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Long Read-Range UHF-RFID Tags for Optical Discs (CD, DVD, Blu-Ray)

Summary

Radiofrequency Identification (RFID) is a technology that allows for the identification of objects by means of electromagnetic waves. The objects are labeled using a tag consisting of an antenna matched to an integrated circuit (IC), where the object information is stored. This configuration allows us to track goods at item level and perform fast inventory processes, among other applications, since ICs can store high volume of information. Moreover, there is no need of line-of-sight to read the objects, contrary to barcode technology. The UHF frequency band is typically used for the presented applications. However, some objects, such as metallic ones, can prevent from the correct functionality of the tags, since they may cause mismatch between the tag antenna and the IC, and degradation of the radiation efficiency of the antenna as well. Due to this effect, CD, DVD and Blu-ray discs cannot be labeled with standard passive UHF-RFID tags, since they contain a thin metal layer under the disc surface, which causes a severe degradation of the tag read range.

Some solutions, based on folded dipole antennas or other complex geometries, placed in the central, metal-free, area of the disc have been provided in order to solve the problem. However, due to the proximity of the disc metallic layer and the reduced tag size, the achieved read ranges are of the order of 0.35-0.4 m [1,2], which are inadequate for many typical RFID applications.

A new solution for the design of global band UHF-RFID tags to be mounted on optical discs, with read ranges between 3 and 5 m, has been developed. Hence, the main limitation of state-of-the-art tags for optical discs (the short read range) is solved with the present invention.

Innovative aspects and applications

> Read-range 10 times higher than current solutions (0.35-0.4m vs. 3-5m).
> Whole UHF-RFID regulated band covered.
> Simple design and low-cost fabrication.
> Tag antenna can be directly printed on disc or implemented in inlay.
> Stacked discs can be read.

State of development

Several prototypes for tagging different kind of optical discs have been designed, fabricated and characterized. The tag prototypes have been fabricated on RF/microwave substrates using standard PCB technology, but they can be implemented in inlays or using Printed Electronics techniques. Read-ranges up to 5m have been experimentally obtained, but this value can be further increased by using the latest commercially available UHF-RFID ICs.

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Ongoing research

> Implementation using Printed Electronics techniques and inlays.

> Replace the ICs used in the current prototypes with advanced commercially available ICs in order to increase the read-range.

> Analysis of the limitations that may appear by reading stacked discs.

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The Invention

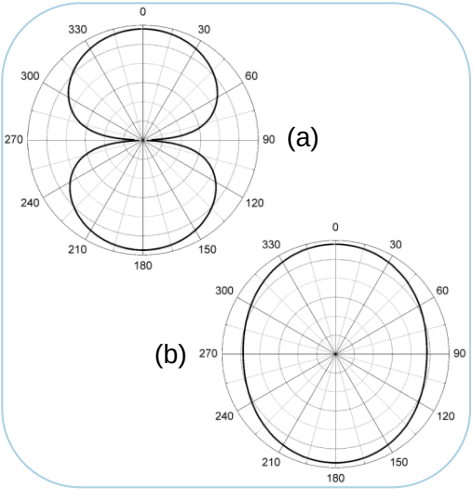
The thin metal layer under the surface of an optical disc is, at first sight, a limitation for UHF-RFID labeling. However, further exploration demonstrates that it is possible to take benefit of this metal layer. The electromagnetic study of the disc structure reveals that, by properly exciting electrical currents on the disc surface, it acts as an antenna. Therefore, the tag can be designed to operate by coupling electromagnetic energy to the metal layer of the disc, resulting in a larger antenna size, as compared to the sizes of conventional CD/DVD tag antennas. Moreover, the radiation efficiency degradation which occurs in the conventional disc tags is avoided with this approach. The tag is carefully designed in order to obtain good matching between the "disc-antenna" and the IC, resulting in a high read-range value. Furthermore, this configuration also allows for reading stacked discs until certain limit which is being studied. The UHF-RFID tag is designed by means of planar, simple semi-lumped elements, easily implementable using standard PCB, inlay or Printed Electronics techniques. The tag can be implemented directly on the inner (metal free) region of the disc.

Scientific References

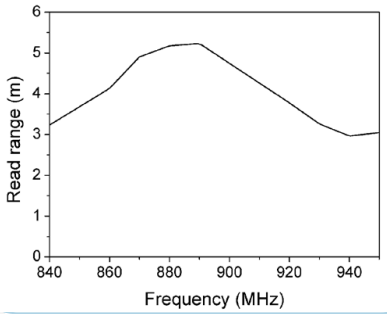
[1] W. T. Luk and K. N. Yung, "Bending dipole design of Passive UHF-RFID tag antenna for CD/DVD discs", *IEEE Asia Pacific Microwave Conference*, Macau, pp. 1-4, December 2008.

[2] A. S. Andrenko, M. Kai, T. Maniwa and T. Yamagajo, "Compact printed-on-CD UHF-RFID tag antennas", *IEEE International Symposium on Antennas and Propagation*, Honolulu (USA), pp. 5455-5458, June 2007.

Prototypes Results



Radiation pattern at 885 MHz for DVD+R with tag: (a) E-plane; (b) H- plane.



Measured read range of a prototype mounted on a DVD+R disc. Read range is higher than 3 m over the whole UHF-RFID band.

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