A literature review on reduction of harmonics using active power filter ≒

K. V. Govardhan Rao; Malligunta Kiran Kumar



+ Author & Article Information

AIP Conf. Proc. 2512, 020083 (2024)

https://doi.org/10.1063/5.0112028

The disturbances or harmonics in power system lines can be minimised by Active Power Filters (APF). An advancement of APF technologies and proper application of active power filter is to use good method for current or voltage reference generation are reviewed in this paper. Here we discussed about the critique of harmonics disturbance issues and their effects on quality of power. The basic configuration of APF is combination of series and shunt (hybrid) APF, series APF and shunt APF are explained. This understanding explains the implementation of p-q extinctions to produce reference signals. Apart from this, APF photovoltaic system is also analysed.

Topics

Electronic filters, Power electronics, Photovoltaics, Review

REFERENCES

1. H. Akagi, "New Trends in Active Filters for Power Conditioning," *IEEE Trans. on Industry Applications*, vol. 32, no. 6, pp. 1312–1322, 1996.

https://doi.org/10.1109/28.556633 Google Scholar Crossref

- 2. J. Wang, "Simulation of three-phase three-wire shunt active power filter," 2009 International Conference on Sustainable Power Generation and Supply, 2009, pp. 1–4. Google Scholar
- 3. R. C. Dugan, M. F. McGranaghan, S. Santoso and H. W. Beaty. *Electrical Power Systems Quality* 2nd. ed. McGraw-

Hill, 2002, USA. Google Scholar

4. W. M. Grady and S. Santoso, "Understanding Power System Harmonics," *IEEE Power Engineering Review*, vol. 21, no. 11, pp. 8–11, 2001.

https://doi.org/10.1109/MPER.2001.961997 Google Scholar Crossref

- 5. Institute of Electrical and Electronics Engineers. Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems. IEEE Standard 519., 1993, USA.
- 6. Baig, K., Prudhvi Raj, K., Raja Sekhar, G. G., Vijay Muni, T., & Kiran Kumar, M. (2020). Power quality enchancement with active power control. *Journal of Critical Reviews*, 7(9), 739–741. https://doi.org/10.31838/jcr.07.09.143.

 Google Scholar Crossref
- 7. J. Xiao, X. Zhang, S. Wen and Z. Liu, "Active power filter design for improving power quality," 2015 International Conference on Advanced Mechatronic Systems (ICAMechS), 2015, pp. 557–561, doi: https://doi.org/10.1109/ICAMechS.2015.

 Google Scholar
- 8. J. K. Phipps, "A Transfer Function Approach to Harmonic Filter Design," *IEEE Industry Applications Magazine*, vol. 3, no. 2, pp. 68–82, 1997. https://doi.org/10.1109/2943.579139 Google Scholar Crossref
- 9. J. C. Das, "Passive Filters Potentialities and Limitations," *IEEE Trans. on Industry Applications*, vol. 40, no. 1, pp. 232–241, 2004.

https://doi.org/10.1109/TIA.2003.821666 Google Scholar Crossref

10. M. El-Habrouk, M. K. Darwish and P. Mehta, "Active Power Filters: A Review," *Proc. IEE Electric Power Applications*, vol. 147, no. 5, pp. 403–413, 2000. https://doi.org/10.1049/ip-epa:20000522
Google Scholar Crossref

11. P. Salmerón, S. P. Litrán, R. S. Herrera and J. R. Vázquez, "A practical assessment of different active power filter configurations," 2011 International Conference on Power

Engineering, Energy and Electrical Drives, 2011, pp. 1–6, doi: https://doi.org/10.1109/PowerEng.

Google Scholar

- 12. C. Y. Hsu and H. Y. Wu, "A New Single-Phase Active Power Filter with Reduced Energy-Storage Capacity," *Proc. IEE Electric Power Applications*, vol. 143, no. 1, pp. 25–30, 1996. https://doi.org/10.1049/ip-epa:19960205
 Google Scholar Crossref
- 13. S. G. Jeong and M. H. Woo, "DSP-Based Active Power Filter with Predictive Current Control," *IEEE Trans. on Industrial Electronics*, vol. 44, no. 3, pp. 329–336, 1997. https://doi.org/10.1109/41.585830
 Google Scholar Crossref
- 14. S. Buso, L. Malesani, P. Mattavelli and R. Veronese, "Design and Fully Digital Control of Parallel Active Power Filters for Thyristor Rectifiers to Comply with IEC-1000-3-2 Standards," *IEEE Trans. on Industry Applications*, vol. 34, no. 3, pp. 508–517, 1998. https://doi.org/10.1109/28.673721 Google Scholar Crossref
- 15. P. Jintakosonwit, H. Fujita and H. Akagi, "Control and Performance of a Fully-Digital-Controlled Shunt Active Filter for Installation on Power Distribution System," *IEEE Trans. on Power Electronics*, vol. 17, no. 1, pp. 132–140, 2002. https://doi.org/10.1109/63.988679

