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Design and Implementation of Sensorless Capacitor Based Three-Level Boost Converter for Photovoltaic System

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Abstract:-Renewable energy sources are pollution free energy sources. They are very useful because of availability, easy to implement, less maintenance and no green house gas emission. Three level boost Converter has an advantage of lower inductor current ripple and lower switch withstanding voltage than the conventional boost Converter. Sensor less Capacitor Voltage Balancing Control method for the three level boost Converter shows that the voltage imbalance can be detected from sensing the inductor current by sampling and hold strategy i,e. it eliminates the need for extra sensors. PV system is normally used with Boost Converter. But these Converters couldn't produce higher voltage gain and these need to operate it at higher duty ratio. In this paper three level Capacitor Clamped boost Converter is proposed. Hence the output voltage is three times greater than the given input. Here higher voltage gain is possible without going for higher duty ratio. Pulse Width Modulation Control technique is implemented. Simulation results and experimental results are also provided to validate the proposed system.

Index Terms*—Pv panel, boost converter Sensorless control, voltage-balancing management.*

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I. INTRODUCTION

To reduce the ability transmission loss and increase the system stability, a lot of and a lot of power-electronics merchandise are forced to incorporate the ability issue correction (PFC)function. Environmental concerns about global warming, fossil fuel exhaustion and the need to reduce carbon dioxide emissions provide the stimulus to seek renewable energy sources. Specifically, solar energy has the advantages of no pollution, low maintenance cost, no installation area limitation and no noise due to the absence of the moving parts. However, high initial capital cost and low energy conversion efficiency had deterred its popularity. Therefore, it is important to reduce the installation cost and to increase the energy conversion efficiency of photovoltaic (PV) arrays and the power conversion efficiency of PV systems.

In High Voltage Power Conversion (HVPC) the multilevel converters are excellent alternatives for engineers and designers when they face with the needs to connect the power semiconductor switches in series. Because in some applications there is not availability of an unique specified semiconductor which can sustaining the desired voltage. The multi-level conversion technique can be applied to either inverter or AC-DC and DC-DC converters, as buck and boost converters, and generalized to any number of switches. In power factor correction applications, by using the three level boost converter two advantages can be highlighted 1) the voltage rating of the power semiconductors is reduced by half of the output voltage 2) the input current ripple is reduced or, for a given ripple, the boost inductor volume and inductance value are decreased.

Photovoltaic is a system which uses one or more solar panels to convert solar energy into electricity. It consists of multiple components including the photovoltaic modules, mechanical - electrical connections, mountings and regulations. For solar cells, a thin semiconductor wafer is specially treated to form an electric field, positive on one side and negative on the other. When light energy strikes the solar cell, electrons are knocked loose from the atoms in the semiconductor material. If electrical conductors are attached to the positive and negative sides, forming an electrical circuit the electrons can be captured in the form of an electric current -i.e. electricity. This electricity can then be used to produce power to the load. PV cell can either be circular or square in construction.

Boost converter is a power converter with an output DC Voltage is greater than its given input voltage. It is the class of switch mode power supply containing semiconductor switch and energy storage element. Three level boost converter produced the output voltage is three times greater than the given input. The inductor voltage in the three-level boost DC/DC converter has three levels, which makes the three-level boosting DC/DC converter to have smaller inductor current ripple than the boost converter under the same switching frequency. Therefore, the three-level boost converters are often used in the high-voltage-ratio applications such as the fuel cell applications and the grid-connected applications. In addition, the high-withstanding-voltage semiconductor switches often have higher cost and the larger drain-source resistances than the low-withstanding-voltage ones. Thus, the three-level boost converter has the additional advantages of the low switching loss and the high efficiency. In addition, the three-level boost converter has the advantages of low inductor current ripple and high efficiency. Therefore, the three-level boost PFC converter is often used in the high output voltage , the photovoltaic system and the wind power system usually speaking, the emission perform include sshaping the ac-side current wave form and control the dc-sidevoltage. because of the characteristics of the continual current, theboost-derived greenhouse emission converters are wide accustomed deliver the goods the desired greenhouse emission perform.

