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An Improved Back Propagation Control strategy for a Distribution System connected STATCOM

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Abstract

This paper shows a usage of a three stage dispersion static compensator (DSTATCOM) utilizing a back propogation (BP) control calculation for its capacities, for example, symphonious end, stack adjusting and receptive power remuneration for control factor revision, and zero voltage direction under nonlinear burdens. A BP-based control calculation is utilized for the extraction of the principal weighted estimation of dynamic and responsive power segments of load streams which are required for the estimation of reference source ebbs and flows. A model of DSTATCOM is produced utilizing a computerized flag processor, and its execution is examined under different working conditions. The execution of DSTATCOM is observed to be attractive with the proposed control calculation for different kinds of burdens.

***Key Words*:**Back propagation (BP) control algorithm, harmonics, ANN-Artificial Neural networks, load balancing, PQ-power quality, weights.

1 INTRODUCTION

The nature of accessible supply control has a direct financial effect on modern and residential divisions which influences the development of any country [1]. This issue is more genuine in electronic based frameworks. The level of sounds and responsive power request are prevalent parameters that determine the level of contortion and receptive power request at a specific transport of the utility [2]. The consonant reverberation is a standout amongst the most widely recognized issues detailed in low-and medium-level circulation frameworks. It is because of capacitors which are utilized for control factor redress (PFC) and source impedance [3]. Power converter-based custom power gadgets (CPDs) are valuable for the decrease of energy quality issues, for example, PFC, consonant remuneration, voltage hang/swell pay, reverberation because of twisting, and voltage gleam diminishment inside indicated worldwide gauges [4] [6]. These CPDs incorporate the dissemination static compensator (DSTATCOM), dynamic voltage restorer, and bound together power quality conditioner in various designs [7] [9]. Some of their new topologies are additionally announced in the writing, for example, the backhanded grid converter-based dynamic compensator where the dc-interface capacitor can be evacuated [10]. Other new arrangements depend on stacked multicell converters where the fundamental highlights are on the expansion in the quantity of yield voltage levels, without transformer activity and common self-adjusting of flying capacitor voltage, and so on [11]. The execution of any custom power gadget depends especially upon the control calculation utilized for the reference current estimation and gating beat age conspire. A portion of the established control calculations are the Fryze control hypothesis, Budeanu hypothesis, p-q hypothesis and SRF hypothesis [12] [14], Lyapunov-work based control [15] and nonlinear control system [16], and so on.

Numerous non-model and preparing based elective control calculations are accounted for in the writing with utilization of delicate figuring procedure, for example, neural system, fluffy rationale and versatile neuro-fluffy, and so forth [17] [20]. Versatile learning, self-association, ongoing task, and adaptation to internal failure through repetitive data are real focal points of these calculations. A neural system based control calculation, for example, the Hopfieldtype neural system is likewise utilized for the estimation of the abundancy and stage edges of the principal segment both with very misshaped voltage by the supposition of known power recurrence [21]. An enhanced versatile recognizing approach for the extraction of the mistake motion with variable learning parameters can be decided for quick reaction to enhance following velocity and for a low an incentive in a steady period to enhance exactness [22]. Wu et al. [23] have proposed another control calculation in light of converse control with a neural system interface which was connected for the prompt count of turning on off time in a computerized domain. A review on iterative learning control (ILC) is displayed by Ahnetal. [24], and it is grouped into various subsections inside the extensive variety of utilization. The primary thought of ILC is to discover an information succession with the end goal that the yield of the framework is as close as conceivable to a coveted yield. Control calculations detailed in accessible messages, for example, the quantized Kernel slightest mean square calculation [25], spiral premise work (RBF) systems [26], and sustain forward preparing [27] can likewise be utilized for the control of CPDs. A safe RBF neural system coordinates the resistant calculation with the RBF neural system. This calculation has the favorable circumstances in the learning rate and precision of the astringent flag. In this way, it can recognize the sounds of the current opportune and correctly in the power arrange [28]. A multilayer perceptron neural system is valuable for the ID of nonlinear qualities of the heap. The principle preferred standpoint of this strategy is that it requires just waveforms of voltages and streams. A neural system with memory is utilized to recognize the nonlinear load permission. When preparing is accomplished, the neural system predicts the genuine consonant current of the heap when provided with a spotless sine wave. Its application with SRF hypothesis is portrayed by Mazumdar et al. [29], [30]. Sustain forward back proliferation (BP) manufactured neural system (ANN) comprises of different layers, for example, the information layer, shrouded layer, and yield layer. It depends on bolster forward BP with a high capacity to manage complex nonlinear issues [31]. The BP control calculation is likewise used to outline the example in view of choice emotionally supportive network. The standard BP show has been utilized with the full association of every hub in the layers from contribution to the yield layers. A few uses of this calculation are with regards to the distinguishing proof of client faces, mechanical procedures, information investigation, mapping information, control of energy quality change gadgets, and so forth [32].

