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Off grid charging system for electrical vehicle

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ABSTRACT

Global warming has lead to the large adoption of Electrical Vehicles (EV) which appear to the best replacement to IC engines. Due to increased number of EVs in the road, charging of the vehicles with conventional fossil fuel based grid is not economical and efficient. Thus, a renewable energy based charging stations finds immense potential and controlfor electric vehicle charging. An electric vehicle charging station integrating solar power and a Battery Energy Storage System is designed for the current scenario. For uninterrupted power in the charging station an additional grid support is also considered without becoming an extra burden to the grid. An efficient design of charging station with MPPT, PID and current control strategy is developed for the optimal power management between solar, BESS, grid with the EVs in the charging station.

Keywords: PV (Photovoltaic), BOOST Converter, BI-directional converter, Battery, Electrical vehicle, off grid charging.

1. INTRODUCTION

The need for the electric vehicle (EV) is rising exponentially if the present Indian scenario is taken into account. The statement can be validated by considering India's atmospheric pollution level. According to Choudhary (1997), India is one of the main fossil fuels consuming country for transportation purposes. However, the quantity of fossil fuels is expected to reduce at a great extent in the future. Therefore, the presence of EVs in the automobile industry is the need of the present scenario. These EVs are powered through the grid i.e., grid to vehicle (G2V). As a result, the numberof EVs and hence energy demand increases. Therefore, to overcome this issue, Kempton and Letendre (1997) had proposed the idea of Vehicle to Grid(V2G) which states that the energy stored in the EV battery can be transferredback to the grid. In addition, the battery storage may support the frequency regulation while the EV is transferring energy to the grid. Therefore, the V2G and G2V mode of operation presents the bi-directional behaviour of a grid- connected EV charger.
G2V mode, grid side converter works as a rectifier while the battery side is used as a buck converter. On the other hand, the battery side is used as a boost converter and grid side is used as an inverter in V2G mode. However, the energy source of the GCBD charger is fossil fuel which results in pollution of the environment. Hence, the EVs are required for the pollution- free transportation. Thus, there is a need to shift from grid-based EV charging stations to the clean energy based or off-grid CS (OGCS). In this way, Singhet al. (2016) have suggested that the source for OGCS is the renewable energy. It can be used at the remote locations where the reach of the grid isnot possible. The RESs used for the OGCS are wind and photovoltaic (PV). However, the wind energy consists of more conversion stages to produce power as compared to the PV. Therefore, the feasibility of PV energy based off grid charging station is more [1-5].

2. LITERATURE SURVEY

It is difficult to maintain the teaching level of the Power Electronics discipline due to the program's rapid best growth. This system allows voltage and current to be monitored and controlled [6]. It is significant to mention, however, that other types of measurement techniques, such as temperature, acceleration, and others, will be possible. This proposal focuses on assisting in the teaching of Power Electronics as well as the advancement of data analysis into the converters under consideration, which can be tested experimental data. [7].
Only two electrical detectors (for capturing voltages across the transformer diode and inductances) and two temperature sensors are used to perform the aforementioned monitoring tasks. All non-isolated DC-DC converters, including buck, boost, and buck power switches, can benefit from the presented measurement system, which is simple, expensive, and highly efficient. In experiments carried out on a scaled model, the performance of the monitoring system can be evaluated by evaluating multiple possibilities. [8].
An online condition monitoring algorithm for power electronics is presented. To fully evaluate the progress and

state of power electronics, the proposed algorithm uses voltage measurements between the collector terminals [9]. The proposed algorithm detects and monitors four different conditions of the device: accessible error detection, short-circuit fault detection, overheating fault detection, and valuable suggestion lifetime estimation. In comparison to previous methods in the literature, the proposed algorithm provides complete device state monitoring and recognition using only one sensed volume. [10].

