DESIGN AND ANALYSIS OF PWM MULTI-LEVEL NPC INVERTER FOR POWER QUALITY INTEGRATION OF WIND POWER INTO GRID

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Abstract-* *This paper studies the modeling switching strategy and control scheme for neutral point clamped converter fed into grid. Design and Analysis of PWM 3–level inverter for power quality integration of wind power in to grid to connect to the medium voltage grid. Inverters are classified into single level inverter and multi-level converter. Multi-level converter has a lot of advantage to single level inverters have minimum harmonic distortion, reduced EMI/RFI creation and run on totally different voltage levels. Multi-level inverter is used for several industrial applications such as power filters, static var compensators and drives applications. The drawbacks are the isolated power supplies needed for each one of the stages of the multi-level converter and costlier, tough to manage in software. This project aims at the simulation study of 3-ϕ single level and multi-level convertor. The role of convertor in active power filter for harmonic elimination is studied and simulated in MATLAB/SIMULINK. Firstly, the 3-ϕ system with non-linear loads is modeled and their characteristic is determined. Secondly, the active power filters are creating with the convertor and appropriate switch regulation technique (PWM technique) to hold out harmonic elimination

Keywords:* *Transmitted and power generation, fuel cells, photo-voltaic (PV), power electronics, renewable energy.

I.INTRODUCTION

When ac loads are connected with inverters it required that the output voltage of desired voltage magnitude and frequency be achieved. A changeable output voltage may b obtained by changing the input dc voltage and keeps up the gain of the converter constant. On the other hand, if the dc input voltage is fixed to a certain magnitude and it is not variable, a changeable output voltage may be obtained by adjusting the gain of the converter, which is normally done by pulse-width-modulation (PWM) control within the converter. The inverters which generate an output voltage and a current with levels between 0 or +V and –V are known as 2 level inverters. In high-power and high-voltage applications these 2-level converters however have some restriction in operating at high frequency mainly due to switching losses and constraints of device rating. This is where multilevel inverters are advantageous. Increasing the no of voltage levels in the inverter without using higher rating on individual inverter devices may increase power rating of the device. The unique model of multilevel VSI allows them to approach high voltages with low harmonics content without the use of transformers device or series-connected synchronized-switching devices. The harmonic content of the output voltage waveform decreases in inverter rapidly. Multilevel converters have been under research and development for more than 30 years and have successful commercial applications. The present work creates a solution to form an efficient multilevel model which is suitable for medium and high power industrial applications. There are many different power inverter model and regulating technique used in inverter designs. Different technique approaches address many issues that depending on the way that the inverter is intended to be used. Thus performance of waveform may be adjusted. Note that, typical inverters always generate very low standard output waveforms. To make the output waveform qualitative, LC filter are used in the circuit. Thus, at this point of time researcher might have a question that, why the quality of inverter output is low? And why LC filter are frequently used in the circuit. Further, which type of solutions is available to enhance quality of output waveform without losing performance and its efficiency? However, eventually all this will be managed in this thesis paper. But at first we try to converter applications from low power to high power and then we meet the requirements to meet the high power demand. Finally we try to mitigate the problems and its solutions are available to meet the high power demand. This presents the industrial applications from low power to high power range device. From it is quite predictable that, power converters are an enabling technique. They are potentially useful for a very wide range of applications like; low power devices, home appliances, electric vehicles, photovoltaic, transport, and manufacturing, mining, and petrochemical application.

II. POWER INVERTERS

While many researcher have built a various type of power inverters, but still researchers are in look for a new type of topology which may generate high quality waveform with compact size. In other terms enhancing power quality is the main purpose. By considering above idea, let us make an outline regarding the demanding idea of power electronics converters, particular in Medium and high power range.

