Performance Analysis of Positive Output Luo Converter (Polc) for Pv Applications

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Abstract: The POLC (Positive Output LUO Converter) is a broadly useful DC to DC converter with buck and boost highlights. The geography of the POLC is unobtrusive, and it has the additional advantage that the extremity of the yield voltage doesn't get reversed with regard to the polarity of input voltage. Since the primary force control switch is arranged in series manner with the input switch and DC source, at whenever the exit point yields from the POLC isn't fundamental, it may be wholly stopped down or swapped by possession the other control switch which is to control the force is present in the OFF state. To the extent the topology of the POLC is concerned, it comprises of four stockpiling components such as two inductors and two capacitors, the force control switch and the force bearing managing diode. The appearance of four energy stockpiling components expands the request for the exchange capacity of the converter. The attribute of the converter gets nonlinear. The utilization of a PI regulator is checked for the voltage guideline of the yield DC voltage of the POLC. Utilizing the K_p and K_i esteems as provided by the Zeigler Nicholas strategy to change the exhibition of the POLC with a PI regulator, under source and burden aggravations just as following execution under adjusting rules are saved. Intellectual regulators which use a Fuzzy Logic to regulate and Artificial Neural Network (ANN) are at steady state, in recent times they include intelligence in their work. These regulators do not need perfect dimensional model, and similarly it can be utilized for schemes which are nonlinear is architecture and simulated in MATLAB platform for expanding the performance of the POLC converter. From this examination it is observed that there is an enhancement in the rise time and settling time with decrease in overshoot.

1. Introduction

Energy is the catchphrase for our everyday life, as people need it as electrical, mechanical, warm and substance energy for incalculable employments. World energy utilization has been expanding quickly, since the modern industrial revolt presented automated creation strategies.

Utilization of sustainable power ensures the climate, by decreasing the utilization of vaporous, atomic material and discharge of warmth radiations. It accommodates shielding effect the world's climate from an Earth-wide temperature boost issue. It saves non-sustainable types of energy, diminishes ecological harm brought about by evaluation and deliberation of petroleum derivatives, and limits presentation of individuals and natural life to huge traditional force plants. The idea of inexhaustible versus non-environmentally friendly power assets gives the foundation of supportability. An environmentally friendly power framework changes over the energy found in daylight, wind, falling-water. The majority of the environmentally friendly power comes either straight forwardly or in a roundabout way from the sun and wind and it can never be depleted. Consequently, they are called environmentally friendly power sources. As indicated by International Energy Agency (IEA), energy creation from sustainable sources would outperform the coal and become the world's main wellspring of power in the "mid 2030s.

2. Problem Identification And Definition

As a rule, the nonlinear I–V attribute of the Photo voltaic energy source makes the MPPT more complex. To impress this issue, customarily a few MPPT methods have been utilized for augmenting the force extraction. These procedures shift in the quantity of sensors required, cost, blending pace, and convolution in equipment usage. While introducing a MPPT tracker for Photovoltaic power framework, the fundamental occupation is to pick and plan exceptionally compelling converter, which diminishes the wave in current and voltage and builds the transformation productivity. Thus, it targets overcoming this issue by granting reenactment investigation of the extended framework with higher request power converter principal LUO converter.

Apart from this, projected PV power frame work are utilized by the state-space average model which is a higher request of DC-DC LUO converter. The circuit model is constructed for this State space model to yield indistinguishable outcomes. By demonstrating this model, it helps to identified whether the info is inside or outside the predefined range. They are also useful for perceiving the strength area for exemplary force rating.

A. Objecties Of The Work

The principle targets of the exploration effort are:

1. Reproducing logical archetypal of solar powered Photovoltaic module and to approve its attributes (I-V and P-V) under fluctuating ecological circumstances. (i.e., irradiance and temperature of cell).
2. To build up a regulator for DC-DC central LUO converter based Photovoltaic power framework.
3. To examination and assess a presentation of the proposed LUO converter in the PV power framework utilizing MATLAB/SIMULINK and equal outcomes over the customary PI regulator, as far as settling time and rise time.

