WHITE PAPER

Guide to Scanning Technologies

Intermec

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Introduction

The debate over scanning technologies rivals the religious fervor of the "PC vs. Macintosh" debate. When it comes to scanning technology, the two competing camps are proponents of laser and supporters of a technology known as CCD. Much of the laser bias can be chalked up to the "it's a laser so it must be better" argument, whereas CCD advocates tout its unmatched reliability and value.

The reality lies somewhere in the middle. Both technologies are exceptionally good at what they do, as long as they're used in the correct environment and the proper application. Both technologies have been around for many years and continue to improve.

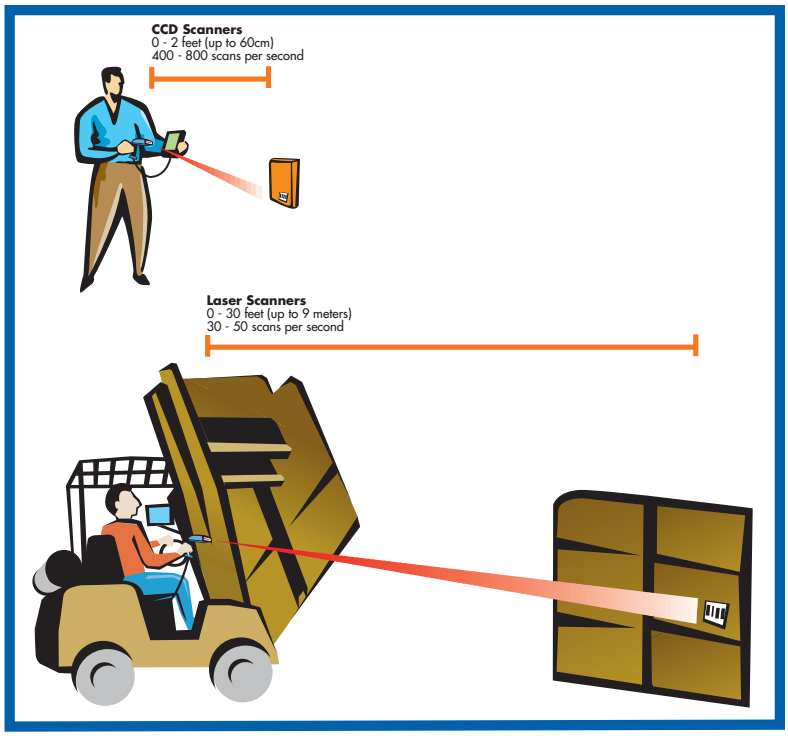
The question then arises, "How do I choose the best scanner for my application?" This guide will help you do just that. Because Intermec has a wide variety of each type of scanner, this guide delivers an unbiased assessment of both technologies. You'll get the technical information and application guidelines you need to choose the technology that will work best for you.

CCD Scanners

The basic technology of this type of scanner is a *CCD,* or charge-coupled device. CCD components are also found in other image capture devices such as fax machines, video cameras, and digital cameras. In a scanner, the CCD captures different levels of reflected light from a bar code's bars and spaces and converts them into a video signal.

For optimum performance, CCD scanners need their own light source, which is provided by low-power, long-life LEDs (light-emitting diodes). The LEDs' low power consumption and long life enable the light to be on all the time, eliminating the need for a trigger. However, some scanners do incorporate triggers and sleep/wake modes for power saving, especially when they are connected to battery-operated devices.

CCD scanners are solid-state, without moving parts, so they are inherently more reliable than laser scanners, which use fast-moving mirrors to move a beam across the bar code. To read a bar code, a CCD scanner illuminates it with light from the LED and uses a lens to focus the image of the bar code onto the CCD component. The simplest reading process identifies the peaks and troughs in the signal and applies one or a number of decode algorithms to get the bar code data. These decode algorithms are applied by the scanner's analog-to-digital converter and by software running on the processor. The speed of the processor and efficiency of the software largely determine how fast the bar code data is retrieved and how "snappy" the scanner feels to the user.



CCD scanners scan most effectively at shorter distances, but scan at a much higher rate of speed. lasers are ideal for long-range scanning applications.

While CCD capability has been around for many years, recent advances in the technology have dramatically improved the performance of this type of scanner. Some of the most recent generations of CCD scanners are sometimes referred to as *linear imagers* because they are designed to capture "linear" information — that is, they image one line across a linear bar code. Manufacturers of these next-generation CCDs have developed advanced ways of reading the video signal and special decode hardware/software to improve speed, depth of field, and read success rates. These refinements, coupled with faster scan rates (up to ten times faster than a laser scanner) and faster processors, help explain why some scanners are better or snappier than others when it comes to reading poor-quality or laminated bar codes.

