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DUAL FLYBACK CONVERTER ELECTRIC VEHICLE CHARGING APPLICATIONS

Dr.N. ARUNKUMARM.E.,Ph.D,Ms. KAVIYARASI K

Abstract— A dual flyback converter is a type of DC-DC converter used in electric vehicle charging applications. It is a high-frequency transformer-based converter that can be used to step up or step down voltage levels. In an electric vehicle charging application, the dual flyback converter is used to convert AC power from the grid into DC power that can be used to charge the vehicle's battery. The converter can also be used in reverse to convert DC power from the vehicle's battery into AC power that can be used to power other devices. The paper on dual flyback converter electric vehicle charging applications would summarize the main points of the paper, including the design, operation, and performance of the converter in this application. It would also highlight any unique features or advantages of the converter over other types of DC-DC converters commonly used in electric vehicle charging applications.

I. INTRODUCTION

A dual flyback converter is a type of power converter that can be used in electric vehicle charging applications. The dual flyback converter is designed to convert AC power from the electrical grid to DC power that can be used to charge the electric vehicle's battery. The converter uses two flyback transformers that operate in a complementary manner to provide the required voltage and current levels for charging the battery. The dual flyback converter is an efficient and reliable solution for electric vehicle charging applications. It offers several advantages over other types of converters, including high efficiency, low electromagnetic interference (EMI), and a compact design. Additionally, the dual flyback converter can be easily integrated into existing electric vehicle charging infrastructure. The dual flyback converter is its high efficiency. The converter can achieve efficiency levels of up to 95%, which means that less energy is wasted during the charging process. This results in a lower overall cost of ownership for the electric vehicle owner. Another advantage of the dual flyback converter is its low EMI. This is important for electric vehicle charging applications because EMI can interfere with other electronic devices, causing them to malfunction or fail. The low EMI of the dual flyback converter ensures that the charging process is reliable and safe. Finally, the compact design of the dual flyback converter makes it easy to install in existing electric vehicle charging infrastructure. This means that electric vehicle owners can take advantage of the benefits of the converter without having to replace their existing charging infrastructure. The dual flyback converter is an efficient and reliable solution for electric vehicle charging applications. Its high efficiency, low EMI, and compact design make it an ideal choice for electric vehicle owners who want to take advantage of the benefits of this advanced power converter technology.

Dr.N. Arunkumar M.E.,Ph.D, Department Of Me Power Electronics , Dhanalakshmi Srinivasan Engineering College, Perambalur (621212).
Kaviyarasi K , Department of ME Power Electronics , Dhanalakshmi Srinivasan Engineering College, Perambalur (621212).

II. RELATED WORK

The DC-DC bidirectional Flyback converter is utilised in dual-power applications such as charging and discharging electric cars. On the other side of the circuit, an extra inductor and capacitor were added to power the Flyback network in both forward and backward directions. In the inverting step, the switches use zero voltage switching (ZVS). ZVS decreases losses and enables greater frequency performance, resulting in smaller magnetic filters that are less in size, weight, and volume while enhancing power density. Converter simulation is used to confirm the conceptual framework is correct.

This paper presents an AC-DC flyback converter with a half-bridge single-phase grid converter with high-DC gain for EV battery charging applications, capable of improving the line side power factor and the current total harmonic distortion (THD) of the grid current. The first stage in the proposed model is a front end active rectifier with a reduced number of switch counts because it is a single-leg converter with high DC voltage gain.

Motorcycles are one of the various private transportation options available today. Unfortunately, motorbikes continue to rely on fossil fuels, which are becoming increasingly scarce and unsustainable. As a result, numerous companies have created ecologically friendly electric vehicles powered by renewable energy. However, the battery charging procedure is required for energy storage. As a result, this research proposes a flyback converter mechanism controlled by a fuzzy logic controller. The values of Vin, Iin, Vout, and Iout are monitored during the battery charging process, with an output voltage goal of 14.4 V. The fuzzy logic controller is capable of controlling an output voltage of 14.37 Vdc with an error voltage of 0.208%.

