DESIGN OF PV SYSTEM USING DC-DC BOOST CONVERTER INTERFACED WITH FIVE LEVEL MULTILEVEL INVERTER

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Abstract— In this paper, Dual input Dual output DC-DC boost converter is used to interface the solar energy resource with the five level cascaded H-bridge multilevel inverter. The input to the proposed time variant five level multilevel inverter system is obtained from the photovoltaic solar panel. In order to maintain the constant voltage, maximum power point tracking (MPPT) algorithm is used where photovoltaic array(PV).The proposed approach helps in reducing the number of independent dc voltage sources, number of switches, capacitor, inductor and resistor by using dual input dual output boost converter.

*Keywords—*MPPT, (DIDO) boost converter, PV, MLI

1. INTRODUCTION

The non-conventional energy sources are rapidly depleting. Moreover the cost of energy is rising and therefore to choose alternative method is renewable energy source (solar energy. The electrical power is generated by atmospheric condition such as solar irradiation and temperature. Also, due to the intermittent nature of renewable energy sources, a MIMO system is considered such that maximum utilization of energy source is possible. Non isolated multiport DC-DC converters are usually used in electric vehicle applications because the isolated DC-DC converters need a high-frequency transformer. Renewable source can be connected to the power grid only through inverter.

The main aim of the industries is to have less production cost with high efficiency. By increasing the number of levels, the output waveform produced by the inverter will have more steps which are closer to sine waveform. Since the output voltage from the converter is obtained. Multilevel inverter technology has emerged recently as a very important alternative in the area of high-power medium voltage applications. The multilevel inverter has been implemented in various applications, such as motor drives, power conditioning devices, renewable energy generation and distribution. PWM inverters can simultaneously control output voltage and frequency thereby it can reduce the amount of harmonics in output current which results in better THD content.

II. PV MODELLING

The output current from the photovoltaic array is

$$I = I_{sc} - I_D \qquad (1)$$

$$I = I_0 (e^{qv_d / KT} - 1) \qquad (2)$$

Where Io is the reverse saturation current of the diode, q is the electron charge, VD is the voltage across the diode, k is Boltzmann constant (1.38 * 10-19 J/K) and T is the junction temperature in Kelvin (K) from eq. 1 and 2

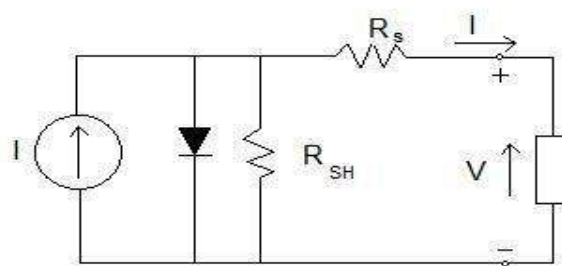$$I = I_{sc} - I_0 (e^{qv_d / KT} - 1) \qquad (3)$$

Fig 1: Single diode model of a PV cell

Using suitable approximations,

$$I = I_{sc} - I_0 \, (e^{(v+IR_s)/nKT} - 1) \qquad (4)$$

The characteristic equation for single diode model is given by

$$I = I_{ph} - I_0 \, (e^{((v+R_s I)/V_t a)} - 1) - (V + R_s I)/R_{sh} \quad (5)$$

A. Incremental Conductance

Incremental conductance method uses two voltage and current sensors to sense the output Voltage and current of the PV array. At MPP the slope of the PV curve is 0.