	Low Power	Medium Power	High Power
Power Range	Up to 2 KW	2-500 KW	More Than 500 KW
Usual Converter Topologies	ac/dc, dc/dc	ac/dc, dc/dc, dc/ac	ac/dc, dc/ac
Typical Power Semiconductors	MOSFET	MOSFET, IGBT	IGBT, IGCT, Thyristor
Technology Trend	High Power Density, High Efficiency	Small Volume and Weight Low Cost and High Efficiency	High Nominal Power of the Converter high Power Quality and Stability
Typical Applications	Lower-Power Devices, Home Appliances	Electric Vehicles, Roof PV	Transportation, Power Distribution, Renewable Energy, Industry

Fig1 . Power Inverters

The dependence on conventional fuels and the increase of its cost is depend to the investment of huge amounts of resources, economical, to develop new cheaper and cleaner energy resources not related to conventional energy [3]. In fact, for many years, renewable energy resources have been the focus for researchers, and different type of power electronic converter have been designed to make the integration of these types of device into the distribution grid now a current reality. Therefore, power converters have the responsibility to carry out with high efficiency. The power electronics researcher and commercially have focus to this demand in two ways: developing semiconductor technique to reach higher voltages and currents (currently 8 kV and 6 kA) while maintaining old converter model (mainly two-level voltage and current source inverters); and by developing new inverter models, with old semiconductor technique, known as multilevel converter [5]. In the first approach there is benefit of well known circuit structures and regulation technique. Also the newer semi-conductors are more costly and higher in power, other power-quality requirements have to be meet, thereby there may be need of extra power filters. Therefore it will be quite feasible to choose to make a new inverter model based on multilevel concept. At present there is tough competition between the use of traditional power inverter model using high-voltage semiconductors and new inverter model using medium-voltage devices. This idea is shown in Fig. where converters are making by connecting devices in series. But in present day, multilevel technique with medium voltage semiconductors are connecting in a development race with traditional power inverters using high-power semiconductors device, which are under research and are not mature. Although, traditional converters are good for minimum power applications, but they are fail to fulfill the requirements of high-power level inverter.