Power generation from renewable energy sources (RES) is becoming increasingly important as energy demand rises. Because these sources are intermittent, an energy storage system (ESS) is necessary. This study achieves the widely used idea of renewable power production technology with the integration of Hybrid Renewable Energy Sources (HRES) such Solar Photovoltaic System (PV) and Wind Energy Conversion System (WECS) along with Battery. The PV voltage generated is increased with the help of a Flyback Converter and a Fuzzy Logic Controller (FLC) to get a stabilised voltage. As a result, the voltage from WECS is converted to DC and supplied via a Diode Bridge Rectifier (DBR).

Constant current (CC) control schemes for multimode primary-side regulation (PSR) flyback converters are popular in low and medium power applications due to their inexpensive cost and wide power range. Despite the fact that certain multimode CC control systems have been proposed to improve CC accuracy, the existing divergence caused by mode conversion and intrinsic propagation latency remains unresolved. To limit the impact of propagation delay or mode conversion on CC accuracy, an enhanced CC control technique is used, which may be included into an IC controller with no extra pin penalty. The technique described is implemented in a 0.18lm 5V/40V BCD process. The experimental findings show that the output current variation is within 1 0.8% under various input and load situations.

The suggested flyback converter performs both AC/DC and DC/DC conversions and appears to be adjustable to any cause. The suggested converter has three modes of operation and can give a variety of output voltages. As a result, many output voltages may be controlled with a single control and a wide range of input voltages can be used. In contrast to existing converters already on the market, the proposed zeta-flyback hybrid converter can perform both voltage control and energy storage for PV applications. The MATLAB/Simulink programme was used to show the steady-state response and behaviours of the proposed system.

III. PROPOSED SYSTEM

The Dual Flyback Converter is a proposed system for electric vehicle charging applications that can provide several benefits over traditional charging systems. This system uses a dual converter architecture to provide a more efficient and compact charging solution for electric vehicles. In a Dual Flyback Converter, two isolated flyback converters are connected in series to provide high voltage output suitable for charging the electric vehicle battery. The primary side of the flyback converter is connected to the AC grid, and the secondary side is connected to the electric vehicle battery. The two flyback converters operate in a complementary manner to deliver power to the battery while minimizing voltage stress on the primary side.

The proposed system can provide several advantages over traditional charging systems. The Dual Flyback Converter can provide high power density with minimal size and weight, making it an ideal solution for electric vehicle charging. The high efficiency and low electromagnetic interference (EMI) due to the complementary operation of the flyback converters. This results in lower losses, reduced heat dissipation, and longer operating life. In highly flexible and can support different charging modes, including AC and DC fast charging. The Dual Flyback Converter can also integrate with renewable energy sources such as solar panels, allowing for more sustainable and environmentally friendly electric vehicle charging. The system can be

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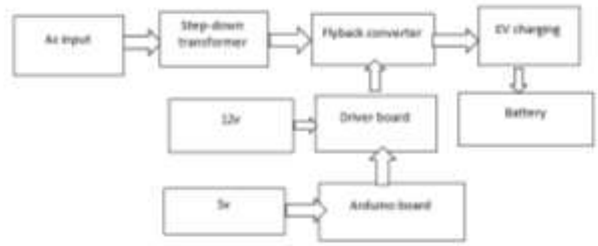
controlled by a microcontroller, which can monitor and adjust the charging current and voltage to ensure safe and efficient charging. Additionally, the microcontroller can communicate with the electric vehicle to exchange data and manage the charging process. The Dual Flyback Converter is a promising solution for electric vehicle charging applications that can provide high efficiency, high power density, low EMI, and flexibility in supporting different charging modes. The proposed system has the potential to significantly improve the charging experience for electric vehicle users and contribute to a more sustainable transportation system.

A flyback converter can be used in an electric vehicle (EV) charging system to convert the AC power from the charging station to the DC power needed to charge the EV battery. The flyback converter operates in a similar way to other DC-DC converters, but it uses a transformer to provide isolation between the input and output circuits.

- AC power from the charging station is input to the flyback converter through a rectifier circuit to convert it into a high-voltage DC voltage.
- The DC voltage is then fed into the primary winding of the flyback transformer through a switch.
- When the switch is on, current flows through the primary winding and energy is stored in the magnetic field of the transformer.
- When the switch is turned off, the magnetic field collapses and energy is transferred to the secondary winding of the transformer. The output voltage of the secondary winding is then rectified and filtered to provide the DC voltage required to charge the EV battery.
- The duty cycle of the switch is controlled by a feedback control circuit that adjusts the output voltage to the desired level.

