

Business Action Group

Pilot and Implementation Workgroup Work Stream Practice Briefings

The Science of Tag Locations

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Table of Contents

1	Introduction/Abstract	3
2	The Goal	3
3	Engineering the Tag Location	3
4	Tag Placement	4
4.1	Carton Tag Placement Strategies	4
4.2	Pallet Tag Placement Strategies	4
5	Testing Procedures	5
6	Conclusion.....	6

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1 Introduction/Abstract

This paper discusses the processes involved in determining the optimum RFID tag location on the case level for products requiring 100% reads throughout the Supply Chain.

Author/Company

Jason Catchings
Project Manager
Xterprise Solutions
15660 North Dallas Parkway, Suite 400
Dallas, Texas 75248
469-387-5755 Mobile
972-690-9495 Fax
jcatchings@xterprise.com
www.xterprise.com

Jason Catchings received a Bachelor's of Science in Industrial Distribution and a Master of Industrial Distribution both from Texas A&M University. Presently he is a Project Manager offering engineered RFID solutions to companies requiring customer product compliance and operational integration.

Xterprise is a supply chain & RFID solutions integrator based in Dallas, TX and helping many suppliers in the RFID implementation with scalable compliance solutions.

2 The Goal

As the deadlines are quickly approaching, suppliers to the organizations that have issued mandates of RFID compliance have a considerable amount of hurdles to get over. Issues like tag costs, information overload, and additional processes to apply tags are all weighing heavily on the minds of executives and the IT staffs of companies with visions of compliance. One area that is not so much overlooked, but its importance is often underestimated is tag placement. The very nature and physics of radio waves do not necessarily pair up well with the product make-up and configurations of pallets and cases of the consumer packaged goods industry. Even the most sensitive readers won't find a poorly placed tag, especially when traveling through its lobe at speeds as high as 540 ft/min. These tags will need to be read several times throughout the Supply Chain, so finding the exact spot that will yield the greatest potential for a positive read should be the goal of a product tester, not just finding a spot that works.

3 Engineering the Tag Location

For years, finding the optimum tag placement on a product has been known in the industry to be more of an art than a science. Now that Supply Chains are expected to see millions of RFID tags pass through their processes each year, tag placement as an art is already ceasing to exist and the science of tag placement is becoming the replacement. Structured, detailed, and heavily repeated tests will yield data that should be introduced to extensive statistical analysis. This statistical analysis will pinpoint the exact location that will provide the greatest possibility of a tag read when passed through a portal.

When starting the processes of determining optimal tag locations, it should be known that there are experts out there that can perform these tests correctly and will provide you with the type of information that you are looking for, in the level of detail that you need. Since this process is now a science, unless someone in your organization has an intimate knowledge of RFID readers and data collection from the reader, it is likely that it would be beneficial to leave the tag placement discovery to the experts. Just make sure that you do your research about their tag placement processes, and that they are scientists; not artists.

4 Tag Placement

The tag location is critical to the ability of the supply chain to capture repeated reads. In some products, especially in those that are more difficult to read, the precision of the tag location is so important that the movement of as little as a half an inch in any direction can cause a tag that was reading 100% of the time to not read at all. Certain cartons become difficult to read because the product inside the carton either absorbs or reflects the radio waves emitted by the antennas. Liquids have a tendency to absorb these waves, while metals have a tendency to reflect, so products that contain these types of material can be difficult to find an acceptable tag location.

4.1 Carton Tag Placement Strategies

The first step to any tag location discovery process is a detailed carton study. In this step, the product's configuration and physical make-up is studied. By inspecting these attributes, potential hot spot areas can be identified. Most commonly, locations on the outside of the carton that are adjacent to areas of the inside of the carton with a lower density of materials make good candidates for tag locations. This process becomes even more critical when there are large amounts of metal or liquids inside the carton. Basically, the locations with the strongest potential for high readability will be the areas inside the carton with the most radio frequency friendly dielectric properties. These areas are commonly referred to as "air gaps" and will be where the tag selection areas begin. Consideration can be given to marketing and identification graphics printed on the carton. Many companies are not willing to change the layout of the box's graphics, so certain locations may be eliminated.