B. Block diagram of PV fed high gain boost converter for standalone system

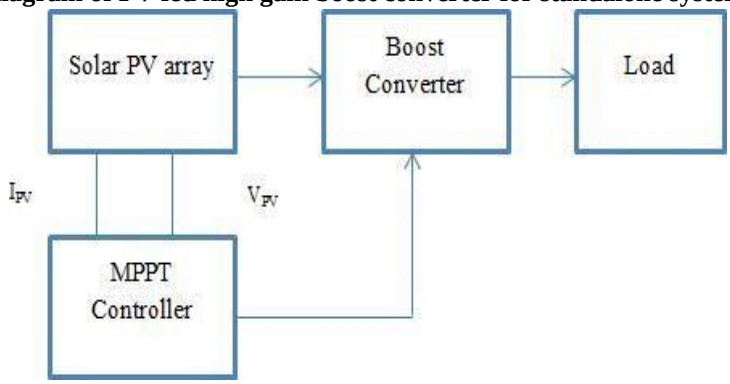


Figure no:1 Block Diagram

C. EQUIVALENT CIRCUIT (SOLAR PV MODULE)

The current Equation is,

$I_{sc} = I_D + Ipv + (V_D / R_p)$ (1)

$Ipv = V_D – (Ipv * R_s)$ (2)

Diode current is,

$I_D = I_o + (e^{(V/V_D)} – 1)$ (3)

$Vt = NsKT / q$ (4)

Where,

I_{sc} – Short Circuit Current,
V_t – Thermal Voltage,
N_s – Series Connection of Cells,
K- Boltzmann Constant,
q – Charge of Electron, &
T – Temperature of PV cells.

- In this, I_{sc} α Irradiation and also
- I_{sc} is somewhat proportional Temperature of a cell.

The above-mentioned equations are used for the solar PV module demonstration. In that (1) & (2) gives the results in MATLAB/simulation. It helps in the prediction of the I & P characteristics with respect to voltage, so that it enhances the understanding of the module. It also analysis the temperature effects and variation in the irradiation.

Irradiation variations produces an oscillation in both Open and short circuit. In that open circuit causes a fluctuation voltage at a very small amount and where in the short circuit it causes the sharp fluctuation in the current. Increasing in temperature, decreases an open circuit voltage in Non-Linear condition.

D. MPPT (MAXIMUM POWER POINT TRACKER)

The conversion of a solar radiation into an electrical energy are the process done by the solar panel. They have the ability of 30% to 40% for a conversion. Therefore, a novel technique is used to increase the productivity of the solar panel. That novel technique employed are known as Maximum Power Point Tracking (MPPT).

A MPPT is an electronic system, its ultimate operation is to yield maximum power using PV modules. For the maximum power distribution, the modules are pointed by the MPPT. By this process, panel is delivered with a maximum power.

a. MPPT Algorithm

MPPT has various algorithms to enhance the performance of the PV system. In that, Perturb-Observe (PO) and Incremental Conductance (IC) algorithms are mostly implemented in PV based systems because of their high efficiency and simplicity.

The technique adopted here is the Perturb & Observation algorithm. This algorithm states that the operating voltage of the PV array key point are increasing or decreasing condition according to the climatic situations. Thus, the increase in operating voltage of an array increases the output power of the system or in vice versa. Increase of a power system indicates the next perturbation in the existing direction, in decreasing it is directed to the opposite direction of the present position. This process is repeated until the MPPT is reached

b. P&O Algorithm

The non-isolated DC-DC converter is connected through the MPPT, in order to meet the requirements of the grid. They may be step-up or step-down converter. This operation is possible because of the obtained maximum power. By adjusting the gating signals of the converter switch, the MPPT controls the output of the DC-Dc converter.

