



## Case Study on Optimal Packaging Strategies RFID Feasibility at the Pallet-Level

The Axia Institute, October 2023 | By Ethan Claucherty, Danielle Cummins and Bahar Aliakbarian

### Abstract

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Radio Frequency Identification (RFID) is being utilized globally to increase supply chain visibility and optimize manufacturing processes. Full-scale implementation of this technology has proven difficult as tag readability can fluctuate due to interference from a product's material composition and packaging density.

This research explores RFID performance, product tagging configurations, and reader positions that would provide optimal tag readability for retail-level consumer packaging and shipping parcels. Several factors contribute to this being a challenging goal:

1. The retail packages contain a small volume of aqueous solution in a foiled bag;
2. The retail packages are packed into a shipping parcel of up to 40 units in a volume of ~8.2-L;
3. Up to 200 shipping parcels are stacked onto a shipping pallet;
4. The customer's goal is 100% RFID reading of the individual retail units and the shipping parcels when in the stacked pallet configuration, using only a handheld RFID reader.

Two Ultra High Frequency (UHF) RFID tags were assessed for this project. The testing was conducted over four phases: each phase exploring reader distance, case-level configurations, layer-level product configurations, and pallet-level readability conditions. Measures were taken to simulate the conditions of an industrial manufacturing setting.

For the complete case study, please contact Axia at [axiainstitute@msu.edu](mailto:axiainstitute@msu.edu)

## Testing Methodology

For this case study a hierarchical framework for packaging is used, separating the tiers of packaging into primary (item), secondary (case), and tertiary (pallet) levels. Axia Lab received two different UHF RAIN tags from the manufacturer, 60 cases, each containing six pre-wrapped packages of four RFID-tagged, liquid-filled consumer products wrapped in aluminum foil, for a total of 1440 saleable units. A Brady HH-85 handheld scanner was used for all tests to determine a readability ratio, which is determined by the following equation:

$$(Eq. 1) \text{ readability ratio } \% = \frac{\text{number of tags read}}{\text{total number of tags}} \times 100$$

Following the completion of determining a readability ratio of Tag 1, the products were returned to the manufacturer, where Tag 2 was mounted onto the 1,440 saleable units and returned to Axia for testing.

A summary of the four-phased testing methodology is outlined below.

### Phase 1: Reader Distance at the Case-Level

The saleable units remained as delivered. A readability ratio was generated by the number of tags read in a five-second interval, with the reader reading four sides of a case, and the reader height was fixed at the center of the case. The best-performing reading distance was selected for Phase 2.

### Phase 2: Item Configuration at the Case-Level

The goal of this phase was to refine the product configuration within the case level to maximize the desired read ratio. Sixteen unique item configurations were tested. The four best item configurations and two best reader sides were selected for Phase 3.

### Phase 3: Item Configuration at the Layer-Level

The goal of this phase was to refine the product configuration at each layer of the pallet to maximize the desired read ratio in a full 60-case pallet. Starting with just one layer, a readability ratio was generated by the number of tags read in 30 seconds. The same procedure was repeated until the pallet was five layers high. The best layer configuration and reader position were selected for Phase 4.

### Phase 4: Reader Height and Distance at the Pallet-Level

Reader height and distance were investigated in this phase to determine the optimal position for best readability in a full pallet configuration. The reader was fixed at five different heights and nine distances. Each test was conducted for 60 seconds. Following Phase 4, the best-performing tag was put through a rotating table test to determine if this component could improve readability.

## Conclusions

The results of this case study highlight the importance of research and development when selecting a UHF RFID tag for a product. This case study emphasizes the importance of tag placement, packaging design, environmental factors and RFID readers and their deployment, all of which can affect a tag's readability.

For the complete case study, please contact Axia at [axiainstitute@msu.edu](mailto:axiainstitute@msu.edu).

## Optimize Your Packaging with RFID Feasibility Testing

There are many reasons to add RFID tags to your retail-level consumer packaging and shipping parcels. The Axia Institute can ensure you maximize visibility and optimize manufacturing processes.

Our RFID Testing Services can help identify:

- the best-performing tag for your product or parcel;
- the most reliable product tagging configurations;
- tag positions that would provide optimal tag readability.

Our testing is done using your actual product and materials, so you can be confident in the test results.

If you are planning or considering upgrading your tags to RFID, contact us to discuss testing.

### Contact Us

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