

A Novel Hybrid HPF primarily based Back Propagation management formula for PQ Improvement mistreatment STATCOM

¹A.MURALI , ²B.Pradeep Kumar Reddy ,
³A.L.Sahitya , ⁴Kanakamedala Poojitha

¹Assistant Professor, Department of Electrical & Electronics Engineering,
B.V.Raju Institute of Technology, Narsapur, T.S, India.

²Assistant Professor, Department of Computer Science Engineering,
B.V.Raju Institute of Technology, Narsapur, T.S, India.

³Assistant Professor, Department of Electrical & Electronics Engineering,
B.V.Raju Institute of Technology, Narsapur, T.S, India.

⁴Assistant Professor, Department Of Electrical & Electronics Engineering,
HITAM Engineering College, Gowdavelly, T.S, India.

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Abstract

This paper presents associate implementation of a 3part distribution static compensator (DSTATCOM) employing a back propagation (BP) management formula for its functions like harmonic elimination, load equalisation and reactive power compensation for power issue correction, and 0 voltage regulation below nonlinear hundreds. A BP-based management formula is employed for the extraction of the elemental weighted price of active and reactive power elements of load currents that area unit needed for the estimation of reference supply currents. A model of DSTATCOM is developed employing a digital signal processor, and

its performance is studied below varied operative conditions. The performance of DSTATCOM is found to be satisfactory with the projected management formula for varied varieties of hundreds.

Key Words: Back propagation (BP) management formula, harmonics, ANN-Artificial Neural networks, load equalisation, PQ-power quality, weights.

1 Introduction

The quality of accessible provide power includes a direct economic impact on industrial and domestic sectors that affects the expansion of any nation [1]. This issue is a lot of serious in electronic primarily based systems. the amount of harmonics and reactive power demand area unit well-liked parameters that specify the degree of distortion and reactive power demand at a selected bus of the utility [2]. The harmonic resonance is one in every of the foremost common issues reported in low- and medium-level distribution systems. it's as a result of capacitors that area unit used for power issue correction (PFC) and supply electrical resistance [3]. Power converter-based custom power devices (CPDs) area unit helpful for the reduction of power quality issues like greenhouse gas, harmonic compensation, voltage sag/swell compensation, resonance as a result of distortion, and voltage flicker reduction among nominal international standards [4][6]. These CPDs embrace the distribution static compensator (DSTATCOM), dynamic voltage preserver, and unified power quality conditioner in numerous configurations [7][9]. a number of their new topologies also are reported within the literature like the indirect matrix converter- primarily based active compensator wherever the dc-link electrical device are often removed [10]. alternative new configurations area unit supported stacked multicell converters wherever the most options area unit on the rise within the variety of output voltage levels, while notelectrical device operation and natural self-balancing of flying electrical device voltage, etc. [11]. The performance of any custom power device depends noticeably upon the management formula used for the reference current estimation and gating pulse generation theme. a number of the classical management algorithms area unit the Fryze power theory, Budeanu theory, p-q theory and SRF theory [12][14],

Lyapunov-function-based management [15] and nonlinear management technique [16], etc.

Many non-model and training-based various management algorithms are reported within the literature with application of sentimental computing technique like neural network, mathematical logic and adaptive neuro-fuzzy, etc. [17][20]. Adaptive learning, self-organization, real-time processing, and fault tolerance through redundant data area unit major benefits of those algorithms. A neural network-based management formula like the Hopfield-type neural network is additionally used for the estimation of the amplitude and part angles of the elemental part each with extremely distorted voltage by the idea of best-known power frequency [21]. An improved adaptive police investigation approach for the extraction of the error signal with variable learning parameters are often chosen for quick response to enhance following speed and for a coffee price in an exceedingly stable amount to enhance accuracy [22]. Wu et al. [23] have projected a brand new management formula supported inverse management with a neural network interface that was applied for the fast calculation of shift on/off time in an exceedingly digital atmosphere. A survey on repetitious learning management (ILC) is bestowed by Ahn et al. [24], and it's classified into totally different subsections among the wide selection of application. The most plan of ILC is to search out associated input sequence specified the output of the system is as shut as doable to a desired output. Management formulas reported in offered texts like the quantal Kernel least mean sq. algorithm [25], radial basis operate (RBF) networks [26], and feed forward coaching [27] may also be used for the management of CPDs. An associated immune RBF neural network integrates the immune formula with the RBF neural network. This formula has the benefits within the learning speed and accuracy of the astringent signal. Therefore, it will discover the harmonics of the present timely and exactly within the power network [28]. A multi-layer perceptron neural network is beneficial for the identification of nonlinear characteristics of the load. The most advantage of this methodology is that it needs solely waveforms of voltages and currents. A neural network with memory is employed to spot the nonlinear load admittance. Once coaching is achieved, the neural network predicts truth harmonic current of the load once provided with a clean undulation. Its application with SRF theory is delineate by

Mazumdar et al. [29], [30]. Feed forward back propagation (BP) artificial neural network (ANN) consists of assorted layers like the input layer, hidden layer, and output layer. It's supported feed forward BP with a high ability to touch upon advanced nonlinear issues [31]. The BP management formula is additionally accustomed style the pattern supported call network. The quality BP model has been used with the total association of every node within the layers from input to the output layers. Some applications of this formula are unit on the identification of user faces, industrial processes, knowledge analysis, mapping knowledge, management of power quality improvement devices, etc. [32].

