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Article Title: Control Strategies of Different Energy Storage for EV Applications

Control Strategies of Different Energy Storage for EV Applications

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ABSTRACT

This project proposes a hybrid energy storage systems for electric vehicles. With a low duty cycle and less voltage stress across the power semiconductor switches, the DC-DC converter's delivers significant voltage gain. A high gain, fast charging DC-DC CUK Converter is utilized for solar PV at the electric vehicle charging station with hybrid storage system backup. An uninterruptible power supply and proper solar PV utilization under various operational situations are delivered by hybrid energy storage system and the PI controller. The project is implemented by DSPIC30F4011 microcontroller and Simulation is done by MATLAB.

Keywords: PV System, DC-DC CUK Converter, total harmonic distortion (THD), Luo converter.

1. Introduction

Climate change has been a concern for governments in the majority of industrialized nations as they work to reduce greenhouse gas emissions during the past few eras. Both the amount of air pollution in the atmosphere and the average global temperature have considerably improved as a result of exhausting fossil fuels as the foremost source of energy. However, EVs and their charging systems establish a remarkably high load for the power system and should not purely be seen as a passive load but also as an integrated active power resource. It is crucial to describe the existing power system's growing changes and the framework's problems for the future power system in order to understand the goals of this research paper

2. Recent Works

Bin Liu et al [2018] propose the photovoltaic (PV) system is upgraded to a home PV/battery system, it is suggested that the single-phase PV inverter should be properly maintained under both input scenarios of battery and PV to reduce the input current ripple and grid-current harmonics. In order to accomplish this, equivalent circuits of a PV array and a Li-ion battery pack are first built and then examined in turn. To obtain the feedback signal, the current ripple is extracted using a third-order general integrator.

Rahmat Khezri et al [2020] proposes the ideal solar PV and battery energy storage (BES) capacity for grid-connected homes to reduce the net current cost of electricity. For the purpose of optimization, real-time rule-based home energy management systems are utilized, which use actual annual data on solar insolation, ambient temperature, electricity tariffs and household electricity use. To verify the best outcomes, the uncertainty analysis is put into practice by using 10 years of actual data.

Shubhra et al [2020] proposes a three-phase grid interfaced solar photovoltaic (PV)-battery energy storage microgrid system control with a normalized gradient adaptive regularization factor neural filter. The suggested system's dynamic behavior is enhanced by the neural filter-based current controller, which also supplies active power to the utility grid under varying atmospheric conditions.

3. Proposed Work Explanation

This paper explains a enactment analysis of various power electronic converters with RL load to decrease the total harmonic distortion. The power converters examined are as follows CUK converter and Z SOURCE converter and Single-ended primary inductance converter

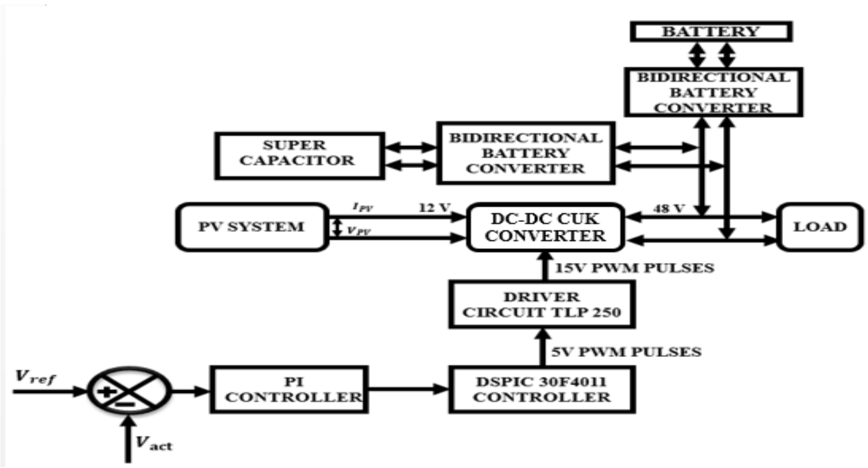

Figure 1: *Proposed Block Diagram*

Analysis of power electronic converters with lower total harmonic distortion (THD) and higher efficiency is the main goal in order to choose the best converter for an electric vehicle propulsion system. MATLAB/SIMULINK is used to run the simulations, and the results are displayed. In the proposed work, the solar PV power is applied to the DC-DC Cuk converter and to the load. For the controlling of Cuk converter, a PI controller is connected. The actual voltage and reference voltage are compared and fed to PI controller which minimize the error. The output of PI controller is fed to DSPIC30f4011 microcontroller which produces the PWM pulses. For hybrid energy storage systems here battery storage and super capacitor are employed with a help of a bidirectional battery converter. An uninterruptible power supply is possible with the different energy storage system and with the PV system.