For many applications, DC-DC converters must operate reliably. For defect detection and effective corrective techniques, an appropriate converter monitoring framework is developed. Switch faults and electrolytic capacitor destruction account for a significant portion of converter mistakes. Although the rate of diode failures is not particularly high, a power switch may be affected if a diode fails [11]. Furthermore, if diode fault detection is not included in the monitoring scheme for applications where a redundant switch is used as a remedy, it will be vulnerable to diode inadequacies. [12].

One of the most important contents in electric/hybrid vehicles is powertrain reliability. By boosting or chopping reference voltage between the battery storage and the DC link, the DC-DC converter plays an important role in the electric power train [13]. As a result, the DC-DC converter's reliability and efficiency are critical for safe and efficient machine operation. Multistage Markov analysis was conducted to evaluate reliability in this technique [14].

The present era is fully concerned with energy harvesting, which is the process of extraction of energy from the external surroundings. Although extracted energy is very low in amplitude and also faces irregular fluctuations, the most important task is to regulate the circuit before inserting it into the integrated circuit. Energy harvesting gives the possibility to build autonomous Microsystems. Especially, energy harvesting is the way of removing batteries in implantable Microsystems [15].

A truly united control scheme for Automatic Resonant Frequency Tracking (ARFT) in uncontrolled LLC series resonant DC-DC converters is presented in this method. The optimal strategy detects bandwidth drift in an LLC tank by looking at the phase or gains relationship of the exclusive variable array. The equipment is modeled for a feasible runway variation in resonant frequency using both phase difference and amplitude rate of return of the system parameters [16].

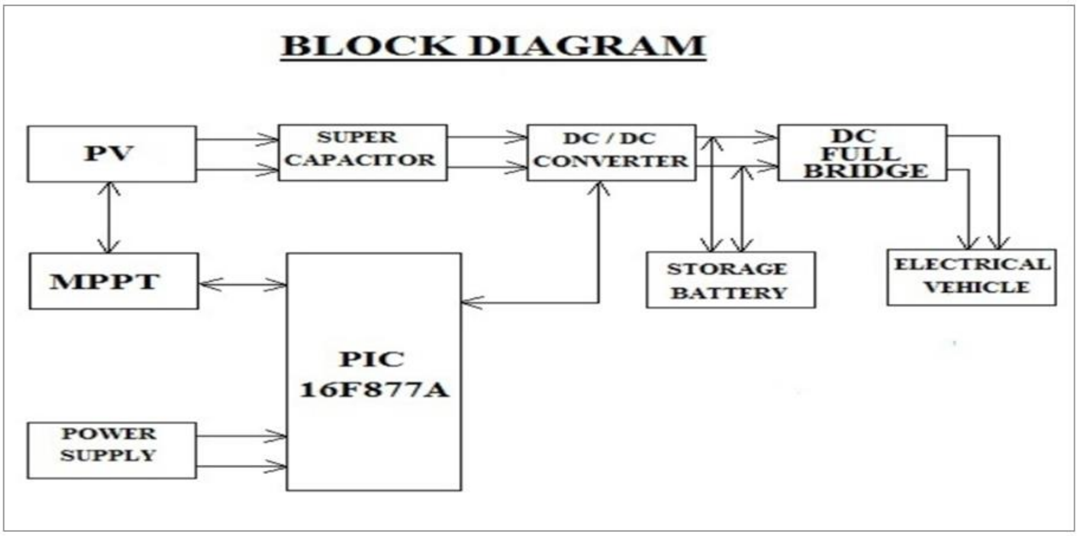
For the LLC series resonant DC-DC converter, a thorough examination, configuration, and hardware implementation of an ARFT method are introduced. The basic design equations of the LLC tank network are used to describe key features. By observing either the phase or gain relationship of a finite difference pattern in an LLC tank, the recommended ARFT scheme detects off-resonance [17].

This introduced a multi-battery charging system capable of improving Lithium-ion (Li-ion) battery charging effectiveness. A pulse power pack, a step-down constant current converter, and a power connection control logic are the three main components of the proposed battery ignition system [17]. The pulse charger can be powered by a wall outlet or a solar energy system. It employs charge techniques that improve the Li-ion battery's measure of economic [18].

