ARPN Journal of Engineering and Applied Sciences

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AN IMPROVISED POWER QUALITY OF POWER GRID USING UPQC BASED ON MODIFIED NEURAL NETWORK

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ABSTRACT

The utility of synthetic intelligence is growing fast within the region of energy electronics and drives. The artificial neural Network (ANN) is considered as a brand new device to layout manipulates circuitry for Power Quality (PQ) gadgets. On this paper, the ANN-primarily based controller is designed for the cutting-edge control of the shunt active energy clear out and skilled offline the use of records from the traditional proportional-crucial controller. A digital-sign-processor-based totally microcontroller is used for the actual-time simulation and implementation of the control set of rules. An exhaustive simulation have a look at is executed to investigate the overall performance of the ANN controller and compare its performance with the traditional PI controller effects. The machine overall performance is also verified experimentally on a prototype version developed inside the laboratory.

Keywords: artificial intelligence(AI),artificial neural net-work (ANN),proportional integral (PI),unified power-quality conditioner (UPQC), switching.

INTRODUCTION

The Use of electronic controllers in the electric power-supply gadget has turn out to be very not unusual. These digital controllers behave as nonlinear load and reason critical distortion within the distribution gadget and introduce unwanted harmonics inside the supply system, main to reduced performance of the energy device community and gadget linked within the network [1]. To fulfill the requirements of harmonic regulation, passive and active electricity filters are being utilized in aggregate with the traditional converters [2]. Presently, lively electricity filters (APFs) are getting extra inexpensive because of fee re- ductions in strength semiconductor gadgets, their auxiliary parts, and included digital manage circuits. Similarly, the APF additionally acts as a power-conditioning device which affords a cluster of a couple of features, such as harmonic filtering, damping, isola- tion and termination, load balancing, reactive-power manipulate for power-factor correction and voltage regulation, voltage-flicker reduction, and/or their combinations. Resent studies specializes in use of the ordinary strength best conditioner (UPQC) to catch up on electricity-satisfactory issues [3], [4].The performance of UPQC specifically relies upon upon how correctly and quickly reference alerts are derived. After green extraction of the distorted sign, a suitable dc-hyperlink modern-day regulator is used to derive the actual reference indicators. Numerous control approaches, such as the PI, PID, fuzzy-good judgment, sliding-mode, predictive, unified regular frequency (UCF) controllers, and many others., are in use [5]–[7]. Just like the PI conventional controller, the PID controller requires unique linear mathematical fashions, which can be hard to gain, and fails to carry out satisfactorily below parameter variation nonlinearity load disturbance, etc.

Contemporary manage concept-primarily based controllers are kingdom remarks controllers, self-tuning controllers, and version reference adaptive controllers, and many others. Those controllers additionally want mathematical models and are therefore sensitive to parameter variations [8]. In current years, a major effort has been underway to increase new and unconventional manage techniques which can often increase or replace traditional manipulate strategies. A number of unconventional control strategies have developed; imparting solutions to many tough manipulate issues in industry and manufacturing sectors. In contrast to their traditional opposite numbers, these unconventional controllers (sensible controllers) can study, take into account, and make choices. Synthetic-intelligence (AI) strategies, particularly the NNs, are having a sizable effect on power-electronics applications. Neural-community-based totally controllers provide rapid dynamic reaction even as retaining the stability of the converter machine over a wide operating variety and are considered as a new device to design manipulate circuits for PQ gadgets [9]-[12]. Over the last few years, main studies works had been automobileried out on manipulate circuit design for UPQCs with the goal of acquiring reliable manipulate algorithms and rapid reaction procedures to reap the transfer manage alerts [13]-[15]. On this paper, for improving the performance of a UPQC, a multilayer feedforward-kind ANN-primarily based controller is designed for the cur- hire control of the shunt energetic clear out in preference to the traditional PI controller. An algorithm for education the ANN controller is evolved and trained offline. Numerous simulation results are provided and confirmed experimentally, and evaluate the performance of the ANN controller with traditional PI controller outcomes. A DSP-primarily based microcontroller is used for the actual-time simulation and implementation of the manage algorithm. The machine configuration is defined in phase II, even as PI and ANN controller design are explained in Sections III and IV, respectively. Simulation and experimental results are mentioned in Sections V and VI, respectively.