The control of energy quality gadgets by neural system is a most recent research territory in the field of energy designing. The extraction of symphonious parts chooses the execution of remunerating gadgets. The BP calculation which prepared the example can identify the flag of the power quality issue continuously. Its recreation consider for symphonious location is introduced in [33]. Numerous neural system based calculations are accounted for with hypothetical examination in single stage framework, however their usage to DSTATCOM is not really revealed in the accessible writing.

In this paper, a BP calculation is executed in a three stage shunt associated custom power gadget known as DSTATCOM for the extraction of the weighted estimation of load dynamic power and responsive power current segments in nonlinear burdens. The proposed control calculation is utilized for symphonious concealment and load adjusting in PFC and zero voltage direction (ZVR) modes with dc voltage control of DSTATCOM. In this BP calculation, the preparation of weights has three phases. It incorporates the encourage forward of the information flag preparing, estimation and BP of the mistake flags, and redesigning of preparing weights. It might have at least one than one layer. Coherence, differentiability, and non-diminishing tedium are the fundamental qualities of this calculation. It depends on a scientific recipe and does not require unique highlights of capacity in the learning procedure. It additionally has smooth minor departure from weight amendment because of group refreshing highlights on weights. In the preparation procedure, it is ease back because of more number of learning steps, yet after the preparation of weights, this calculation delivers quick prepared yield reaction. In this application, the proposed control calculation on a DSTATCOM is executed for the remuneration of nonlinear burdens.

2 SYSTEM CONFIGURATION AND CONTROL ALGORITHM

A voltage source converter (VSC)- based DSTATCOM is associated with a three stage air conditioning mains bolstering three stage straight/nonlinear burdens with inside matrix impedance which is appeared in Fig. 1. The execution of DSTATCOM relies on the exactness of consonant current recognition. For lessening swell in remunerating streams, the tuned benefits of interfacing inductors (Lf) are associated at the air conditioner yield of the VSC. A three stage arrangement mix of capacitor (Cf) and a resistor (Rf) speaks to the shunt aloof swell channel which is associated at a state of regular coupling (PCC) for decreasing the high recurrence exchanging commotion of the VSC. The DSTATCOM streams (iCabc) are infused as required remunerating ebbs and flows to drop the responsive power parts and sounds of the heap ebbs and flows so stacking because of receptive power segment/music is diminished on the dissemination framework.

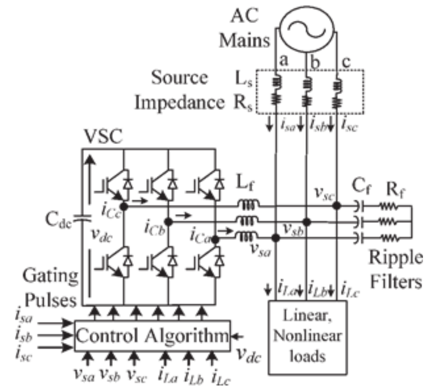


Fig. 1. Schematic diagram of VSC-based DSTATCOM.

