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UHF KU-RFID Tag

Technology Opportunity

Overview

The University of Kansas (KU) Information and Telecommunication Technology Center (ITTC) has developed a passive UHF RFID tag that overcomes the difficulties encountered by current tags when placed near metal or liquid. Current passive tags do not work when placed directly on metal or on a container holding liquid. The UHF KU-RFID tag, or KU-Tag, has been specifically designed to address this issue and, at the same time, maintain a size and thickness similar to those of current popular tags. Additionally, the KU-Tag can be manufactured using standard tag manufacturing techniques, allowing it to be produced at a price competitive with passive tags currently on the market that do not work when placed on metal or liquid materials. The KU-Tag embodies five enabling technologies that are patent pending.

Table 1: Performance comparison of the passive KU-Tag and current passive and active RFID tags.

	KU-Tag	Comparable Tags	
		Passive	Active
Cost	✓	✓	
Performance on metal	✓		✓
Performance on containers with liquid	✓		✓
Size	✓	✓	
Thickness	✓	✓	
Manufacturability	✓	✓	

Advantages of the KU-Tag

The KU-Tag tag performs 20%–100% better than the leading tags currently in use when tested at the KU RFID Alliance Laboratory (**www.rfidalliancelab.org**). (See Table 1, above right.)

Read Distance:

Read distance (distance from which a standard reader can read RFID tags) for the KU-Tag—suspended in free air, on metal, or on a container containing liquid—is better than for comparable tags under the same conditions. Table 2 (on reverse) illustrates the KU-Tag's performance in free air, separated from a metal surface by 7 mm, and mounted on a metal surface, compared with the performance of current passive RFID tags. The design of the KU-Tag allows its performance to be independent of mounting surfaces (including containers of liquid).

Thickness:

The technology within the KU-Tag has allowed us to build the thinnest tag that works near metal and liquid—1.6 mm thick (about the thickness of a quarter).

Size:

The current KU-Tag prototypes have been designed with profiles as large as 4 by 6 inches, and as small as 2 by 4.5 inches. The most recent prototype, with profile 4 by 5.5 inches, has been conservatively measured to give consistent reads at 20 feet when placed on any surface.

Cost:

Low cost is achievable, as the KU-Tag is:

- Designed for easy manufacturing, of readily available materials, by standard processes.
- Completely planar, constructed by layering-up two-dimensional materials (see Fig. 1, on reverse):

Standards Compliance:

The design of the KU-Tag is not constrained to a particular chip or standard—which, as related to chip performance, makes the KU-Tag comparable to all other tags currently on the market.

Active-Tag Replacement:

Performance of the UHF KU-RFID tag, combined with its ability to be manufactured on a scale and at a cost comparable to current passive tags, makes it well suited for applications that currently require expensive active-tag solutions. Active tags used to overcome the metal/liquid tagging problem cost from $20.00 to more than $150.00 per tag. In comparison, cost of manufacture of the passive KU-Tag, which works near metal and liquid, is estimated to be between $0.50 and $1.50.

Barriers Overcome by the KU-RFID Tag

Current passive tags do not work well:

- When placed near water (bottled water, dampened cardboard, etc.).
- When placed on or near metal (steel cans, electrical appliances, etc.).

Previous "solutions" have drawbacks:

- Positioning the tag 5–8 mm from the metal or water presents problems because of size and space.
- Active tags (that do work near water and metal) are expensive replacements for passive tags.

Radio Frequency Identification (RFID) Background

RFID technology is:

- The current successor to bar coding.
- Achieving capabilities and efficiencies far beyond those of bar codes.
- Projected to increase 25-fold in the next four years, reaching $33 billion (based on findings by market research company In-Stat, in *Information Week* magazine article posted January 18, 2006).

The RFID tag is:

- The basic building block of an RFID system.
- In its simplest and most economical form, composed of an antenna and a small silicon-based integrated circuit (or IC chip) that contains a radio receiver, a radio modulator for sending a response back to the reader, control logic, memory, and a power system.
- "Passive" if the power system is completely powered by the incoming RF signal.
- "Active" if the tag's power system has a battery.

Passive tags:

- Have been widely adopted for use in supply-chain tracking.
- Cost between $0.05 and $20.00.

Active tags:

- Are generally used in situations where passive tags do not work well (i.e., near metal or liquid) or where sensor data is integrated into the tag (e.g., a tag that would monitor the temperature of a container during transport).
- Can cost from $2.00 to more than $150.00.

Further Facts About the UHF KU-RFID Tag

Table 2: Read distance for the KU-Tag in comparison with passive and active RFID tags currently in use.

Read Distance (ft)	Avery AD-620	Avery	Symbol	Avery	KU-Tag
					
Free Space	14.5	17	21	22	21
7mm cardboard separation	11.5	12.5	7.5	11	21
On Metal	0	0	2.5	8	21

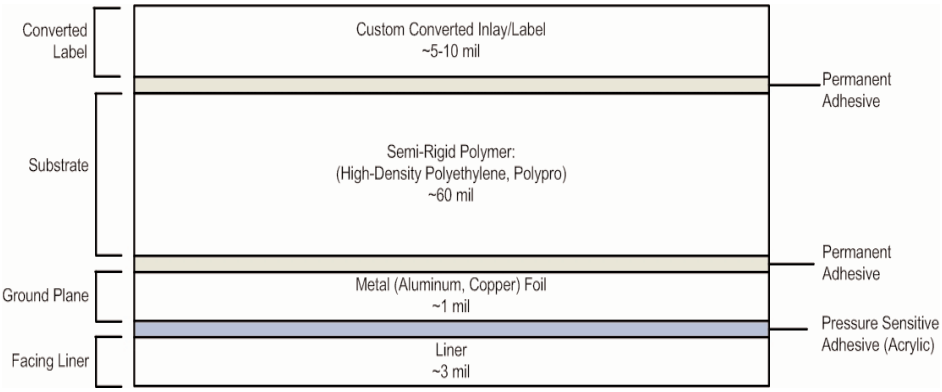

Fig. 1: Sample construction of the KU-Tag.

Readily available, low-cost construction materials and standard manufacturing processes for the KU-Tag:

- Substrate material 60 mils thick, provides a semi-rigid, high-performance, highly impact-resistant, low water-absorption mounting surface for the microstrip antenna.
- Metal foil is laminated to bottom of substrate. (Aluminum foil seems to be most cost-effective.)
- Pressure-sensitive adhesive laminates bottom of foil to liner.
- RFID tag inlay (tag antenna and IC chip on polyester film) is laminated on top of substrate.
- Standard conversion process laminates paper or plastic label (for product identification) atop inlay.

Summary

- The KU-Tag technologies (five patents pending) outperform the technology of RFID tags currently in use.
- The KU-Tag (operating in the UHF spectrum) is readable at distances of more than 20 feet and overcomes the difficulties experienced with currently available tags when placed near metal or liquid materials.
- The KU-Tag may be manufactured using readily available commodities and standard processes, keeping its size and thickness small and its costs low—to approximately $0.05 to $1.50 per tag.

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