CONTROL STRATEGY FOR SINGLE PHASE, SINUSOIDAL PWM CONVERTER USING PI-CONTROLLER

Neeraj Priyadarshi,Phd Scholar
Department of Electrical Engineering,CTAE, Udaipur

Abstract— This paper presented a control strategy for fixed pattern rectifier. Single-phase, sinusoidal, active rectifier is presented, based on the classical inverter topology. The switches **are** governed by a fixed PWM pattern, and the control strategy is extremely simplified **as** compared with many active rectifiers. General Feedback control techniques are commonly used nowadays in single-phase pulse width modulation (PWM) converters to improve the AC current waveform and the power factor. Simulations were obtained using MATLAB/SIMULINK. The simulation and hardware results proved that the control scheme have the advantages of better static and dynamic characteristics, small overshoot of the system response, rapid dynamic response and good robustness.

***Keywords*: fixed pattern rectifier, PI controller, PWM converter etc.**

I. INTRODUCTION

As power electronic systems are extensively used not only in industrial field but also in consumer products. Several problems with regard to their diode rectifiers, which are employed mainly in the dc power supplies, have arisen in recent years. One of the problems is a low input power factor and another problem is caused by harmonics in the input currents. Therefore pulse width modulation converters are adopted in applications that require less distortion in the current waveform. Since the converters have abilities to control the current in sinusoidal waveforms. The unity power factor operation can be easily performed by regulating the current in phase with the power source voltages. The ac-dc conversion of electric power has been used in battery energy storage systems. Traditionally, acdc converters, which are also known as rectifiers, are developed using diodes and thyristors to provide controlled and uncontrolled dc power. The main disadvantage of these naturally commutated converters is the generation of harmonics and reactive power .Harmonics has a negative effect on the operation of the electrical system and, therefore, increasing attention is paid to their generation and control. To improve these shortcomings, three-phase PWM converter is employed to guarantee the good static characteristic and the fast dynamic respond, maintaining the undistorted sinusoidal input current waveform and unity power factor. Its control includes a dual-loop control structure

Voltage controller controls the amount of power required to maintain the dc-link voltage constant. The fast current controller controls the input current, so the high input power factor is obtained. PI voltage controllers as the outer-loop are proposed. Based on analysis of mathematical model of system and target of current control PWM converter was presented. . From the simulation results, the proposed control scheme and controller have the advantages of better static and dynamic characteristics, small overshoot of the system response, rapid dynamic response and good robustness. In this paper, a PI voltage control strategy of single-phase AC/DC pulse width modulation (PWM) converters applying a feedback linearization technique is proposed. First, incorporating the power balance of the input and output sides in system modeling, a nonlinear model of the PWM converter is derived with state variables such as AC input currents and DC output voltage. Then, by input-output feedback linearization, the system is liberalized and a state feedback control law is obtained. With this control scheme, output voltage responses become faster than those in a conventional control structure. As is usual with PWM converters, the input current is regulated to be sinusoidal and the source power factor can be controlled at unity.

II. THE CONTROL PRINCIPLE AND CONFIGURATION

System Control Conf Fig. 1 shows the system control configuration block diagram. The converter have a single-phase controllable bridge which is made up of four controlled power switches to produce a controlled output Voltage three inductances (Ls) in series with the ac side and a capacitor (Cd) on the dc side. z is the equivalent resistance. Control of the dc link voltage requires a feedback control loop .the dc voltage is compared with a reference signal and error signal obtained from this comparison is used to generate a template waveform. The template should be a sinusoidal waveform with the same frequency of the main supply. This template is used to produce the PWM pattern. Current control PWM controls the input current and control is achieved by measuring the instantaneous phase currents and forcing them to follow a sinusoidal current reference template. Voltage control PWM controls the magnitude and phase of the voltage. The current control method is simpler and more stable than the voltage controlled method, and for these reasons it will be explained first.