The flyback converter in an EV charging system can provide high efficiency and power density, as well as the isolation required for safety and reliability. Additionally, the flyback converter can be designed to provide multiple output voltages, which can be useful for charging different types of EV batteries.

1) Block diagram



2)Dual flyback converter

The Dual Flyback Converter is a type of power converter that uses two flyback converters connected in series to provide high voltage output with high efficiency and low electromagnetic interference (EMI). This architecture is often used in applications where high voltage output is required, such as in electric vehicle charging systems. The basic operation of the Dual Flyback Converter involves two flyback converters operating in a complementary manner to deliver power to the load. The primary side of each flyback converter is connected to the AC input voltage, while the secondary side is connected to the load, which in the case of electric vehicle charging, is the battery. During operation, one flyback converter charges the output capacitor, while the other discharges it. This complementary operation results in low voltage stress on the primary side and low EMI. The use of two flyback converters in series also provides a higher voltage output than a single flyback converter. The benefits of the Dual Flyback Converter is its high efficiency. The complementary operation of the two flyback converters results in lower losses and reduced heat dissipation. This allows the converter to operate at higher power densities, making it an ideal solution for electric vehicle charging applications. Another advantage of the Dual Flyback Converter is its flexibility. It can support different charging modes, including AC and DC fast charging. The converter can also be integrated with renewable energy sources such as solar panels, making it more environmentally friendly. A promising solution for high voltage applications such as electric vehicle charging. Its high efficiency, low EMI, and flexibility make it an ideal choice for a wide range of applications where high voltage output is required.

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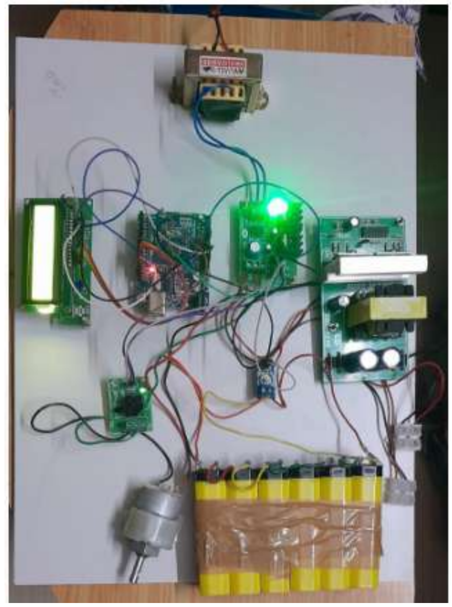
3)Electric vehicle

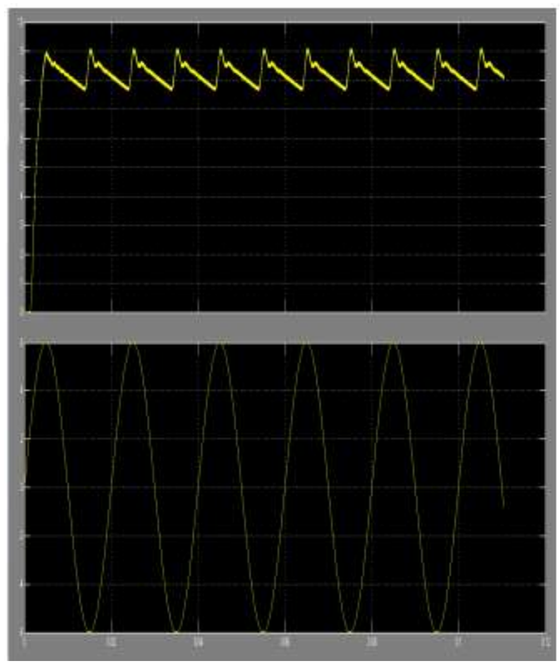
An electric vehicle (EV) is a type of vehicle that uses one or more electric motors for propulsion instead of an internal combustion engine (ICE). EVs are powered by rechargeable batteries and are considered to be more environmentally friendly than traditional gasoline or diesel-powered vehicles since they produce zero tailpipe emissions. There are two types of EVs: Battery Electric Vehicles (BEVs) and Plug-in Hybrid Electric Vehicles (PHEVs). BEVs are powered entirely by electric batteries and have a driving range of anywhere from 100 to over 300 miles on a single charge, depending on the vehicle and battery size. PHEVs, on the other hand, have both an electric motor and an ICE and can be charged using an external power source, such as a charging station or a household outlet. PHEVs can drive for a limited distance on electric power alone before switching to the ICE, extending their driving range beyond that of a BEV.EVs have several benefits over traditional ICE vehicles. They produce no tailpipe emissions, which means they help reduce air pollution in cities and improve air quality. EVs also have lower operating costs since they don't require gasoline or oil changes. Additionally, they are quieter and smoother to drive since electric motors provide instant torque and smooth acceleration. One of the challenges of EVs is their limited driving range and the need for charging infrastructure. However, the development of fast-charging stations and advancements in battery technology have helped address this issue and make EVs more practical for everyday use. The transition to a more sustainable transportation system and offer numerous benefits over traditional ICE vehicles. As technology continues to improve, EVs are likely to become even more practical and widespread in the coming years.

