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Article

Fuzzy Logic Constructed on Sepic Converter For Maximum Power Point Tracking with Five Level Inverter

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ABSTRACT

The test with solar energy extraction are talked in the planned method through improvement and demo of multilevel inverter architecture and the connected controller algorithms. The planned multilevel inverter topology along with the control algorithms for solar photovoltaic (PV) systems growths the overall energy capture from the sun. Multilevel inverters are frequently used in medium and high power applications because of their strength and dependability. In real the energy demand catastrophes in the current scenario will actually raise its demand hence these are the obligatory purposes in the economy growth of the country. PV arrays are castoff to make the electricity by using sunlight or irradiation and temperature for maximum power output MPPT are castoff with SEPIC converters. The multilevel inverters have been familiarized an array of power semiconductor switches with several lower DC voltage sources. Hence multilevel inverters are developing out as another solution for high and medium power voltage levels. PV (photovoltaic) system With Single-Ended Primary-Inductor Converter(SEPIC) and Maximum Power Point Tracking (MPPT) using fuzzy logic controller with proper constraints clear for algorithm are available here to solve the harmonic problem of PV system. Fuzzy logic controller demonstrations high precision in current transition and gives crisp output to the SEPIC converter for buck/boost the output voltage of PV array. FLC founded on madmen technique and gives duty cycle to the SEPIC converter for boost up the output voltage of PV array so SEPIC converter also known as dc to dc converter or buck/boost converter, inverters are used for conversion of dc to ac but for reduction of harmonics, multilevel inverter is used in this paper since, it gives near to sine wave with less harmonic output and increasing the higher order inverters we can more control the output waveform.

Keywords: DC-DC Power Converters, Fuzzy Control, Photovoltaic Cell

Introduction

Inrecent years PV (Photovoltaic) energy has amplified in electrical power application. PV array are used to generate electricity by using sunlight, output of the PV array varies according to the sunlight or irradiation & temperature, for maximum power output, MPPT are used with SEPIC (single ended primary inductor converter) where SEPIC converter are used as a buck/boost converter or dc-dc converter. SEPIC converters are used here because of its non-inverted output and it uses a series capacitor to isolate input from output.

SEPIC converter variations its output according to the duty cycle of fuzzy logic controller, selection of converter be contingent on numerous factors such as competence, flexibility, cost and case of flexibility characterizes the capability to preserve the output while varying the input. SEPIC, conventional Buck-boost and CUK converters have the ability to step up and step down the input voltage. Hence this converter is able to transfer energy at all radiation level.

Both CUK and SEPIC converters are cast-off to make accessible either higher or lower output voltage associated to the input voltage. PV panel gives exponential curves for current and voltage where maximum power happens at the knee of the curve The everyday MPPT uses a process to discovery out the maximum point, this technique is recognized as perturb and observe (P&O). Investigators have used PI controller to apply for dc-dc converters, as in literature. Rahim et al.[6] used a five level inverter to decrease the THD (Total harmonic distortion) value. Though cost of the system amplified and THD value did not get diminished till expected value. Sera et al. applied optimization for MPPT using PI controller for their converter. Femia et al. and fortunate et al., in [9] and [10], correspondingly, used one cycle control for MPPT and a single stage inverter where as in.[2, 6] The authors used PI controllers with MPPT scheme, but there is some boundaries of PI controller and it is sensitive to parameter variations, weather conditions. Consequently, there is necessity to put on a converter which can be operative and work on all reservations.

Here multilevel inverter is castoff with PV system and FLC is also busy for extra correct sine wave which is near to sine wave which will be recovering for reduction of THD value. Mathematical modeling of the system and the imitation consequence using MATLAB/SIMULINK are presented.

Proposed System

The function of dc-dc converter is to boost the output of PV array and fed the output voltage to the inverter. In this paper the level of voltage depend on maximum power,[1] therefore controller changes voltage level according to the duty cycle of the PWM (pulse width-modulation)signal, a sinusoidal reference signal is compared with the output signal to produce zero error signal, next reference signal is used to compare the sepic output to get the maximum power, orientation signal is adaptive and it vicissitudes shape rendering to the weather condition then SEPIC output signal compared with the adaptive situation signal to feed the inverter. Inverter input should be smooth but SEPIC output has no smooth signal so to speechless this problem, filters are used to make it as conceivable as smooth.

