DIGITAL PROPORTIONAL INTEGRAL AND DERIVATIVE CONTROL IMPLEMENTATION AND DESIGN OF NOVEL DC TO DC HIGH SETUP CHOPPER FOR PHOTOVOLTAIC ENERGY SYSTEM

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ABSTRACT

This project proposes a novel dc to dc high step up chopper and good efficiency for photovoltaic renewable energy system in order to simplify the power system and their cost. The proposed power converter consists of a boost fused dc to dc converter added to cascaded H- bridge inverter circuit across the load. A proposed system includes three major units first is an operation type wherein power is delivered to dc chopper from solar photovoltaic (PV) cell, second is a single stage type design of dc to dc converter with high voltage gain to regulate the required output voltage and third for a closed loop control mechanism used to produce the good efficiency and control output for the system. Using MATLAB/Simulink the proposed scheme is developed.

I. INTRODUCTION

The objective of this project is to propose a dc to dc boost power converter with high voltage gain using closed loop proportional integral and derivative control mechanism for renewable solar photovoltaic energy source. The proposed renewable power converter system has three advantages: i) power from the PV can be delivered to the utility load with expected values and without loss. ii) Maximum voltage and efficiency is realized by design of dc to dc converter and iii) a wide range of input irradiance and temperature is acceptable. The objective of this project is to propose a dc to dc high set up chopper and good efficiency for photovoltaic renewable energy system in order to simplify the power system and their cost. The proposed power converter consists of a boost fused dc to dc converter. The DC-DC converter with high step-up voltage gain is widely used for many applications, such as fuel-cell energy-conversion systems, solar-cell energy conversion systems, and high-intensity-discharge lamp ballasts for automobile headlamps. Conventionally, the DC-DC boost converter is used for voltage step-up applications, and in this case this converter will be operated at extremely high duty ratio to achieve high step-up voltage gain. However, the voltage gain and the efficiency are limited due to the constraining effect of power switches, diodes, and the equivalent series resistance (ESR) of inductors and capacitors. Moreover, the extremely high duty-ratio operation will result in a serious reverse-recovery problem. The transformer less DC-DC converters, such as the cascade boost type, the quadratic boost type , the switched-inductor type, the voltage-lift type, the voltage doubler technique, the capacitor-diode voltage multiplier type , and the boost type that is integrated using a switched-capacitor technique. These converters can provide higher voltage gain than the conventional DC-DC boost converter. However, the voltage gain of these converters is only moderately high. If higher voltage gain is required, these converters must cascade more power stages, which will result in low efficiency.

II. PROPOSED SYSTEM

The block diagram of the proposed system power converter is shown in Fig.1. It consists of a design of boost dc to dc converter [2, 18] and a resistive load. The input dc voltage source, Vpv is obtained from the PV module. By applying the pulse-with-modulation (PWM) control scheme with appropriate closed loop control mechanism to the power MOSFET switches S1, the designed dc–dc converter can draw maximum voltage and power from PV module. The dc bus voltage VDC will be regulated by the dc/dc converter with sinusoidal pulse width modulation (PWM) control to achieve the input, output power flow balance. Details of the operation principle for the proposed system are introduced as follows.