IV. EXPERIMENTAL RESULTS

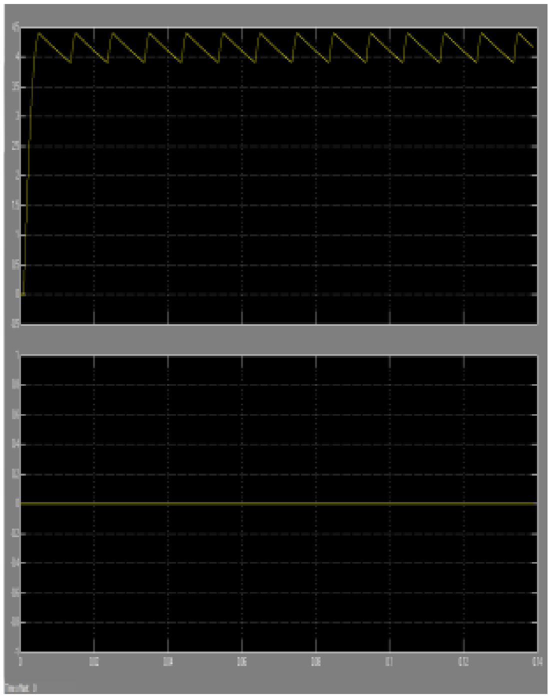


V. SIMULATED WAVEFORM

1)Result 1



2)Result 2



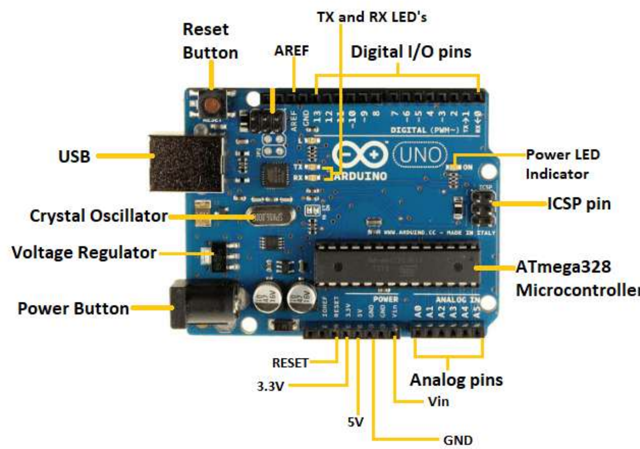
VI. HARDWARE REQUIREMENT

S.NO	COMPONENTS	SPECIFICATIONS
1	ARDUINO UNO	ATmega328P
2	Ferrite core inductor	
3	DIDOE	IN4007
4	Step down transformer	(230-12V),(230-6V),(230-18V)
5	AC source	
6	Bridge Rectifier	
7	Voltage sensor	25V
8	LCD display	16*2
9	Flyback converter	24V
10	Battery	12V,5V
11	EV charging	

VII. HARDWARE DESCRIPTION

1) ARDUINO UNO

The Arduino UNO is a standard Arduino board. In this context, UNO denotes 'one' in Italian. The original release of Arduino Software was labelled as UNO. It was also the first USB board made available by Arduino. It is regarded as a powerful board that is employed in a variety of tasks. The Arduino UNO board was created by Arduino.cc. The Arduino UNO is built on the ATmega328P microprocessor. In comparison to other boards, such as the Arduino Mega, it is simple to use. The board is made up of digital and analogue I/O pins, shields, and other circuitry. The Arduino UNO has six analogue input pins, fourteen digital pins, a USB connection, a power jack, and an ICSP (In-Circuit Serial Programming) header. It's written in IDE, which stands for Integrated Development Environment. It is compatible with both online and offline platforms.