Fig. 2 demonstrates the piece outline of the BP preparing calculation for the estimation of reference source streams through the weighted estimation of load dynamic power and responsive power current segments. In this calculation, the stage PCC voltages (vsa, vsb, and vsc), source streams (isa, isb, and isc), stack ebbs and flows (iLa, iLb, and iLc) and dc transport voltage (vdc) are required for the extraction of reference source ebbs and flows (isa, isb, and isc).

There are two essential modes for the task of this calculation: The first is a nourish forward, and the second is the BP of blunder or regulated learning.

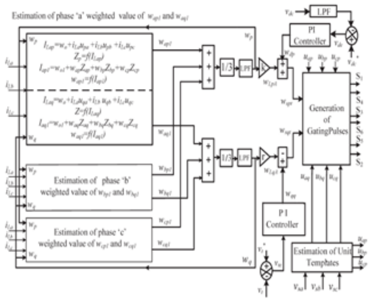


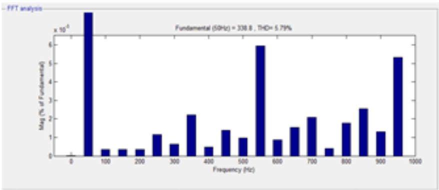
Fig. 2. Estimation of reference currents using BP control algorithm.

3 SIMULATION RESULTS AND DISCUSSIONS

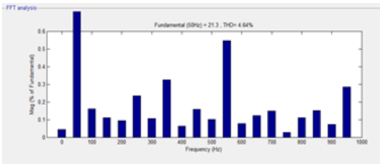
MATLAB with SIMULINK and Sim Power System tool kits is utilized for the improvement of the recreation model of a DSTATCOM and its control calculation. The execution of the BP calculation in the time area for the three stage DSTATCOM is recreated for PFC and ZVR methods of task under nonlinear burdens. The execution of the control calculation is seen under nonlinear burdens.

3.1 Performance of DSTATCOM in PFC Mode:

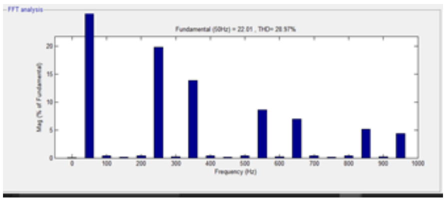
The dynamic execution of a VSC-based DSTATCOM is contemplated for PFC mode at nonlinear burdens. The execution files are the stage voltages at PCC (versus), adjusted source streams (is), stack ebbs and flows (iLa, iLb, and iLc), compensator ebbs and flows (iCa, iCb, and iCc), and dc transport voltage (vdc) which are appeared in Fig. 4. The waveforms of the stage "a" voltage at PCC (vsa), source current (isa), and stack current (iLa) are appeared in Fig. 3(a) (c), separately. The aggregate symphonious mutilation (THD) of the stage "an" at PCC voltage, source current, and load dog lease are observed to be 5.79%, 4.64%, and 28.97%, individually. It is watched that the DSTATCOM can play out the elements of load adjusting and symphonious disposal with high exactness.



(a) PCC voltage



(b) Source curr1ent



(c) Load current

Fig. 3. Waveforms and harmonic spectra of phase a in PFC mode.

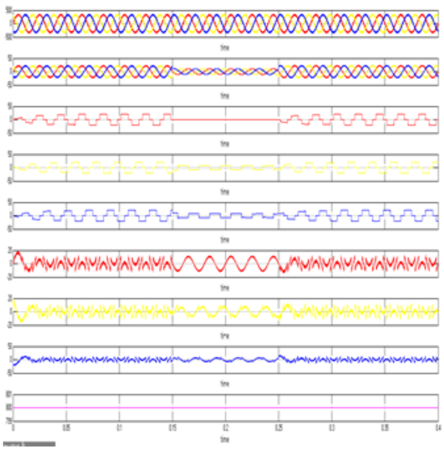
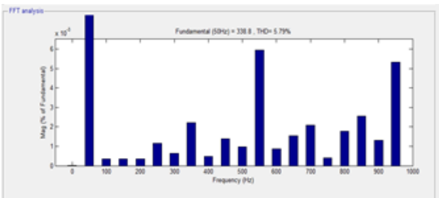