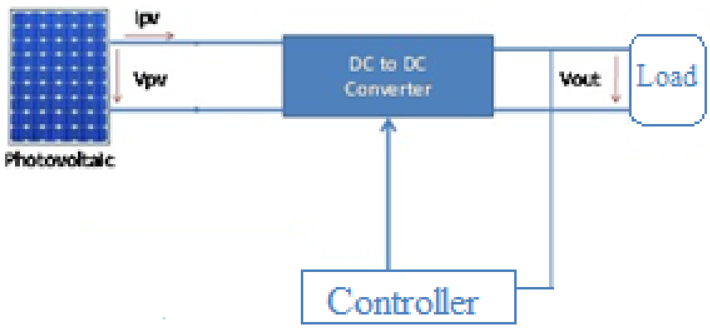

Fig.1. Proposed Block Diagram

A solar cell is a solid state device that converts the energy of sunlight directly into electricity by the photovoltaic effect. Assemblies of cells are used to make solar modules, also known as solar panels. The energy generated from these solar modules, referred to as solar power, is an example of solar energy. DUE to the growing demand on electricity, the limited stock and rising prices of conventional sources (such as coal and petroleum, etc.),photovoltaic (PV) energy becomes a promising alternative as it is omnipresent, freely available, environment friendly, and has less operational and maintenance costs. Therefore, the demand of PV generation systems seems to be increased for both standalone and grid-connected modes of PV systems. Photovoltaic (PV) as a renewable energy resource naturally is not stable by location, time, season and weather and its installation cost is comparatively high. An important consideration in increasing the efficiency of PV systems is to operate the system near maximum power point (MPP) so to obtain the approximately maximum power of PV array. To achieve maximum energy produced by a PV array, maximum power point tracking (MPPT) techniques are used.

III. DC-DC AND DC-AC CONVERTER

A boost converter (step-up converter) is a DC-to-DC power converter with an output voltage greater than its input voltage. It is a class of switched-mode power supply (SMPS) containing at least two semiconductor switches (a diode and a transistor) and at least one energy storage element, a capacitor, inductor, or the two in combination. Filters made of capacitors (sometimes in combination with inductors) are normally added to the output of the converter to reduce output voltage ripple. Power for the boost converter can come from any suitable DC sources, such as batteries, solar panels, rectifiers and DC generators. A process that changes one DC voltage to a different DC voltage is called DC to DC conversion. A boost converter is a converter with an output voltage greater than the source voltage. A boost converter is sometimes called a step-up converter since it "steps up" the source voltage. Since power ( ) must be conserved, the output current is lower than the source current. D.C.-A.C. inverters are electronic devices used to produce mains voltage A.C. power from low voltage D.C. energy (from a battery or solar panel). This makes them very suitable for when you need to use A.C. power tools or appliances but the usual A.C. mains power is not available. Examples include operating appliances in caravans and mobile homes, and also running audio, video and computing equipment in remote areas.

IV. H – BRIDGE INVERTER"

"H" topology has many redundant combinations of switches' positions to produce the same voltage levels. As an example, the level "zero" can be generated with switches in position S(1) and S(2), or S(3) and S(4), or S(5) and S(6), and so on. Another characteristic of "H" converters is that they only produce an odd number of levels, which ensures the existence of the "0V" level at the load. For example, a 51-level inverter using an "H " configuration with transistor-clamped topology requires 52 transistors, but only 25 power supplies instead of the 50 required when using a single leg. Therefore, the problem related to increasing the number of levels and reducing the size and complexity has been partially solved, since power supplies have been reduced to 50%. The single-phase H – Bridge of cascaded inverter. The ac terminal voltages of each bridge are connected in series. Unlike the diode clamp or flying capacitors inverter, the cascaded inverter does not require any voltage-clamping diodes or voltage balancing capacitors. The ratio of the power supplies between the auxiliary bridge and the main bridge is 1:3. One important characteristic of multilevel converters using voltage escalation is that electric power distribution and switching frequency present advantages for the implementation of the set apologies. The full-bridge topology is used to synthesize a three-level square-wave output waveform. The half-bridge and full-bridge configurations of the single-phase voltage source inverter are shown in Fig. 2. In a single-phase half-bridge inverter, only two switches are needed. To avoid shoot-through fault, both switches are never turned on at the same time. S1 is turned on and S2 is turned off to give a load voltage, VAO in Fig. 2, of +V s/2. To complete one cycle, S1 is turned off and S2 is turned on to give a load voltage, VAO, of -V s/2. In full bridge configuration, turning on S1 and S4 and turning off S2 and S3 give a voltage of VS between point A and B (VAB) in Fig. 2, while turning off S1 and S4 and turning on S2 and S3 give a voltage of -Vs.

