

A SIMULATION DRIVEN ANN-BASED INTELLIGENT FAULT DIAGNOSIS SYSTEM FOR A BUCK DC–DC CONVERTER

J Lokesh* and G.A. Rathy**

*Government Polytechnic College,
Kadathur, Dharmapuri,
Chennai, Tamil Nadu, INDIA
Email Id: lokeshnova@gmail.com

**National Institute of Technical Teachers Training and Research,
Chennai, Tamil Nadu, India

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ABSTRACT:

The bulk Buck DC–DC converters are extensively employed in modern power electronic systems as a result of their high efficiency and simple voltage step-down capability. They are commonly used in applications namely Electric Vehicles (EV), Battery Management Systems (BMS), Renewable Energy Systems (RES), and Industrial Power Supplies (IPS). During prolonged operation, critical components including power switches, diodes, inductors, and capacitors are subjected to electrical and thermal stresses, which may result in performance degradation and unexpected failures. Early detection of such faults is essential for improving system reliability and minimizing maintenance costs. The present research proposes a novel fault detection method for a buck DC–DC converter using an Artificial Neural Network (ANN). The proposed model also continuously monitors the converter's voltage and current signals to discriminate between normal and faulty operating conditions. The ANN trained model can also be deployed on an embedded platform to enable intelligent online fault diagnosis with minimal computational complexity. The Experimental results reveal that the developed ANN approach achieves high accuracy of fault detection, indicating its suitability for real-time monitoring of buck converters in a wide range of power electronic applications. The proposed ANN-based fault diagnosis methodology is not limited to the buck converter and can be widespread to available other power electronic converter topologies by retraining the model with representative electrical features obtained under their respective operating conditions.

KEYWORDS: Artificial Neural Network (ANN), Buck Converter, Fault Detection, DC-DC Converter.

REFERENCES:

1. Kumar, G.K. and Elangovan, D. (2020), "Review on fault-diagnosis and fault-tolerance for DC–DC converters", IET Power Electronics, vol.13, issue. 1, pp. 1-13, <https://doi.org/10.1049/iet-pel.2019.0672>
 2. P. K. V, K. Gowrishankar, E. Sivanantham, K. S. Rao, N. Kiran and A. Vimal, "Detection of Early Fault in Power Electronic Converters through Machine Learning and Data Mining Techniques," 2023 Third International Conference on Artificial Intelligence and Smart
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- Energy (ICAIS)*, Coimbatore, India, 2023, pp. 1438-1442, doi: 10.1109/ICAIS56108.2023.10073820.
3. Kou, L., Liu, C., Cai, G. W., & Zhang, Z. (2020). "Fault Diagnosis for Power Electronics Converters based on Deep Feedforward Network and Wavelet Compression". *Electric Power Systems Research*, vol. 185, Article 106370. <https://doi.org/10.1016/j.epsr.2020.106370>
 4. V. Aviña-Corral, J. J. Rangel-Magdaleno, J. H. Barron-Zambrano, and S. Rosales-Nuñez, "Review of fault detection techniques in power converters: Fault analysis and diagnostic methodologies," *Measurement*, vol. 235, 2024. <https://doi.org/10.1016/j.measurement.2024.114864>
 5. C. Liu, L. Kou, G. Cai, Z. Zhao, and Z. Zhang, "Review for AI-based open-circuit faults diagnosis methods in power electronics converters," 2022 <https://doi.org/10.48550/arXiv.2209.14058>
 6. S. Fouladi Panah et al., "Machine Learning Fault Diagnostic Techniques in Power Converters: A Review," 2025. <https://dx.doi.org/10.2139/ssrn.6837686>
 7. S. Kim and K. Kim, "ANN design of multiple open-switch fault diagnosis for three-phase PWM converters," *IET Power Electronics*, vol. 13, no. 16, pp. 3562–3572, 2020.
 8. X. Tan, Y. Zhang, and H. Wang, "Artificial neural network-based fault diagnosis of power electronic converters," *IEEE Transactions on Industrial Electronics*, 2020
 9. J. Ko, H. Kim, and J. Lee, "Artificial neural network-based diagnosis for converter faults using current signatures," *IEEE Transactions on Power Electronics*, 2012.
 10. S. Ou et al., "Physics-Informed Neural Network for Parameter Identification: A Buck Converter Case Study," 2025. <https://doi.org/10.48550/arXiv.2504.20528>
 11. C. Liu, L. Kou, G. Cai, Z. Zhao, and Z. Zhang, "Review for AI-Based Open-Circuit Faults Diagnosis Methods in Power Electronics Converters," 2022.
 12. K. A. Mahafzah, M. A. Al-Nabi, M. Alkhawaldeh, and A. Al-Hinai, "Artificial-Intelligence-Based Open-Circuit Fault Diagnosis in VSI-Fed PMSMs: A Comprehensive Review," *Sustainability*, vol. 14, no. 24, Art. 16683, 2022
 13. El-Naeem, K.S.A., A. Nayel, M., Abdelrahman, M. et al. Detecting Open-Circuit Faults in Power Electronic Converters Using Continuous Wavelet Transform and Convolutional Neural Networks for Simultaneous Charging Systems. *Arab J Sci Eng* 51, 10823–10845 (2026). <https://doi.org/10.1007/s13369-025-10780-z>
 14. Chu KSK, Chew KW, Chang YC, Morris S. An Open-Circuit Fault Diagnosis System Based on Neural Networks in the Inverter of Three-Phase Permanent Magnet Synchronous Motor (PMSM). *World Electric Vehicle Journal*. 2024; 15(2):71. <https://doi.org/10.3390/wevj15020071>
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