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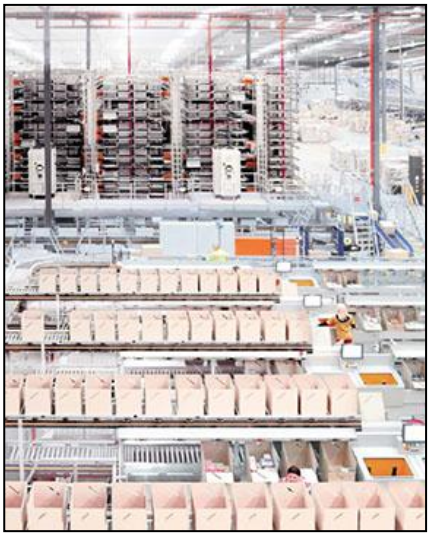
Selecting the Correct Automatic Identification & Data Collection Technologies for your Retail Distribution Center Application

Have camera/image-based code readers replaced traditional laser scanners? Has RFID's day finally come? Learn how to better understand the potential benefits and limitations of each of these technologies, so that you are better armed in your decision as to whether or not the added investment for each technology is justified for your applications.

For decades, manufacturers have relied upon one-dimensional (1D) bar codes as a highly cost-effective means to encode identifying information about the products they make. In turn, industrial and commercial distribution centers (DCs) have most commonly utilized laser scanning technology to accurately read those 1D bar codes on cases and individual items (eaches) as they move through the different processing areas of facilities at increasingly high transport speeds.

As throughput and accuracy requirements at retail distribution centers continue to increase, the prevailing idea is that cameras/image-based code readers are the new technology of choice, and that laser scanners are not as effective. While camera technology has had performance improvements in recent years, and it does maintain some advantages for some limited retail distribution applications, it is not a certainty that camera technologies will read a bar code better – assuming such could prove costly.



This white paper will discuss the Automatic Identification and Data Collection (ADIC) technologies most commonly used in retail DCs, explain their benefits and limitations for various handling practices, and offer examples of their potential applications to help prospective users determine the best, most cost justifiable investment for their operation.

Trends

A variety of automatic identification and data collection trends have emerged in retail logistics in recent years, including some of the following:

- Identification by vendor supplied codes vs. LPN (license plate number)
- Reduced code footprints
- Demands to achieve more throughput through reduced product gaps and higher speeds
- Need for higher read accuracy to reduce handling errors
- Addition of 2D matrix codes to the traditional 1D bar codes
- Increased case and item level RFID tagging
- User demands for increasingly poor quality bar codes
- User demands for code grading & image storage for root cause analysis

Recognizing these trends, AIDC solutions manufacturers have developed new, complementary technologies – while continuously improving traditional laser scanning capabilities – to help retail DCs better meet these new identification challenges and help achieve the desired process improvement goals.

The Technologies: An Overview

To read the many types of bar codes – such as linear / 1D bar codes created from patterns of dark lines and light spaces (UPC, EAN, Code 128, Code 39 and Interleaved 2 of 5) along with the newer matrix / 2D codes that encode data into round or square patterns of dark and light dots (PDF 417, DataMatrix, Maxicode, QR code) – which are applied to products at the each, case and pallet level we essentially have two primary families of identification technology: Laser Based (line scan or Omni directional) and Camera / image – based (area array and line array). All these technologies have a place in a modern retail logistics operation and when properly applied and installed, any of these technologies is capable of achieving read rates well in excess of 99.5% or even 99.9% in some operations. However, it is important to understand their differences to best identify which technology will be the best fit for each application within your supply chain and to try to minimize spending more than needed for the same or even lower level of performance.

Laser Scanners:

The dominant 1D code reading technology for the past 30 plus years, laser scanning, is still frequently the lowest cost way to achieve the highest read rates in many logistic operations, assuming reasonable bar code quality. In fact, there are some applications where a lower-cost laser solution will outperform camera technology and typically offer superior maintenance characteristics. This technology is extremely well-suited for industrial use and able to provide consistent high read rates for many years with extremely low maintenance effort. There is a large variety of solutions available that allow users to select equipment that is optimally suited for each applications specific combination of codes to be read, code placement, code orientation and area of coverage. Modern laser scanners are able to achieve scan rates in excess of 1200 scans per second, allowing them to solve applications up to 700 fpm.

