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Grid Connected PV System with hysteresis Current Controller based three phase inverter fed induction motor drive application

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***Abstract*— Power inverters are devices which can convert electrical energy of DC form into that of AC. Inverters can come in many different varieties, different parameters like price, power rating, efficiency and applications. The DC/AC power inverter is normally to take DC power supplied by a solar panel (or) battery, such as a sum volt battery, and transform it into a sum volt AC power source operating at 60 Hz, it has emulates the power available at an ordinary household electrical application. The tasks of Power inverters are used for day today life powering appliances in Domestic applications. When the inverter output is pure sinusoidal and its connected to the grid. But, to match the frequency, phase and amplitude of the grid and inverter output. Inverter output is depends upon the PWM (Pulse Width Modulation) signals to the gating of the inverter switches. The power generated by Renewable Energy Source (RES) should be fed to the distribution grid through an interfacing converter. This interfacing converter is controlled using a hysteresis current control which is simple in operation. Active power transfer from RES through a grid interfacing converter model is carried out. The converter is designed to drive a three-phase squirrel induction motor directly from photovoltaic (PV) energy source. The use of three-phase induction motor presents a better solution to the commercial DC motor water pumping system. A three phase Induction motor connected to Voltage Source Inverter (VSI), which in turn runs the centrifugal pump. The whole system is controlled using Matlab/Simulink environment.**

Keywords*— Distributed generation, Renewable Energy Source (RES), hysteresis current control. Interfacing, Induction motor.

I.INTRODUCTION

The increasing number of renewable energy sources and distributed generators requires new strategies for the operation and management of the electricity grid in order to maintain or even to improve the power supply reliability and quality. In addition, liberalization of the grids leads to new management structures, in which trading of energy and power is becoming increasingly important. The power electronics technology plays an important role in distributed generation and in integration of renewable energy sources into the electrical grid [1], and it is widely used and rapidly expanding as these of applications become more integrated with grid-based systems.

The energy demand for electric power is increasing day by day. End users and electric utilities are concerned about meeting the growing energy demand. Distributed generation (DG) systems are presented as a suitable form to offer high reliable electrical power supply. The concept is particularly interesting when different kinds of energy resources are available such as photovoltaic panels, fuel cells, or speed wind turbines [2],[3].Most part of these resources need power electronic interfaces to make up local ac grids [4],[5].This way inverters are connected to an ac common bus with the aim to share properly the disperse loads connected to the local grid. The integration of

Renewable Energy Resources at the distribution level is termed as Distributed Generation (DG).In this grid integration, communication systems are crucial technologies, which enable the accommodation of distributed renewable energy generation and plays an extremely important role in monitoring, operating, and protecting both renewable energy generators and power systems.
Electricity generation using renewable resources is often taking place in small scale due to disperse nature of the recourses. The size of these generators typically varies from a few hundreds of kilowatts to several megawatts. The types of grid interfaces used with Photovoltaic's are Power electronics converter & Induction generator/ Power electronics converter. In this paper, recent ongoing trends in grid integration of solar energy system are presented, the power quality improvement by using hysteresis current control [6].

Most suitable energy sources supply energy in the form of electrical power Distributed Generation (DG) systems are often connected to the utility grid through power electronic converters for induction motor drive [7]. A grid-connected inverter provides the necessary interface of the DG to the phase, frequency and amplitude of the grid voltage, and disconnects the system from the grid when islanding.

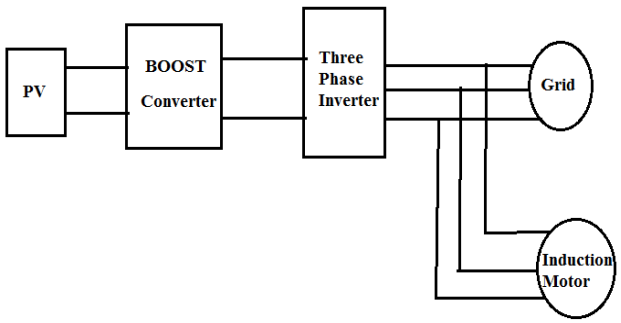

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Fig.1.Block diagram of Interconnection of RES to main Utility Distribution Grid and drive applications.

