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A Comparative Study of Different Filters on Bridgeless Interleaved closed loop AC-DC Converter for Power Factor Correction

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ABSTRACT: This paper presents the closed loop controlled bridgeless interleaved PFC (Power Factor Correction) Ac to Dc converter system. The proposed PFC converters consist of controlled rectifier, PFC converter and DC converter. The π filter is connected at the output of converter to reduce output ripple of DC converter. The performance of the proposed converter is verified by interfacing Dc loads. This work deals with comparison of PI & PID controlled interleaved bridgeless PFC converter system. The steady state performance parameter like output voltage ripple, speed, power factor is analyzed with PI (Proportional Integrative) and PID Controller. The Transient parameters such as rise time, peak time, settling time, and steady state error also compared for both controller. The Closed loop PI & PID controlled bridgeless interleaved PFC converter systems are modeled and simulated.

KEYWORDS: PID control, PI control, ∏-filter, PMSM, output voltage ripple

I. INTRODUCTION

The Performance evaluation of bridgeless PFC boost rectifiers is given by Huber [1]. A high-performance single-phase bridgeless interleaved PFC converter for plug-in hybrid electric vehicle battery chargers is presented by Musavi [2]. Evaluation and efficiency comparison of front end AC–DC plug-in hybrid charger topologies is suggested by Edington [3]. A ZVS interleaved boost AC/DC converter used in plug-in electric vehicles is given by Pahlevaninezhad [4]. Electromagnetic Compatibility (EMC) Limits for Harmonic Current is presented by Emissions [5]. Ultra flat interleaved triangular current mode (TCM) single-phase PFC rectifier is suggested by Marx gut [6]. An ultra-fast dc-charge infrastructure for EV-mobility and future smart grids is given by Agiler [7]. Single-stage high-power-factor electronic ballast with ZVS buck–boost conversion is presented by Cheng [8]. Characterization of an active clamp fly back topology for power factor correction applications is suggested by Watson [9]. Nonlinear-carrier control for high-power factor rectifiers based on up-down switching converters is given by Zane [10].

A new family of single-stage isolated power-factor correctors with fast regulation of the output voltage is given by Redl [11]. Comprehensive study of single-phase AC–DC power factor corrected converters with high frequency isolation is presented by Singh [12]. Analysis and design of a low-stress buck-boost converter in universal-input PFC applications is suggested by Maksimovic [13]. New bridgeless DCM SEPIC and Cuk PFC rectifiers with low conduction and switching losses is given by Sabzali [14]. Bridgeless SEPIC PFC rectifier with reduced components and conduction losses is presented by Mahdavi [15]. Bridgeless SEPIC rectifier with unity power factor and reduced conduction losses is suggested by Ismail [16].

A new efficient bridgeless Cuk rectifier for PFC applications is given by Fardoun [17]. Swiss rectifier: A novel three-phase buck-type PFC topology for electric vehicle battery charging is presented by Soeiro [18]. Design and implementation of a three-phase buck-type third harmonic current injection PFC rectifier SR is suggested by Kolar[19].

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Design-oriented analysis and performance evaluation of buck PFC front end is presented by Huber [20]. Zero-voltage-switching control for a PWM buck converter under DCM /CCM boundary is suggested by Chiang [21]. The zero voltage switching (ZVS) critical conduction mode (CRM) buck converter with tapped-inductor is given by Park [22]. Design considerations of a high efficiency soft-switched buck AC–DC converter with constant on-time (COT) control is presented by Zhang [23]. Variable on-time (VOT) controlled critical conduction, mode buck PFC converter for high input AC/DC HB-LED lighting application is suggested by Zhang [24].

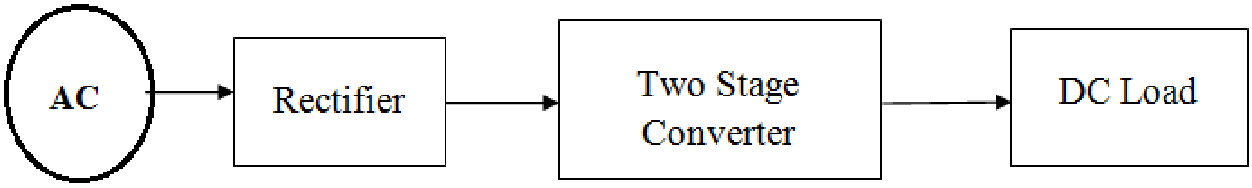

Fig 1.1 Block diagram of Existing system

A loss-adaptive self-oscillating buck converter for LED driving is given by Chen [25]. Bridgeless high-power-factor buck converter is presented by Jovanovic [26]. An improved buck PFC converter with high power factor is suggested by Zheng [27]. A novel single-phase buck PFCAC–DC converter with power decoupling capability using an active buffer is given by Ohnuma [28]. A Block diagram of Proposed System is shown in Fig 1.2

