

HIGH EFFICIENCY BRIDGELESS SINGLE POWER CONVERSION BATTERY CHARGER FOR LIGHT ELECTRIC VEHICLE

Submitted in partial fulfillment of the requirements for the award of
Bachelor of Engineering Degree in
Electrical and Electronics Engineering

by

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**DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING
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SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY) Accredited with Grade "A" by
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This is to certify that this Project Report is the bonafide work of **TAMILSELVAN.A**(Reg. No. 38140057) and **JAGADESH.VS** (Reg. No. 38140015) who carried out the project entitled **"HIGH EFFICIENCY OF BRIDGELESS SINGLE POWER CONVERSION BATTERY CHARGER FOR LIGHT ELECTRIC VEHICLE"** under our supervision from November 2021 to May 2022.

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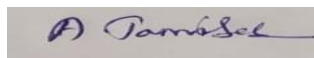
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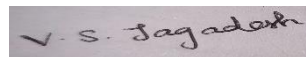
DECLARATION

We **TAMILSELVAN.A** (Reg. No. 38140057) and **JAGADESH.VS** (Reg. No. 38140015) hereby declare that the Project Report entitled “**HIGH EFFICIENCY OF BRIDGELESS SINGLE POWER CONVERSION BATTERY CHARGER FOR LIGHT ELECTRIC VEHICLE**” done by us under the guidance of **MRS.D.RAMYA** is submitted in partial fulfillment of the requirements for the award of Bachelor of Engineering degree in Electrical and Electronics Engineering.

1.



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DATE: 20/04/2022

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ABSTRACT

High efficiency chargers having high power are required to charge the batteries of light electric vehicles. This work proposes a single-power-conversion battery charger without a bridge made up of a boost AC-DC converter that is isolated and with a circuit having resonance in series to suit this need. The circuit with a series resonance decreases by offering zero current switching, you may reduce output diode recovery losses, while conduction losses associated with the input diode rectifier are reduced by using a bridgeless arrangement. Further more, injection of current by direct and series-resonance allows the transformer to excite the core in both directions, providing for high power capabilities. In conversion of power using single stage, the feedback linearization-derived control algorithm is also built, allowing the suggested charger for power factor correction and output power regulation. This straightforward circuit construction results in good efficiency and a large power factor. The proposed charger's ideas that are theoretical are tested in an actual setting with a 1.7 kW prototype.

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CHAPTER 1

INTRODUCTION

1.1 GENERAL INTRODUCTION

There has been a surge in interest in various environmentally friendly vehicles, such as electric vehicles (EVs) and plug-in hybrid EVs, they have the potential to significantly reduce environmental pollution. EVs are entirely powered by propulsion On-board chargers charge batteries from the grid, making them a critical component of an electric vehicle. The charger's efficiency and power quality are used to determine its performance (i.e., total harmonic distortion and power factor). Furthermore, because the charger is built into the EV, it must be tiny, light, and long-lasting. The PFC stage, commonly a boost converter, results in dc-link voltage from AC voltage at unity power factor, while the DC-DC power-conversion stage, usually an isolated high-frequency DC-DC converter, regulates power at the output with a good galvanic isolation to ensure safety of the user [9]. However, the two-stage structure also has many disadvantages, such as low efficiency and circuit complexity on account of its two power-processing stages. A hefty intermediate dc-link capacitor that filters power fluctuations is another significant disadvantage. The high current flowing through the intermediate dc-link capacitor results in significant power loss as well as a significant reduction in capacitor lifetime, which eventually leads to capacitor failure. Single-stage techniques are being developed to replace two-stage architectures in order to eliminate the PFC stage and lower the dc-link capacitance [12], [13]. The PFC stage and the DC-DC stage are integrated in single-stage converters with a capacitor fed to the dc-link by sharing the switches. Because of the DC-link, however, There is no need for a DC-link capacitor in these converters, there by removing the difficulties that come with it Using the appropriate PFC-control techniques, almost unity power factor can also be accomplished. However, these single stage converters not only has high conduction losses but also necessitates extra heat management but has. Single-stage bridgeless topologies based on a two-stage boost-fly back converter and a Power factor converter with half bridge have been investigated to solve these drawbacks. However, because the applicable topologies generally imply significant electrical stresses, such converters are only suited for low-power applications. Because of these factors, an isolated bridgeless type converter was developed, which comprises of an isolated bridgeless step-up ACDC converter with a

control algorithm for PFC control and power regulation. Conduction losses and heat management issues associated with the bridge diode are reduced with the bridgeless configuration. The secondary side's series-resonance circuit provides bidirectional core excitation, allowing for high power capacity with soft switching(ZCS) .The following is how the rest of the paper is organized. The proposed charger's operating principle and features are discussed in Section II, and a control algorithm for single-power conversion is proposed in Section III. The findings of trials conducted with a 1.7 kw prototype, which was utilized to verify the charger, are presented in Section I.

1.2 LITERATURE SURVEY

[1] S. Haghbin, S. Lundmark, M. Alakula, and O. Carlson, “Grid-connected integrated battery chargers in vehicle applications: Review and new solution,” IEEE Transactions on Industrial Electronics, vol. 60, no. 2, pp. 459–473, 2013.

Because traction circuit components are not engaged during the charging process for vehicles using grid power to charge the battery, they can be used in the charger circuit to create an onboard integrated charger. The grid can be galvanically isolated or nonisolated from the battery charger. Different types of integrated chargers, both isolated and nonisolated, are discussed and described. In addition, this study describes a novel isolated-high-power three-phase battery charger based on a split-phase permanent-magnet motor and its winding structure. The proposed charger is a high-efficiency bidirectional high-power charger with a unity power factor operation capability.

[2] M. Yilmaz and P. T. Krein, “Review of battery charger topologies, charging power levels, and infrastructure for plug-in electric and hybrid vehicles,” IEEE Transactions on Power Electronics, vol. 28, no. 5, pp. 2151–2169, 2013.

This study examines the present state of battery chargers, charging power levels, and infrastructure for plug-in electric vehicles and hybrids, as well as their implementation. Off-board and on-board charger systems with unidirectional or bidirectional power flow are divided into two categories. The use of unidirectional charging reduces the amount of hardware required and simplifies connecting concerns. Battery energy injection back to the grid is made possible through bidirectional charging. Because of weight, space, and cost limits, most on-board chargers limit power. To circumvent these issues, they can be incorporated with the electric drive. The availability of charging infrastructure minimises the need for and expense of on-board energy storage. Conductive or inductive on-board charger systems are available. An off-board charger is less bound by size and weight and can be configured for high charging rates. The power levels of Level 1 (convenient), Level 2 (primary), and Level 3 (rapid) are explored. Aspects of the future, such as roadbed charges, are discussed. The amount of power, charging time and location, cost, equipment, and other considerations are presented, compared, and evaluated for various power level chargers and infrastructure setups.

[3] A. Khaligh and S. Dusmez, “Comprehensive topological analysis of conductive and inductive charging solutions for plug-in electric vehicles,” IEEE Transactions on Vehicular Technology, vol. 61, no. 8, pp. 3475– 3489, 2012.

The coming global energy crisis has provided the automobile sector with new chances to address the growing demand for cleaner, more fuel-efficient vehicles. This has prompted the development of fully or partially electrified drivetrains in the form of electric and plug-in hybrid electric cars (EVs and HEVs), which are referred to collectively as plug-in EVs (PEVs). In comparison to HEVs, PEVs often have more on-board storage and power electronics for charging and discharging the battery. The nature of the charging solution used has a considerable impact on the extent to which PEVs are used. A topological survey of the currently available PEV charging systems is offered in this study. This study examines PEV chargers in terms of charging nature (conductive or inductive), conversion stages

(integrated single stage or two stages), power level (level 1, 2, or 3), and semiconductor devices used (silicon, silicon carbide, or gallium nitride).

[4] S.-G. Jeong, W.-J. Cha, S.-H. Lee, J.-M. Kwon, and B.-H. Kwon, “Electrolytic Capacitor-Less Single-Power-Conversion On-Board Charger With High Efficiency,” IEEE Transactions on Industrial Electronics, vol. 63, no. 12, pp. 7488–7497, 2015.

This paper presents an electrolytic capacitor-less single-power-conversion on-board charger with high efficiency. A step-up ac-dc converter with an active-clamp circuit and a series-resonant circuit is used in the proposed on-board charger. The active-clamp circuit switches at zero voltage and recycles the energy stored in the transformer's leakage inductance. In addition, the surge voltage of switches is clamped by this circuit. By offering zero-current switching, the series-resonant circuit minimizes the reverse-recovery problem of output diodes. The control method was specifically designed to produce a high power factor under universal input voltage without the use of any auxiliary circuits. As a result of these features, the suggested charger has a high power efficiency and power factor. Furthermore, the single-power-conversion arrangement is extremely advantageous to the vehicle's on-board charger. To confirm the theoretical analysis and validity of the proposed on-board charger, a 2-kW prototype is implemented under the universal input voltage.

[5] B. Whitaker, A. Barkley, Z. Cole, B. Passmore, D. Martin, T. R. McNutt, A. B. Lostetter, J. S. Lee, and K. Shiozaki, “A high-density, highefficiency, isolated on-board vehicle battery charger utilizing silicon carbide power devices,” IEEE Transactions on Power Electronics, vol. 29, no. 5, pp. 2606–2617, 2014.

This paper presents an isolated on-board vehicular battery charger that utilizes silicon carbide (SiC) power devices to achieve high density and high efficiency for application in electric vehicles (EVs) and plug-in hybrid EVs (PHEVs). The proposed level 2 charger has a two-stage architecture where the first stage is a bridgeless boost ac-dc converter and the second stage is a phase-shifted full-bridge isolated dc-dc converter. The operation of both topologies is presented and the specific advantages gained through the use of SiC power devices are discussed. The design of power stage components, the packaging of the multichip power module, and the system-level packaging is presented with a primary focus on system density and a secondary focus on system efficiency. In this work, a hardware

prototype is developed and a peak system efficiency of 95% is measured while operating both power stages with a switching frequency of 200 kHz. In this paper, a hardware prototype is created, and a peak system efficiency of 95% is measured while both power stages are operated at 200 kHz switching frequency. When considering the volume and mass of the system including a casing, a maximum output power of 6.1 kW results in a volumetric power density of 5.0 kW/L and a gravimetric power density of 3.8 kW/kg.

[6]D. S. Gautam, F. Musavi, M. Edington, W. Eberle, and W. G. Dunford, "An automotive onboard 3.3-kW battery charger for PHEV application," IEEE Transactions on Vehicular Technology, vol. 61, no. 8, pp. 3466– 3474, 2012

In a modular half-electric vehicle, a built-in charger is responsible for charging the battery pack (PHEV). Currently, a 3.3-kW two-organize battery charger arrangement for a PHEV application is on display. The plan's goal is to achieve high efficiency, which means limiting charger size, charging time, and the amount and cost of electricity drained from the utility. Despite a point-by-point plan method, the charger power converter arrangement's activity is given. To confirm the applicability of the suggested charger power engineering, the mechanical bundling structure and significant experiment results are provided.

1.3 AIM OF THE PROJECT

We achieve a higher efficiency in the conversion of AC to DC for the use of electric vehicles. That AC-DC conversion consist of AC- source, rectifier circuit. The rectifier circuit consist of two diodes which is responsible for AC-DC voltage conversion. There will be an inverter circuit is present. This is responsible for DC-AC conversion. That inverter circuit will consist of two switches which means MOSFET switches. For that switching device we will give pulse for that, based on the pulse the DC voltage conversion is achieved. By using the transformers we will increase the voltage level, which means step-up transformers is used. On the transformer side again we connect the rectifier circuits for the AC-DC voltage conversion. There will be a filter circuit is used. That filter circuit will include an LC-filter for converting pulsing output voltage to clear voltage, or DC-voltage. This is the long conversion method to get the higher DC voltage.

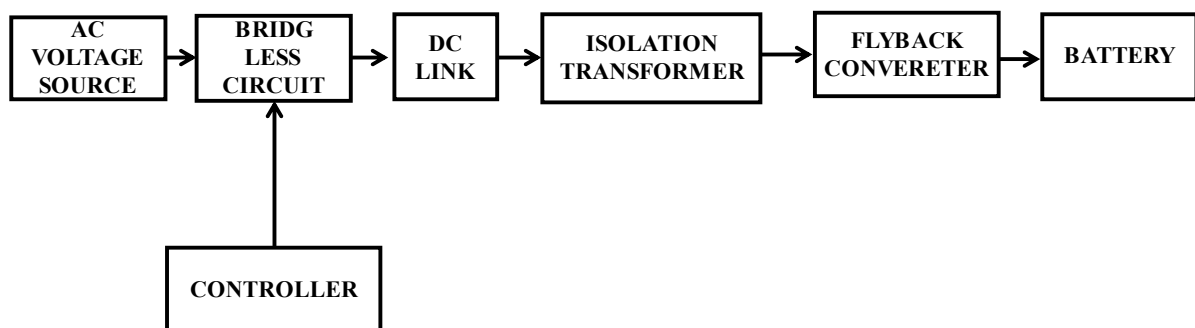
1.4 FUTURE SCOPE

Energy has always been and will continue to be a major global issue. The United States consumes about 106.96 quadrillion BTU of energy per year, of which about 30% is used for transportation (EIA, 2007). Internal-combustion engines account for a significant amount of energy in the transportation sector, and they also contribute to greenhouse and noxious gas concentrations in the atmosphere, which are harmful to the environment, air quality, and public health. Reforms to reduce these emissions have already begun, with rising interest in electric vehicles being the most notable. Although rising use of electric vehicles (EV) reduces CO₂ emissions, there is a lack of infrastructure to facilitate their widespread adoption. This thesis examines the feasibility of adapting a garage to support intense electric vehicle use using a thin vertical slice technique.