II.INTERCONNECTION OF RES TO MAIN UTILITY DISTRIBUTION GRID

The planned system consists of RES connected to the dc-link of a grid-interfacing inverter as shown in Fig. 2. The voltage supply inverter may be a key part of a weight unit system because it interfaces the renewable energy supply to the grid and delivers the generated power. The RES is also a DC supply or associate degree AC supply with rectifier coupled to dc-link. Usually, the photo-voltaic system generates power at variable low dc voltage, whereas the variable speed wind turbines generate power at variable ac voltage. Thus, the power generated from these renewable sources needs power learning (i.e., dc/dc or ac/dc) before connecting on dc-link. The DC capacitor decouples the RES from grid and conjointly allows freelance management of converters on either side of dc-link. Due to the intermittent nature of RES, the generated power is of variable nature. The dc-link plays a very important role in transferring this variable power from renewable energy supply to the grid. RES area

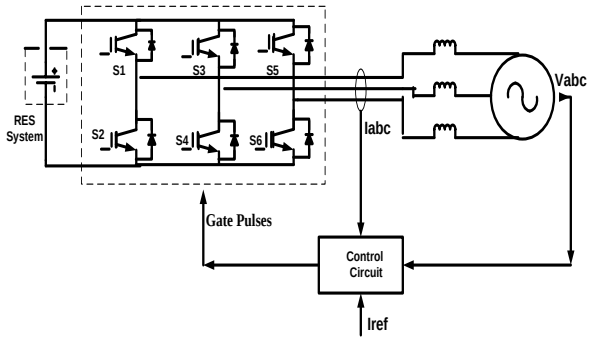

Fig.2.Interconnection of RES to main Utility Distribution Grid.

Unit described as current sources connected to the dc-link of a grid-interfacing electrical converter. A voltage source converter (VSC) could be a power device that connected in shunt or parallel to the system. It will generate a curving voltage with any needed magnitude, frequency and point in time. It additionally converts the DC voltage across storage devices into a group of 3 part AC output voltages. it's additionally capable to get or absorbs reactive power. If the output voltage of the VSC is larger than AC terminus voltages, is alleged to be in electrical phenomenon mode. So, it'll compensate the reactive power through AC system. The sort of power switch used is ANIGBT in anti-parallel with a diode. The 3 part four leg VSI is sculpturesque in Simulink by exploitation IGBT.

III.Simplified Hysteresis Control Strategy

Low cost with easy implementation and its excellent dynamic response makes hysteresis control a prior option as control strategy. One of the simplest current control PWM techniques is the hysteresis band (HB) control shown in this figure 3. The obtained current reference signal, while converted from dq/abc transformation, is split into each phase reference currents and is measured with the actual phase currents of individual grid phases. The error signal thus generated fed to relay producing pulses. This method contains hysteresis band (HB) to obtain pulses to the switches of grid interfacing converter.

Pulse generation is explained in figure 4. Basically, it is an instantaneous feedback current control method in which the actual current continuously tracks the command current within a pre assigned hysteresis band. As indicated in the figure 3, if the actual current exceeds the HB, the upper device of the half-bridge is turned off and the lower device is turned on. As the current decays and crosses the lower band, the lower device is turned off and the upper device is turned on. If the HB is reduced, the harmonic quality of the wave will improve, but the switching frequency will increase, which will in turn cause higher switching losses.

The physical phenomenon of current management (HCC) is that the best management methodology to implement; it had been developed by Brod and Novotny in 1985. The shunt APF is enforced with three sections current controlled VSI and is connected to the ac mains for compensating the present harmonics. The VSI gate signals area unit brought out from physical phenomenon current controller. A Hysteresis current controller is enforced with a closed-loop system system and waveforms area unit shown in Fig. 4. An error signal is employed to manage the switches during voltage supply electrical converter. This error is that the distinction between the specified current and the current being injected by the electrical converter. If the error exceeds the higher limit of the physical phenomenon band, the higher switch of the inverter arm is turned off and also the lower switch is turned on. As a result, the present starts decaying.

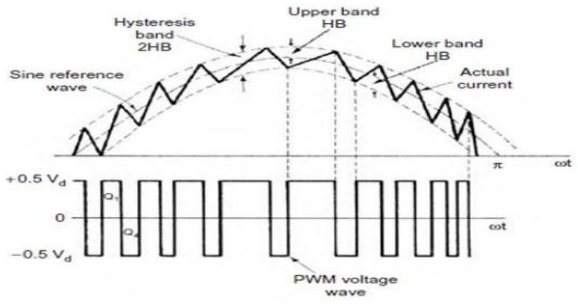

Fig.3. Hysteresis Band Current control.