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CONFIGURATION

A conventional UPQC topology consists of the mixing of lively power filters are related lower back to lower back to a commonplace

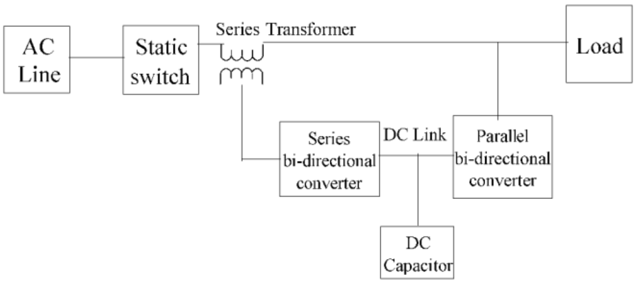

Figure-1. BlockdiagramofaUPQC.

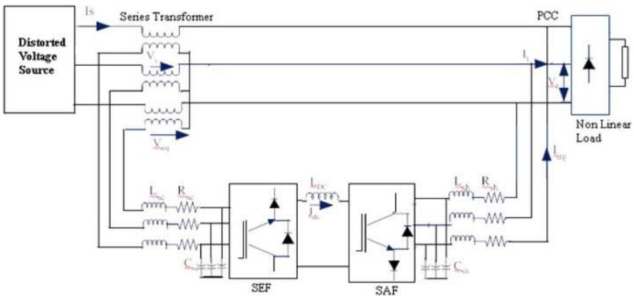

Figure-2. UPQC topology using current-source converters.

Dc-link bus [16].A easy block diagram of a standard UPQC is shown in Figure-1.

It is able to be configured both with voltage-supply converters or present day source converters in single section, three-section three- cord, or 3-phase 4-twine configurations. The UPQC with the voltage-source converter (VSC) is most commonplace due to its smaller size and occasional fee. No matter those formerly mentioned advantages, the VSI topology has sluggish manipulate of the converter (LC clear out) output voltage and no quick-circuit/over- current protection. Whilst the lively rectifier within the UPQC is used as a energy factor corrector, dc bus voltage oscillations appear which makes the control of the collection filter output voltage more difficult. The CSI-based UPQC has blessings of excel- lent modern manage capability, clean protection, and excessive reliability over VSI-primarily based UPQC [17]. The primary drawback of the CSI-based UPQC has been to date the shortage of proper switching gadgets and big dc-aspect clear out. The brand new insulated-gate bipolar transistors (IGBTs) with opposite blockading capability are being launched in the markets which are appropriate for the CSI-primarily based UPQC [18]. With the use of SMES coils, the scale and losses can be decreased substantially [19]. A configuration of UPQC the usage of modern-day-supply converters linked again to lower back thru a huge dc-link reactor is proven in Figure-2.

The overall performance of the UPQC particularly depends on how accurately and quickly the reference signals are derived. After efficient extraction of the distorted sign, a appropriate dc-hyperlink cur- hire regulator is used to derive the actual reference signals. A dc present day regulator will serve as power-loss compensation within the clear out circuits, a good way to take area through the activation of a shunt unit. This regulator will preserve dc-link cutting-edge constant for strong operation of the filter. In the conventional PI controller, the mistake between the real dc-hyperlink current and a reference value, which is generally slightly greater than the height of the dc-hyperlink value, is fed to the PI controller. The output of the PI controller is introduced suitably for the generation of a reference template.

DESIGN OF THE PI CONTROLLER

For the reason that dc-hyperlink current is managed with the aid of the shunt filter, the subsequent primary equations are used for designing the manipulate device:

$$Pind = \frac{d}{dt}\left(\frac{1}{2}\, LdcIdc^2\right) = LdcIdc\frac{dIdc}{dt} \quad (1)$$