 Google Scholar Crossref
- 16. H. Usman, H. Hizam and M. A. MohdRadzi, "Simulation of single-phase shunt active power filter with fuzzy logic controller for power quality improvement," 2013 IEEE Conference on Clean Energy and Technology (CEAT), 2013, pp. 353–357, doi: https://doi.org/10.1109/CEAT.2013.6775655.

 Google Scholar
- 17. S. Khositkasame and S. Sangwongwanich, "Design of Harmonic Current Detector and Stability Analysis of a Hybrid Parallel Active Filter," *Proceedings of the Power Conversion Conference (PCC)*, Nagaoka, Japan, 1997 pp. 181–186.

 Google Scholar Crossref
- 18. M. Routimo, M. Salo and H. Tuusa, "A Novel Control Method for Wideband Harmonic Compensation," *Proceedings of the IEEE International Conference on Power Electronics*

and Drive Systems (PEDS), Singapore, 2003, pp. 799–804. Google Scholar

- 19. V. F. Corasaniti, M. B. Barbieri, P. L. Arnera and M. I. Valla, "Hybrid Active Filter for Reactive and Harmonics Compensation in a Distribution Network," in *IEEE Transactions on Industrial Electronics*, vol. 56, no. 3, pp. 670–677, March 2009, doi: https://doi.org/10.1109/TIE.2008. Google Scholar
- 20. T. J. Hammons, et al., "Renewable Energy Alternatives for Developed Countries," *IEEE Trans. on Energy Conversion*, vol. 15, no. 4, pp. 481–493, 2000. https://doi.org/10.1109/60.900511
 Google Scholar Crossref
- 21. S. R. Bull, "Renewable Energy Today and Tomorrow," *Proc. IEEE*, vol. 89, no. 8, pp. 1216–1226, 2001. https://doi.org/10.1109/5.940290
 Google Scholar Crossref
- 22. N. M. Maricar, et al., "Photovoltaic Solar Energy Technology Overview for Malaysia Scenario," *Proceedings of the IEEE National Conference on Power and Energy Conference (PECon)*, Bangi, Malaysia, 2003, pp. 300–305. Google Scholar
- 23. S. Kim, G. Yoo and J. Song, "A Bifunctional Utility Connected Photovoltaic System with Power Factor Correction and U.P.S. Facility," *Proceedings of the IEEE Conference on Photovoltaic Specialist*, Washington, USA, 1996, pp. 1363–1368.

Google Scholar

24. Y. Komatsu, "Application of the Extension pq Theory to a Mains-Coupled Photovoltaic System," *Proceedings of the Power Conversion Conference (PCC)*, Osaka, Japan, 2002, pp. 816–821.

Google Scholar

25. T. – F. Wu, C. – L. Shen, C. H. Chang and J. – Y. Chiu, "1/spl phi/ 3W Grid-Connection PV Power Inverter with Partial Active Power Filter," *IEEE Trans. on Aerospace and Electronic Systems*, vol. 39, no. 2, pp. 635–646, 2003. https://doi.org/10.1109/TAES.2003.1207254

Google Scholar Crossref

26. Y. Komatsu and T. Kawabata, "Characteristics of Three Phase Active Power Filter using Extension pq Theory," *Proceedings of the IEEE International Symposium on Industrial Electronics (ISIE)*, Guimaraes, Portugal, 1997, pp. 302–307.

Google Scholar Crossref

27. B. Dobrucky, H. Kim, V. Racek, M. Roch and M. Pokorny, "Single-Phase Power Active Filter and Compensator using Instantaneous Reactive Power Method," *Proceedings of the Power Conversion Conference (PCC)*, Osaka, Japan, 2002, pp. 167–171.

