Amelioration of Electrical Power Quality based on Modulated Power Filter Compensator

Karrar Hameed Kadhim
AL-Furat AL-Awsat Technical University /Al-Musaib Technical College
karrar.almussawi.87@gmail.com

Abstract

This paper deals with the performance of modeling and implementation of Modulated Power Filter Compensator (MPFC) based on synchronous generator to enhance Electrical Power Quality (EPQ) performance , rectification power factor , voltage fixity and decreasing transmission line losses for 300 km transmission line . In this paper (MPFC) sketch attendants for intelligent network stability and optimum exploitation. The proposal Flexible AC Transmission Systems (FACTS) can be expanded to distributed renewable energy interface and exploitation systems and also will be easy to modify for voltage fixity, Achieve the required stability, perfect usage and Compensation requirements. MATLAB SIMLINK version R2009b were used as a model of (MPFC).

Keywords: Electric Power Quality (EPQ), Flexible Ac Transmission Systems (FACTs), modulated power filter Compensator (MPFC), synchronous generator

الخلاصه

توليد القدرة الكهربائية يمثل العمود الرئيسي الذي يستند عليه موضوع تحليل النظم الكهربائية. هذا البحث يقدم محاولة لوضع مجموعة من الحلول لمشاكل توليد القدرة الكهربائية خلال مولد تزامني وحمل خطي خلال اسلاك نقل بطول ٣٠٠ كم . الدراسات الحديثة حول هذا الموضوع والتطورات كثيرة جدا لأن خصوصية كل نظام كهربائي تحدد طبيعة و نوعية الدراسة لهذا النظام . يتناول هذا البحث اداء النمذجة والتصميم للمسيطر (MPFC) خلال المحرك التزامني للتخفيف من مشاكل جودة الطاقة الكهربائية و تصحيح معامل القدرة مع ثبات الجهد و تقليل الخسائر الناتجة عن طريق عملية نقل الطاقة الكهربائية وبعد التطبيق يمكن الحصول على استقرار الشبكة الكهربائية والاستغلال الامثل للطاقة وتحقيق الاستقرارية المطلوبة والاستخدام الامثل لمنظومة توزيع الطاقة الكهربائية.

الكلمات المفتاحية :- معامل القدرة ،انظمة نقل التيار المتناوبة المرنة ، مرشح مكثف القدرة المعدل ، محرك تزامني .

1. Introduction

Electrical power quality study is the backbone of any electrical power system .The analysis of electric distribution system is portion of an electric system between the magnitude of power source and the consumer's electrical equipment. The magnitude power source is located within easy reach of the load zone to be transfer by the distribution system and may be either generating supplied over transmission lines. distribution systems on the whole can be divided for five categorize, namely, sub transmission and distribution circuits, primary feeders, distribution transformers, secondary circuits and consumer's electrical equipment. In a modernistic electrical distribution system, an unexpected raise of nonlinear loads will be there for many reasons such as generating supplies and rectifier equipment often used in intelligence networks, household instrument, arrangement moving drives, etc. Due to non-linearity characteristics electrical power quality problems will apparent and boost such as variation the magnitude of voltage, current and frequency that may be lead equipment service's for damage or washout **(Jos *et.al.*, 1997.; Yacamini, 1994.).** Inefficient use of electrical power manifested in needy power factor , hardly subversive current and voltage waveforms and increase reactive power and damage, fire, failure of electrical equipment , use potential ground , neutral hot in addition to risk of trauma occurs because of voltage sag/ swell and the state of quasi-stable harmonics , harmonics and dynamic switching deflection. Capacitors of electrical grid are employed to improve power factor of mains and efficiency **(Noha, 2015; Claus *et.al.*, 2013.).**