A single laser scanner is able to provide a very wide area of coverage and depth of field relatively cost effectively when compared to a camera with comparable read coverage. These devices can be used for applications as diverse as identifying a single carton by its UPC code up to full Omni-directional coverage on a pallet due to the incredible flexibility of these laser solutions. Laser technology is able to run in virtually any lighting condition from no external lighting to sunlight, extreme cold (-30F) or high heat (120F) with no loss in reading performance and no need for additional calibration.

Cameras:

Also known as image-based code reading technology, cameras can read both 1D bar code and 2D matrix codes Omni-directionally (in any orientation). One of the limitations in implementing this technology comes from the relatively high price to achieve comparable areas of coverage to that of a laser scanner; when speaking of area array cameras. Individual cameras are often limited to a relatively small field of view or depth of field, requiring multiple units to solve a single application. Further, some users find the complexity of configuring the camera, lens and associated illumination too complicated to implement consistently.

- **Area Array Cameras:** Utilizing a two-dimensional data capture imager, these cameras capture a full image of an entire region at one time, similar to a snapshot taken with a digital camera. The image area is measured in pixels; for example, a 480 x 800 pixel sensor captures a rectangle-shaped image at that resolution. The camera takes multiple pictures, capturing anywhere from five to 100+ images per second, depending on the capabilities of the individual device. The images are decoded by the camera, which transmits the information to upper level control systems.

Due to their image speed limitations and constrained field of view (generally less than 16 inches wide), a single area array camera fixed over a conveyor line is typically not sufficient for code reading. To ensure that a code is fully captured two or more – perhaps up to six – area array cameras must be set up side-by-side with a minimum 4-inch overlap of fields. In a situation where multiple area array cameras need to be used for adequate coverage, a single line array camera might be more cost effective while offering improved capabilities.

- **Line Array Cameras:** Utilizing a one-dimensional array of pixels on the sensor, this camera technology takes the picture differently than the area camera. Instead of taking the full image in one snapshot this type of camera acquires slices of the image progressively as the item moves through the illumination field. This technology produces incredibly high resolution images even at very high transport speeds – with the newest devices on the market capable of 30,000 scans per second. This high resolution image is ideal for reading the widest range of codes possible. The lines are assembled into a two-dimensional image of the code, which is ideal for Optical Character Recognition (OCR) or other external image processing. Integrated code grading tools also tend to be more accurate and consistent in line array camera systems then those in area array cameras due to the improved illumination consistency throughout the field of view, and the continuously adjusted focal distance.

  Because of how they function, line array cameras have an inherently large depth of view and distance of field (similar to laser Omni-directional systems). This technology is typically more costly than an area camera; however a single line array camera can cover a 40-inch wide conveyor with 36-inch tall cartons, which could take 2, 3 or even 4 area cameras in some cases, making it the more cost effective solution with premium performance.

These devices are typically marketed as superior at reading low-quality bar codes, and in fact there are some code quality flaws that readability may be improved by utilizing modern camera technology. Some examples of printed code symbol problems that may see improved readability characteristics include code contrasts below 30%, insufficient quiet zone and vertical voids caused by a missing print element. It is important to consider all the users of the printed code throughout the supply chain. Each user must determine for themself if it is better to invest in more expensive camera/image-based code reading technology in an effort to maximize the read rate at all cost, or to use a more cost effective laser code reading technology to read all reasonably printed codes, and resolve unreadable labels early on in the material handling process before it creates issues throughout the supply chain.

Because this technology must first take a picture of the code in order to read it, the cameras can be used to flag bad codes and the resulting images stored for analysis and visual evidence to work with suppliers about code quality issues. The ability to both grade and capture images of codes on the fly is one of the primary reasons the added investment in this technology makes sense for many users. It is important to verify that the particular product being considered is capable of delivering on this task and that facilities are utilizing these tools or the added investment will not be worth it for many. Methods to implement these types of tools should be discussed as part of any distribution center's automatic identification supplier selection.

<u>RFID:</u>
A third AIDC technology, ultra high frequency (UHF) radio frequency identification (RFID) is also used in retail DCs. Unlike laser scanners and cameras, RFID does not use an integrated light to decode data encoded into a printed code. Instead, RFID employs tags at the item level with data embedded in a microchip attached to a small antenna often embedded in a paper tag. RFID readers transmit an electromagnetic field to capture tag data. Because it relies on radio frequency technology, RFID does not require direct line-of-sight to read the data, and it can identify a variety of objects in a single read operation simultaneously. Indeed, RFID enables fast, accurate verification of case packed inventory without opening the box.

