Design And Simulation of INC MPPT Based Super Lift -Luo Boost Converter For Solar Pv Applications.

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Abstract—This paper develops the solar photovoltaic array fed super lift luo converter for numerous solar pv based applications. In DC-DC conversions now various cutting-edge methods are available like Voltage-lift (VL), Super-lift(SL), and ultra-lift technique(UL). In this paper super lift technique is used, it is popular currently because of its simplicity and economic in nature. The super lift luo boost converter(SLLBC) with compact quantity of components and only one power semiconductor switch has many features of reducing ripples in output current, voltage and it helps to get maximum power output. The selection and design of SPV array is such that it can operates in standard test conditions(STC) and maximum switch utilization of super lift luo boost converter is obtained which results in maximum power output, maximum efficiency improvement. The design analysis and simulation of the proposed system is done using MATLAB version 2014b.

Keywords- SPV Array, INC Mppt, Super Lift Luo Boost Converter (SLLBC).

I. INTRODUCTION

In DC-DC Transformation, the voltage-lift and the super-lift technique are the popular conversion techniques, this converter give boosted voltage gain. Nowadays these translation methods are used in DC to DC Conversion. In these converters have many opportunities to developing high voltage dc or ac converters. In voltage-lift method\(^1\) voltage at output side increase phase to phase in arithmetic progression though trendy super-lift performances at output side of converters increases in geometric progresses. To attain high step up and high efficiency, DC to DC converters are the main attention in the renewable powered applications, the power transfer gain is competently improved due to this SuperLift method \(^2\) These converters are usually called as; “Super-Lift Luo Boost converters (SLLBC)” in order to sort these converters dissimilar from present voltage lift converters. The series of these super-lift converters can be divided into main series and additional series. Each main series circuit contains one switch ‘\(S\)’, ‘\(n\)’ inductors, (3\(n\)-1) diodes and ‘\(2n\)’ capacitors. The switching frequency is ‘\(f\)’ (period \(T = 1/f\)), conduction duty ratio is ‘\(D\)’, the load is resistive output current is \(I_o\). For increasing the stages only passive elements are increased where as the number switch is not changed and is kept only one. Assuming no power loss during conversion process, \(V_{in} * I_{in} = V_{out} * I_{out}\). The voltage transfer gain is \(G\): \(G = V_o/V_{in}\). This means that with the addition of the \(n\)th phase, the improvement of the converter is equivalent to an super-lift basic circuit raised to the \(n\)th power. The super lift luo Boost converter have the advantages of high-voltage transfer gain, high power density, high efficiency, reduced ripples in output voltage and output current. These converters are maximum broadly used in computer peripheral equipment, industrial applications and SMPS (switch mode power supply), specially for HV projects.

II. LUO CONVERTER

Luo converters were the new series of DC-DC converters developed by Fang Lin Luo \(^2\). They are completed an modest configuration in addition economical topologies. These converters have more performance in terms of extraordinary voltage improvement and least output voltage ripples. The converters basically two type i.e voltage-lift method and the super-lift method. Luo converters are primarily used to step-up (boost) DC voltage but some circuits are primarily used to
step-up (boost) DC voltage but some circuits (such as the voltage-lift fundamental) can also be used to step-down voltage, similar to the buck-boost converter. Since switching pressure loss is mainly reduced. Compared with the voltage-lift technique, Super-lift technique implements a Maximum output voltage gain swelling in geometrics progression. The section VI describes the complete analysis of the Main circuit of the Super-Lift Luo Converter like Elementary circuit. Section III covers the ideas of Solar PV, Section V(a), shows the Matlab/simulation model and Fig V(b) results of the SPV fed Positive Output Super-Lift Luo Boost Converters (SLLBC). Input voltage and Ripple free output voltage of Super-Lift Luo Boost Converter in Fig V(b).

