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Three phase Two Stage Hysteresis Current Controlled Grid Connected Inverter System

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Abstract

Design and implementation of a hysteresis current controlled grid-connected voltage source inverter (VSI) is presented. The proposed control technique retains the benefit of fast dynamic response, good reference tracking capability and simple implementation. Power from the renewable source is fed to the dc-dc boost converter to meet the grid required voltage level. Boosted voltage is connected to the inverter DC link. Power is fed to the 110V, 50Hz grid. Current injected to the grid is well within the IEEE 519 standard.

INTRODUCTION

The current control methods play an important role in power electronic circuits, particularly in current directed PWM inverters, which are broadly connected in air conditioning engine drives and persistent air conditioning power supplies where the goal is to deliver a sinusoidal air conditioning yield. The principle errand of the control frameworks in current managed inverters is to constrain the present vector in the three-stage stack as indicated by a reference direction. The performance of converter system is mainly depends on type of current control technique. The main objective of current control technique is to enhance the output of the inverter and also to control the inverter switches in order to shape the output ac voltage and currents to be as close to sine wave as possible[1][2]. In current controller, load currents are measured and compared with reference currents, the errors are used as an input to the PWM modulator, which provides inverter-switching signals[1]. There are two types of current control namely linear and nonlinear current control. Linear current control has constant switching frequency[1] (eg: PI, PID Current Controller) where as Non Linear current control has variable switching frequency[1] (eg: Hysteresis Current Control, Sliding Mode Control, Delta Modulation Technique).

Hysteresis current control

In power electronics, gate often implements hysteresis intentionally to prevent gate from "chattering" when signals close to its threshold are applied. It is used to filter signals. In a hysteresis controller, the hysteresis comparators are used to impose hysteresis or hysteresis around the reference current[2]. Hysteresis current control schemes are based on a nonlinear feedback loop with hysteresis comparator. The main advantages of hysteresis current control technique are simplicity, outstanding Robustness, lack of tracking errors, insensitivity to load parameter changes but the disadvantages are the variable switching frequency and, for a three- phase, unexpected high switching frequency[2],[3]. Very high switching frequency may result if three independent controllers are used. The actual current 6 waveform is not only determined by the hysteresis control: depending on operating conditions, the current slope may vary widely and the current peaks may appreciably exceed the limits of the hysteresis band.

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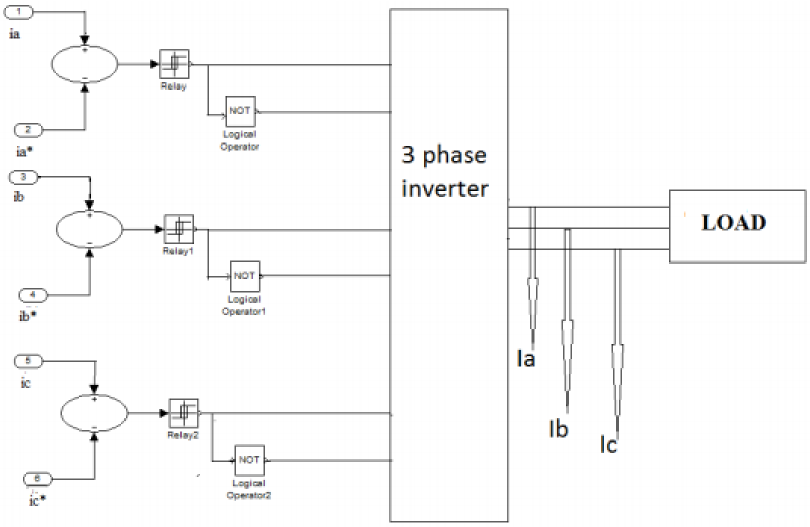

Fig.1 *Block diagram of hysteresis controller*

Block diagram of hysteresis current control shown in fig 1,consists of comparator, hysteresis comparator and NOT gate. The comparator is a device, which compares the two signals namely actual load current and reference current (sine wave) for each phases. When the actual load current of phase A exceeds the reference current (Sine wave with 0deg phase shift),error is positive then the inverter switch S1-OFF and S4-ON.If the error is negative, inverter switch S1-ON and S4-OFF. When the actual load current of phase B exceeds the reference current (sine wave with -120deg phase shift),error is positive then the inverter switch S3-OFF and S6-ON.If the error is negative, inverter switch S3-ON and S6-OFF. 12 When the actual load current of phase C exceeds the reference current (Sine wave with 120deg phase shift),error is positive then the inverter switch S5- OFF and S2-ON.If the error is negative, inverter switch S5-ON and S2-OFF.