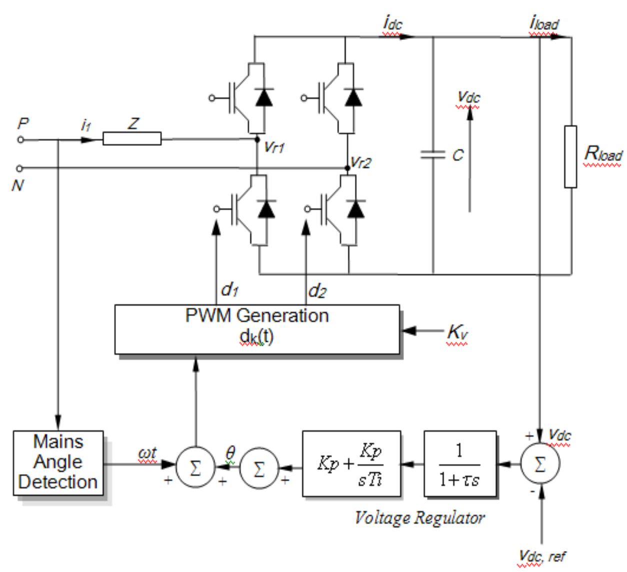

Fig1.system control configuration

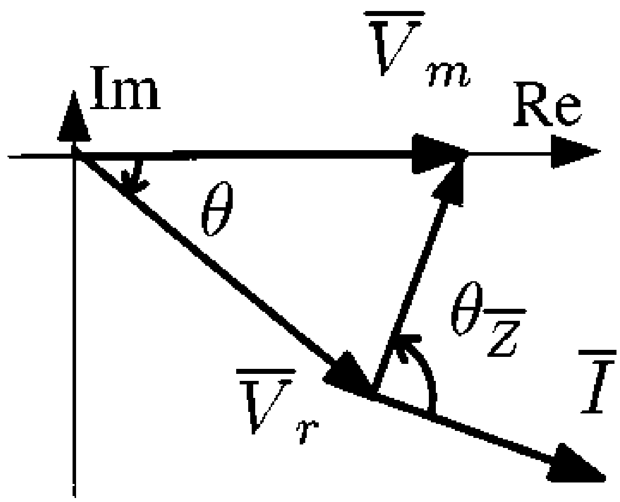

Fig2.phasor diagram of fixed pattern rectifier

A.PHASE-LOCKED LOOP(PLL)

Based on the principle of single phase PWM converter the input current must track the input voltage. A **phase-locked loop** or **phase lock loop** (PLL) is a control system that generates a signal that has a fixed relation to the phase of a "reference" signal. A phase-locked loop circuit responds to both the frequency and the phase of the input signals, automatically raising or lowering the frequency of a controlled oscillator until it is matched to the reference in both frequency and phase. A phase-locked loop is an example of a control system using negative feedback.

B.PI CONTROLLER

PI Controller (proportional-integral controller) is a feedback controller which drives the plant to be controlled with a weighted sum of the error (difference between the output and desired set-point) and the integral of that value. It is a special case of the common PID controller in which the derivative (D) of the error is not used.

III. SIMULATION AND EXPERIMENT RESULTS

Simulations have been obtained using MATLAB/SIMULINK. Experimental results have been obtained with a low power laboratory prototype of a single –phase PWM converter. The main parameters are as followings: The input voltage is 230V/50Hz, Ls=0.75mH, C =.1µF,R=0.1ohm.fig2 shows the generation of pulses for IGBT converter by comparing sinusoidal signal and triangular signal.fig 3 is the pulses for IGBT converter.fig 4 shows the simulated open loop PWM converter.fig 5 shows simulated IGBT Converter.fig6 shows the simulated closed loop. Fig7shows the simulated output waveform of PWM converter.fig 8shows the simulated ac voltage and current waveform. The line current is nearly a sine wave with unity power factor.fig9 shows the simulated fundamental current waveform.