Laser Scanners

Laser scanners read bar codes with a laser beam in conjunction with oscillating mirrors to automatically move the beam back and forth across the symbol. Laser engines come in a variety of configurations (e.g., standard range, wide angle, high density, long range, and high visibility) to meet the needs of different applications. The major advantage of lasers is their depth of field; they can read bar codes from several feet away. In fact, if the symbol is printed large enough, the laser can read it from as far away as 35 feet (11 m). For applications such as use by a forklift operator in a warehouse, the ability to read a bar code without having to constantly get off the forklift is a distinct advantage.

Another advantage of lasers is that they can be focused to a very small beam. Because the light is coherent (a single frequency), the beam will not spread much over a given distance. Therefore the diameter of the beam will remain small enough to resolve the wide and narrow bars of the bar code even if the reading distance varies. That property allows laser scanners to read bar codes over a wide range of depths of field.

On the downside, lasers tend to be more expensive than CCDs and have moving parts (those oscillating mirrors), which can be sensitive to rough use and temperature extremes.

Laser scanners, like CCDs, include hand-held or fixed-position models. Hand-held units generally operate at the lower end of scanning speeds

(30 to 50 times a second) because the symbol being scanned is usually stationary. Fixed-position scanners on a conveyor operate at the higher end (50 to 14,000 times a second) to be fast enough to read the label before it moves past the scanning area.

Considerations for Selecting a Scanner

Both lasers and the new generation of CCDs are excellent technologies. While there is some overlap in their appropriate applications, each technology has characteristics that recommend it for specific uses.

Deciding which technology to use — or how to mix the technologies within your enterprise — should take into account the scanning application (from what distances will scans be made, what is the condition of the bar codes being scanned, etc.) as well as price/performance considerations.

The chart below summarizes the characteristics of the most recent generation of CCD and laser scanning technologies.

What is the reading distance to the item being scanned?

CCD scanners work exceptionally well at close range, less than 18 inches (46 cm). Therefore, if the scanner can be brought close to the label (or vice versa), a CCD would be a good choice. However, if the labels are more than 18 inches (46 cm) away, laser scanners are the best option.

What type of code will be used?

Most scanning technologies read the same common set of bar code symbologies, including EAN/UPC, Code 39, and Code 128. The latest

Application	CCD Scanners	Laser Scanners
Scanning distances less than 18 inches (45 cm)	✔	
Scanning distances up to 35 feet (9 meters)		✔
Higher bar codes densities	✔	requires special scan engine
Poor quality/damaged bar codes	✔	
Over-laminated bar codes	✔	
Linear bar codes	✔	✔
2D stacked bar codes – PDF 417, Code 29 (requires special software)	✔	requires special scan engine
Matrix codes (Datamatrix, QR code)	(see "Future Trends")	
Reliability	✔	
Scan rate: 30-50 scans per second		✔
Scan rate: 400-800 scans per second	✔	
Very bright spotting and scanning beam		✔
Fast scanning in fixed positions	✔	✔
Retail price (with cable): US$150 - $700	✔	
Retail price (with cable): US$500 - $2,000		✔

generation of CCDs work best on these codes at higher code densities, in the region of X (narrow bar width) dimensions between 2 and 5 mil (0.05 and 0.1 mm) and with code widths up to 8 inches (203 mm) for X dimensions between 10 and 20 mil (0.25 and 0.5 mm). The latest generation of CCDs not only are excellent at higher densities, but also read poor-quality codes and bar codes through laminates well. Generally, CCD scanners can read codes with low contrast between bars and spaces (caused by the color or poor printing/fading). Some CCDs can also cope well with damaged codes. The fast scan rate of CCD engines plays a significant role in reading these, as do the methods used to decode the complex video signal information provided by the CCD. In turn, which methods are employed depends on the investment the supplier has made in decoding techniques.

What are the environmental conditions?

CCD scanners are solid-state without any moving parts. They therefore tend to be more reliable than lasers, which use moving mirrors to make a laser spot travel across a code. However, it's the casing of the scanner that dictates its suitability for certain environments. In retail, a CCD in a standard ABS plastic case will provide a durable, long-life solution, whereas a more durable casing would be needed for the same scanner in a warehouse or industrial application.

How important is performance?