Google Scholar

28. A. Ghosh and G. Ledwich, *Power Quality Enhancement Using Custom Power Devices*. Kluwer Academic Publishers, 2002, Massachusetts, USA.

Google Scholar Crossref

29. J. Stones and A. Collinson, "Power Quality," *IEE Power Engineering Journal*, vol. 15, no. 2, pp. 58–64, 2001. https://doi.org/10.1049/pe:20010201
Google Scholar Crossref

30. C. W. Jr. Smith, "Power Systems and Harmonic Factors," *IEEE Potentials*, vol. 20, no. 5, pp. 10–12, 2001. https://doi.org/10.1109/45.983332

Google Scholar Crossref

31. Herrera, R. S.; Salmerón, P.; Kim, H.; "Instantaneous Reactive PowerTheory Applied to Active Power Filter Compensation: DifferentApproaches, Assessment, and Experimental Results," *IEEE Trans. OnIndustrial Electronics*, Vol. 55, Issue 1, Jan. 2008, pp. 184–196 https://doi.org/10.1109/TIE.2007.905959

Google Scholar Crossref

32. K. C. Umeh, A. Mohamed and R. Mohamed, "Comparing the Harmonic Characteristics of Typical Single-Phase Nonlinear Loads," *Proceedings of the IEEE National Conference on Power and Energy (PECon)*, Bangi, Malaysia, 2003, pp. 383–387.

Google Scholar

33. L. S. Czarnecki, "An Overview of Methods of Harmonic Suppression in Distribution Systems," *Proceedings of the IEEE Power Engineering Society Summer Meeting*,

Washington, USA, 2000, pp. 800–805. Google Scholar

34. B. Singh, K. Al-Haddad and A. Chandra, "A Review of Active Filters for Power Quality Improvement," *IEEE Trans. on Industrial Electronics*, vol. 46, no. 5, pp. 960–971, 1999. https://doi.org/10.1109/41.793345

Google Scholar Crossref

35. K. N. M. Hasan and M. F. Romlie, "Comparative study on combined series active and shunt passive power filter using two different control methods," 2007 International Conference on Intelligent and Advanced Systems, 2007, pp. 928–933, doi: https://doi.org/10.1109/ICIAS.2007.4658522.

Google Scholar

- 36. J. Perez, V. Cardenas, F. Pazos and S. Ramirez, "Voltage Harmonic Cancellation in Single-Phase Systems using a Series Active Filter with Low-Order Controller," *Proceedings of the IEEE International Power Electronics Congress (CIEP)*, Guadalajara, Mexico, 2002, pp. 270–274. Google Scholar
- 37. V. B. Bhavaraju and P. Enjeti, "A Fast Active Power Filter to Correct Line Voltage Sags," *IEEE Trans. on Industrial Electronics*, vol. 41, no. 3, pp. 333–338, 1994. https://doi.org/10.1109/41.293904
 Google Scholar Crossref
- 38. Y. Haroen and S. Riyadi, "Analysis of Instantaneous Representative Active Power Equality based Control Method for Three Phase Shunt Active Power Filter," 2005 International Conference on Power Electronics and Drives Systems, 2005, pp. 542–547, doi: https://doi.org/10.1109/PEDS.2005.1619746.

 Google Scholar
- 39. B. S. Rigby and R. G. Harley, "The Design and Control of an Inverter-Based Series Compensator for Dynamic Performance," *Proceedings of the IEEE Power Engineering Society Summer Meeting*, Alberta, Canada, 1999, pp. 1146–1151.

Google Scholar

40. R. Li, A. T. Johns, M. M. Elkateb and F. V. P. Robinson, "Comparative Study of Parallel Hybrid Filters in Resonance Damping," *Proceedings of the IEEE International Conference*

on Electric Power Engineering, Hungary, 1999, pp. 230. Google Scholar

41. L. Chen and A. Jouanne, "A Comparison and Assessment of Hybrid Filter Topologies and Control Algorithms," *Proceedings of the IEEE Power Electronics Specialists Conference (PESC)*, Vancouver, Canada, 2001, pp. 565–570.