2)PINSGeneral Pin functions

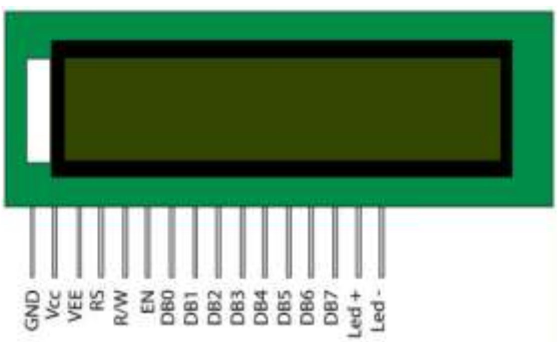
- LED: There is a built-in LED driven by digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.
- VIN: The input voltage to the Arduino/Genuino board when it's using an external power source (as opposed to 5 volts from the USB connection or other regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.
- 5V: This pin outputs a regulated 5V from the regulator on the board. The board can be supplied

with power either from the DC power jack (7 - 20V), the USB connector (5V), or the VIN pin of the board (7-20V). Supplying voltage via the 5V or 3.3V pins bypasses the regulator, and can damage the board.

- 3V3: A 3.3 volt supply generated by the on-board regulator. Maximum current draw is 50 mA.
- GND: Ground pins.
- IOREF: This pin on the Arduino/Genuino board provides the voltage reference with which the microcontroller operates. A properly configured shield can read the IOREF pin voltage and select the appropriate power source or enable voltage translators on the outputs to work with the 5V or 3.3V.
- Reset: Typically used to add a reset button to shields which block the one on the board.

3)LCD DISPLAY

LCD is an abbreviation for liquid crystal display. It is a type of electronic display module that is used in a wide variety of applications such as various circuits and devices such as mobile phones, calculators, computers, TV sets, and so on. These displays are mostly used for light-emitting diodes with multiple segments and seven segments. The primary advantages of adopting this module are that it is affordable, easily configurable, has no constraints for displaying unique characters, special and even animations.



- Pin1 (Ground/Source Pin): This is a GND pin of display, used to connect the GND terminal of the microcontroller unit or power source.
- Pin2 (VCC/Source Pin): This is the voltage supply pin of the display, used to connect the supply pin of the power source.
- Pin3 (V0/VEE/Control Pin): This pin regulates the difference of the display, used to connect a changeable POT that can supply 0 to 5V.
- Pin4 (Register Select/Control Pin): This pin toggles among command or data register, used to connect a microcontroller unit pin and obtains either 0 or 1(0 = data mode, and 1 = command mode).
- Pin5 (Read/Write/Control Pin): This pin toggles the display among the read or writes operation, and it is connected to a microcontroller unit pin to get either 0 or 1 (0 = Write Operation, and 1 = Read Operation).
- Pin 6 (Enable/Control Pin): This pin should be held high to execute Read/Write process, and it is connected to the microcontroller unit & constantly held high.
- Pins 7-14 (Data Pins): These pins are used to send data to the display. These pins are connected in two-wire modes like 4-wire mode and 8-wire mode. In 4-wire mode, only four pins are connected to the microcontroller unit like 0 to 3, whereas in 8-wire mode, 8-pins are connected to microcontroller unit like 0 to 7.
- Pin15 (+ve pin of the LED): This pin is connected to +5V
- Pin 16 (-ve pin of the LED): This pin is connected to GND.