CHAPTER 2

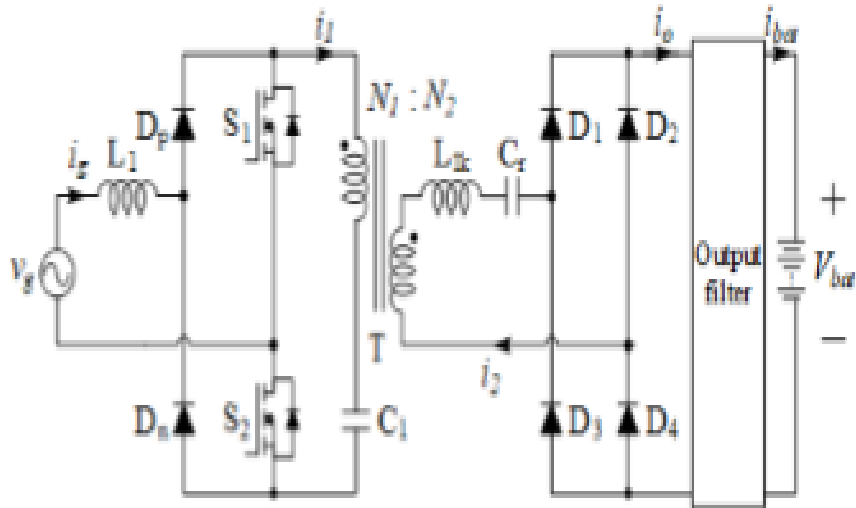
PROJECT DESCRIPTION

2.1 BLOCK DIAGRAM



2.2 EXISTING SYSTEM

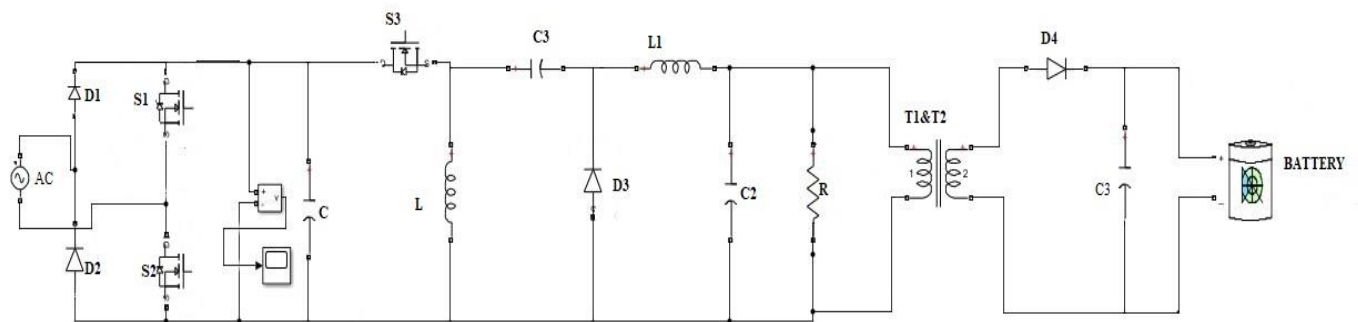
In the existing system we use the AC-DC converter for electrical vehicles with normal transformer Rectification involves conversion of AC into DC. It presented a charger that uses the transformer and has an bridgeless isolated step-up ACDC converter with a PFC control and power regulation algorithm. Heat management and losses due to conduction associated with the bridge diode are minimized with the bridgeless configuration. Bi-directional core excitation and zero-current switching is allowed by series-resonance thus eliminating the output diodes' reverse-recovery difficulty. Furthermore, efficiency is improved since without the use of an energy buffer, transfer of energy from input to output takes place. We create a control approach using feedback linearization, a an improved power factor can be achieved without the use of a separate PFC circuit.



2.3 PROPOSED SYSTEM

In the proposed system we use the transformer based AC-DC Converter. The suggested system is clearly illustrated, and the modes of operation are also explained. A bridge less

Zeta converter is a fourth-order DC-DC converter that can operate in step-up or step-down mode. It can improve the power stability and stable boost capacity so here we are using zeta converter And here we are isolate the both using isolation transformer circuit for control the bi directional power flow .Flyback converter help to increase the battery charging efficiency.



Activate Windows

2.4 DIFFERENCE BETWEEN EXISITING AND PROPOSED SYSTEM

S.NO	EXISITING	PROPOSED
1.	These single stage converters contain many components and an input bridge diode that not only causes high conduction losses but also requires additional heat management. To overcome these drawbacks, single-stage bridgeless topologies based on two-	This paper presents a high efficiency isolated ac-dc converter topology. The proposed converter consists of a full-bridge diode rectifier, an isolated zeta dc-dc converter, and only one controller.

	stage boost-fly back converter and half-bridge PFC converter have been investigated	
2.	The series-resonance circuit of the secondary side provides bidirectional core excitation, which enables high power capacity and zero-current switching(ZCS), thereby reducing the reverse-recovery problem of the output diodes.	The proposed ZETA converter provides the isolation technique for all components operating at high frequency, allowing for an improvement in power density without a cost of power-conversion efficiency.
3.	In the existing system we use the lithium ion battery but the output will be less.	In the proposed system we use the same lithium ion battery but the output will be high
4.	In this system high losses will be happen compare to proposed.	In this system low losses compare to existing.
5.	Bridgeless converter only used.	Bridgeless and zeta converter also used.

2.5 MODES OF OPERATION

In the proposed system we use the transformer based AC-DC Converter. The above suggested system is clearly illustrated, and the modes of operation are also explained. It can improve the power stability and stable boost capacity so here we are using zeta converter. And here we are isolate the both using isolation transformer circuit for control the bi directional power flow. Flyback converter help to increase the battery charging efficiency.

Because M1 is turned on, the voltages V_{L1} and V_{L2} are equal to V_{in} . Diode D1 is turned off with a reverse voltage of $-(V_{in} + V_O)$ for this time span. The voltage source provides energy

to inductor L1 and L2, and their corresponding currents I_{L1} and I_{L2} are increased linearly by the ratio $V_{in}/L1$ and $V_{in}/L2$.

At this time, C_{fly} is being discharged and capacitor C₀ is being charged. [M1 OFF] Stage 2 Neither inductor has a DC voltage across it. As a result, C_{FLY} has a ground potential on one side and a V_{OUT} on the other, resulting in a DC voltage across C_{FLY} equal to V_{OUT}.

Because M1 is turned on, the voltages V_{L1} and V_{L2} are equal to V_{in} . Diode D1 is turned off with a reverse voltage of $-(V_{in} + V_O)$ for this time span. The voltage source provides energy to inductor L1 and L2, and their corresponding currents inductors are increased linearly by the ratio $V_{in}/L1$ and $V_{in}/L2$. As a result, $I_{M1} = I_{L1} + I_{L2}$ is the switch currents. At this time, capacitor C_{fly} is being discharged and capacitor C₀ is being charged. [M1 OFF] Stage 2 Neither inductor has a DC voltage across it. As a result, C_{FLY} has a ground potential on one side and a V_{OUT} on the other, resulting in a Direct current voltage across C_{FLY} equal to V_{OU}

2.5.1 BRIDGELESS CONVERTER

Compared to a conventional-boost PFC, a bridgeless- zeta converter eliminates the losses caused by the bridge rectifier. However, the body diode of the inactive MOSFET conducts and effectively acts as a slow diode for the corresponding half-line cycle. This converter consists of two diodes and two Mosfets in the circuit.

2.5.2 ZETA CONVERTER

This converter, provides a positive output value, similar to the SEPIC DC/DC converter topology. ZETA converter uses a flying capacitor with two inductors and a series capacitor. In contrast to the SEPIC converter, which uses a normal boost converter, the ZETA converter uses a buck controller to drive a high-side PMOS FET. Another alternative for regulated input-power source, such as a low-cost wall wart, is the ZETA converter. A linked inductor can be utilized to save space on the board. This article shows how to design ZETA converter with an inductance connected to operate in continuous-conduction mode (CCM).

2.5.3 FLYBACK CONVERTER

The flyback converter has a mutually coupled inductor for energy storage which regulates flow of current incase of power is switched off. Flyback converters are analogous in architecture and performance with boost converters. The primary winding of the transformer, on the other hand, acts as an inductor, with the secondary providing the output. Two separate inductors are employed in the flyback design on primary and secondary side

2.6 HARDWARE DESCRIPTION

2.6.1 AC-DC converters

Electric power is transmitted through wires as either a direct current (DC) flowing in one direction at a constant voltage or an alternating current (AC) flowing back and forth due to an oscillating voltage. Since of the creation of the transformer, AC is the most used mode of power transmission because it has various advantages over DC, including cheaper distribution costs and a straightforward manner of changing between voltage levels. AC power

that is transmitted at a high voltage over a long distance and then converted to a lower voltage is a more efficient and safer power source in homes. High voltage can range from 4kV (kilovolts) to 765kV (kilovolts) depending on the location. To refresh your memory, AC mains in homes varies from 110V to 250V, depending on where you live. The usual AC main line in the United States is 120V. To refresh your memory, AC mains in homes varies from 110V to 250V, depending on where you live. The usual AC main line in the United States is 120V.

Converters direct alternating current into reactive impedance devices such as inductors (L) and capacitors (C), where it is stored and integrated as the voltage varies. The power associated with positive and negative potentials is separated in this procedure. Filters smooth out the stored energy, resulting in the creation of a DC source for other circuits.

This circuit can take many different forms, but it always has the same core components and can include one or more conversion steps. A 'forward converter,' as shown in Figure 1, has a higher efficiency than a 'fly back converter,' which has a somewhat simpler architecture. A fly back converter varies from a forward converter in that its operation is dependent on energy stored in the airgap of the transformer in the circuit, which is not discussed in depth. Apart from that, they can both use the same basic building blocks. An input filter is necessary because it prevents noise from being reflected back onto the mains power supply from the power supply switching elements. It also keeps noise from seeping into subsequent circuits from the mains power source. The filter goes through the mains frequency of 50/60Hz and reduces higher frequency noise and harmonics that may be present. Reactive elements such as capacitors and inductors, like other sections of an AC to DC converter, play a vital role in frequency – selective suppression. Capacitors do not pass DC and can be utilized in series (as DC blocking 'high pass filter' elements) or parallel (as DC blocking 'low pass filter' elements) (to shunt high frequencies to ground preventing them from getting through to the converter).

A voltage dependent resistor, or varistor, is usually included in the input filtering block to prevent excessive voltage spikes on the electrical power grid from damaging the power supply. On the input in Figure 1, this is the rectangular box with the diagonal line through it. A metal-oxide varistor is the most common type of varistor (MOV). Any voltage above the

'clamping voltage' of the device makes the MOV conductive, shunting the high voltage spike and suppressing the surge.

2.6.2 RECTIFICATIONS

The most basic AC/DC converters consist of an input filter followed by a transformer, which then goes through a rectifier to produce DC. Because transformers do not pass DC, rectification takes place after the transformer. Due to the advantages of smaller transformer requirements and lower noise referred back to the mains power supply, many AC/DC converters use more complicated, multi-stage conversion topologies as represented in figure 1.

Rectifiers are made up of semiconductor devices like diodes that conditionally conduct electricity in one direction only. Thyristors are more advanced semiconductor rectifiers. In the same way that a relay controls the passage of a bigger voltage and current, silicon controlled rectifiers (SCR) and triodes for alternating current (TRIAC) are equivalent to relays. These only operate when a controlling 'gate' is triggered by an input signal, which is how they work. Current is guided to create a DC separation by turning the device on or off at the proper time while the AC waveform flows. Many circuits exist that employ signals tapped from the AC waveform as control signals to turn on or off the phase quadrants of thyristors. This is known as commutation, and it can be natural (as in the case of a simple diode) or forced (as in the case of more complex devices).

Active devices like MOSFETs can be used as switches in high-efficiency power supply. The objective for employing more complex topologies is usually to improve efficiency, reduce noise, or act as a power control. When diodes conduct, there is an inherent voltage drop across them. They lose power as a result of this, however other active components may have a much lower decrease and hence lose less power. Low-cost power control circuits, such as the light dimmer shown below, use SCR and TRIAC circuits to directly steer and control current delivered to the load when the input mains alternates. These implementations are not galvanic when there is no transformer in the circuit - they are only helpful in circuits where a transformer is required, such as direct mains connected light control. They're also employed in high-power industrial and military power supplies where reliability and simplicity are key.

2.6.3 (PFC)power

Understanding this component of a converter is the most difficult. PFC (power factor correction) is a critical component in increasing a converter's efficiency by adjusting the relative phase of current drawn to the voltage waveform in order to maintain the best possible power factor. This decreases the converter's 'reactive load' attributes to the mains power supply. This is necessary for maintaining high-quality, efficient electrical networks, and electrical supply providers can even charge consumers with low power factors special reactive current tariffs. The use of active or passive elements to rectify phase connections is referred to as passive or active PFC. Semiconductor PFC refers to special-purpose ICs with built-in controllers that actively monitor and alter the PFC circuit, lowering component count and simplifying the overall design while improving performance. Other functionalities like as over/under voltage protection, over current protection, soft start, and fault detection/response can be included.

A one stage PFC converter is represented in Figure 1. This section's capacitor stores the imbalanced energy between the stage's pulsing input power and relatively stable output power. For more information, see the "Reactive Energy Storage" section. Two-stage PFC converters are popular because they don't have to deal with the wide voltage range across the storage capacitor found in universal power supplies, which reduces conversion efficiency. They may also be able to provide better trade-offs in capacitor size, which can assist save money.

2.6.4. Power stage

The power stage regulates the flow of electricity from the primary to the secondary side of the transformer. It is made up of an active switching device that operates at a high frequency of hundreds of kHz. A pulse width modulation (PWM) input controls the ON/OFF state of the switch, which changes based on the amount of power that needs to be dynamically delivered to the load. This information is collected via a secondary-side feedback path, which can be sent via a variety of approaches that meet the converter's isolation requirements. Higher frequency switching necessitates a smaller transformer, which reduces both size and cost.

2.6.5. Transformer

A transformer is made up of wires twisted on a common core that are inductively coupled

to each other. When connecting to high voltage (mains) sources, this is significant because inductive coupling disconnects the mains from the subsequent circuit, which is a much safer scenario than direct connection. Galvanic isolation limits the maximum energy that might cause electric shock or harmful sparking discharge to the stored energy in the transformer's magnetic field flux lines via coupling by an electromagnetic field rather than a direct copper link. The transformer's ability to store energy (as a function of size and materials) is critical in converter design because it determines how successfully the transformer can provide the energy required to maintain the proper voltage potential under changing load conditions. The theory and operation of transformers may be found in detail. Due to a magnetization current inherent in the construction, a block called 'Mag Amp Reset' is linked with demagnetizing the transformer. The remanence of the core material would saturate it in a few cycles of the power stage PWM if this wasn't done.

