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Article Title: Design Of High Gain Luo Converter for PV System Applications

Design of High Gain Luo Converter for PV System Applications

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ABSTRACT

Photovoltaic (PV) power generation requires a bigger area per unit capacity than traditional power plants since it employs a limitless and clean energy source. As a result, installing floating PV systems (FPVs) on open sea surfaces is becoming more common in countries with tiny landmasses, such as South Korea, Japan, and Vietnam. For use in applications involving PV systems, this paper suggests a design for a high-gain LUO converter. This proposed system consists of a LUO converter for a PV system. A converter's output voltage can be increased while staying constant throughout the system by using the proposed converter (a Luo converter). Step-up or boost converters increase the voltage from their input (supply) to their output (load) while converting DC to electricity. The PWM generator, which is connected to the power source and produces PWM pulses to modify the signal in the LUO converter, is used to produce PWM pulses.

Keywords: Photovoltaic (PV) energy, LUO converter, Boost converter, Power supply, Load.

1 Introduction

Fossil fuel scarcity and the effects of global warming have recently drawn attention on a global scale. Light electric vehicles (LEVs) therefore provide the most trustworthy and practical alternative to adhere to strict environmental safety rules [1]. For EVs, a lead-acid battery serves as the primary power source. As a result, an effective charger is required to power both the EV and other auxiliary devices. [2].The demand for effective battery chargers for EVs has been sparked by rising energy and fuel efficiency concerns among manufacturers and EV buyers. With the goal of providing high efficiency and reliability during charging, power factor correction (PFC) converters are now a necessary component of modern EV chargers [3]. On the other side, the battery charger acts as a necessary component to charge these EVs, which negatively affects the operation of other grid-connected utilities [4]. PWM (pulse width

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modulation) and analogue are now the two main methods utilised for dimming LEDs. PWM dimming provides different brightness levels with better precision. The control method, however, is intricate and results in extra expenses [5]. The need for renewable energy sources (RES) is growing as a result of the severe air pollution and energy crises. In actuality, DC microgrids rely heavily on RESs as power sources. Because the majority of RESs, including fuel cells and photovoltaic (PV) panels, provide a low terminal voltage, a tolerably high output voltage may be attained. By the cascade of cell connections [6]. Many industrial applications, including electric vehicles (EV), microgrids, more electric aeroplanes, and more electric ships, use power electronics systems using dc-dc cascaded converters [7]. It is a consequence of the development of various applications that require power supplies with high conversion ratios. For instance, in renewable energy systems, energy sources like batteries, fuel cells, solar cells, etc. have very low output voltages, necessitating the use of a DC-DC converter with enough gain before connecting to the grid [8]. Small-scale renewable energy generators (REGs) and low-voltage, low-power DC distribution systems (LVPDS) with a single or multiple sources are currently accessible. A workable system that can both fulfil the power needs of urban residential structures and those in remote places that are still cut off from the grid. About traditional energy sources [9]. A prominent example is a continuous power supply in the output port of a DC-DC switching converter, which is used in power distribution systems for boats, microgrids, and renewable energy. The level of performance often deviates from expected behaviour when a switching converter is used to supply a constant power load (CPL) with a negative incremental resistance [10].

The list below demonstrates how the paper is organised: Section II describes the most recent work. Section III describes the proposed work in detail. The results are presented in Section IV. Section V provides a conclusion.

2 Recent Works

Xiangke Li *et al* (2020) [11] have proposed the traditional boost converter, the interleave boost converter, and the AC/DC interlinking converter are a few examples of different converter topologies that can utilise an assortment stabiliser. The multilayer boost converter has been widely employed in DC microgrid systems due to its high voltage gain. However, when the negative impedance of the CPLs rises, microgrid systems become less reliable.

Qianwen Xu *et al* (2020) [12] have presented to feed CPLs from boost converters, It is suggested to use adaptive backstepping sliding mode control. Operating RESs with substantial integration in DC microgrids is economical, dependable, and steady. But their typical low boost ratios and low power converter designs make them unsuitable for grid-scale applications.