Google Scholar

- 42. S. Bhattacharya and D. Divan, "Design and Implementation of a Hybrid Series Active Filter System," *Proceedings of the IEEE Power Electronics Specialists Conference (PESC)*, Georgia, USA, 1995, pp. 189–195. https://doi.org/10.1109/PESC.1995.474811
 Google Scholar Crossref
- 43. S. A. Taher, M. H. Alaee and Z. DehghaniArani, "Model predictive control of PV-based shunt active power filter in single phase low voltage grid using conservative power theory," 2017 8th Power Electronics, Drive Systems & Technologies Conference (PEDSTC), 2017, pp. 253–258, doi: https://doi.org/10.1109/PEDSTC.2017.7910332.

 Google Scholar
- 44. F. Z. Peng, H. Akagi and A. Nabae, "A New Approach to Harmonic Compensation in Power Systems a Combined System of Shunt Passive and Series Active Filters," *IEEE Trans. on Industry Applications*, vol. 26, no. 6, pp. 983–990, 1990. https://doi.org/10.1109/28.62380

 Google Scholar Crossref
- 45. J. S. Lai, "Power Electronics Applications in Renewable Energy Systems," *Proceedings of the IEEE Industrial Electronics Society Annual Conference*, Virginia, USA, 2003, pp. 3025–3026.

Google Scholar

- 46. D. C. Martins, R. Demonti and I. Barbi, "Usage of the Solar Energy from the Photovoltaic Panels for the Generation of Electrical Energy," *Proceedings of the IEEE International Telecommunications Energy Conference (INTELEC'99)*, Copenhagen, Denmark, 1999, pp. 17–3.

 Google Scholar
- 47. H. Dehbone, Nayar, Chem, L. Borle and M. Malengret, "A Solar Photovoltaic In-Line UPS System using Space

Vector Modulation Technique," *Proceedings of the IEEE Power Engineering Society Summer Meeting*, Vancouver, Canada, 2001. pp. 632–637.

Google Scholar

48. U. Herrmann, H. G. Langer and H. Broeck, "Low Cost DC to AC Converter for Photovoltaic Power Conversion in Residential Applications," *Proceedings of the IEEE Power Electronics Specialist Conference (PESC)*, Washington, USA, 1993, pp. 588–594.

Google Scholar Crossref

49. N. G. Sung, J. D. Lee, B. T. Kim, M. Park and I. K. Yu, "Novel Concept of a PV Power Generation System Adding the Function of Shunt Active Filter," *Proceedings of the IEEE Transmission and Distribution Conference*, Yokohama, Japan, 2002, pp. 1658–1663.

Google Scholar Crossref

50. S. J. Chiang, K. T. Chang and C. Y. Yen, "Residential Photovoltaic Energy Storage System," *IEEE Trans. on Industrial Electronics*, vol. 45, no. 3, pp. 385–394, 1998.

Google Scholar Crossref

51. M. El-Habrouk, M. K. Darwish and P. Mehta, "A Survey of Active Filters and Reactive Power Compensation Techniques," *Proceedings of the IEE International Conference on Power Electronics and Variable Speed Drives*, London, UK, 2000, pp. 7–12.

Google Scholar

Google Scholar

52. W. M. Grady, M. J. Samotyj and A. H. Noyola, "Survey of Active Power Line Conditioning Methodologies," *IEEE Trans.* on Power Delivery, vol. 5, no. 3, pp. 1536–1542, 1990. https://doi.org/10.1109/61.57998

Google Scholar Crossref

53. M. Norman, A. Ahsanul, M. Senan and H. Hashim, "Review of Control Strategies for Power Quality Conditioners," *Proceedings of the IEEE National Conference on Power and Energy Conference (PECon)*, Kuala Lumpur, Malaysia, 2004, pp. 109–115.

54. D. – H. Chen and S. – J. Xie, "Review of Control Strategies Applied to Active Power Filters," *Proceedings of the IEEE International Conference on Electric Utility*

Deregulation, Restructuring and Power Technologies (DRPT), Hong Kong, 2004, pp. 666–670.