Other factors can be taken into consideration when choosing the optimum tag location for a product, or even a group of products. Production lines and shipping operations should play a role in choosing tag locations. Especially with tag locations that require a small or tight tolerance in the application of the tag and situations with high levels of throughput, an automated label applicator might need to be utilized. A single printer/applicator can apply tags to several types of products that move through the line, so if a common tag location can be found the setup time for the printer applicator can be minimized. In such cases, the carton study phase becomes even more critical. Products that will be sharing a printer/applicator should be put into groups to share possible locations. Several acceptable locations should be identified for testing, and the results of each of the common locations can be compared in order to isolate the position that will perform the strongest for the group as a whole.

4.2 Pallet Tag Placement Strategies

As these cases are tagged and stacked onto a pallet, they will need to be labeled with a tag that will identify the pallet. Once again, the goal is to read the pallet tags 100% of the time

throughout the supply chain, so choosing the correct tag location is extremely important. Using the proper strategies, pallet tag locations are not difficult to find.

When selecting a pallet tag location, material handling issues should be taken into consideration. Remember that metals will reflect radio waves, so most industrial material handling equipment will shield certain parts of the pallet from the readers. For instance, a forklift will likely shield most of the side that the forks enter the pallet. So if the supply chain members will be using forklifts to move pallets, then pallet tags should be located on the sides of the pallet that will not be forked under normal conditions.

Antenna configurations will also play an important role in pallet tag locations. Most pallet level portals will read the tagged pallet from two sides by placing antennas on either side of a dock door, or similar configuration. In this type of situation, the strongest reads will result from tags placed on one of the two the sides of the pallets that face the antennas as it passes through the portal. No matter what the antenna configurations are, the best tag locations will be the on the side of the pallet that faces at least one of the antennas on the reader.

After the side of the pallet to apply the tag has been selected, the actual tag location can be identified. Most pallets will be wrapped in stretch wrap before being shipped and this extra layer of "RF Friendly" material can be used to your advantage. If any gaps are formed between the stacked product and the stretch wrap, this is an obvious first choice. Often Ti-Hi's are designed with small spaces between some cases, which will create a large air gap. Sometimes layers of cases will not vertically align, creating a small, angled air gap. If there are no obvious air gaps, the stretch wrap will still provide a small layer that separates the tag from the product, increasing readability, so always apply the pallet tag after the pallet as been wrapped. If the pallet is comprised of difficult to read material and the Ti-Hi does not allow for air gaps, then a more detailed pallet study should be conducted to determine a precise location.

5 Testing Procedures

Testing procedures should imitate situations that the tag will experience throughout the supply chain. If the tag will need to be read on a conveyor traveling at 540 ft/sec, then testing should be performed on a conveyor traveling at that speed. It is also important to take into consideration the environment that the tags will be read in. Many warehouses are hot, busy with forklifts and other types of equipment, and filled with radio interference from hand held RF guns and other wireless networks. Therefore, the testing facility should not exclude these and other common types of warehouse environments.

There are several ways to test a tag location, but one of the most important key to testing is repetition. No matter if the testing criteria is number of reads, reads per second, pass/fail, or anything else, several trials must be performed in order to mine the data necessary to perform the statistical analysis with an acceptable level of confidence. Readers operate within a specified range of frequencies, but can only read in a single frequency at a single point in time. Therefore, readers will move from frequency to frequency over a period of time through a process called frequency hopping. If a tag location is tested at the right point in time, it can give skewed results if the reader is operating at a frequency that the particular tag reads exceptionally well or poorly at. Repetition of trials will help to smooth out any skewed data caused by frequency hopping.

6 Conclusion

The overall goal of discovering the optimum location of an RFID tag location is 100% reads throughout the Supply Chain. Through proper engineering, this can be accomplished on most, if not all products. Many make the mistake of tagging the carton, turning the reader on, and verifying if there is a positive read or not. Each product will require a detailed statistical analysis that takes into consideration not only the strength, but also marketing and operational issues that the product will experience throughout the Supply Chain.