

Solar Lighting System and E-Vehicle Emergency Point Charging for Highway Travelers

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Abstract— This paper presents a multifunctional SEPIC converter and an H-bridge inverter based stand-alone photovoltaic (PV) microgeneration system for toll plaza lighting. The proposed system feeds a lighting luminaire based on light emitting diodes (LEDs), from a.c single-phase mains with high power factor and reduced harmonic distortion, and is also designed for an optional charging dock for electric vehicles (EVs) in the emergency case. The SEPIC converter is controlled by Maximum Power Point Tracking (MPPT) controller works on Perturb and Observe (P&O) algorithm, while the H- bridge inverter is controlled by conventional PI controller. The Total Harmonic Distortion (THD) has been analysed in the proposed system. This stand-alone architecture is designed without battery storage so that the system can be used in day time for office lighting and charging purposes.

Keywords: SEPIC converter, EV charger, MPPT controller, Solar Lighting, Perturb & obserb, H-Bridge inverter, Standalone system, FFT (Fast Fourier Transformation).

I. INTRODUCTION

The infrastructure that offers the strength to replenish electric powered motors is called the E-car re-energizing station or EV charging station, strength charger, charging station, electric powered charging station (ECS), and electric powered car supplier (EVSE). Solar Based Charging Station for E-Vehicle” is to get the maximum power out of the sun panel with the aid of using converting the perspective of rotation in reaction to the electricity of mild falling on it. In the modern-day scenario, the electrical car (EV) is rising as a promising strategy to the issues resulting from fossil fuel-powered motors [1]. However, the adaptability of EV relies upon at the charging infrastructure. The charging of EV calls for a massive quantity of electrical power, which typically comes from coal-/gas-primarily based totally strength plants. Therefore, in a real sense, the EVs may be a inexperienced and smooth opportunity to the existing delivery device while the electric power required for the charging of EV, comes from the renewable power re-assets inclusive of sun and wind [3]. The benefit of this form of charging station is that the photovoltaic (PV) array strength is generated and used locally. Because of this, the transmission traces want now no longer be upgraded for excessive strength. Moreover, the charging station does now no longer require to attract strength from the grid while the fee of power is excessive. Another benefit of PV array primarily based totally charging station is that it isn't always location-specific. In this paper, we show a concept for the use of renewable power re-assets; namely, sun power, to strength a lighting fixtures device in tollgates for travelers, which can alleviate a whole lot of pressure at the traditional strength grid, and take us a step similarly with inside the manner of transferring closer to a greater sensible strength grid. We done each hardware and software program layout, wherein the hardware component blanketed numerous circuits, inclusive of the converter, inverter, SEPIC converter and the principle circuit that connects the road mild and the PV panel with emergency EV charger, at the same time as the software program part of the layout targeted on growing the manipulate algorithm, which places collectively all of the hardware parts, and controls the operation of the distinct circuits with inside the device. The software program used to run this device became the MATLAB/SIMULINK, which became used for controlling the device operation, in addition to tracking it and verifying its conditions. To make certain right device operation, numerous critical parameters have been monitored which includes the sun irradiation, the open circuit voltage, the fast circuit modern-day, the enter and output strength to the PV panel, similarly to the fame of the dirt cleansing tool and the movement sensor, all of which have been monitored and recorded periodically as soon as each second. However, with inside the literature, a dc– dc converter (typically SEPIC converter) is used to attach the PV array to the dc link. In this article, the sun PV array is without delay related to the dc link. The principal benefits of this topology encompass the discount in a single strength degree via the removal of dc–dc converter degree, circuit complexity, and the fee of the converter, without compromising the overall performance of the PV array. Moreover, this topology is a form of retrofit answer in which the PV array may be augmented to the prevailing charging infrastructure with minimal alternate with inside the software program (most strength factor tracking (MPPT) manipulate algorithm) alone.