If any scanner, regardless of its technology, can read a code, the performance differences between it and another will be judged on issues like speed of read, depth of field, and definition of reading zone. Within its depth of field, a CCD can provide exceptional performance. Scan rates of 100 scans per second are common, and top-of-the-range scanners offer up to 800 scans per second. CCDs can, in certain circumstances, read a set of codes faster than laser scanners can simply because they do not need a trigger.

Some CCD scanners are contact readers and will only read if the scanner's nose is touching the code. This approach is appropriate for flat surfaces but can cause problems if the code is on a curved surface. Long-range CCDs and lasers are better for curved-surface scans. Some CCDs can read out to 2 inches (5 cm), and the latest-generation, long-range CCDs can read up to 18 inches (46 cm).

As the reading distance increases, it becomes more important to know where the scan line is. With laser scanners, the laser clearly marks the scan line, but CCDs depend on the illumination of the LEDs. As a result, the scan line for CCDs becomes difficult to see as the reading distance increases or in high ambient light conditions such as direct sunlight.

How much do I want to pay?

CCD scanners are generally less expensive than lasers are. With U.S. retail prices between $150 and $700, CCD scanners are easy to justify. However, the range in price is still quite wide (and even wider with lasers), which can be an issue for some buyers, particularly those who are considering high volumes. If price is an issue, take care not to compromise on the following features, particularly if the purchase is intended to improve productivity:

1. Is the scanner's depth of field suited to the application? Is there a "comfort zone" (depth of field on the actual code of at least 0.4 inches [1 cm]) to make reading intuitive and to allow curved labels to be read? Does the user need to see the scan line on the bar code?
2. Is the resolution range of the scanner suitable for the application? The scanner should read the codes with some allowance for the comfort zone.
3. Does the scanner read all the possible qualities of code the application will present?
4. Is the scanner easy and comfortable to use? Can it be picked up and set back down easily? Is the scanning plane and zone suitable for the operator's position and placement of the coded items? If the scanner has a trigger, is it easy to use?
5. If an extended depth of field is necessary, does the scanner have adequate field depth on the actual codes?
6. Does the scanner read all the codes easily or does it take time to read? A good test is to check the time it takes to read 10 or 20 real-world codes rather than just one sample.
7. Is the scanner suitable for the environment? Consider such factors as the scanner's ruggedness, style, cable strength and length, and sealing against water, dust, and vibration, as well as the ambient light, temperature, etc., of the environment.
8. Does the scanner meet the obvious requirements such as symbology type, data formatting needs, etc.

Future Trends

CCD and laser technologies continue to evolve. Both have improved dramatically over the years, and advances in performance as well as reductions in price can be expected. The most dramatic area of change has been the increased depth of field and decode performance of the latest generation of CCDs. In the future, look for the following developments:

Laser scan engines will continue to decrease in size, allowing better form factors for some applications.

Laser safety will continue to grow as an issue, especially in Europe, where concern over high-energy lasers hitting the eyes already is a hot topic of discussion. In the United States, the move to bring scanners into the home for e-commerce applications is raising the question of laser safety around children.

Rastering lasers have mirrors that dither on two axes (up and down, back and forth). This allows them to read PDF symbology and capture linear codes in any orientation. Advanced long-range lasers also are in development.

Long-range CCD scanners will increase the scan range to 18 inches (46 cm) in the short term, with longer ranges possible in the future, making them more competitive with the types of standard-range lasers used in retail and other applications. This and the length of the scan line will help remove some of the code-width limits. The illumination will become brighter and sharper, helping users to see where the CCD's scanning plane is.

Area Imagers use a CCD to capture a two-dimensional picture of the symbology being scanned and translate that into data. Area Imagers can read matrix codes as well as PDF. Because Area Imagers capture a 2D area and decode any bar code found, they act as an omnidirectional scanner, allowing users to scan any code without having to be in alignment with it.

The size of the optics will also decrease. This will have a big influence on the shape of the scanner, since a long optical path needs a long scanner. Shorter optical paths will allow different and increasingly ergonomic shapes, as well as facilitate CCD integration into other products.

Scanning Solutions from Intermec Technologies

Intermec offers a full range of laser and CCD scanners to meet virtually every application requirement along the supply chain. From fixed-position to corded and wireless hand-held scanners, and for applications from industrial to retail to health care, Intermec has a product designed to meet virtually every environmental, scanning, and ergonomic need.

To Learn More

For more information on Intermec scanning solutions and input products, contact Intermec Technologies Corporation at 1.800.347.2636 or visit Intermec's Web site at http://www.intermec.com/products/input.htm.

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