航空学报
ACTA AERONAUTICA ET ASTRONAUTICA SINICA
ISSN 1000-6893
CN 11-1929/V

航空学报 » 2013, Vol. 34 » Issue (1) :141-152 DOI: 10.7527/S1000-6893.2013.0017

电力作动器用高可靠性永磁容错电机控制系统的设计及其试验分析

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Design and Experimental Analysis on the Control System of High Reliability Fault Tolerant Permanent Magnet Motor Used in Electric Actuator

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摘要

针对电力作动器的高可靠性要求,结合转子磁钢采用离心结构的六相十极永磁容错电机(FTPMM),提出一种基于电流直接控制法的容错控制系统。当电机绕组或功率管发生断路及短路故障时,系统无需硬件故障辨识信号及软件算法切换就可实现系统的强容错功能,即故障后电机输出转速不变,输出功率与发生故障的相数有关,当电机系统出现一相、两相、三相故障时,电机分别可输出100%、80%、60%的额定功率;设计了一台750 W六相十极永磁容错电机的原理样机及其全数字化控制器,证明了该容错控制策略的正确性及整个电机控制系统的强容错性及可行性。

关键词： 容错 永磁电机 电流直接控制 断路故障 短路故障

Abstract:

For the six-phase-ten-pole fault tolerant permanent magnet motor (FTPMM) with a centrifugal permanent magnet on the surface of its rotor, a strong fault tolerant system is proposed and realized with the current direct control strategy to improve the reliability of the electric actuator with the motor. Without fault diagnosis and algorithm switching, this method enables the motor speed to remain invariant. Motor output power corresponds to the number of phases which fail, i.e., with one, two, and three phases broken down the motor output will be respectively 100%, 80%, and 60% of the rated power. A 750 W principle prototype of the fault tolerant permanent magnet motor with a digital controller is designed and tested. The experiment results validate the theoretical prediction and show the strong fault tolerant capacity and feasibility of the whole control system.

Keywords: fault tolerance permanent magnet motor current direct control open-circuit fault short-circuit fault

Received 2012-01-20;

Fund:

中国博士后科学基金(20110491408); 航空科学基金(2011ZC52039)

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郝振洋, 胡育文. 电力作动器用高可靠性永磁容错电机控制系统的设计及其试验分析[J]. 航空学报, 2013, 34(1): 141-152.DOI: 10.7527/S1000-6893.2013.0017

HAO Zhenyang, HU Yuwen. Design and Experimental Analysis on the Control System of High Reliability Fault Tolerant Permanent Magnet Motor Used in Electric Actuator[J]. Acta Aeronautica et Astronautica Sinica, 2013, 34(1): 141-152.DOI: 10.7527/S1000-6893.2013.0017