Design and Implementation of Photovoltaic System Based on Super-Lift LUO Converter

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Abstract. The battery's DC voltage has a high voltage ripple, and therefore does not apply to most devices. DC converters are used in the voltage to relieve ripples regardless of the change in load voltage. In this paper, a design and implementation of positive output super lift POSL LUO converter using maximum power point tracking (MPPT) Algorithm in photovoltaic (PV) system. In LUO converter is highly efficient with low ripple in current and voltage. The super lift converter is a developer converter that comes from the buck boost converter, it is considered of the best converters. Used for low voltage irregular in photovoltaic to a higher voltage without ripples or voltage step down according to the design of the converter, it therefore applies to most devices, such as electric vehicles, dc-chargers, etc. The efficiency of the panels can be improved using maximum power point tracking algorithm, among the many accessible MPPT methods, perturb and observe method. The proposed P&O method based on the PI controller gives the best duty cycle, to eliminate the oscillations in the converter output value, and extracts the highest energy from the PV system. The values of the PI controller are adapted by trial and error method. The results were confirmed using MATLAB / Simulink in DC-DC converter design with MPPT.

Keyword: POSL converter, MPPT, P&O, photovoltaic.

1. Introduction

The DC-DC converters have been developed with high voltage and efficient transmission gains with low voltage and current ripples. [1]. DC converters are important in renewable energy applications because of low photovoltaic voltage and converters make research highly efficient [2]. In many industrial apps, DC / DC converters are commonly used, such as DC motor disks, computer systems, and communication devices, hybrid electric vehicles etc. [3]. The methods used to develop the converter to raise the voltage without ripple are super lift (SL) technique and voltage lift (VL) [4]. These techniques are used in the design of converters with elevated increase in voltage- lift (VL) technology that improves output voltage step by step either the super lift (SL) technology improves output voltage in engineering advancement [5]. In power series, the SL technology improves the voltage transfer gain effectively [6]. The converter are known as positive output super lift LUO boost converter and the converter are sorted from voltage lift (VL) converter differently [7] The series of high-performance super lift converters are split into two groups: the primary and the extra primary circuit include, (2n )capacitors, switch (S), (n) inductors and diodes equal to (3n-1) The switch frequency is f (T = 1/f period), the d is the ratio of the conduction duty, current output is Io and load is resistive. To increment the stages, negative components are only improved if there is no change in the number switch and only one is maintained [8, 9]. Super- lift converters enjoy the advantages of earning gains gradually increase stage by stage [10]. Photovoltaic energy has been used for decades. Focusing on PV has become a significant source for a variety of apps, PV works to generate electricity from the sun [11]. The MPP site is unknown in the photovoltaic cell and can be determined by Perturb-and-Observe (P&O) algorithm that uses a hypothetical PV point at maximum power [12]. In this paper, good results were obtained compared to the results of previous researchers.
2. PV MODELLING
Of the photovoltaic module, Photovoltaic cell dual-photovoltaic model provides an effective trade between accuracy and simplicity and is commonly used in the modeling and control of photovoltaic systems [13]. It basically comprises of a source of photocurrent generation along with a parallel resistor and a linear resistor in parallel connection with the diode as shown in Figure (1).

![Figure 1. A single-diode PV circuit](image)

There are values Io, Iph, Rs, Rsh and one that must be estimated before creating a non-linear link between system factors I and V. The unit features are provided below under distinct radiation conditions and temperature. Figure(2) represents the characteristics of IV and PV characteristics in the 25 °C STC Under different radiations from 200 to 1000W/m². Figure(3) provides curves IV and PV at a standard 1000 W/m² irradiation under variation temperature conditions of 10, 20 and 30, 40 and 55 °C. Table 1. parameter of PV

3. The proposed design of POSL converter with MPP
The POSL converter is a type of converters developed from Buck Boost converters, contains high efficiency among DC converters. The LUO converter has high energy density characteristics, high voltage transfer gain and low ripple in current and voltage. The POSL converter has the highest efficiency among non-isolated converters. There are techniques used in the POSL converter, VL technology and SL technology are commonly used to enhance voltage. The proposed converter with MPPT appears in figure (2).

![Figure 2. Proposed system diagram](image)

The developed converter is POSL converter. The SL technology is better than the VL technology, which facilitates the increase of output voltage in engineering progress.
3.1. Positive output super lift converter.
The P/O super lift converter works to output the positive source voltage to load at a higher value while remaining on the same polarity. The converter displayed in figure (3).

![POSL LUO converter](image)

The POSL converter has more execution as far as remarkable voltage improvement, high voltage increase, high power thickness and least yield voltage swell. The POSL converter circuit is utilized to venture up (support) DC voltage yet a few circuits can likewise be utilized to venture down voltage, like the buck-help converter [14]. The POSL converter plays out the voltage from positive source voltage to positive load voltage, resulting in increased output voltage, essentially builds the voltage move increase organize By stage in geometric development [15]. In fundamental arrangement, the POSL converter circuits are called as primary circuit, re lift and triple lift, separately. These arrangement might be numbered as n=1, 2, 3 [16]. The converter appears in figure (3) It consists of (MOSFET), L inductor, C1 and C2 condensers, two D1 and D2 diodes and resistance to load (R).

