

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & MANAGEMENT DESIGN & ANALYSIS OF MULTILEVEL INVERTERS FOR ENHANCEMENT OF POWER QUALITY IN PV/WIND HYBRID ENERGY SYSTEM

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Abstract

Multilevel inverters are power electronic device which converts DC power to AC power at required voltage and frequency. Now a day's Multilevel inverter demand is increased for high voltage high power application. Renewable energy sources uses in large area for generation of electrical power at present time. Availability of renewable energy is very unpredictable because its availability changes with time. Conventional inverter not fulfills a requirement of renewable energy sources application due to its unpredictable availability. So, multilevel inverters are uses for renewable energy sources application. Switching losses and total harmonic distortion reduces with increases number of levels in multilevel inverter. This paper presents cascaded H-bridge multilevel inverter topology for hybrid renewable energy sources in MATLAB/Simulink environment. Cascaded H-bridge multilevel topology shows a total harmonic distortion reduces after increasing number of levels. Simulation of five level, nine level and fifteen level perform in this paper and analysis their result.

Keywords – Multilevel inverter, Renewable energy sources, Total harmonic distortion.

Introduction

Electricity demand increases with time in the world and non-renewable energy sources not fulfill total electricity demand. Renewable energy sources fulfill remaining electricity demands [1]. Solar energy generated power in form of DC and wind generator generates power in AC but first they convert AC to DC with help of rectifier and then convert DC to AC with help of inverter for matching frequency [2]. Conventional inverters convert power from DC to AC but they have higher switching losses and total harmonic distortion [3][4]. To reduce switching losses and total harmonic distortion in output voltage, multilevel inverters uses in place of conventional inverter. Losses of output voltage are reduced by obtaining staircase waveform in output voltage [5]. Array of power semiconductors and DC voltage sources are composed in multilevel inverter. Multilevel inverter generates output voltage in stepped stair case waveform. Different DC levels supported by series connected batteries form a voltage output waveform [6]. Steps in output waveform increases by number of levels increases in multilevel inverter. A fine stair case stepped waveform produces and approach to towards desired sine waveform by increasing number of levels [7]. Advantages of multilevel inverter over conventional inverter are reduces total harmonic distortion, improve voltage output waveform, reduces voltage stress on device and also reduces electromagnetic interference problem [8][9].

Topology is basic need of any multilevel inverter for their power rating, operation, efficiency and application. Common topologies used for multilevel inverter are Cascaded H-bridge multilevel inverter, Diode clamped multilevel inverter and Flying capacitor multilevel inverter [10]. Combining of these topologies also forms hybrid multilevel topologies [10][11]. Renewable energy sources are easily interfaced with multilevel inverter topologies. This paper proposes a five, nine and fifteen level multilevel inverter in cascaded multilevel inverter topology. Cascaded multilevel inverter consist of H-bridge in series for getting output voltage in stair case waveform and which is very closed to desired sinusoidal waveform. Number of voltage levels in cascaded H-bridge multilevel inverter are $2n+1$, where n is the number of DC sources [12][13]. Cascaded H-bridge multilevel inverter chooses switching angles in such a way that minimum total harmonic distortion is obtained. The proposed multilevel inverter topology implemented in three phase by pulse width modulation techniques. PWM technique is most effective method to control voltage output waveform [14][15]. This paper tries to prove that total harmonic distortion value decreases with respect to number of level increases in cascaded multilevel inverter for hybrid renewable energy sources.

SIMULINK MODEL OF CASCADED H-BRIDGE MULTILEVEL INVERTE

Cascade H-bridge multilevel inverter models are developed by using simulink environment. Five level inverter have two number of H-bridges connected in series. Twelve pulse generating units for feeding pulses in eight switches per phase. Similarly four and seven number of H-bridges is connected in cascaded manner for nine and fifteen level inverters. Twenty four and forty two pulse generating units for pulse feeding in sixteen and twenty eight switches per phase in nine and fifteen level inverters. Simulink model of nine and fifteen level cascaded H-bridge multilevel inverter shown in fig. 2 and fig. 3.