3.1 PV System

A tracking controller, power converters and tracking controllers such inverters and DC-DC converters make up the PV system utilized for power conversion. Because of this, the DC voltage produced can be boosted using a DC-DC converter and converted to AC with an inverter. Based on the load rating, the PV panel should be selected.

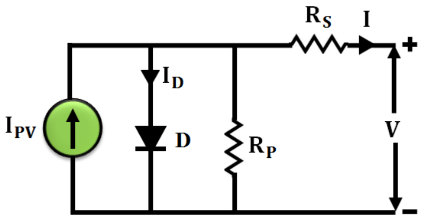

Figure 2: *Equivalent circuit*

The PV model constitutes current sources, diode Shunt resistanceR_{sh}, Cell reverse saturation current is denoted as I_0, Absolute temperature of cell is denoted asT_c, Series Resistance R_s and Shunt Resistance R_{sh} represents the cell surface leakage through the edges.

$$I = I_G - I_0\left\{exp\left[\frac{q}{mkT_c}(V + IR_s)\right] - 1\right\} - \frac{V+IR_s}{R_{sh}} \qquad (1)$$

3.2 Cuk Converter circuit Operation

Figure 3 depicts Luo converter's circuit diagram. D denotes the freewheeling diode and S denotes the power switch in the circuit. Inductors are the passive components used for energy storage.

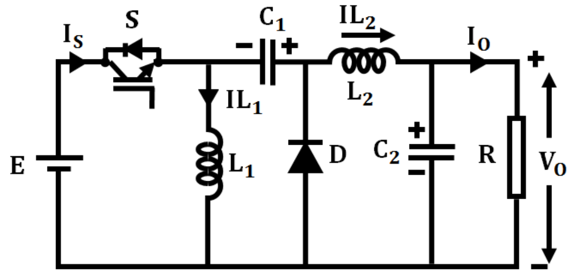

Figure 3: *Luo converters circuit diagram.*

The circuit can be split into two modes in order to analyze the Luo converter works. By the supply voltage E the inductor $L_{1,}$is charged while the switch is ON. Simultaneously, from source and the capacitor C_1 , the inductor L_2 captivates the energy. To lower the output voltage's harmonic levels, additional filter elements such a capacitor and an inductor may be added.

3.3 PI Controller

PI Controller operates the plant that must be regulated using the integral of that value and a weighted sum of error. Utilizing the integral of that value and a weighted total of error, it

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controls the plant that needs to be regulated. Despite this achievement, the issue of tuning PI-controllers has continued to be a focus of research.

4. Results and Discussion

4.1 Result View

The following outcomes are attained as a result of implementing the planned work in MATLAB simulation. Figure 4 shows the solar panel voltage representation of input AC, the source of output voltage is 70(V) attained. Figure 4 displays the input current waveform of Luo converter.

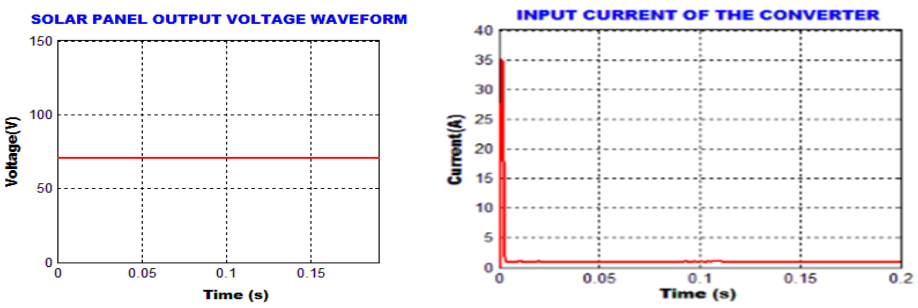

Figure 4: *Solar Panel Output Voltage Waveforms and b) Input Current of the Converter*