The power input to the PWM converter

$$Pconv = 3VshIinj \quad (2)$$

The average rate of change of energy associated with the capacitor filter

$$Pcap = \frac{d}{dt}\left(\frac{1}{2}CshVsh^2\right) \quad (3)$$

Power loss in the resistor Rsh

$Ploss = 3Iinj^2Rsh$

To be able to manipulate the clear out cutting-edge, the simplest manipulate variable is the duty cycle of the PWM converter. The hassle of control is to decide the obligation cycle in this type of manner that the dc-link modern stays steady and to provide suitable filter contemporary to cancel the weight modern harmonics. This filter modern-day ought to be contrary of the harmonic modern-day that is split into additives (i.e., one loss issue plus the reactive aspect and another harmonic issue). The energy transfer to the non-stop facet takes location best on the essential frequency to compensate all of the losses inside the PWM converter). Therefore, it is required to govern outputs, namely and from one control variable (i.e., the obligation cycle of the PWM converter). But, the main goal is to govern the filter contemporary, and the control approach ought to cause specific compensation of the harmonic thing. The price of wishes to most effective be approximately steady and there's no dynamic performance to be attained. The more it's far constant, the more linear the device might be. Subsequently, is controlled circuitously through processing the actual source modern and envisioned reference modern in a hysteresis modern controller. Those reference currents are expected via regulating dc-link

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current. So one can estimate the consistent-nation errors within the dc-hyperlink current, a PI controller is used. Even though the dynamic reaction of the dc-hyperlink inductor has no effect at the repayment function of the scheme, a mathematical version is required for the stableness analysis and, as a result, for determining the parameters of the PI controller. The subsequent assumptions are made for deriving the mathematical model of the gadget.

a) The voltage at % is sinusoidal and balanced.

b) Since the harmonic thing does not affect the average electricity stability expressions, handiest the essential component of currents is taken into consideration.

c) 3) Losses of the system are lumped and represented by an equivalent resistance related in series with the filter out inductor.

d) Ripples inside the dc-hyperlink current are ignored.

The block diagram of the modern-day control loop is shown in Figure-3, in which
G advantage of the PI controller; transfer feature of the PWM converter.

A linear version of the PWM converter may be derived through applying a small-sign perturbation technique to achieve its transfer function. In this technique of deriving a linear version,

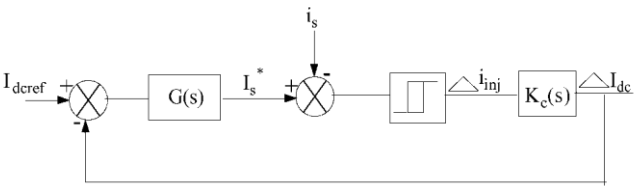

Figure-3. Block diagram of the current control loop.

DESIGN OF ANN CONTROLLER

The rapid detection of the disturbance sign with high accuracy, rapid processing of the reference sign and excessive dynamic reaction of the controller are the top necessities for favored reimbursement in case of UPQC. The traditional controller fails to carry out satisfactorily underneath parameter variations nonlinearity load disturbance, etc. A recent study shows that NN-based totally controllers offer speedy dynamic response even as preserving balance of the converter device over wide operating range.

The ANN is made up of interconnecting synthetic neurons. It is essentially a cluster of definitely interconnected nonlinear elements of quite simple form that own the capability to research and adapt. It resembles the brain in two factors: 1) the expertise is acquired by the network via the gaining knowledge of technique and 2) interneuron connection strengths are used to shop the expertise [10]-[11]. These networks are characterized via their topology, the manner in which they speak with their surroundings, the way in which they're trained, and their ability to method facts. ANNs are getting used to solve AI problems without necessarily growing a version of a actual dynamic gadget. For improving the performance of a UPQC, a multilayer feed ahead- kind ANN-based controller is designed. This network is designed with 3 layers, the input layer with 2, the hidden layer with 21, and the output layer with 1 neuron, respectively.

The education set of rules used is Levenberg-Marquardt back propagation (LMBP). The MATLAB programming of ANN schooling is given as follows:

```
net=newff(minmax(P),[2,21,1],{'tansig','tansig','purelin'},'trainlm');
net.trainParam.show=50;
net.trainParam.lr=0.05;
net.trainParam.mc=0.95;
net.trainParam.lr_inc=1.9;
net.trainParam.lr_dec=0.15;
net.trainParam.epochs=5000;
net.trainParam.goal=1e-6;
[net,tr]=train(net,P,T);
a=sim(net,P);
gensim(net,-1);
```

SIMULATION RESULTS

a) UPQC with current supply inverters

The machine taken into consideration is 3-phase device and cargo is taken as non linear load. UPQC consists of series inverter and shunt inverter that are contemporary source inverters. An inductor is taken as taken as a dc link among the inverters.

The parameters of transmission line are taken identical values that are cited layout of PI controller. The simulation diagram is proven in Figure-4.