For the standard boost dc/dc convertor, the only switch needs to stand up to the dc output voltage once the only switchblocks.fig2 shows 1, 2 cascaded switches and 2cascaded capacitors area unit connected along within the three-level boosting dc/dc convertor. Once one in all the switches conducts and the different blocks, the block switch must stand up to solely half dc output voltage if each capacitor voltages area unit balanced. If not balanced, one in all the capacitor voltages could also be larger than the breakdown voltage of the switch, which might contribute to make injury to the switch.

It is noted that the electrical device voltage within the three-level boostdc/dc convertor has 3 levels, that makes the three-level boosting dc/dc convertor to own and the standard electrical device voltage equalisation management loop.than the boost convertor below constant change frequency.Therefore, the three-level boost converters area unit typically utilized in the high-voltage-ratio applications like the electric cell applications and also the grid-connected application

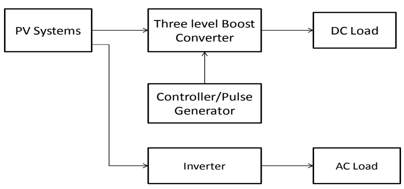


fig.1 Block diagram of the proposed system

In this paper photovoltaic system is used to supply the electricity to consumer unit. Solar panels are an orderly arrangement of solid state photovoltaic cells in series and parallel strings which convert incident solar energy into direct unregulated current. The Fig.1 shows the block diagram of proposed system .The output from the PV panel is dc. Here three level capacitor clamped boost converter is proposed. Boost converter is a power converter with an output DC Voltage is greater than its given input voltage. It is the class of switch mode power supply containing semiconductor switch and energy storage element. Three level boost converter produced the output voltage is three times greater than its input voltage. The dc output from the PV panel given to the three level boost converter. Hence we can achieve the output voltage is three times greater than the given input. Here higher voltage gain is possible without going for higher duty ratio. At the same time the dc output from PV panel is converted into ac power using a inverter. The dc-ac inverter changes dc power from the solar panel to ac power to perform work in ac load. A dc to dc converter can be used if the load is designed for dc power.

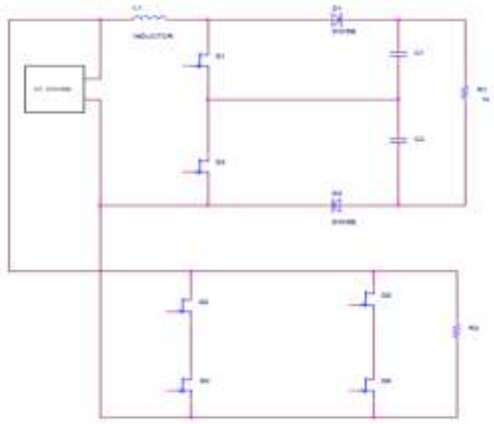


fig.2 Circuit diagram of proposed system

Therefore, the management of the three-level boosting convertor must balance each capacitor voltages.the voltage equalisation control loop for three-level boosting converters will be found.In fact, the opposite voltage equalisation management will be found within thecontrols of the half-bridge greenhouse emission convertor and also the multilevel electrical converter. All the ways got to sense capacitor voltages to discover the voltage imbalance and yield thedesired voltage equalisation perform.One management signal is generated by the multiloop management, and also the different management signal is yielded by CVBC with sensing the capacitor voltages. For the three-level boosting dc/dc convertor, a voltage equalisation management technique with sensing solely electrical device current was initial projected.

In this paper, the concept is extended to the three-level boosting pfc application and also the projected controller is called the sensorless capacitor voltage equalisation management (SCVBC).The voltage imbalance between 2 capacitor voltages is skilfully detected by sensing the capacitor current. The careful analysis and the style rule of the proportion-type voltage balance controller are provided. It follows that sensing individual capacitor voltage isn't needed, and a minimum of one voltage detector is saved. The provided simulation and experimental results show the effectiveness of the projected SCVBC.

II. Sinusoidal Pulse Width Modulation

In the sinusoidal pulse width modulation scheme, as the switch is turned on and off several times during each half-cycle, the width of the pulses is varied to change the output voltage. Lower order harmonics can be eliminated or reduced by selecting the type of modulation for the pulse widths and the number of pulses per half-cycle. Higher order harmonics may increase, these are of concern because they can be eliminated easily by filters. The SPWM aims at generating a sinusoidal inverter output voltage without low-order harmonics.