$$(dP/dV)_{MPP} = d\,(VI)/dV \qquad (6)$$

$$0 = I + V dI/dV_{mpp} \qquad (7)$$

$$dI/dV_{mpp} = -I/V \qquad (8)$$

The left hand side is the instantaneous conductance of the solar panel. When this instantaneous conductance equals the conductance of the solar then MPP is reached. Here we are sensing both the voltage and current simultaneously. Hence the error due to change in irradiance is eliminated. However the complexity and the cost of implementation increases. As we go down the list of algorithms the complexity and the cost of implementation goes on increasing which may be suitable for a highly complicated system. This is the reason that Perturb and Observe and Incremental Conductance method are the most widely used algorithms.
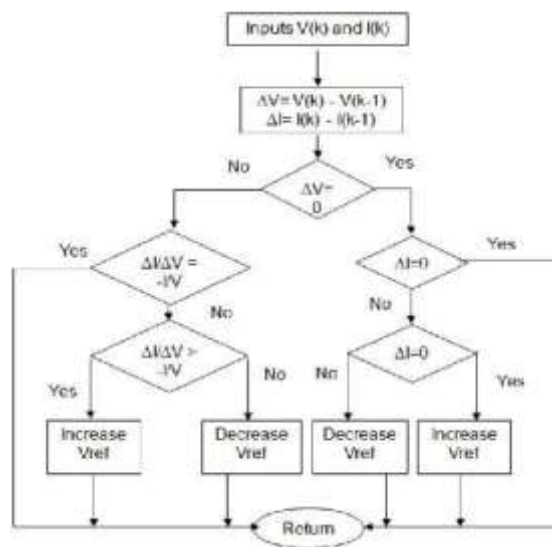

Fig2: Flow chart of incremental conductance

The ratio of change in output conductance is equal to the negative output Conductance Instantaneous conductance. We have,

$$P = VI \qquad (9)$$

Applying the chain rule for the derivative of products yields to

$$\partial P/\partial V = [\partial(VI)]/\partial V \qquad (10)$$

At MPP, as $\partial P/\partial V = 0$ $\qquad (11)$

The above equation could be written in terms of array voltage V and array current I as

$$\partial I/\partial V = -I/V \qquad (12)$$

The MPPT regulates the PWM control signal of the dc – to – dc boost converter until the condition:

$$(\partial I/\partial V) + (I/V) = 0 \text{ is satisfied.}$$

In this method the peak power of the module lies at above 98% of its incremental conductance. The Flow chart of incremental conductance MPPT.

III. CONVERTER MODELLING

A new two output DC/DC converter for non-isolated DC source like photovoltaic system with a single inductor used as a storage element. The proposed converter is suitable to integrate the different DC sources like PV, FC, and battery energy storage system.

The major merits of this topology have required reduced power electronic devices and it can produce two different output voltages at the load. The performance of the proposed two output converter is simulated. Circuit diagram for two input two outputs DC-DC boost converter is shown in Figure 3.

It consists of two input sources Vin1 and Vin2 with the condition Vin1<Vin2 such that the operation can be simplified. It has three switches (S1, S2and S3), three diodes (D0, D1and D2) and two capacitors (C1and C2). Pulses for the switches and voltage and current waveforms of the inductor are shown in Figure 6. According to the switching pattern there are four different modes of operation which are explained in Table 1.
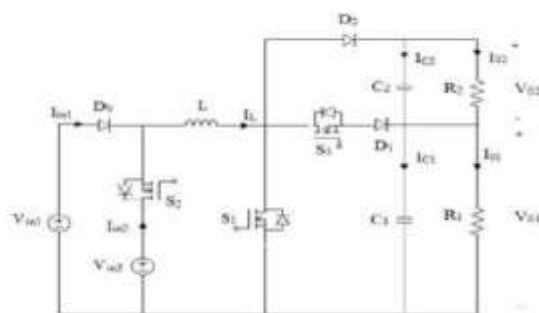

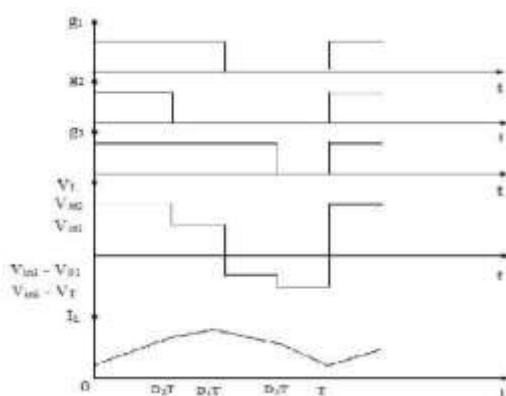Fig 3: Circuit diagram of dual input dual output of a boost converter

