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Proportional-Resonant-Control of KY-Boost-converter with grid-connected -inverter for Power-Quality-Improvement

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***ABSTRACT** Recently, "KY-Boost-Converter (KYBC)" has been extended as a substitute between PV-system &AC-load. DC-level is enhanced using Boost-Converter (BC) &its yield is inverted and AC is applied to a three-phase-load. This work suggests the combination of KY Boost converter with grid-connected-three-phase-inverter-system (KYBCTPIS). The KYBC is exploited to escalate the voltage-gain. Simulink-models are developed for (-Proportional*Integral) PI, (-Fractional*order-proportional-integral-derivative) FOPID-controller (*proportional resonant) PRC based KYBCTPI-systems. This effort mainly compares the time-responses of PI, FOPID controller and PR controller based KYBCTPI- systems. The investigations indicate that the response of PR Control based KYBCTPI system is better than PI & FOPID based KYBCTPI systems.*

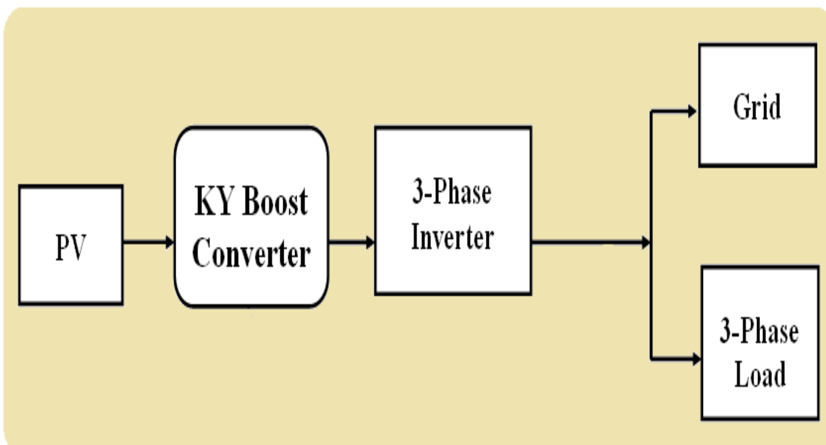
***Keywords:** KY-Boost converter, PV, Boost Converter, Proportional Resonant Control, Fractional Order PID.*

1. INTRODUCTION

Renewable energies play an essential role in the production of electricity today and also lead to distributed production, to micro-rated and smart cities. Researchers have constantly worked on the converters to obtain better voltage gain and efficiency with reduced ripple both in voltage and in current. A converter was an electrical energy converter that changes the voltage or current of an electrical energy source. Renewable energy systems required a high gain pulse converter for most applications. This could be done effectively by implementing the boost converter. In general, batteries were used as a power source in compact applications and were of a variable nature [1]. DC-DC switching mode converters were widely used in compact, low-power applications due to their extremely high capacity and small size.

'The author presented-a novel-BBC (-buck boost converter) which unites the KY & buck-converters'. In this, the 2D converter was presented with a positive output voltage, which combines the KY converter and the traditional synchronized reducer (SR) converter. Since said converter inherently operates in continuous drive mode, it has non-pulsed output-current, therefore, it not only decreases the current voltage in the output capacitor but also reduces the ripple of the output voltage. In this study, a new DC / DC booster converter was presented. The-recommended converter-circuit-structure consisted of a solitary-power switch, 2diodes, &a few-energy-storage constituents [2]. -The scrutiny &execution of a novel-DC/DC-converter with a solitary booster was suggested by Ardi. In addition, the pulse converter consisted of a positive output positive pulse converter which combined KY and SR dollar converters. This converter inherently operates in continuous pilot mode and has a non-pulsed output current, so that the current voltage in the output capacitor and the ripple of the output voltage had been reduced. The author presented the improvement in voltage gain for an elevator converter built by KY and buck-boost converters [3-8]

KY-converter contains 2power-switches, 1 power diode, 1 power transfer capacitor, an output capacitor and an inductor [9]. YH Chang [12] proposed a capacitor converter exchanged by a closed-circuit inductor which uses PWM compensation for progression towards the DC-DC transformation / guideline, and consolidates together the adaptive stage number, the control of use of the upper switch and a higher supply voltage. '*The-block diagram of the-KY boost-open loop*converter' is described in-Figu1.



-Fig1. -Block-diagram of-KY-Boost-open-loop-converter

Jose [13] presented a step-up converter with positive output which combines the step-down converters KY and SR-step-down. In most portable electronic equipment, batteries were used as a power source. An effective power management technique was necessary to extend the life of the battery. In some batteries, the output voltage was not constant, so an additional switching power unit was required to obtain a constant output voltage. -Jeeva presented the "-enhanced performance of the step-up-elementary split inductance-converter utilizing SMC plus FLC". -Continue the implementation of SMC-plus a double-PIC for the elementary boost converter with negative-yield [15-19]. Finally-SMC-Modelling, simulation &plan of variable structure based on SMC for-KY step-up-converter.

It has been designed to control the output voltage of the positive output booster converter (POBC) KY operating in DC coil current with the proportional integral controller (PIC). The average KY-POBC model was first obtained, and then the PIC was designed. -The concert of the controller utilizing-KY-POBC had been corroborated in diverse-provinces [20]. To conquer the drawbacks of Boost*Converter, a KY-converter was utilized with a synchronous-rectified-boost* converter [21]

1.1 Research Gap

The above works do not report the comparison of-PI, FOPID-control &-PRC based KYBCTPI-systems. This work suggests the combination of KY Boost converter with grid-connected-three-phase-inverter-system. -Hence, -the-present-work deals with FOPID-control &-PRC based KYBCTPI-systems.

2. SYSTEM DESCRIPTION

Block diagram of KYBCTPIS with-FOPID/PR controller is appeared in Fig2.