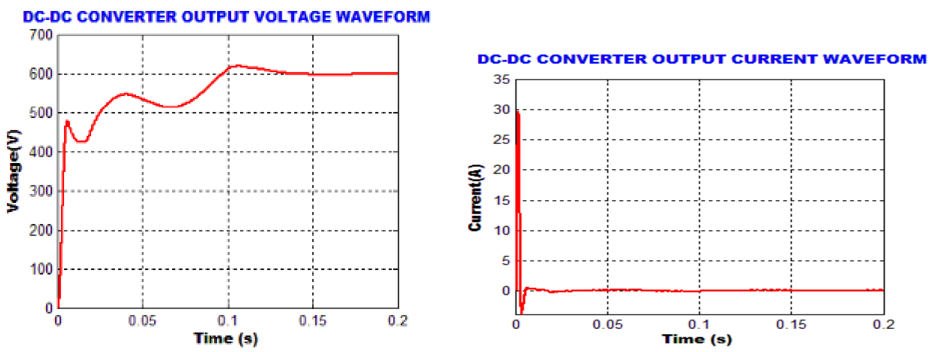

Figure 5: *a) Output Voltage Waveform of DC-DC Converter b) Output Current Waveform of DC-DC Converter*

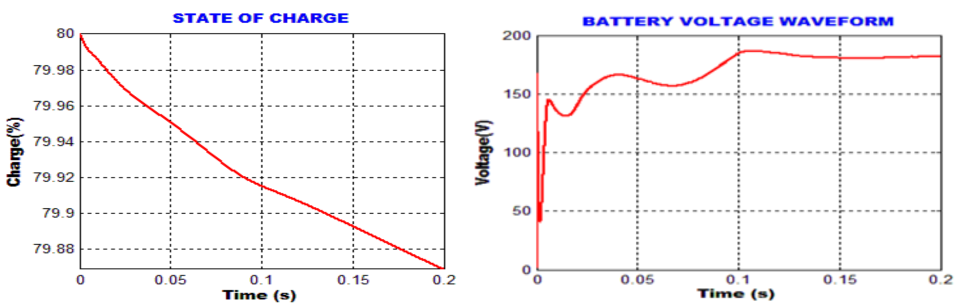

Figure 6: *State Of Charge* **Figure 7**: *Battery Voltage Waveform*

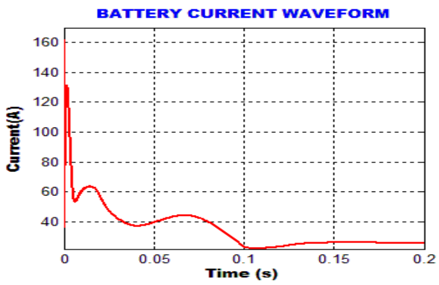

Figure 8: *Battery Current Waveform*

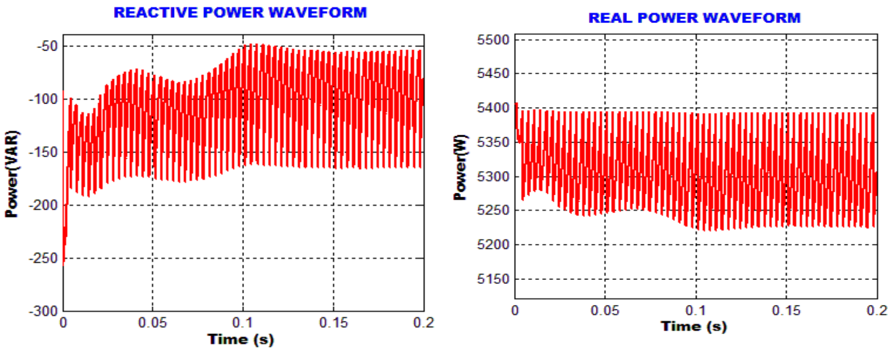