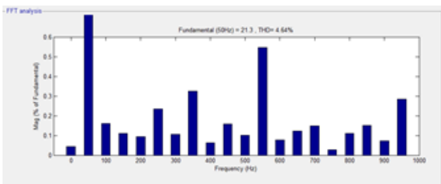
Fig.4: Dynamic performance of DSTATCOM under varying nonlinear loads in PFC mode

3.2 Performance of DSTATCOM in ZVR Mode:

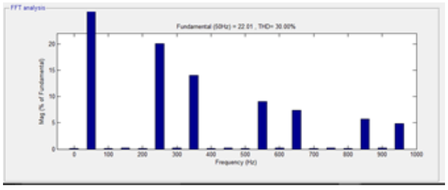
In ZVR mode, the plentifulness of the PCC voltage is directed to the reference adequacy by infusing additional driving receptive power segments. The dynamic execution of DSTATCOM as far as PCC stage voltages (versus), adjusted source streams (is), stack ebbs and flows (iLa, iLb, and iLc), compensator ebbs and flows (iCa, iCb, and iCc), plentifulness of voltages at PCC (vt), and dc transport voltage (vdc) waveforms is appeared in Fig. 6. The symphonious spectra of the stage "a" voltage at PCC (vsa), source current (isa), and stack current (iLa) are appeared in Fig. 5(a) (c). The THDs of the stage "an" at PCC voltage, source current, stack current are seen to be 5.79%, 4.64%, and 30.00%, separately. Three stage PCC voltages are directed up to the appraised esteem. The sufficiency of the three stage voltages is directed from 335.2 to 338.9 V under nonlinear burdens. It might be seen that the consonant bends of the source current and PCC voltage are inside the IEEE-519 standard cutoff of 5%. The PCC voltage is likewise controlled at various working states of load.



(a) PCC voltage



(b) Source current



(c) Load current

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

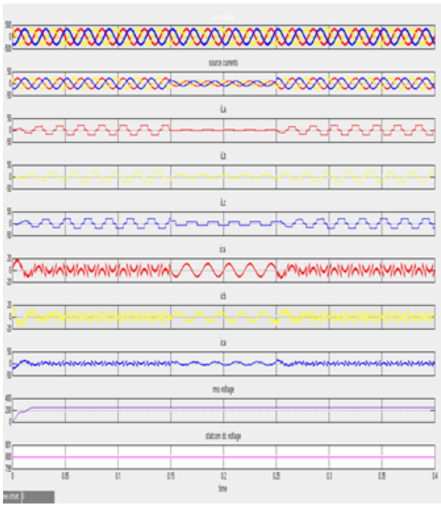


Fig. 6. Dynamic performance of DSTATCOM under varying nonlinear loads in ZVR mode.

4 CONCLUSION

A VSC-based DSTATCOM has been acknowledged as the most favored answer for control quality change as PFC and to keep up appraised PCC voltage. A three stage DSTATCOM has been actualized for the pay of nonlinear burdens utilizing a BPT control calculation to check its viability. The proposed BPT control calculation has been utilized for the extraction of reference source streams to create the exchanging beats for IGBTs of the VSC of DSTATCOM. Different elements of DSTATCOM, for example, consonant end and load adjusting have been shown in PFC and ZVR modes with dc voltage direction of DSTATCOM. From the recreation and usage comes about, it is inferred that DSTATCOM and its control calculation have been discovered appropriate for the remuneration of nonlinear burdens. Its execution has been discovered palatable for this application in light of the fact that the separated reference source streams precisely followed the detected source ebbs and flows amid the unfaltering state and in addition dynamic conditions. The dc transport voltage of the DSTATCOM has additionally been managed to the appraised an incentive with no overshoot or undershoot amid stack variety. Substantial preparing time in the utilization of the perplexing framework and the determination of the quantity of shrouded layers in the framework are the drawbacks of this calculation.