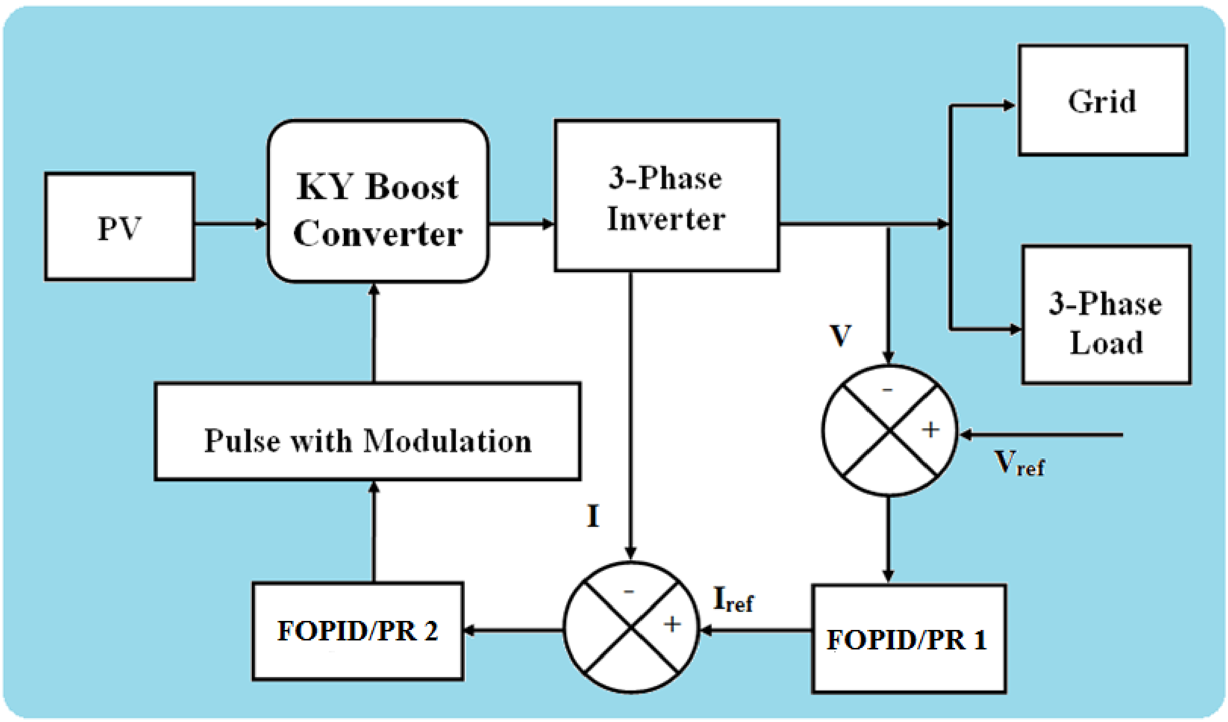


Figure 2. Block diagram of KYBCTPIS with-FOPID/PRcontroller

3. SIMULATION RESULTS

Circuit diagram of KYBCTPIS with source disturbance is described in Figu3.

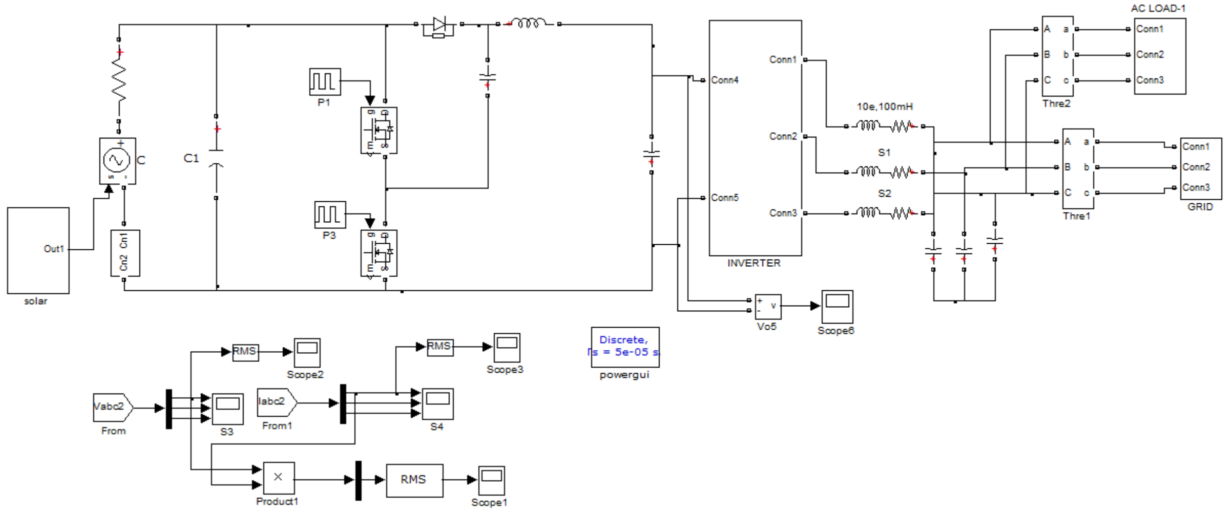


Figure 3. Circuit diagram of KYBCTPIS with source disturbance

Voltage across PV is appeared in Fig4&its-value is 225Volts. Voltage across KY boost converter with disturbance is outlined in Fig5 &its-value is 490 Volts.