Zeinab Karami *et al* (2021) [13] have focused on a Decentralised model predictive controllers (DMPCs) are used to assure power sharing and DC bus voltage management in constant power loads (CPL) DC microgrids (MGs). The control goals are then taken into account while calculating the cost function in order to accomplish optimal state switching at each sample

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period and, as a result, manage the dc bus voltage and accurate current distribution among the MG. Using active converters alone for stability would be absurdly costly and unjustified.

Veer Karan Goyal *et al* (2021) [14] have developed a dual-inductor, full-bridge, pan-isolated, current-fed dc-dc boost converter. By amplifying variable low voltage from a power source and connecting it to a high-voltage dc-ink, which regularly feeds an inverter, it may function as a front-end dc-dc converter. It demands lower voltage-rated rectifier diodes, a low transformer turn ratio, greater efficiency, and reduced input current ripple.

Mummadi Veerachary *et al* (2020) [15] have proposed an up-converter that nearly mirrors the voltage of the quadratic converter. With trade-off duty ratios, this converter can boost lower input dc voltages to higher values at the load side than the traditional boost converter. Efficiency is compromised when the battery pack voltage is raised excessively Because of the pulsing output current and the inability of the converters to run at extreme duty ratios to increase gain, a large output capacitor is needed to decrease ripple voltage. Its low voltage and efficiency are drawbacks.

3 Proposed Work Explanation

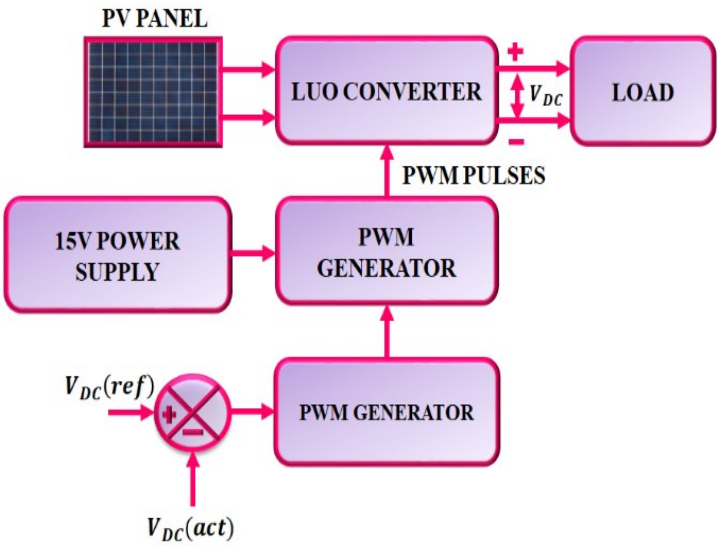

Figure 1: *Block Diagram for Proposed System*

This essential activity is found in photovoltaic (PV) systems. Due to the fluctuating environmental circumstances, it is difficult to detect a solar PV (photovoltaic) module's maximum power point. This recommended solution comprises a LUO converter for a PV system. The recommended converter (the Luo converter) is used to raise a converter's output voltage and maintain it constant throughout the system. A boost converter, also known as a step-up converter, is a type of DC-to-DC power converter that lowers current while increasing voltage from its input (supply) to its output (load). PWM pulses produced by the PWM generator, which is driven by the power source, change the signal going to the LUO converter.

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3.1 PV System

Light is converted into energy using semiconducting materials that exhibit the photovoltaic effect in photovoltaics (PV), a field of study that includes physics, photochemistry, and electrochemistry. Commercially, the photovoltaic effect is used in both power generation and photo sensors. A photovoltaic system generates energy using solar modules, each of which comprises a number of solar cells. PV systems can be anchored to the ground, a roof, a wall, or even a boat. A solar tracker can be used to keep track of the mount's position, or it can be attached to the ground. Photovoltaic technology contributes to the mitigation of climate change since it emits far less carbon dioxide than fossil fuels.