II. LITERATURE SURVEY

In the current scenario, the electric vehicle (EV) is emerging as a promising solution to the problems caused by fossil fuel-powered vehicles. Tough, the capability of Electric Vehicle based on the charging internal structure. The charging of Electric Vehicle needs a large amount of electrical energy; the main source comes from coal/gas-based power plants. Therefore, in a true sense, the Electric Vehicles can be a green and clean that differ from the now-a-days transport system when the electrical energy required for the charging of Electrical Vehicle, comes from the renewable energy sources such as solar and wind. The advantage of this kind of

charging station is that the photovoltaic (PV) array power is generated and used locally [1]. The exact behavior of PV panel by simulation, developing a suitable model is necessary. The single and double diode models have been familiarly used to extract the solar cell parameters has been studied [2]. According to statistics, the driving time of 80% of vehicles is about 1 h per day, and they are passive for 95% of the day. The energy stored in EVs is considerable [3]. Solar photovoltaic (PV) is one of the most promising renewable energy resources that converts solar energy into electricity with environment friendly manner. However, it has less amount of efficiency and higher amount of relative costs. In order to overcome these drawbacks, a grid-connected PV energy system should be required to satisfy the load demand [4]. The aim of this thesis is to study, design and performance analysis of grid-connected PV system as follows: System modeling; that is composed of two-diode model to describe the I-V and P-V characteristic curves of PV system performance [5]. Modeling of photovoltaic system regards important goal in the design and performance study of grid based connected photovoltaic system using specific parameters of PV module. Two-diode model with accurate seven type of parameter is introduced to improve design, and predict optimum PV system efficiency at different irradiance and temperature levels. Seven types of parameter are introduced using the Newton-Raphson method with the aid of initial values which are obtained from basic equations of the model and manufacturing datasheet at standard test conditions [6]. The procedures were verified on three different modules of PV manufacturers using Newton-Raphson and RungeKutta Merson iteration methods. The results of proposed model show good agreement with respect to datasheet and other related works at different irradiance and temperature levels [7]. Improving the efficiency of grid-connected PV system to operate at maximum power point (MPP) with the help of perturb and observe (P&O) tracker through DC/DC converters. Although, P&O algorithm is mostly applied due to its simple nature, costless and easy way implementation, it suffers from instabilities, and oscillation around Maximum Power Point at steady-state [8]. This thesis presents a modified P&O algorithm to overcome such drawbacks and improve MPP tracker (MPPT) performance of PV system under rapidly changes of weather. It makes use of a constant load technique to enable the P&O algorithm to track Maximum Power Point at rapid-change of irradiance and other weather conditions. The modified form of P&O algorithm is simulated with a Photovoltaic system and a DC/DC buck-boost converter to compare its results with other related works [9]. Additionally, the proposed algorithm is simulated and experimentally validated using an 80W PV module, a boost converter and an embedded microcontroller. The experimental setup presents a model-based design (MBD) methodology that uses measurements' data for MPPT systems' design [10]. It combines hardware-in-the-loop (HIL) simulation and prototype testing using actual weather measurements. The simulation and experimental results achieved maximum power tracking with increased efficiency and minimum number of oscillations, which is much better than dynamic response, and suitable and stable for all weather conditions.

III METHODOLOGY

1. SEPIC CONVERTER

The single-ended primary-inductor convertor (SEPIC) could be a sort of DC/DC converter that enables the electrical potential (voltage) at its output to be bigger than, less than, or capable that at its input. The output of the SEPIC is management led by the duty cycle of the control switch (S1). A SEPIC is basically a lift convertor followed by associate degree inverted buck-boost convertor, so it's kind of like a conventional buck-boost convertor, however has the benefits of getting non-inverted output (the output has constant voltage polarity because the input), employing a series capacitance to couple energy from the input to the output (and so will respond additional graciously to a short-circuit output), and being capable of true shutdown: once the switch S1 is turned off enough, the output (VO) drops to zero V, following a reasonably hefty transient dump of charge.

SEPICs square measure helpful in applications during which battery voltage may be on top of and below that of the regulator's meant output. for instance, one metallic element particle battery generally discharges from four. If alternative elements need 3.3 volts, then the SEPIC would be effective.