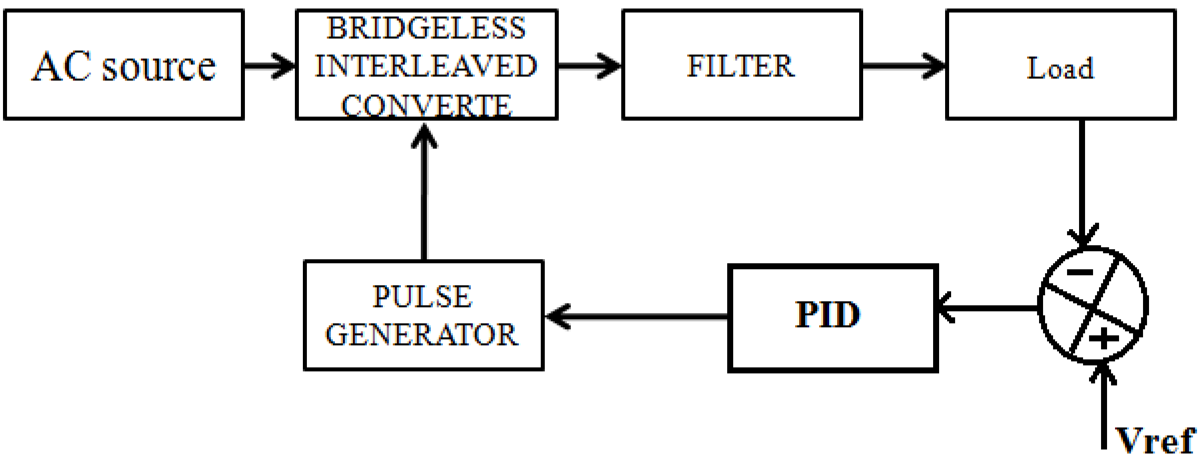

Fig 1.2 Block diagram of Proposed System

Advanced integrated bidirectional AC/DC and DC/DC converter for plug-in hybrid electric vehicles is presented by Khaligh [29]. A bidirectional high-power quality grid interface with a novel bidirectional noninverted buck-boost converter for PHEVs is suggested by Kobayashi[30]. Duty-ratio feed forward for digitally controlled boost PFC converters is given by Gusseme[31].

The above literature does not deal with comparison of TSPFCCT system. Thus work proposes FLC for the control of TCPFCCI system. The block diagram of existing system is shown In Fig 1.1. In the proposed system, Three-phase inverter with PMSM load is used. FLC is used to improve speed regulation block diagram of proposed system is shown in Fig 1.2.

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II. SIMULATION RESULTS

Simulation is done using matlab and the results are presented here. Open loop system with increase in input voltage is shown in Fig 2.1.The input voltage is shown in Fig 2.2 and its peak value is 230 V. The output voltage of bridgeless interleaved PFC is shown in Fig 2.3 and its peak value is 400 V.