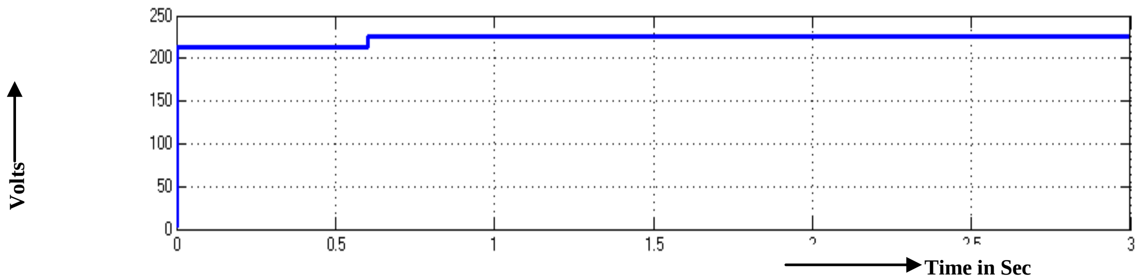


Figure 4. Voltage across PV with source disturbance

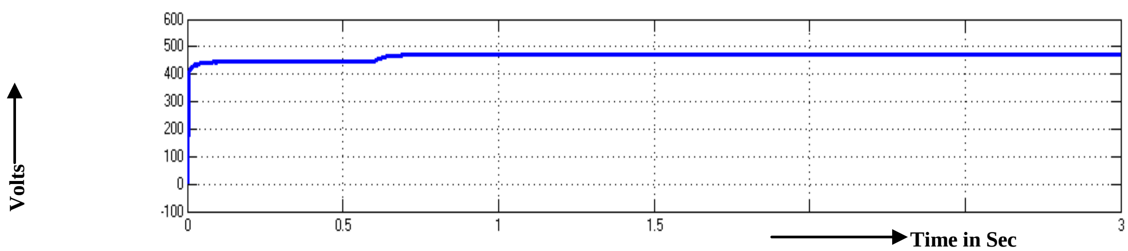


Figure 5. Voltage across KY boost converter with source disturbance

Output voltage across RL –Load with disturbance is delineated in Fig6 &its-value is 450 Volts. RMS voltage across RL –load with disturbance is appeared in Fig7 &its-value is 293.49 Volts.

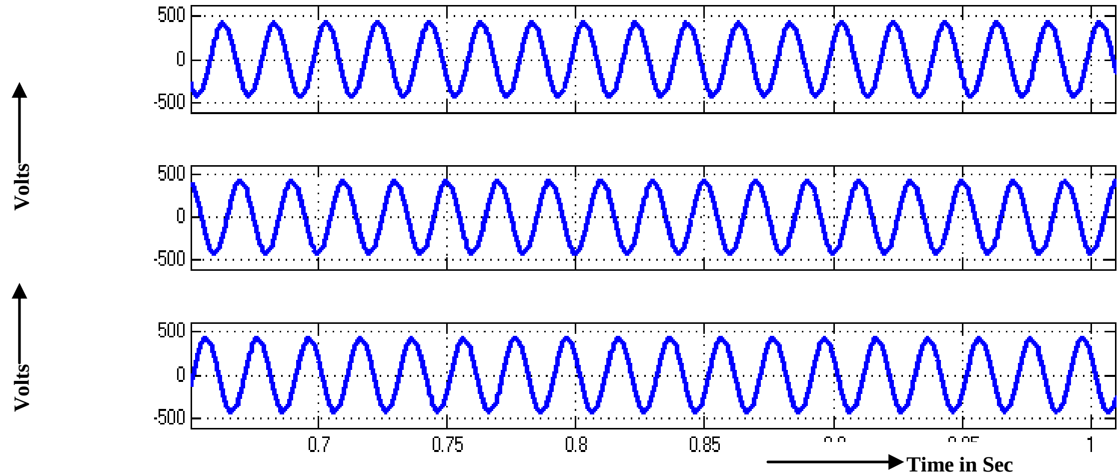


Figure 6 Voltage across RL –Load with source disturbance

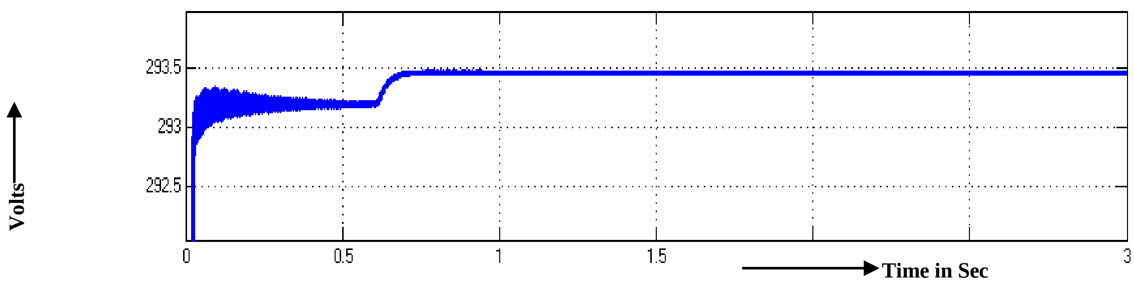


Figure 7 RMS Voltage across RL –load with source disturbance

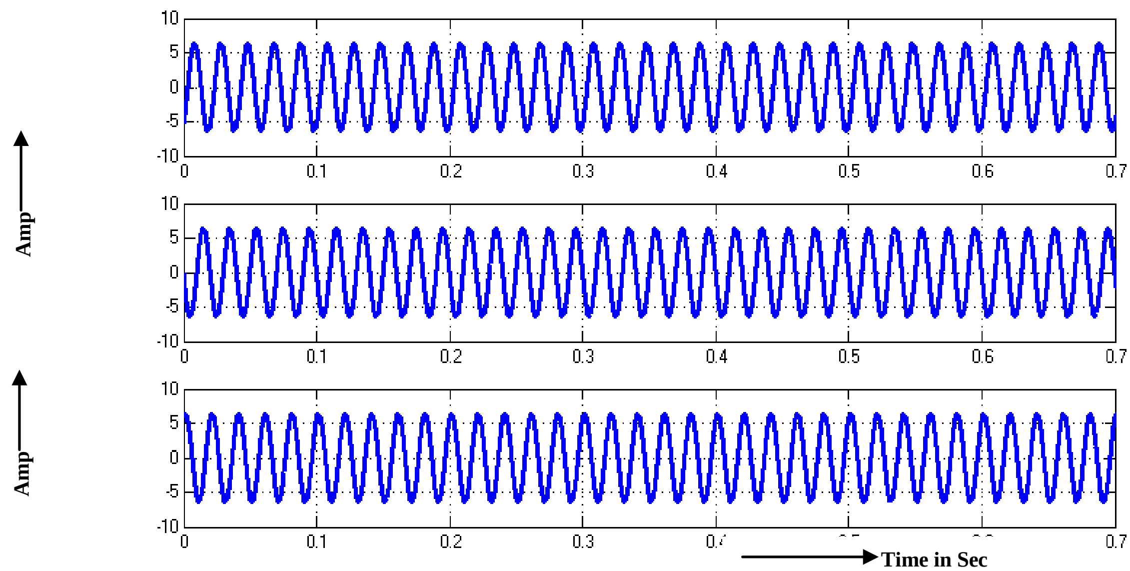


Figure 8 Current through RL-Load with source disturbance

Current through RL-Load with source-disturbance is appeared in Fig8&its-value is 7.5 A. Output power is outlined in Fig9 &its-value is 946 W.

