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SIMPLIFIED TRANSFORMER BASED MULTILEVEL INVERTER TOPOLOGY FOR RENEWABLE ENERGY APPLICATIONS

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ABSTRACT- As renewable energy sources are playing an important role in development of grid and reducing the pollution of environment but it is polluting the electric power. There are number of power quality issues which are introduced in system due use of switching devices. The renewable energy sources are associated with fundamental framework with the assistance of force electronic gadgets. Also, power hardware gadgets impacts as force quality issues. Consequently to limit the force quality issues happening because of general inverter geography can be diminished utilizing progressed geographies of staggered inverter. This work focuses on developing a nine level inverter having a single transformer and reduced component numbers. An optimization of the number of transformers and their turns ratio for a given number of voltage levels resulting in the least number of switches is analysed by designing hardware.

Index Terms- Multilevel inverter, Renewable energy sources etc,

I. INTRODUCTION

In this era use of renewable energy is increasing and also integration of these micro sources with main grid is also increasing. Due to advancement in power electronics controller, it is easy to integrate microsources with grid which can provide eliable and efficient operation. Hence microsources are get integrated with main grid with help of inverter. Inverter is device which converts DC to AC. Mostly VSI are used in RES because these inverters are easy to control than that of CSI. The utilization of more force gadgets prompts more force quality issues in power framework. Inexhaustible and non-sustainable power sources are the energy sources that human uses everyday life. The contrast between these two is inexhaustible assets can normally recharge themselves while non sustainable can't. It implies that non environmentally friendly power sources are restricted and can't be utilized reasonably. The instances of environmentally friendly power sources are sun oriented energy, wind energy, hydro energy, flowing energy, geothermal energy and biomass energy. Among which sun based photovoltic and wind power age are more well known and it is seen that there is development from most recent couple of years. Energies from these sources can meet local energy demands and also improve the environmental loss. The power electronic converter play a very important role as an linkage between renewable energy sources and power grid. The two level inverter is one of the power processor used as integrator. These conventional two level inverters have some limitations in operating at high frequency pulse width modulation(PWM), filtering efforts and electromagnetic interface(EMI) issues. The problem resolved by means of multilevel inverters(MLIs). Nabae el al proposed the the first MLI Three level configuration. Capability to generate output voltage with low harmonic distortion, (dv/dt) stress, smaller common mode voltage and lower EMI are the main advantages of MLI. These advantages play very important role in the application of MLI for HVDC transmission, wind energy, railway traction, pumps, mining and fans. Neutral point clamped (NPC) MLI or diode clamped, capacitor clamped or flying capacitor (FC) MLI and cascaded H-bridge(CHB) MLI are the main topologies of MLI. Each one has its own advantage and disadvantage. To increase the voltage level NPC MLI requires to add higher number of clamping diodes.

II. IDENTIFY, RESEARCH AND COLLECT IDEA

Renewable Energy Sources and Overview:- The use of renewable energy sources (RESs) increases worldwide, there is an increase in interest on their impacts on power system operation and control. The issues and new difficulties on recurrence guideline identified with the combination of environmentally friendly power units into the force frameworks are talked about. There is an effect of force change created by factor inexhaustible sources on framework recurrence execution [1]. Wind energy is the most cutting edge innovation due to its installed power capacity and the recent improvements of the power electronics and control technology[2][3]. Management of DG unit capabilities should be used also to help manage the local distribution grids and the production/transmission system [8].