Figure 9: *a) Reactive Power Waveform and b) Real Power Waveform*

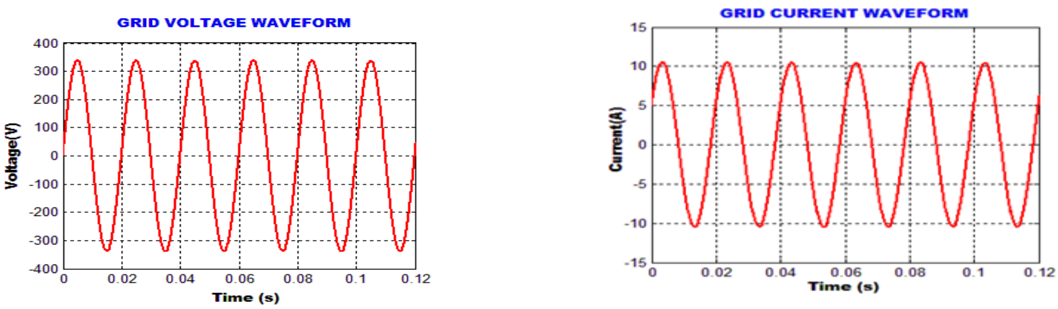

Figure 10: *a) Grid Voltage Waveform and b) Grid Current Waveform.*

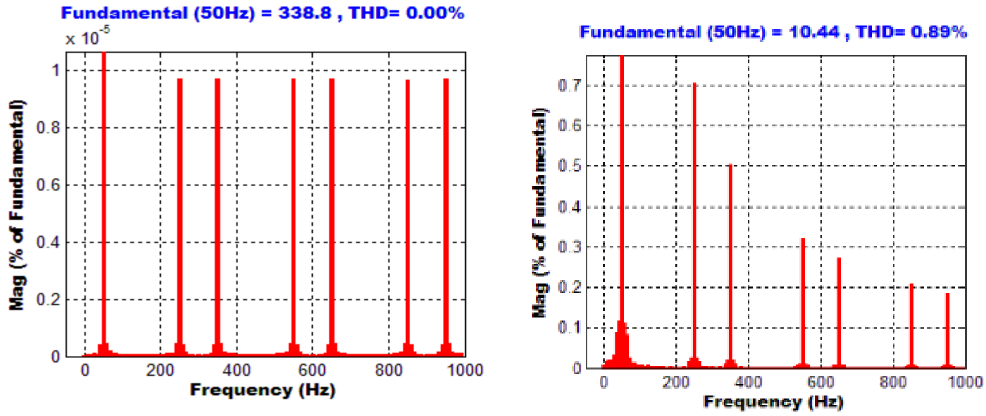

Figure 11: *a) Voltage Waveform of THD Grid and b) THD Grid Current Waveform*

Figure 11.a) and b) shows the representation of AC voltage input and b) current source of THD of 0.89 % is attained.