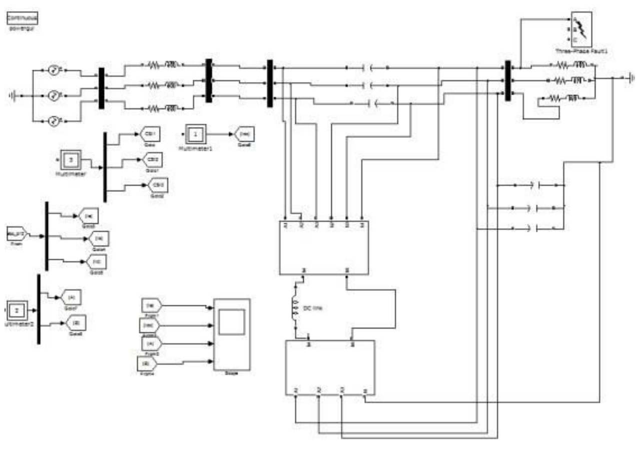

Figure-4. Simulation diagram UPQC with current source inverters.

The simulation is performed for 0.3secand a disturbance at load is applied for a certain period of time and the performance of PI and ANN controller are compared.

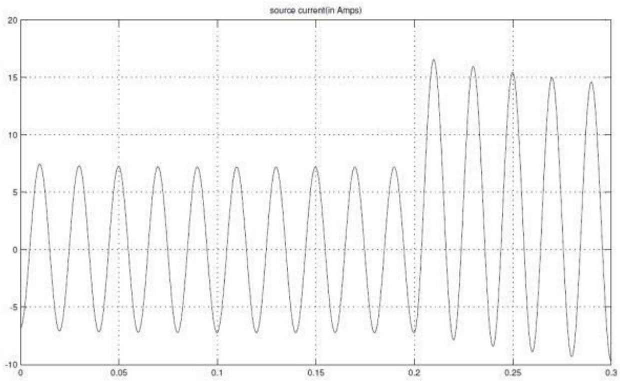

Figure-5. Performance of UPQC with PI controller at load perturbations.

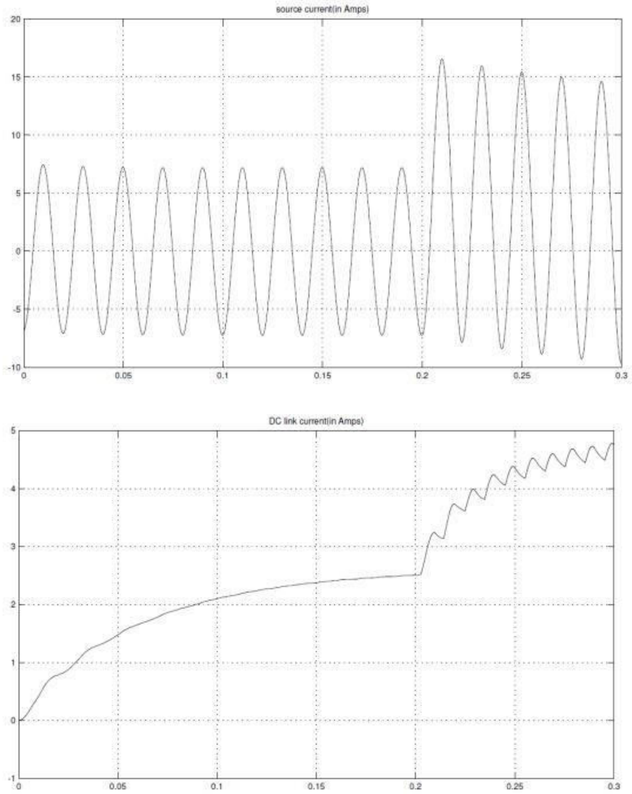

Figure-6. Performance of UPQC with ANN controller atload perturbations.

Total harmonic distortion is also taken (0.15sec and 0.25sec). PI and ANN controller performance is compared.