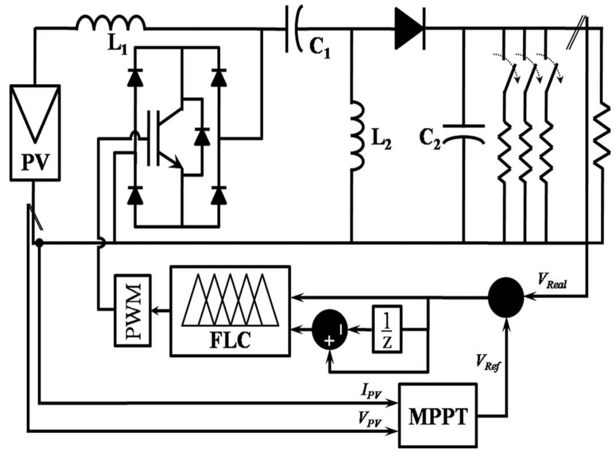

Figure 1.1Circuit diagram of the SEPIC converter for FLC based MPPT scheme

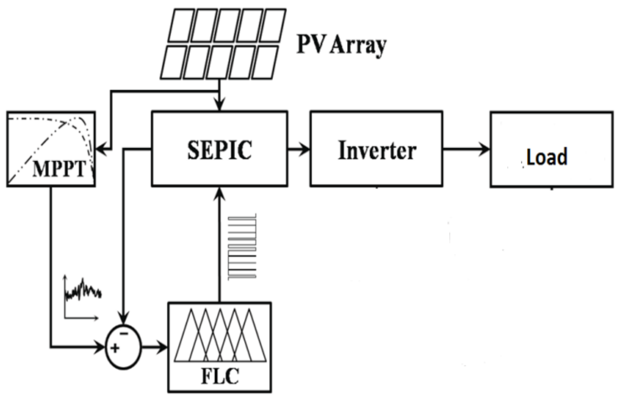

Figure 1.2Basic block diagram of energy system

Fig.1.1 shows circuit diagram of SEPIC dc-dc converter with MPPT and fuzzy logic controller. The design of the fuzzy logic controller is based on Mamdani's method. The assortment of membership function will be reflected in next section and here according to control signal PWM changes duty cycle. Here maximum power adaptation be contingent on duty cycle's changes. So SEPIC converter can use single switch which could be IGBT switch.

Objectives

The chief purposes of this thesis are to study, design, pretend and instrument a PV array with SEPIC converter and maximum power point tracker and to advance algorithm which can perform individual supreme power point tracking for the solar panels and maximize the energy capture on the DC side. Finally, the objective is to test the THD value of five level multilevel inverter for solar panel and battery operation.

A further constraint prohibiting their operation is that the real potential of these resources is not well-known, partly because of the lack of research emphasis in developing these technologies, and partly because of the insufficient resources data base. Thus, in this thesis solar renewable power generation system represent vast solar resources is designed and modeled.

Solar PV Systems

Solar photovoltaic arrays are configured either in parallel, series or the grouping of series and parallel to set the desired terminal voltage and current. In the case of series string configuration, a higher voltage level can be achieved but the current ratings are limited by the individual panel rating. On the other hand, higher current ratings can be achieved for the parallel configuration, but distinct panel voltages limit the total voltage output. Therefore, in most cases, a series-parallel configuration is used, where both voltage and current level can be increased and a desired power level can be achieved. The series connection and the series-parallel connection of solar PV array configurations. The grid connected inverters are designed to stop the flow of electricity to the utility grid if power from the grid fails. This prevents injury to those who work on the power lines to restore power. To get the greatest electricity from the solar cell array, inverters comprise a module that monitors the voltage and current from the array and the load and makes adjustments to exploit the energy output from the array. This module is called the max power point tracker. Table 1 contains the voltage and current of a PV module as the load is varied from near a short circuit (zero resistance) to near the open circuit (infinite resistance). When the current voltage (IV) curve is plotted, it is not linear like devices that follow Ohms law but follows a curve as shown in the figure next to the table. While a solar module is similar to a battery, the junction barrier also acts like a diode and the description of the circuit becomes complex.

The short circuit current is comparative to the incident solar radiation while the open circuit voltage is nearly self-governing of the incident energy. The power from the array is the current times the voltage. The maximum power point is the voltage and current where the maximum power is obtained for a given solar radiation level. Modern inverters contain max power point trackers to keep the solar electric system operating at optimum efficiency.