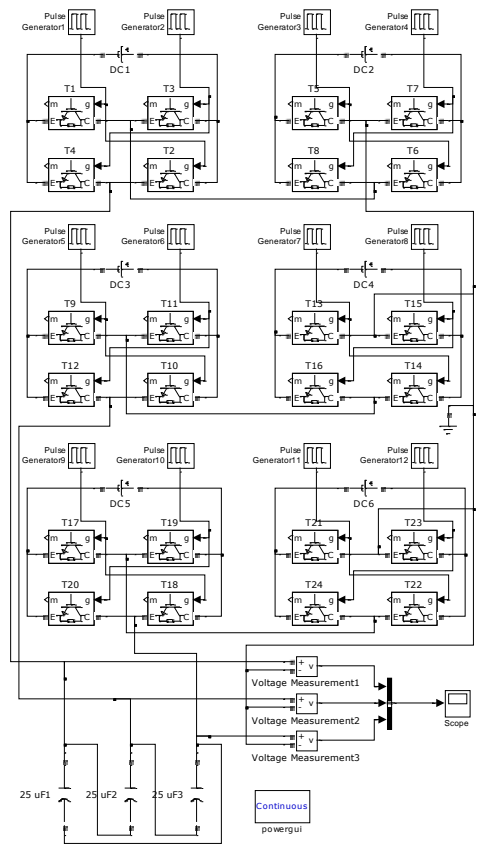


Fig. 1: Five level Cascaded H-bridge multilevel simulink model

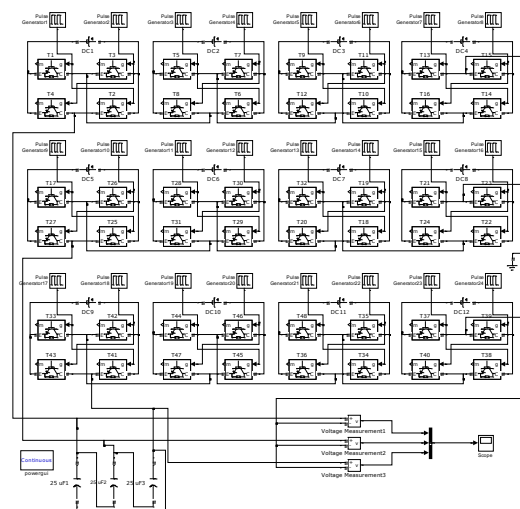


Fig. 2: Nine level Cascaded H-bridge multilevel simulink model

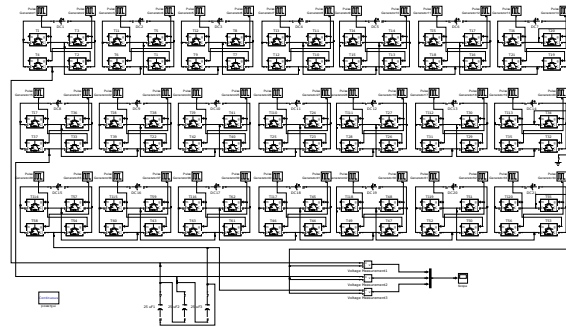


Fig.3: Fifteen level Cascaded H-bridge multilevel simulink model

Simulation Results

Fig. 1, 2 and 3 shows the proposed cascaded H-bridge multilevel inverter topology model of five, nine and fifteen level respectively. Fast Fourier Transform (FFT) analysis in MATLAB/Simulink is used for total harmonic distortion calculation in model. By applying real values as input in the model, real time total harmonic distortion obtained in FFT analysis. IGBT used as switch with internal resistance of 0.001 ohm and model used 12 V as DC source voltage with fundamental frequency of 50 Hz. Eight, sixteen and twenty eight number of IGBT switches per phase used in five, nine and fifteen level of multilevel inverter. Total Harmonic Distortion (THD) in proposed model is 29.18 %, 15.12 % and 4.9 % in five, nine and fifteen level cascaded H-bridge multilevel inverter topology model by using FFT analysis. Harmonic spectrum of five, nine and fifteen levels of multilevel inverters are shown in fig. 4, 5, and 6 respectively. Total harmonic distortion obtained by FFT analysis in decreasing order with respect to increase in number of levels and number of switches used in cascaded H-bridge multilevel inverter increases with respect to increase in number of levels.