PERTURBATION	POWER	NEXT PERTURBATION
RISE	RISE	RISE
RISE	DECEND	DESEND
DECEND	RISE	DESEND
DESEND	DOWN	DESEND

Table no 1: P&O algorithm

From the table, it clearly seen that the direction of the next perturbation is same when the voltage and power are increases. Otherwise, the next perturbation is in different direction. This operation is obtained when the power and voltage is decreased or either one decreases.

3. Design Of Luo Converter

Amid to all existing converter, this converter (LUO) affords a regulated positive output voltage. They act for any required level such as higher or lower. The profits of this converter are

- Output voltage ripple are low,
- Compensation are easier,
- Performance are good,
- Particularly no freeloading problem.

They cause the output voltage and power transfer efficiency to be controlled to low value. Hence, the innovative shot is made using this converter.

A. POESLLC MODELLING FOR AN ON MODE CONVERTER

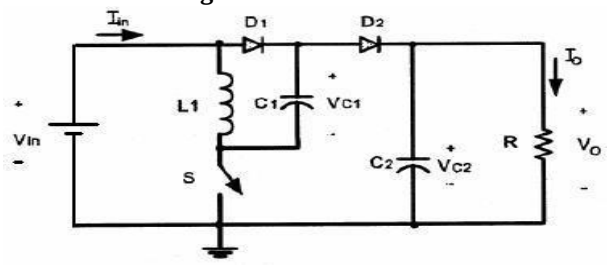
PI control is the finest solution for optimizing the stability of Positive Output Elementary Super Lift LUO converter dynamics. It gives the accurate operation for the different working condition and also used in the place of switching converters. The advantage of the PI controller is:

- Invariant dynamics (system constraint variation)
- Static response (ideal cases).

B. CIRCUIT ACT

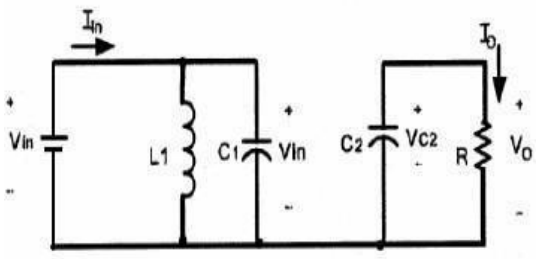
POESLLC (positive output elementary super lift LUO converter) consists of an Dc Voltage (V_{in}), Capacitors (C1 & C2), Inductor (L1), Power switch MOSFET n-channel (S), Freewheeling Diodes (D1 & D2), and Resistance(R).

Figure no:2 POESLLC



The capacitor voltage (VC1 & VC2) in the sliding mode controller is same as the voltage references of a capacitor. By the above-mentioned circuit and description, the POESLLC converter works in a continuous conduction manner and the apparatuses are ideal.

Figure no:3 Mode 1 Operation



In switching operation of mode 1 at closed condition:

The voltage across the capacitor (C1) is charged into V_{in}. The current in the inductor (iL1) increases with this voltage (V_{in}). This figure indicates decrease in voltage is of $V_o - 2\ V_{in}$ and the ripple current of the inductor is

of iL1.

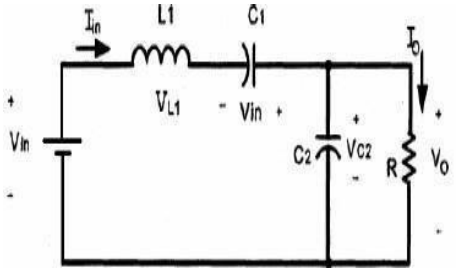


Figure no:4 Mode2 Operation

In switching operation of mode 2:

The input current and capacitor current values are obtained by:

Input current:

Switch at on condition (i_{in} = iL1 +ic1)

Input current:

Switch at off condition (i_{in} = iL1)

Capacitor current:

Switch at off condition (icl = iL1),

The average across the capacitor is not changed.