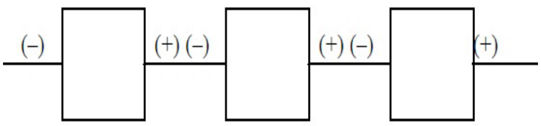

Figure 2.1 Solar cell in series

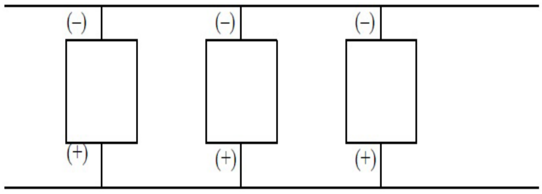

Figure 2.2 Solar cell in parallel

Modeling of PV Array

Modeling of PV array has been done in MATLAB and its block diagram which is in subsystem is showing in fig3.3

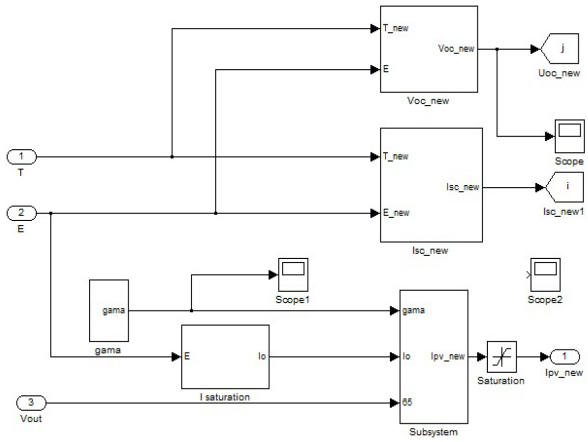

Figure 2.3 PV Array Internal Simulation Model

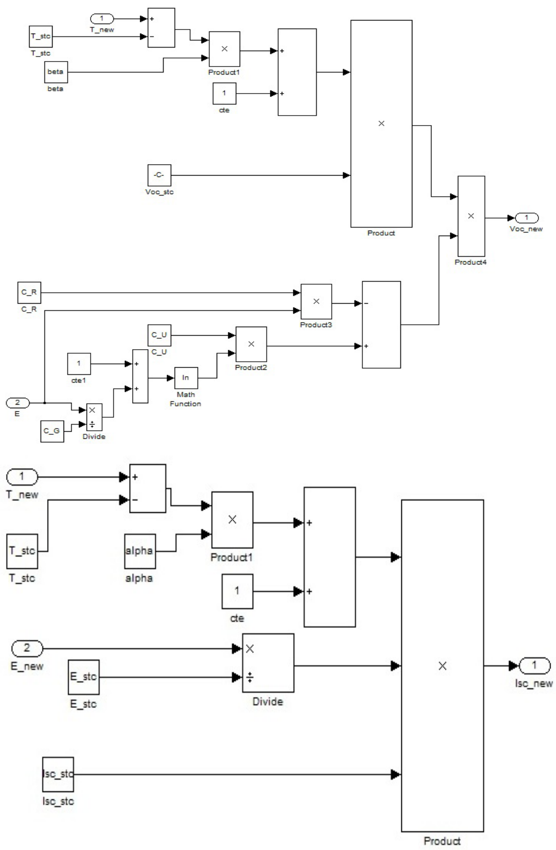

Figure 2.4 PV Array Internal Simulation Model

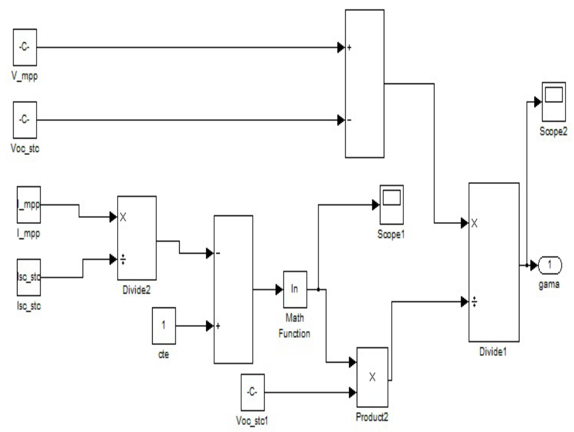

Figure 2.5 PV array internal simulation model

Above figure shows the internal block diagram of PV module and these all blocks are under the subsystem in SIMULINK.