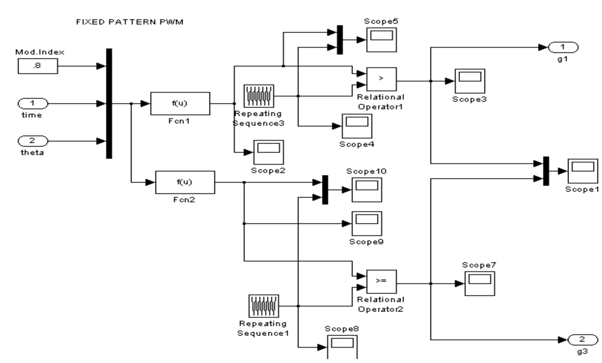

Fig2. Generation of pulses for IGBT converter

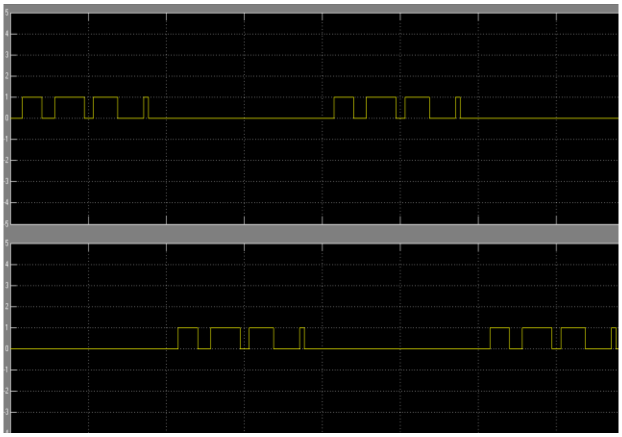

Fig3. Pulses for IGBT CONVERTER

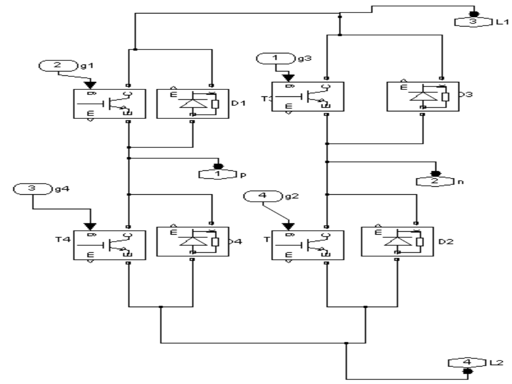

Fig5.IGBT Converter

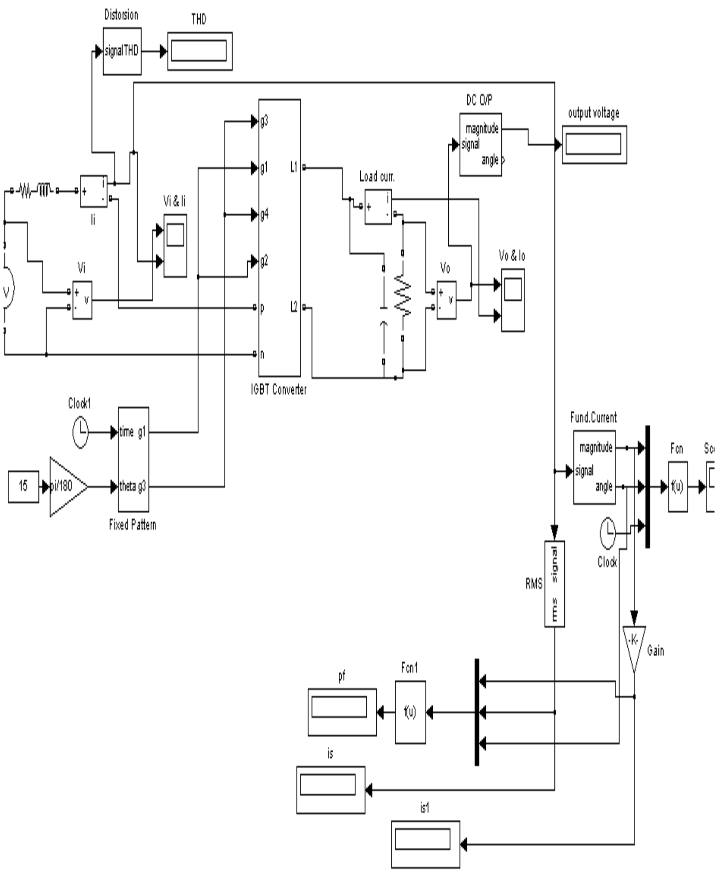

Fig4.open loop simulation

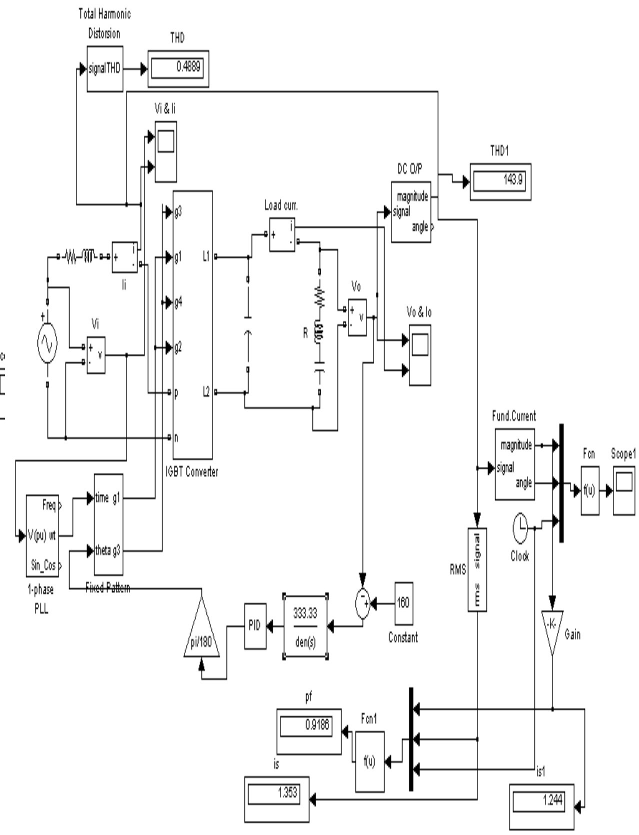

Fig6.Closed loop simulation

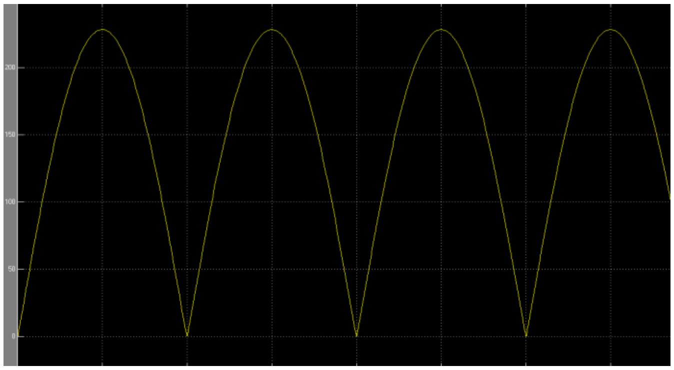

Fig7.Output Waveform