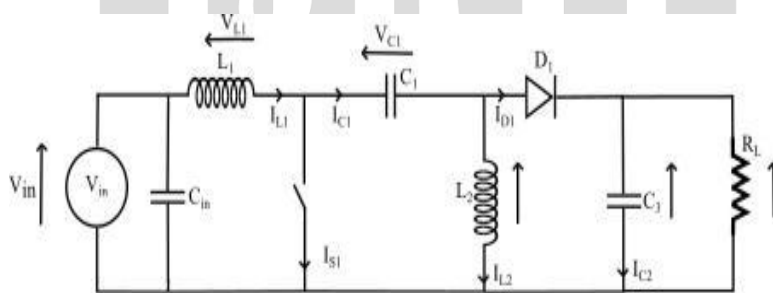


Fig.1 SEPIC Circuit Diagram

2. MPPT CONTROLLER

MPPT is known as 'maximum power point trackers' are the type of far more advanced way than Pulse Width Modulation controllers that makes the solar panel to work in its most increased power point, or to be in the much precise format, the optimal voltage for maximum power output. By using this technology, Maximum Power Point Tracker solar charge controllers will be up to 30% more systematic, based on the battery voltage and operating voltage (V_{mp}) of the solar panel. The cause for the maximum efficiency and how to make the correct size a Maximum Power Point Tracker charge controller is explained.

MPPT charge controllers should be mainly focused on all higher power systems using two or more solar panels, or whenever the panel voltage (V_{mp}) is 8V or higher than the battery voltage.

A maximum power point tracker, is generally an effective way for DC to DC converter used to increase the power output of a solar system. The first Maximum Power Point Tracker was invented by a small Australian company called AERL in 1985, and

this technology is now used in all type of virtually and grid-connect solar inverters and all Maximum Power Point Tracker solar charge controllers.

The working principle of a Maximum Power Point Tracker solar charge controller is basically simple - due to the changing amount of irradiance falling on a PV panel throughout the day where the panel voltage and current continuously changes. In order to produce the maximum power, a Maximum Power Point Tracker swifts through the panel voltage to find the 'sweet spot' or the best combination of voltage and current to produce the high power. The Maximum Power Point Tracker constantly track down and make adjustments in the PV voltage to produce the maximum power, does not make count what time of day or weather conditions. Using this efficient technology, the operating efficiency become maximum and the energy generated can be up to 30% more compared to a Pulse Width Modulation solar charge controller.