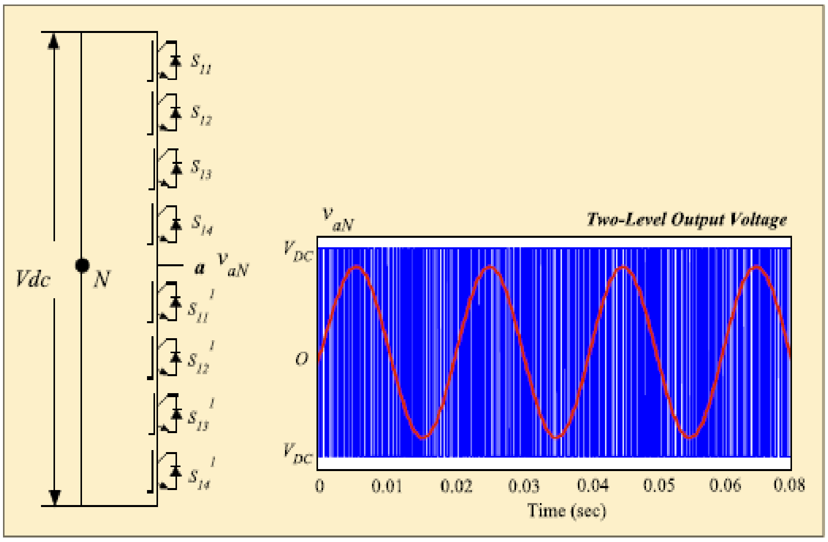

Fig.2Classical converter and output waveform

In view of later, to retrieve the demerits of traditional inverters we know about the multilevel technology and the merits it offer. Multilevel converters are a good choice for power applications due to the fact that, it can be achieves high power using medium-power inverter technique. Practically, multilevel inverters present more advantages comparing with traditional converter. These advantages are basically focused on betterments in the output signal quality (Voltage & Current) and power increase in the inverter [6]. These advantages make multilevel converters very attractive to the commercially and, these days, researchers all over the world are making tremendous efforts and trying to improve multilevel inverter characteristics performances such as the regulation modification and the performance of many optimization algorithms technique in order to improve the total harmonic distortion [7] of the output signals, the controlling of the dc capacitor voltage [8], and the ripple of the currents, harmonic mitigation to fulfill a certain grid codes, the development of new multilevel inverter model (hybrid or new ones), and regulation strategies [9]. However, before introducing about the multilevel converters, we are making an overview about the traditional converters and their problems. To address the problems of traditional converters, one should have an idea about the Mean to high-power range converters and related challenging issues. Some of the facts summarized.

1. Today's, application power range of converter ckt using the fundamental "inverter leg" building block is enormous (<1 kW to 10 MW+)
2. In large application area is in commercial (PWM controlled induction motor) drives (See Fig.3) are around 3 kW to 100 kW power limit. IGBT devices are using almost High in this power range.

III. WIND POWER

With increasing power demands in India, wind power becomes a very popular due to the decreasing limit amount of conventional energy ,that's why recent change in the public opinion towards protecting the environment. And it is also viewed as a safe and reliable energy that does not depends on any limited resources