Because of low set back and simple sturdy structure, passive filters are used to absorb harmonics, but they originate system resonance and equip fixed reparations . The filtering Features of passive filters are mostly difficult to organize and design and can be calculated by the impedance ratio of the passive filter and the supply. The shunt active power filters (SAPF) are used for supplying compensation of improving voltage balance circuit in 3-phase system , voltage flicker deactivation , Terminal-voltage and output-power regulation, reactive power in AC networks , neutral current , Harmonic current in the neutral and harmonics **(Sharaf *et.al.*, 1995.; Nakagima et.al., 1988.; Sharaf *et.al.*, 1995; Gyugi and Strycula, 1976.).** Passive filters demand a large current with high current bandwidth and does not entail a high cost that effect on harmonic flitter of non-linear loads, but they have been a very effective solution for power system harmonic mitigation between supply and load . These filters have several topologies that give different frequency response characteristics. Hybrid harmonic filtering is the combination of passive and active harmonic filtering. Hybrid harmonic filtering combines the two solutions in situations where the use of passive harmonic filters can be used reliably for static loads of an electrical installation and a smaller active filter can be used to mitigate harmonics generated by the other variable loads. This solution can be both cost and effective application .These combines used to improve power factor and enhancing power quality.**(Oku *et.al.*, 1995; Rastogi *et.al.*, 1995; Brennen and Stacey, 1987; Mohit and Ratan, 2015).**

The paper is organized as follows: in Section II, the model of the power system, including modulated power filter Compensator (MPFC) is presented to utilize and improve the power quality . The tri-loop dynamic error driven PI controller to control the MPFC was explained in Section III. The results of the simulation are finally given in Section IV and success to improve power quality and enhance power factor. Finally, conclusions are presented in section V .

II. Modulated Power Filter Compensator (MPFC)

MPFC is an organ of incoming new FACTS hardware . Figure (1) shows a synchronous generator connect to the MPFC and delivers power to (induction motor, linear load and non-linear load) through 300 km transmission line . Figure (2) presents the functional model of the MPFC. MPFC is Consists of resistance, an inductor, capacitor, three phase diode bridge and two Pulse With Modulation (PWM) wave controlled Insulated Gate Bipolar Transistor (IGBT) switches. The resistance and the Inductor are connected to the DC side of the diode bridge, while capacitor is located at AC side of the diode bridge . The equivalent admittance will be able to change with different cases of the supplementary pulses by using two (IGBT) switches. If (S_1) is close and (S_2) is open , the resistance and inductance will be short circuit. If (S_1) is open and (S_2) is close, the resistance and inductance will be connect to the circuit.

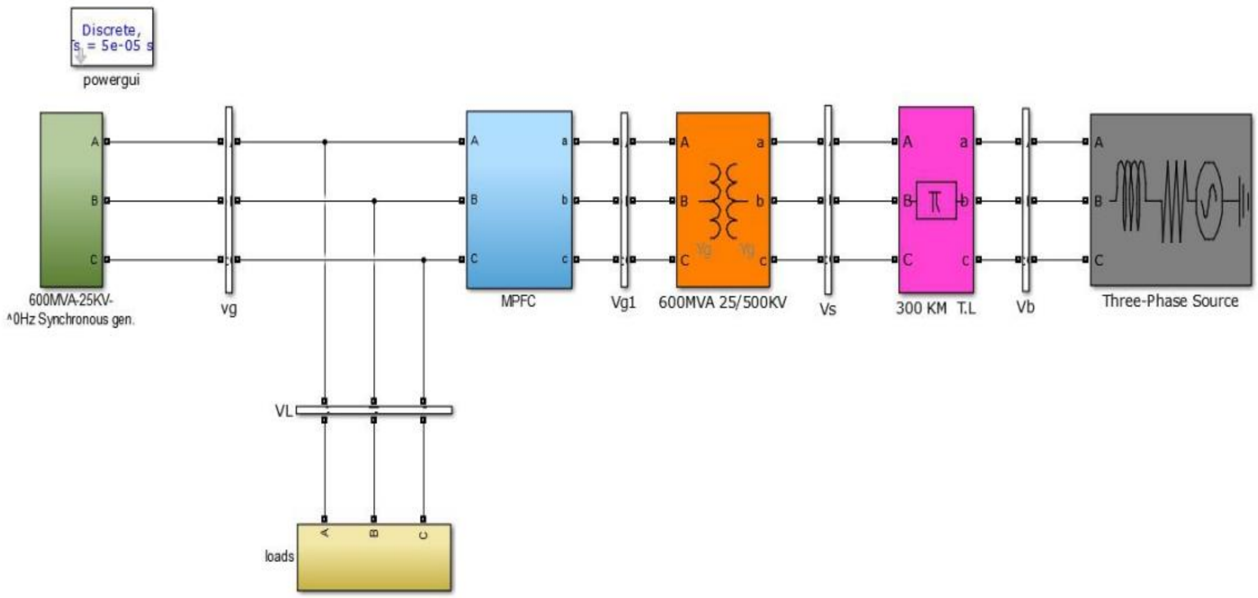


Fig. (1) synchronous generator connect to the MPFC through single line diagram AC system