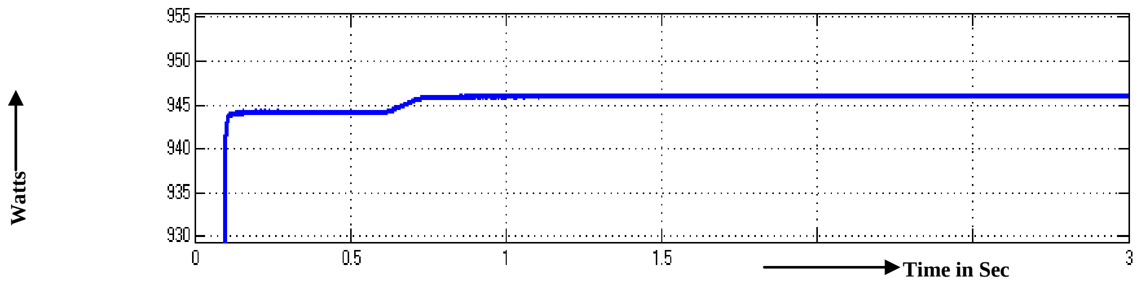


Figure 9 Output power with source disturbance

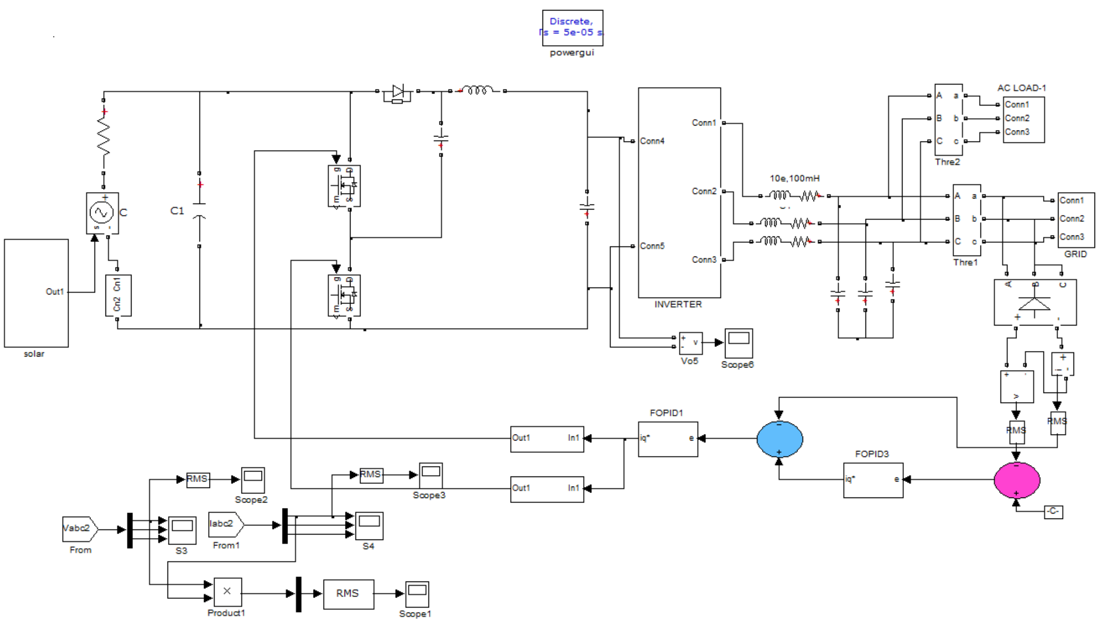


Figure 18 Circuit diagram of KYBCTPI system with-FOPID controller

Voltages across PV are outlined in Fig19 &its-value is 225Volts.

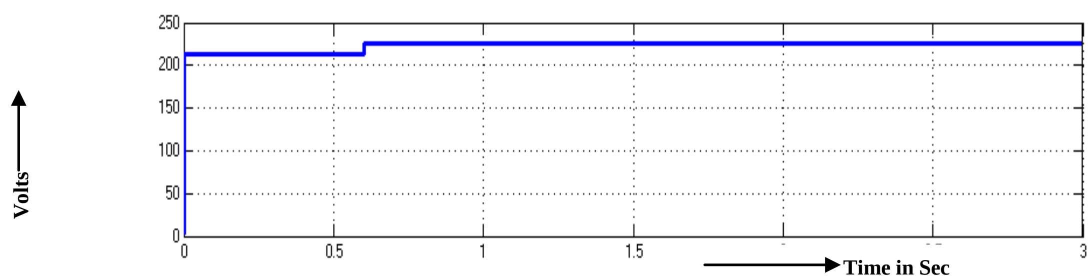


Fig19--Voltages across PV

Voltage across KY boost converter with-FOPID controller is appeared in Fig20 &-its- value is 455Volts.

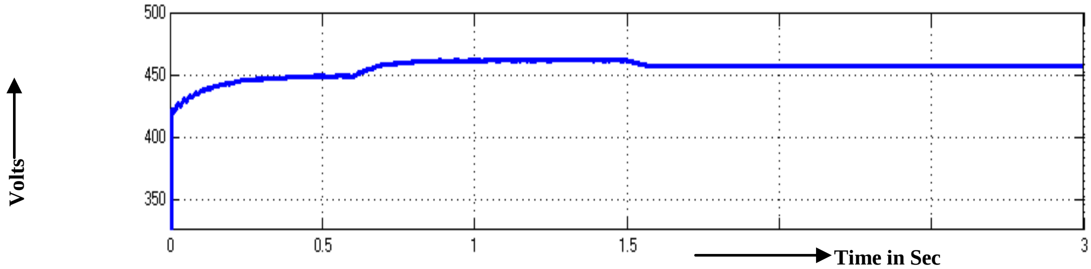


Figure 20 Voltage across KY boost converter with-FOPID controller

Output voltage across RL –Load of KYTPIS with-FOPID controller is delineated in Fig21 &its-value is 450Volts.

