Design of Interleaved Buck Boost Converter with Proportional Integral Derivative controller

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Abstract— In real time application the power system generation is a challenging aspect. Generating power for all the appliances needs of day today life plays a vital role. To overcome this challenge renewable energy production system is applied for small scale industries. A design of photovoltaic power generating system with controller of integral derivative with proportional system is applied in interleaved buck boost converter. The novel design of Interleaved Buck Boost Converter with Proportional Integral Derivative controller is discussed with its methodology and simulation are done using model of closed loop methodology. A brief discussion of photovoltaic system and converters used in past days are discussed. The designed methodology of proportional integral derivative controller for interleaved buck boost converter is discussed and the simulation results are tabulated.

Keywords— Power generating system (PGS), Photovoltaic system (PVS), Design of converters, Interleaved Buck Boost Converter (IBBC); Maximum power point trackers (MPPT); Proportional Integral Derivative Controller (PIDC);

Introduction

In the recent years, the emphasis of power generation in the growing society structure is a necessary need because of the variations in the supplies and demands requirement of energy. The produced amount of the power cannot grasp sufficient level of the demand so as to balance the insufficiency condition present in the recent years based on this gap there is a necessity of designs to enhance the generation of power using some methodologies. The new technologies were used in the power generating system by designing various types of converters. The existing models do not support the maximum generation of power due to its complexity made in the design with controllers and in series connection of operators provides a low power generation.

In order to increase the efficiency of the generated power using photovoltaic system a buck boost converter model is required. The novel model of interleaved buck boost converter gives a best output compared with the most of the existing models. A brief discussion of photovoltaic system and converter is made from the literature and a new model of proportional integral derivative with interleaved buck boost converter is designed, simulated and results were executed.

Wang, C.M [1] designed a model of Analysis, design, and realisation of a ZVT interleaved boost dc/dc converter with single ZVT Auxiliary circuit. Viswanatha, V [2] given a novel approach in Microcontroller based bidirectional buck–boost converter for photo-voltaic power plant. Wai, R.J [3] modeled an Adaptive fuzzy-neural-network design for voltage tracking control of a DC–DC boost converter. Wai, R.J [4] stated an improvement in Design of voltage tracking control for DC– DC boost converter via total sliding-mode technique.T.Sundar [5] applied a Modeling and Simulation of Closed Loop Controlled Parallel Cascaded Buck Boost Converter Inverter Based Solar System. Wang, Y.X [6] designed a model of Robust Time-Delay Control for the DC - DC Boost Converter'. Weissbach, R.S [7] applied a non inverting buck-boost converter with reduced components using a microcontroller. Yang, B [8] modeled a Design and analysis of a grid connected photovoltaic power system. Yao, C [9] modeled an Isolated Buck-Boost DC/DC Converter for PV Grid-Connected System. Chen, A [10] designed a Soft switching circuit for interleaved boost converters. Yilmaz, U [11] proposed a PV system fuzzy logic MPPT method and PI control as a charge controller. Zhang, H [12] approached the A new MPPT algorithm based on ANN in solar PV systems. Zhao, Z [13] approached the A new Derivation, analysis, and implementation of a boost - buck converter - based high - efficiency PV inverter.

The application interleaved buck boost converter in the closed loop model in power generation using Proportional Integral Derivative was not applied in the discussed literature. By applying closed loop system in Proportional Integral Derivative as an interleaved buck boost converter in solar system is done and executed with a simulated result. The Figure 1 shown in below the block diagram of Proportional Integral Derivative Controller with interleaved buck boost converter for solar system.

An interleaved buck boost converter gives an output with step up photovoltaic system of DC output. The DC output is converter to AC load by using inverter. A comparison for the voltage reference of the output with the error of proportional integral derivative is made.

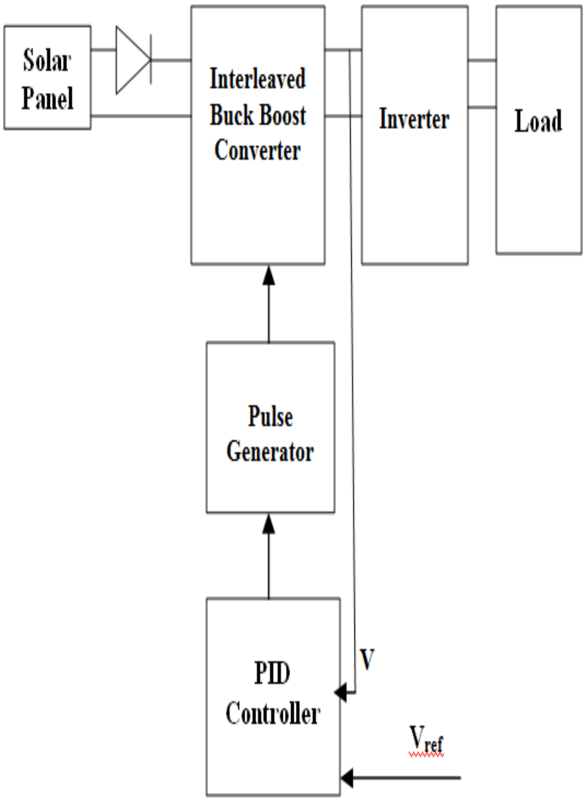

Fig. 1. Proportional Integral Derivative Controller in Photovoltaic interleaved buck boost converter for solar system system