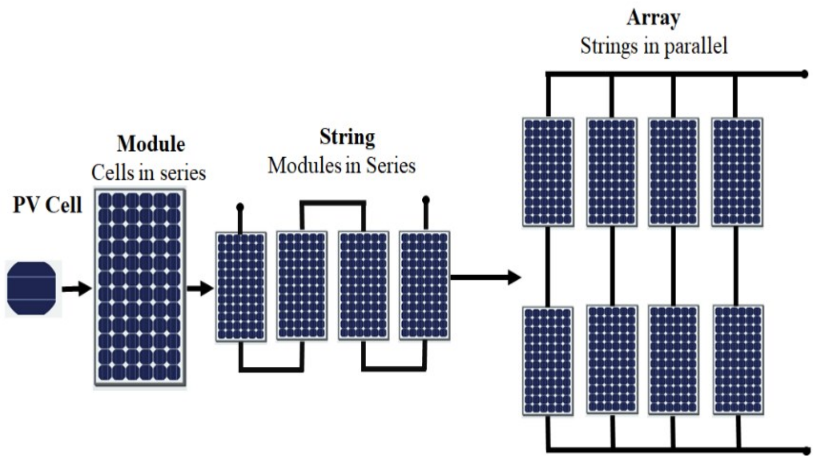

Figure 2: *PV Array Configuration*

3.2 LUO Converter

LUO converters are used to scale up the voltage obtained from solar and wind energy. With few ripples and great efficiency, this converter produces a maximum output voltage. Figure 3 shows the LUO converter's circuit. This circuit consists of a switch (S), a diode (D), coupling capacitance, which serves as a storage element, an inductance, which transmits energy from the input side to the output side, and capacitance and inductance, which combine to form a low-pass filter. Both the Continuous Conduction Mode (CCM) and the Discontinuous Conduction Mode (DCM), which depend on how much current passes through an inductor, are inoperative in this case.

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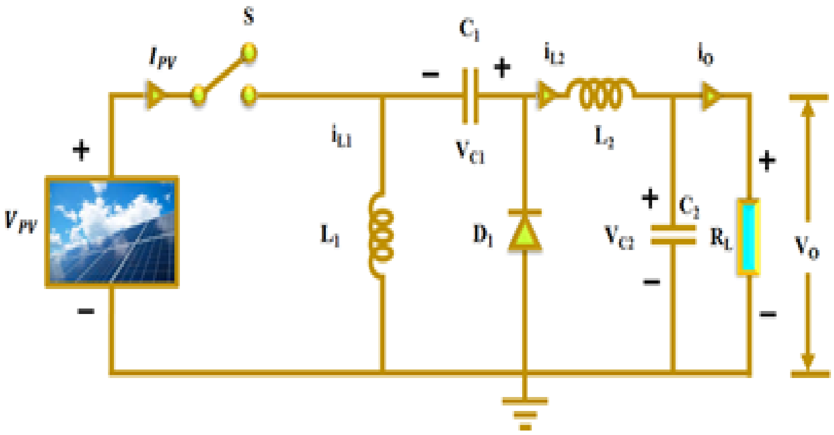

Figure 3: *LUO converter's circuit*

3.2.1 Modes of Operation of LUO converter

It is vital to consider two switching modes, such as closed and open states, while evaluating the LUO converter's working principle.