Google Scholar Crossref

- 55. M. El-Habrouk and M. K. Darwish, "Design and Implementation of a Modified Fourier Analysis Harmonic Current Computation Technique for Power Active Filters using DSPs," *Proc. IEE Electric Power Applications*, vol. 148, no. 1, pp. 21–28, 2001. https://doi.org/10.1049/ip-epa:20010014

 Google Scholar Crossref
- 56. S. Rahmani, A. Hamadi, K. Al-Haddad and L. A. Dessaint, "A Combination of Shunt Hybrid Power Filter and Thyristor-Controlled Reactor for Power Quality," in *IEEE Transactions on Industrial Electronics*, vol. 61, no. 5, pp. 2152–2164, May 2014, doi: https://doi.org/10.1109/TIE.2013.2272271.

https://doi.org/10.1109/TIE.2013.2272271.
Google Scholar Crossref

57. P. L. Leow and A. A. Naziha, "SVM Based Hysteresis Current Controller for a Three Phase Active Power Filter," *Proceedings of the IEEE National Conference on Power and Energy Conference (PECon)*, Kuala Lumpur, Malaysia, 2004, pp. 132–136.

Google Scholar

- 58. H. L. Jou, "Performance Comparison of the Three-Phase Active-Power-Filter Algorithms," *Proc. IEE Generation, Transmission and Distribution*, vol. 142, no. 6, pp. 646–652, 1995. https://doi.org/10.1049/ip-gtd:19952247
 Google Scholar Crossref
- 59. T. F. Wu, C. L. Shen, J. Y. Chiu and C. C. Chen, "An APF with MAPPT Scheme to Improve Power Quality," *Proceedings of the IEEE International Conference on Electrical and Electronic Technology*, Singapore, 2001, pp. 620–626.

Google Scholar

60. S. G. Seifossadat, R. Kianinezhad, A. Ghasemi and M. Monadi, "Quality improvement of shunt active power filter, using optimized tuned harmonic passive filters," 2008 International Symposium on Power Electronics, Electrical Drives, Automation and Motion, 2008, pp. 1388–1393, doi: https://doi.org/10.1109/SPEEDHAM.2008.4581063.

Google Scholar

- 61. S. Buso, L. Malesani and P. Mattavelli, "Comparison of Current Control Techniques for Active Filter Applications," IEEE Trans. on Industrial Electronics, vol. 45, no. 5, pp. 722–729, 1998. https://doi.org/10.1109/41.720328 Google Scholar Crossref
- 62. L. Malesani, P. Mattavelli and S. Buso, "Dead-Beat Current Control for Active Filters," Proceedings of the Industrial Electronics Conference (IECON), Aachen, Germany, 1998, pp. 1859-1864. Google Scholar
- 63. K. Nishida, Y. Konishi and M. Nakaoka, "Current Control Implementation with Deadbeat Algorithm for Three-Phase Current-Source Active Power Filter," Proc. IEE Electric Power Applications, vol. 149, no. 4, pp. 275–282, 2002. https://doi.org/10.1049/ip-epa:20020257 Google Scholar Crossref
- 64. K. Nishida, M. Rukonuzzman and M. Nakaoka, "Advanced Current Control Implementation with Robust Deadbeat Algorithm for Shunt Single-Phase Voltage-Source Type Active Power Filter," Proc. IEE Electric Power Applications, vol. 151, no. 3, pp. 283–288, 2004. https://doi.org/10.1049/ip-epa:20040317 Google Scholar Crossref
- 65. Somlal J., Rao M.V.G., Karthikeyan S.P. (2017), 'Experimental investigation of an indirect current controlled Fuzzy-SVPWM based Shunt Hybrid Active Power Filter', IEEE Region 10 Annual International Conference, Proceedings/TENCON,PP. 801-806.
- Google Scholar
- 66. Kumar K., Vanukuru, Pakkiraiah B.(2018), 'Development of control techniques for SAPF for power quality enhancement', Journal of Advanced Research in Dynamical and Control Systems, 10(9 Special Issue), PP. 1900–1907 Google Scholar
- 67. Dukkipati S., Siva Shankar P., Marthanda A.V.G.A. (2019), 'A novel approach for power factor controller design', International Journal of Innovative Technology and Exploring Engineering, 8(4), PP. 628–631.

Google Scholar Crossref 68. Muppavarapu, Mounika, et al. "Enhancement of Power Quality In A Grid Connected UDE Based PV Inverter." *JCR* 7.2 (2020): 340–343

Google Scholar

This content is only available via PDF.

©2024 Authors. Published by AIP Publishing.

You do not currently have access to this content.

Sign in

Don't already have an account? Register

Sign In Username		Sign in via your Institution
		Sign in via your Institution
Password		
Register	Reset password	

Pay-Per-View Access \$40.00

BUY THIS ARTICLE