2024
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APPENDIX 1