

Embedded Antenna for Smart Pavement Monitoring System

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Ideas for smart pavement monitoring systems have been introduced numerous times over the years in order to monitor pavement conditions and plan for road rehabilitation so that the remaining fatigue life of a pavement structure can be predicted. Ravneet Bajwa in his work (R. Bajwa, "Wireless Weigh-In-Motion: using road vibrations to estimate truck weights," Technical Report, EECS Department, University of California, Berkeley, 2013) demonstrated a prototype data collection process by using an external access point and an integrated transmitting system embedded in the pavement. However, because of the use of the commercial transceiver with a standard antenna, the transmitting signal experienced significant loss through pavement. To decrease signal attenuation and thereby extend battery lifetime, a dedicated antenna with higher efficiency and gain along with reasonable size is needed for this challenging application. This work describes the design and functionality of a microstrip patch antenna specially designed to provide adequate power gain through pavement while remaining practical for embedded package integration.

The limitation of designing traditional patch antennas for packaging lies in the dimension of the ground plane. It is usually difficult to maintain the gain of the antenna while keeping the ground plane within acceptable size. Here, this work develops a compact microstrip patch antenna with sufficient gain to support operation while buried under the road pavement. Our prior work (G. H. Huff and J. T. Bernhard, "Improvements in the performance of microstrip antennas on finite ground planes through ground plane edge serrations," *IEEE Microwave and Wireless Components Letters*, 2002) demonstrated that applying serrations to the ground plane can reduce the overall size and increase the realized gain of the antenna. By applying serrations to the ground plane and using high permittivity material as the substrate, our present work shows that in both simulation and measurement, this new antenna design can deliver the desired gain and bandwidth for operation at 915 MHz while embedded beneath pavement with a suitable package size. Comparisons with other proposed embedded pavement systems will also be provided.