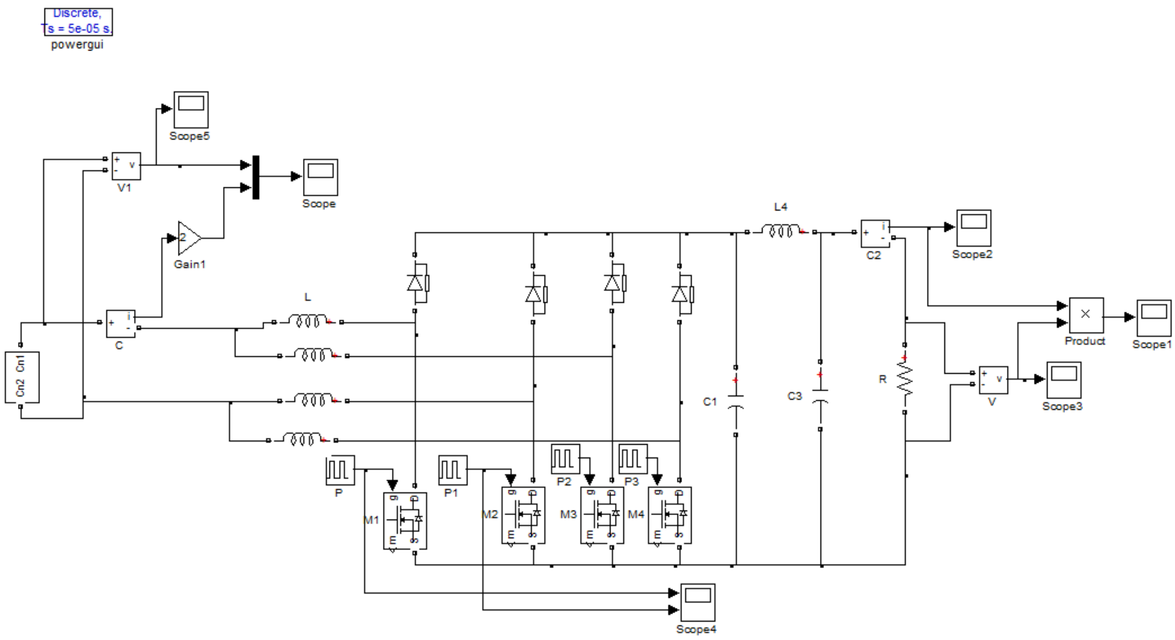

Fig 2.1 Open loop system with disturbance

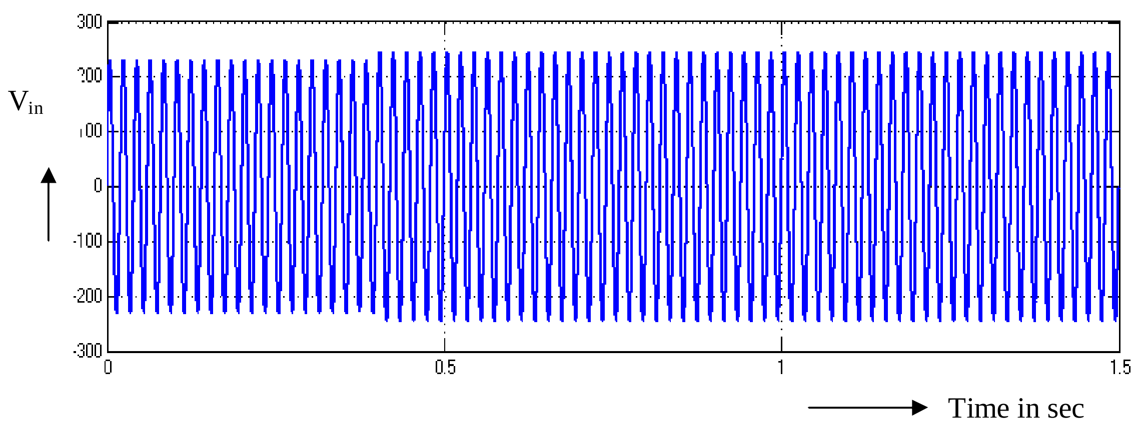

Fig 2.2 Input voltage

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The output current is shown in Fig 2.4 and its peak value is 5.2A. The output power is shown in Fig 2.5 and its value is 2000W.

