An Avery Dennison White Paper

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Tracking Reusable Metal Shipping Containers Using Passive RFID

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Background

Our evaluation focused on tracking large steel shipping containers and their contents as part of a parts distribution system. This study looks at two main problem areas; tracking the containers throughout their lifetime using a permanent durable hard-tag, and using a standard print, encode and apply RFID label as a shipping label.

Scope

The scope of this report is only on the performance of various tagging options required to meet the demands of the shipping label and container tag.

Test Setup

There were two components to this testing. First, a set of range measurements was conducted in Avery Dennison's anechoic chamber. The second set of tests was performed with selected tags mounted on the shipping containers and passed through a dock bay door portal.

Tested Products

The readers chosen for initial testing were 2 of the top-tier Gen2 RFID readers. The tagging solutions consist of five hard tags from 3 vendors and a standard RFID label placed on a custom RF isolating pad

Chamber Results

The chamber test data is split across two types of products. The first set is standard RFID inlays converted to pressure sensitive labels to be applied to the RF isolating pad. The other set is hard tag transponders.

Container Results

Even considering this basic antenna arrangement, all the selected transponders performed very well.

Conclusions

The data presented in this report shows that it is possible to achieve the container and content tracking that is desired for effective RFID tracking of these goods and containers.

RFID Tracking of Reusable Metal Shipping Containers

Background

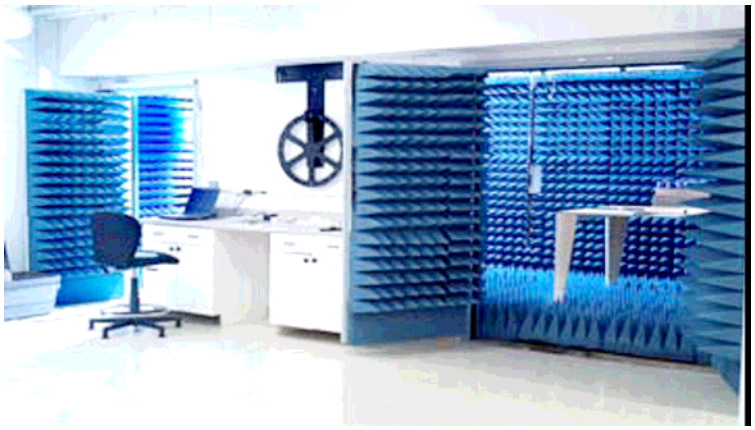
In an effort to increase the efficiency of our customers shipping and handling of goods using reusable metal containers, Avery Dennison has evaluated the effectiveness of various Passive UHF RFID solutions for use in this process. The evaluation focuses on tracking large steel shipping containers and their contents as part of a parts distribution system. This study looks at two main problem areas; tracking the containers throughout their lifetime using permanent durable hard-tags, and using standard print, encode and apply RFID labels as shipping labels.

Scope

The scope of this report is only on the performance of various tagging options required to meet the demands of the shipping label and container tag. The wide range of available tagging options in the market has been narrowed to a handful of top performing products. These products were chosen because they are expected to work reliably on large metal items through a dock bay door portal.
Just as critical to the performance of the overall system is the portal configuration. Additional testing is being performed to better understand the impact of the portal configuration on overall read rates. The appropriate combination of tagging technology, reader selection, and portal configuration is key to a successful RFID deployment.

Test Setup

There were two components to this testing. First, a set of range measurements was conducted in Avery Dennison's anechoic chamber. This chamber testing sets a baseline for the real world performance of the different tagging options. Only the top performing tags tested in the chamber were selected for testing on the shipping container.



Anechoic Chamber: a testing room isolated from external electromagnetic interference by RF-energy absorbent cones.

Figure 1: Avery Dennison's Anechoic Chamber

The chamber testing consisted of two measurements. The first measurement was the range of the transponder in free space, where the tag is not placed near anything that could affect its performance. The second measurement in the chamber was the range of the transponder when placed on a metal surface. This is meant to emulate the performance of the transponder when placed on the shipping container.

The second set of tests was performed with the selected tags mounted on the shipping container and passed through a dock bay door portal. The dock door portal is designed to model a typical dock bay door, with antenna placement consistent with a real-world setup. The container was passed through the portal 20 times, with both narrow ends of the container leading through the portal 10 times.

The antenna configuration used consisted of two linearly polarized antennas placed on a single side of the portal. One antenna was placed vertically, the other horizontally. The shipping container was passed through the center of the portal. This configuration represents a worse case setup employed to provide a baseline measurement of the inlays on the container. An actual portal setup would contain many more antennas with more optimum placement and orientation resulting in enhanced performance.