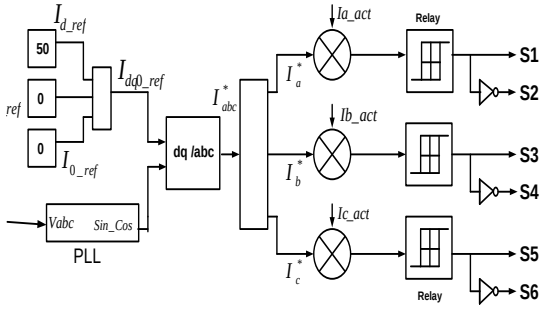

Fig.4.Hysteresis Current Controller.

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IV.INDUCTION MOTOR

Induction Motor (IM) An induction motor is an example of asynchronous AC machine, which consists of a stator and a rotor. This motor is widely used because of its strong features and reasonable cost. A sinusoidal voltage is applied to the stator, in the induction motor, which results in an induced electromagnetic field. A current in the rotor is induced due to this field, which creates another field that tries to align with the stator field, causing the rotor to spin. A slip is created between these fields, when a load is applied to the motor.

Compared to the synchronous speed, the rotor speed decreases, at higher slip values. The frequency of the stator voltage controls the synchronous speed. The frequency of the voltage is applied to the stator through power electronic devices, which allows the control of the speed of the motor. The research is using techniques, which implement a constant voltage to frequency ratio. Finally, the torque begins to fall when the motor reaches the synchronous speed. Thus, induction motor synchronous speed is defined by following equation,

$$n_s = \frac{120f}{p}$$

Where f is the frequency of AC supply, n, is the speed of rotor; p is the number of poles per phase of the motor. By varying the frequency of control circuit through AC supply, the rotor speed will change.

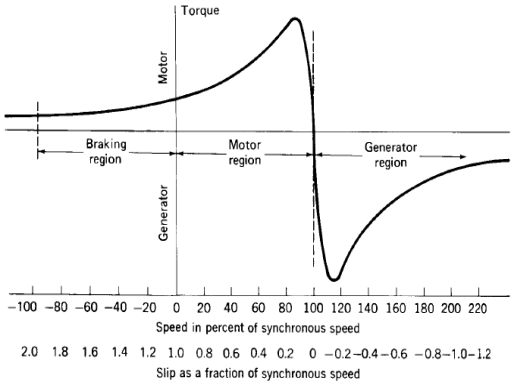

Fig.5.Speed torque characteristics of induction motor.

V.MATLAB/SIMULATION RESULTS

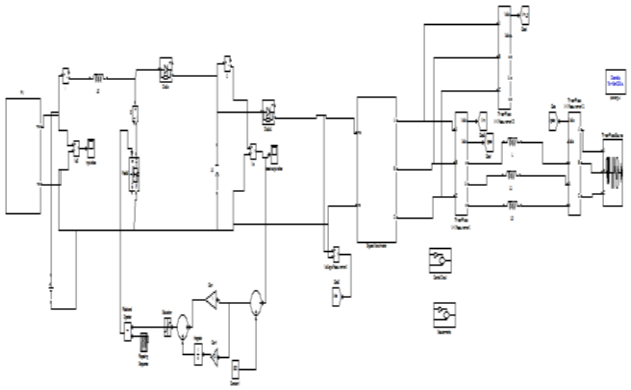

Fig.6.Matlab/Simulink model of Interconnection of RES to main Utility Distribution Grid.

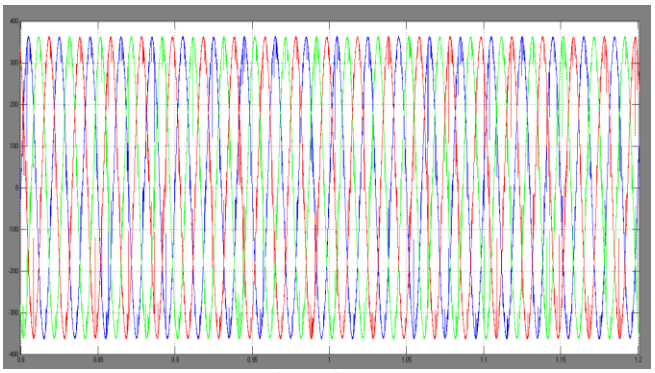

Fig.7.Simulation waveform of three phase Grid Voltage.