Although this additional circuit is too complicated to discuss in this course, it can be highly perplexing when looking at converter circuit diagrams, so it's helpful to know why it's needed. When the power stage switch is turned off, a demagnetizing current is supplied back diode through a separate auxiliary winding, which is the simplest method of demagnetization. The highest PWM duty cycle is limited to 50% with this circuit, although more complex approaches can be employed to permit greater duty cycles.

Information signals are routinely sent between the primary and secondary sides using transformers or other galvanic isolation methods (such as optocouplers). This is required to allow for more complex control of the conversion process, such as allowing a control circuit on the primary side to respond to the status of the secondary side load and dynamically adjust how it guides current to achieve lower noise and higher efficiency.

2.6.6. Output Circuits

Electric fields in passive reactive (storage) devices like capacitors and inductors store energy, as indicated in the filtering section. They operate as a store of energy during the alternating input power cycle when used after charge steering rectification. This is an important component in a converter since it functions as a source, allowing for a steady output

voltage under fluctuating load conditions. Active elements detect the voltage applied to the load and/or the current flowing into the load, and use this information to adjust the energy pumped into these storage elements in a negative feedback control loop to maintain a constant output voltage level. This pumping operation, which is referred to as regulation, uses active elements to turn on and off the current flowing into the storage elements.

2.6.7 Regulation

We need a constant voltage applied to a load circuit, regardless of the load's dynamic impedance. Over or under voltage circumstances may develop if this is not done, resulting in erroneous circuit behaviour or even circuit damage. This is especially true in low-voltage digital devices, where supply voltages must be carefully regulated within a few percent of their nominal value window. This is not something that reactive elements have built-in control over. Conditionally regulating the energy stored in the low impedance reactive store source is how an AC/DC converter achieves a tightly controlled output voltage window.

As power drains from these elements, the voltage output will change over time, and it may also vary due to non-ideal device features such as series resistance or parasitic capacitance. To replenish this source, some type of dynamic control is required. This is referred to as regulation. Microprocessors, for example, modify the amount of power they use as they conduct different processes, exacerbating the need for active dynamic control.

A feedback circuit that controls the switching elements is known as regulation control. The switching element is on the primary side of the converter in this example. A switch must be either hard ON (lowest impedance possible) or hard OFF (highest impedance possible) to be efficient, as electricity going through the switch is dissipated and squandered in intermediate states. Semiconductor switches, such as MOSFETS, are non-ideal and have some resistance; as a result, they waste energy and reduce conversion efficiency. There are only two ways to regulate a switch: by adjusting the duty cycle at which it is on or off (PWM) or by controlling the frequency at which it is ON or OFF. Hard switching techniques are used by non-resonant mode converters, however Resonant Mode converters use a more sophisticated soft-switching strategy. Soft switching eliminates switching losses and leads to very high efficiency architectures by turning on or off alternating current waveforms at zero voltage or zero current points. Synchronous rectification techniques use active switching

devices like MOSFETS to replace rectification diodes. When compared to diode rectification, controlling the switching synchronised to the input AC waveform allows the MOSFET to conduct with a very low ON resistance and minimal voltage loss at the proper time, resulting in improved efficiency. When the regulation circuit switches, how does it know? Voltage control and current control are the two most common control modes. Regulators use one or both of these ways to control the voltage applied to the load circuit.

2.7 CONVERTER TYPES

As touched on briefly, there are several converter types relating to their topology, including fly back and buck- fly back architectures. These are frequent topologies because they use transformers, have a low component count, and are relatively inexpensive compared to other alternatives. Flyback converters are buck-boost (step-up/step-down) converters with a transformer in place of the inductor. Through an active or passive rectification circuit, the stored energy inside the transformer is utilized to commutate the secondary. The most common type of fly back converter utilizes discontinuous mode (DCM) – with current flowing in the transformer getting to zero – as this typically has the simplest control loop and lowest cost. Continuous current mode (CCM) fly back convertors are required for higher power levels but result in higher transformer winding losses due to continuous conducting. Many power supplies switch between modes depending upon the load level. More sophisticated circuits, such as quasi-resonant (QR) and valley switching/variable frequency variants on the flyback topology, optimize when and how switching happens to increase efficiency. QR flyback does this by recycling the energy of non-ideal leakage inductances, and valley switching decreases overshoot spikes. They're most commonly found in low-power applications.

2.7.1 THYRISTOR

A thyristors is a solid-state semiconductor device with four layers of alternating N and P-type material. It acts exclusively as a bi-stable switch, conducting when the gate receives a current trigger, and continuing to conduct while the voltage across the device is not reversed (forward-biased). A three-lead thyristors is designed to control the larger current of its two leads by combining that current with the smaller current of its other lead, known as its control lead. A two-lead thyristor, on the other hand, is designed to turn on when the potential difference between its leads is sufficiently large (breakdown voltage).

Silicon-controlled rectifier (SCR) and thyristors are sometimes used interchangeably. Thyristors are defined as a larger group of devices containing at least four layers of alternating N and P-type material, according to other sources.

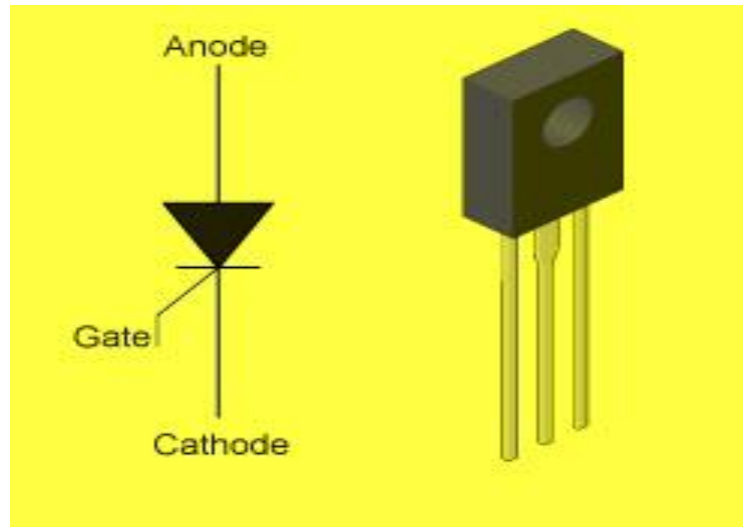


Fig 2.7.1 Thyristors Diagram

2.7.2 MOSFET

The MOSFET (metal–oxide–semiconductor field–effect transistor) is a type of transistor that can be used to amplify or switch electronic signals.

Despite the fact that the MOSFET has four terminals: source (S), gate (G), drain (D), and body (B), the body (or substrate) of the MOSFET is frequently linked to the source terminal, making it a three-terminal device like other field-effect transistors. Only three terminals appear in electrical schematics because these two terminals are generally connected to each other (short-circuited) inside.

A voltage drop across the oxide creates a conducting channel between the source and drain contacts in enhancement mode MOSFETs via the field effect. The phrase "enhancement

mode" refers to the rise in conductivity that occurs when the oxide field, commonly known as the inversion layer, is increased. The channel can include electrons (an n-MOSFET or n-MOS) or holes (a p-MOSFET or p-MOS), which are of opposite type to the substrate, therefore n-MOS is made with a p-type substrate and p-MOS is made with an n-type substrate (see article on semiconductor devices). The channel of the less common depletion mode MOSFET, which will be discussed later, is made up of carriers in a surface impurity layer of the opposite type to the substrate, The application of a field that depletes carriers from this surface layer reduces conductivity.

Because the previously metal gate material is now commonly a layer of polysilicon, the term "metal" in the name MOSFET is now often a misnomer (polycrystalline silicon). Aluminum was the gate material until the mid-1970s, when polysilicon, with its capacity to make self-aligned gates, overtook it. Because it is difficult to enhance the speed of operation of transistors without metal gates, they are regaining favour. Similarly, the word "oxide" in the name can be misleading, as many dielectric materials are employed to achieve robust channels with lower applied voltages.

A related name, insulated-gate field-effect transistor, or IGFET, is practically synonymous with MOSFET. Because many "MOSFETs" have a gate that is not metal and a gate insulator that is not oxide, the word may be more comprehensive. MISFET (metal–insulator–semiconductor FET) is another synonym. The MOSFET is by far the most common transistor in both digital and analog circuits, though the bipolar junction transistor was at one time much more common.

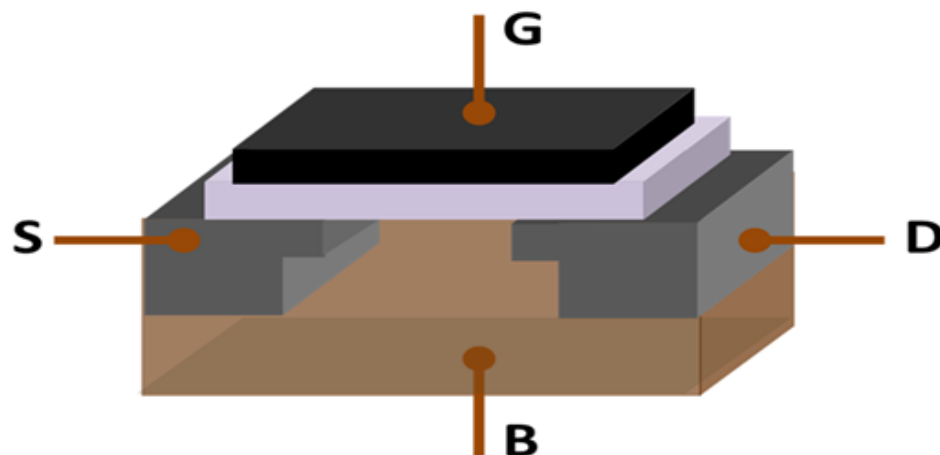


Fig 2.7.2 MOSFET Construction Diagram

2.7.2.1 OPERATION OF MOSFET

The traditional metal–oxide–semiconductor (MOS) structure is obtained by growing a layer of silicon dioxide (SiO_2) on top of a silicon substrate and depositing a layer of metal or polycrystalline silicon (the latter is commonly used). Because silicon dioxide is a dielectric material, its construction is similar to a planar capacitor with a semiconductor replacing one of the electrodes.

When a voltage is placed across a MOS structure, the charge distribution in the semiconductor is changed. A positive voltage applied from gate to body (see figure) creates a depletion layer by forcing positively charged holes away from the gate-insulator/semiconductor interface, leaving a carrier-free region of immobile, negatively charged acceptor ions exposed (see doping (semiconductor)).

The inversion layer electrons in the MOS capacitor are produced much more slowly by heat generation through carrier generation and recombination centers in the depletion zone, as opposed to the MOSFET, where they are supplied swiftly from the source/drain electrodes. The threshold voltage is the gate voltage at which the volume density of electrons in the inversion layer is equal to the volume density of holes in the body. Overdrive voltage occurs when the voltage between the transistor gate and source (V_{GS}) surpasses the threshold voltage (V_{th}). The n-type MOSFET is built on this p-type body structure, which necessitates the inclusion of n-type source and drain regions.

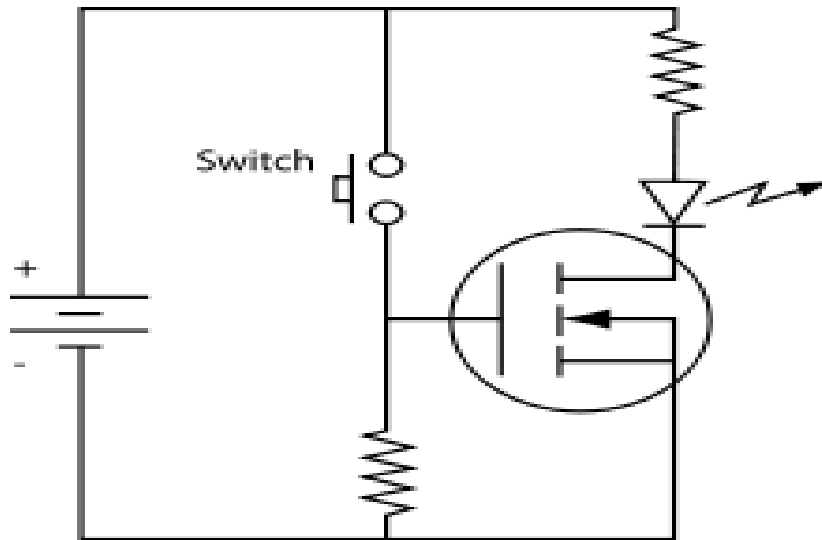


Fig 4.6 MOSFET Block Diagram

2.7.3. INDUCTOR

An inductor, also called a coil or reactor, is a passive two-terminal electrical component which resists changes in electric current passing through it. It consists of a conductor such as a wire, usually wound into a coil. As long as current runs, energy is stored in a magnetic field in the coil. According to Faraday's law of electromagnetic induction, when the current flowing through an inductor varies, the time-varying magnetic field induces a voltage in the conductor. According to Lenz's law the direction of induced electromotive force (or "emf.") is always such that it opposes the change in current that created it. As a result, inductors always oppose a change in current, in the same way that a flywheel opposes a change in rotational velocity. Care should be taken not to confuse this with the resistance provided by a resistor.

An inductor is characterized by its inductance, the ratio of the voltage to the rate of change of current, which has units of Henrys (H). Inductors typically have values ranging from 1 nH (10⁻⁹H) to 1 H. Inside the coil of many inductors is a magnetic core made of iron or ferrite, which increases the magnetic field and therefore the inductance. Inductors are one of the three passive linear circuit elements that make up electric circuits, along with capacitors and

resistors. Inductors are common in alternating current (AC) electronic equipment, especially in radio equipment. Chokes are inductors that are designed to block AC while allowing DC to pass. They're also employed in electronic filters to separate signals of different frequencies, and in tuned circuits to tune radio and TV receivers, where they're combined with capacitors.