The relations are given as follows:

V0- 2-kV/1-kin

Voltage transfer gain (G),

$G = V_o / V$

$G = 2 - K / 1 - K$

I_{in-off} = iC1 - off

I_{in-off} = $iL1_{-on}$ + iC1 - on

$dTiC1_{-on} = (1-d)_{1-o\ ff}$

If L1 is large, then

iL1 = avg iL1

I_{in-off} = iC1 – off

I_{in-on} = iL1 + 1- diL1/d IC1- on - (1 -d)*L1

Avg i/p current,

$I_{in} = di_{in-on}$ + (1-d)-off = iL1 + (1-d) iL1

= (2-d) iL1

By this considering,

$Vin/Iin=(1-d)/(2-d)^2 V0/i0=(1-d)/2-d)^2$

Therefore, the variation ratio of output voltage *V0* is

$\sum=V02/V0=(1-d)/2Rfc2$

C. PI

In industrial applications and exhibits robust performance over a wide range of operating conditions PI controller are habitually used. The elementary construction of PI controller is depicted. The have two parts:

- Proportional part: Responsible for ensuring the desired set- point.
- Integral part: Accounts for the accumulation of past errors.

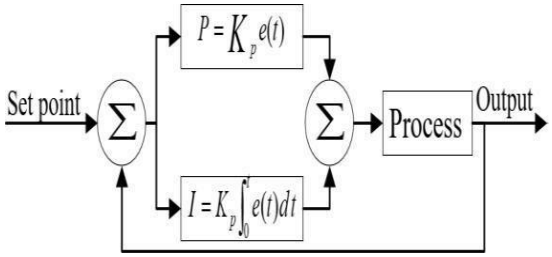


Figure no:5 Structure of PI Controller

D. FUZZY CONTROL SCHEME

Fuzzy control scheme is based on the expert knowledge or experience. This processing is based on the uncertain information of linguistic statements, and by the common rules of physical system modelling un intelligent control systems are categorized by a set of linguistic statements. The FLC contains four key elements. They are:

- Fuzzier
- Rule base
- Inference Engine and

- Defuzzifier

1. Configuration of FLC

In the function of each block FLC and its realization is explained below.

2. Pre-Processing

In this process, measuring equipment are used for the measurement of data which is far better than the linguistic method. The constraints are valid before entering into a controller. Due to this operation, better processing is obtained.

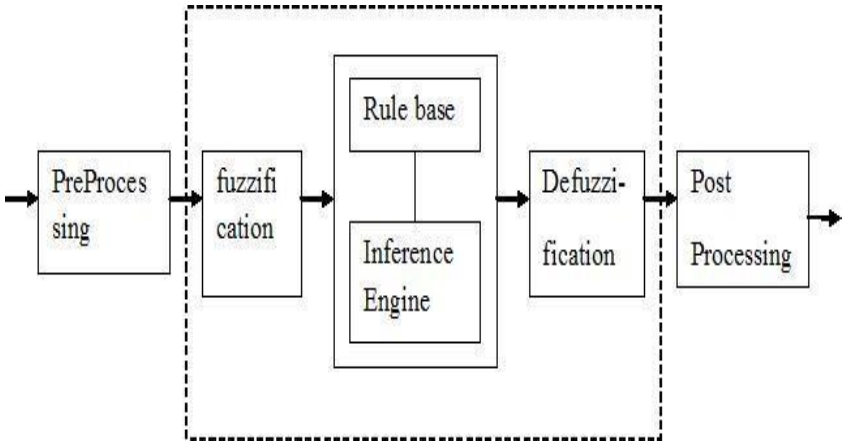


Figure no :6 Fuzzy Logic Configuration

Fuzzification is the process of converting the crisp quantity into a fuzzy value and are denoted by the membership functions or membership values. They are allotted by the various method, and are also one of the imperative ideas for the fuzzy logic theory.

A DESIGN OF RULE BASE

The inference is obtained via the individual rule firing. The output value has both the proportional error and integral error which gives some fuzzy contributions to the system.