Multilevel Inverter and Issues:- The multilevel voltage source converters gives the staircase voltage wave from several levels of dc capacitor voltages. One of the major limitations of the multilevel converters is the voltage unbalance between different levels. The techniques to balance the voltage between different levels normally involve voltage clamping or capacitor charge control [4]. Pulse width modulation (PWM) techniques are developed for inverters to reduce the magnitude of the harmonics and to control the fundamental component of output voltage[5]. Multilevel converters have reached a certain level of maturity, given their industrial presence and successful practical application [6][7][9]. Rule based fuzzy logic controller can be used control the output power of a Pulse Width Modulated (PWM) inverter used in a Stand Alone Wind Energy Conversion Scheme (SAWECS) [10][11]. Emerging Grid Code proposals for wind farm connection will, of necessity, become increasingly demanding of the performance of connected wind farms with respect to voltage control capability, reactive range capability, active frequency ability, and fault ride through capability [12] . Adjustable speed drives (ASDs) are still an emerging technology pushed by the evolution in power electronic components and microprocessors [13]. Grid connection of renewable energy sources is essential it creates problems of voltage fluctuation and harmonic distortion [14][15]. The design of large induction motor drives with low torque ripple and fast dynamic response for latest applications are limited by the device ratings and problems of series connections [17][18]. Use of Microprocessors eliminate the need of PWM techniques which are easily implemented with hardware for inverter control [19]. The important topologies are as diode clamped inverter, capacitor clamped[20][21].

III. WRITE DOWN YOUR STUDIES AND FINDINGS

The electric energy demand is constantly increasing in world, and conventional energy resources are diminishing and are even threatened to be depleted. This is the reason that their prices are rising. So, the need for alternative energy sources has become necessary, and solar

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energy has proved to be a very useful alternative because of its availability and pollution-free nature. Due to the increase in efficiencies and decreasing cost of photovoltaic cells and the improvement of the switching innovation utilized for power transformation we are attempting to plan an inverter controlled by PV boards and that could supply independent AC loads. Sunlight powered chargers give direct inventory (DC), and to interface these boards to the primary framework or to use for other modern applications, we wanted an AC yield at a specific required voltage level and recurrence. The change from DC to AC is basically refined through a DC to AC inverter, which is the significant part in the framework. The yield of the solar system is not constant continuously and it is dependent on instantaneous sunlight intensity and ambient temperature

A. Proposed Inverter Topology

The circuit consist of two isolated dc sources, one transformer, four unidirectional devices and two bidirectional devices as shown in Fig. 3.1. The transformation ratio N2/N1 of the transformer is defined as n1. The output voltage is the summation of the voltage across the secondary winding of the transformer and the switched voltage at the terminal Va with respect to the dc link mid point. The output voltage is the summation of the voltage across the secondary winding of the transformer and the switched voltage

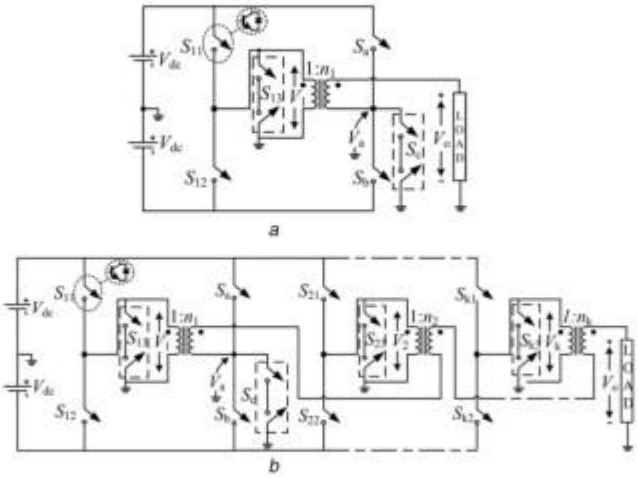

Figure 1: Circuit of Proposed MLI

V_a with respect to the dc link mid point. The recommended approach to expand the proposed 9L a topology to a higher number of voltage levels is discussed here. It is important that two unidirectional switches S_k1 and S_k2 , one bidirectional switch S and one transformer with a transformation ratio of n to has to be added at every stage of addition such that (k = 1, 2, 3, K), where K is the number k of transformers added in the process of extension including the initial one. The secondary windings of all the transformers are connected in series following the convention of additive polarity. With V being the pole voltage of the second leg. The output voltage can be given as,