Fig 2.7.3 Inductor Diagram

2.7.4 CAPACITOR

A capacitor (also known as a condenser) is a two-terminal passive electrical component that stores electrical energy in an electric field briefly. Practical capacitors come in a variety of shapes and sizes, but they all have at least two electrical conductors (plates) separated by a dielectric (i.e. an insulator that can store energy by becoming polarized). Thin films, foils, or sintered metal beads, as well as conductive electrolytes, can be used as conductors. The capacitor's charge capacity is increased by the non-conducting dielectric. Glass, ceramics, plastic film, paper, mica, and oxide layers are all common dielectric materials. Many typical electrical gadgets employ capacitors as part of their electrical circuits. An ideal capacitor,

unlike a resistor, does not waste energy. A capacitor, on the other hand, stores energy as an electrostatic field between its plates.

When a potential difference exists between the conductors (for example, when a capacitor is connected to a battery), an electric field forms across the dielectric, causing positive charge $+Q$ to gather on one plate and negative charge Q to collect on the other. No current can flow through a capacitor if a battery has been connected to it for an extended period of time. A displacement current can flow if a time-varying voltage is put across the capacitor's leads.

The capacitance of an ideal capacitor is characterized by a single constant value. The ratio of each conductor's electric charge Q to the potential difference V between them is defined as capacitance. The farad (F), or one coulomb per volt (1 C/V), is the SI unit of capacitance. Capacitance levels in the range of 1 pF (10^{-12} F) to 1 mF (10^{-3} F) are typical.

The capacitance is increased by increasing the surface area of the "plates" (conductors) and decreasing the space between them. In practice, the dielectric between the plates leaks a small amount of current and has a limit on the strength of the electric field, known as the breakdown voltage. Inductance and resistance are introduced by the conductors and leads, which is undesirable. Capacitors are commonly employed in electrical circuits to block direct current while allowing alternating current to flow through them. They smooth the output of power supply in analogue filter networks. They use resonant circuits to tune radios.

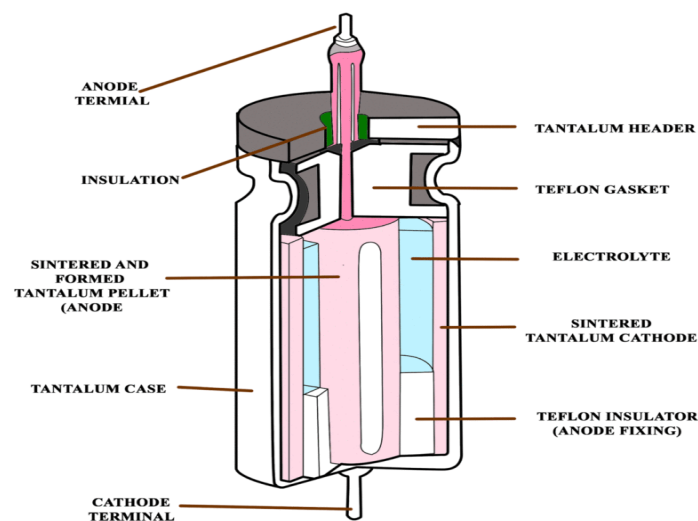


Fig 2.7.4 Capacitor Diagram

2.7.4.1 OPERATION OF CAPACITOR

Two conductors are separated by a non-conductive area in a capacitor. A vacuum or an electrical insulator substance known as a dielectric can be used as the non-conductive zone. Glass, air, paper, and even a semiconductor depletion area chemically similar to the conductors are examples of dielectric media. The assumption is that a capacitor is self-contained and isolated, with no net electric charge and no external electric field impact. On their opposing surfaces, the conductors carry equal and opposite charges, and the dielectric generates an electric field. One farad of capacitance means that one coulomb of charge on each conductor results in a voltage of one volt across the device in SI units. An ideal capacitor is wholly characterized by a constant capacitance C , defined as the ratio of charge $\pm Q$ on each conductor to the voltage V between them

$$C = \frac{Q}{V}$$

Because the conductors (or plates) are close together, the opposite charges on the conductors attract one another due to their electric fields, allowing the capacitor to store more charge for given voltage than if the conductors were separated, resulting in a greater capacitance in the capacitor. Condensers were the name given to early capacitors, and the term is still used infrequently today, especially in high-power applications like automobile systems.

2.8 DRIVER CIRCUIT

We know from our Transformer tutorials that they can provide not only a step-down voltage, but also "electrical isolation" between the higher voltages on the main side and the lower voltages on the secondary side. In other words, transformers use electromagnetic coupling to separate the primary input voltage from the secondary output voltage via a magnetic flux circulating within the iron laminated core. However, by employing an Optocoupler, an ubiquitous and valuable electronic component, we may achieve electrical

isolation between an input source and an output load using just light. An optocoupler, also known as an opto-isolator or photo-coupler, is an electronic component that uses a light-sensitive optical interface to join two distinct circuit.

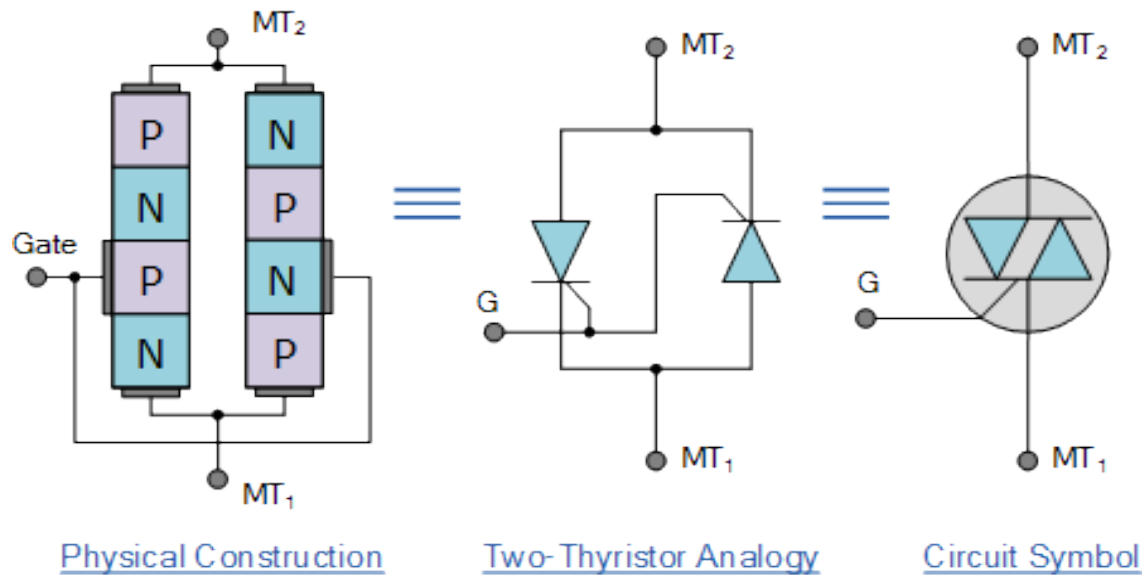


Fig 2.8 Triac Construction Diagram

2.9 MICROCONTROLLER

2.9.1 PIN DIAGRAM

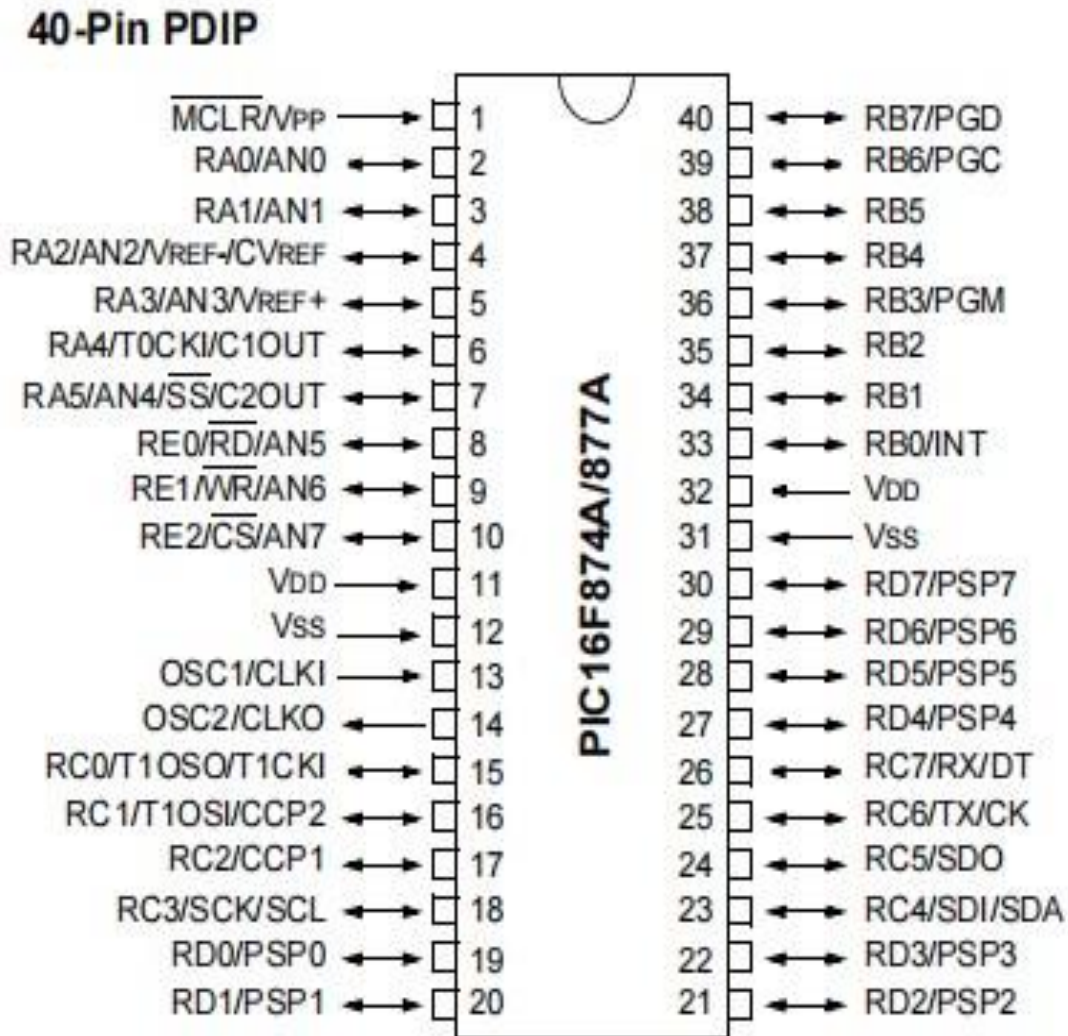


Fig 2.9.1 Pin Diagram

For the dsPIC30F4011/4012 device, this paper offers device-specific information.. The dsPIC30F devices contain extensive Digital Signal Processor (DSP) functionality within a high performance 16bit microcontroller (MCU) architecture block diagrams for the dsPIC30F4011 and PIC30F877A device.

2.9.2 PIC16F877A BLOCK DIAGRAM

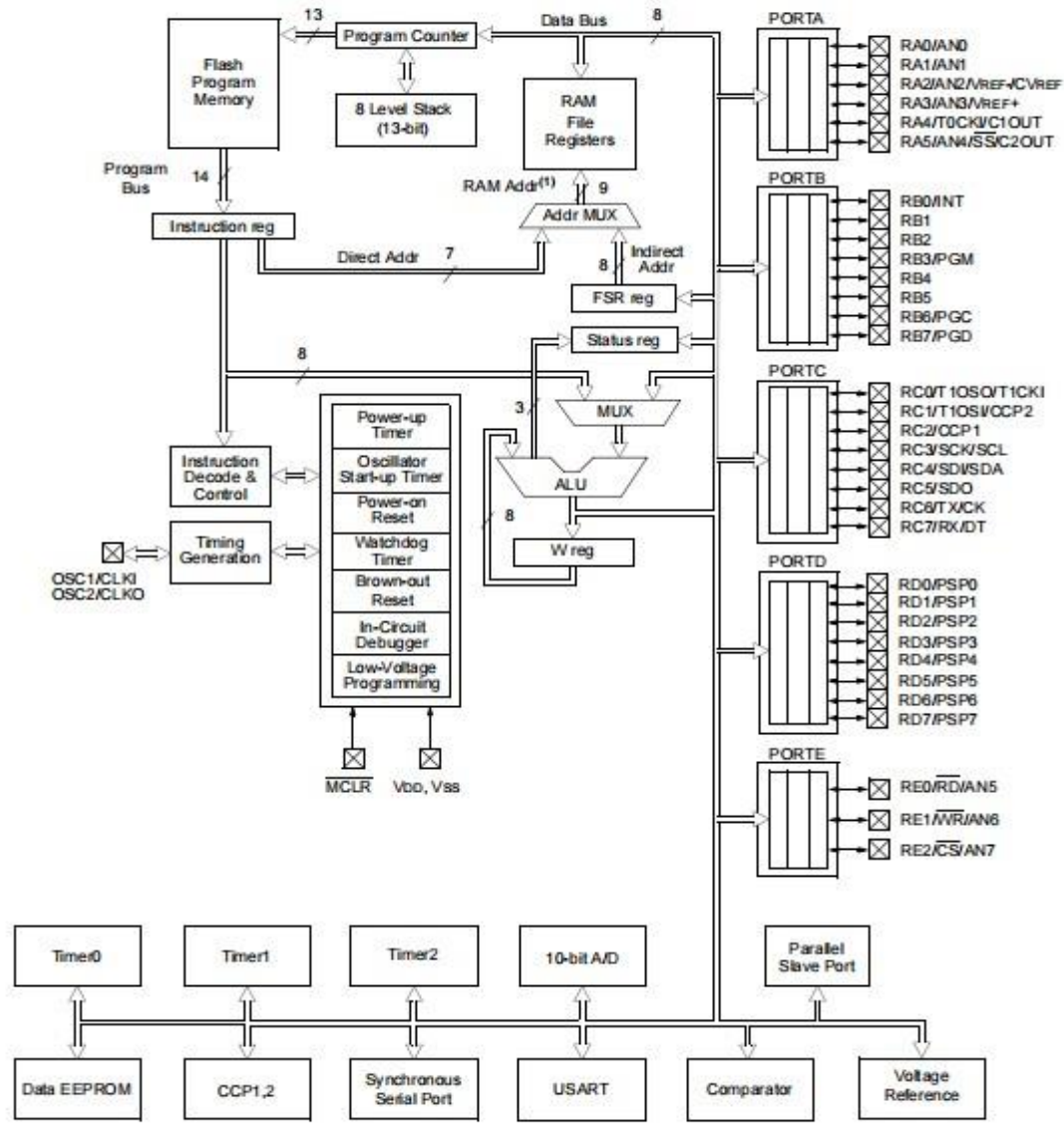


Fig 2.9.2 PIC16F877A Block Diagram

2.9.3 DESCRIPTION

A 24-bit instruction word is used in the core. Except for some specialized instructions, the Program Counter (PC) is 23 bits wide, with the Least Significant (LS) bit always clear (see Section 3.1), and the Most Significant (MS) bit ignored during regular program execution. As a result, the PC may address user program space with up to 4M instruction words. To aid throughput, an instruction pre-fetch method is employed. The DO and REPEAT instructions, both of which are interruptible at any point, are used to allow program loop constructions that are devoid of loop count management overhead. Each of the 16x16-bit registers in the working

register array can be used as a data, address, or offset register. For interrupts and calls, one working register (W15) serves as a software stack pointer. The data memory is divided into two blocks, referred to as X and Y data memory, and is 64 Kbytes (32K words) in size. Each block has its own Address Generation Unit (AGU) (AGU). The X memory AGU is used exclusively by most instructions, giving the impression of a single unified data space. The Multiply-Accumulate (MAC) class of dual source DSP instructions uses both the X and Y AGUs to divide the data address space into two pieces. The device-specific X and Y data space border cannot be changed by the user. Most instructions can address data as words or bytes, and each data word is made up of two bytes.

