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Test-Based Analysis of Fault Tolerance Capability of Six-Phase Asynchronous Motors

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Abstract

Six-phase asynchronous motors are becoming increasingly popular in transport and industrial applications due to their advantages such as less torque ripple, better power distribution between the phases, higher efficiency, and increased tolerance capability errors compared to three-phase ones. This paper presents an analysis, primarily based on the results of experimental tests but also on theoretical arguments, of the natural fault tolerance capacity of an asynchronous motor (induction machines) in six phases with symmetrical and asymmetrical windings. The degree of tolerance is examined, defined as the ability of the machine to create a starting and overload torque and to withstand operation for a certain period of time without danger to the integrity and reduction of the life resource of the insulation. A matrix of tolerance rating is defined regarding the operation of the motor on loss of supply on one, two or three phases in different sequences.

Keywords: symmetrical windings, asymmetrical windings, fault tolerance, induction motors, torques, symmetric matrices, stator windings, six-phase asynchronous motors

References

1. E. Levi, F. Barrero and M.J. Duran, "Multiphase machines and drives-revisited", *IEEE Trans. Ind. Electron.*, vol. 63, no. 1, pp. 429-432, 2016.
View Article
Google Scholar
2. F. Barrero and M. J. Duran, "Recent advances in the design modeling and control of multiphase machines - part 1", *IEEE Trans. Ind. Electron.*, vol. 63, no. 1, pp. 449-458, 2016.
View Article
Google Scholar
3. Ilie Nuca, P. Todos and V. Esanu, "Urban electric vehicles traction: achievements and trends Conference: Electrical and Power Engineering (EPE)", *2012 International Conference and Exposition*.

View Article
Google Scholar
4. Vitalie Esanu, Alexandr Motroi, Ilie Nuca and Iurie Nuca, "Electrical Buses: Development and Implementation in Chisinau Municipality8Moldova", *Published in: 2019 International Conference on Electromechanical and Energy Systems (SIELMEN)*, 09–11 October 2019.
View Article
Google Scholar
5. Ahmed Salem and Mehdi Narimani, "Fault-Tolerant Operation of Asymmetrical Six-Phase Motor Drives in EV Applications", *Conference: 2020 IEEE Transportation Electrification Conference & Expo (ITEC)*.
View Article
Google Scholar
6. Uzair Javaid, Francisco D. Freijedo, Drazen Dujic and W. Merwe, "MVDC supply technologies for marine electrical distribution systems", *CPSS Trans. Power Electron. Appl.*, 2018.
View Article
Google Scholar
7. Nuca, I., P. Todos and A. Jalba, "Mathematical modeling of the asynchronous motors for underwater vehicle drives", *Proceedings of the 10th International Conference on Electromechanical and Power Systems SIELMEN 2015*, pp. 292-296, 8–9 octombrie 2015, ISBN 978-606-567-284-0.
Google Scholar
8. Alejandro G. Yepes, 'Oscar Lopez, Ignacio Gonzalez-Prieto, Mario J. Duran and Iisus Doval-Gandoy, "A comprehensive fault tolerance study in multiphase AC converters Part 1: Overview considering several types of faults", *Machines*, 2022.
Google Scholar
9. Alejandro Gomez Yepes, Ignacio Gonzalez Prieto, Oscar Lopez, Mario J. Duran and J. Doval-Gandoy, *A Comprehensive Survey on Fault Tolerance in Multiphase AC Drives Part 2: Phase and Switch Open-Circuit Faults*, vol. 10, no. 3, March 2022.
CrossRef Google Scholar
10. Multiphase Drives, "DOT: Automatic Fault-Tolerant Control of Multiphase Induction Machines: A Game Changer" in IEEE Transactions on Energy Conversion, vol. 37, no. 3, pp. 1921-1933, Sept. 2022.
t Google Scholar
11. J. Sun, C. Li, Z. Zheng, K. Wang and Y. Li, *A Generalized Fast and Robust Open-Circuit Fault Diagnosis Technique for Star-Connected Symmetrical*.
View Article
Google Scholar
12. Aishah Munim, M. J. Duran, M. Bermudez, I. Gonzalez-Prieto, Hangseng Che and Nasrudin Abd Rahim, "A Unified Analysis of the Fault Tolerance Capability in Six-Phase Induction Motor Drives", *Tranzactii IEEE pe Power Electronics*, vol. 32, no. 10, pp. 7824-7836.
View Article
Google Scholar
13. Petru Todos, Hie Nuca, Ghenadie Tertea and Vadim Cazac, "Determination of Parameters and Power Losses of Six-Phase Asynchronous Machines by Induction Regenerative Method", *Published in: 10th International Conference on Modern Power Systems (MPS)*, 21–23 June 2023.
View Article
Google Scholar
14. P. Todos, G. Tertea, I. Nuca and M. Burdiniuc, "Acceptance Testing of the Six-Phase Asynchronous Machines", *2021 International Conference on Electromechanical and Energy*

Systems (SIELMEN), pp. 511-516, 2021.
View Article
Google Scholar
15. *IEC 60034-1: 2022. Rotating electrical machines - Part 1: Rating and performance*.
Google Scholar
16. "IEC 600349-1 Electric traction - rotating electrical machines for rail and road vehicles - Part 1: Machines other than electronic converter-fed alternating current motors", *Part 2: Electronic converter-fed alternating current motors*.
Google Scholar
.