Table 1: Module specifications under STC

| Make: BP SOLAR SX3190 |  |
|-----------------------|--|
| V<sub>oc</sub> (Open Circuit Voltage) | 30.00 volts |
| I<sub>sc</sub> (Short-Circuit Current) | 8.55 amps |
| V<sub>mp</sub> (Maximum Voltage) | 24.3 volts |
| I<sub>mp</sub> (Maximum Current) | 7.8 amps |
| P<sub>mp</sub> (Maximum Power Point) | 190 watts |
| T (Cell temperature) | 25°C |
| STC: Irradiance | 1000W/m² |

III. SOLAR PV ARRAY SELECTION

(A)

The SPV array with peak power generating capacity of P<sub>mp</sub> = 390W is designed for PV applications. BPSOLAR SX3190 make PV module, is selected to realize a PV array of appropriate size. Electrical specifications of this module are indicated in table 1. Identification of spv array voltage at Mpp, V<sub>mp</sub> initiates the sizing of SPV array. Belonging to the category of buck boost converter, maximum switch utilization of super lift luo converter [5] occurs at duty ratio of 0.5. Therefore, the input and output voltage of super lift luo converter must be equal to satisfy the condition Vdc i.e.

I<sub>mp</sub> = P<sub>mp</sub>/V<sub>mp</sub> = 190/24.3 = 7.8 A

Ns = V<sub>mp</sub>/V<sub>m</sub> = 24.3/12.5 = 2

Output voltage of super lift luo converter is 180 v. Now, to achieve the duty ratio of 0.5 by the Mppt operation at standard test condition and hence the maximum switch utilization of Super lift-luo Boost converter, it is mandatory to select V<sub>mp</sub> i.e. Input voltage of super lift luo converter as 50 v. For a 390w, 50v (ratings at MPP) SPV array, 7.8amp current at Mpp.

III. INC MPPT METHOD

(B)

The basic equations of this method are as follows.

\[ \frac{d}{dV} = -i \times V \]  \hspace{1cm} \text{(An Mpp)}

\[ \frac{d}{dV} > -i \times V \]  \hspace{1cm} \text{(Left Of Mpp)}

\[ \frac{d}{dV} < -i \times V \]  \hspace{1cm} \text{(Right of Mpp)}

Figure 2. P-V Characteristics Of PV Array At 25°C
INC MPPT technique is built proceeding the detail of the slope of the P-V characteristics of pv array remains null at MPP (dp/dv = 0), positive on the left, then negative on the right, as presented in Fig 2. On the left of MPP, and represents the condition on the right of MPP. In INC (Incremental Conductance Method) the array terminal voltage is always adjusted according to the MPP voltage it stands based on the incremental conductance in addition to instant conductance of the Solar PV unit.

IV. DESIGN  SUPER -LIFT LUO BOOST CONVERTER (SLLBC):

Super Lift-Luo Boost converters suggestively increasing the voltage transfer gain stage to stage in symmetrical progressions. This optimistic output basic super lift-luo boost converter (achieves the voltage translation beginning positive source voltage to positive load voltage and thus gives increased output voltage The model has been done on the progressive output Super lift-Luo Boost converter for solar Pv systems through constraints presented in Table II

![Fig 3(a) Equivalent Circuit SLLBC](image)

This equivalent circuit SLLBC with single switch (S) as shown Fig(a), voltage across capacitor C1 is charged to Vin. In this circuit current \( I_L \) flowing through inductor \( L \), increase with voltage \( Vin \) throughout switch ON Period DT and decreases with voltage \( (Vo-2Vin) \) thru switching-OFF period (1-D) T. So

\[
\Delta I = \frac{Vin \times D \times T}{L} = (Vin - 2Vo) \left( \frac{1 - D}{L} \right) T \quad \text{............ (1)}
\]

\[
\frac{Vo}{Vin} = \frac{2 - D}{1 - D} \quad \text{............... (2)}
\]

\[
T = \frac{L \times \Delta I}{Vin} - \frac{L \times \Delta I}{Vo - 2Vin} \quad \text{............ (3)}
\]

\[
L = \frac{Vin \times D}{f \times R \times \Delta Vc} \quad \text{............... (4)}
\]

\[
\Delta Vc = \int_{DT}^{t} 10 \, dt \quad \text{............. (5)}
\]

\[
C = \frac{V(1 - D)}{f \times R \times \Delta Vc} \quad \text{............... (6)}
\]
From the above equation (1) –equation (6) design of SLLBC of converter is obtained for PV based applications, Table II shows the following parameter for this proposed system.

