GRID CONNECTED REDUCED SWITCH 7 LEVEL INVERTER BY MODEL PREDICTIVE CONTROL

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Abstract: Multilevel inverter's (MLI's) has been considered as the primary choice for most of the industrial applications because of its reliabilityand high power handling capability. In this paper, model predictive control has employed to guess the future values of load current by referring all the possible voltage vectors delivered by the inverter . Discrete-time model of the system is utilized to achieve the above mentioned function. The voltage vector by which the quality function is minimized, is selected. Then the usage of switch state deduced that obtained by the selected voltage vector is used to control the next output voltage of the inverter. This model is easy to implement and it has the ability to overcome the drawbacks of conventional control techniques that are applied to the MLI's. The result conveys that the model predictive control can effectively controls the load current and this system functions well.

Keywords – multilevel inverter; model predictive control; tracking performance

I. INTRODUCTION

Because of the vast usage of the fossil fuels, there is a sharp decrement in the availability of fossil fuel resources. To meet the day-to-day requirements of electricity, it's time to shift to the renewable energy sources. With the advancements in solar energy, the control techniques of grid connected inverters has been deploying from the few years. In order to obtain the above mentioned features , a multilevel inverter with minimum number of switches can be implemented to get a smooth sine wave . MLI's is widely used in high power applications such as large induction drive , UPS systems and FACTS systems.

Required output will be obtained from several levelof dc links that are used in the circuit .Most commonly there are three differenttypes of multilevel inverter topologies [1]-[2] used and they are Diode-clamped MLI's,Flying capacitorMLI's and Cascaded H-Bridge

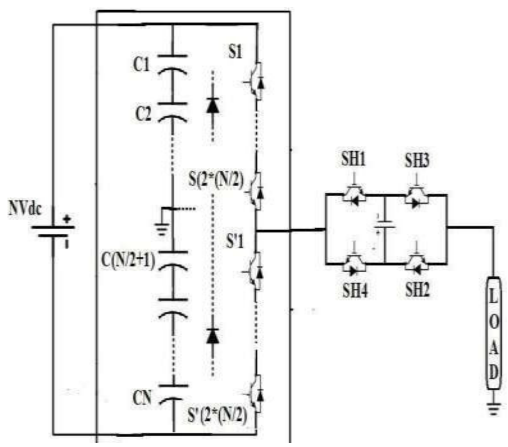

Fig1.Diode Clamped Multilevel Inverter DC-MLI

MLI's. Basically, three control techniques are available for controlling the grid connected multilevel inverters and those are Carrier wave comparison technique, Hysteresis loop control technique and predictive control technique. The widely used technique is the carrier wave comparison control, which tracks the output current by using a PI Controller [3]. But, it fails in reducing the steady-state error between the target current and the original current. The simplest control technique is the hysteresis loop control technique and it has the advantage of having good robustness [4]-[6], but it has high ripple content in the output current, which may increase the losses and thereby reducing the efficiency of the system. The another major

drawback is the unstable switching frequency. Model Predictive control is the main branch of Predictive control techniques. A model has to be established for the system in MPC [7]-[12]. Depending upon the designed model, the upcoming values of the variables can be predicted. Based on the comparison of the predicted values and the required reference values, the control action atthis present moment will be taken. MPC structure is very simple for designing and modelling. Predictive control mode can be implemented on adigital signal processor and its output has small distortions in the current and harmonics are minimized.

II. DIODE CLAMPED MULTILEVEL INVERTERS

The most common multilevel architecture was introduced in 1975 and uses diode-clamped inverters. A diode serves as the clamping device in DC-MLI, which steps the output voltage by clamping the dc bus voltage. The primary concept behind the inverter is to employ diodes to minimize the voltage stress on the power elelctronic elements. A Vdc voltage is applied to each capacitor and switch. The number of shifting elements required are 2*(m-1), diodes are (m-2)*(m-1), and voltage sources are necessary for a m level inverter (m-1). As the number of output voltage levels increase, the voltage waveform grows closer to a sinusoidal waveform and the output voltage quality improves.

III. SUGGESTED TOPOLOGY

A DC-MLI is a popular type of multilevel structure that uses diodes to clamp a component to the voltage of a dc bus to produce voltage steps in the output voltage waveform. The output voltage level determines the number of components required in all types of multilevel inverter. Fig.1 proposed new single-phase topology

When more power switches are added to the inverter circuit, the price, control complexity, size, and the area for set up also increase. To providea wide range of output levels while minimising the number of switches, the envisaged multilevel inverter employs an innovative power generating schematic diagram and an appropriate method to detect the level of the dc voltage source.

Figure 1 depicts the basic component of the recommended multilevel inverter.

The new configuration is as shown in Fig.1. The variety of different output voltage levels can be calculated by using the following equation. as in the shown MLI:

$NLevels\ = 2N + 3$ (1)

Where N is the number of voltage levels.

The following equation represents the single phase maximum output voltage (Vomax).