SIMUATION OF THREE PHASE INVERTER USING HYSTERESIS

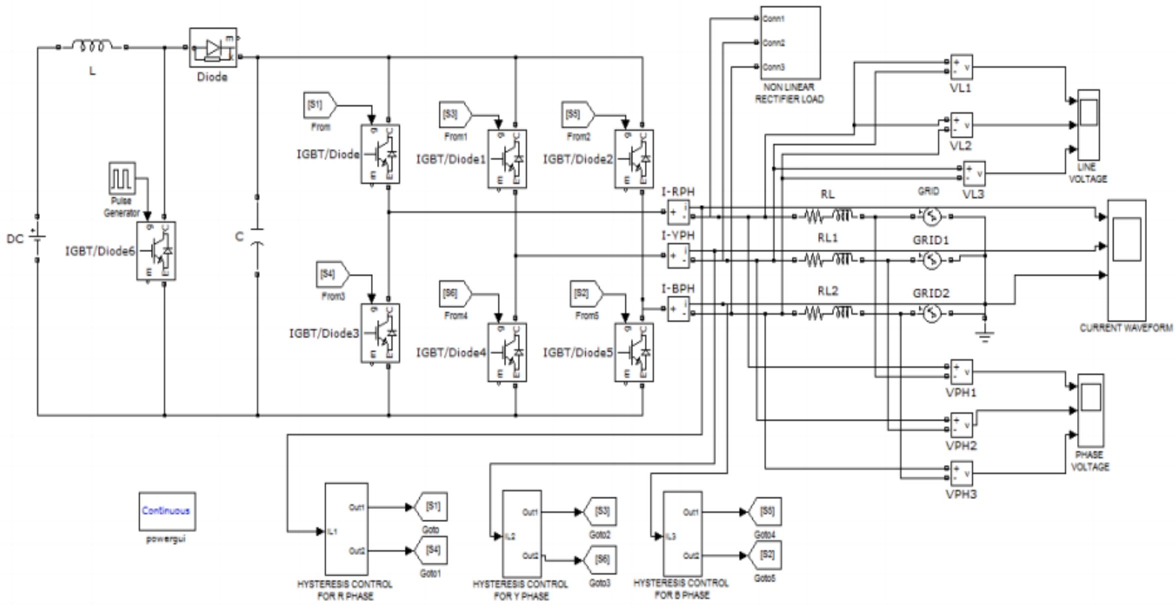

Fig.2 *Simulated power circuit of proposed system*

Fig.2 shows the DC-DC converter fed inverter current can be controlled using hysteresis current control technique. It is a renewable energy application .the power obtained from the renewable energy sources are very small which is not sufficient for operating three phase inverter. In order to increase the voltage, boost converter is used. The voltage from renewable sources are boosted up and fed to the three phase inverter. It is connected to the 110 Volt grid through interfacing inductor. The value of interfacing inductor is 41.25mH.Non-linear rectifier load is also connected to inverter. The main disadvantage of inverter is switching losses and harmonic distortion. Current distortion reduced by this technique is very less. By reducing the bandwidth of the hysteresis band, current distortion get further reduced.

The reference sine wave is compared with the R-phase current of the inverter, error is produced. When the actual current is greater than reference current, the produced error is positive. Then the inverter switch S1- OFF and S4-ON. When the actual current is less than reference current, the produced error is negative. Then the inverter switches S1-ON and S4-OFF as in fig 3.

