Peng-kang Xie, Jia-zheng Lu, Guo-zhu Chen, Heng-lin Chen, 2018. Influence of motor cable on common-mode currents in an inverter-fed motor drive system. *Frontiers of Information Technology & Electronic Engineering*, 19(2):273-284. https://doi.org/10.1631/FITEE.1601518

Influence of motor cable on common-mode currents in an inverter-fed motor drive system

Key words: Common-mode currents; Cable model; Motor drive system; Parameter extraction

Corresponding author: Heng-lin Chen
E-mail: henglin@zju.edu.cn
ORCID: http://orcid.org/0000-0003-3513-0625

Motivation

1. High-frequency switching of power devices will cause common-mode (CM) voltages during operation, leading to serious CM currents in motor drive systems. CM currents through the cables and motors in the drive systems can cause electromagnetic interference (EMI) with the surrounding electronic equipment and shorten the life of induction motors.

2. Simulation models for high-frequency analysis of induction motor drive systems have been proposed and validated in the time and frequency domains (Amarir and Al-Haddad, 2008; Moreau et al., 2009; Wang et al., 2010; Vidmar and Miljavec, 2015). However, in the existing works, the mutual inductances between conductors in unshielded cables have not been considered.

Main idea

1. Unshielded and shielded cable models are built, accounting for the skin, proximity effects, and dielectric losses of the cables. Contrary to existing works, the mutual inductances between the conductors in unshielded cables are considered. The cable parameters are extracted using the finite element method.

2. The proposed model has effective accuracy. The influence of cable parameters on CM currents is also studied in both the time and frequency domains.

Method

1. Experiments were carried out to validate the simualtion results.

2. Simulation models were built to study the common-mode currents. Parameters of the circuit elements were obtained using experiments and finite element methods.

Major results

1. Our model can simulate the common-mode (CM) currents to an effective accuracy.

2. In the three-wire unshielded cable system, CM current at the inverter terminal is consistent with that at the motor terminal, which decreases when the cable length is increased.

3. In the four-wire shielded cable system, CM current at the inverter terminal is larger than that at the motor terminal. For a longer cable, the CM current increases at the inverter terminal but decreases at the motor terminal in the four-wire shielded cable system.

Major results (Cont'd)

When the cable length is longer, the resonant frequency decreases with the increase in the cable length in both the three- and four-wire cable systems.

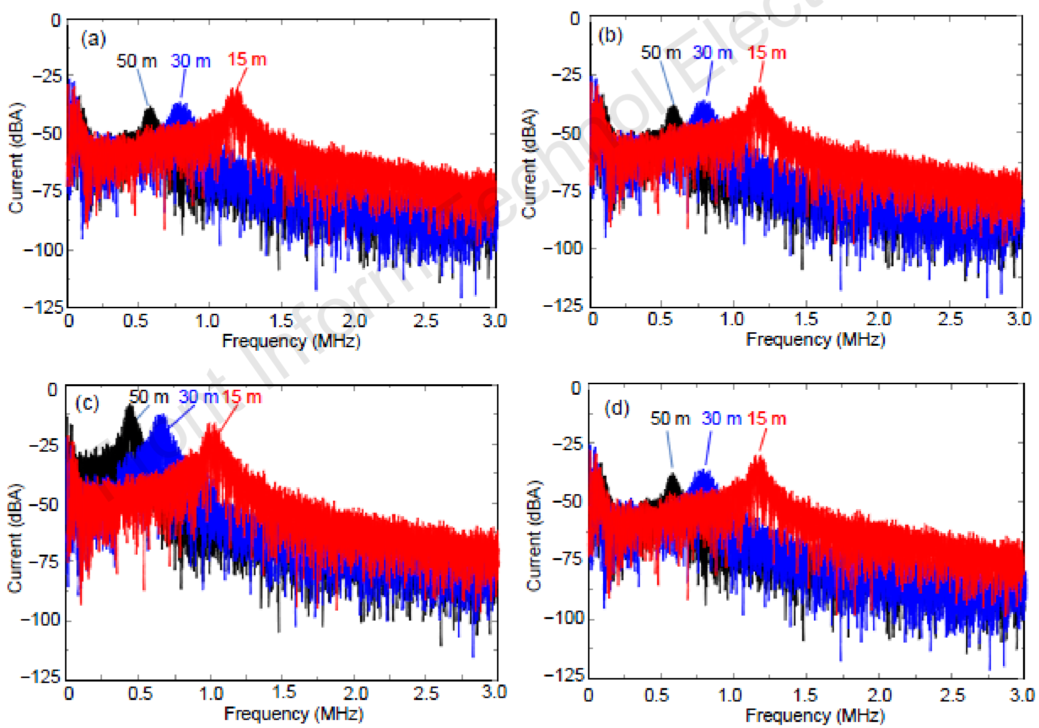

Fig. 15 Frequency spectra of CM currents: (a) three-wire unshielded cable at inverter terminal; (b) three-wire unshielded cable at motor terminal; (c) four-wire shielded cable at inverter terminal; (d) four-wire shielded cable at motor terminal (References to color refer to the online version of this figure)

Conclusions

1. The variation of common-mode (CM) currents with different cable types at the motor and inverter terminal is mainly caused by the stray capacitance on the motor cable.

2. The high-frequency models can be used to predict and evaluate CM currents in the ASDs with different motor cables, which would help in EMI filter design and CM interference suppression of ASDs.