2.9.4 DATA STORED IN PROGRAM MEMORY

At any 16K program word boundary established by the 8-bit Program Space Visibility Page (PSVPAG) register, the upper 32 Kbytes of data space memory can be mapped into the lower half (user space) of program space memory. This lets any instruction access program space as if it were data space, with a limitation that the access requires an additional cycle. Furthermore, this approach can only read the lower 16 bits of each instruction word.

SWW Linear indirect access to 32K word pages within programme space is also feasible through table read and write instructions in any working register. To access all 24 bits of an instruction word, table read and write instructions can be used. In both the X and Y address spaces, overhead-free circular buffers (modulo addressing) are available. This is primarily meant to reduce DSP algorithm loop overhead. The X AGU also enables bit-reversed addressing on destination effective addresses, which considerably simplifies radix-2 FFT technique data reordering. For more information on modulo and bit-reversed addressing, see Section 4.0. Inherent (no operand), Relative, Literal, Memory Direct, Register Direct, Register Indirect, Register Offset, and Literal Offset Addressing modes are supported by the core. Depending on their functional requirements, instructions are connected with preset Addressing modes.

The core can do a data (or program data) memory read, a working register (data) read, a data memory write, and a program (instruction) memory read every instruction cycle for most

instructions. As a result, 3-operand instructions can now be used, allowing $C = A+B$ operations to be completed in a single cycle.

A DSP engine has been incorporated to improve the fundamental arithmetic capability and throughput dramatically. A high-speed 17-bit by 17-bit multiplier, a 40-bit ALU, two 40-bit saturating accumulators, and a 40-bit bi-directional barrel shifter are among the features. In a single cycle, data in the accumulator or any working register can be moved up to 16 bits right or left. The DSP instructions work in tandem with the other instructions and are optimized for real-time performance. The MAC instruction family can read two data operands from memory at the same time as multiplying two W registers. The data space has been split for these instructions and linear for all others to facilitate parallel fetching of data operands. By allocating specific working registers to each address space for the MAC class of instructions, this has been accomplished in a clear and flexible manner.

A multi-stage instruction pipeline is not supported by the core. However, in order to maximize available execution time, a single stage instruction pre-fetch mechanism is implemented, which accesses and partially decodes instructions a cycle ahead of execution. With a few exceptions, most instructions run in a single cycle. With 62 independent vectors, the core has a vectored exception processing framework for traps and interrupts. Up to 8 traps (four of which are reserved) and 54 interrupts are available as exceptions. . Each interrupt is assigned a priority between 1 and 7 by the user, with 1 being the lowest priority and 7 being the highest, in accordance with a specified 'natural order.' Traps have fixed priority ranging from 8 to 15 traps have fixed priorities varying from 8 to 15 traps have fixed priorities ranging from 8 to 15 traps have fixed priorities ranging from 8 to 15 traps have fixed

The address space for the program is 4M instruction words. When program space is mapped into data space, it is addressable by the 23-bit PC, table instruction Effective Address (EA), or data space EA, as specified by Table 3-1. In order to maintain compatibility with data space addressing, the program space address is incremented by two between program words.

For all accesses other than TBLRD/TBLWT, which employ TBLPAG to determine user or configuration space access, user program space access is limited to the lower 4M instruction word address range (0x000000 to 0x7FFFFE). Bit 23 of the Read/Write instructions provides access to the Device ID, User ID, and configuration bits. Otherwise, bit 23 is always set to

zero. Any 16K word program space page may optionally be mapped into the upper 32 Kbytes of data space. This provides transparent access of stored constant data from X data space, without the need to use special instructions (i.e., TBLRDL/H, TBLWTL/H instructions).

Program space access through the data space occurs if the MS bit of the data space EA is set and program space visibility is enabled, by setting the PSV bit in the Core Control register (CORCON). The functions of CORCON are discussed in Section 2 DSP Engine. Data accesses to this area add an additional cycle to the instruction being executed, since two program memory fetches are required. It's worth noting that the X data space always includes the upper half of addressable data space. As a result, when a DSP operation accesses this memory region using program space mapping, the Y data space should normally include state (variable) data for DSP operations, whereas the X data space should typically hold coefficient (constant) data. Although each data space address, 0x8000 and higher, maps directly into a corresponding program memory address.

CHAPTER 3

SIMULATION THEORY

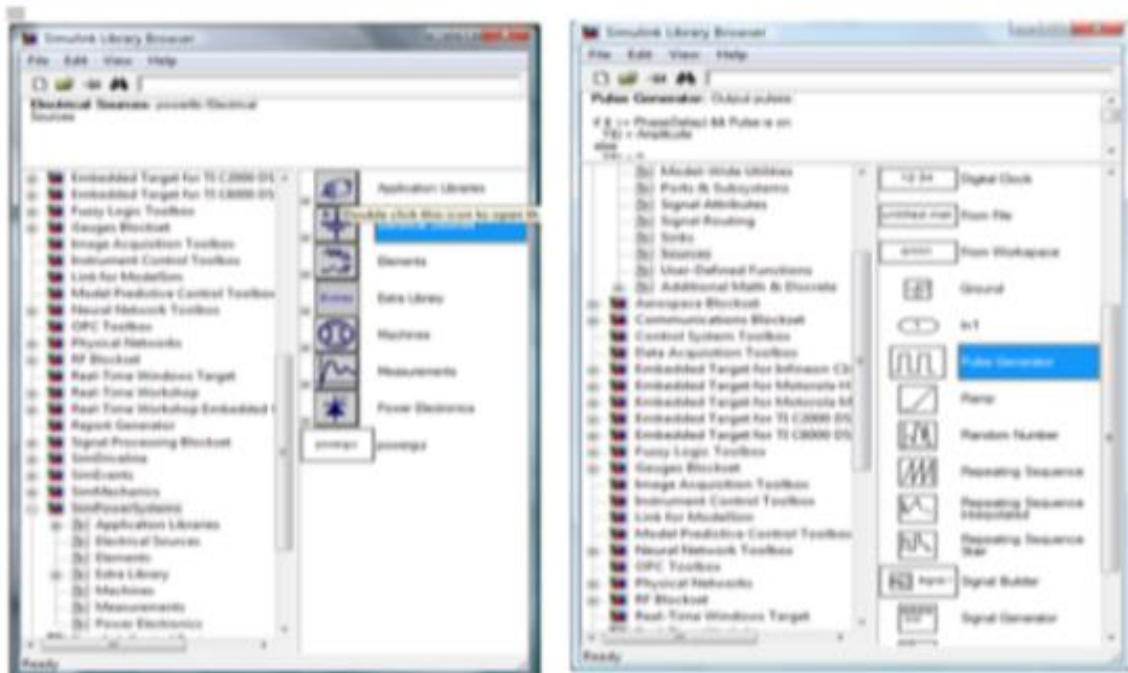
3.1 MATLAB DESCRIPTION

MATLAB is a high-performance language for technical computing. It integrates computation, visualization, and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation. Typical uses include

1. Math and computation
2. Algorithm development
3. Data acquisition
4. Modelling, simulation, and prototyping
5. Data analysis, exploration, and visualization
6. Scientific and engineering graphics
7. Application development, including the creation of graphical user interfaces

MATLAB is an interactive system with an array as its basic data element that does not require dimensioning. This allows you to solve many technical computing issues in a fraction of the time it takes to build a program in a scalar non-interactive language like C or FORTRAN, especially ones using matrix and vector formulations. Matlab is an acronym for matrix laboratory. MATLAB was created to make matrix software developed by the LINPACK and EISPACK teams more accessible. The LAPACK and BLAS libraries are now included in MATLAB engines, putting the state-of-the-art in software for matrix computation. Many users have contributed to the development of MATLAB over the years. It is the standard instructional tool for introductory and advanced mathematics, engineering, and science courses at universities. For high-productivity research, development, and analysis in industry, MATLAB is the tool of choice. Toolboxes are a type of add-on application-specific solution available in MATLAB. Toolboxes are essential for most MATLAB users since they allow you to understand and use specific technologies. Toolboxes are large sets of MATLAB functions (M-files) that allow you to extend the MATLAB environment to solve specific types of issues. Signal

processing, control systems, neural networks, fuzzy logic, wavelets, simulation, and many other areas have toolboxes available.



CHAPTER 4

SIMULATION CIRCUIT AND RESULT

4.1 SIMULATION CIRCUUIT

The simulation of the project was carried out in matlab Closed loop control of motor with respect to speed and torque was achieved. Simulation Circuit Diagram for bridgless DC to DC Converter is also shown in hardware description.

The figures in the subsequent pages show the following output parameters of the simulation setup