The power connection system operates as a power display, determining the best able to charge path, which is either through the use of an energy harvesting system or a power connector. The energy harvesting system's initial supply power is controlled by the step-down DC-DC converter [19]. The Semiconductor technology method is used to implement the Functional Circuit (IC) design. When compared to the standard performance Constant Current Constant Voltage(CC-CV) charging technique, unconventional results show that the proposed heartbeat charger reduces the required charge time and enhances the measure of economic.

3. MATERIALS AND METHOD

The proposed off-grid EV charging station consists of three subsections, they are PV generation, EV charger and ESS. The first section is PV generation system which includes a PV array, maximum power point (MPPT) and a boost converter. The PV array converts solar energy into clean electrical energy and provides voltage VPV and current IPV. The VPV and IPV are given to the boost converter which fluctuates due to change in irradiance. Therefore, an MPPT technique is proposed to manage the fluctuations in VPV and IPV. The MPPT extracts maximum power PPV from the PV array and provides corresponding operating voltage and current to the boost converter. The boost converter regulates the output voltage according to desired DC-link voltage by generating the PWM signals. The EV charger consists of a DC-DC bi-directional converter (BDC) and EVs. The operation of BDC depends on the charging and discharging of the EV battery. During charging mode, BDC acts as a buck converter. On other hand, it works as a boost converter during discharging mode. Similarly, the ESS also consists of a BDC and a battery bank. This battery bank is used as the energy saver during excess energy generation and is utilized at the maximum extent. The power that is stored in the ESS is feedback to the DC-link through BDC which is operated in boost mode. The mode of conversion is carried out with the help of constant current(CC) control strategy. This control strategy generates PWM signals to switch on the BDS. The mode (boost or buck) of converter changes according to the control signal generated by the control strategy. In this way, the operation of an off- grid EV charging is carried out. Further, the brief modeling and control of PV array, boost converter, bi-irectional converter.



3.1 BIDIRECTIONAL DC TO DC CONVERTER

A traditional buck-boost converter can only maintain power movement in one direction, whereas a transformer can manage power flow in both directions. Bidirectional DC-DC converters are devices that can step up or down the voltage level while also allowing power to flow in either including forwarding reverse directions. DC converters operate in both directions. The output of fuel cell systems fluctuates due to changing environmental conditions in power generation. Because of the wide variations in output, these energy systems are always attached with energy storage types of batteries and a supercapacitor to feed the authority as a standard platform. Both converters are made to work together.

The buck converter's minimal pulse width (maximal frequency) and the boost converter's maximal pulse width (minimal frequency) correspond to the optimal operation point. The converter current flows through the transistors or a parallel capacitor during solving the optimal. The internal transistors' element, diodes, do not participate in the current because they only have positive attributes. A DC-to-DC converter is an integrated component or mechanical and electrical device that changes the voltage level of a direct current (DC) source. It's a particular kind of electric power converter. Energy output ranges from extremely low (small batteries) to extremely high (large batteries) (high-voltage power transmission).

