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Electric return current distribution through train wagons in AC railway systems

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ABSTRACT

The electric railway environment has long been considered electromagnetically unfriendly and has been plagued by electromagnetic interference. Recently, it has been found that a substantial percentage of return current flows through the couplers of moving trains. This current has been the cause of electromagnetic interference in neighbouring systems and the electrical erosion of wagon bearings.

This document provides a brief background around the observed current in the wagon couplers of electric trains as well as the effects thereof. Information from railway experts is presented in the form of a literature survey in order to establish a high level understanding of electric railway configurations and the challenges that have been experienced with the various configurations.

The document goes on to establish a theoretical background of the concepts expanded upon in the development of a system model. Some theoretical discussion included is the concept of power factors, basic magnetic circuits, internal inductance, the proximity effect, mutual-inductance, the dot convention and multi-conductor transmission lines.

Once the theoretical background is established, the development of a system model is proposed and presented. The model that is proposed considers the supply infrastructure configuration, locomotive or locomotive consist and a single wagon which is cascaded to form a train. This model is the culmination of the research.

Following the system model development, the model was tested against measured data both from Sweden (external) and South Africa (internal) to give confidence in the model.

The model was used to perform investigations of various conditions on the current distribution in a train. Some interesting observations that were made include the uneven distribution of current exiting the axles of a wagon, as well as the idea that higher frequency components of the return current will tend to travel in the couplers of the train, whilst lower frequency components will tend to travel through the electrical supply infrastructure such as the rails.