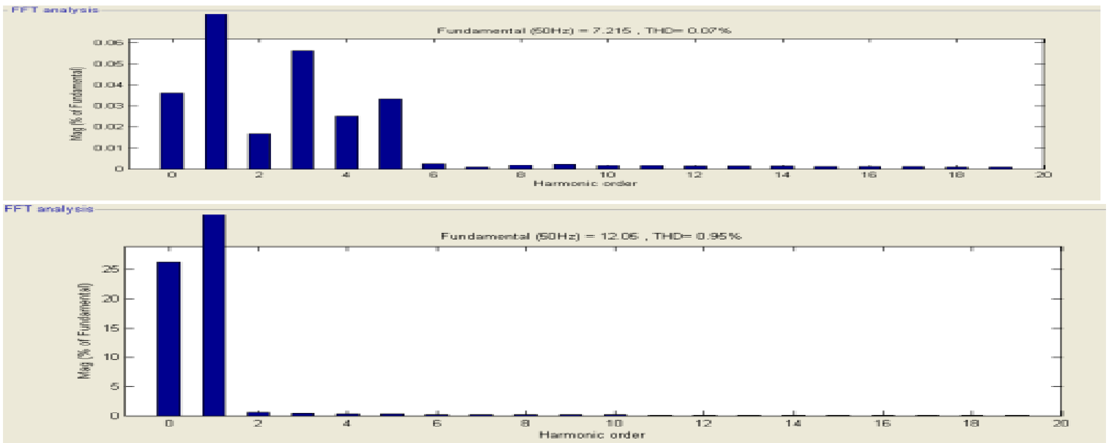

Figure-7. Frequency spectrum of the source current at different loading conditions with the PI controller.

VOL. 12, NO. 23, DECEMBER 2017 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

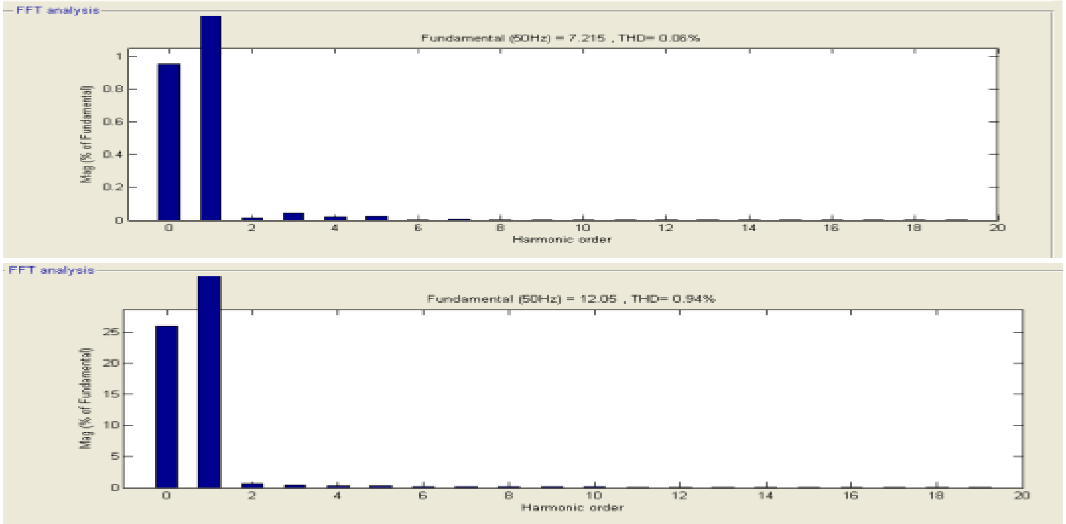

Figure-8. Frequency spectrum of the source current at different loading conditions with the ANN controller.

From Figures 5 and 6 the dc hyperlink current is taking more to stabilize at preliminary situations and load perturbations in the case of PI controller and inside the different case of ANN controller dc hyperlink modern is stabilizing speedy in both conditions as compared to PI controller.

The overall performance of harmonic present day filtration is proven. The load contemporary in both instances is observed to be content material of all unusual harmonic minus triplen, supplying a complete harmonic distortion (THD) of 27.82 %. It's far discovered from the determine that the THD of the supply cutting-edge at 0.15 s is 0.07% within the case of the PI controller while it is 0.06% inside the case of the ANN controller scheme. Further, the THD of the source modern-day at 0.25 s is 0.95% in case of the PI controller whilst it's miles 0.94% in case of the ANN controller scheme. At each instances ANN controller overall performance is proving better than PI controller.

b) UPQC with voltage source inverters

The machine taken into consideration is 3-phase device and load is taken as non linear load. UPQC consists of series inverter and shunt inverter which can be voltage source inverters. A capacitor is taken as taken as a dc link among the inverters.