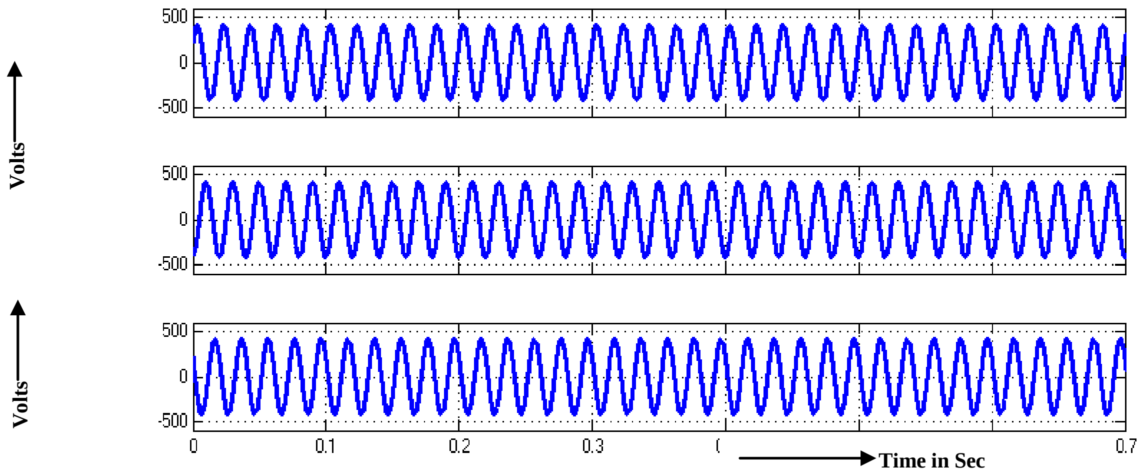


Figure 21 Voltage across RL –Load of KYBCTPI system with-FOPID controller

RMS voltage across RL –load of KYBCTPIS with-FOPID controller is appeared in Fig22 &its-value is 293.4Volts.

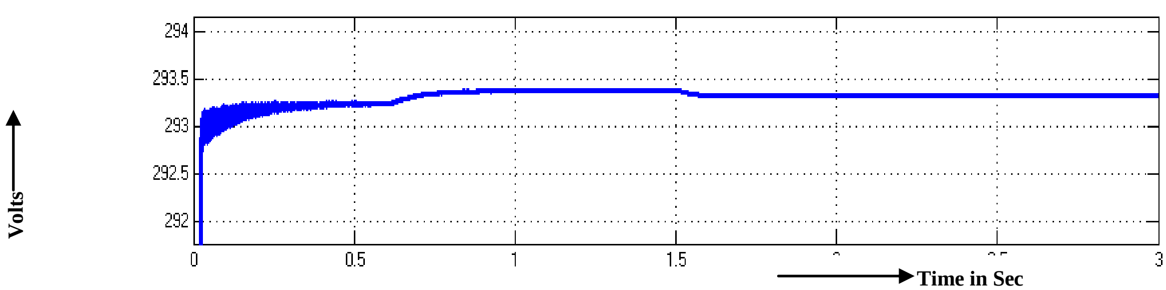


Figure 22 RMS voltage across RL-load of KYBCTPI system with-FOPID controller

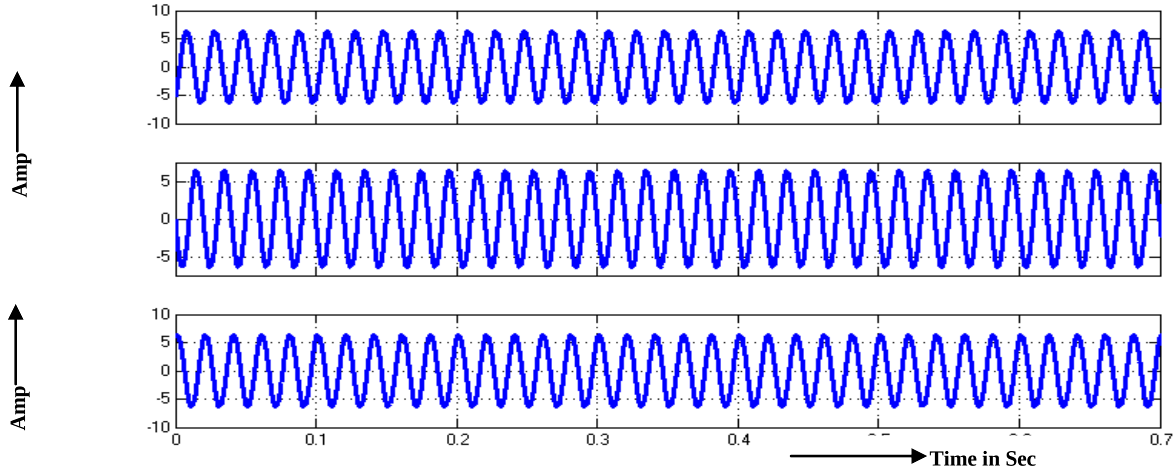


Figure 23 Current through RL-Load of KYBCTPI system with-FOPID controller

Current through RL-Load of KYBCTPIS with-FOPID controller is outlined in Fig23 &its-value is 7A. Output current THD of KYBCTPIS with-FOPID controller is outlined Fig24. The output power of KYTPIS with-FOPID controller is outlined in fig25 &its-value is 945 W.