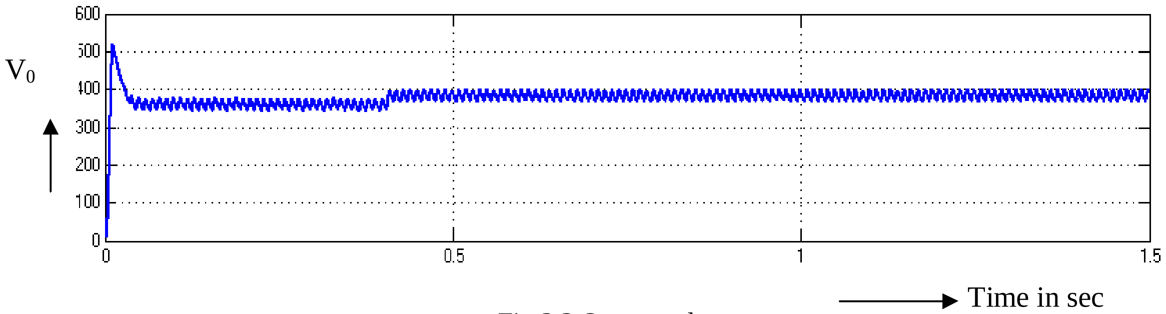

Fig 2.3 Output voltage

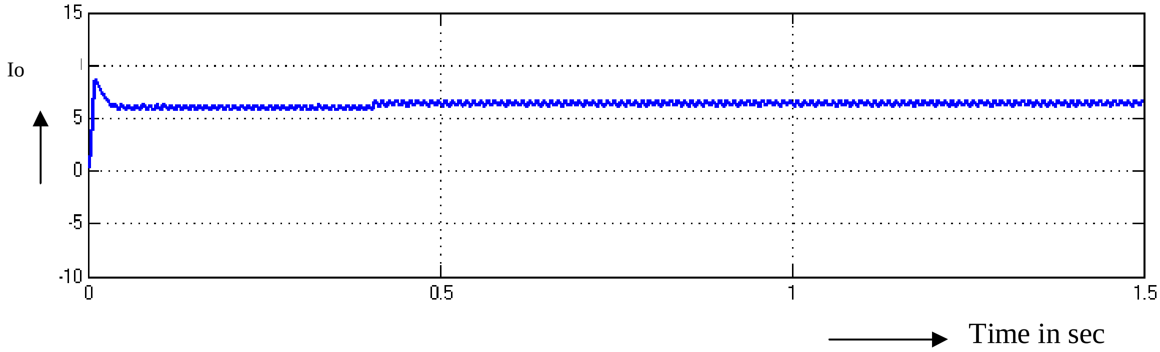

Fig 2.4 Output current

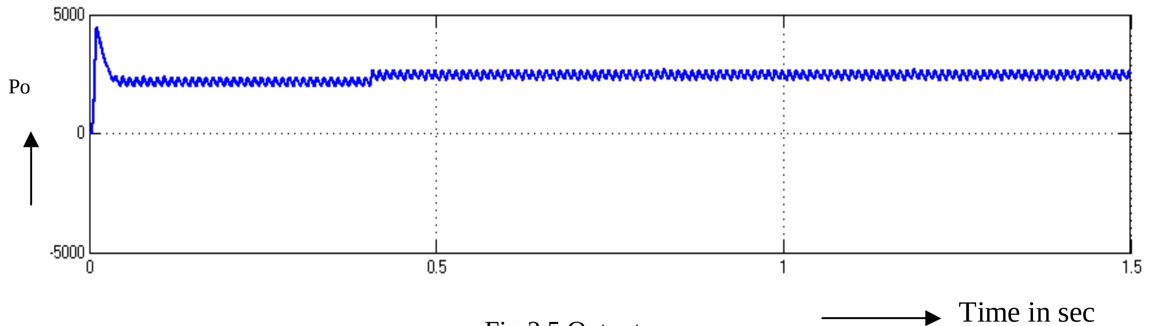

Fig 2.5 Output power

Closed loop system with PI controller is shown in Fig 3.1. The input voltage is shown in Fig 3.2 and its peak value is 230 V. The output voltage of bridgeless interleaved PFC is shown in Fig 3.3 and its peak value is 380 V. The output current is shown in Fig 3.4 and its peak value is 3.5 A. The output power is shown in Fig 3.6 and its value is 2200 W.