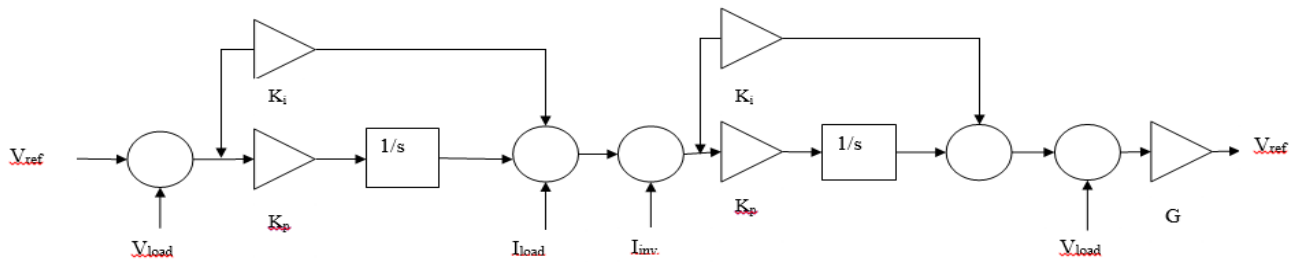


Fig.2 Functional Block Diagram

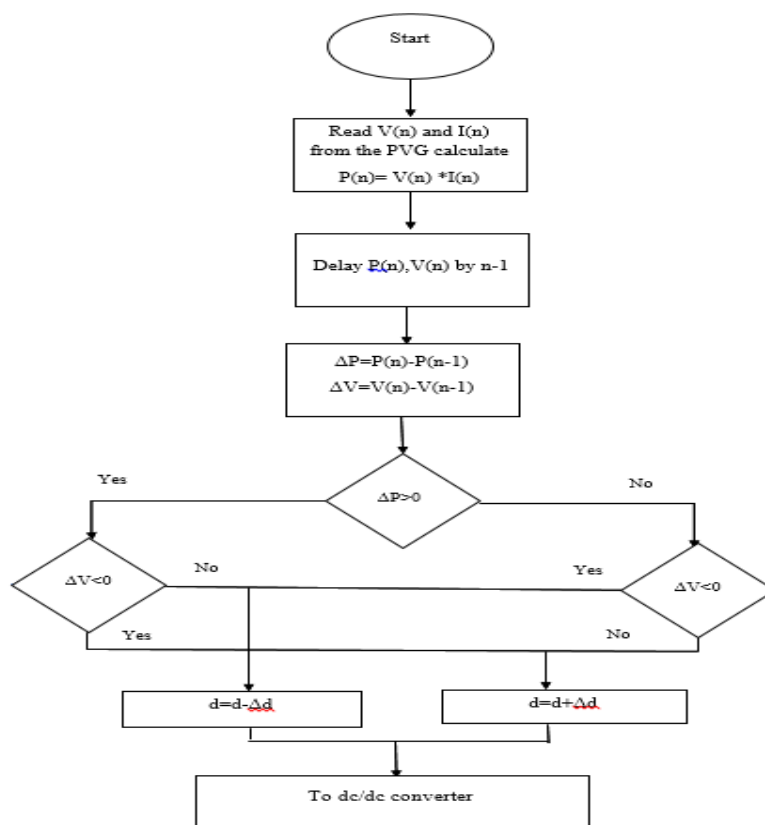


Fig. 3 P&O Algorithm Flow Chart

IV SOFTWARE

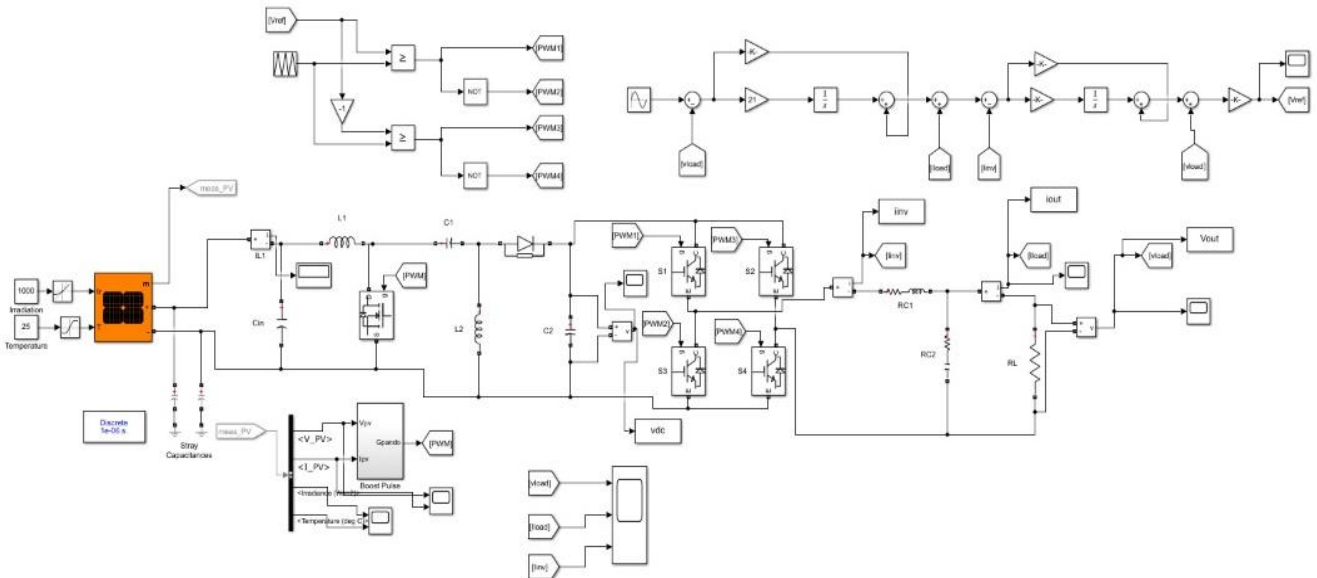


Fig.4 Simulation Design

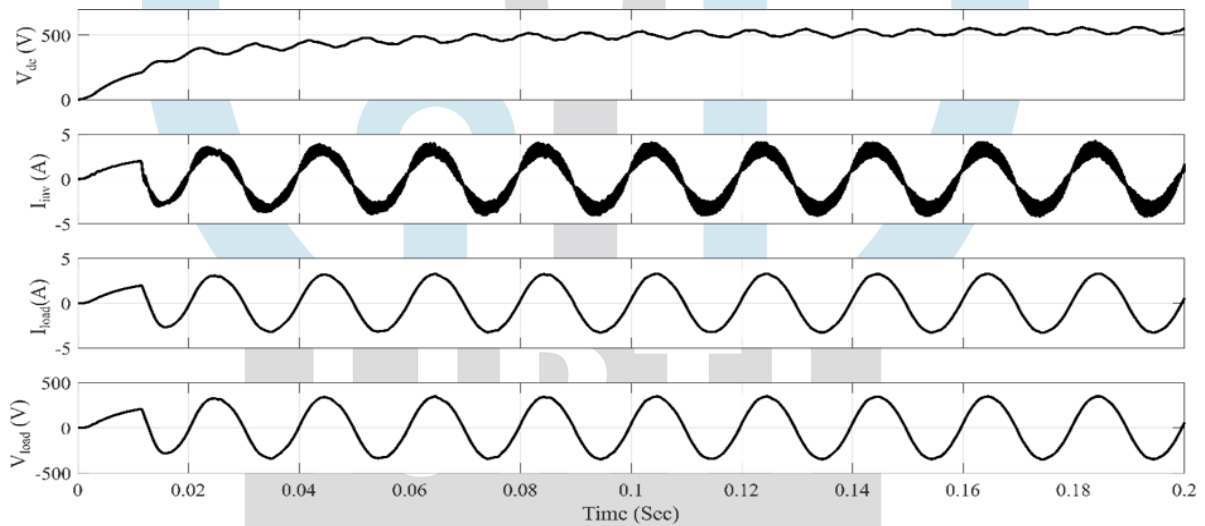


Fig.5 Simulation Output

V. HARDWARE

The input section consists of a solar panel in that the obtained energy is given as input to the SEPIC converter. The input voltage is read by a voltage divider in PIC Microcontroller. The voltage and current parameters are set up as coding in the microcontroller which is used to generate PWM generation. After generating PWM, by using the P&O algorithm it will generate the output. The output will be in dc, then dc is given to the inverter which is H-bridge inverter. In H-bridge inverter, two capacitors are connected in series where the input dc supply is divided. And the load is connected between capacitor and switches. Where the input dc supply is converted into ac and given to the load.