Multilevel Inverters

The multilevel inverter topologies have turn out to be popular as a very significant alternative in the area of high-power medium-voltage requests. In recent years, numerous industrial uses have been needful the higher power equipment's. Multilevel inverters have been familiarized as an alternative solution for high power and medium voltage levels. The smallest number of voltage levels for a multilevel inverter using cascaded inverter with SDCSs is three. To complete a three-level waveform, a single full-bridge inverter is working. Fundamentally, a full-bridge inverter is acknowledged as an H-bridge cell, which is demonstrated in Fig.3.8. The inverter circuit contains of four main switches and four freewheeling diodes.

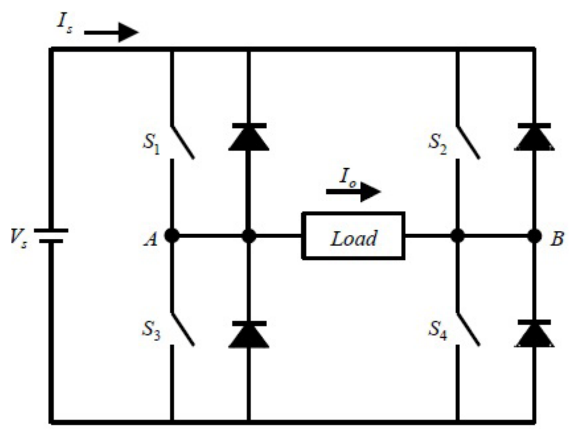

Figure 2.6 An H-Bridge Cell

Cascade Inverter Configuration

Single-Phase Structure

To manufacture a multilevel waveform, the ac output of each of the dissimilar level H-bridge cells is associated in series. The manufactured voltage waveform is, consequently, the sum of the inverter outputs. The number of output phase voltage levels in a cascaded inverter is distinct by M=2s+1 where s is the amount of dc causes.

For instance, a nine-level output phase voltage waveform can be gained with four-separated dc sources and four H-bridge cells. Demonstrations a general single-phase m-level cascaded inverter. Since zero voltage is mutual for all inverter outputs, the total level of output voltage waveform becomes 2s+1. An example phase voltage waveform for a nine-level cascaded inverter and all H-bridge cell output waveforms are exposed in Fig.2.6 In this proposition, all dc voltage are assumed to be equal.

Rendering to sinusoidal-liked waveform, each H-bridge output waveform must be quarter-symmetric as exemplified by V1 waveform in Fig.2.7 Obviously, not even harmonic components are obtainable in such a waveform. To minimalize THD, all switching angles will be mathematically intended, which will be future in next chapter.

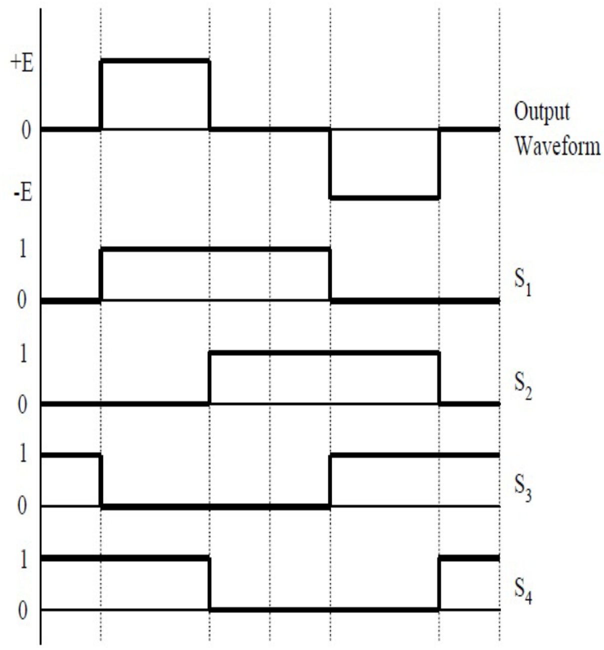

Figure 2.7Swapped zero-level switching pattern

Proposed MPPT Based SEPIC Converter

In normal condition the P-V curve has only one maximum value so it is not problematic but if the PV array is partially shaded, there are multiple maxima in these curves so in order to overcome this problem some algorithm has been realized as P&O method. Modify the operating voltage or current of photovoltaic panel until obtain maximum power from it. For example, if increased the voltage to a panel increase the power output of panel, the system continuous increasing the operating voltage until the power output begins to decrease. Once this happens, the voltage is decreased to get back towards the maximum power point. This P&O continues indeterminately, thus the power