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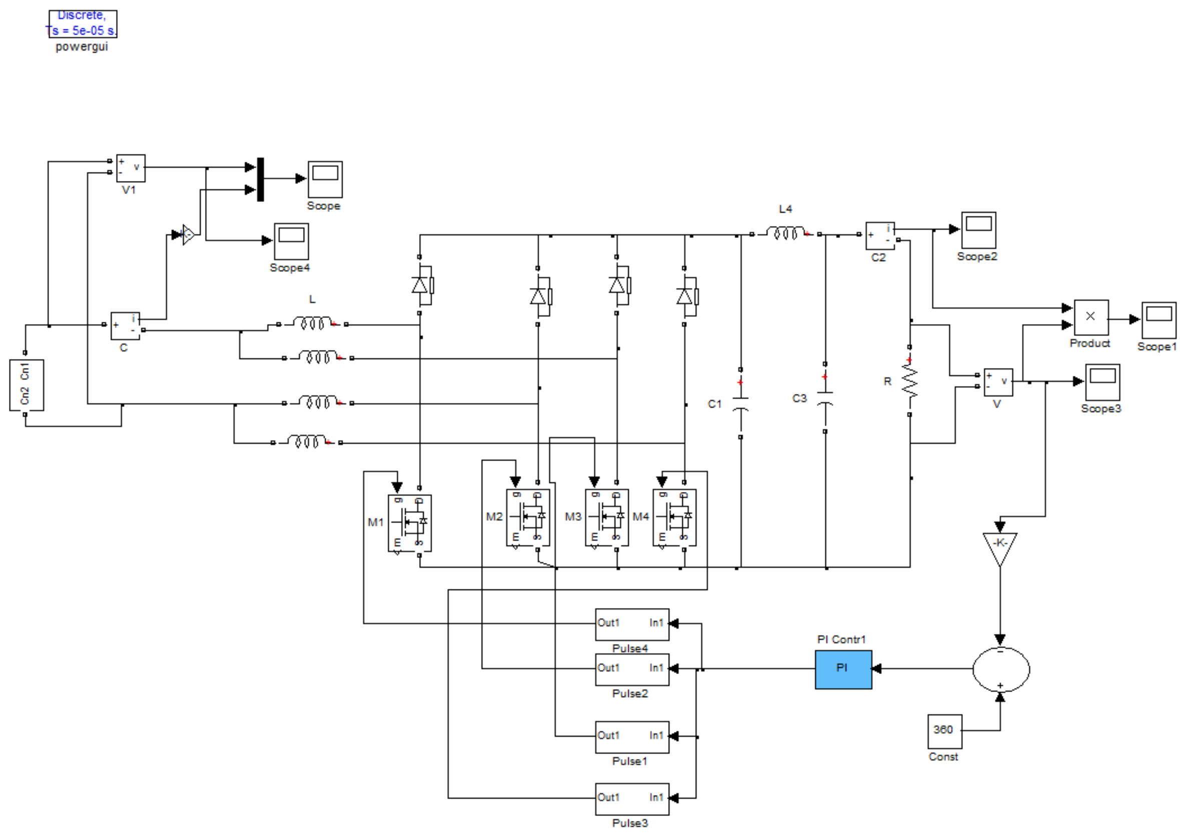

Fig 3.1 Closed loop system with PI controller

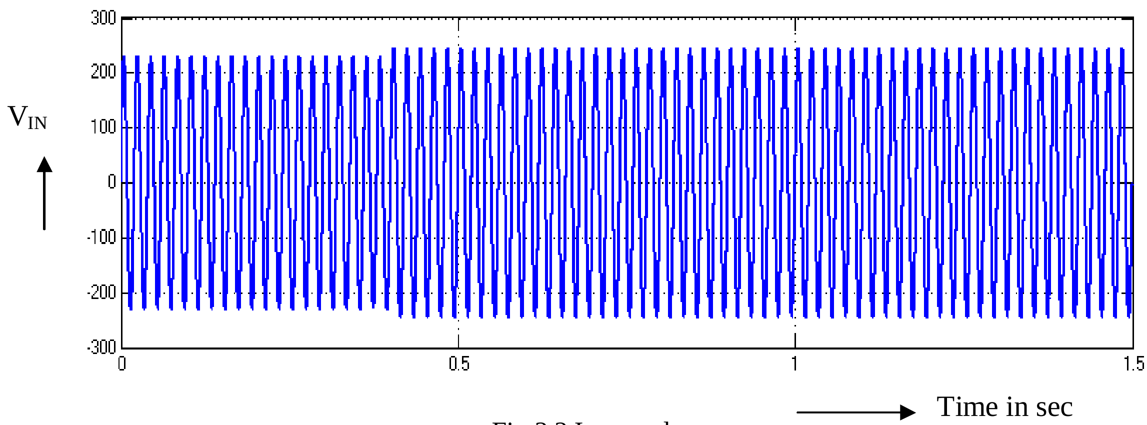

Fig 3.2 Input voltage

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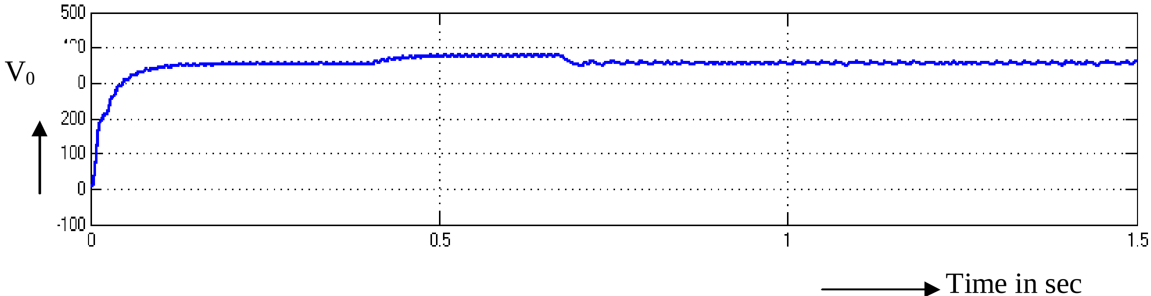