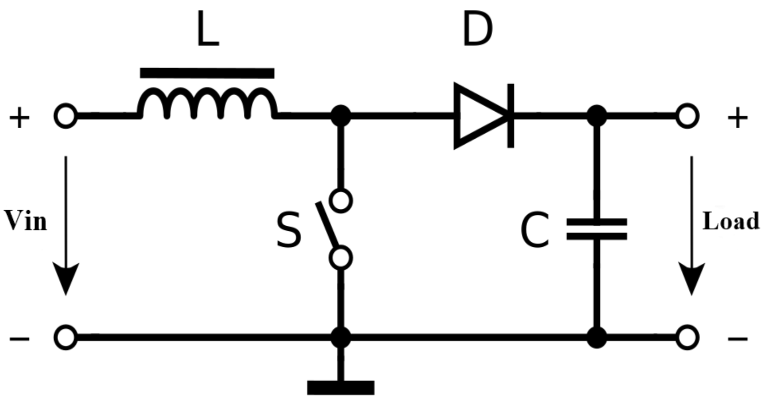


Fig 1: A circuit diagram of Bi-directional DC-DC converter

Fig 1 shows the boost converter (also known as a step-up converter) is a DC-to-DC power converter that increases the voltage from the input supply to the output load. A cascaded constant current converter is used to improve the circuit's high performance. A boost converter (also known as a step-up converter) is a DC-to-DC power converter that increases voltage while decreasing current from its input (supply) (load). It's a type of switched-mode power supply (SMPS) with at least two semiconductors (a diode and a transistor) and at least one energy storage element, such as a capacitor, inductor, or both

Filters made of capacitors (sometimes in combination with inductors) are typically added to such a converter's output (load-side filter) and input (input-side filter) to decrease ripple current (supply-side filter). Any appropriate DC source, such as batteries, solar panels, rectifiers, and Direct current power, can be used to power the buck converter. DC to DC conversion is a process that converts one DC voltage to another DC voltage. A boost converter is a DC to DC converter that produces a higher output voltage than the input voltage. Because it "steps up" the source voltage, a boost converter is also known as a step-up transformer.

The voltage output is lower than the continuously distributed because power (P=VI) must be conserved. A Boost converter's basic principle is made up of different states of operation. The Electrical efficiency from the solar panel is fed into this boost converter, which raises the input voltage to the desired large electrical current that will be used as grid input voltage. Because this converter is an electronic component, it produces noise and harmonics in addition to the boosted voltage. As a result, the power system's stability is negatively affected, resulting in some failure and reliability.Any suitable DC source, such as Power converters, batteries, photovoltaic arrays, and inverters, can be used to power the buck converter. DC to DC conversion is the process of converting one DC voltage to another DC voltage. A boost converter is a DC-to-DC converter that has a higher output voltage than the source voltage. Because it "steps up" the input signal, it's also known as a step-up inverter.In a boost converter, the output voltage is greater than the input voltage – hence the name "boost". A boost converter using a power MOSFET.

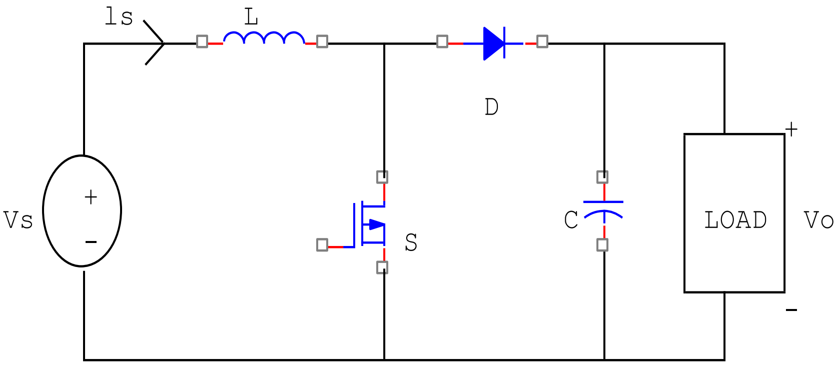


Fig 2: DC-DC converter circuit

Fig 2, 3 and 4 shows the are two modes of operation for boost converters: Mode 1 and Mode 2. When transistor M1 is turned on at time t=0, mode 1 begins. The input current increases and continues to flow through the inductance L and transistor M1 as the input current rises. When transistor M1 is turned off at time t=t1, mode 2 begins. L, C, load, and diode Editor now carry the input current. Until another cycle, the inductor current decreases. The energy stored in inductor L is connected to the load.