I. ANALYSIS

The equations used for design of interleaved buck boost converter and PID Controller is as follows:

$$C = \frac{I_0 K}{fC} V\Delta \quad (1)$$

$$L = \frac{(1-K)R}{2f} \quad (2)$$

$$I_p = \left(\frac{I_s}{K}\right) + \left(\frac{I}{2\Delta}\right) \quad (3)$$

The output of PID controller in S domain is

$$C(s) = K_P + \frac{K_I}{s} + K_D s$$

$$C(s) = \frac{K_p s + K_I + K_D s^2}{s} \quad (4)$$

The design of PID controller Flow chart is shown in Fig. 2.

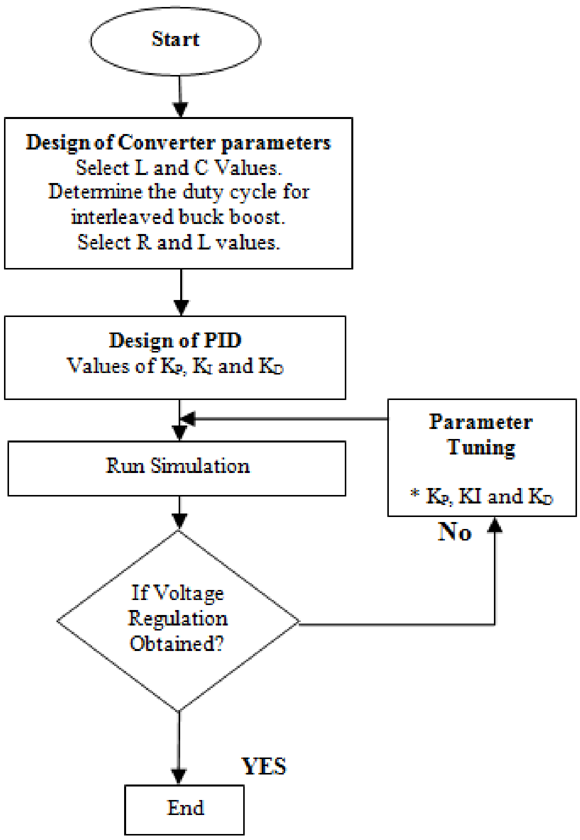

Fig. 2. Flow Chart for Design of Proportional Integral Derivative Controller

II. SIMULATION RESULTS

The result of closed loop proportional integral derivative Controlled Interleaved Buck Boost Converter system is presented.

A. *Proportional Integral Derivative Controller for Closed Loop System*

Fig. 3 shows the Proportional Integral Derivative controller in a closed loop system using Interleaved Buck Boost Converter. The voltage output produced by DC model in interleaved buck boost converter design is compared with the reference voltage. The application of proportional derivate controller gives a small change in the error. The proportional derivate controller with interleaved buck boost system updates the pulse width modulation. The Input voltage waveform of Photovoltaic System is represented in the Fig. 4.

The DC link voltage waveform of Converter Output is shown in Fig. 5. The Output voltage of inverter with PID controller is represented in the Fig. 6. The Output current of Inverter with PID Controller is shown in Fig. 7. The Table I is the comparison of the

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output load resistance with the Current and Power. The parameters with respect to time domain of Proportional Integral Derivative Controller are shown in Table II. The simulation results with requirements of Interleaved Buck Boost Converter are represented in Table III. The Summary of K_p, K_I and K_D is shown in Table IV.

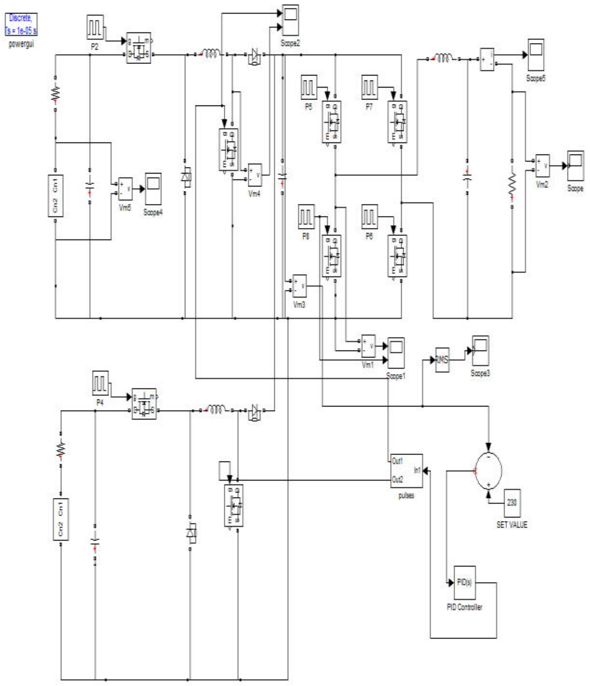

Fig. 3. PID controller in a closed loop system using Interleaved Buck Boost Converter