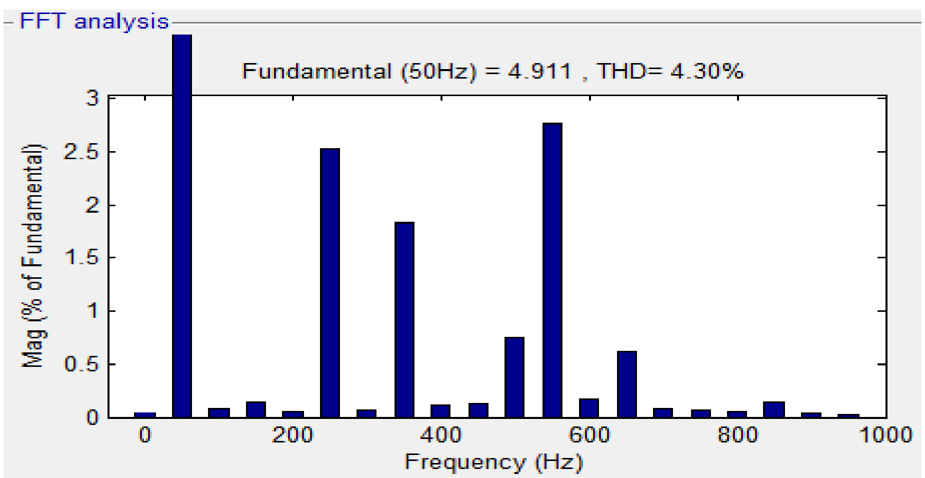


Figure 24 Current THD of KYBCTPI system with-FOPID controller

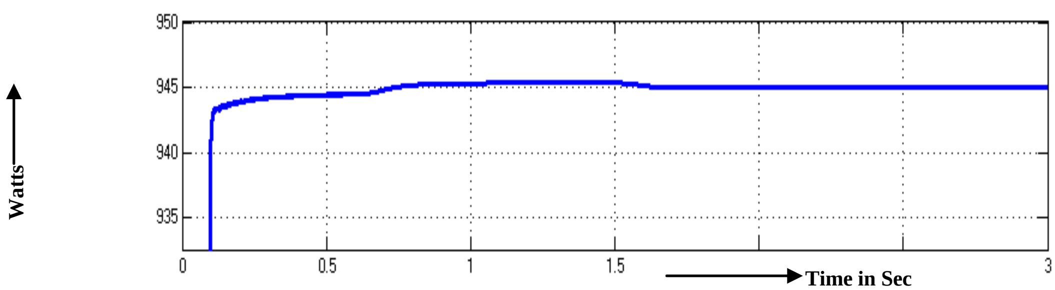


Figure 25 Output power of KYBCTPI system with-FOPID controller

Circuit diagram of KYBCTPIS with PR controller outlined in Fig26.

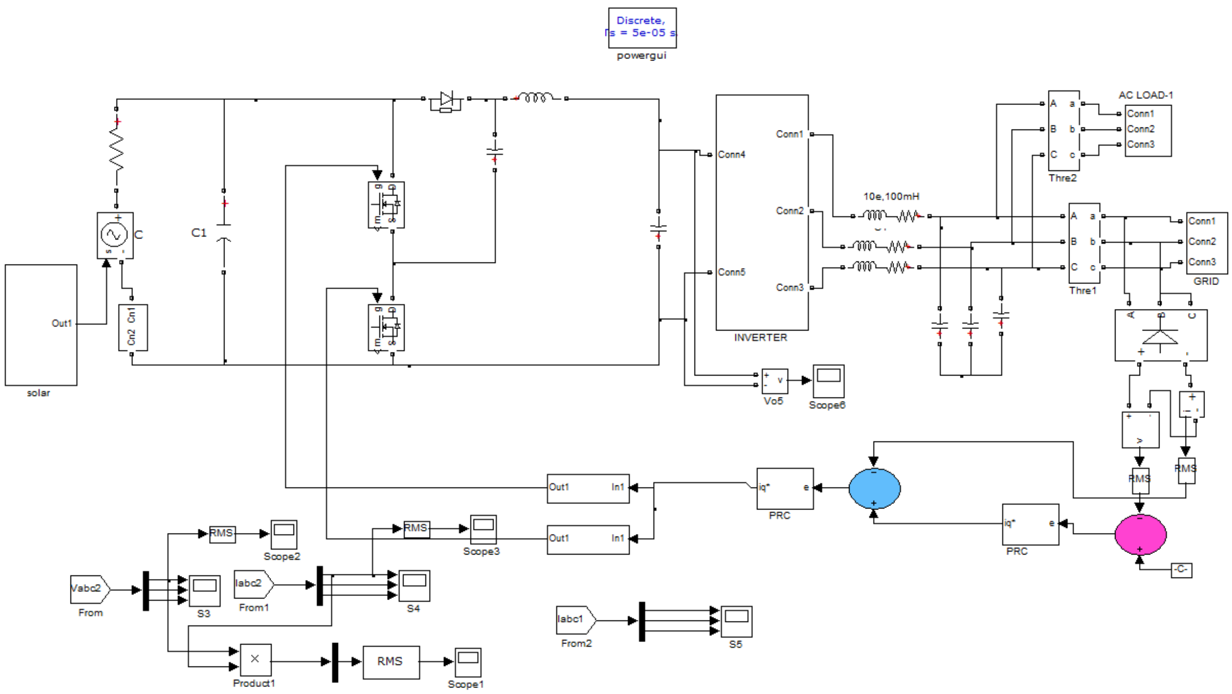


Fig26.Circuit diagram of KYBCTPI system with-PR controller

Voltages across PV are outlined in Fig27 &its-value is 225Volts.

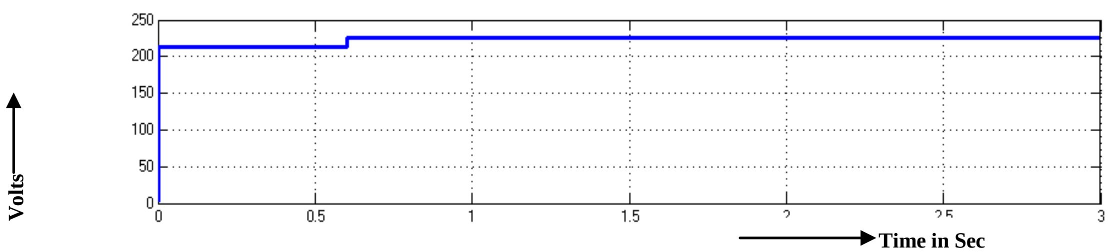


Fig27Voltages across PV

Voltage across KY boost converter with PR controller is appeared in Fig28 &its value is 455 Volts.