The management of power quality devices by neural network may be a latest analysis space within the field of power engineering. The extraction of harmonic elements decides the performance of compensating devices. The BP formula that trained the sample will discover the signal of the ability quality downside in real time. Its simulation study for harmonic detection is bestowed in [33]. Several neural network-based algorithms are unit reported with theoretical analysis in single part system, however their implementation to DSTATCOM is hardly reported within the offered literature.

In this paper, a BP formula is enforced in an exceedingly 3-part shunt connected custom power device referred to as DSTATCOM for the extraction of the weighted price of load active power and reactive power current elements in nonlinear hundreds. The project management formula is employed for harmonic suppression and cargo equalisation in greenhouse gas and 0 voltage regulation (ZVR) modes with dc voltage regulation of DSTATCOM. During this BP formula, the coaching of weights has 3 stages. It includes the feed forward of the signal coaching, calculation and BP of the error signals, and upgrading of coaching weights. It should have one or over one layer. Continuity, differentiability, and non-decreasing monotony are unit the most characteristics of this formula. It's supported a mathematical formula and doesn't would like special options of operate within the learning method. It conjointly has sleek variation on weight correction as a result of batch change options on weights. Within the coaching method, it's slow as a result of a lot of variety of learning steps, however once the coaching of weights, this formula produces in no time trained output response. During this application, the projected management formula on a DSTATCOM is

enforced for the compensation of nonlinear loads.

System Configuration And management formula

A voltage supply device (VSC)-based DSTATCOM is connected to a 3—3 part ac mains feeding three part linear/nonlinear loads with internal grid electrical resistance that is shown in Fig. 1. The performance of DSTATCOM depends upon the accuracy of harmonic current detection. For reducing ripple in compensating currents, the tuned values of interfacing inductors (L_f) are connected at the ac output of the VSC. A 3part series combination of electrical device (C_f) and electrical device (R_f) represents the shunt passive ripple filter that is connected at some extent of common coupling (PCC) for reducing the high frequency shift noise of the VSC. The DSTATCOM currents ($i_{Ca,b,c}$) are injected PRN compensating currents to cancel the reactive power elements and harmonics of the load currents so loading as a result of reactive power component/ harmonics is reduced on the distribution system.

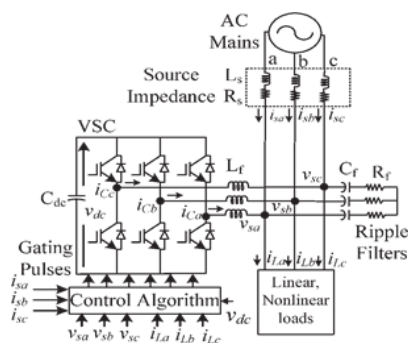


Fig.1 Schematic diagram of VSC-based DSTATCOM.

Fig.2 shows the diagram of the BP coaching formula for the estimation of reference supply currents through the weighted price of load active power and reactive power current elements. during this formula, the part PCC voltages (v_{sa} , v_{sb} , and v_{sc}), supply currents (i_{sa} , i_{sb} , and i_{sc}), load currents (i_{La} , i_{Lb} , and i_{Lc}) and dc bus voltage (v_{dc}) are needed for the extraction of reference supply currents (i_{sa} , i_{sb} , and i_{sc}). There are two primary modes for the operation of this algorithm: the primary one may be a feed forward, and therefore the second is that the BP of error or supervised learning.

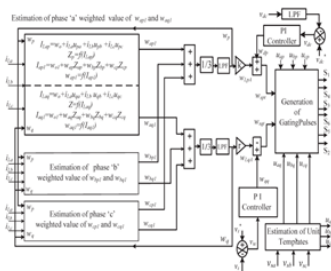


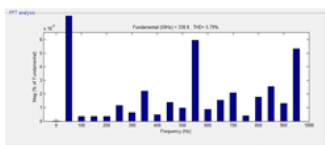
Fig.2 Estimation of reference currents mistreatment BP management formula.

2 Simulation Results and Discussions

MATLAB with SIMULINK and Simgrid tool-boxes is employed for the event of the simulation model of a DSTATCOM and its management formula. The performance of the BP formula within the time domain for the 3part DSTATCOM is simulated for greenhouse gas and ZVR modes of operation below nonlinear hundreds. The performance of the management formula is ascertained below nonlinear hundreds.