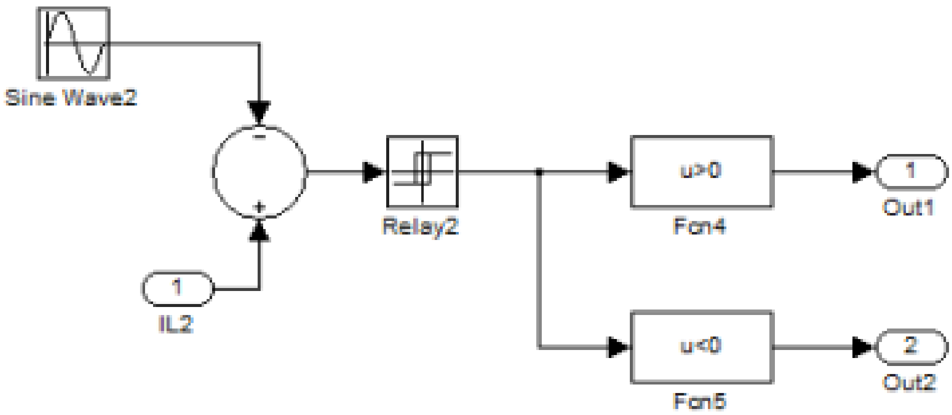

Fig.3 *subsystem of hysteresis controller R phase*

The reference sine wave with -120deg phase shift is compared with the Y-phase current of the inverter, error is produced. When the actual current is greater than reference current, the produced error is positive. Then the inverter switch S3-OFF and S6-ON.

The reference sine-wave with 120deg phase shift is compared with the B-phase current of the inverter, error is produced. When the actual current is greater than reference current, the produced error is positive. Then the inverter switch S5-OFF and S2-ON.When the actual current is less than reference current, the produced error is negative. Then the inverter switches S5-ON and S2-OFF.

In NON-LINEAR LOAD, the current is not proportional to applied voltage. Step inputs are given to corresponding three switches, which is connected to the three phases of the non-linear load. Step time is fixed in the step input (eg: 0.05sec).when the step time is reached, switch get closed and the nonlinear load is connected to the inverter as in fig 4.. After the load is connected, it draws some amount of current from the inverter thus the current get distorted.

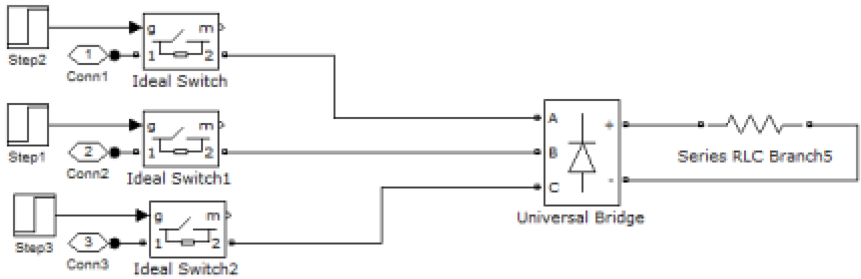

Fig.4 *Rectifier fed R load connected to grid*

SIMULATION RESULTS

Hysteresis bandwidth=±0.4 R=5ohm,L=41.25mH Reference current amplitude= 6A. Fig 5 shows the output of boos converter. It step up the voltage from 200V to 400V.fig. 6 shows the three phase grid currents. Reference current is changed from 5A to 6A at 0.005s, proposed system perfectly tracks the reference current. Current harmonics of this injected currents are well within the limits as shown in harmonic spectrum fig.7. Inverter line and phase voltages are shown in fig.8 and 9 respectively.

