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Flexible Circuits and Materials for Creating Large-Area RFID Reader Antenna Systems

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Abstract

One of the applications for RFID technology is to monitor and position RFID-tagged objects over large volumes. To achieve this, one possible option is to implement RFID reader antennas, which are relatively thin but with significantly large areas, and place them beneath the RFID-tagged objects. In order to realise RFID reader antennas with large-areas, circuit materials other than conventional rigid PCB materials should be investigated and utilized. Therefore, this thesis addresses how non-conventional PCB materials can be used to achieve large-area RFID reader antenna structures.

Non-conventional PCB materials are firstly chosen, which comprises patterned Al-polyimide foil, printed conductive Ag inks onto paper, polyethylene foam as antenna substrate. The physical and electrical properties of the materials are measured. These properties are later used in antenna simulations. In addition, assembly methods, e.g. circuit lamination and VIA fabrication, for the chosen materials are developed.

Three novel surface mounting techniques are developed and characterized in this thesis. The techniques are developed for mounting SMD components onto tracks made by Al, a screen printed Ag flake ink, and an inkjet printed Ag nanoparticle ink. These techniques are characterized and evaluated by various methods, including contact resistance measurements, bonding strength tests, and microscopy studies. The characterizations show these techniques have achieved low contact resistance and sufficient bonding strength.

Based on the previous efforts, two antenna systems, respectively operating on UHF (867 MHz) and HF (13.56 MHz) bands, are fabricated. The two antenna systems are designed into SP4T switching networks, using standard antenna elements as the loads of the network. The input RFID interrogation signals from commercial industrial RFID readers are directed into every antenna element periodically through the SP4T switching networks. Both antenna systems are characterized by means of various RF power attenuation measurements and passive RFID tag interrogation tests. It is shown in the results that both antenna systems have low RF attenuations, potentials to perform passive RFID tag positioning, and possibilities to be expanded to larger areas.

In the end, based on the antenna system characterization results and design parameters, a great amount of calculation is performed in order to discuss how large the antenna system areas can be as well as how many antenna elements can be achieved in one antenna system.

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