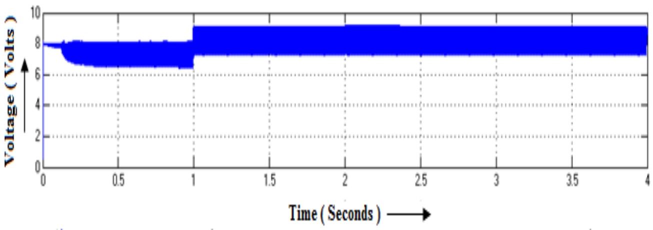

Fig. 4. Input voltage waveform of Photovoltaic System

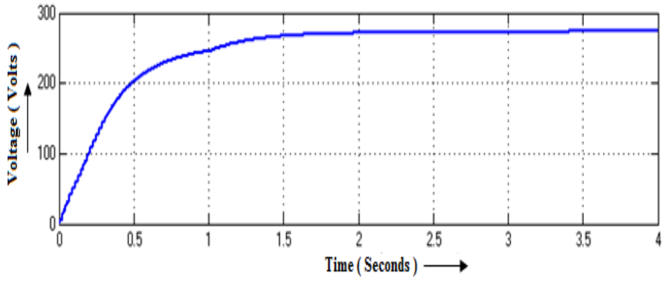

Fig. 5. DC link voltage waveform of Converter Output

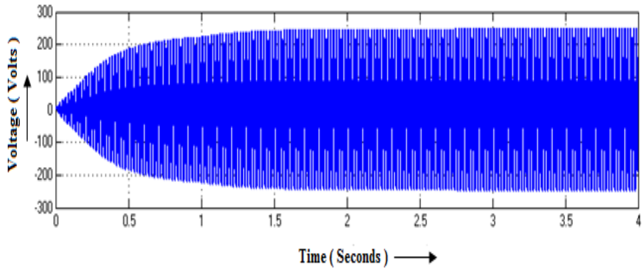

Fig. 6. Output voltage of inverter with PID controller

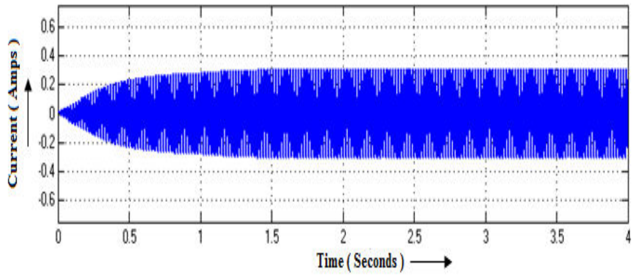

Fig. 7. Output current of Inverter with PID Controller

TABLE I. COMPARISON OF THE OUTPUT LOAD RESISTANCE – CURRENT / POWER

Sl.No	R_L	Current	Power
	Ohms	*Amps*	*Watts*
1.	100	1.7	230
2.	200	0.80	115
3.	300	0.55	79
4.	400	0.36	58
5.	500	0.29	45
6.	600	0.24	38
7.	700	0.20	31

Sl.No	R_L	Current	Power
	Ohms	*Amps*	*Watts*
8.	800	0.17	29
9.	900	0.15	25
10.	1000	0.12	22
11.	1100	0.10	20
12.	1200	0.09	18

TABLE II. TIME DOMAIN PARAMETERS USING PID CONTROLLER

Type of Controller	Rise Time	Peak Time	Settling Time	Steady State Error
	Sec	*Sec*	*Sec*	*Volts*
PID	1.4	1.6	2.0	1.5

TABLE III. REQUIREMENT AND SIMULATION RESULTS OF INTERLEAVED BUCK BOOST CONVERTER

Sl.No	Description	Simulation
1.	Solar Power PV Output	12V
2.	IGBT	G4BC305
3.	Power Diode	IN4007
4.	Inductor	9 MH
5.	DC Capacitor	2000MF/240V
6.	Capacitor Filter	65µF
7.	Inductor Filter	0.9µH
8.	Output Voltage of Converter	245V
9.	Output Voltage of Inverter	230V
10.	Inverter Frequency	50HZ

TABLE IV. SUMMARY OF K_P, K_I & K_D

Types of Controller	K_p	K_I	K_D
PID	0.15	1.2	0.95

III. CONCLUSION

The design of PID is modeled to an IBBC with closed loop system were the converters are arranged in cascaded. For the closed loop system with PID controller applied in the converter are presented as an output values. The closed loop system applied with IBBC in the cascaded arrangement reduces the error with PID controller. The designed model of proportional integral derivative controller in interleaved buck boost converter is simulated using Matlab Sim Power system and outputs were presented. The proposed design can be applied for the appliances using low power system and the results gives an optimal power usage.

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