Comparing Scanning Performance:
Laser vs. Linear CMOS Technologies

A Technology Brief with Tips on Improving Scanning Performance

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Socket offers a comprehensive line of bar code scanning products, which use either of two types of scanning technologies: laser scanning or CMOS linear imaging. These two technologies differ in a variety of aspects, including performance, price, ease of use, power consumption, and scanning distance.

Socket's bar code scanning products using lasers include:

- CF Scan Card 5M, 5P
- Cordless Hand Scanner with *Bluetooth*® Wireless Technology 7M, 7P
- RFID Reader-Scan Card 6M, 6P
- Gun Scanner 2X

Socket's bar code scanning products using linear CMOS technology include:

- SD Scan Card 3E
- CF Scan Card 5E
- Cordless Hand Scanner with *Bluetooth*® Wireless Technology 7E

This paper describes the differences between the laser and CMOS linear imaging technologies incorporated into Socket's various bar code scanning products. Additionally, suggestions are offered on how to maximize performance from the more affordable CMOS-based scanning products.

Laser Scanning Technology

Socket's laser-based bar code scanners use laser scanning technology from Symbol Technologies. During scanning, a laser beam sweeps back and forth across an arc of about 50-55° at a rate of about 50 times per second. An electronic sensor reads the reflected laser light, constantly searching for patterns of white and black and comparing these patterns to those used by various bar code symbologies to represent numbers and letters. Each sweep of the laser is an independent scan attempt, and to ensure accuracy, the system is normally configured to declare a "good scan" only after two or three consecutive scans read matching data.

The high scanning rate of laser scanners — 50 scans per second — makes them easy to operate. All the user needs to do to achieve a good scan is position the laser beam over the entire width of the bar code for a few milliseconds. Additionally, the clean, bright red line from the sweeping laser

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beam provides an intuitive aiming aid that allows users to become proficient very quickly.

Laser scanners are powerful enough to scan large bar codes at long distances, such as in warehouse applications. With the addition of "fuzzy logic" technology included in some Socket products, they are also more able to read worn or damaged bar codes. Laser scanners are also versatile because the laser beam itself illuminates the target bar code. This greatly reduces the need for auxiliary lighting, making laser scanners more effective for scanning in low ambient lighting conditions.

Because of the large amount of "competing" red light in sunlight (unlike artificial light sources), a laser scanner may have difficulty reading bar codes in direct sunlight.

Note: The CF Scan Card, Cordless Hand Scanner, and RFID Reader-Scan Card are offered with either Class 1 or Class 2 lasers. To learn about the laser classes, please visit: www.socketcom.com/pdf/TechBriefClass1Class2.pdf.

CMOS Linear Imaging

Socket's scanners based on CMOS linear imaging technology are more affordable than Socket's laser scanners, but they also offer somewhat limited performance. For this reason, the entry-level versions of Socket's CF Scan Card and Cordless Hand Scanner feature CMOS imaging technology, while the mid-range and performance versions incorporate laser technology.

Socket's CMOS-based scanning products use CMOS linear imaging technology from Symbol Technologies. A CMOS linear imager is basically a camera that captures rectangular digital images about 1 degree high and 40 degrees wide. Each digital image is analyzed for black and white bar code patterns and processed by decoding algorithms in the engine processor.

The imaging rate varies between about 20-40 frames per second and automatically compensates for ambient lighting conditions — the more ambient light, the faster the scan rate, just like the shutter speed of a camera. However, this imaging rate cannot be directly compared to the rate of a laser scanner, because the CMOS image is affected by blurring, while laser technology is not. With a slower scan rate, CMOS imagers require a steady hand for about a quarter to half a second. As a result, new users may find it slightly more difficult to achieve a good scan with CMOS linear imagers than with laser scanners.

Adequate lighting of the target bar code is critical to scanning with imaging technology. Unfortunately, providing auxiliary lighting increases the size, energy consumption, control complexity and cost of the scanning device. For these reasons, the red light from Socket's CMOS linear imager products was designed simply as an aiming beam — it does not add any auxiliary lighting to the target bar code. Socket's CMOS-based scanners are most effective in well-lit conditions.

Like all cameras, the CMOS engine has a "focal length" (the minimum and maximum distance from the target) where the captured image will be clearer. While the focal length of a laser engine is quite large, the focal length of the CMOS engine is much smaller. For best results in scanning “normal” sized bar codes (e.g., retail UPC codes), a CMOS linear imager should be held about 4-7 inches (10-18 cm) from the target bar code.

Note: To learn about bar code scanning in a patient safety environment, please visit: www.socketcom.com/support/learn.asp.

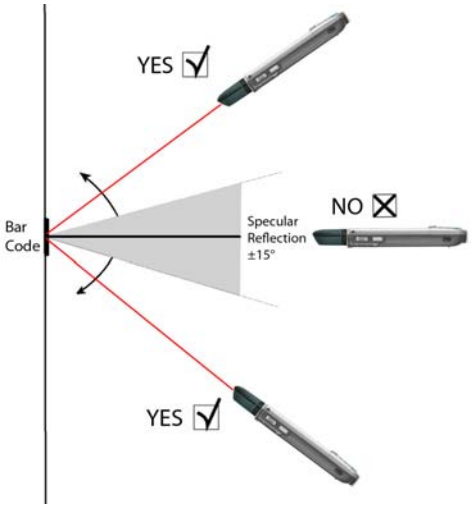
Tips for Maximizing CMOS Scanner Performance:

1. *Minimize movement during scanning* — While users of laser scanners are used to casually sweeping the laser beam line across the bar code, the red aiming beam of the CMOS scanners must be held reasonably steady on the target for a short period of time while the camera focuses and captures a clear image. This time should not be more than a quarter to a half of a second.

2. *Provide adequate ambient lighting* — While the laser scanner works best in low ambient light conditions, the CMOS scanners, like any camera, work best when the target bar code is well lit.

3. *Determine the optimum focal length* — The CMOS scanners have a fairly small focal length compared to laser scanners, so it is helpful to experiment until you find the best scanning distance.

   *Hint: When encountering scanning difficulties, most people have a tendency to move the scanner too close to the target bar code! Try moving it **farther away** for better results.*



4. *Position the scanner at an angle*— Neither laser scanners nor CMOS linear imagers work well when the scanner is positioned exactly perpendicular (90°) to the target bar code label, as the reflected light tends to ‘blind’ the sensing mechanism (this is known as specular reflection). For best results with both types of scanners, tilt the scanner at least 15° from perpendicular to the surface of the target bar code label. Simple practice quickly shows what tolerances to work within. See diagram at left.

5. *Experiment with different techniques and conditions* — The more you experiment with different techniques, lighting conditions, scanning distances and positions, the more proficient you will become.

Conclusion

Socket’s scanners based on CMOS linear imaging technology provide convenient and affordable bar code scanning from your mobile device, and with a little experimentation and practice, the performance will approach that of the more expensive laser-based devices. Bear in mind, however, that depending on the amount and intensity of scanning activity required in your job, it may be cost-effective to invest in one of the more aggressive, laser-based scanners.