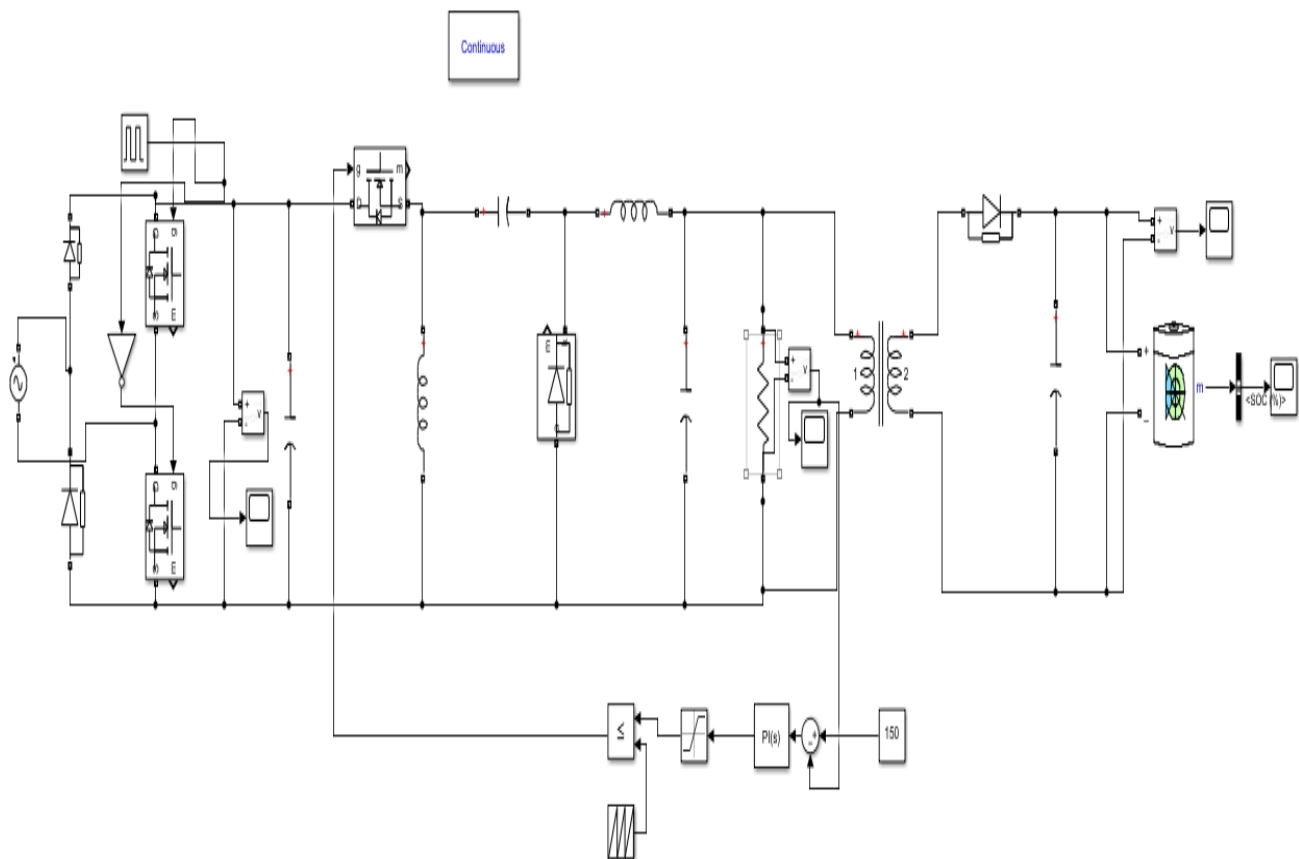


Fig 4.1. simulation circuit

4.2 TOTAL HARMONIC DISTORTIONS

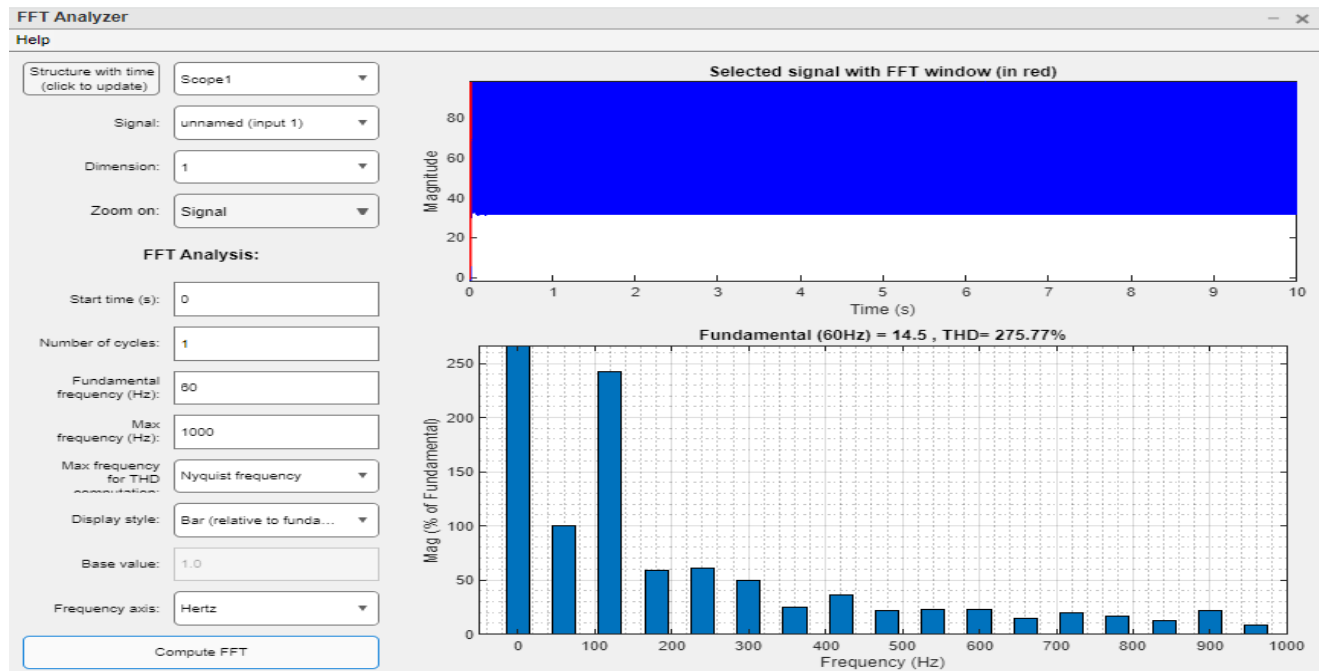


Fig 4.2.1 bridgeless converted voltage

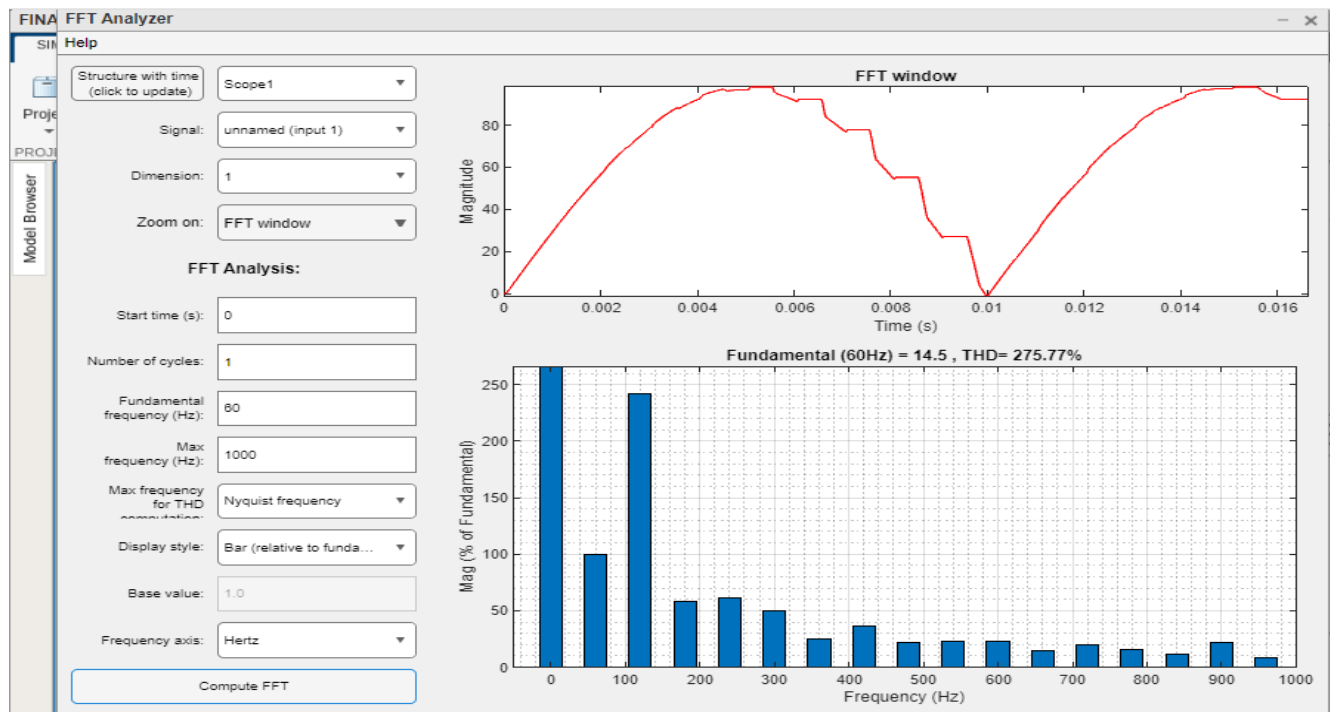


Fig 4.2.2 bridgeless converted voltage (FFT Window)

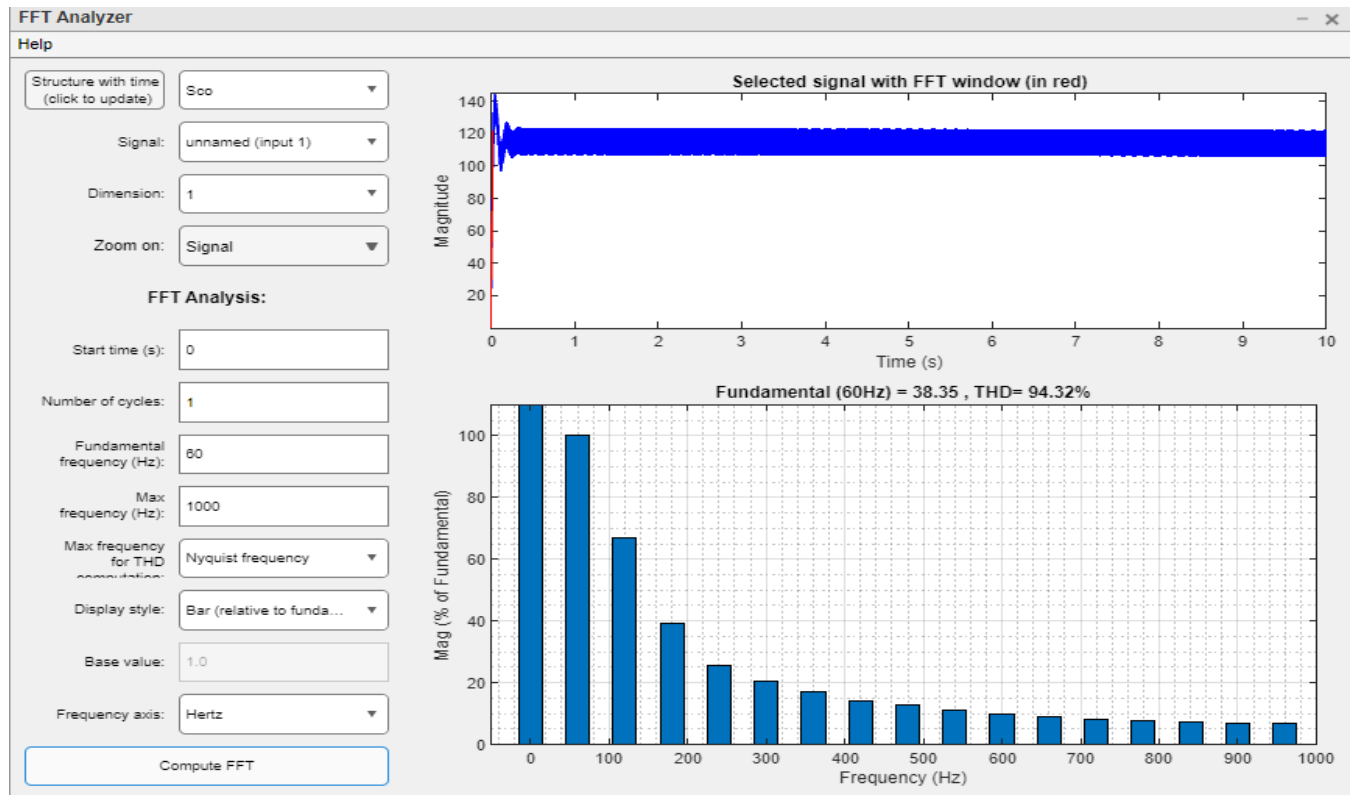


Fig 4.2.3 Dc-Dc Boosted voltage

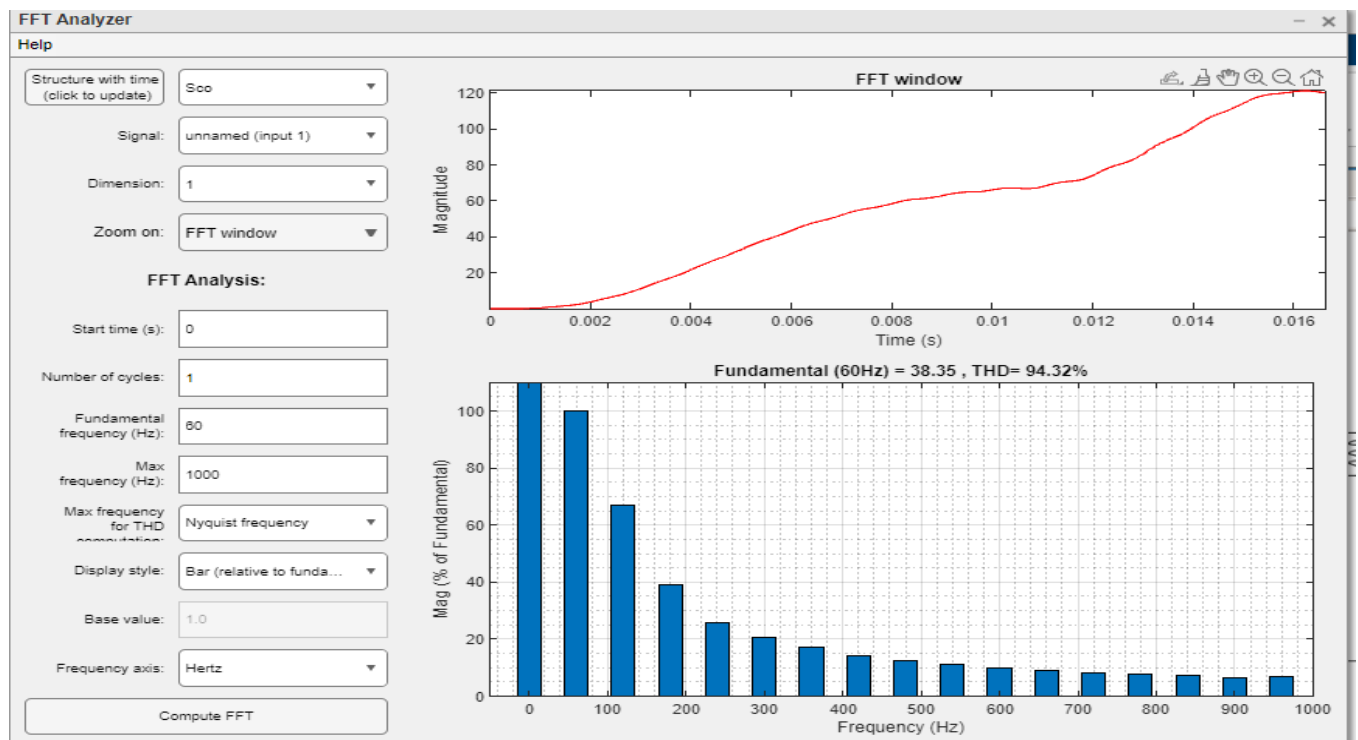


Fig 4.2.4 DC-DC boosted voltage(FFT window)