Mode 1

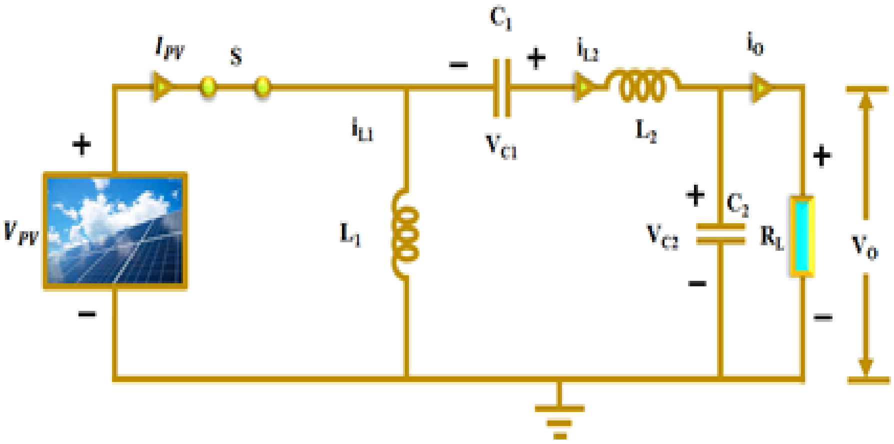

Figure 4: *Mode 1*

Figure 4 shows the mode 1 circuit configuration of the LUO converter. The switch is now closed, which results in the diode being reverse biassed. While the input PV current is equal to the total of the inductive currents in this mode, the input PV voltage charges the inductance. Both inductive currents and capacitance rise at this time because the inductance absorbs energy from the input PV in addition to capacitance.

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Mode 2

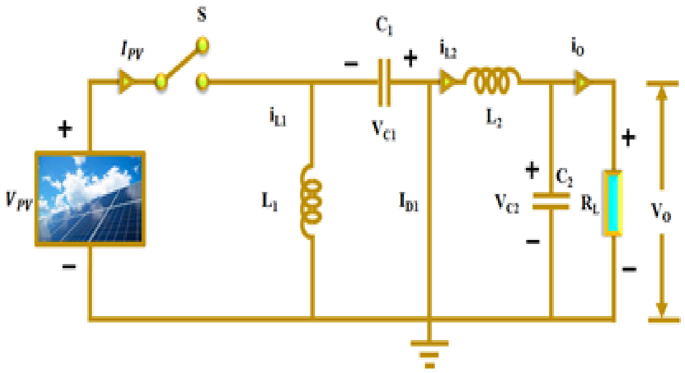

Figure 5: *Mode 2*

Figure 5 shows the mode 2 circuit configuration of the LUO converter. The switch is currently open, and the bias of the diode is forward. While the current obtained from the input PV is equal to zero in this mode, the inductive current passes through the diode and charges the capacitance. In the interim, the capacitance and the resistive load are both traversed by the inductive current, resulting in an alternating inductive current.

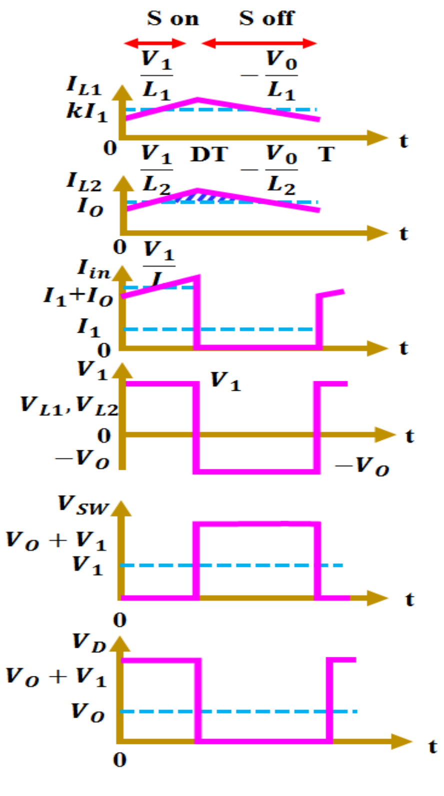

Figure 6: *Waveforms of LUO converter*

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Figure 6 shows the LUO converter's voltage and current waveforms in various modes.