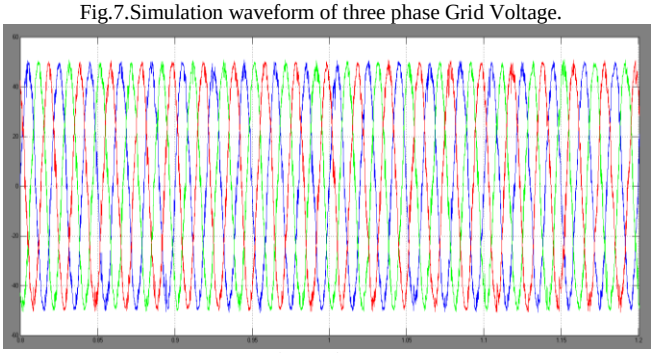

Fig.8.Simulation waveform of three phase Grid Current.

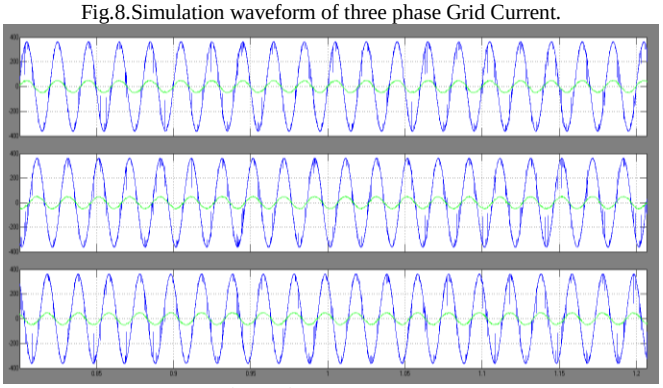

Fig.9.Simulation waveform of the grid phase voltages and currents.

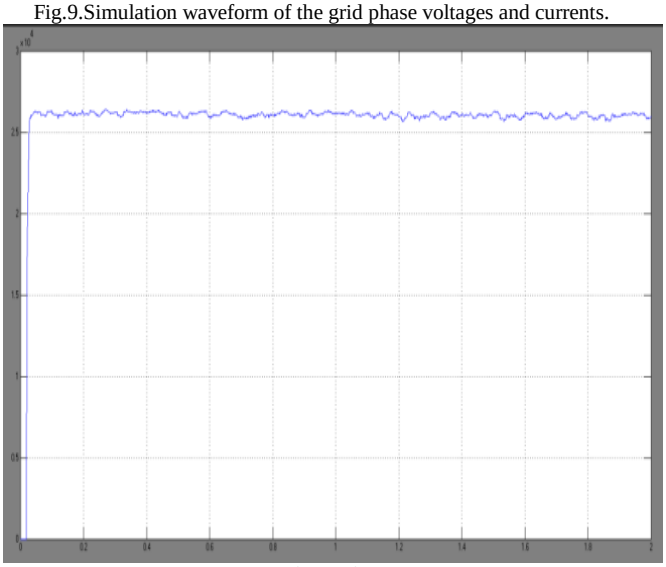

Fig.10.Simulation waveform of the grid Active power.

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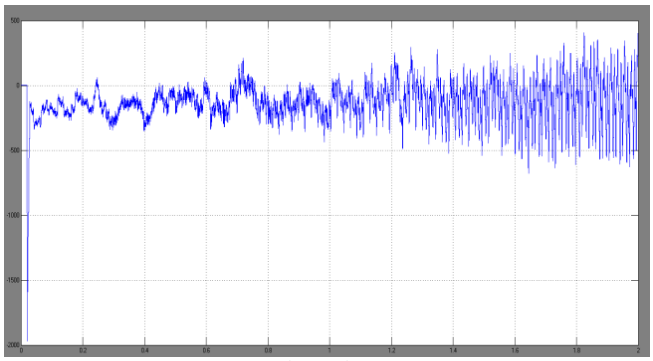

Fig.11.Simulation waveform of the grid Reactive power.

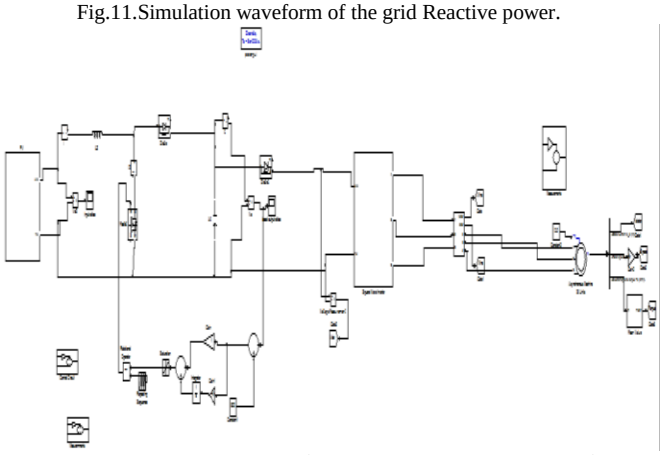

Fig.12.Matlab/Simulink model of RES based three phase inverter fed Induction motor drive.