Fig 3.3 Output voltage

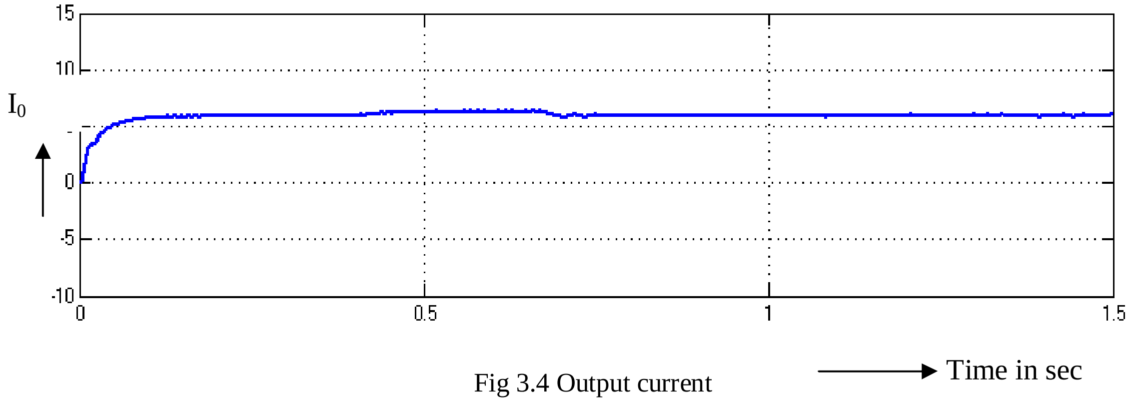

Fig 3.4 Output current

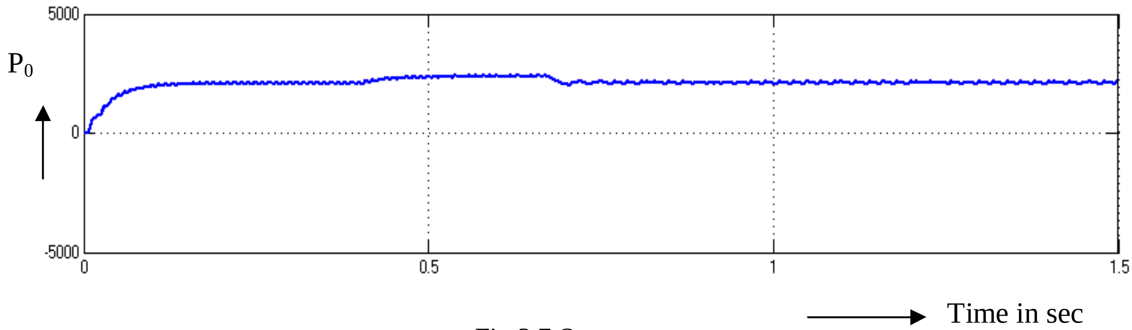

Fig 3.7 Output power

The closed loop system with PID is shown in Fig 4.1. The input voltage is shown in Fig 4.2 and its peak value is 230 V. The output voltage of bridgeless interleaved PFC is shown in Fig 4.3 and its peak value is 380 V. The output current is shown in Fig 4.4 and its peak value is 5.2 A. The output power is shown in Fig 4.5 and its value is 2000 W. The Comparison of time domain parameters is shown in Table 1. The steady state error and settling time is reduced using PID controller.