Fig 4: Waveform for a boost converter

Table 1: Switching States of Dual input Dual output DC-DC boost converter

Switching state	Interval	S1	S2	S3
1.	0<t<D2T	ON	ON	OFF
2.	D2T<t<D1T	ON	OFF	OFF

| 3. | D1T<t<D3T | OFF | OFF | ON |
| 4. | D3T<t<T | OFF | OFF | OFF |

A. Cascaded H-bridge multilevel inverter

A single phase five level inverter with a dual reference single carrier Pulse Width Modulated (PWM) control scheme is presented. The inverter is capable of producing five levels of output voltage levels (Vdc, Vdc/2, 0, −Vdc/2, −Vdc) from the dc supply voltage. For this, the proposed multilevel inverter needs a single dc voltage source with a series connection of two capacitors, a bidirectional switch formed with four diodes and a switch, and an H-bridge cell. The proposed approach helps in reducing the number of independent dc voltage sources and number of switches as compared with conventional circuits.
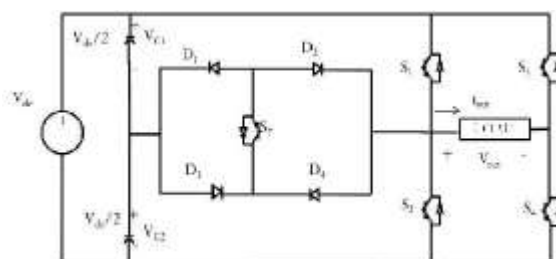

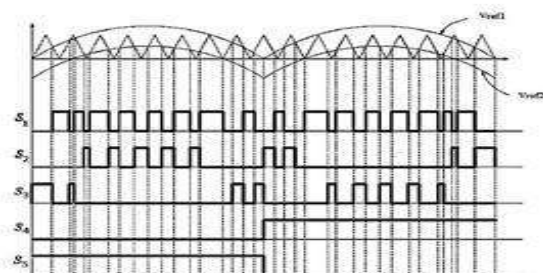Fig 5: Circuit diagram for 5 level cascaded H-bridge

Fig 6: Switching pattern for generating 5-level PWM output voltage

Two reference signals Vref1 and Vref2 will take turns to be compared with the carrier signal at a time. If Vref1 exceeds the peak amplitude of the carrier signal Vcarrier, V ref2 will be compared with the carrier signal until it reaches zero. At this point onwards, Vref1 takes over the comparison process until it exceeds Vcarrier. This will lead to a switching pattern as shown in Fig.3. Switches S1- S3 will be switching at the rate of the carrier signal frequency while S4 and S5 will operate at a frequency equivalent to the fundamental frequency.

IV. RESULT ANALYSIS SIMULATION AND DISCUSSION

DC (DIDO) boost converter interfaces of panel and multilevel inverter. The performance is analyzed and the graph are plotted between voltage and current on both load and inverter side. FFT analysis is done for total harmonics distortion.
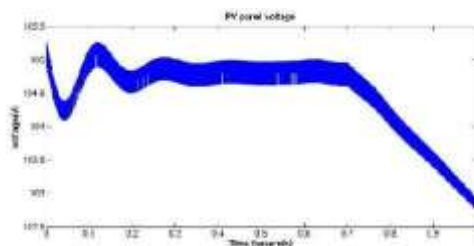

Fig 7: simulation result obtained on PV panel waveform (Voltage V)