3.4 PWM Generator

The LUO converter's switch produces and applies a pulse width of the modulated signal. The PWM generator really breaks down the average power reduction into several components. When the switch is on for a longer amount of time than it is off, the normal voltage and current levels transferred to the load side will get more power as a result of the longer ON duration. To produce the high peak power levels, the FLC-based MPPT controller feeds the PWM generator. Pulse-width modulated gate pulse signals are produced by the PWM generator and then transmitted to the switch inside the LUO converter.

4 Results and Discussion

4.1 Hardware View

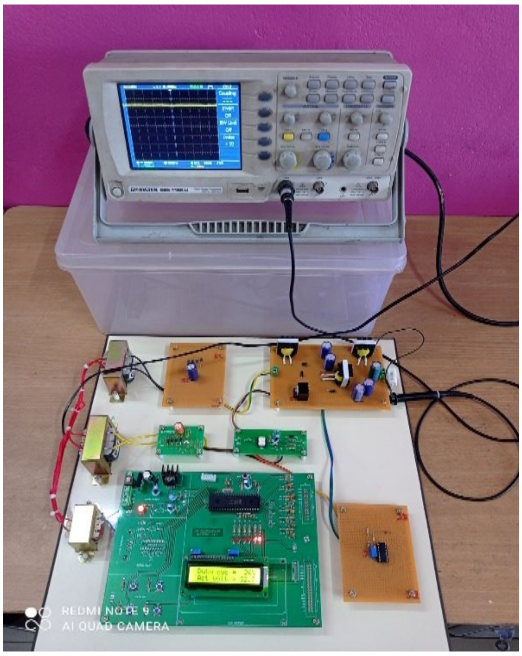

Figure 7: *Hardware View*

Figure 7 shows a LUO converter used in a PV system with high gain. PWM generator, PV system, power supply, LUO converter, and load are the components of this work. The recommended solution includes the LUO converter for the PV system. The indicated converter, sometimes known as the Luo converter, is used to increase a converter's output voltage while keeping the system's voltage constant. While converting power, a boost converter, also known as a step-up converter, decreases current while increasing voltage from its input (supply) to its output (load). The PWM generator, which is driven by the power source, generates PWM pulses that modify the signal going to the LUO converter.

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4.2 Experimental Analysis

The waveform of the input DC voltage supply is shown in Figure 8(a). A DC power supply is a type of power source that delivers direct current (DC) voltage to power a device. A DC power source that is regularly used on an engineer's or technician's workbench for various power testing activities is known by the moniker of a bench power supply.