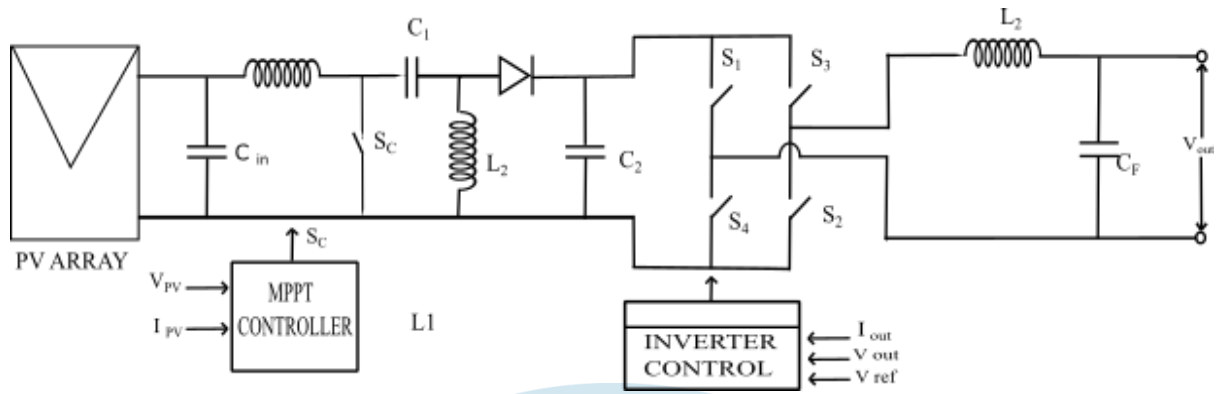


Fig.6 Circuit diagram (Hardware)

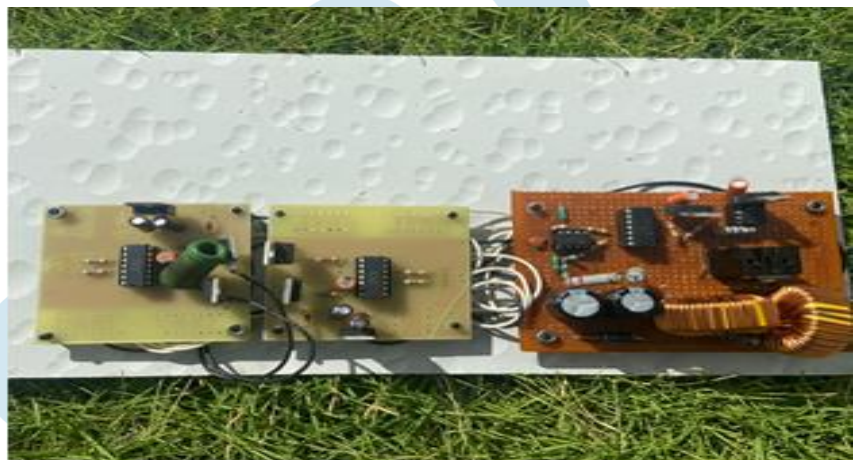


Fig.7 Implementation of Circuit diagram (Hardware)