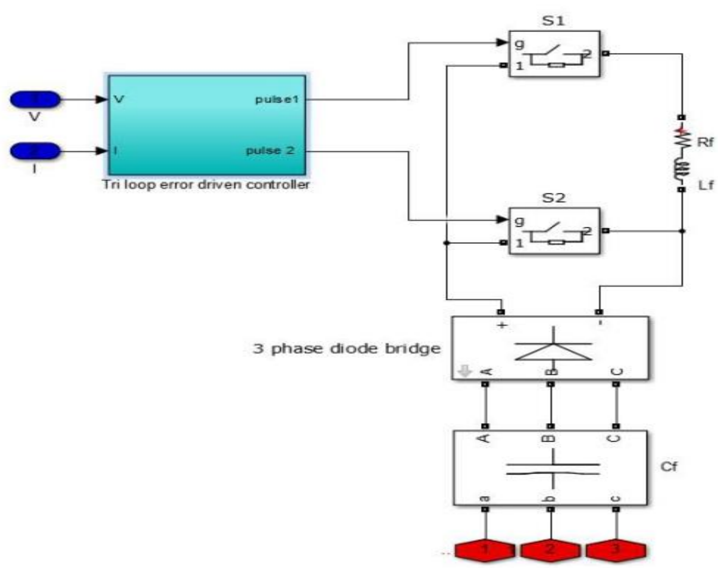


Fig. (2) Modulated Power Filter Compensator model

III. Tri-loop Dynamic Error Driven PID Controller

MPFC is controlled by using Tri-loop Dynamic Error Driven PI Controller . with using (phase –to- phase) Root-Mean-Square (RMS) of current, (RMS) voltage and harmonics of current will be able for tri-loops to determine the global error (et). as shown is figure (3). The first loop is the load bus current dynamic error going after loop which is an associate loop to compensate for any sudden increase of electrical load or wind velocity alteration. The second loop is the voltage stabilization loop which functions as keep track after the error for the Root- Mean- Squared (RMS) value of load voltage at the radiate distribution and maintaining the value of voltage at (1) per unit. The third loop is the current harmonics dynamic tracking loop which a supplementary loop using to sense and minimize the harmonic component of the current. To get a fast response the scaling and time delay for these loops were selected guide trial and error method. **(Serhat *et.al.*, 2015.).**

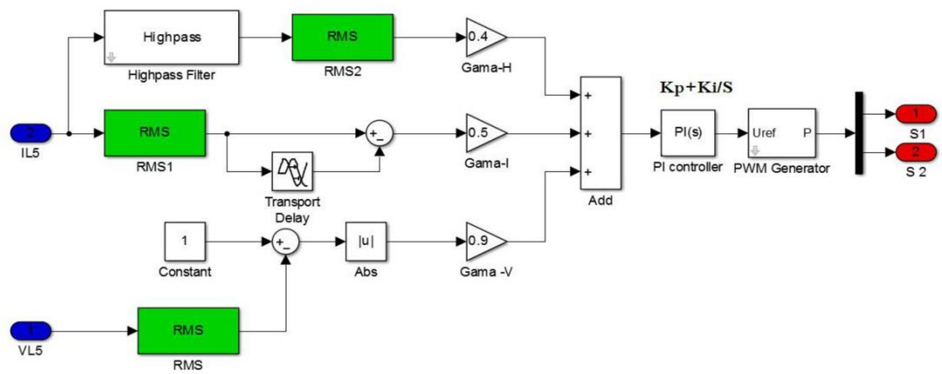


Fig. (3) Modified tri loop error driven PI controller

IV . Simulation result

In this paper MATLAB SIMULINK version R2009b were used for model of as a model of Modulated Power Filter Compensator .The MPFC is controlled by using the tri-loop dynamic error . Simulations are performed RMS voltage , RMS current , reactive power and The power factor at AC buses under normal operation (generator bus) and performed also the voltage waveforms and current waveforms of MPFC :