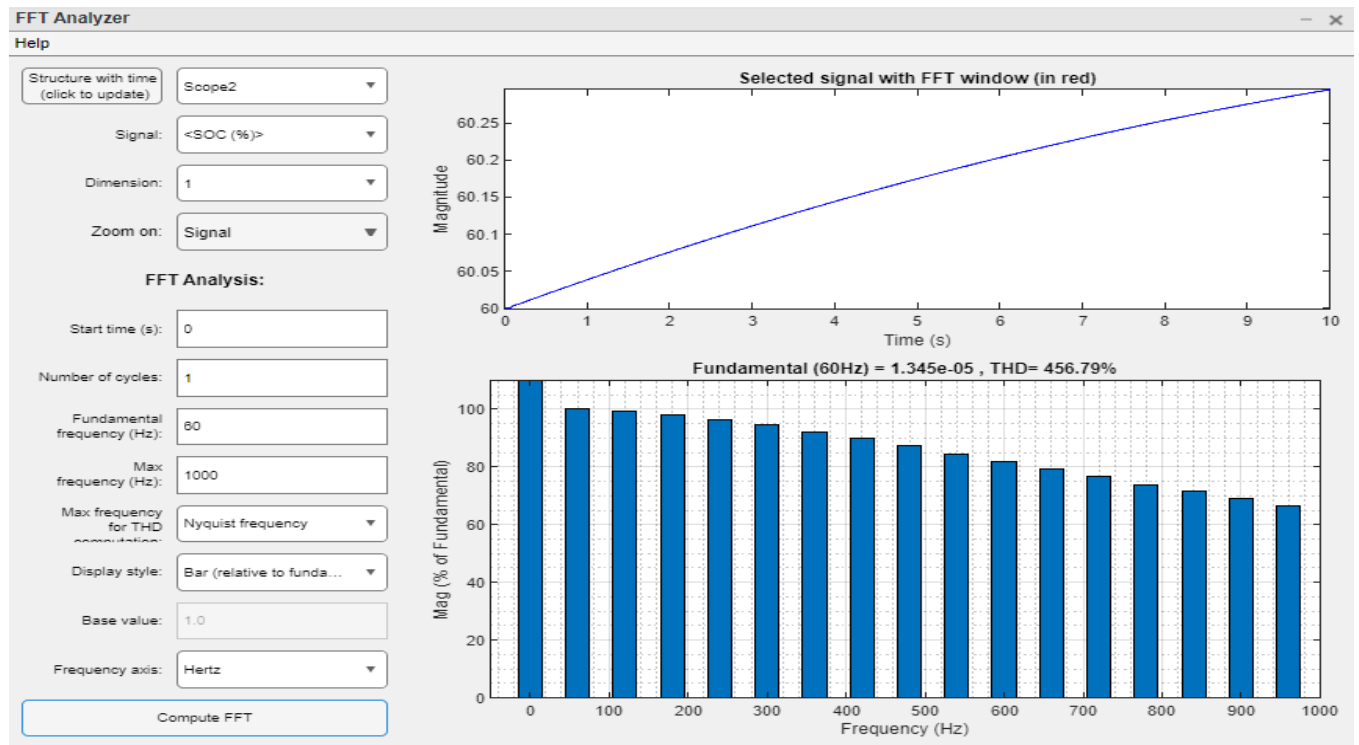


Fig 4.2.5 Flyback converted voltage

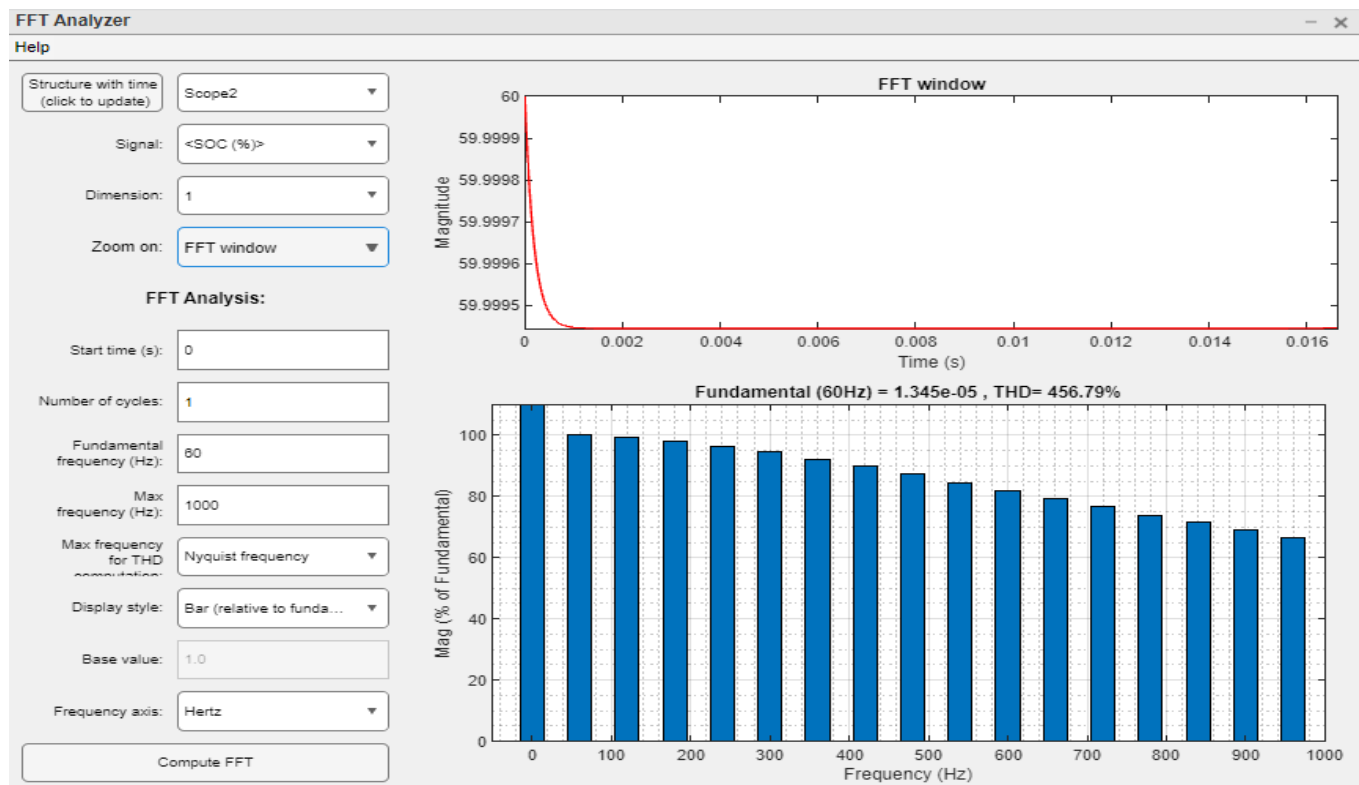


Fig 4.2.6 Flyback converted voltage (FFT window)