Figure 2: Three hard tags

Figure 3:
Two hard tags on the left and a label on an RF isolating pad on the right

Figure 3 shows the tags that were used for the container testing. The form factor of "Label A" is for testing purposes and the dimensions of the RF isolating pad can be customized for the application and label size.

Tested Products

The readers chosen for initial testing were 2 of the top-tier Gen2 RFID readers. The tagging solutions consist of five hard tags from 3 vendors and a standard RFID label placed on a custom RF isolating pad. The hard tags are recommended for use as a permanent container tag since these tags are more durable. In order to utilize a standard pressure sensitive RFID label as a one-time-use shipping label, an RF isolating pad must be used. This pad limits the effect that the metal container would normally have on an RFID label. The pad is permanently adhered to the container, and the shipping label is replaced prior to each shipment with a new label. The hard tags are not recommended for use as shipping labels because they are more difficult to encode and do not have human readable backup.

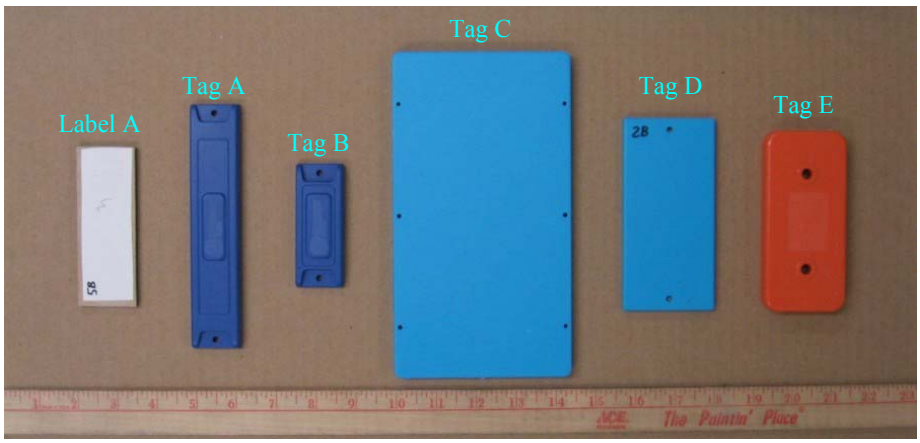
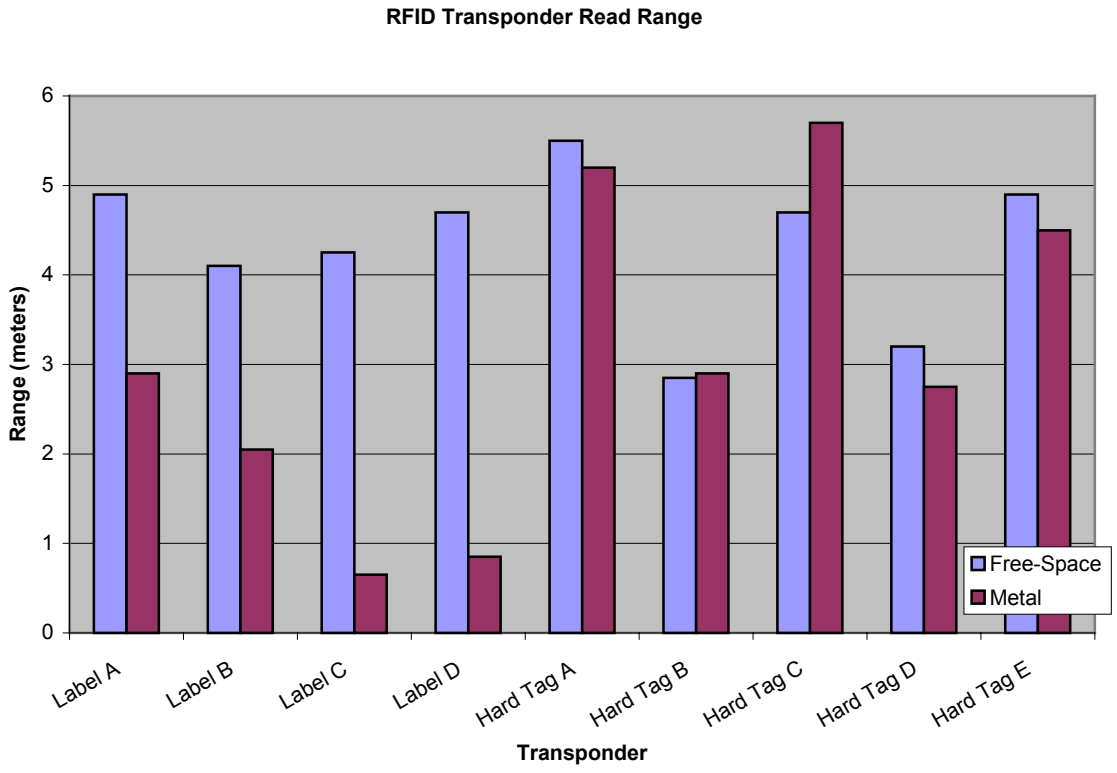