$$V_0 = n_1V_1 + n_2V_2 + \cdots + n_kV_k + V_a.$$

B. Operating modes of proposed inverter topology.

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Various switching combinations generate different output voltage levels. In figure among switches S_{11}, S_{12} and S, only one at a particular instant should be ON to avoidthe shoot through and the same applies for switches S_a, S_b and S_c. The one and only purpose of connecting a bidirectional switch across the transformer winding is to ensurethat the transformed voltage is of zero value, which is required in generating specific levels of the output voltage. Depending on the selection of the value of n, the resultant output voltage can have a maximum of nine levels in it. The number of voltage levels

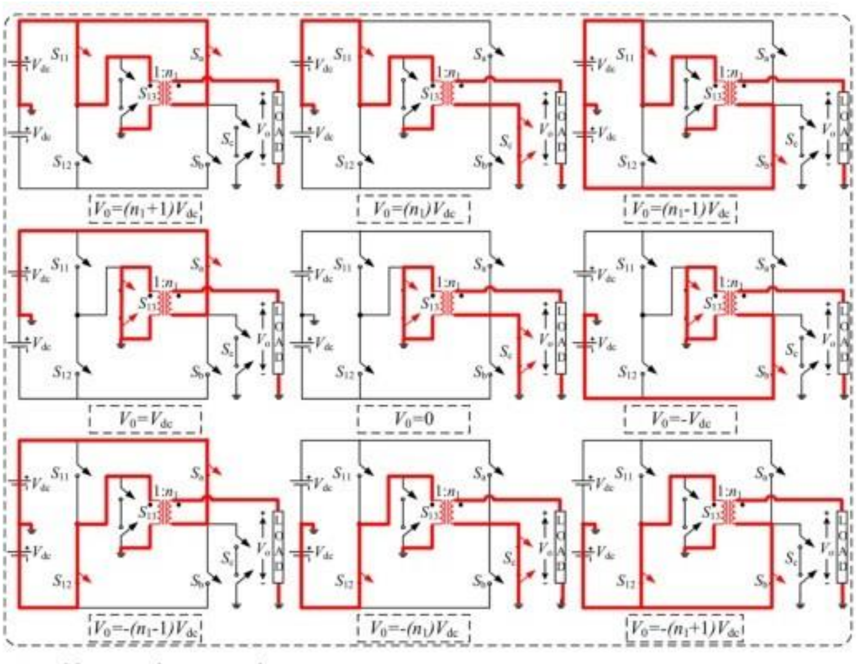

Figure 2: Modes of operation of the proposed inverter topology

N_L for a given number of transformers p is given by, Number of power switches and gate drivers are as,

$$N_L = 3^{p+1}$$

$$N_{SW} = 4_P + 4$$

$$N_{GD} = 3\,(p + 1)$$

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As to voltage stress of the switches, it is the most extreme voltage across the switch when it is OFF. Here, all bidirectional switches need to impede a voltage of size V , and the excess changes need to hinder a voltage of greatness 2V dc. The complete hindering voltage for the proposed geography can be communicated as far as the quantity of transformers dc and is communicated as V pressure, m = 6(p + 1)V dc where, V is the maximum blocking voltage for given number of transformers p and for p equals to one, the maximum blocking voltage is equal to 12 V dc stress.