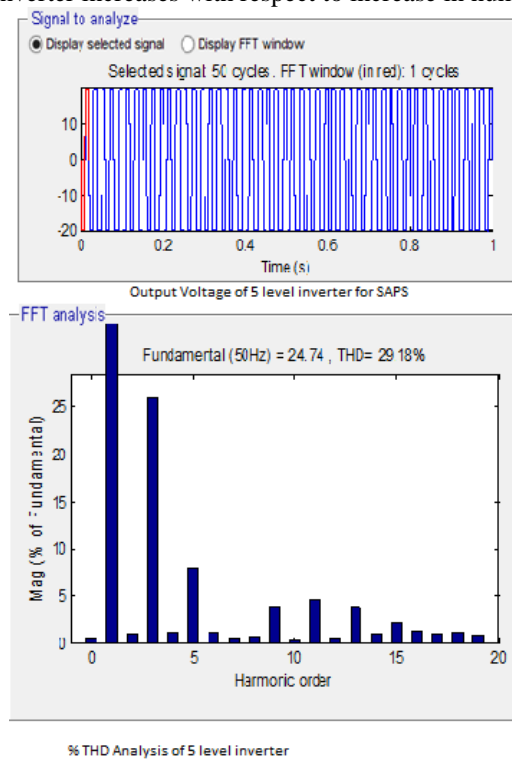


Fig.4: Harmonic spectrum of five level cascaded H-bridge multilevel inverter by using FFT analysis

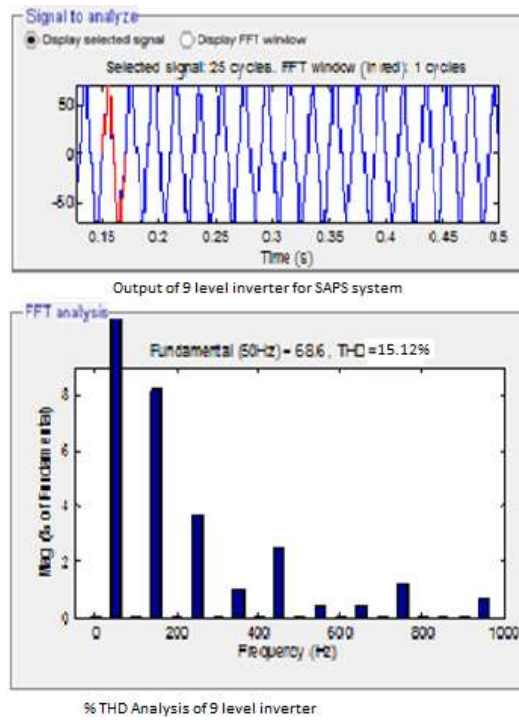


Fig. 5: Harmonic spectrum of nine level cascaded H-bridge multilevel inverter by using FFT analysis

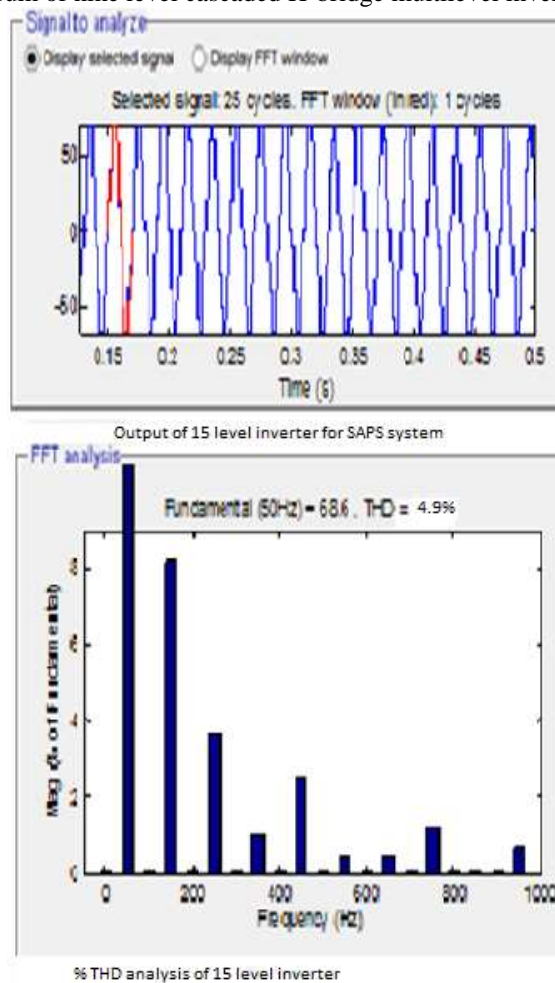


Fig. 6: Harmonic spectrum of fifteen level cascaded H-bridge multilevel inverter by using FFT analysis

Conclusion

Five, nine and fifteen level multilevel inverter using cascaded H-bridge multilevel inverter topology proposed with PWM technique in this paper. THD value obtained in five, nine and fifteen level of cascaded H-bridge multilevel inverter is 29.18 %, 15.12 % and 4.9 % respectively. THD values shows that total harmonic distortion decreases with increases the number of levels in cascaded H-bridge multilevel inverters but cost & weight increases, due to increase in number of switches increased.

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