References

[1] R. C. Dugan, M. F. McGranaghan, and H. W. Beaty, Electric Power Systems Quality, 2nd ed. New York, NY, USA: McGraw-Hill, 2006.

[2] A. Ortiz, C. Gherasim, M. Manana, C. J. Renedo, L. I. Eguiluz, and R. J. M. Belmans, Total harmonic distortion decomposition depending on distortion origin, IEEE Trans. Power Del., vol. 20, no. 4, pp. 2651 2656, Oct. 2005.

[3] T. L. Lee and S. H. Hu, Discrete frequency-tuning active filter to suppress harmonic resonances of closed-loop distribution power systems, IEEE Trans. Power Electron., vol. 26, no. 1, pp. 137148, Jan. 2011.

[4] K. R. Padiyar, FACTS Controllers in Power Transmission and Distribution. New Delhi, India: New Age Int., 2008.

[5] IEEE Recommended Practices and Requirement for Harmonic Control on Electric Power System, IEEE Std.519, 1992.

[6] T.-L. Lee, S.-H. Hu, and Y.-H. Chan, DSTATCOM with positive- sequence admittance and negative-sequence conductance to mitigate voltage fluctuations in high-level penetration of distributed generation systems, IEEE Trans. Ind. Electron., vol. 60, no. 4, pp. 14171428, Apr. 2013.

[7] B. Singh, P. Jayaprakash, and D. P. Kothari, Power factor correction and power quality improvement in the distribution system, Elect. India Mag., pp. 4048, Apr. 2008.

[8] J.-C. Wu, H. L. Jou, Y. T. Feng, W. P. Hsu, M. S. Huang, and W. J. Hou, Novel circuit topology for three-phase active power filter, IEEE Trans. Power Del., vol. 22, no. 1, pp. 444449, Jan. 2007.

[9] Z. Yao and L. Xiao, Control of single-phase grid-connected inverters with nonlinear loads, IEEE Trans. Ind. Electron., vol. 60, no. 4, pp. 1384 1389, Apr. 2013.

[10] A. A. Heris, E. Babaei, and S. H. Hosseini, A new shunt active power filter based on indirect matrix converter, in Proc. 20th Iranian Conf. Elect. Eng., 2012, pp. 581586.

[11] M. Sadeghi, A. Nazarloo, S. H. Hosseini, and E. Babaei, A new DSTATCOM topology based on stacked multicell converter, in Proc. 2nd Power Electron., Drive Syst. Technol. Conf., 2011, pp. 205210.

[12] G. Benysek and M. Pasko, Power Theories for Improved Power Quality. London, U.K.: Springer-Verlag, 2012.

[13] B. Singh and J. Solanki, A comparison of control algorithms for DSTATCOM, IEEE Trans. Ind. Electron., vol. 56, no. 7, pp. 27382745, Jul. 2009.

[14] C. H. da Silva, R. R. Pereira, L. E. B. da Silva, G. Lambert-Torres, B. K. Bose, and S. U. Ahn, A digital PLL scheme for three-phase system using modified synchronous reference frame, IEEE Trans. Ind. Electron., vol. 57, no. 11, pp. 38143821, Nov. 2010.

[15] S. Rahmani, A. Hamadi, and K. Al-Haddad, A Lyapunov-function-based control for a three-phase shunt hybrid active filter, IEEE Trans. Ind. Electron., vol. 59, no. 3, pp. 14181429, Mar. 2012.

[16] S. Rahmani, N. Mendalek, and K. Al-Haddad, Experimental design of a nonlinear control technique for three-phase shunt

active power filter, IEEE Trans. Ind. Electron., vol. 57, no. 10, pp. 33643375, Oct. 2010.