3.2. Maximum power point tracking (MPPT)
To enhance the solar panel's effectiveness, the maximum power point tracking method is used. A circuit's energy output is maximum when the impedance of the source matches the impedance of the load. There is no maximum power point (MPP) at a specific point, but it moves around the P-V curve depending on the light intensity and temperature. MPPT controllers are necessary to change the working cycle in DC / DC LUO converter normally it generates a variable signal voltage and a working cycle that is input to the pulse width modulator (PWM) generator. This is used to generate the needed pulses to control the converter switching effectively. In this work, the PI controller has been proposed on the basis of dp / dv, to effectively enhance the maximum power point tracking. From Figures 2 and 3 it can be inferred that dp / dv should always be derived from zero in the PV source MPP. Several ways to track maximum power point (MPP) have been suggested. Among all these techniques perturb and observe is commonly used because of their simplicity. They differ in many aspects such as accuracy, efficiency and speed. Based on the control variable it use. Figure shows (4) the technique of perturbing and observing P&O [17, 18].

![P&O algorithm block diagram](image)
3.3. Perturb and observe P&O technique
The perturbation and observation algorithm is commonly used to monitor the monitoring of maximum power point, one of the most commonly used techniques for easy execution and simple design. P&O technology controls the performance and disturbance (increase or reduce) of the photovoltaic array when altering the current or voltage of the operation of the PV array [19]. The (P & O) algorithm is a hill climbing method that operates to locate the highest place in the energy curve when operating the electrical array as shown in figure (5). The technique of P&O includes only two detectors. Used for present sensing and photovoltaic voltage to calculation of energy, this technique operates on voltage nuisance and notes the impact of output power to achieve the necessary point (MPP)[20,21]. When the maximum power point is reached, the system oscillates to minimize oscillation. The turbulence step size should be decreased. If the operating point is away from MPP, a bigger step is the shift in the job cycle [22].

4. SIMULATION RESULTS
Figure (6) shows the proposed converter associated with PV. It consists of a PV, MPPT block, POSL LUO converter and lastly a load.

To alter the panel's input impedance to fit the load resistance by altering the working cycle, a DC to DC converter is needed. The heart of the model is the MPPT block, which helps to locate the solar panel's peak operating point. This can be done using the MPPT algorithm which in turn gives the pulse
to the LUO converter. This maintains the operating voltage at maximum point regardless of solar radiation. The simulation result shown in figures below.

![Figure 7. Output power of DC-DC converter with MPPT](image7.png)

![Figure 8. Output voltage of DC-DC converter with MPPT](image8.png)

![Figure 9. Output current of DC-DC Converter](image9.png)

![Figure 10. PV power with MPPT](image10.png)

5. HARDWARE IMPLEMENTATION
Figure(10) shows the implementation and operation of the devices for the suggested POSL LUO converter. The input of 17.4 V is applied to the converter and the output is approximately 68V with 0.67 the duty cycle.
Figure 11. Implementation of Photovoltaic System with proposed POSL converter

The hardware consists of POSL LUO converter, arduino controller, PV, and the load. Here the switch used in LUO converter is MOSFET. ARDUINO UNO is used to control the MOSFET. However, understand it can produce 5 volts of PWM pulse and therefore a gate driver circuit is required to turn the MOSFET on.

| Parameter | Value       |
|-----------|-------------|
| Vmp       | 17.4 V      |
| Ncell     | 36          |
| Io        | 3.6619e-13 A|
| IPh       | 3.1694 A    |
| Rsh       | 112.7608 Ω  |
| Rs        | 0.66713 Ω   |
| A         | 0.7856      |
| Ns        | 1           |
| Np        | 1           |
| Voc       | 21.6 V      |
| ISC       | 3.15 A      |

Table 2.

| Parameter                  | Value       |
|----------------------------|-------------|
| Input voltage              | 17.4V       |
| Capacitor C1,C2            | 470μF       |
| Inductor L                 | 1mH         |
| Diode                      | 4007N 3A    |
| Input power                | 50W         |
| Output voltage             | 68V         |
| Load resistance            | 100 Ω       |
| Duty cycle                 | 0.67        |
| switching frequency        | 50KHz       |
| Output power               | 46W         |
6. CONCLUSION
This paper discussed a high-gain DC/DC POSL converter using super lift technology. The proposed converter for PV applications has been verified. From the results, it is observed that the converter results in high conversion gain and output voltage ripple reduced compared to the classical topologies. Furthermore, the efficiency of the converter is researched by interacting with PV using the MPPT algorithm, tracking the peak energy of the PV and verifying the outcomes. The suggested Perturb and Observe (P&O) algorithm monitors the sun's peak energy. This technique calculates the peak power and directly regulates the energy obtained from the PV by altering the LDU converter's duty cycle. The unregulated voltage is converted into a controlled voltage by the LUO converter. A prototype was finally developed and the findings of simulation were checked. Thus, for PV applications, the suggested DC/DC converter is very appropriate.

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