4)FERRITE CORE INDUCTOR

Ferrite core inductors are inductors that have a ferrite core inside their coil. Because of the electrical conductivity of the metal, when these solid metal cores are employed in inductors, the changing magnetic field produces enormous eddy currents. Along with the closed-loop of electric current, these currents cycle within the inductors. Inductors with ferrite cores are utilised in a variety of electric circuit applications such as power conversion, broadband, and interference suppression.

In 2000 volts primary / secondary insulation 60°C ambient temperature For reinforced insulation, the construction complies with IEC950, IEC335, and IEC61558. UL94-V0 listed materials are used exclusively. A ferrite core inductor is a type of inductor that increases its inductance by using a ferrite core. When an electric current flows through an inductor, it stores energy in the form of a magnetic field. An inductor's inductance is proportional to the number of wire turns in the coil and the permeability of the core material.A ferrite core inductor is made out of a wire coil wrapped around a ferrite core. Ferrite is a ceramic substance with high permeability but poor electrical conductivity. The ferrite core boosts the coil's inductance by providing a low reluctance channel for the magnetic field to pass through. Because of the high permeability of the ferrite core, the inductor can store more magnetic energy for a given amount of current. Because of their great performance and small size, ferrite core inductors are commonly employed in electronic circuits. They're frequently found in power supply, filters, and signal processing circuits. Ferrite core inductors come in a variety of sizes and forms to suit a variety of applications.

The inductance of a ferrite core inductor is determined by the number of turns of wire in the coil, the wire diameter, and the permeability of the ferrite core. The following formula may be used to determine inductance:

$L = (N^2 * \mu * A)/L$

Where:

L = inductance in henries (H)

N = number of turns

μ = permeability of the core material

A = cross-sectional area of the core

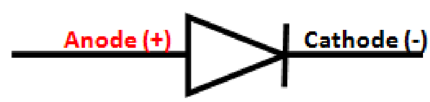
l = length of the core

Ferrite core inductors can be purchased with pre-calculated inductance values, or they can be custom-made to meet specific requirements.

Figure : Ferrite core inductor

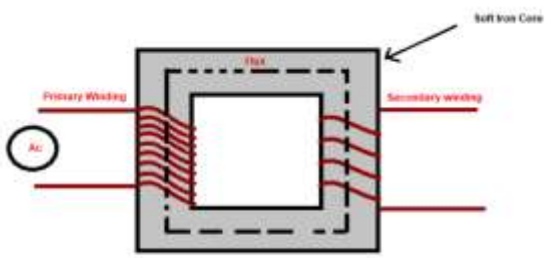
5)DIDOE IN4007

A diode is a device that only enables current to flow in one direction. In other words, current should always travel from anode to cathode. A grey bar, as illustrated in the image above, identifies the cathode terminal. The maximum current carrying capability of the 1N4007 diode is 1A, and it can endure peaks of up to 30A. As a result, we may utilise this in circuits designed for less than 1A. The reverse current is just 5uA, which is insignificant. This diode has a power dissipation of 3W.



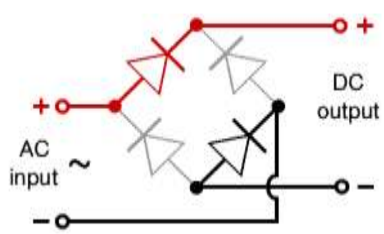
6)STEP DOWN TRANSFORMER

A step-down transformer is one that has a higher number of turns in the primary winding and a lesser number in the secondary winding. As we can see from the preceding calculation for the relationship between the number of turns in winding and voltage, if the number of turns in the primary is more than the number of turns in the secondary, the EMF generated in the secondary is less than the primary input. As a result, the secondary coil of a step-down voltage transformer has a lower voltage. The step-down transformer, as the name implies, is used to convert higher voltage electricity to lower voltage power.



7)RECTIFIER

The rectifier circuit is used to convert AC (Alternating Current) to DC (Direct Current). Rectifiers are grouped into three types: half-wave, full-wave, and bridge rectifier. The primary job of all of these rectifiers is to convert current, although they do not do so effectively. Both the centre tapped full wave rectifier and the bridge rectifier convert well. A bridge rectifier circuit is a ubiquitous component of electronic power systems. Many electronic circuits require a rectified DC power source to power the numerous electronic fundamental components from an available AC mains supply. This rectifier may be found in a broad range of electronic AC power devices, including household appliances, motor controllers, modulation processes, welding applications.