Performance of DSTATCOM in greenhouse gas Mode:

The dynamic performance of a VSC-based DSTATCOM is studied for greenhouse gas mode at nonlinear hundreds. The performance indices area unit the part voltages at PCC (vs), balanced supply currents (is), load currents (iLa, iLb, and iLc), compensator currents (iCa, iCb, and iCc), and dc bus voltage (vdc) that area unit shown in Fig. 4. The waveforms of the part a voltage at PCC (vsa), supply current (isa), and cargo current (iLa) area unit shown in Fig. 3(a)(c), severally. the full harmonic distortion (THD) of the part "a" at PCC voltage, supply current, and cargo current area unit found to be five.79%, 4.64%, and 28.97%, severally. it's ascertained that the DSTATCOM is ready to perform the functions of load equalisation and harmonic elimination with high exactness.



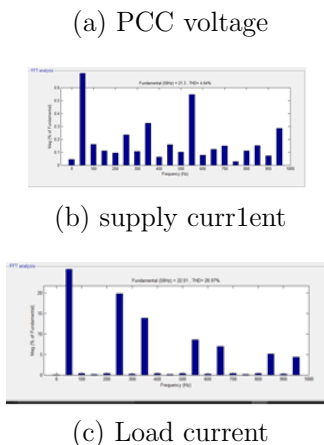


Fig.3 Waveforms and harmonic spectra of part “a” in greenhouse gas mode.

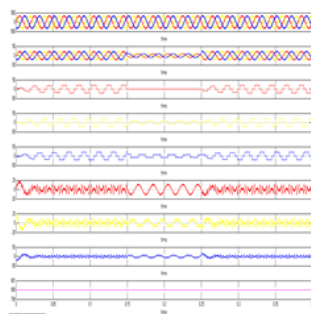


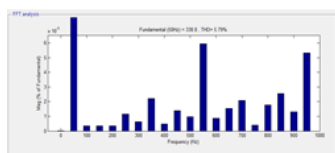
Fig.4: Dynamic performance of DSTATCOM below variable nonlinear hundreds in greenhouse gas mode

Performance of DSTATCOM in ZVR Mode:

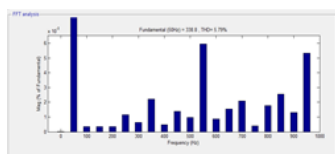
In ZVR mode, the amplitude of the PCC voltage is regulated to the reference amplitude by injecting further leading reactive power elements. The dynamic performance of DSTATCOM in terms of PCC part voltages (v_s), balanced supply currents (i_s), load currents (i_{La} , i_{Lb} , and i_{Lc}), compensator currents (i_{Ca} , i_{Cb} , and i_{Cc}), amplitude of voltages at PCC (v_t), and dc bus voltage (v_{dc}) waveforms is shown in Fig. 6.

The harmonic spectra of the part “a” voltage at PCC (v_{sa}), supply current (i_{sa}), and cargo current (i_{La}) area unit shown in Fig. 5(a)(c). The THDs of the part “a” at PCC voltage, supply

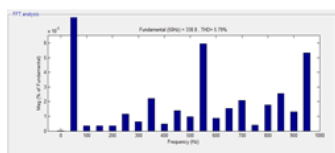
current, load current area unitascertained to be five.79%, 4.64%, and 30.00%, severally. 3part PCC voltages area unit regulated up to the rated price. The amplitude of the 3part voltages is regulated from 335.2 to 338.9 V belownonlinearhundreds. it should be seen that the harmonic distortions of the supply current and PCC voltage area unitamong the IEEE-519 customary limit of fifty. The PCC voltage is additionally regulated at totally differentoperative conditions of load.



(a) PCC voltage



(b) supply current



(c) Load current

Fig. 5 Waveforms and harmonic spectra of part a in ZVR mode.

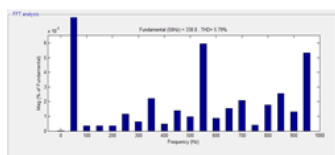


Fig.6 Dynamic performance of DSTATCOM below variable nonlinear hundreds in ZVR mode.

3 Conclusion

A VSC-based DSTATCOM has been accepted because the most popular resolution for power quality improvement as greenhouse gas and to take care of rated PCC voltage. a 3part DSTATCOM has been enforced for the compensation of nonlinear hundred-employing a BPT management formula to verify its effectiveness. The projected BPT management formula has been used for the extraction of reference supply currents to come up with the shift pulses for IGBTs of the VSC of DSTATCOM. varied functions of DSTATCOM like harmonic elimination and cargo equalisation are incontestable in greenhouse gas and ZVR modes with dc voltage regulation of DSTATCOM. From the simulation and implementation results, it's complete that DSTATCOM and its management formula are found appropriate for the compensation of nonlinear hundreds. Its performance has been found satisfactory for this application as a result of the extracted reference supply currents precisely derived the detected supply currents throughout the steady state further as dynamic conditions. The dc bus voltage of the DSTATCOM has conjointly been regulated to the rated price with none overshoot or undershoot throughout load variation. massive coaching time within the application of the advanced system and therefore the choice of the quantity of hidden layers within the system area unit the disadvantages of this formula

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