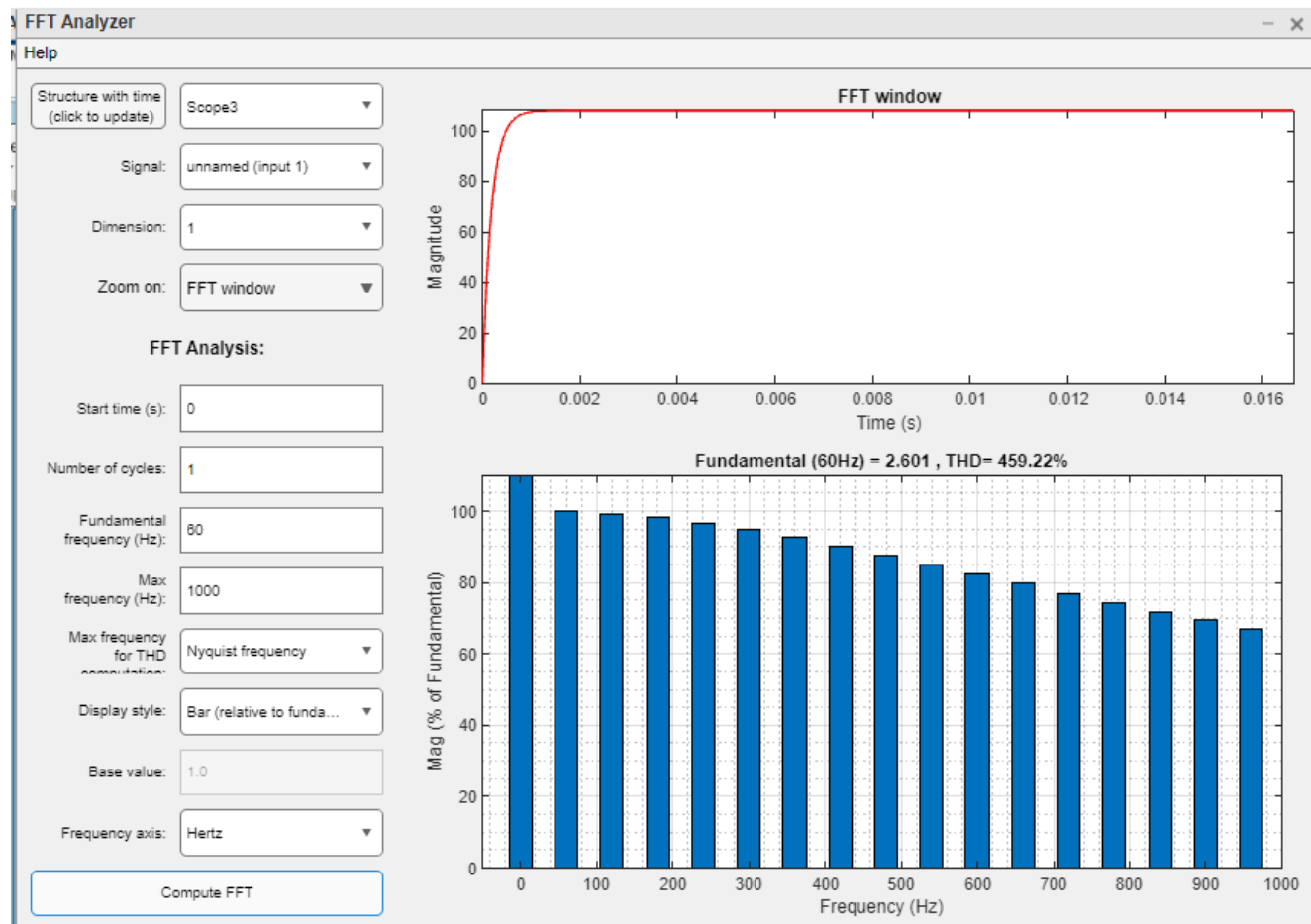


Fig 4.2.7 Speed Charger

4.3 SOC s of simulations

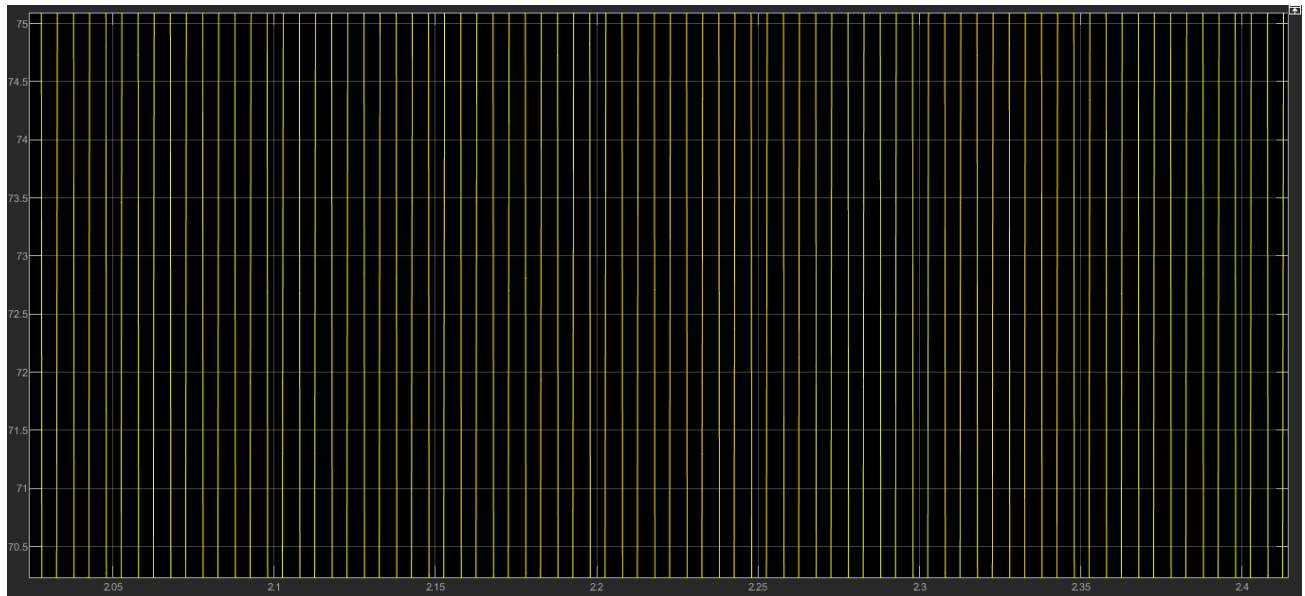


Fig 4.3.1 Input Voltage

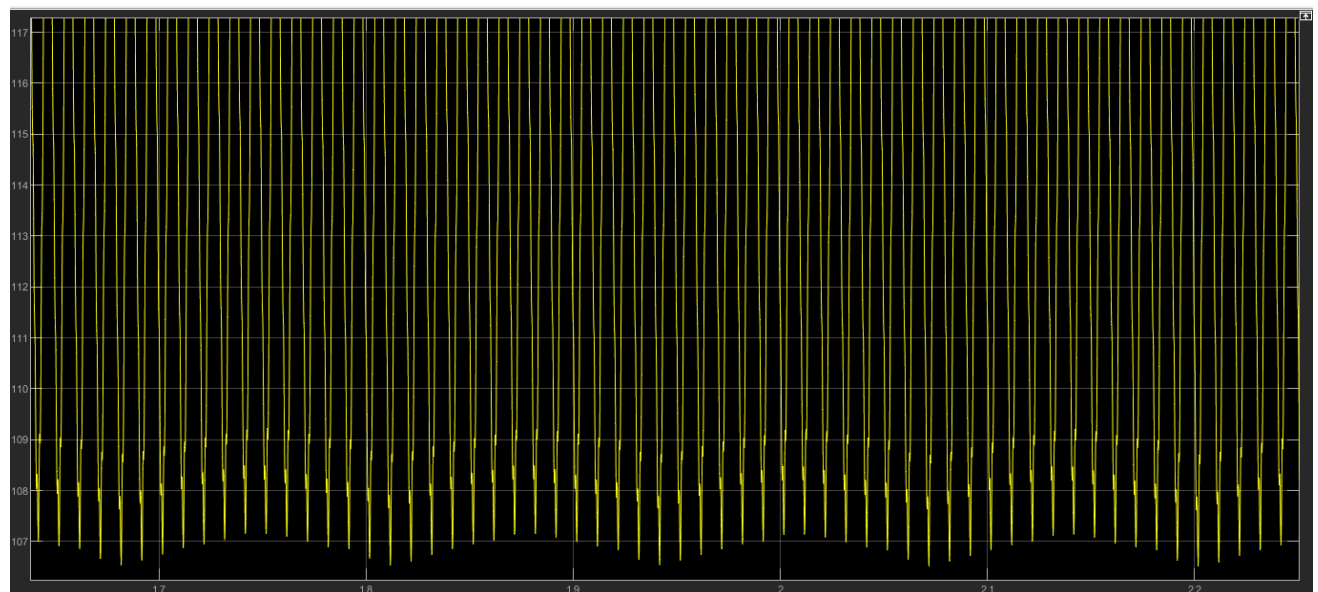


Fig 4.3.2 Dc-Dc boosted voltage

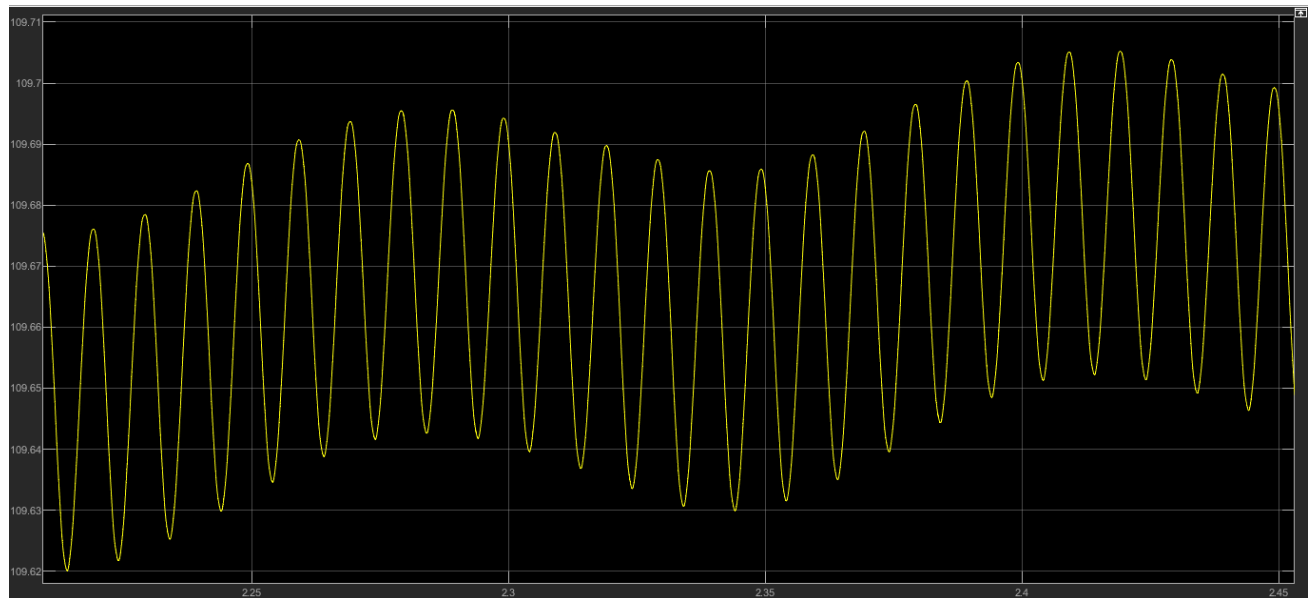


Fig 4.3.3 Flyback converted output voltage

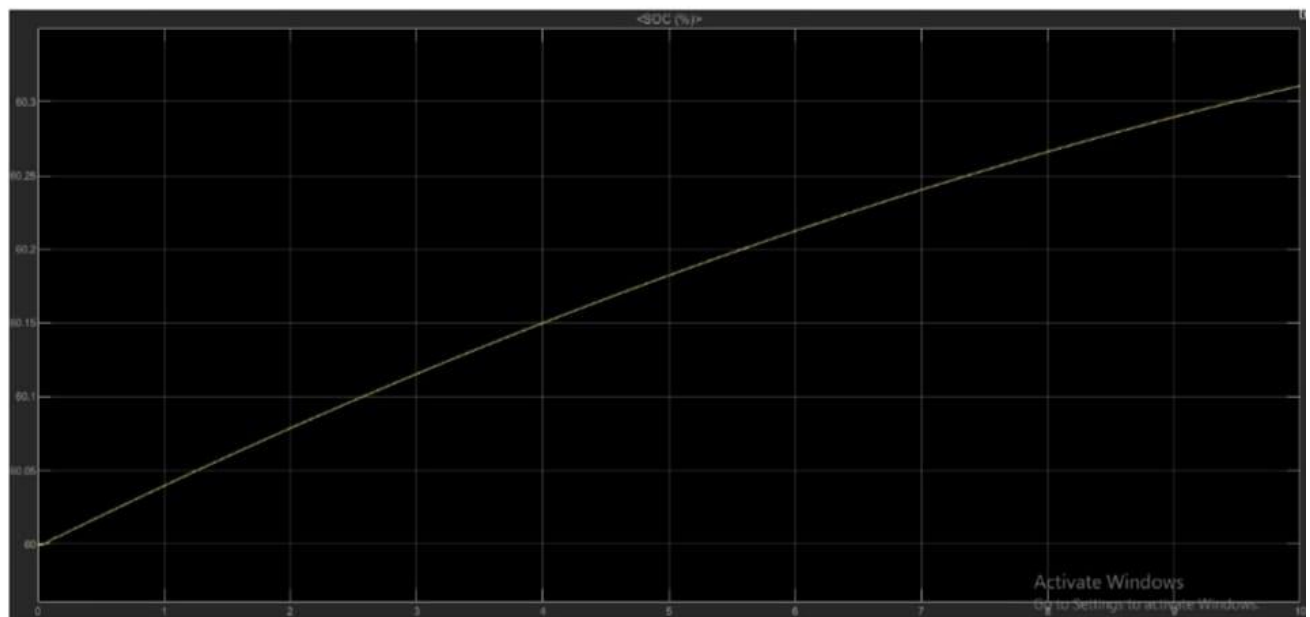


Fig 4.3.4 Speed Of Charger

4.4 HARD WARE PROTOTYPE

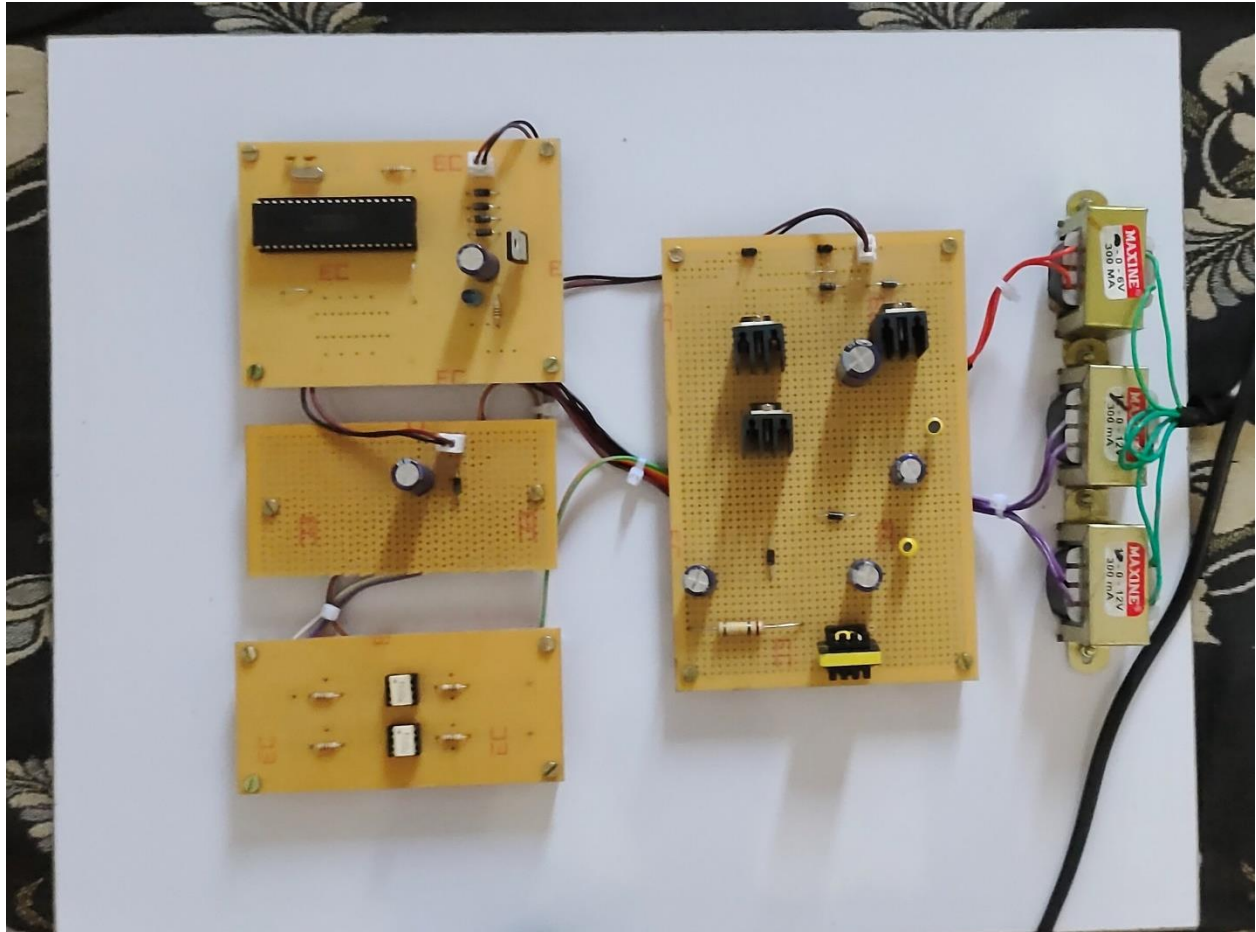


Fig 4.4 photography hardware connection

4.5 HARD WARE OUTPUT

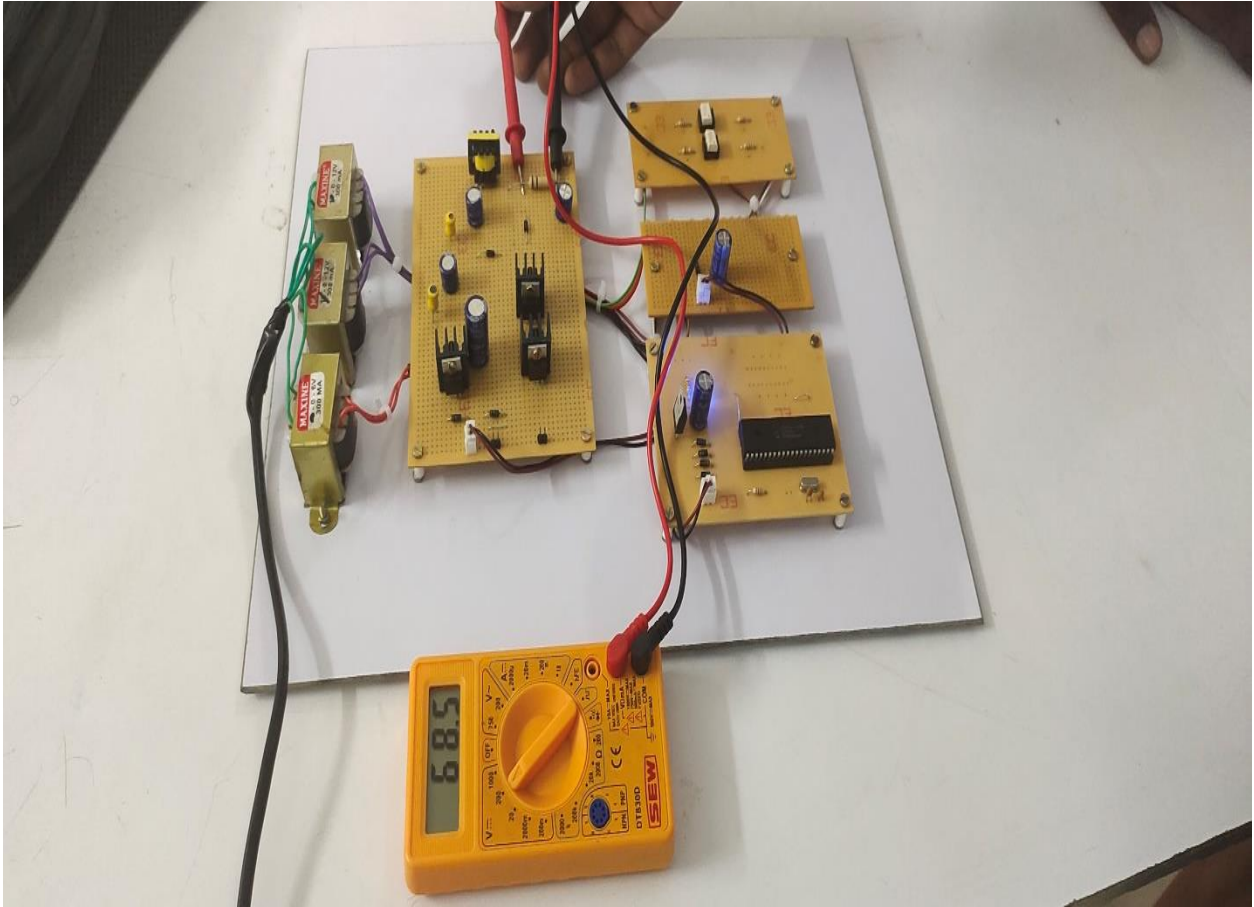


Fig 4.5 Photography of Hardware circuit

This project work was constituted with the above fig.4.3 shown hardware modules. The outputs obtained as the results of the above setup are given as follows.

Table 4.6 Experimental output Results

S.No	Parameters	Value
1.	Input Voltage in V	12 V
2.	Frequency in HZ	60 HZ
3.	Output voltage in V	68 V
4.	Output current in A	9.0 A
5.	Output power in W	620 W
6.	Efficiency	0.96

4.7 Difference between Existing and Proposed Results

S.NO	EXISTING RESULTS	PROPOSED RESULTS
1.	Input voltage = 12 v	Input Voltage = 12 v
2.	Frequency = 60 Hz	Frequency = 60 Hz
3.	Output voltage = 60 v	Output voltage = 69 v
4.	Output current = 8.4 A	Output current = 9.0 A
5.	Output power = 504 w	Output power = 621 w
6.	Here Lithium Io Battery used for charging.	Here also we use Lithium Battery used. B Output voltage is higher than the existing one.

CHAPTER-5

CONCLUSION

This research offers a bridgeless battery charger with high efficiency to be used in light electric vehicles to analyse its theoretical and actual working. The addition of a series resonance circuit gives ZCS and alleviates the difficulty of reverse recovery for output diodes, while removing the input bridge diode reduces conduction losses. Traditional bridgeless converters have a lower power capability due to bidirectional core excitation of the transformer. Because the proposed charger uses an electrolytic capacitorless scheme with a sinusoidal-like dc current on the battery side, the input power is immediately delivered to the battery side, increasing efficiency.

Through single-power-conversion, the suggested control method allows the charger to rectify the power factor and manage the output. The proposed charger boasts good efficiency and power quality as a result of these features. The simple circuit topology and output diodes with soft-switching characteristics result in a maximum efficiency of 96.2 percent. In addition, when the control method is used, the power factor for a universal grid voltage is close to unity. As a result, the suggested charger and its control algorithm are an excellent option for electric vehicles (EVs) that necessitate charging efficiency, a high power factor, and a straightforward design.

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