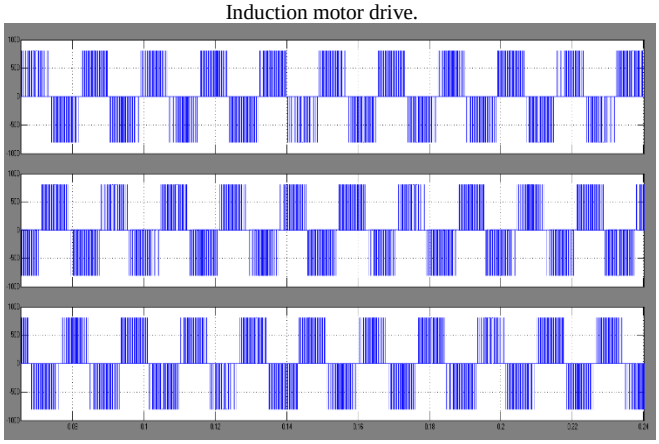

Fig.13.three phase inverter line to line Voltage.

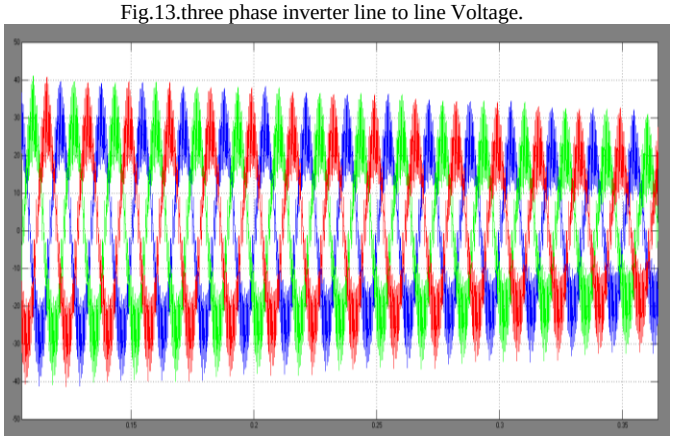

Fig.14.three phase inverter line to Line current.

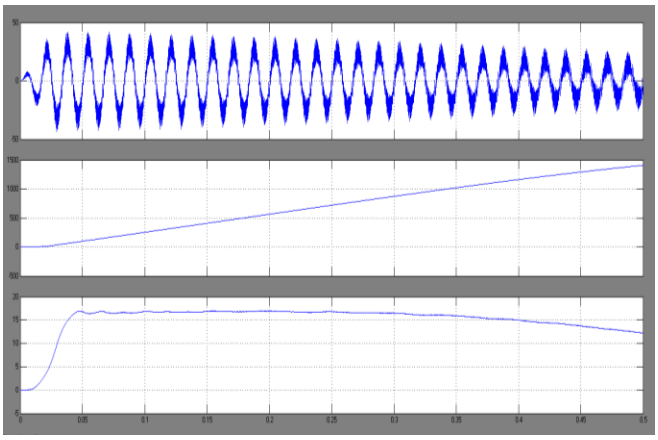

Fig.15.Stator current, speed and torque of induction motor.

VI. CONCLUSION

The new power electronics technology plays a very important role in the integration of renewable energy sources into the grid. Hysteresis current control method is used to generate gate pulses. The inverter is controlled to perform as a multi-function device by incorporating active power filter functionality. The Voltage, Current and Power flow waveforms are obtained. Reactive power demand of the grid is compensated and current harmonics are reduced. It has been found that the total harmonic distortion of grid and load current are reduced. Hence, hysteresis current controller has fast response, high accuracy of tracking the DC-voltage reference, and strong robustness to load sudden variations. Total Harmonic Distortion of the grid connected system is analyzed and it is reduced. Distributed generation (DG) is one of the emerging trends in power system these days. Incorporation of DG can be made at distribution level. The power generated by Renewable Energy Source (RES) is fed to the distribution grid through an interfacing converter. And by using this converter the speed of the induction motor control is easy.

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