4.2 Experimental Analysis

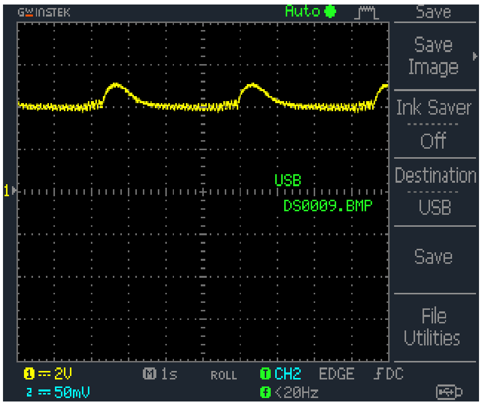

Figure 12: *Input Dc Voltage Waveform*

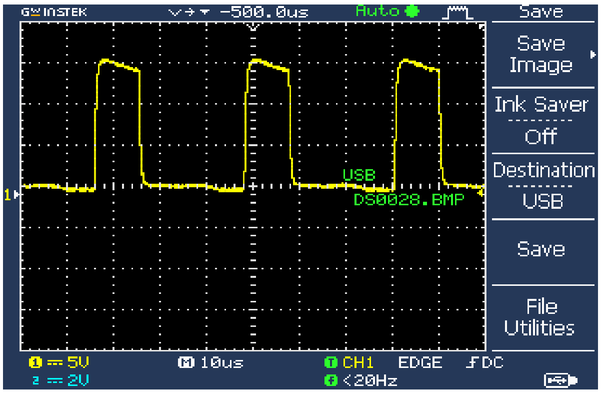

Figure 13: *PWM Pulses to the Converter*

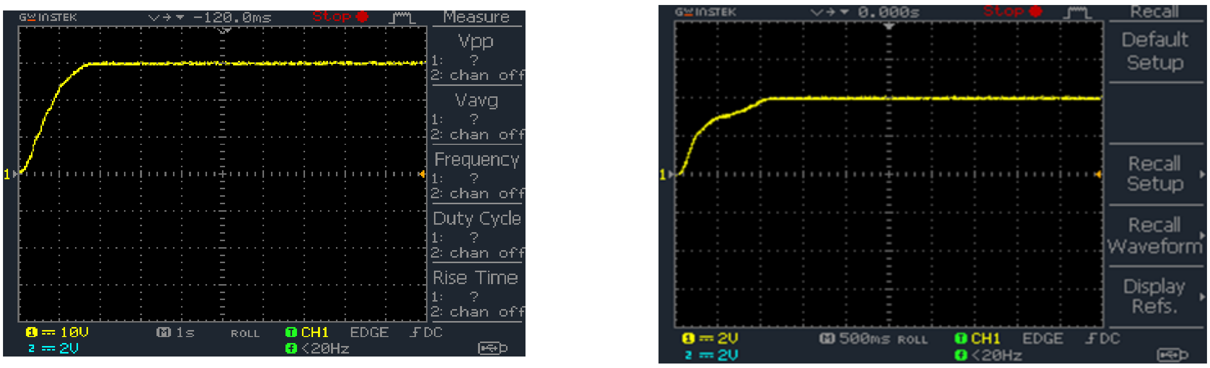

Figure 14: ***a)** Converter Output DC Voltage Waveform and b) Converter Output DC Current Waveform*

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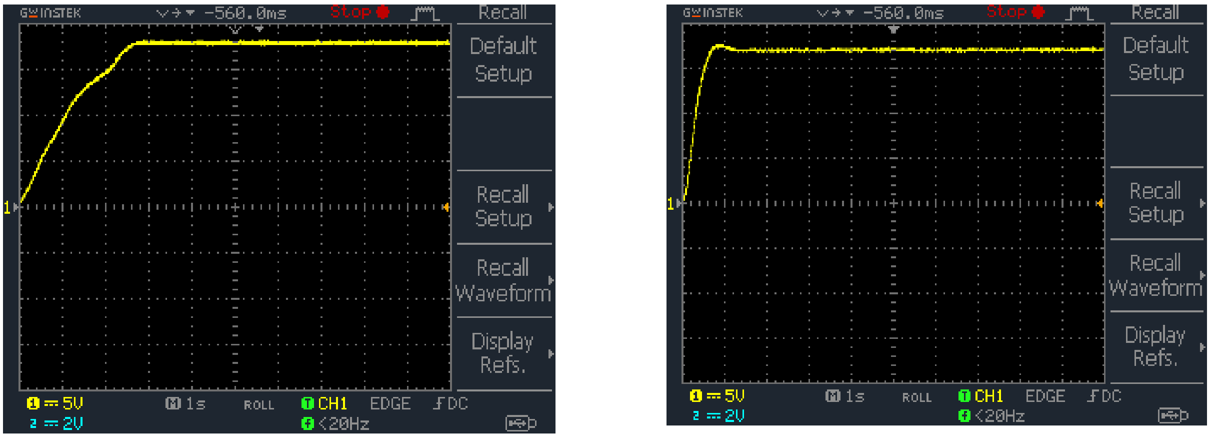

Figure 15: *a) Battery Converter Voltage Waveform and b) Super Capacitor Voltage Waveform*

5. Conclusions

This study shows a PI controller with an efficient Luo converter. The PV system's ineffective voltage output is fed to a Luo converter, which boosts the output while maintaining the same polarity as the input voltage. The converter operates without taking irradiance level variations into account and gives a superior voltage gain with minor switching losses. As a result the grid synchronization of the suggested solution provides a decreased distortion and improved power quality.

References

1.Bin Liu;Lina Wang;Dongran Song;Mei Su;Jian Yang;Deqiang He;Zhiwen Chen;Shaojian Song,2018, “Input Current Ripple and Grid Current Harmonics Restraint Approach for Single-Phase Inverter Under Battery Input Condition in Residential Photovoltaic/Battery Systems”, IEEE Transactions on Sustainable Energy, Vol: 9, no: 4, pp. 1957 – 1968.

2. Rahmat Khezri;Amin Mahmoudi;Mohammed H. Haque,2020, “Optimal Capacity of Solar PV and Battery Storage for Australian Grid-Connected Households”, IEEE Transactions on Industry Applications, IEEE Transactions on Industry Applications Vol: 56, no: 5,pp. 5319 – 5329.

3. Shubhra Shubhra;Bhim Singh,2020, “Three-Phase Grid-Interactive Solar PV-Battery Microgrid Control Based on Normalized Gradient Adaptive Regularization Factor Neural Filter”, IEEE Transactions on Industrial Informatics, Vol: 16, no: 4,pp. 2301 – 2314.