[17] S. N. Sivanandam and S. N. Deepa, Principle of Soft Computing. New Delhi, India: Wiley India Ltd., 2010.

[18] J. S. R. Jang, C. T. Sun, and E. Mizutani, Neuro Fuzzy and Soft Computing: A Computational Approach to Learning and Machine Intelligence. Delhi, India: Pearson Educ. Asia, 2008.

[19] P. Kumar and A. Mahajan, Soft computing techniques for the control of an active power filter, IEEE Trans. Power Del., vol. 24, no. 1, pp. 452 461, Jan. 2009.

[20] A. Bhattacharya and C. Chakraborty, A shunt active power filter with enhanced performance using ANN-based predictive and adaptive controllers, IEEE Trans. Ind. Electron., vol. 58, no. 2, pp. 421428, Feb. 2011.

[21] L. L. Lai, W. L. Chan, and A. T. P. So, A two-ANN approach to frequency and harmonic evaluation, in Proc. 5th Int. Conf. Artif. Neural Netw., 1997, pp. 245250.

[22] X. Mao, The harmonic currents detecting algorithm based on adaptive neural network, in Proc. 3rd Int. Symp. Intell. Inf. Technol. Appl., 2009, vol. 3, pp. 5153.

[23] J. Wu, H. Pang, and X. Xu, Neural-network-based inverse control method for active power filter system, in Proc. IEEE Int. Symp. Intell. Control, 2006, pp. 30943097.

[24] H.-S. Ahn, Y. Q. Chen, and K. L. Moore, Iterative learning control: Brief survey and categorization, IEEE Trans. Syst., Man, Cybern. C, Appl. Rev., vol. 37, no. 6, pp. 10991121, Nov. 2007.

[25] B. Chen, S. Zhao, P. Zhu, and J. C. Principe, Quantized kernel least mean square algorithm, IEEE Trans. Neural Netw. Learn. Syst., vol. 23, no. 1, pp. 2232, Jan. 2012.

[26] Y. Hao, X. Tiantian, S. Paszczynski, and B. M. Wilamowski, Advantages of radial basis function networks for dynamic system design, IEEE Trans. Ind. Electron., vol. 58, no. 12, pp. 54385450, Dec. 2011.

[27] X. Jing and L. Cheng, An optimal-PID control algorithm for training feed-forward neural networks, IEEE Trans. Ind. Electron., vol. 60, no. 6, pp. 22732283, Jun. 2013.

[28] F. Guangjie and Z. Hailong, The study of the electric power harmonics detecting method based on the immune RBF neural network, in Proc. 2nd Int. Conf. Intell. Comput. Technol. Autom., 2009, vol. 1, pp. 121124.

[29] J. Mazumdar, R. G. Harley, and G. K. Venayagamoorthy, Synchronous reference frame based active filter current reference generation using neural networks, in Proc. 32nd IEEE Annu. Conf. Ind. Electron. 2006, pp. 44044409.

[30] J. Mazumdar, R. G. Harley, F. Lambert, and G. K. Venayagamoorthy, A novel method based on neural networks to distinguish between load harmonics and source harmonics in a power system, in Proc. IEEE Power Eng. Soc. Inaugural Conf. Expo. Africa, 2005, pp. 477484.

[31] A. Zouidi, F. Fnaiech, K. Al-Haddad, and S. Rahmani, Artificial neural networks as harmonic detectors, in Proc. 32nd Annu. Conf. IEEE Ind. Electron., 2006, pp. 28892892.

[32] I. Jung and G. N. Wang, Pattern classification of back-propagation algorithm using exclusive connecting network, J. World Acad. Sci., Eng. Technol., vol. 36, pp. 189193, Dec. 2007.

[33] C. Ying and L. Qingsheng, New research on harmonic detection based on neural network for power system, in Proc. 3rd Int. Symp. Intell. Inf. Technol. Appl., 2009, vol. 2, pp. 113116.