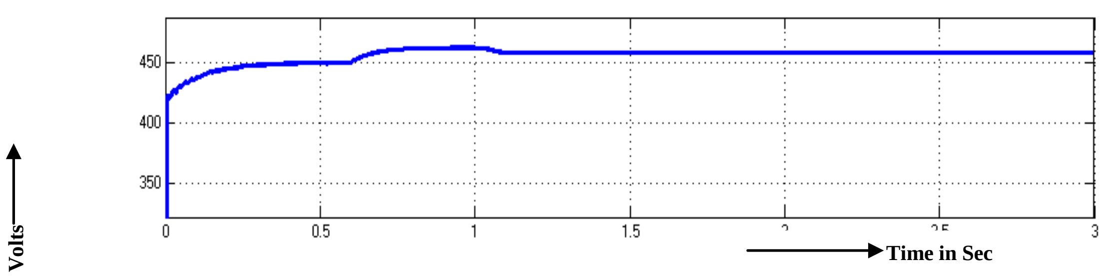


Figure 28 Voltage across KY boost converter with - PR controller

Output voltage across RL –Load of KYBCTPIS with-PR controller is delineated in Fig29 &its- value is 450Volts.

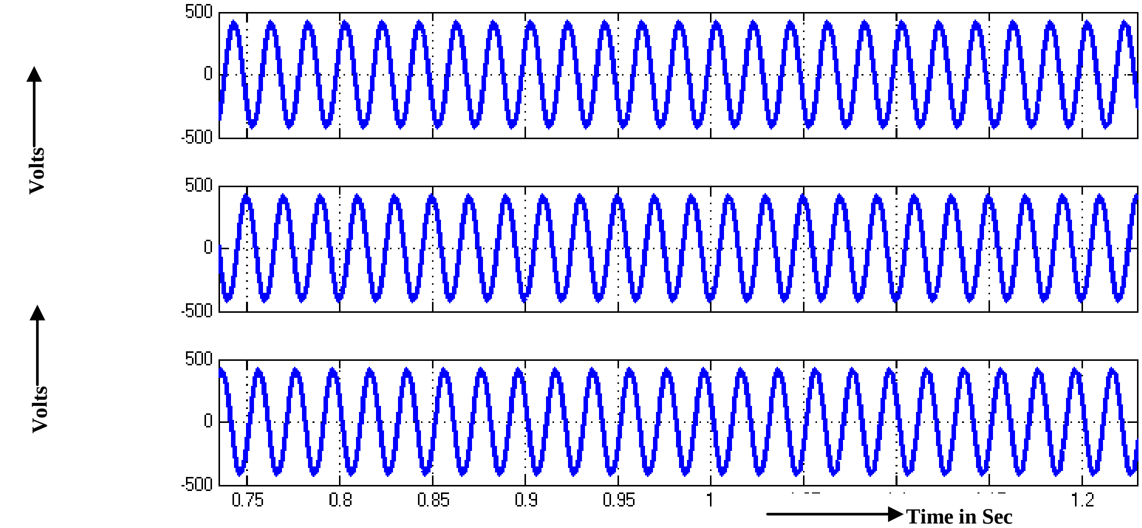


Fig29 Voltage across RL –Load of KYBCTPI system with- PR controller

RMS voltage across RL –load of KYBCTPIS with- PR controller is appeared in Fig30 &its-value is 293.4 Volts.

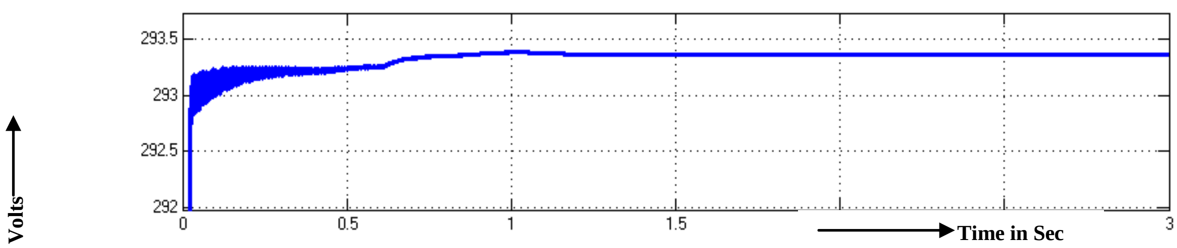


Fig30.RMS voltage across RL –load of KYBCTPI system with- PR controller

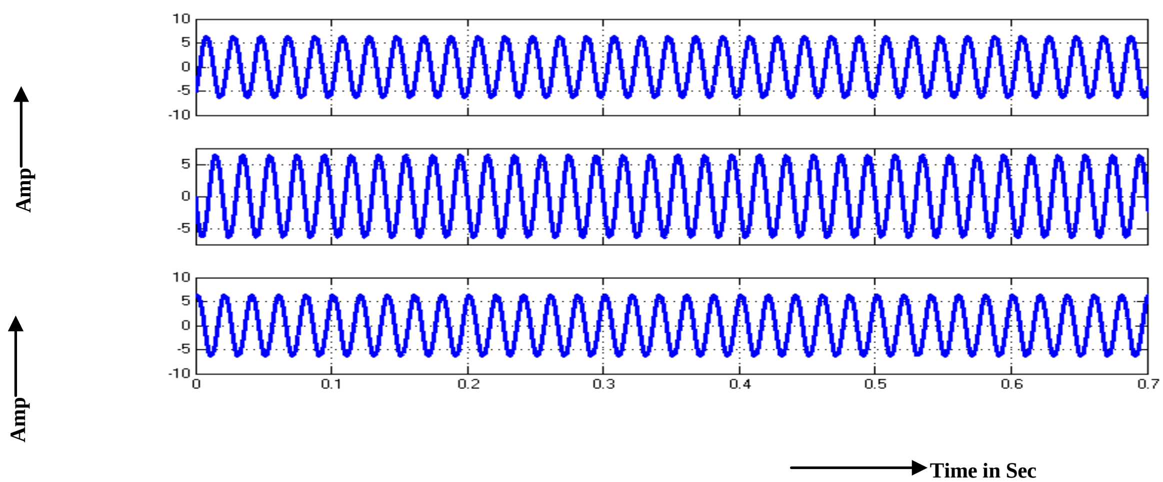


Fig31 Current through RL-Load of KYBCTPI system with- PR controller

Current through RL-Load of KYBCTPIS with- PR controller is outlined in Fig31 &its -value is 6.5A. Output current THD of KYBCTPIS with- PR controller is outlined Fig32. The output power of KYBCTPIS with -PR controller is outlined in fig33 &its-value is 945 W.