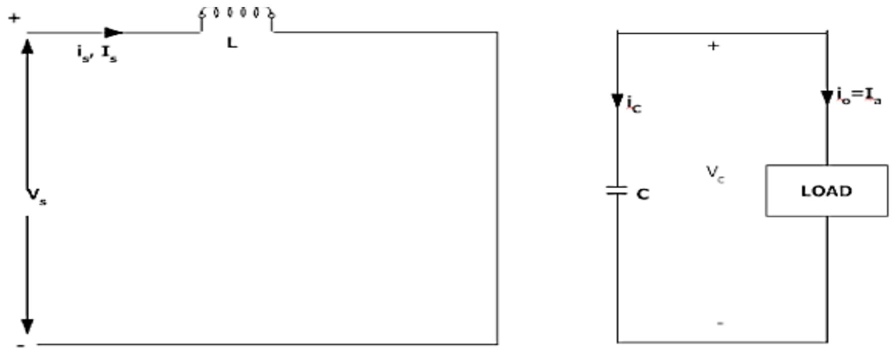


Fig 3: Circuit operation Mode1for boost converter

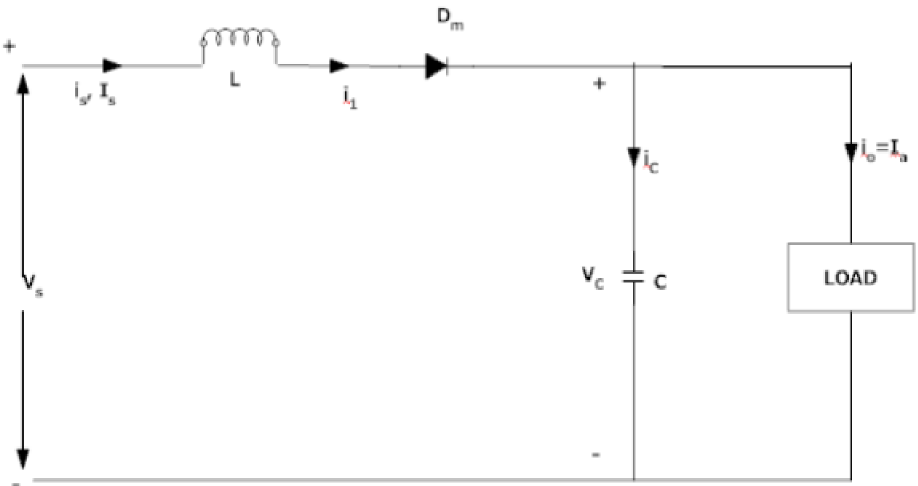


Fig 4: Circuit operation Mode2 for boost converter

3.2 SOLAR

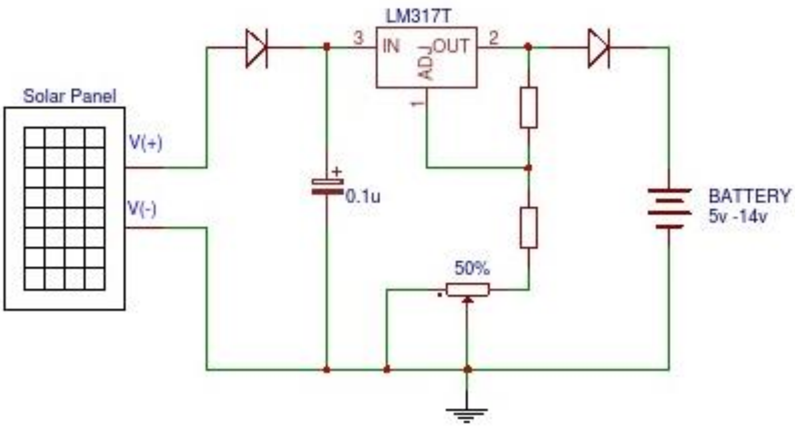


Fig 5: Circuit diagram of solar panel.