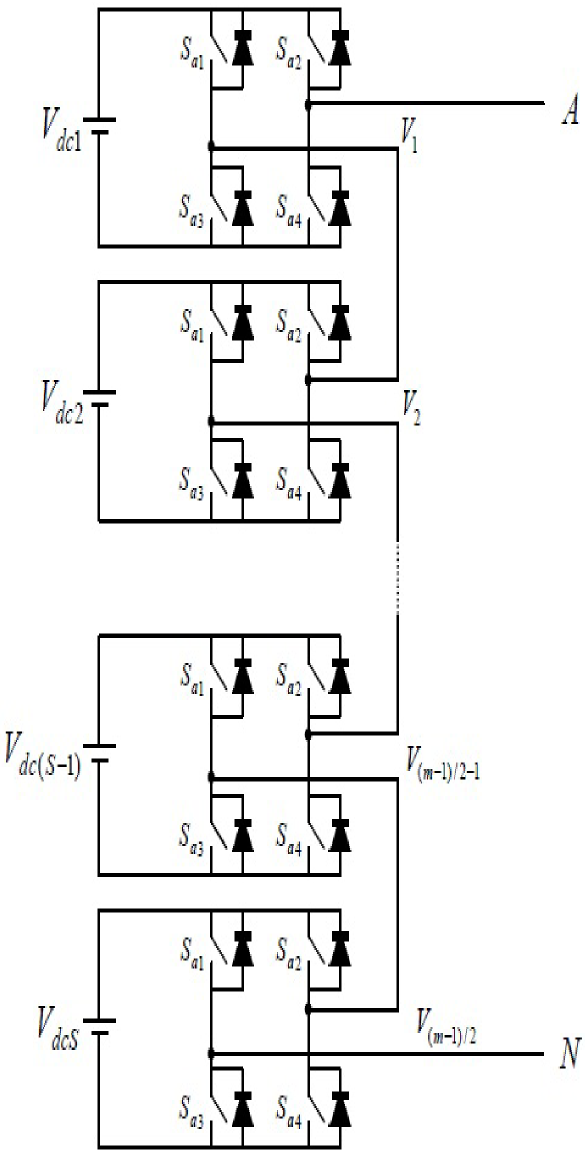

Figure 2.8Single-phase configuration of an m-level cascaded inverter

output value vacillates around a maximum power point and never steadies. It is the drawback that it oscillates around the maximum power point and it can track in wrong direction under rapidly varying irradiation levels and load level Incremental conductance considered the fact that the slope of power-voltage curve is zero. Positive at left of maximum power point and negative the right of maximum power point. By comparing the incremental of power vs. the incremental of voltage (current) between two consecutive sample, the MPP voltage can be determined. A MPPT, or maximum power point tracker is an electronic DC to DC converter that enhances the match between the solar array (PV panels), and the battery bank or utility grid. To put it merely, they change a higher voltage DC output from solar panels (and a few wind generators) down to the lower voltage wanted to charge batteries.

Results and Simulation

Simulation of PV Array With SEPIC Converter

PV array based on the theoretical concepts explained here. Here PV module has been used to generate DC output using SEPIC converter with MPPT and FLC blocks and DC output wave form given in figure 4.2 and 4.3 and figure 4.1 represents the model of PV system.

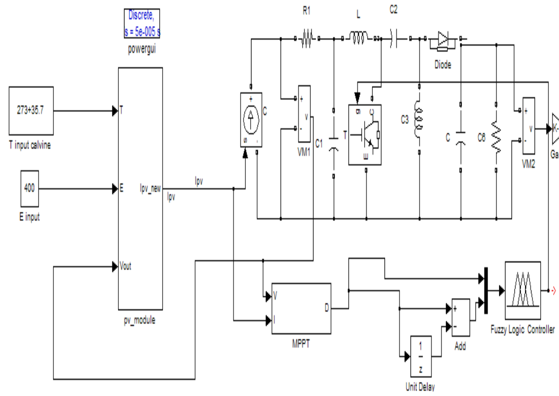

Figure 4.1 MATLAB/SIMULINK Model for PV System

Simulation Results

Figure 4.2 and figure 4.3 shows the output waveform of SEPIC converter and 265 v output observed from the waveform as showing in figure.