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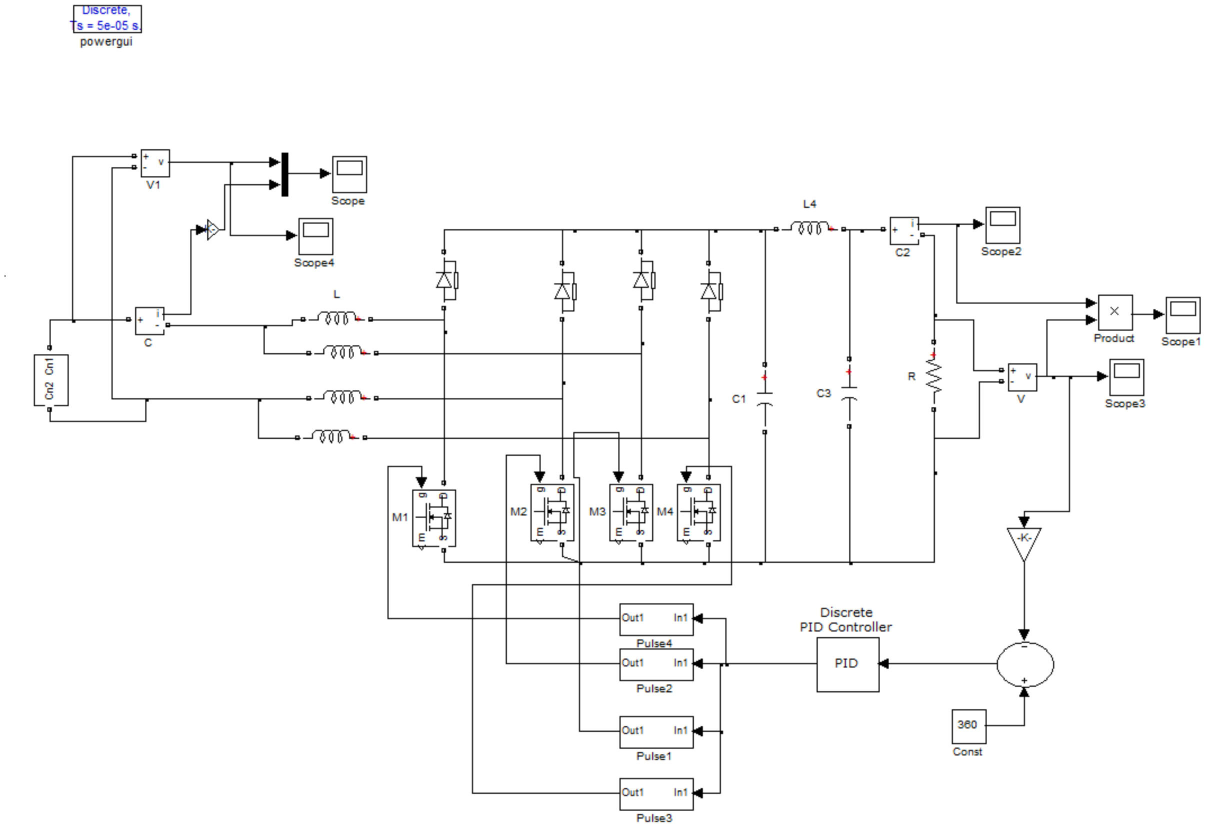