V_{0max} $\frac{(N+1)}{2} V_{dc}$ (2)

In this new configuration , the beiow equations gives the number of switches and diodes required,

$N_{Switches}$=2N+4 (3)

$N_{Clampikg\ diodes}$=N(N-1) (4)

IV. MODULATION STRATEGY

Model Predictive control is the main branch of Predictive control techniques. A model has to be established for the system in MPC [7]-[12]. Depending upon the designed model, the upcoming values of the variables can be predicted. Based on the comparison of the predicted values and the required reference values, the control action at this present moment will be taken. MPC structure is very simple for designing and modelling. Adaptive control mode can be implemented on a digital signal processor, and its output has small deviations in current, reducing harmonics. It uses the toggle states deduced from the selected voltage vectors to control the next output values.

This control technique can be described as follows:

1.A model for the inverter output voltage vector has to be built.
2.A model for the load current has to design.3.Quality function G has to be defined.

V. SIMULATION RESULTS

A model focused on the proposed architecture is simulated in order to confirm that the offered multilevel inverter produces an appropriate waveform of output voltage. Software called Matlab Simulink power blockset was used for the simulation. A seven-level staircase waveform with a frequency of 50 Hz is produced using the proposed multilevel in Figure 2. The following settings were used to test the filter in use: C = 10 f, L = 0.5 mH, and a load of 25 ohm.

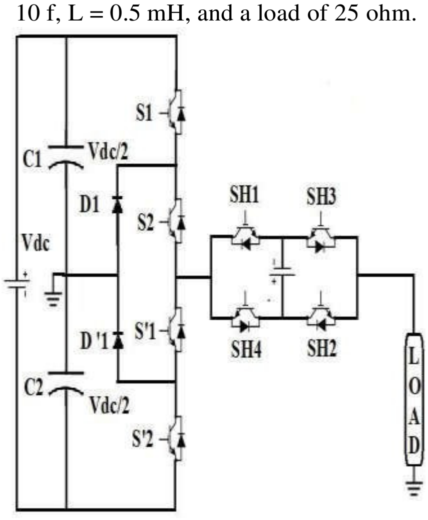

Fig2Single-phase seven-level inverter

Table.1 Switching states of inverter

V0

Switches	1.5 VdC	1 Vdc	0.5 Vdc	0	-0.5 Vdc	-1 Vdc	-1.5 Vdc
s1	ON	ON	OFF	OFF	OFF	OFF	OFF
S2	ON	ON	ON	ON	ON	OFF	ON
S'1	OFF	OFF	ON	ON	ON	ON	ON
S'2	OFF	OFF	OFF	OFF	OFF	ON	OFF
SH1	ON	ON	ON	ON	OFF	OFF	OFF
SH2	ON	OFF	ON	OFF	OFF	ON	OFF
SH3	OFF	ON	OFF	ON	ON	OFF	ON
SH4	OFF	OFF	OFF	OFF	ON	ON	ON

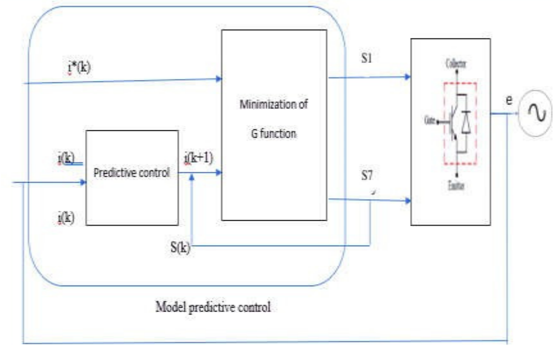

Fig.3 Schematic representation of Model predictive control

The model predictive control block diagram is shown in Figure 3.The following steps has to be followed for obtaining the model predictive control:

1. The measured value of load current is i(k), and the reference value of load current is i*(k).
2. Model predictive control of load current is employed to calculate all possible output current values for future values.
3. A correlation must be carried out to identify the switching states with the smallest quality function values.Figure 4 shows the connventional simulation model of 7-level inverter,which has more number of switches