Design of rules forms a fuzzy logic to produce a fuzzy output by the bases of linguistic variables. The linguistics variables are expressed as follows:

- ANTECEDENTS: Interference.
- CONSEQUENTS: Output.

There are three general forms for any linguistic variable. Using this forms the canonical rules are attained. They are:

1) Assignment statements
2) Conditional statements
3) Unconditional statements

This 3 are connected by linguistic like “and”, “or”, “else”.

a. Defuzzification

Fuzzy to crisp conversions are known as Defuzzification. For further processing, it is essential to alter the fuzzy quantity (results) into a crisp quantity. Because the generated fuzzy outcomes cannot be used for the applications. So, they are obtained by the Defuzzification and are also known as “rounding off” technique. They are converted into a single sealer quantity by the reduction of the membership function constraints. This operation is done by seven different methods.

3. Design of Fuzzy for the proposed technique

In the proposed system, the fuzzy controller has three functional blocks. They are fuzzification, rule interference, and defuzzification. Further they consist of an input variable of the FL Care error (e), and the change in error (ce). The output is obtained in duty cycle form because of the change in FLC.

In this process, input variables (e & ce) and output variable (Δd) are converted into a linguistic variable by the assumption of the membership function values. Due to this variables, different fuzzy levels are obtained, such as: Negative Big (NB), Negative Small (NS), Zero (ZO), Positive Small (PS), Positive Big (PB). For the assumption of any particular input has only one dominant fuzzy subset, triangular membership functions are used. They are based on the experimental knowledge about the problem; hence the number of rules is depending upon the number of linguistic variables in input membership functions. In this study, 49 fuzzy control rules are used to formulate the logical decision in fuzzy interference system which performs the composition operation. And they are known as Max-Min composition operation. Using this method, the control output is generated.

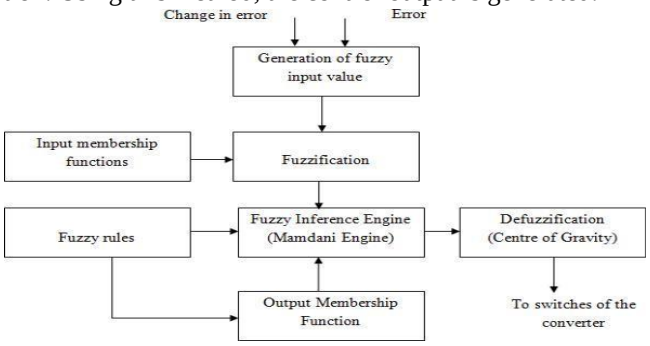


Figure no: 7 Flow Chart of Fuzzy Logic Controller

5. Result

In this chapter, both the performance of the PV system and the proposed LUO converter are inspected.

S.NO	PARAMETERS	SPECIFICATIONS
1	Maximum power (P)	500W
2	Irradiation	2 500W/M
3	Cell temperature	o 25 c

Table no:2

In the Figure 8, indicates the characteristics of current and power with respect to the voltage are shown. By this, effect of the temperature and irradiation are observed.

- Increasing of irradiance produces a fluctuation in both Open and short circuit. In that open circuit causes a fluctuation voltage at a very small amount and where in the short circuit it causes the sharp fluctuation in the current.
- Increasing in temperature, decreases an open circuit voltage in a non-linear condition.

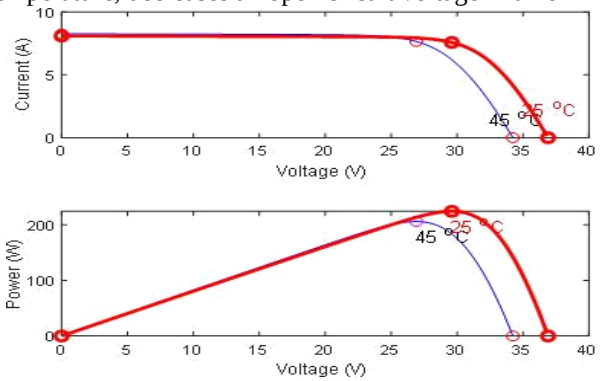


Figure no: 8 Current and power characteristics with respect to voltage

The proposed system consists of a Solar PV module and LUO converter. Their performances are analyzed by applying varies irradiation condition to the MATLAB.