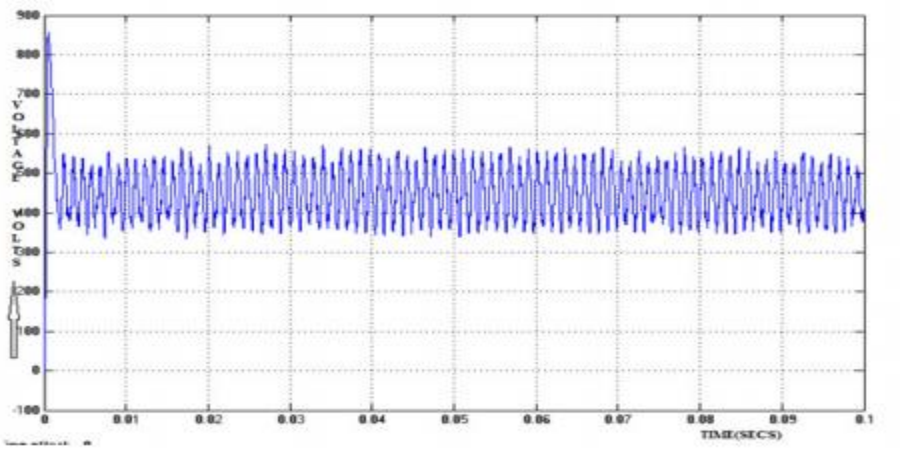

Fig 5.*Inverter DC link voltage*

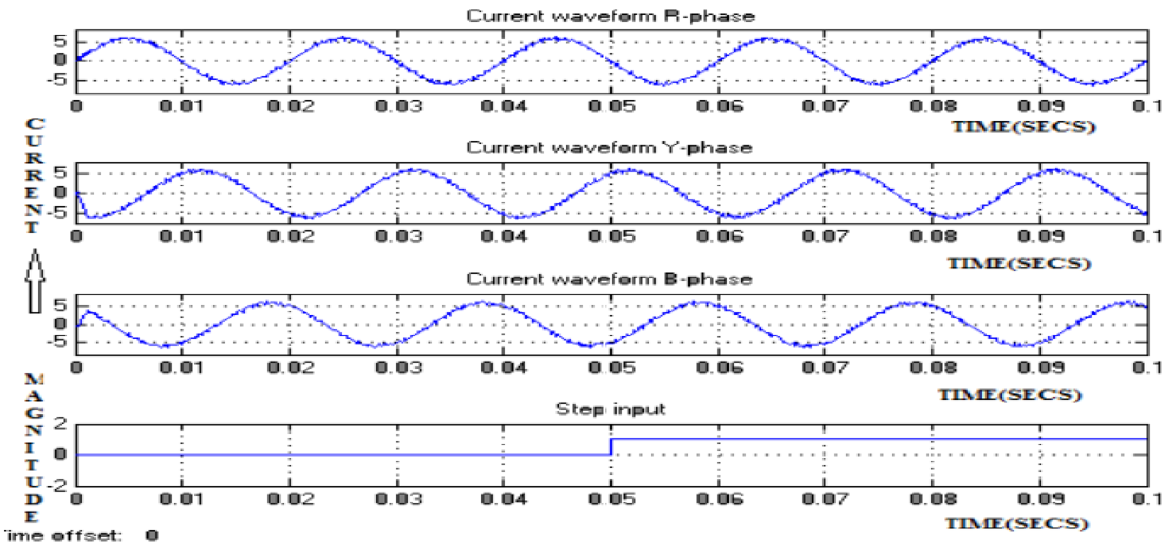

Fig.6 *Three phase injected grid currents*

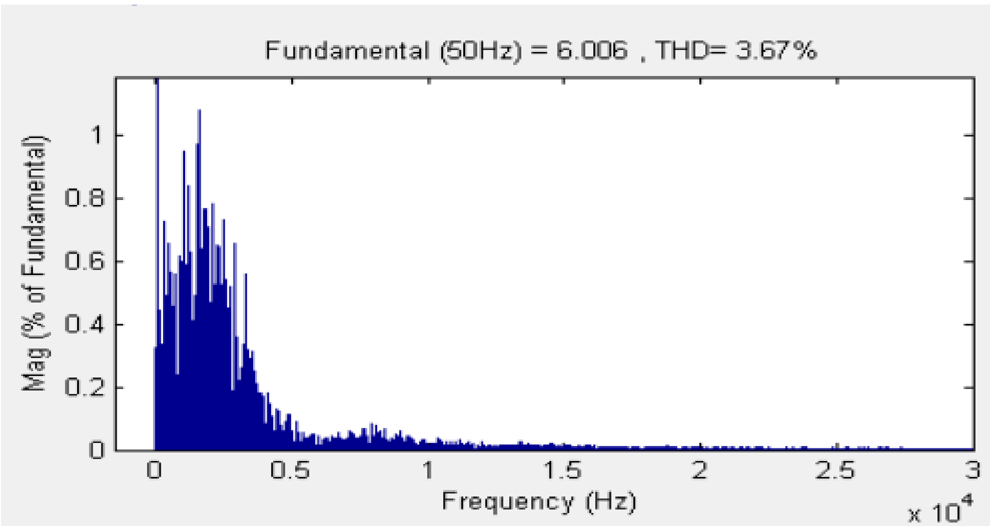

Fig. 7.*Harmonic spectrum of grid current*

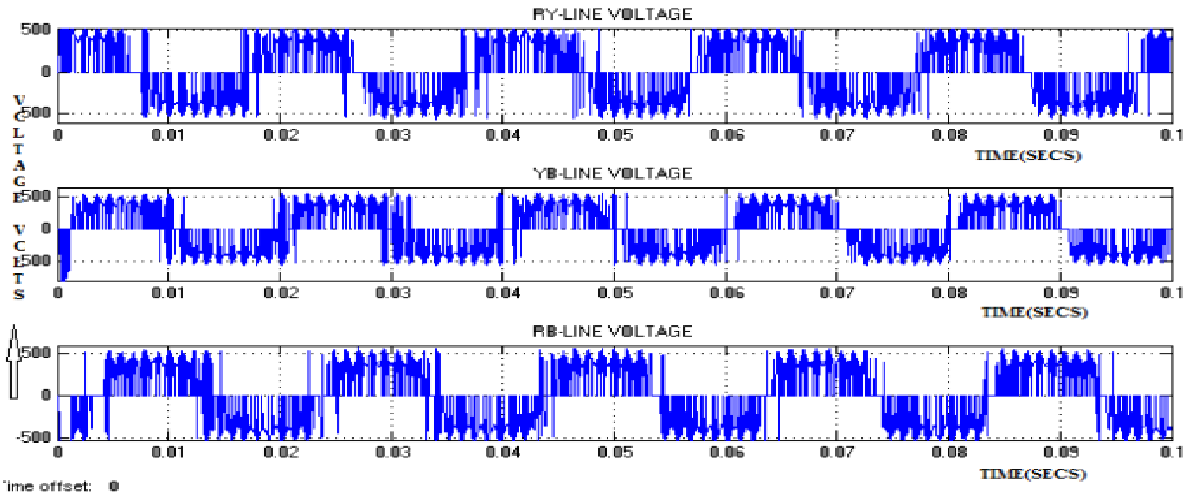

Fig.8 *inverter there phase Line to Line Voltage*

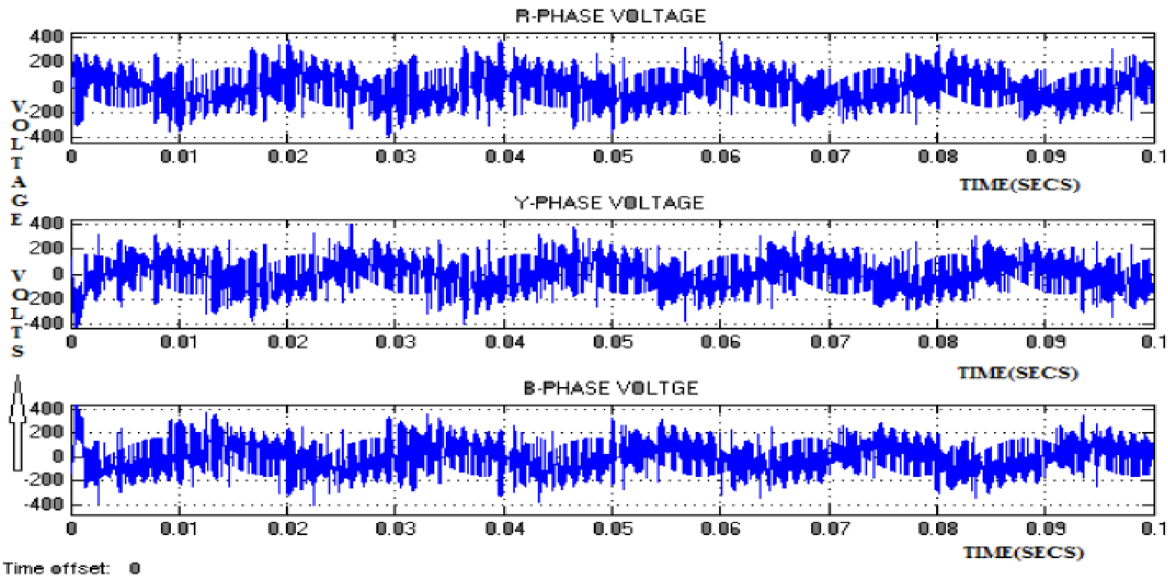

Fig. 9.*Inverter phase Voltage*

CONCLUSION

This paper presents the hysteresis current controlled grid tied inverter for renewable energy applications. The effectiveness of the control scheme has been verified by Mat lab simulation. Current injected to the grid is complies with IEEE 519 standard. Simulation results proved the robustness of the proposed system even during the non linear load operation.

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