Fig 5 shows the Photovoltaic solar power is one of the most widely used renewable energy sources because it makes use of the planet's radiant energy, which really is available almost everywhere. Photovoltaic solar energy is usually used in residential and industrial electrical systems as an alternative energy source. Renewable radiation in transportation, on the other hand, is an important application. The hybrid solar vessels, which are frequently mentioned as an alternative to conventional combustion engine connected systems, are a very well implementations. The "space elevator" principle, which suggests using a nanostructured cable connected between the earth and a counterbalance in space to allow a vehicle to travel to and from space, is another intriguing application of electric vehicles.

The power converter's output voltage provides the required voltage supply to the DC-motor in accordance with the specified assignment, which could be achieving the requested angular acceleration profile or rotation angle source rate of change, for illustration. In the responses control design of Generator power converters, nonlinear average models are commonly used to replace the discrete nature of the switching control in the transistor. Speed sensor-less controllers were created based on the design of these models. In traditional communications, switched implementations of average dynamic output feedback control laws, using a PWM-modulator.

4. RESULT AND DISCUSSION

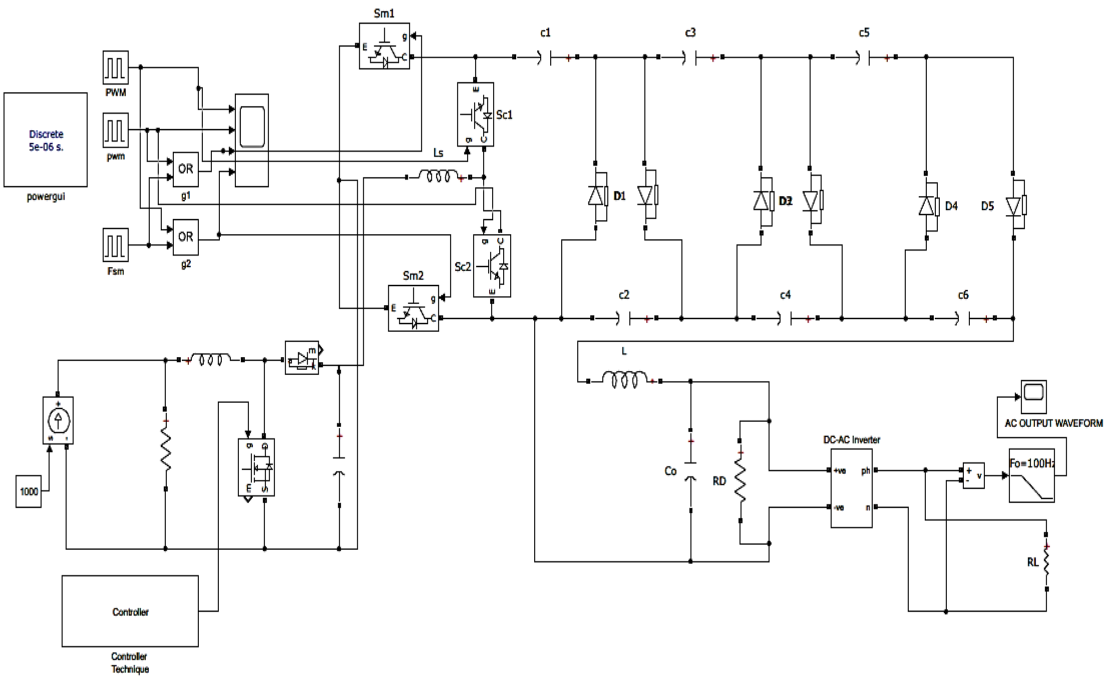


Fig 6: Simulation Output

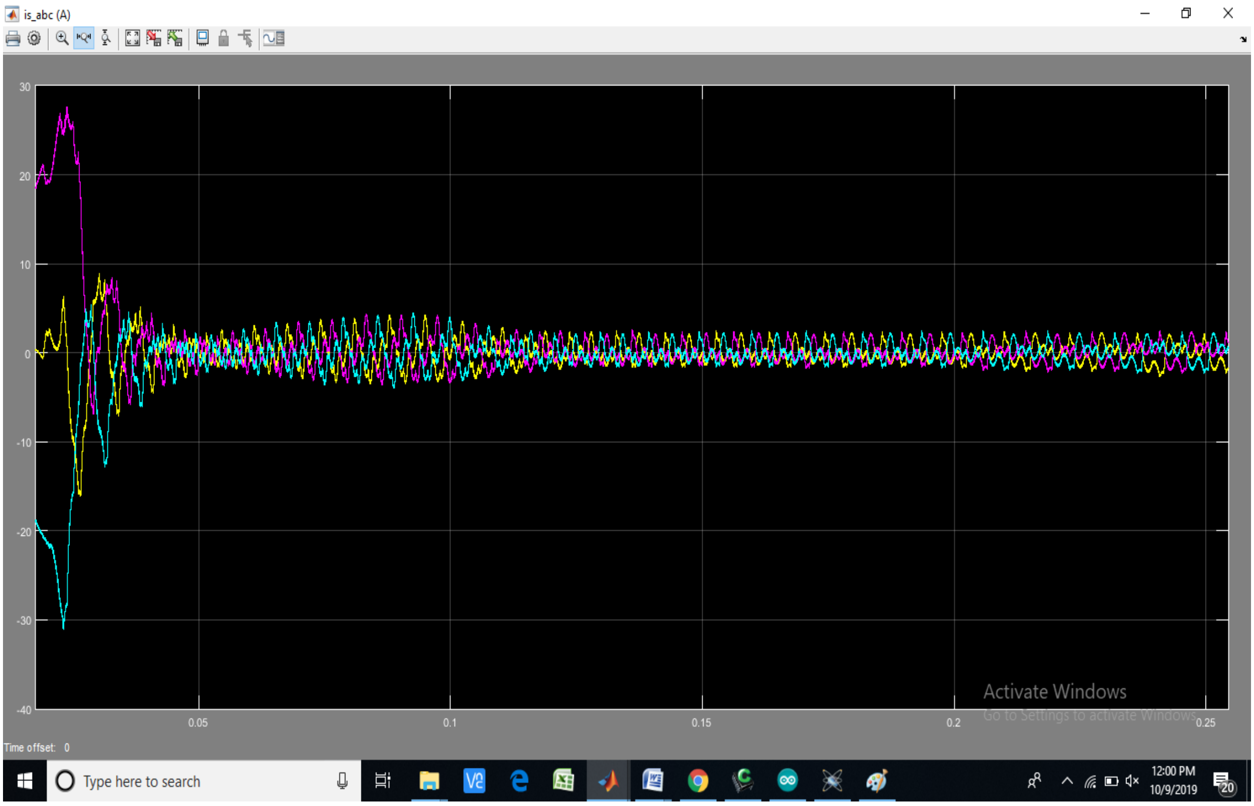


Fig 7: Output waveform

4.1 ADVANTAGES

- Higher efficiency compares, to convectional energy source
- No Greenhouse gases will be emitted
- Operates silently /noise free
- Operating time much longer than environmental
- There are better for the environmental
- They are quieter than gas vehicle
- Battery automotive batteries can render electric vehicles, efficient and refillable.

4.2 APPLICATIONS

- Power system sized
- Home Appliances
- Small scale Industries

5. CONCLUSION

The advancements and increasing favour towards in Electric Vehicles would soon see a increased influx of EVs on the road. This sudden increase in load would be affecting the traditional grid system that is present in India. So it is necessary to enable a smooth integration of the EVs to the grid. This would mean that the EVs should act as act as an Auxiliary source to the grid rather than a load. In the paper a Case study is performed for the Faculty of Engineering campus where a Solar based DC micro grid could be developed. This 10kW micro grid would enable the smooth integration of EVs in campus to the grid. The provision for peak shaving and valley filling is enabled through this thereby reducing the load on the micro grid.

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