Even with tags now available for less than $0.10 a piece, many warehouse logistics uses for RFID diminished in recent years as the return on investment challenge combined with technology limitations and high integration costs made this technology less appealing then lower cost bar coding.

However, there has been resurgence in the last few years with improved ROI business cases brought about by retailers' new multi-channel strategies and the need for logistics infrastructures to support them. The use of RFID offers retailers improved receiving capabilities, improved inventory accuracy, better visibility of the inventory and shrinkage monitoring. With these RFID tools in place, apparel can be quickly identified, located and delivered to a customer. These RFID tags are not replacing the bar code in these applications, but complementing them because the RFID tag is not suitable for identification in all places throughout the supply chain. With this improved ROI allowing more and more retailers to increase the use of RFID tagging of individual clothing articles, the demand for utilizing this data in the logistics environment is also increasing. Solutions are now coming to market with capabilities to identify all items inside of a sealed carton that is being moved dynamically with similar cost and effort of a traditional bar code scanning tunnel. Technical limitations caused by environmental metal and proximity miss-assignment errors are being greatly improved with new solution designs now entering the market.

The Technologies in Action

Retail DCs might find that a mix of all four AIDC technologies—laser scanners, area array cameras, line array cameras and RFID—is the right choice for their needs. The systems can be used independently or can work together as a multi-modal solution, depending on the needs of a specific zone of a facility and the processes (manual, semi-automated or fully-automated) performed there. Some examples include:

- **Inbound Receipt of Cases:** For fully-automated receiving of a range of case sizes with inconsistent code types, quality and placement, a five- or six-sided scan tunnel can be set up. The application might call for a multi-modal solution utilizing both laser scanners and cameras to quickly identify and route product to its next destination (storage, forward picking, cross-docking and more).

  For example, a laser scanner is oriented on the axis where bar codes are predictably placed (the top and/or the bottom to read labels as they pass over gaps in conveyor belting or rollers) and cameras are set on the other four sides to capture any type of code in any location. Having both technologies working in conjunction ensures both proper identification and subsequent routing. Adding an RFID reader immediately after the scan tunnel allows tagged items inside the case to be instantly verified and tied back to the identification data collected in the tunnel without requiring an operator to open the box.

- **Inbound Receipt of Eaches:** For retail DCs that break open cases upon receipt and individually store eaches—such as those fulfilling catalog and e-commerce orders—area array cameras that permit hand presentation are available. These truly hands-free devices give operators more freedom while reducing the required hardware investment associated with handheld RF terminals.

- **Routing:** Retail DCs might implement AIDC at every point in a facility where eaches or cases traveling via conveyor are being routed. These decision points require a laser scanner or camera to identify the item and verify its destination, activating a divert or induction to a different point in the facility (storage, forward picking, cross-docking and more).

- **Automated Print and Apply:** A tunnel equipped with a laser scanner or camera can be used to verify the print quality and proper placement of a code sourced by an automated label print and apply machine.

- **Automated Storage and Handling:** Automated storage and retrieval systems (AS/RS) frequently depend on closed-loop (internally captive) dimensionally-consistent plastic totes to contain eaches and cases. To identify those totes, their contents and their storage locations, internally-generated LPN codes are applied to the same side of every tote. Because of that consistency, this application is perfect for a laser scanner.

Summary

As demands on existing and new distribution facilities continue to increase in the areas of throughput, efficiency and accuracy to support the increasingly complicated retail in the coming years it will be increasingly important for facilities to select the correct AIDC technology for the appropriate application. When properly applied, modern laser, camera and RFID solutions are capable of offering significant benefits in all many areas of operational efficiency from automating receipt of products, vendor compliance programs, accurate routing, efficient picking and packing, shipping label printer-applicator verification, high speed sorters and divert verification. Many new AIDC technologies offer great benefits that you can take advantage of today in existing operations while other established practices may still prove the most efficient and cost effective way to solve the challenge. The selection of a strong AIDC vendor partner with a full solution portfolio that contains all of these diverse solutions may benefit your selection process.

Need more insights into how to select the right AIDC technology for your retail DC and handling application? Email Matthew Mathers, Storage and Conveyor Industry Manager at SICK: matt.mathers@sick.com.