8)VOLTAGE SENSOR

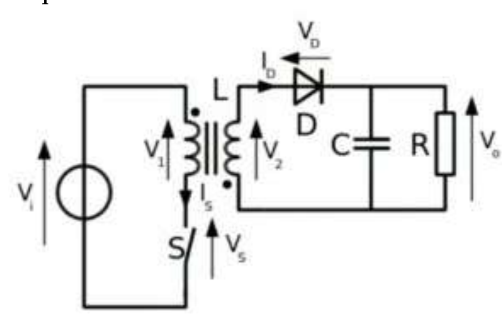
This sensor measures, calculates, and determines the voltage supply. This sensor can detect the amount of AC or DC voltage. This sensor's input can be voltage, and its output can be switches, analogue voltage signals, current signals, audio signals, and so on. Some sensors provide outputs such as sine waveforms or pulse waveforms, while others can create outputs such as AM (Amplitude Modulation), PWM (Pulse Width Modulation), or FM (Frequency Modulation). The voltage divider can affect the measurement of these sensors.

A simple but very useful module which uses a potential divider to reduce any input voltage by a factor of 5. This allows you to use the analogue input of a microcontroller to monitor voltages much higher than it capable of sensing. For example with a 0-5V analogue input range you are able to measure a voltage up to 25V. The module also includes convenient screw terminals for easy and secure connection of a wire.

9)FLYBACK CONVERTER

The flyback converter design is straightforward, with only a flyback transformer, switch, rectifier, filter, and a control device to operate the switch and accomplish regulation. The switch is used to turn the primary circuit on and off, which can magnetise or demagnetize the transformer. The controller's PWM signal regulates the functioning of the switch. The switch in most flyback transformer designs is a FET, MOSFET, or a simple transistor.

Rectifier rectifies the voltage of the secondary winding to provide pulsing DC output and disconnects the load from the transformer's secondary winding. The capacitor filters the rectifier output voltage and raises the DC output level to the required level. The magnetic energy is stored in the flyback transformer, which acts as an inductor. It is built as a two-coupled inductor with primary and secondary windings. It runs at almost 50KHz frequencies.



10) Battery

Batteries are a type of electrochemical cell that can store electrical energy in the form of chemical energy. When connected to a circuit, the stored energy can be released as an electric current.

Batteries come in various shapes and sizes, and are commonly used in a wide range of applications, including portable electronics, power tools, electric vehicles, and renewable energy systems. A 5V battery typically refers to a lithium-ion or lithium-polymer battery that has a nominal voltage of 3.7V per cell. These batteries are commonly used in portable electronic devices, such as smartphones, tablets, and cameras. In order to provide 5V output, multiple cells are connected in series, which increases the overall voltage of the battery. A boost converter can also be used to step up the voltage from a single cell to 5V.A 12V battery, on the other hand, typically refers to a lead-acid battery that has a nominal voltage of 12V. These batteries are commonly used in automotive and marine applications, as well as in backup power systems for homes and businesses. A 12V battery can also be constructed by connecting multiple cells in series, or by using a step-up converter to boost the voltage from a lower voltage battery. The 5V and 12V batteries are common types of batteries used in a wide range of applications. While a 5V battery typically refers to a lithium-ion or lithium-polymer battery with a nominal voltage of 3.7V per cell, a 12V battery typically refers to a lead-acid battery with a nominal voltage of 12V. Both types of batteries can be constructed by connecting multiple cells in series, or by using a step-up converter to boost the voltage from a lower voltage battery.

VIII. CONCLUSION

The Dual Flyback Converter is a promising solution for electric vehicle charging applications due to its high efficiency, low electromagnetic interference, and flexibility. Its complementary operation of two flyback converters provides high voltage output with reduced losses and heat dissipation, allowing for higher power densities. It can support different charging modes, including AC and DC fast charging, making it a flexible and versatile solution for electric vehicle charging. It can also be integrated with renewable energy sources such as solar panels, making it an environmentally friendly option. The potential to play a significant role in the future of electric vehicle charging. As the demand for electric vehicles grows, so will the need for efficient and reliable charging solutions, and the Dual Flyback Converter has the capabilities to meet these demands.

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