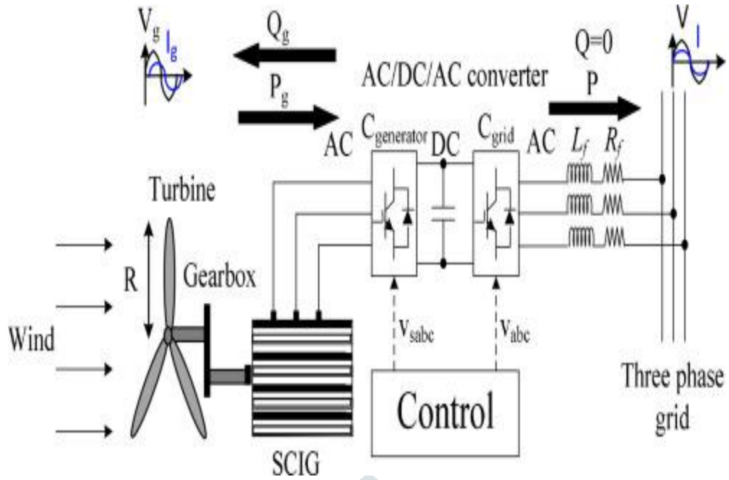

Fig 3 Wind turbine model

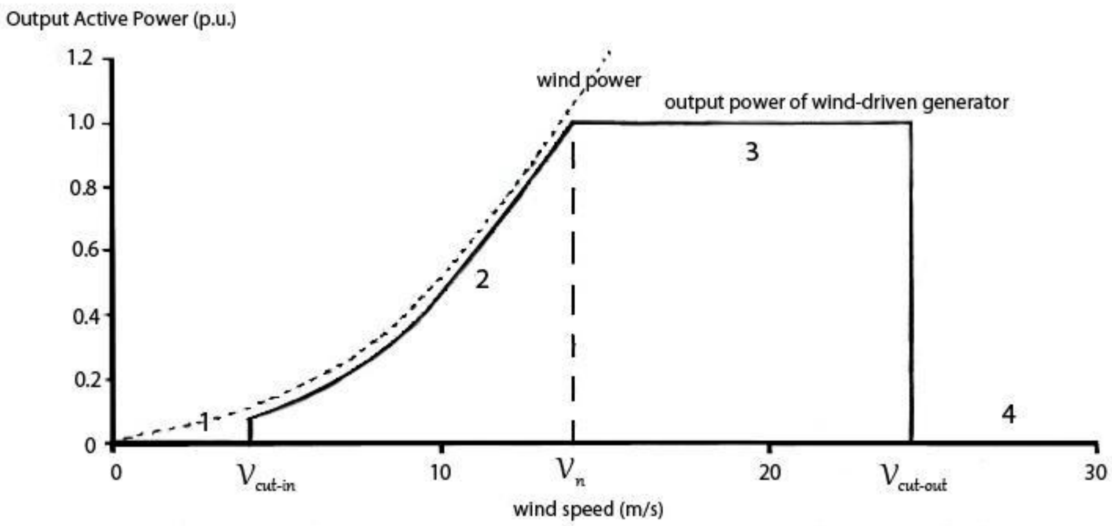

Fig.4 Wind turbine power generating versus wind speed

The graph suggested 3- main factors on the characteristic of wind turbine energy output.
1. Nominal wind speed: the speed of the wind at which power of wind turbine is obtained is called wind speed. The nominal power is the highest energy output of the wind turbine generator. 2. Cut-out wind speed: The highest wind speed at which the turbine is allowed to deliver power or the certain wind speed a wind turbine may run called maximum wind speed operates .This characteristic mention above is changing depending on the type of wind turbine using for power generation

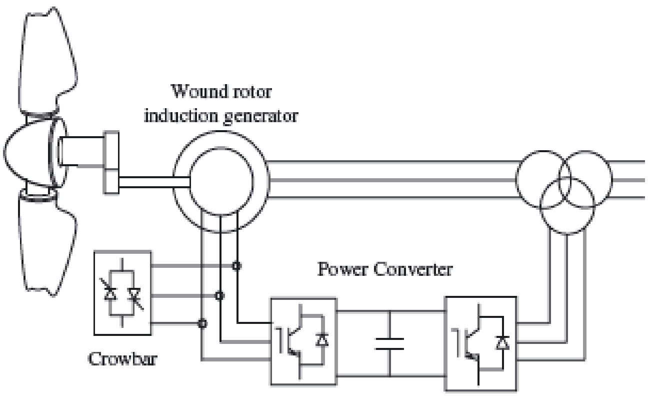

Fig 5 . DFIG wind turbine model

DFIG wind turbine deliver power through the interaction of the stator and rotor of the generator, while the rotor also absorbed energy depends on the rotational speed of the generator. If the generator working above synchronous speed, the power is deliver from the rotor through the power converter to the grid. If the generator is operates below synchronous speed, then the rotor will absorb power from the grid through the power inverter. The power inverter is consist of a Rotor-side converter (RSC) and a Grid-side converter (GSC).The power inverter regulate the active and reactive power flow in the grid, and the DC potential of the DC-link condenser between the DFIG wind turbine and the grid by giving the pulse width modules (PWM) to the inverter (Seyedi, 2009). A crowbar is implemented to control SC (short circuit) in the wind power system that results in high current and high potential. The RSC converters working at the slip frequency and its regulation of the flux in the DFIG wind turbine. The power rating of the RSC is calculated according to the maximum active and reactive power regulates ability. The RSC may be working as a current-controlled voltage sources converter. The GSC worked at a system frequency and regulates the voltage and current level of the DC-link circuit. The wind power plant withstands voltage dips to fixed value of the nominal voltage and for a fixed time