Fig 4.1 Closed loop system with PID controller

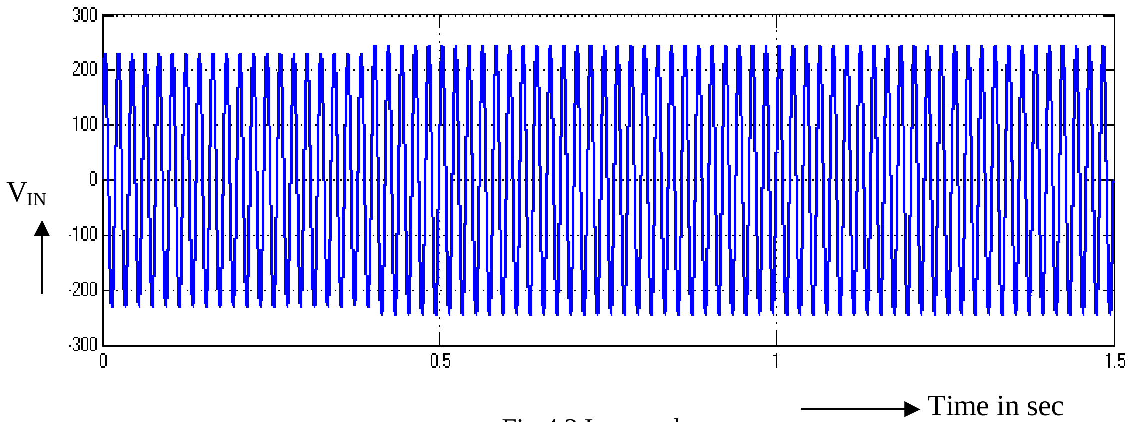

Fig 4.2 Input voltage

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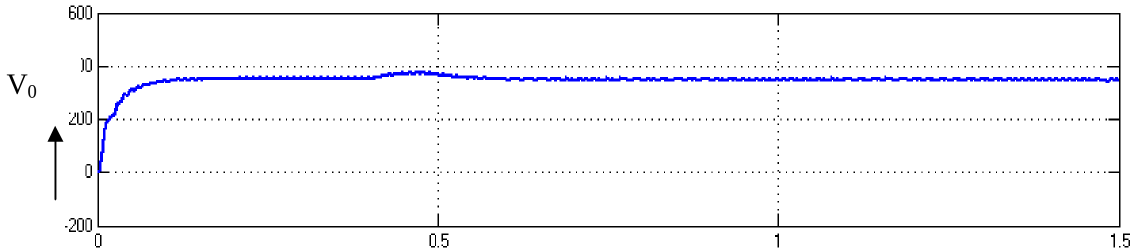
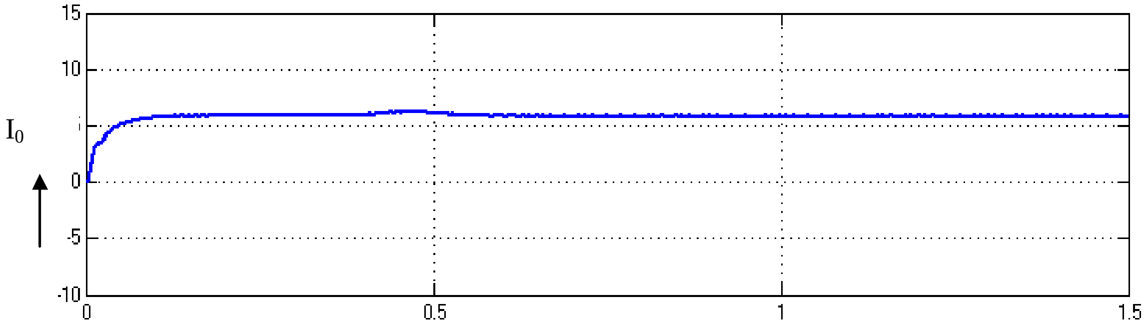


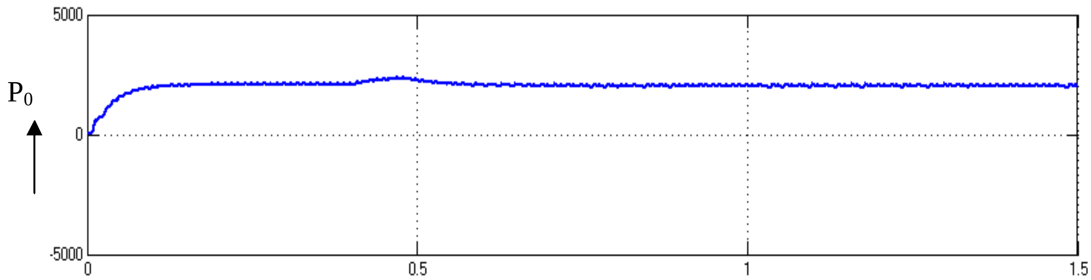
Time in sec

Fig 4.3 Output voltage



Time in sec

Fig 4.4 Output current



Time in sec

Fig 4.5 Output power

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Table-1

Comparison Time Domain Parameters

Controllers	Rise time (s)	Peak time (s)	Settling time (s)	Steady state error (V)
PI	**0.43**	**0.46**	**0.68**	**2.3**
PID	**0.42**	**0.43**	**0.52**	**1.6**

The Comparison of Time Domain Parameter is shown in Table 1. The Comparsion of Output Voltage Ripple is shown in Fig Table 2. The ripple with ∏ filter is reduced to 25 V.

Table-2

Comparsion of Output Voltage Ripple

Bridgeless PFC converter	Voltage ripple
C-filter	**50v**
PI-filter	**25v**

III. CONCLUSION

Open loop controlled bridgeless interleaved PFC systems with C & ∏ filters are modeled and simulated using matlab and the results are compared. The comparison indicates that ripple ∏ filter is less than that of C filter based bridgeless interleaved PFC system Closed loop bridgeless interleaved PFC system is successfully designed, modeled and simulated using MATLAB. The results of simulation with PI and PID controller are presented. These results indicate that the settling time is as low as 0.52 sec and steady state error is reduced to 1.6V using PID. Thus the proposed system has advantages like quick response and reduced deviation from set value. The disadvantage of the proposed system is that it is suitable for low power levels.

The present work deals with comparison of PI & PID controller based bridgeless interleaved PFC systems. The comparison between PI & FLC based bridgeless interleaved PFC system will be done in future.

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