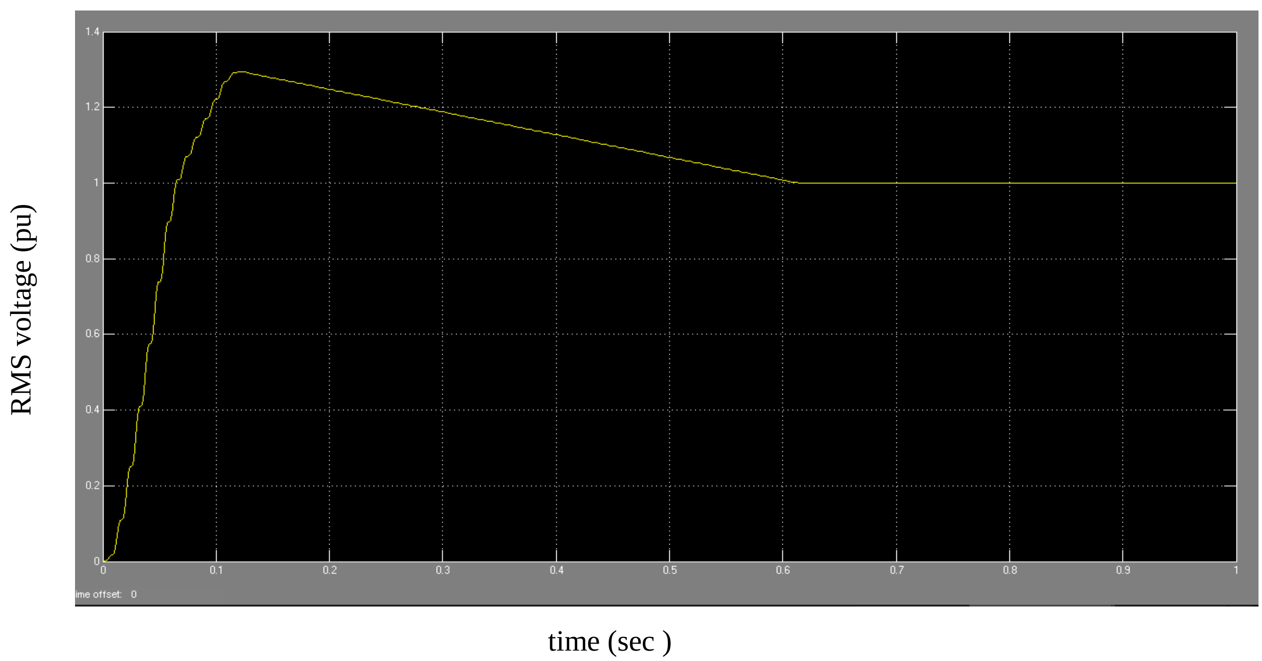


Fig. (4) The RMS voltage without MPFC

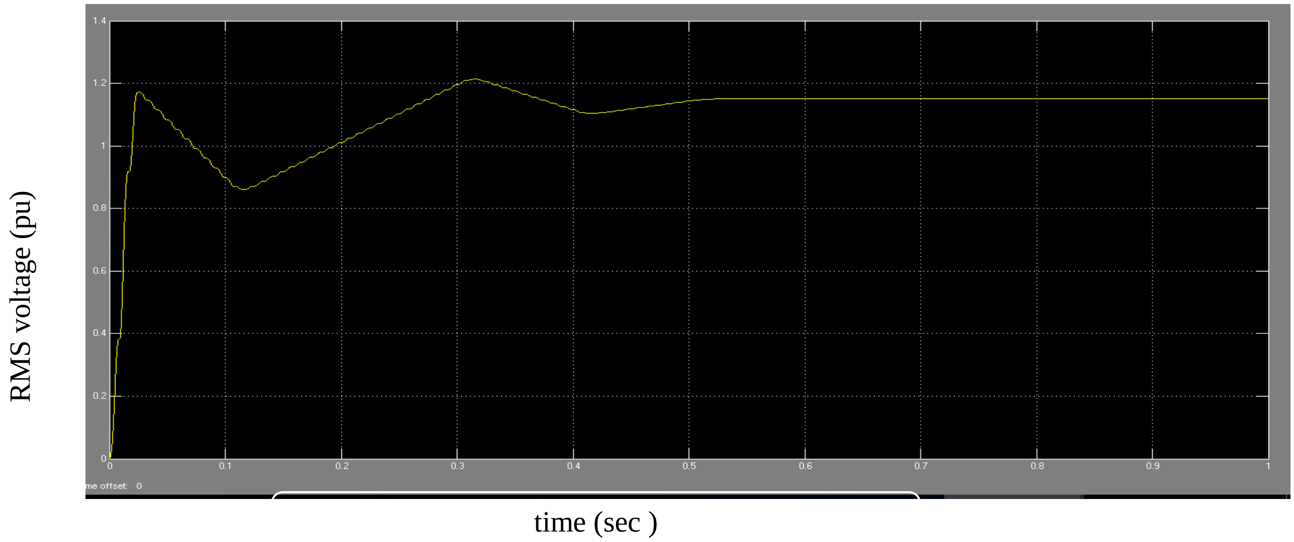


Fig. (5) The RMS voltage with MPFC