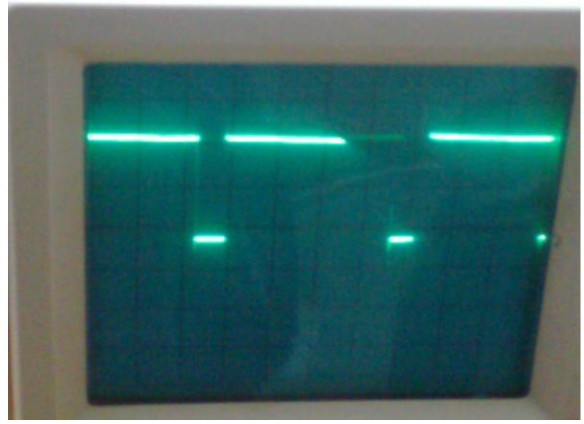

Fig10.Pulses for S1,S3

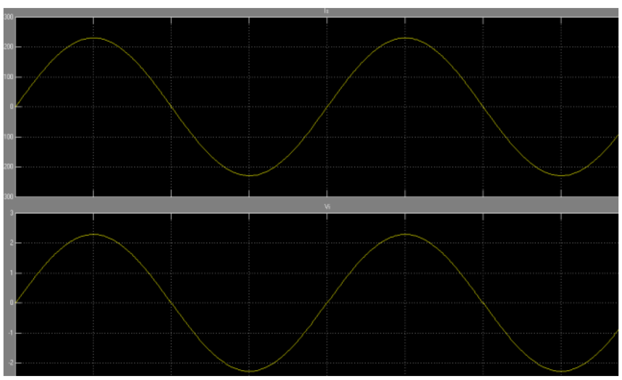

Fig8.input voltage and input current waveform

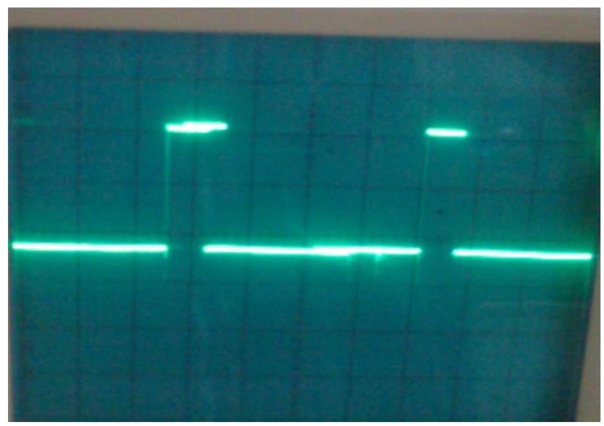

Fig11.Pulses for S2,S4

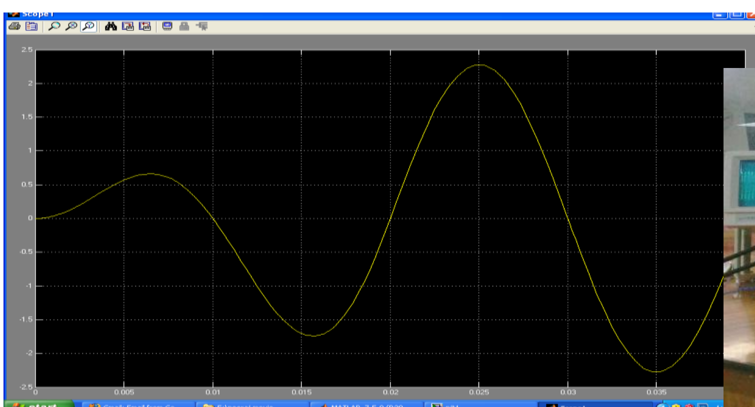

Fig9.Fundamental current

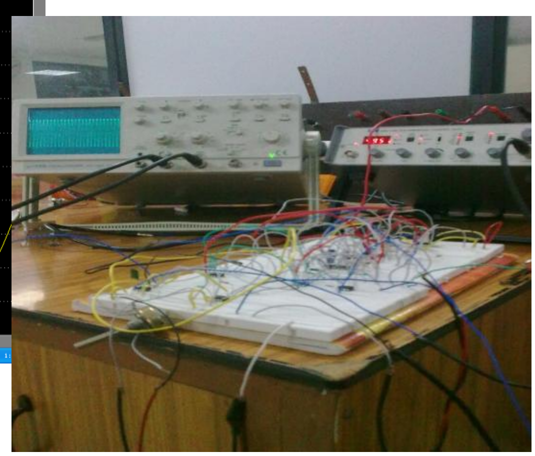

Fig12.Hardware setup

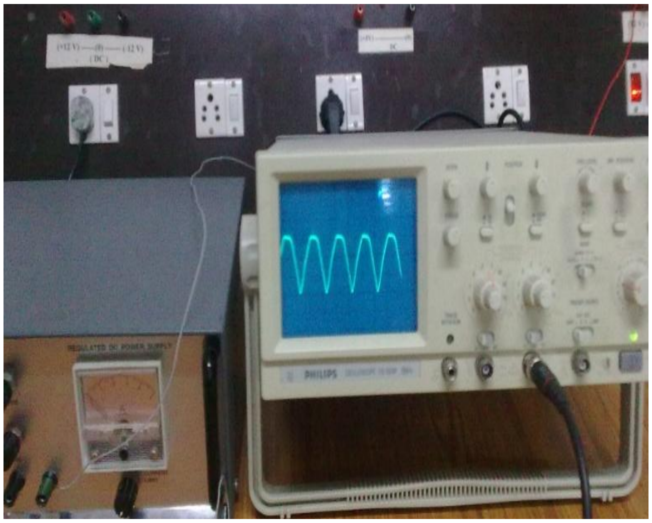

Fig13.Output of single phasePWM converter

IV. CONCLUSION

A single-phase, sinusoidal, active rectifier has been presented. The switches are governed by a fixed PWM pattern. General equations describing the steady-state operation of fixed pattern rectifiers have been presented. The designed method is proved feasible by simulated and experimental results and has better static and dynamic characteristics

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