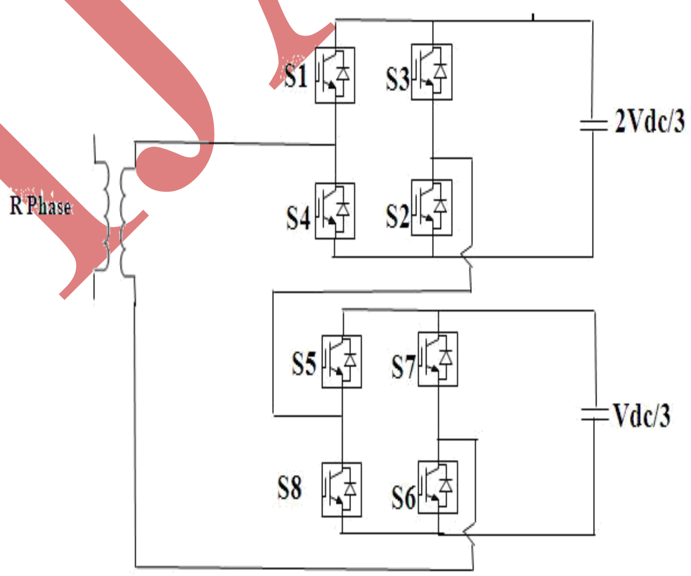

Fig.2: Asymmetrical Cascaded H-Bridge Multilevel Inverter

By using this type of Asymmetrical configuration, for a „n‟ bridge inverter we can get 3n+1 voltage levels and n Capacitors of each rating nVdc/(n+1), Vdc/(n+1) to get Vdc max and 6n switches of each voltage rating is Vdc/(n+1).The following is the switching table of Asymmetrical Cascaded H-Bridge multilevel Inverter.

V. SIMULATION RESULTS

The simulation is done based on the figure shown in figure 1:

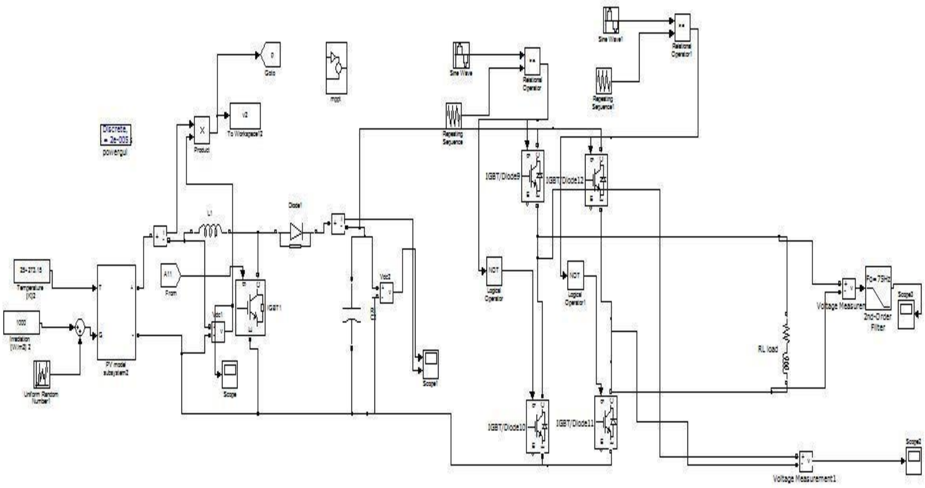

Fig 3 Simulink Model

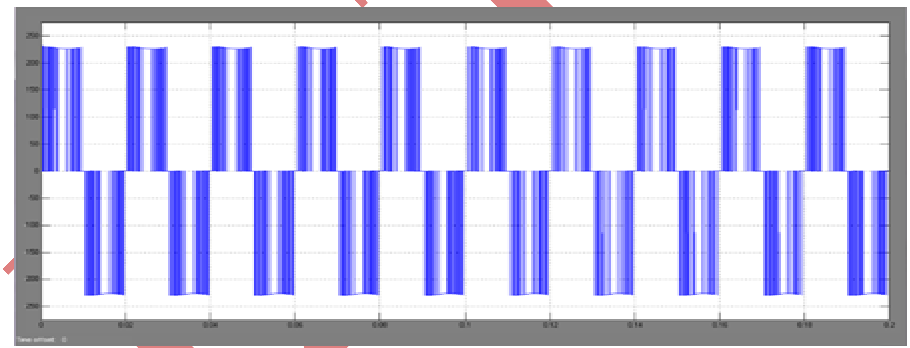

Fig 4: Without Filter in 3-Level Inverter

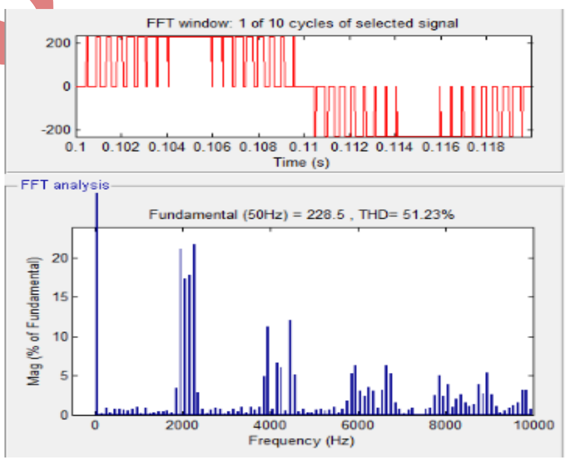

Fig 5 Total Harmonic Distraction without Filter

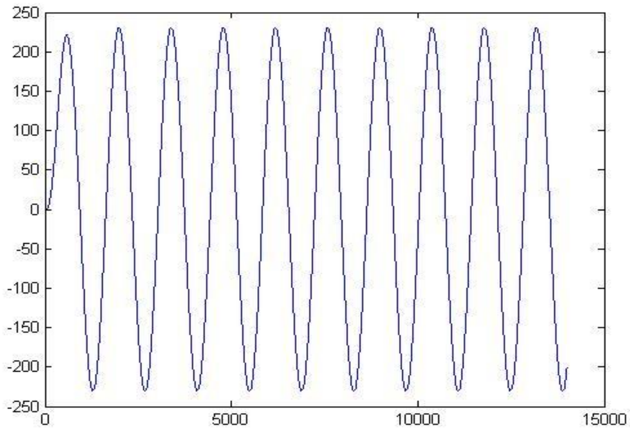

Fig 6 with Filter In 3-Level Inverter

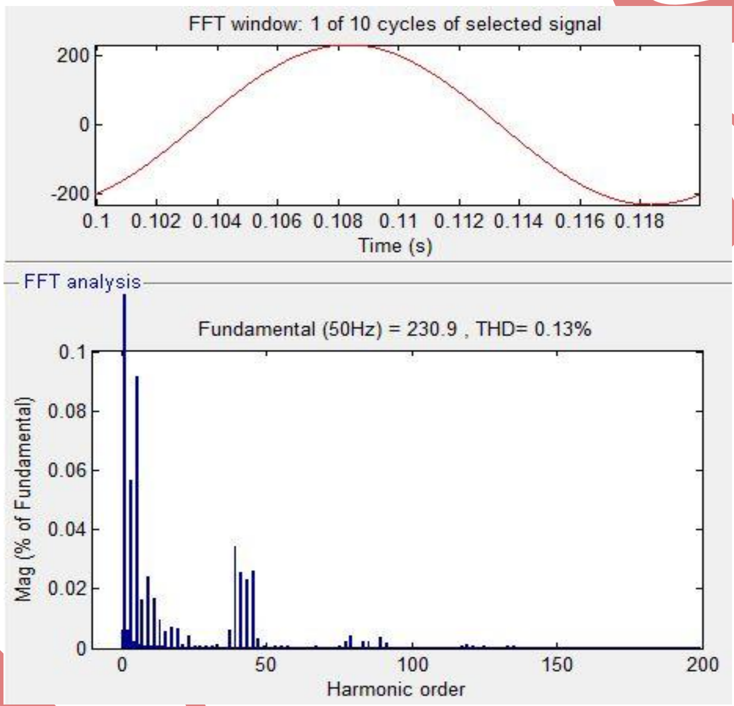

Fig 7 Total Harmonic Distraction with Filter

VI. CONCLUSION

A creative DC to DC boost power converter with high voltage gain output using closed loop proportional integral and derivative control mechanism for solar photovoltaic renewable energy system is proposed. It has the following advantages: 1) power from the PV module can be delivered to the utility load directly without transmission loss. 2) The proposed system is realized high voltage and high efficiency. a large range of input voltage variation caused by different isolation and temperature are made acceptable. In this Project, the operation principle of the proposed dc to dc boost power converter has been introduced using closed loop control mechanism is adopted to realize the maximum power and voltage output of the circuit. The trapped solar energy is converted into DC voltage and the same is again converted into AC voltage using an Inverter and connected to the load. The control circuits are simulated by using MATLAB/Simulink Simulation results at different operating conditions and are shown.

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