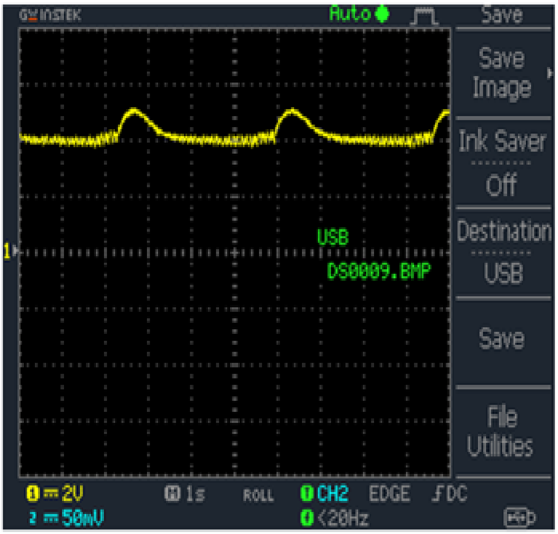

Figure 8 (a): *Input DC voltage supply Waveform*

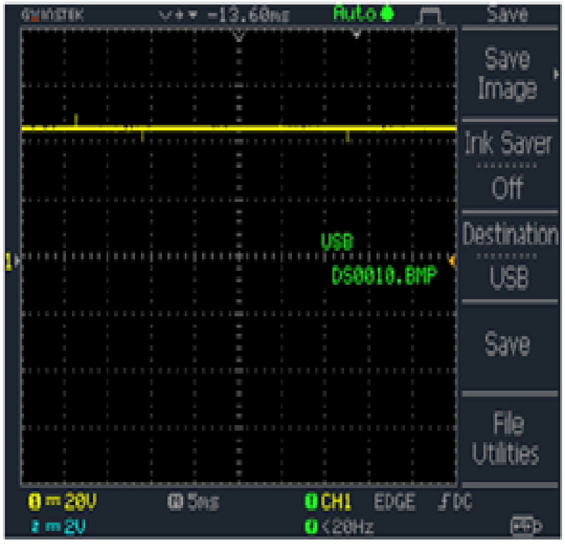

Figure 8 (b): *Converter Output DC Voltage Waveform*

Figure 8(b) depicts the converter's DC voltage waveform. The converter's output voltage, which is regulated, deviates from Vg in terms of both amplitude and perhaps polarity.

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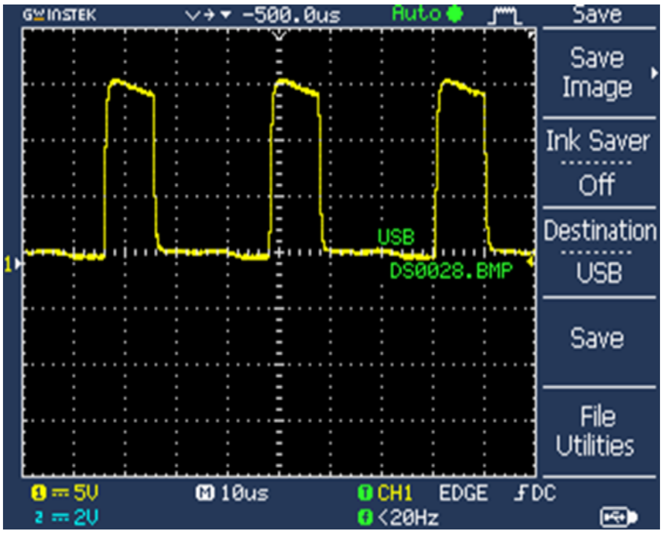

Figure 9: *Pulse Waveform for Converter*

Figure 9 displays the converter's pulse waveform. The pulse number is the number of pulses in the dc output voltage that happen within a single interval of the ac source voltage.

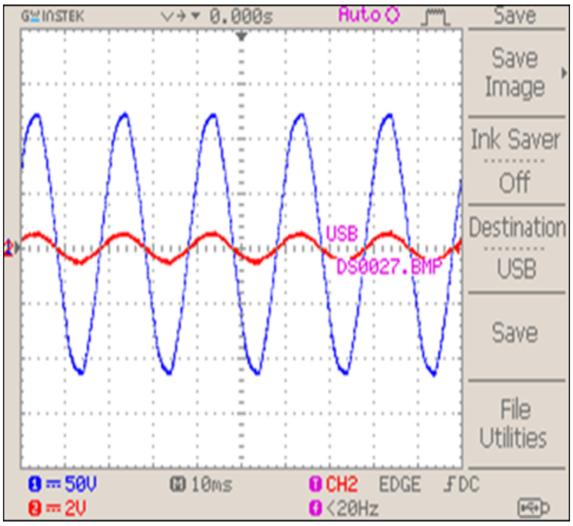

Figure 10: *Grid Synchronization Output*

Figure 10 displays this grid synchronization result. In an alternating current (AC) electric power system, synchronisation refers to the act of matching the frequency, phase, and voltage of a generator or other source to an electrical grid.

5 Conclusion

In this work, a high-gain LUO converter design for PV system applications is suggested. A component of the suggested system is a LUO converter for a PV system. The recommended converter (a Luo converter) is used to increase a converter's output voltage while keeping the

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level constant throughout the system. Through a DC-to-DC power converter known as a boost converter, also known as a step-up converter, the voltage is increased from the input (supply) to the output (load). The PWM generator is connected to the power supply, and it produces PWM pulses that are used to modify the signal in the LUO converter.

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