The simulation result obtained on PV panel side to reach expected voltage to depends on irradiance value as shown in fig 7
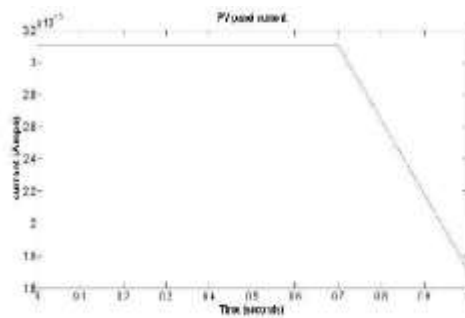

Fig 8: simulation result obtained on PV panel waveform (current amps)

The simulation result obtained on PV panel side to reach expected current to depends on irradiance value as shown in fig 8.
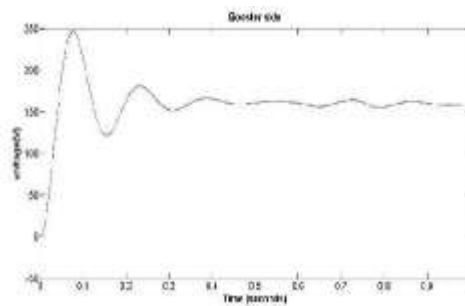

Fig 9: simulation result obtained on boost side

(V01)

The simulation result obtained on booster side to reach the DC high step voltage (V01) waveform as shown in fig 9.
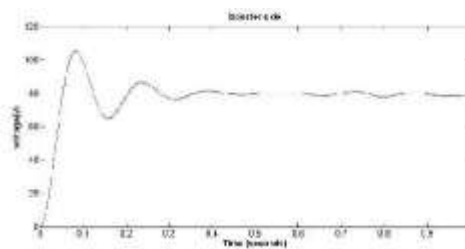

Fig 10: simulation result obtained on boost side (V02)The simulation result obtained on booster side to reach the DC high step voltage (V02).
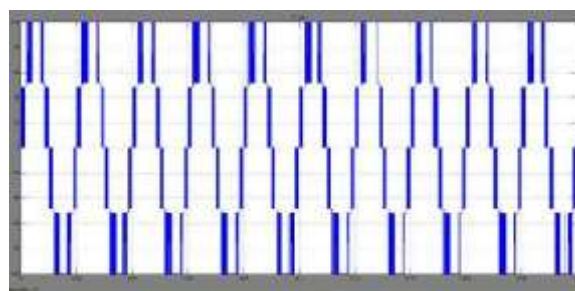

Fig 11: simulation of result obtained on multilevel inverter(voltage waveform)
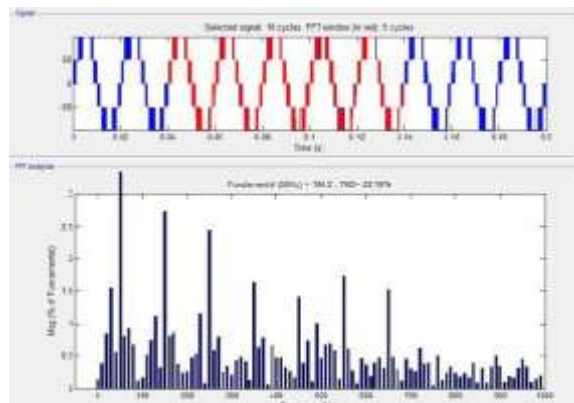
Fig 12: Result obtained is FFT analysis

CONCLUSIONS

Asymmetric CHB-MLI fed from MIMO DC-DC boost converter using PV panel as one of its source has been proposed in this project work. The various analytical equations governing the PV cell are modelled and simulated. MPPT algorithm for PV model is developed to improve the efficiency of the system. Using two input two outputs DC-DC boost converter two different energy sources have been combined by which two different output voltages are produced. Its different modes of operation, steady state and dynamic characteristics have been studied.

In future work, Photovoltaic panel efficiency to be increases, to reduce the harmonics in distorted condition by using increases a level of inverter and improve the dynamic performance in photovoltaic inverter.

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