Figure 4: Tags used in the container testing

Chamber Results

The chamber test data is split across two types of products. The first set of products, labeled as “Label A-D” in the chart below, are standard RFID inlays converted to pressure sensitive labels to be applied to the RF isolating pad. Certain inlays perform better with the isolating pad than others, and purpose of this test was to eliminate any products that would not be suitable for this application. Most of the products tested lose more than 50% of their free space performance when applied to the isolating pad on metal. As a result, only “Label A” was chosen from this set for testing on the shipping container because of its near 3 meter read range on metal.

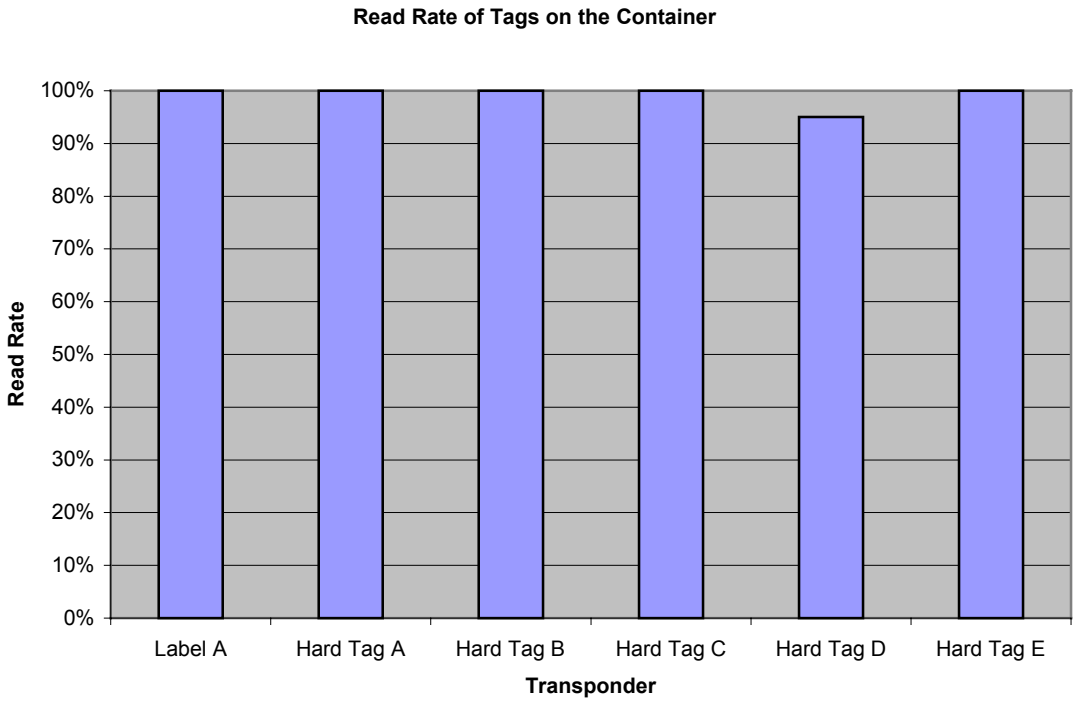
The other set of products are hard tag transponders, labeled “Tag A-E”. These products are designed for harsh environments and would be chosen as a permanent container tag. These tags are specifically designed for direct application on metal items and as a result, their performance on metal is not significantly different from free space. All five hard tag products were selected for testing on the shipping container.



Container Results

For the container testing, Label A, and Tags A through E were placed on the container as shown in figure 2 and figure 3. Even considering this basic antenna arrangement, all the selected transponders performed very well. Only one time was Tag D not read. All other tags were read 100 percent of the time. With a more appropriate portal setup, all of these tags can be read near 100 percent of the time.

Both Tag B and Tag D are the weakest of the hard tag options, and should be chosen with care. If 100 percent read rates are of utmost importance, then it is recommended to choose a higher performing tag.



Conclusions

The data presented in this report shows that it is possible to achieve the container and content tracking that is desired for effective Passive UHF RFID tracking of these goods and containers. RFID tagging and reader technology has reached a point where this type of system can be successfully deployed. There are sufficient choices in tagging technology such that form-factor, durability and cost can also be considered in the decision making process. As part of on-going testing at Avery Dennison, more optimal portal configurations are being explored.

Additional environmental factors will impact the overall system performance. Contact Avery Dennison to discuss your specific application and environment and to fully understand how RFID can work for you.

For more extensive details on Avery Dennison's study regarding Tracking of Reusable Metal Shipping Containers Using Passive UHF RFID, please contact:

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