The figure showing the various operating modes giving the current path

Table 1: Switching States of the Proposed Topology

V_0	S_{11}	S_{12}	S_{13}	S_a	S_b	S_c
$(n_1+1)V_{dc}$	1	0	0	1	0	0
n_1V_{dc}	1	0	0	0	0	1
$(n_1-1)V_{dc}$	1	0	0	0	1	0
V_{dc}	0	0	1	1	0	0
0	0	0	1	0	0	1
$-V_{dc}$	0	0	1	0	1	0
$-(n_1-1)V_{dc}$	0	1	0	1	0	0
n_1V_{dc}	0	1	0	0	0	1
$-(N_1+1)V_{dc}$	0	1	0	0	1	0

There are the modes of operations to generate voltage levels in the positive half cycle of output voltage V. Table 1 gives the list ofthe switching combination for the nine output voltage levels and the various operating modes are given as follows:

Mode 0: Switch S_{13} is ON resulting in the application of zero voltage across the primary, and therefore the voltage across the secondary winding of the transformer is zero. Switch S is ON, i.e V_a is 0.

Mode 1: Switch S_{13} is ON resulting in the application of zero voltage across the primary, and therefore the voltage across the secondary winding of the transformer is zero. Switch S is ON connecting terminal marked V_a to V_{dc} so it can be given as $V_a = V_{dc}$.

Mode 2: Switch S_{11} is ON, hence $V_1 = V_{dc}$ resulting in a voltage of n_1V_{dc} across the sec- ondary of the transformer and switch S_b is ON connecting terminal marked V_a to V_{dc}. Now it can be given as, $V_0 = (n_1 - 1)V_{dc}$.

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Mode 3: Switch S_{11} is ON, $V_1 = V_{dc}$ resulting in a voltage of n_1V_{dc} across the secondary of the transformer and switch S_c is ON to produce zero voltage at terminal marked V_a . the voltage can be given as, n_1V_{dc}.

Mode 4: Switch S_{11} is ON, $V_1 = V_{dc}$ resulting in a voltage of n_1V_{dc} across the secondary of the transformer and switch S_a is ON connecting V_a to V_{dc}, Hence it can be givenas,

$$V_0 = (n_1 + 1)V_{dc}.$$

IV. USE OF SIMULATION SOFTWARE

The simulation has been done in MATLAB. The circuits used for the simulation of 9L and 27L are same ,PDSPWM strategy is employed for generation of signals for both the proposed inverter structure and its extended structure. For a 27L output voltage, two transformers are necessary. For an info voltage of 15 V, 9L and 27L yield voltage just as burden current scaled by a factor of three, individually. The 9L yield voltage has a pinnacle abundancy of 60 V and is made out of nine equivalent advances. The 27L yield voltage has a pinnacle abundancy of 195 V and is made out of 27 equivalent advances. It is to be noted that owing to the turns ratio of the transformer, the output voltage is boosted by a factor of 4 and 13, respectively. c illustrates the voltage across the secondary winding of the transformer as well as the voltage v_a.

It can be observed that owing to the symmetric nature of the voltage applied to the transformer, it a is not subjected to any saturation due to dc offset. DC offsetis mean amplitude displacement from zero. The offset of the waveform is away from the centre zero point. DC offset is source of distortion. Further, Fig.shows the percentage power loss (conduction, switching, and total losses) among the switches for

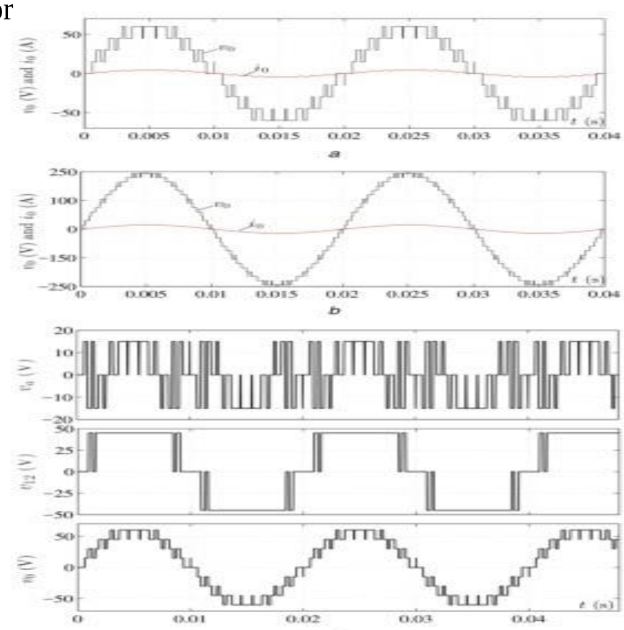

Figure 3: Simulation results

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Figure: Simulation results, (a) 9L output voltage and load current of the proposed topology, (b) 27L output voltage and load current of the proposed topology, (c) Voltages across various ports of the proposed 9L topology