RESULT

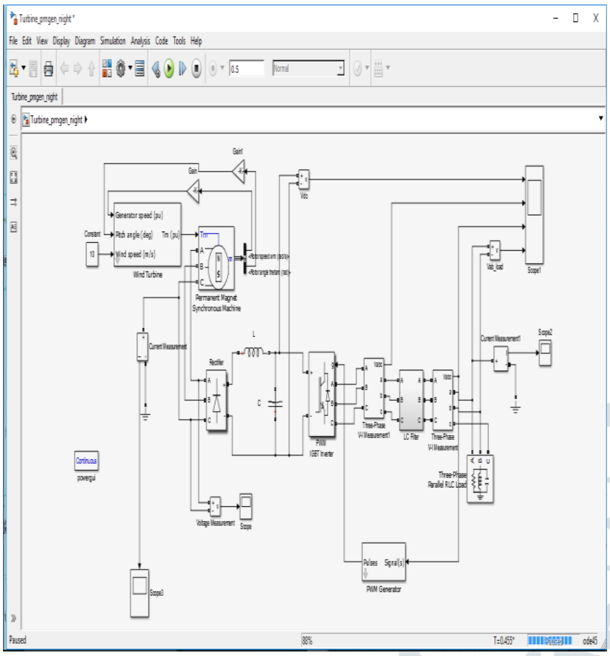

Fig .6. Wind turbine power inverter Block

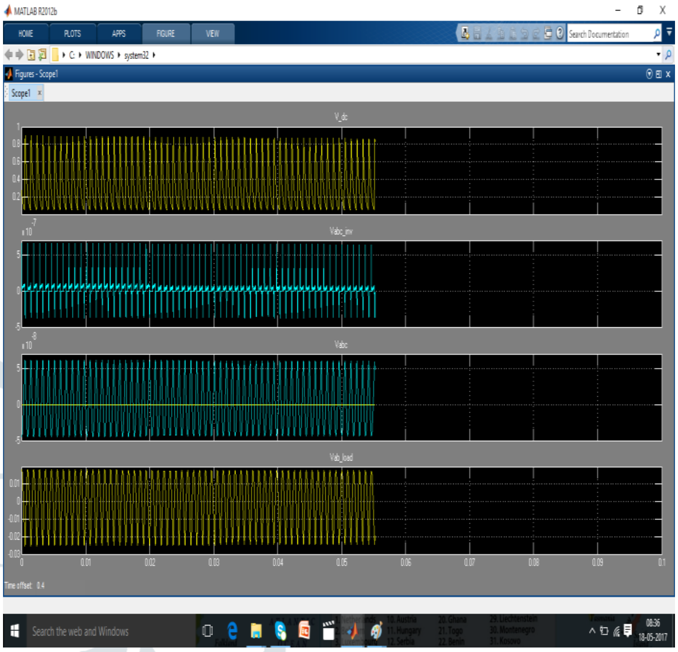

Fig .7. Wind turbine power inverter waveform.

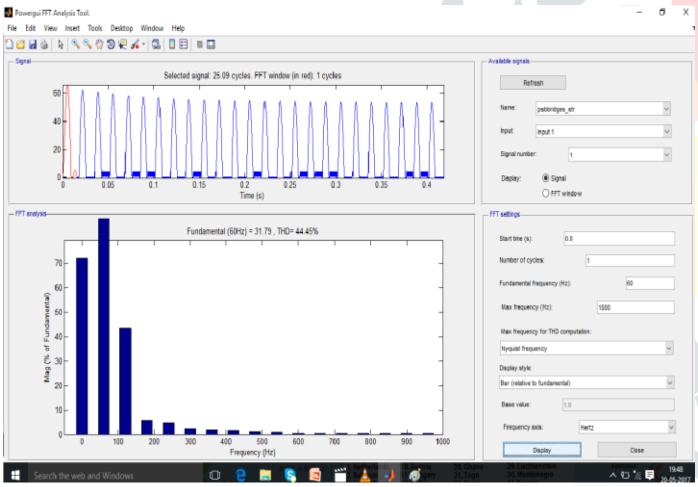

Fig 8. THD of Wind turbine power inverter .