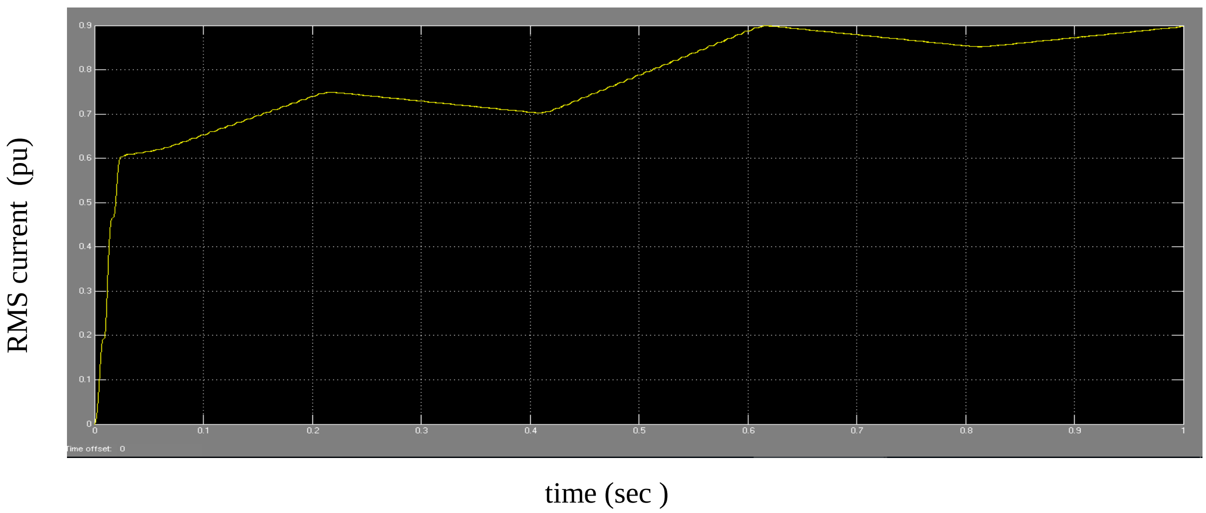


Fig. (6) The RMS current without MPFC

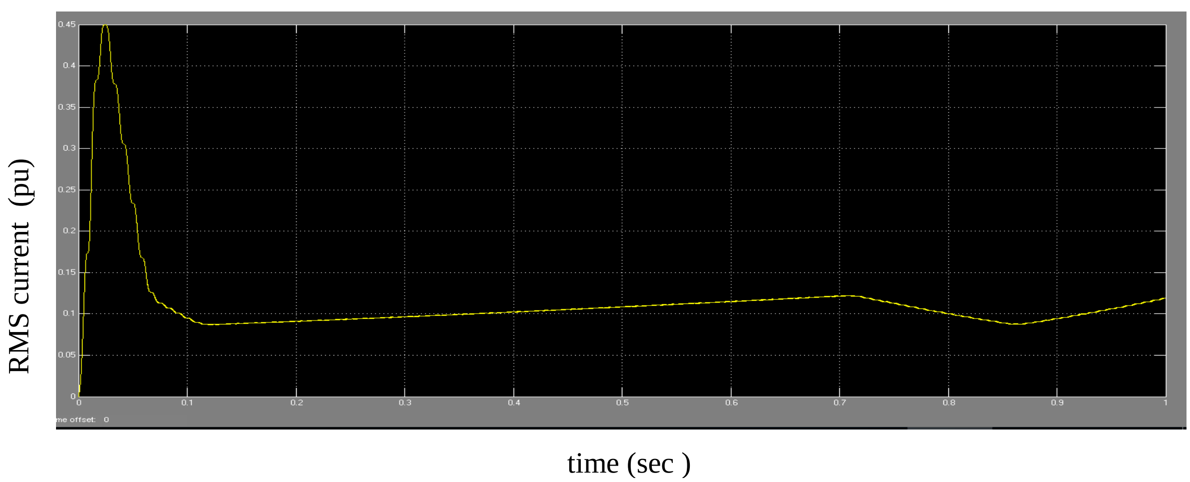