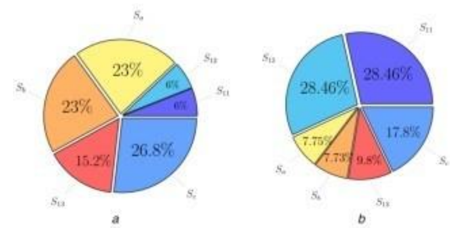

Figure 4: Percentage of Power Loss

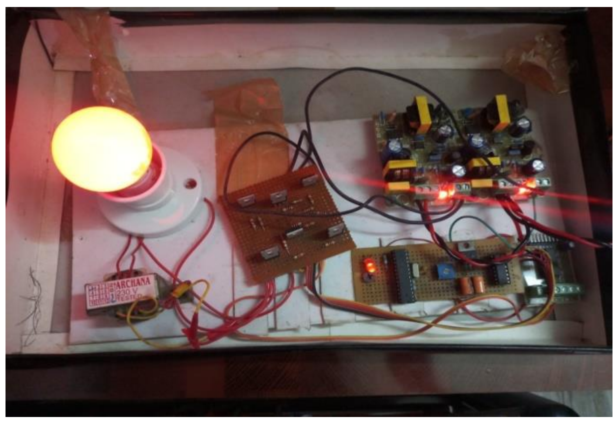

Figure 5: Experimental prototype

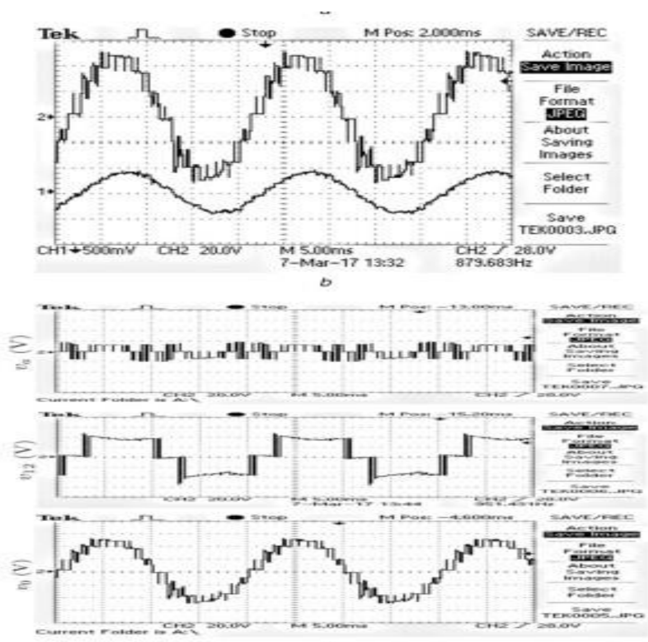

Figure 6 : Experimental Results

V. CONCLUSION

For 9L operation, two dc sources and a single transformer is required. For generating gating signals, a simplified logic gate based PDSPWM strategy is developed. The optimal configuration of the proposed topology for a base number of switches can be dictated by utilizing a calculation. A near investigation of the proposed geography is done with different geographies like the quantity of switches, transformers, on state switches and entryway driver circuits needed for a given degree of yield voltage. After examination the proposed topology is found better among all other topologies. The feasibility of the proposed inverter is validated through simulation and experimental results making proposed configurations a viable alternative with improved voltage waveform quality.

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