The parameters of transmission line are taken equal values which are noted design of PI controller. The simulation diagram is proven in Figure-9.

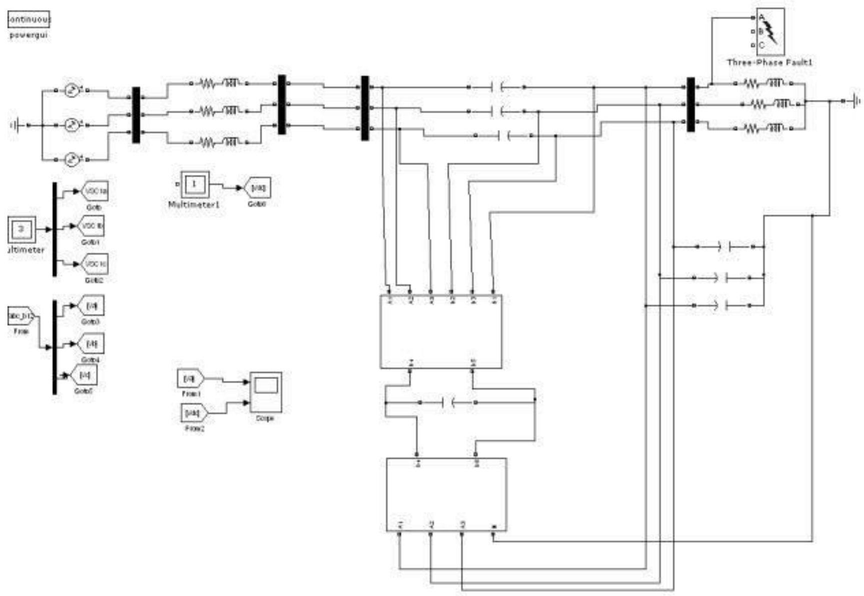

Figure-9. Simulation diagram UPQC with voltage source inverters.

The simulation is completed for 0.3sec and a disturbance at load is implemented for a sure time frame and the overall performance of PI and ANN controller are in comparison

From Figure-10 the dc hyperlink is stabilizing speedy at preliminary conditions with ANN controller as compared to PI controller. Even at load perturbations there are fewer oscillations happening with ANN controller in comparison to PI controller. Subsequently ANN controller is showing a better overall performance in the two cases towards PI controller.

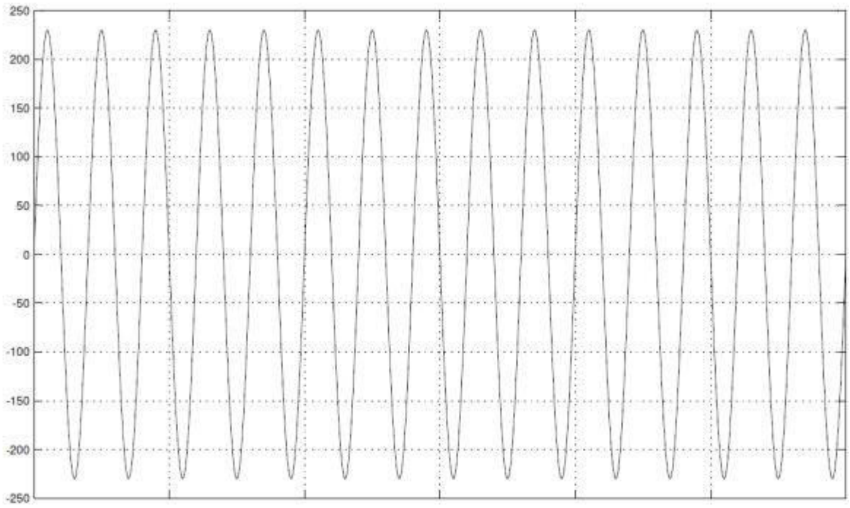

Figure-10. Quality enhanced output of UPQC with MANN approach.

CONCLUSIONS

The performance of the UPQC particularly relies upon how appropriately and quickly reference indicators are derived. There were numerous situations which can be tested. However, the performance of conventional PI controller is not proving higher against proposed ANN controller in both cases of UPQC (thinking about CSI and VSI inverters). This is proved through simulation results. Subsequently, with ANN controller there was big improvement inside the reaction time of the manage of the dc-link present day which is the principle issue inside the case of the electricity system community.

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