Development of a Highly Sensitive 3-Axis Optical Electric Field Sensor for EMC Measurements in Railway Vehicles

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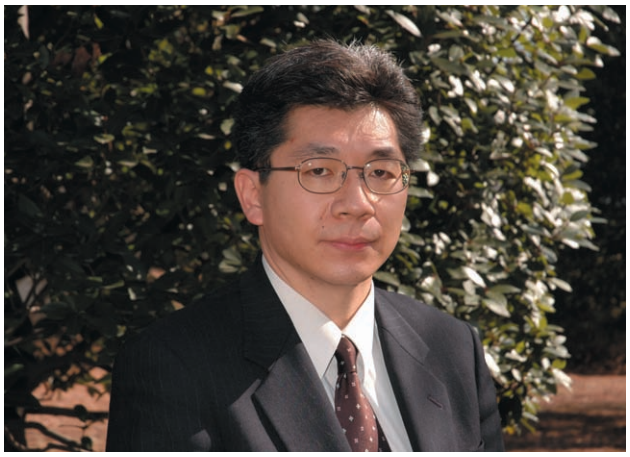
Standardized methods have already been established for the measurement and analysis of radio frequency interference caused by railway systems, and international standards on radiated emission from railway systems to the outside world (IEC 62236-2) were issued in 2003. Even so, there have been no suitable instruments or methods for measuring radio frequency interference inside railway vehicles.

With recent advances in railway drive systems, the introduction of information technology (IT), and the growing demand for EMC (ElectroMagnetic Compatibility) standardization, a better method is needed for measuring and analyzing radio frequency interference inside railway vehicles. We therefore developed a highly sensitive 3-axis optical electric field sensor (Fig. 1) suitable for taking measurements in railway vehicles. It is a compact, wide-band optical electric field sensor with high sensitivity and three axes (one vertical axis, two horizontal axes). We also developed methods for the sensor to be used to measure and analyze the electric field strength of radio disturbance waves.

The new sensor can measure a wide range of frequencies, from 100 kHz to 3 GHz. And, since it is smaller (diameter, 11 cm; length, 40 cm) than a conventional EMC measuring antenna, it can be used to measure electric field strength at any point inside a railway vehicle. By using the sensor and a real-time spectrum analyzer capable of real-time frequency analysis, we were able to ascertain the radio frequency electromagnetic environment inside various types of inverter-controlled vehicles. Our results confirmed that the sensor permits measuring time-serial changes in frequency characteristic of the electric field strength inside railway vehicles (Fig. 2), and that it also permits the ascertaining of radiation direction. Measuring those characteristics and



quantitatively ascertaining electric field strength distribution will facilitate research into effective measures to ensure the desired electromagnetic environment for railway vehicles, and to verify the effect of such measures. The sensor is also very effective for taking measurements that cannot be taken with a conventional EMC measuring antenna.

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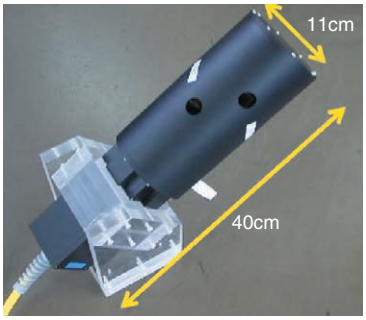

Figure 1. Highly sensitive 3-axis optical electric field sensor for railway vehicles

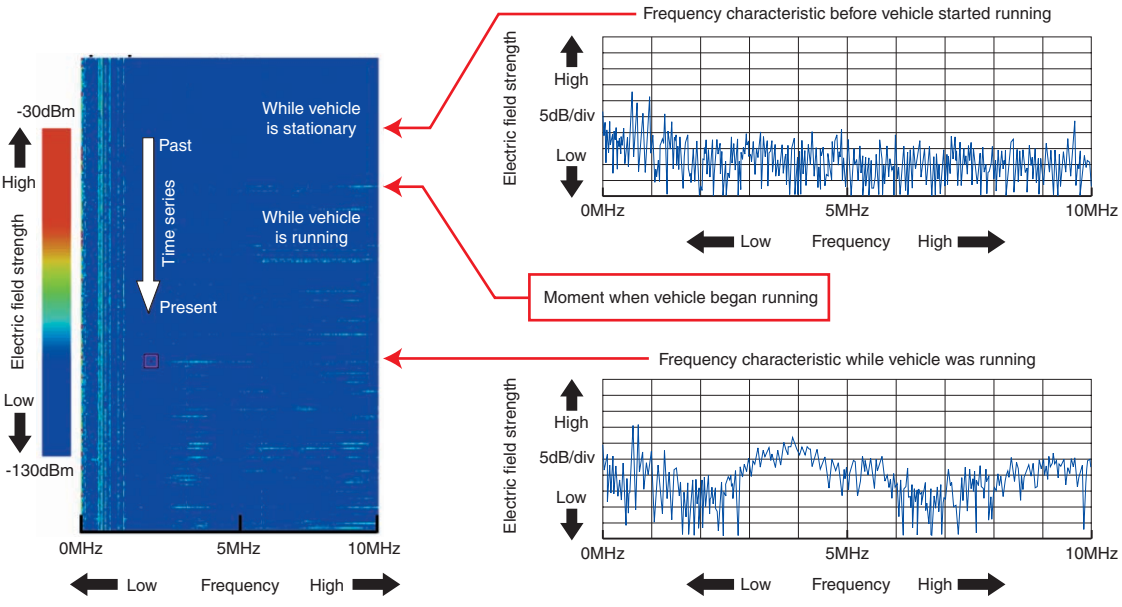

Figure 2. Example of measured time-serial changes in frequency characteristic of electric field strength in an experimental inverter-controlled vehicle