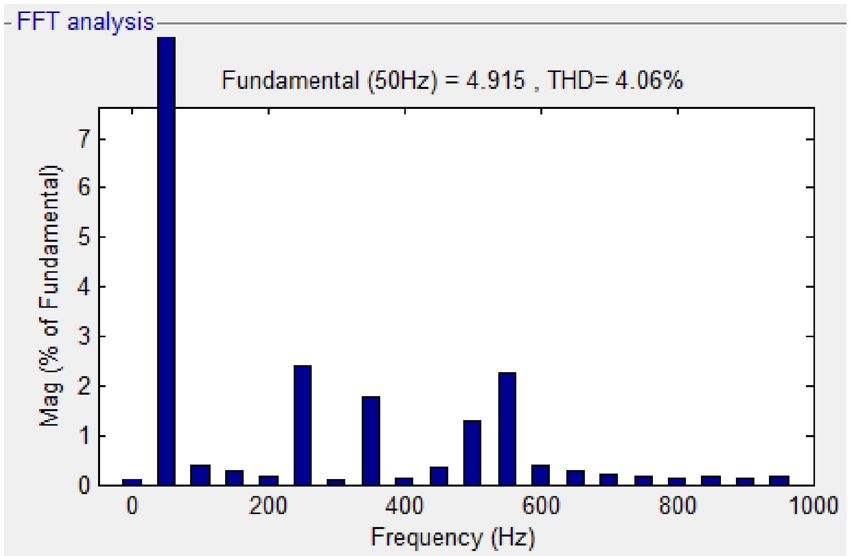


Fig32 Current THD of KYBCTPI system with- PR controller

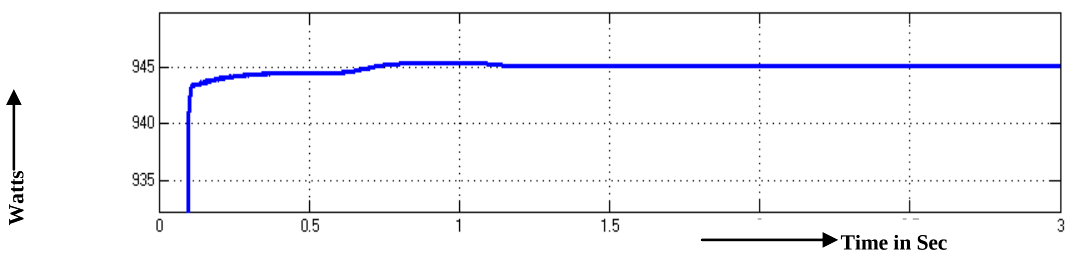


Fig33 Output power of KYBCTPI system with-PR controller

"-Comparison of time-domain-parameters for motor-speed KYBCTPI with- FOPID &PRC is given in Table 1. By using PR-controller, 'rise-time' is diminished from 0.85 sec to 0.78 sec; 'peak-time' is diminished from 1.47 sec to 0.89 sec; 'settling-time' is diminished from 1.52 sec to 1.15 sec ;'steady-state-error' is diminished from 1.5 RPM to 1.1 RPM. Barchart Comparsion Time Domain Parameters for motor speed with FOPID and PRC is outlined in Fig 34. Comparsion output current THD of KYBCTPI with- FOPID &PRC is given in Table-2. By using PR-controller, 'Output-current-THD' is diminished from 4.30% to 4.06%.

Table-1 Comparsion of Time Domain Parameters for motor speed with FOPID and PRC

Controller	**Rise time (s)**	**Peak time (s)**	**Setting time (s)**	**Steady state error (RPM)**
FOPID	**0.85**	**1.47**	**1.52**	**1.5**
PRC	**0.78**	**0.89**	**1.15**	**1.1**

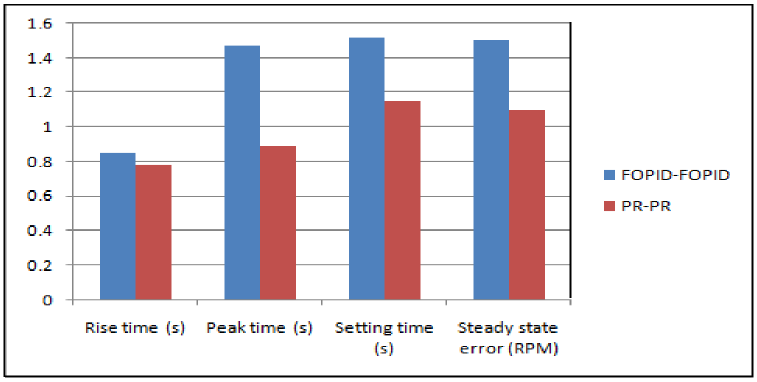


Fig34 Barchart Comparsion of Time Domain Parameters for motor speed with FOPID and PRC

Table-2 Comparsion of output current THD with FOPID and PRC

Controller	THD (%)
FOPID	4.30%
PRC	4.06%

4. CONCLUSION

PI, FOPID and PR controller based KYBCTPIS are designed, simulated &analyzed using Matlab simulink. By using KY Boost converter, By using PR-controller, 'settling-time(ST)' is diminished from 1.52 sec to 1.15 sec , 'steady-state-error(SSE)' is diminished from 1.5 RPM to 1.1 RPM&'outpt-current-THD' is diminished from 4.30% to 4.06%. Both ST and SSE are diminished using PRC. The outcome represents that the PR controlled-KYBCTPIS is superior to FOPID controlled-KYBCTPI systems.

The present work deals with comparison of KYBCTPIS using -PI, FOPID and PR controllers. Evaluation of KYBCTPIS with FL controller can be done in Future.

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