Fig (7). The RMS current with MPFC

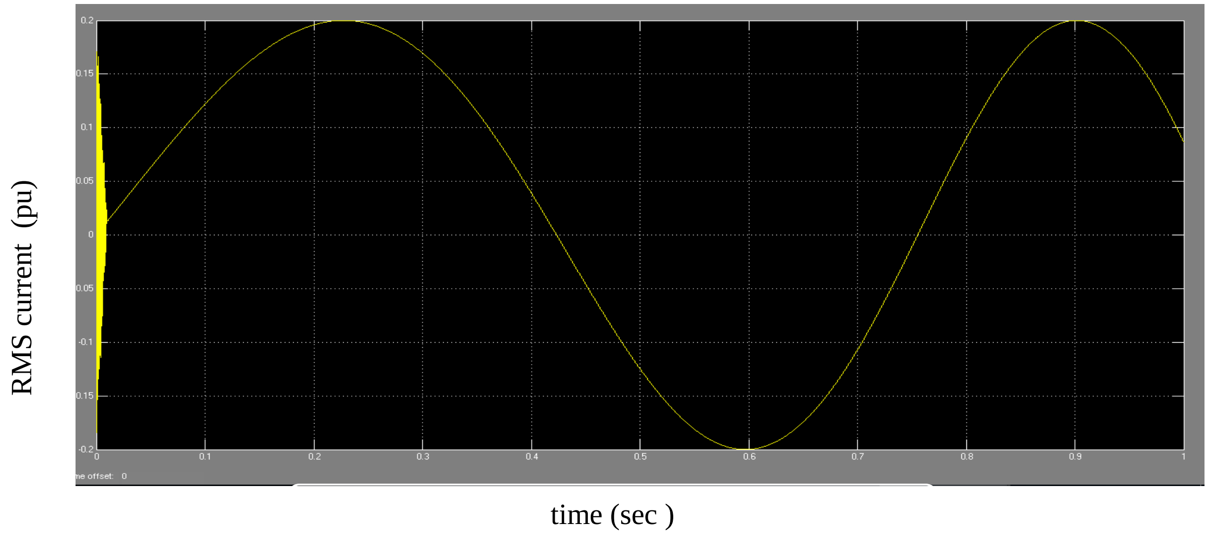


Fig. (8) The reactive power without MPFC

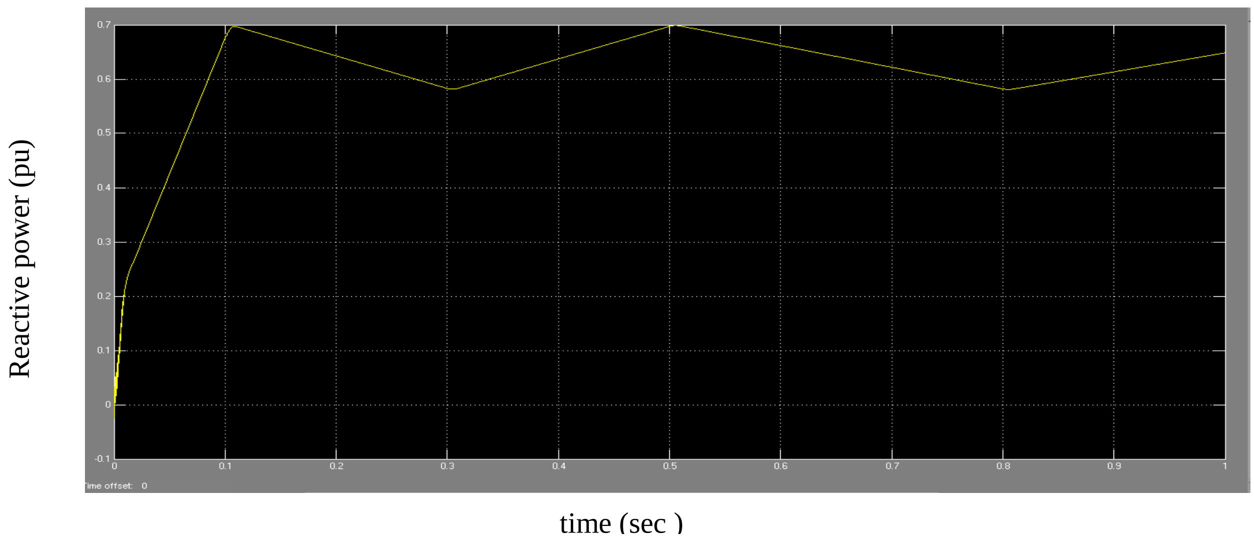