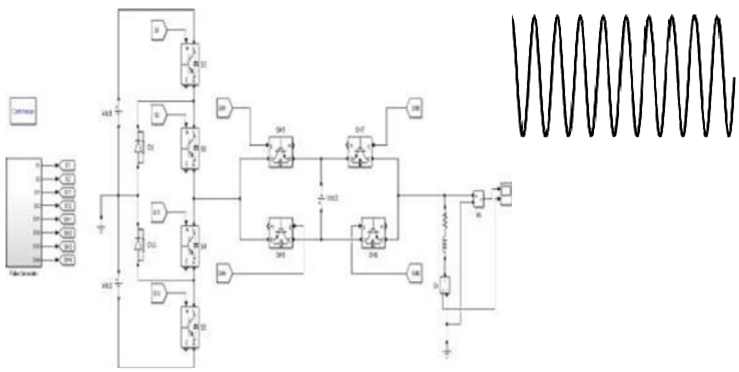

Fig.4 Conventional simulation model of 7-level inverter

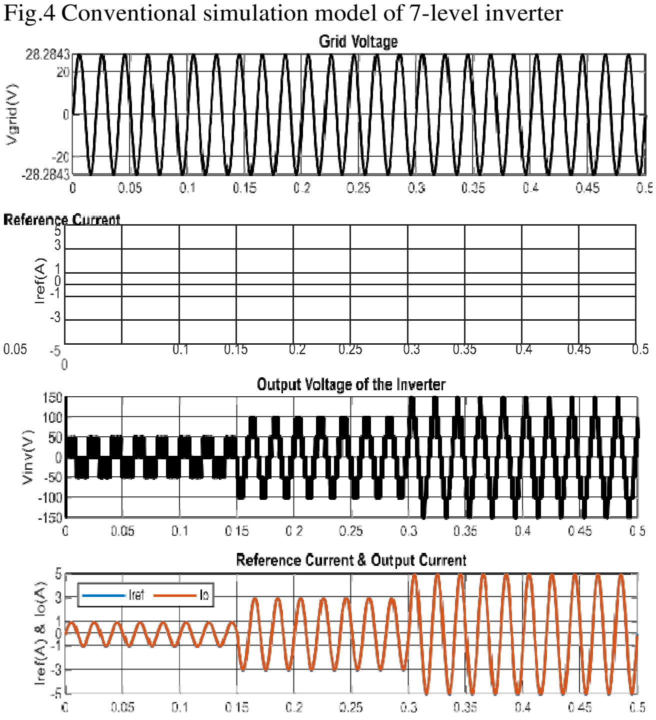

Fig.5 Output waveforms of proposed model by using MPC.With the model predictive control technique, desired output can be obtained as showm in fig.5 .

Figure 6,7 and 8 shows the total harmonic distortion of the load current.

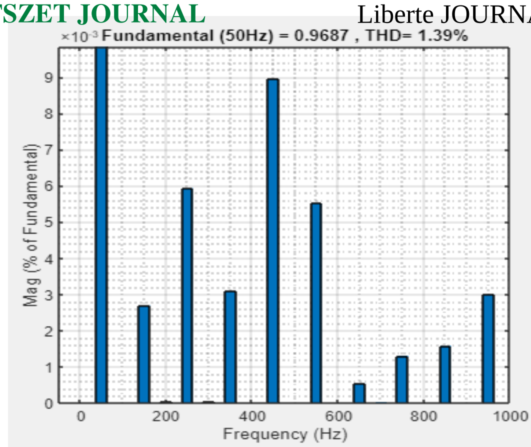

Fig.6 THD with i*(k)=1A

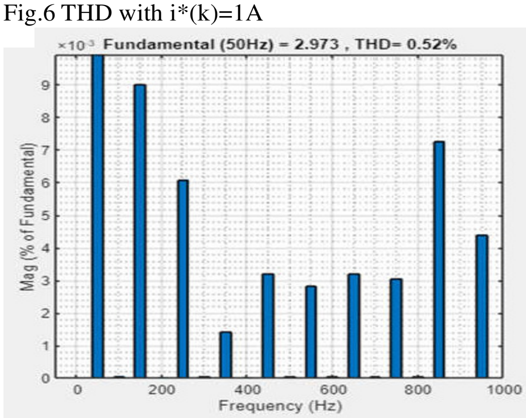

Fig.7 THD with i*(k)=3A

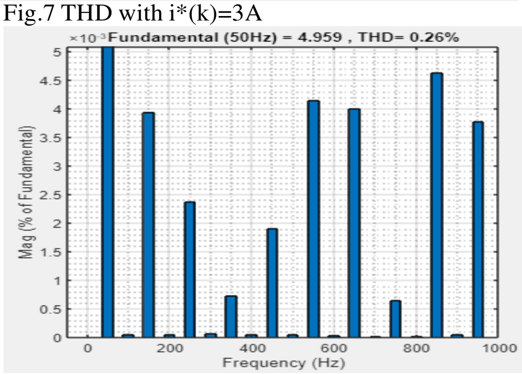

Fig.8 THD with i*(k)=5A

From figures 6,7 and 8,the harmonic content will gets reduced with increase in reference current values.

V. Synopsis

This work proposes a novel multilevel inverter topology that require fewer switches. The multilevel inverter's action is clearly outlined. The proposed topology and recently disclosed topologies with three and four dc voltage sources were thoroughly compared. The topology was investigated using MATLAB/Simulink. The simulation results are also shown to demonstrate how effective the proposed model is. The FFT Analysis is advantageous to the paper because it has a lower Total Harmonic Distortion (THD) As a result, circuit complexity is reduced while system effectiveness is increased.

The recommended circuit would be very reliable and have minimal conduction losses due to its modest component count.REFERENCES

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