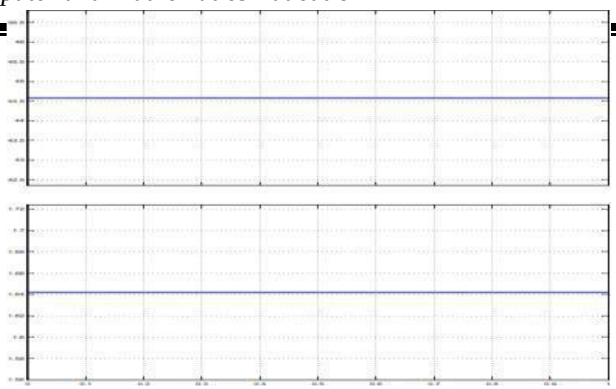


Figure no:9 Voltage and Current PV Array

For the proper operation of the proposed controller, the values of the irradiation are changed from one value to another value and their performances are observed.

The input voltage and input current of POLC are using PI. The energy storage element is charged in a rapid manner when the POLC is energized and the power is drawn from the source during the transient period. After that, the transient current results in a small steady-state current when the storage elements are fully charged. Therefore, the current waveform is initially high and then reaches a steady state value that is just required to feed the load. Figure 6.4 shows the output voltage of POLC using PI controller.

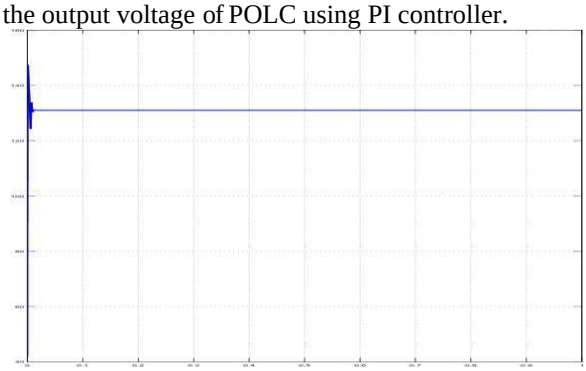


Figure no:10 output Voltage of POLC Using PI Controller

The closed loop controller performance with the fuzzy controller element for the POLC are observed and are represented here.

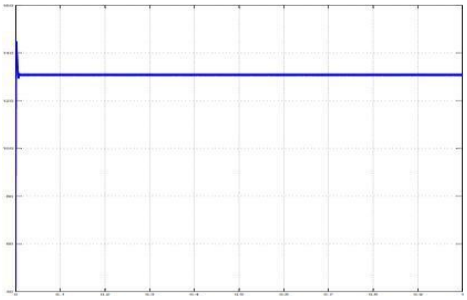


Figure no :11 Output Voltage of **POLC Using Fuzzy Controller**

Since 1000 to 1000 W/m^2 solar radiation at 0.2 sec with constant temperature of 25ºC. The output voltage does not vary according to the input voltage, since the controller are used for the adoption of parameter changes. Due to this process, they track the reference voltage by varying the duty cycle of LUO converter.

By this result, it is clearly seen that the LUO converter with fuzzy controller exhibits quick response for the varying irradiations and reduces the ripple significantly.

Controller	Risetime	Settling Time	Overshoot
PI	5.9525e-004	0.0083	12.4937
Fuzzy	7.1915e-004	0.0049	10.4986

Table no:3

From the table, it is observed that the settling time of the conventional PI controller is 0.0083 sec and is about 0.0049 for the proposed fuzzy controller. Thus, the results conclude that the proposed controller is 50% quicker than the existing controller.

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