| Irradiance W/m² | PV Voltage(volts) | Duty Cycle% | PV Voltage(volts) |
|-----------------|-------------------|-------------|-------------------|
| 200             | 28                | 0.20        | 40 volts          |
| 400             | 36.5              | 0.35        | 45 volts          |
| 600             | 42                | 0.50        | 50 volts          |
| 800             | 46                |             |                   |
| 1000            | 50                |             |                   |

Table 3: Irradiance and PV voltage  
Table 4: Duty cycle and PV voltages

V. MATLAB/SIMULINK OF PROPOSED MODEL

(A)

![Simulink Model for Super lift - Luo Boost converter (SLLBC) fed Solar PV.]

V. SIMULATIONS AND RESULTS

(B)

![Figure 5(a): Solar PV array input voltage of converter 50 Volts]
VI. CONCLUSIONS

In this proposed project using super Lift -Luo Boost Converter (SLLC) performs the voltage conversion obtained output positive voltage from input positive voltage. Variations in time results in variation in switching frequency power converters ion also variation, Hence dynamic performance turn into extremely nonlinear in nature, By using this positive output simple super lift -l uo Boost converters in Pv array produces increasing voltage in geometric progressions. And it produces voltage 180 Volts outside for the voltage of 50V from solar pv module as shown in above Fig 5 (a) & (b). This converter have verified at operational point of its Robustness and Good dynamic performance in the occurrence different input voltage variations in Table III and its performance in presence of variable irradiation conditions.

REFERENCES

[1] Design of Positive Output Super-Lift Luo Boost Converter for Solar Inverter Ms. Anushka S. Tekade Dept. Of Electrical Engg. R. G. C. E. R. Nagpur, India anushka.tekade@gmail.com.
[2] Rajan Kumar and Bhim Singh, “Luo converter fed BLDC motor drive for solar PV array based water pumping,” IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES), 16-19 Dec. 2014
[3] Modeling and Simulation of Grid-connected Hybrid Photovoltaic/Battery Distributed Generation System Fei Ding\Peng Li\Bibin Huang\Fei Ga\Chengdi Ding1, Chengshan Wang1 Ikey Laboratory of Power System Simulation and Control of Ministry of Education, Tianjin University, Tianjin 300072, China.
[4] Positive Output Elementary Superlift Luo Converter for PV Applications Dr.G.Justin Sunil Dhas1, Dr.D.Anto Sahaya Dhas2, and Sreensna M K3 3rd International conference on Innovative Engineering Technologies (ICIET’2016) August 5-6, 2016 Bangkok (Thailand).
[5] Sensorless Control BLDC Motor Drive for an Automotive Fuel Pump Using a Hysteresis comparator &-Won Chun, Member, IEEE, Quang-Vinh Tran, Hong-Hee Lee, Senior Member, IEEE, and Heung-Geun Kim, Senior Member, IEEE Year: 2014, Volume: 29.
[6] Rajan Kumar and Bhim Singh, “BLDC Motor Driven Solar PV Array Fed Water Pumping System Employing Zeta Converter,” in 6th IEEE India International Conference on Power Electronics (ICPE), 8-10 Dec. 2014.
[7] B. Singh, V. Bist, A. Chandra and K. Al-Haddad, “Power Factor Correction in Bridgeless-Luo Converter- Fed BLDC Motor Drive,” IEEE Trans. Ind. Appl., vol.51, no.2, pp.1179-1188, March-April 2015