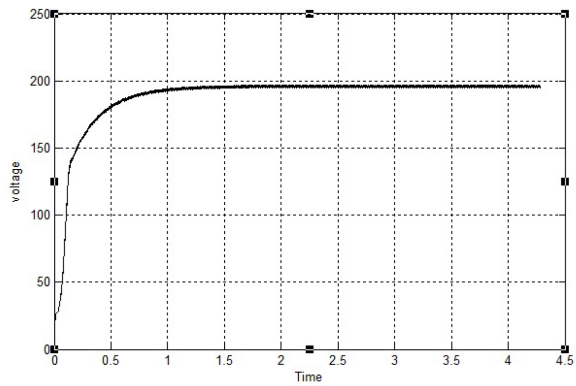

Figure 4.2DC output of SEPIC converter

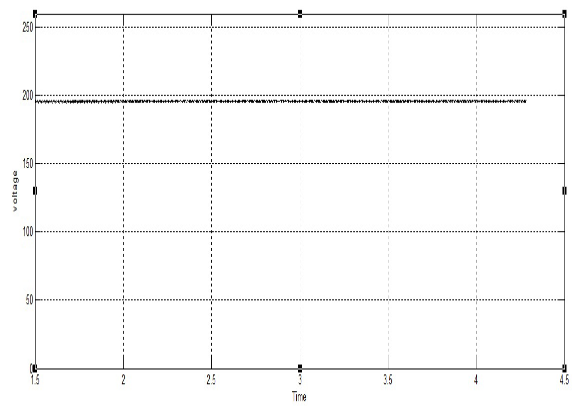

Figure 4.3DC output of SEPIC converter

Simulation of Five Level Inverter

Figure 4.4 shows the MATLAB/SIMULINK model of five level inverter which converts DC to AC and here 1.27% THD value observed which is showing in figure 4.5 .

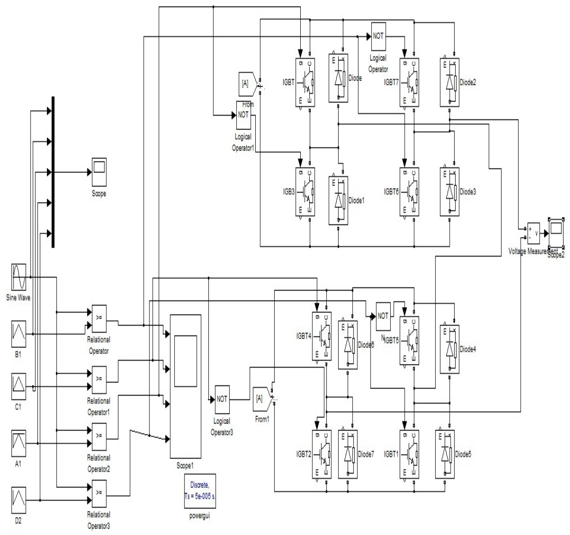

Figure 4.4Five level inverter

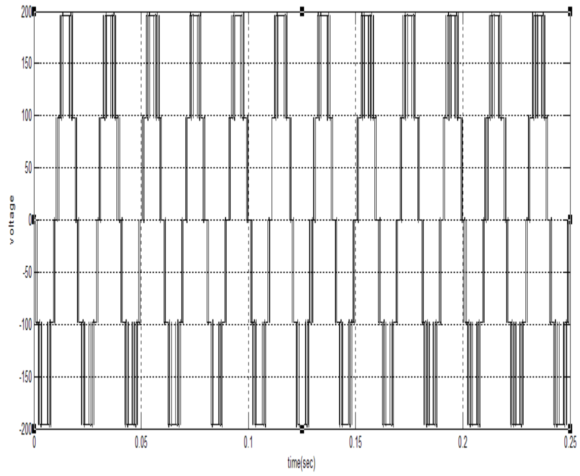

Figure 4.5Multi level inverter output

Comparison of THD

Devices	THD Value
Pv-Module-With-Single-Phase Inverter	4.2%
Pv-Module With Five Level Invrter	1.27%

Conclusion

This proposition has providing a brief summary of PV module with different inverter and their analysis in MATLAB/SIMULINK.

Both types of CUK and SEPIC converters are used to provide either higher or lower output voltage compared to the input voltage. PV panel gives exponential curves for current and voltage where maximum power occurs at the knee of the curve. The functional MPPT uses a method to find out where maximum power happens. Therefore the MPPT uses a method to find out the maximum point this method is known as perturb and observe. Researchers have used PI controller to apply for DC-DC converters as given in the thesis earlier. Many researchers have shown in the previous work that it is very sensitive to parameter variations, weather conditions .Therefore there is need to apply a converter which can be an effective and work under all conditions.Due to the test with power extraction from solar PV systems are addressed already in the thesis. Different array configurations inverter topologies and control algorithm are also discussed. With the Inclusion of multilevel inverters to capture the maximum energy from the individual paths.

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