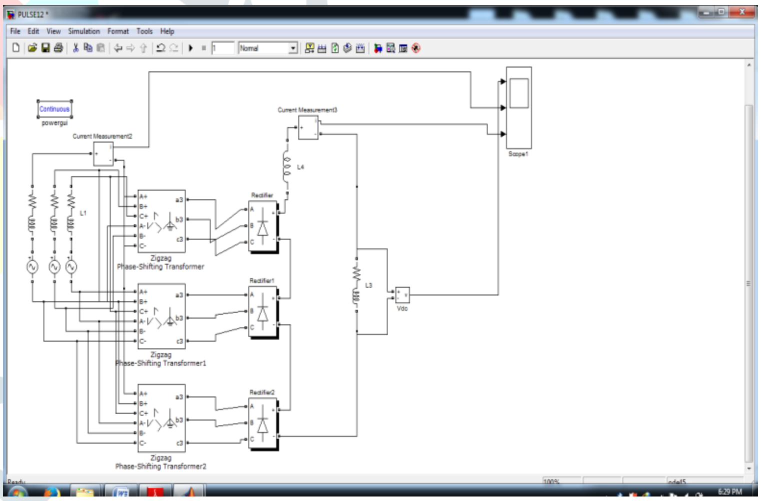

Fig.9. 12 level inverter Block

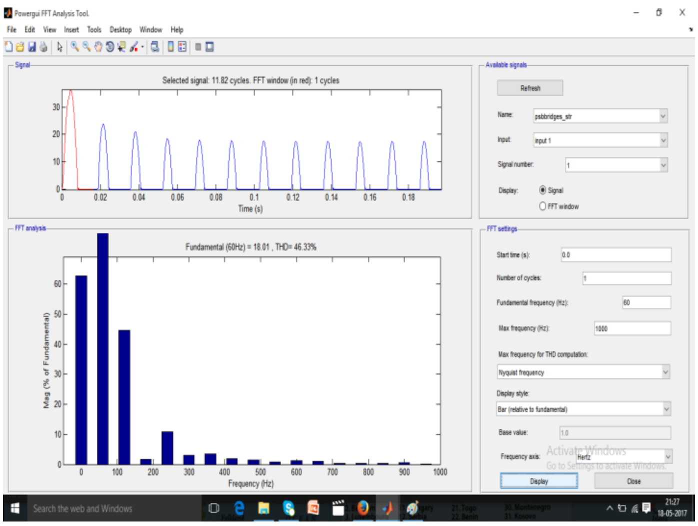

Fig.10 . THD of 12 pulse multi level inverter

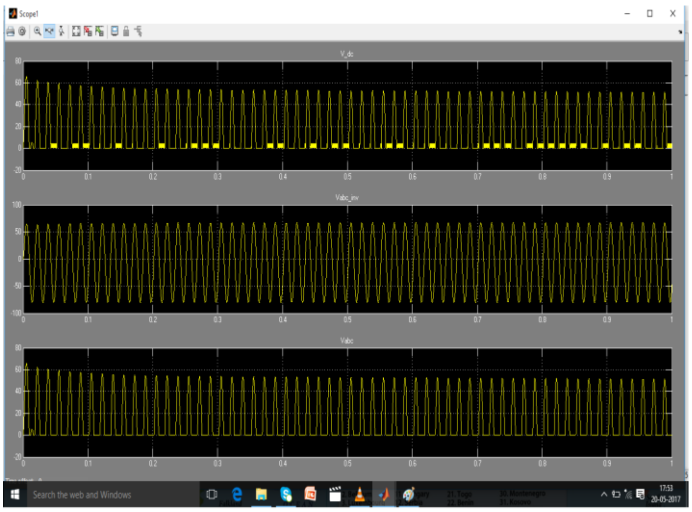

Fig11. 12 level multilevel inverter waveform.

IV. CONCLUSION

In this thesis, a variable control technique for integration of renewable energy resource to the distribution grid is presented .The main objective of the proposed control strategy in both steady state and transient operation have been verified through simulation results. The Neutral point clamped voltage source inverter during connection of non conventional energy resource to the grid has been researched .MATLAB/ SIMULATION results clarified the ability of the proposed control strategy in compensation of active and reactive current in basic frequency and harmonic current components .MATLAB/SIMULATION result shows by setting active power from renewable energy resource as a constant value ,and increasing requested load reactive power in fundamental and harmonic frequency .The regulation technique has the ability to be used in all types of converters model and may be used as a multi objectives are integration of many type of different renewable energy resource into grid

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