After sensing each electrical device voltages, the voltage imbalance is detected and also the standard CVBC generates the compensation signal Δvcont . Then, the opposite management signal vcont2 is obtained by adding the compensation signal Δvcont to the managementsignal vcont1. The gate signal GT2 is obtained from the comparison of the management signal vcont2 and also the triangular signals vtri2 .Due to the input electrical device L and 2 diodes D1 and D2 in the three-level boosting greenhouse emission convertor, each switches will be conducting at constant time while not the priority of the shortcircuit damage. As premeditated in Fig. 2, there area unit four changestates within the three-level boosting PFC convertor.

First Stage: SI and S2 switches are on and the inductor current increases. The output current is supplied by C1, and C2 capacitors. Second Stage: In this stage S1 switch is off and S2 switch is on. The input current flows only through the output Vo. If the input voltage is higher than Vo the input current slope is positive, otherwise it is negative. In other words, it can increase or decrease.

Third Stage: The third stage occurs when S1 switch is on and S2 switch is off. The input source is delivering energy to the output . The input current slope is positive

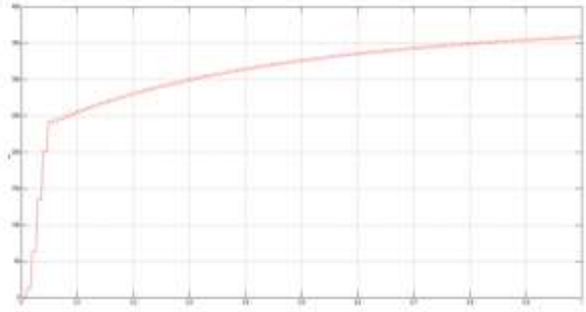
III. SIMULATION

In this section, some simulation results of the three-level boosting convertor area unit provided and also the used parameters area unit tabulated in Table.

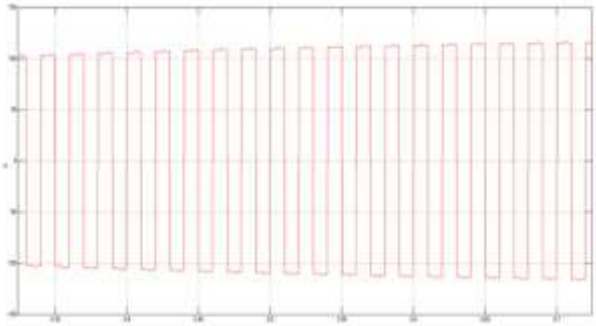
Input voltage	$110V(rms)$, $50Hz$
Output voltage	$V_d^* = 300V$
Inductor	$0.5mH$
Carrier frequency	20kHz
Capacitor	$C_1 = 2240\mu F$, $C_2 = 1410\mu F$ equivalent capacitance $\approx 865\mu F$
Voltage balance parameter	$K_P = 0.05$

fig.3

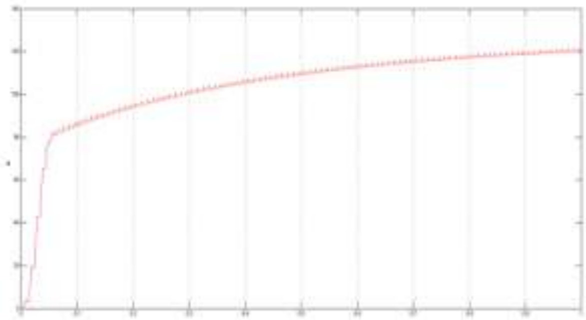
Two mismatched capacitances with C1 = 2240 µF and C2 =1410 µF area unit utilized in the simulation.The capacitance-mismatch condition doesn't seem within the sensible case, however the mismatched conditions area unit useful for the demonstration of theproposed SCVBC.The yielded input currents is area unit curved in part with theinputvoltagevs



