Novel Antenna Designs for Inkjet-Printed RFID Tags and Universal RFID Readers

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Due to increasing demand for automatic identification, RFID's find countless applications in different areas including retail level management, item level tracking, access control, animal tracking, vehicle security, and electronic toll collection. At the same time and driven by several "cognitive-intelligence" applications such as: item-level tracking of temperature sensitive products, pharmaceutical logistics, transport and storage of medical products or bio-sensing applications, a demand for inexpensive, low-power-consumption and durable wireless nodes with sensing capabilities has also increased tremendously.

Paper is considered one of the best candidates for organic substrates for RFID/sensing applications. In terms of mass production and increased demand, this makes paper the lowest cost material made. Paper also has low surface profile with appropriate coating. This is very crucial since fast printing processes, such as conductive paste inkjet-printing, can be used instead of metal etching techniques. In addition, paper is compatible with circuit printing by direct write methodologies. This is one of the biggest advantages since active tags require additional modules like sensors and batteries to be mounted on or embedded in. *A fast process like inkjet-printing can be used efficiently to print these modules on or in the paper substrate.* Paper can also host nanoscale additives (i.e. fire-retardant textiles) and can be hydrophobic. Most importantly, its dielectric constant (~2-3) is close to air's which means electromagnetic power can penetrate easily even if the RFID is embedded in the substrate. In this paper, inkjet printed antennas on paper based substrates are investigated as a potential solution for RFID/sensor module integration with the ultimate goal of an all-printed RFID tag (including antenna, IC, battery and sensor) on paper. First, the paper material is introduced and inkjet printing is discussed as a direct-write technology. A UHF RFID antenna was designed and developed on paper substrate using inkjet printing technology which could serve as a technology for a much simpler and faster method for fabricating RFID tags and ultra-low cost paper-based RF front-ends and antennas. This aim of this work is to show a reliable, low cost, environmentally friendly technology for wireless sensor network applications using RFID tags and already defined RFID protocols.

In addition, novel approaches about compact multi-band / wideband RFID reader antennas will be extensively discussed and evaluated for global supply-chain applications in terms of axial ratio and almost omni-directional radiation patterns.