Fig. (9) The reactive power with MPFC

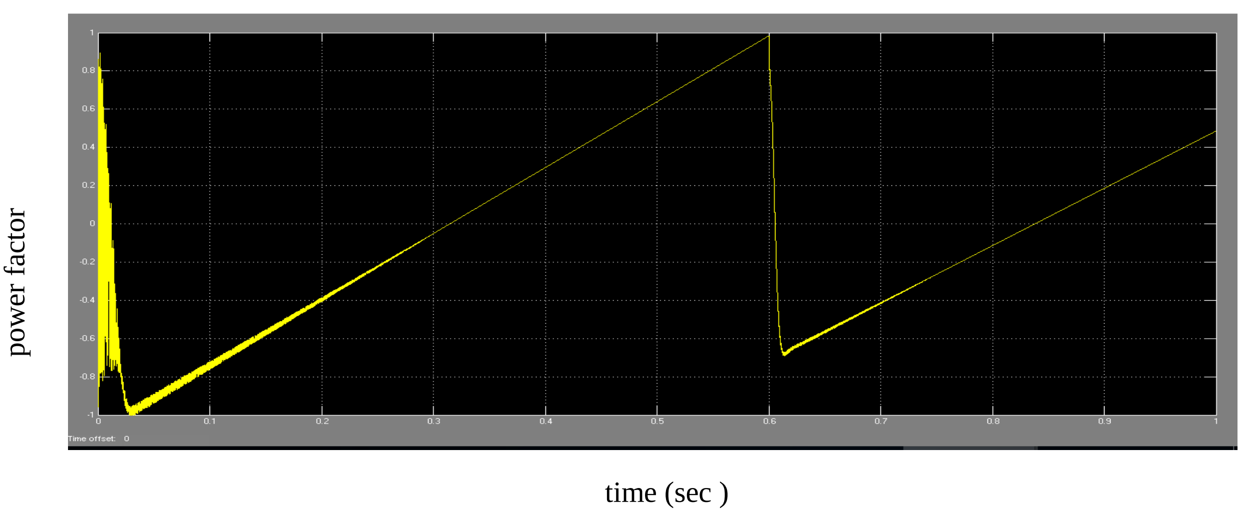
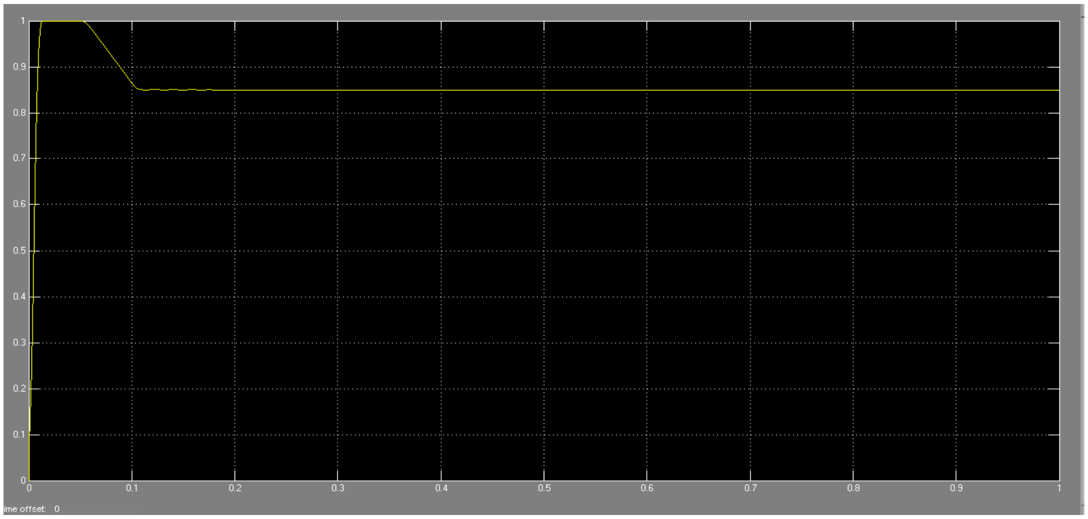