INPUT VOLTAGE

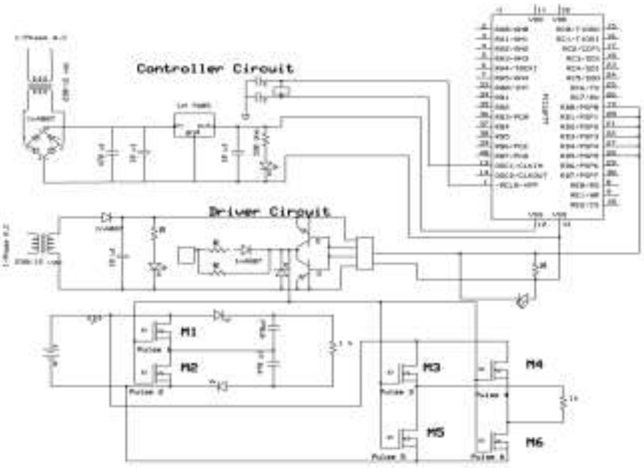


AC OUTPUT VOLTAGE



DC- OUTPUT VOLTAGE

fig.4shows that the projected.SCVBC is ready to discover the voltage imbalance and balance the capacitor voltages.



hardware circuit diagram

fig.5

It is noted that in the transient operation, the difference.ΔIvC becomes positive .once the electrical device voltage vC2 is larger than the opposite electrical device

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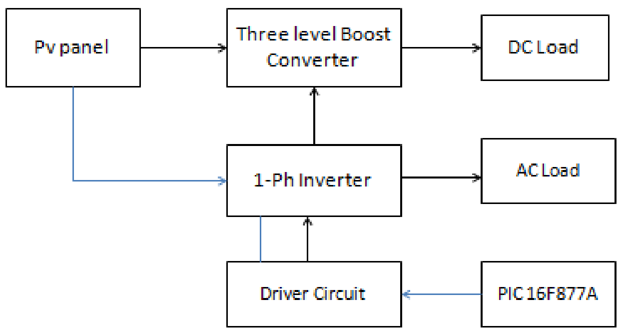
3755 - 3759

voltage vC1 . once the electrical device is removed, both electrical device voltages area unit finally balanced. Obviously,6 the provided simulation results show that the projected SCVBCworks well while not directly sensing the electrical device voltages.. As shown in Figure. 10, two cascaded switches and two cascaded capacitors are connected together in the three-level boosting dc/dc converter. When one of the switches conducts and the other blocks, the blocking switch needs to withstand only half dc output voltage if both capacitor voltages are balanced. If not balanced, one of the capacitor voltages may be larger than the breakdown voltage of the switch, which would contribute to make damage to the switch.

It is noted that the inductor voltage in the three-level boost dc/dc converter has three levels, which makes the three-level boosting dc/dc converter to have smaller inductor current ripple. The three-level boost converter with output load is shown The output voltage Vo is obtained in this converter. An appropriated command signals can regulate the output voltage and minimize the input ripple current. This converter presents three stages of operation which is descripted above:

HARDWARE BLOCK DIAGRAM



IV. EXPERIMENTAL RESULTS

The projected SCVBC had been enforced in associate degree pic controller.Fig. sixteen is that the diagram of the enforced three-level boosting greenhouse emission convertor each output voltage social disease area unit well regulated to three hundred V, and also the input currents is area unit curved in phase with the input voltage vs . though 2 electrical device voltages have voltage ripples as a result of their different capacitance, they have constant average voltage a hundred and fifty V.

DRIVER CIRCUIT:-

It is used to provide 12 to 15 volts to switch the MOSFET Switches of the inverter.Driver amplifies the voltage from microcontroller which is 5volts. Also it has an opto coupler for isolating purpose. So damage to MOSFET is prevented

DRIVER CIRCUIT OPERATION:

The driver circuit forms the most important part of the hardware unit because it acts as the backbone of the inverter because it gives the triggering pulse to the switches in the proper sequence. The diagram given above gives the circuit operation of the driver unit. The driver unit contains the following important units.
Optocoupler,Totem pole,Capacitor
Supply,DiodevResistor

OPTOCOUPLER:

Optocoupler is also termed as optoisolator. Optoisolator a device which contains a optical emitter, such as an LED, neon bulb, or incandescent bulb, and an optical receiving element, such as a resistor that changes resistance with variations in light intensity, or a transistor, diode, or other device that conducts differently when in the presence of light. These devices are used to isolate the control voltage from the controlled circuit.