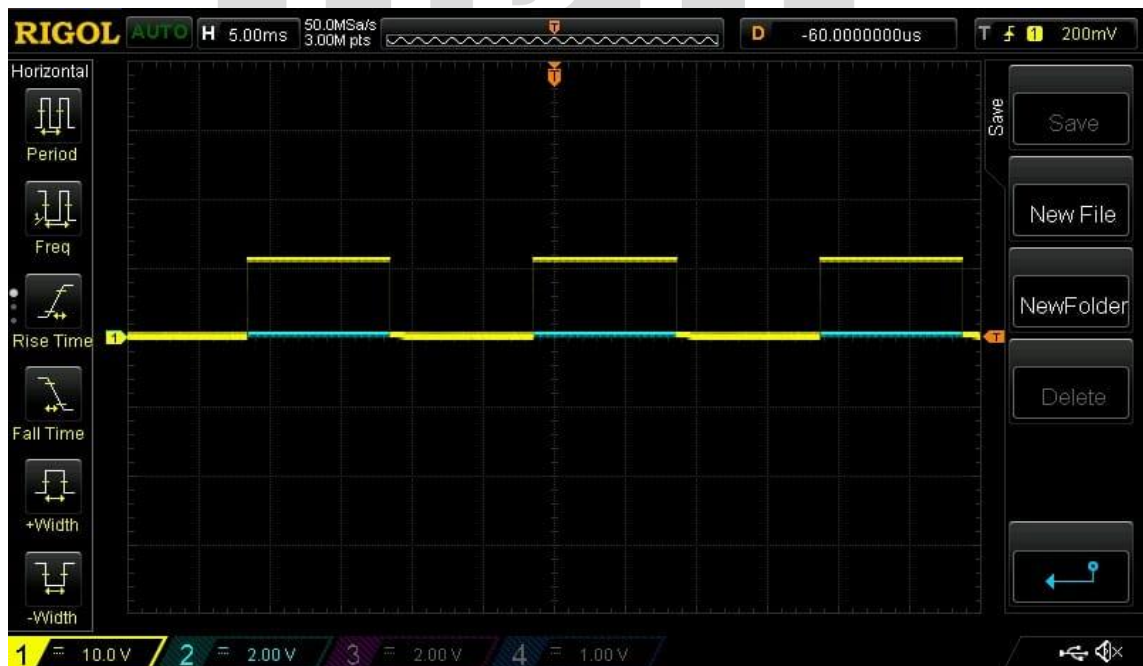


Fig.8 Output (Hardware)

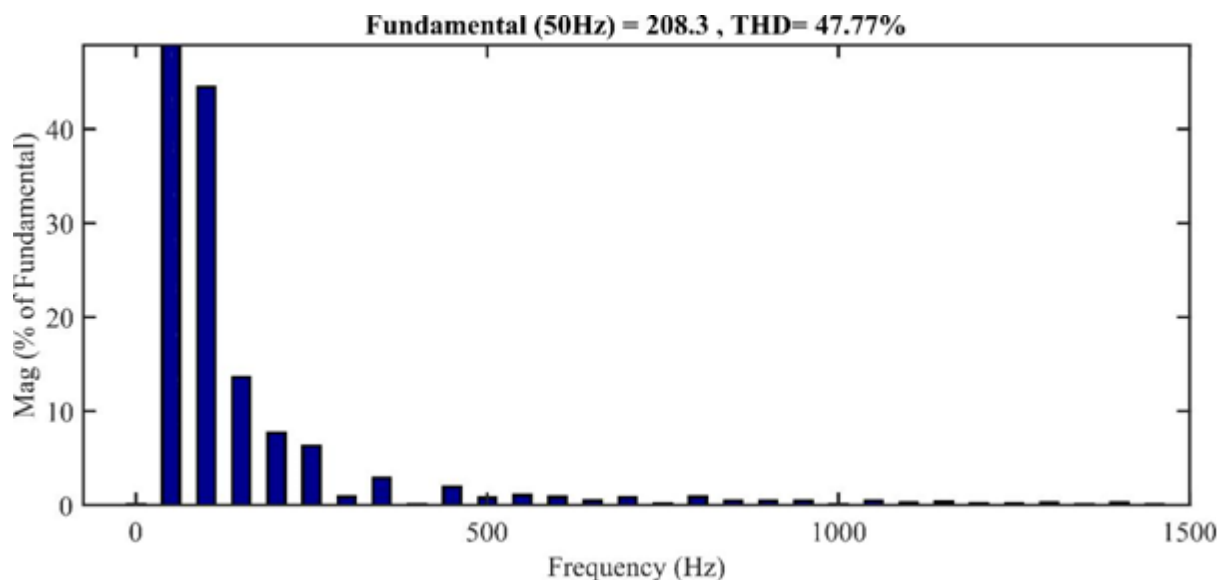


Fig.9 FFT Analysis (Hardware)

V. CONCLUSION

The Proposed System provides an elegant integration of PV and solar source to extract maximum energy from the sources. It is realized by a novel SEPIC converter for DC-DC operation followed by an inverter. After that the inverter converts DC-AC which feeds the AC to the Loads. Detailed Simulation are carried out. The experimental results were nearly closer to the simulation and are supportive for the operation of the system. The proposed configuration has the capacity to provide uninterrupted power to the AC loads. Along with this an integrated charger with solar PV array for toll plaza lighting has been implemented and the charger purpose is to serve the emergency need for Highway travelers. The proposed project has multipurpose usage as a EV charger for highway travelers and lighting system for toll plaza office. The proposed project provides a sustainable environment and doesn't cause any harmful effect. The energy produced will be clean and green. The installation is simple and useful in dual purpose. The future is dependent on eco-friendly source of energy and the project is the need of the hour.

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