Fig. (10) The power factor without MPFC

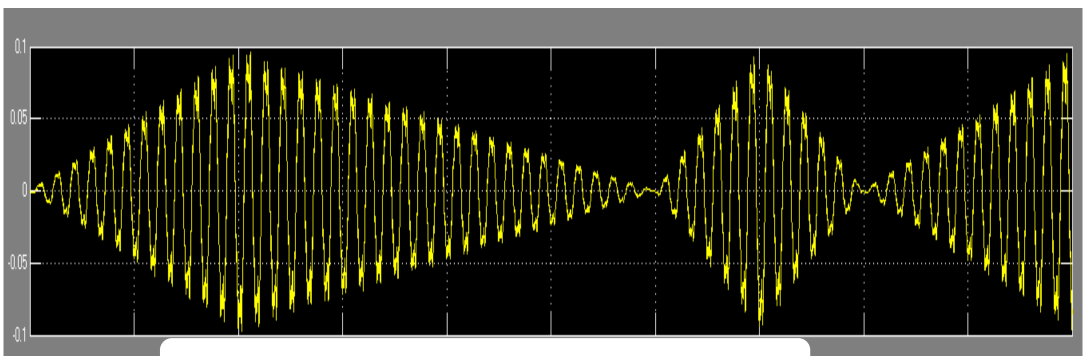
power factor



time (sec)

Fig. (11) The power factor with MPFC

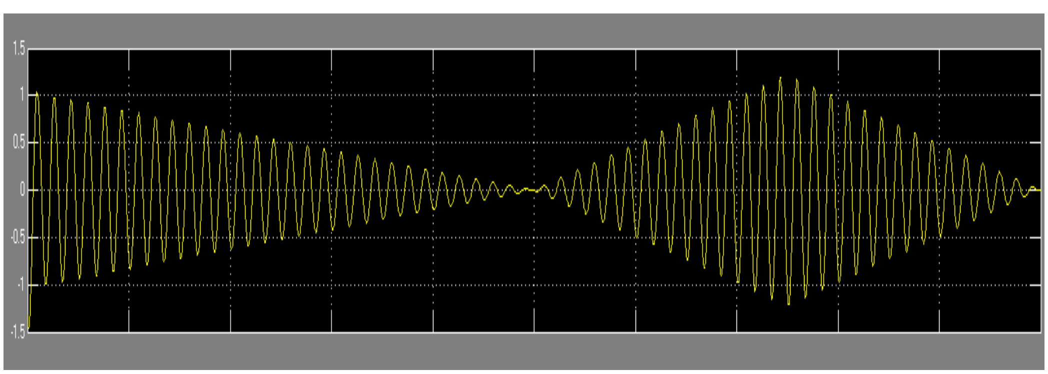
Current (p u)



time (sec)

Fig. (12) current waveforms MPFC

Voltage (p u)



time (sec)

Fig. (13) voltage waveforms MPFC

V . Conclusion

In this paper, dynamic tri-loop dynamic error driven modified PI controller for MPFC was proposed to mitigate power quality problems. The controller was designed for a single line diagram of the unified EHV study AC system. Then simulation results for the system, including MPFC controller were presented. Simulations were performed RMS voltage , RMS current , reactive power and The power factor at AC buses under normal operation (generator bus) and performed also The voltage waveforms and current waveforms of MPFC . Results showed that the proposed MPFC controller has good ability reduce the amplitude of electrical power quality and power factor correction . Also, as a future work, can be using PID or FO PID controller instead of PI controller for more enhancement .

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