TRIGEERING CIRCUIT**:**

We are using PIC 16F877A for producing switching pulses to multilevel inverter. so as to use those vectors which do not generate any common mode voltage at the inverter poles. .This eliminates common mode voltageAlso it is used to eliminate capacitor voltage unbalancing. The microcontroller are driven via the driver circuit so as to boost the voltage triggering signal to 9V.To avoid any damage to micro controller due to direct passing of 230V supply to it we provide an isolator in the form of optocoupler in the same driver circuit.
Therefore, the projected SCVBC is ready to balance voltages throughout the load regulation.After connecting a electrical device 100Ω to the electrical device C1, the experimental results area unit shown in Fig. 10 and also the zoomed waveforms area unit premeditated in Fig. 11. The electrical device is removed from the electrical device once zero.1 s.Due to the connected electrical device across the electrical device C1, the capacitor voltage vC1 drops quickly, and at constant time, the other electrical device voltage vC2 rises so as to manage the dcside voltage vd .
The projected SCVBC is developed supported the assumptions of ideal electrical device and ideal capacitors. The provided experimental results show that the projected SCVBC works well within the practical condition of nonzero electrical device resistance and electrical device resistance.

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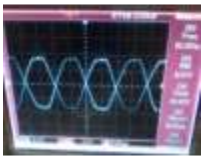
fig6

fig7(a)




fig(b)

V. CONCLUSION

In this paper, the SCVBC method for the three-level boost converter has been proposed. The proposed method shows that the voltage imbalance can be detected from sensing the inductor current by the proposed sampling/hold strategy.It eliminates the need for extra sensors.PV Panel is well utilized in this project.Sinusoidal Pulse Width Modulation Control technique is implemented. Simulation results are also provided to validate the proposed system.

REFERENCES

[1] B. Singh, B. N. Singh, A. Chandra, K. Al-Haddad, A. Pandey, and D. P. Kothari, "A review of single-phase improved power quality ACDC converters," IEEE Trans. Ind. Electron., vol. 50, no. 5, pp. 962–981,Oct. 2003.

[2] J. C. Crebier, B. Revol, and J. P. Ferrieux,"Boost-chopper-derivedgreenhouse emission rectifiers: Interest and reality," IEEE Trans. Ind. Electron., vol. 52, no. 1, pp. 36–45, Feb. 2005.

[3] L. S. Yang, T. J. Liang, H. C. Lee, and J. F. Chen, "Novel high increase DC–DC convertor with coupled-inductor and voltage-doubler circuits,"IEEE Trans. Ind. Electron., vol. 58, no. 9, pp. 4196–4206, Sep. 2011.

[4] A. Shahin, M. Hinaje, J. P. Martin, S. Pierfederici, S. Rael, and B. Davat, "High voltage magnitude relation DC–DC convertor for fuel-cell applications," IEEE Trans. Ind. Electron., vol. 57, no. 12, pp. 3944–3955, Dec. 2010.

[5] M. H. Todorovic, L. Palma, and P. N. Enjeti, "Design of a large input range DC–DC convertor with a strong power management theme appropriate for fuel cell power conversion," IEEE Trans. Ind. Electron., vol. 55, no. 3,pp. 1247–1255, Mar. 2008.

[6] W. Li and X. He, "Review of nonisolated high-step-Up DC/DC convertersin electrical phenomenon grid-connected applications," IEEE Trans. Ind. Electron.,vol. 58, no. 4, pp. 1239–1250, Apr. 2011.

[7] J. M. Kwon, B. H. Kwon, and K. H. Nam,"Three-phase electrical phenomenon system with three-level boosting MPPT management," IEEE Trans. Power lepton.,vol. 23, no. 5, pp. 2319–2327, Sep. 2008.

[8] V. Yaramasu and B.Wu, "Three-level boost convertor primarily based medium voltage megawatt PMSG wind energy conversion systems," in Proc. Energy Convers. Cong. Expo., 2011, pp.