Symbol Reconstruction in Bar Coding Applications

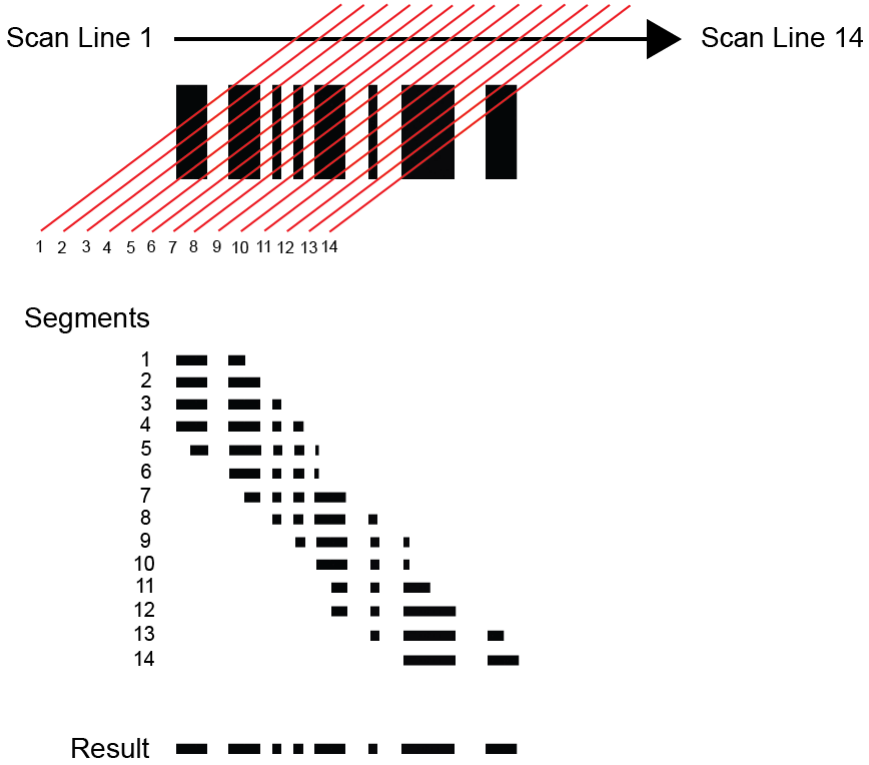
Industrial environments present many data capture challenges, some of which are damaged symbols, partially covered symbols, poorly printed symbols, and variation of label placement. Symbol quality, location, and orientation cannot always be controlled. Labels containing linear symbols (Code 39, Code 128, Interleaved 2 of 5, and UPC/EAN, for example) can be torn, partially obscured, overprinted, or underprinted due to variations in print mechanisms. For industrial tracking and traceability to be reliable, symbols must be decoded regardless of damage, label tilt, or any other discontinuities.

A number of industrial automation vendors have addressed the issue of symbol damage with several product introductions in recent years. These products address the need for reliable decoding capabilities in rugged industrial settings.

Microscan's QX-830 Compact Industrial Laser Scanner features X-Mode technology, which allows the scanner to reconstruct data from damaged or poorly positioned symbols by "stepping though" the elements (bars) in multiple stages and then combining the successfully decoded regions into completed symbol data output.

Symbol Reconstruction Methodology

Microscan's X-Mode symbol reconstruction methodology uses an algorithm that pieces together discontinuous symbol data from multiple scan lines, as demonstrated in the simplified example below.



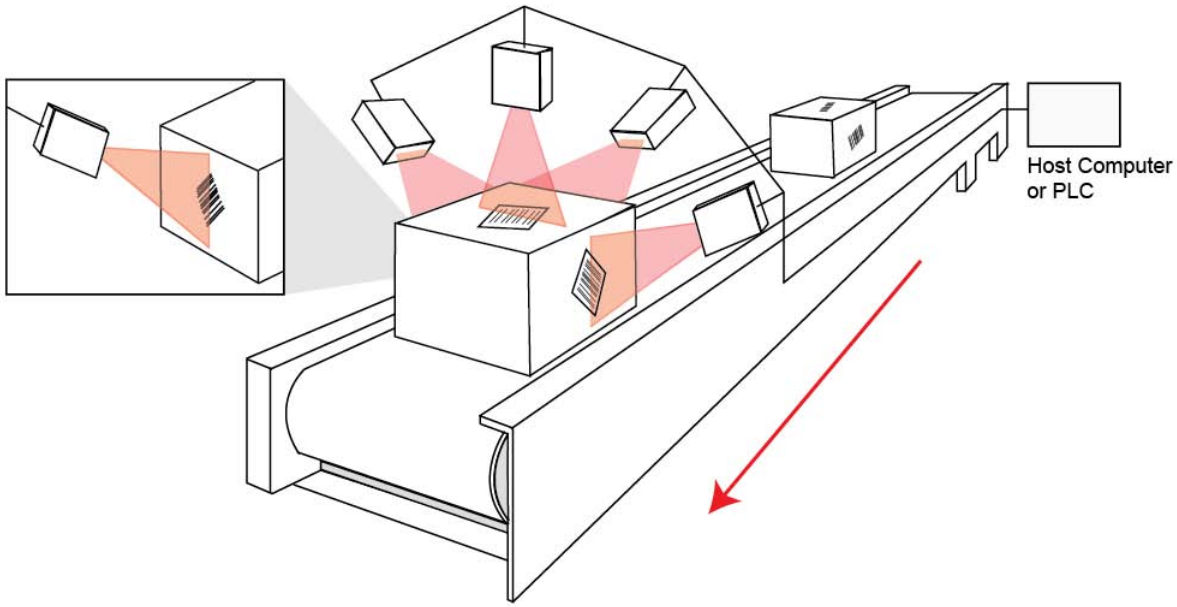
This example illustrates in very general terms how the decoding algorithm combines several incomplete segments of a rotated or damaged symbol into the equivalent of a complete scan line. The data from that complete scan line is then output from the scanner to a host system.

The illustration above shows the scan lines intersecting the symbol elements (bars) at an angle, demonstrating how the algorithm reconstructs data from tilted symbols. Reconstruction of damaged symbols is achieved similarly—by combining multiple small, undamaged and decodable "chunks" of symbol data into a single, continuous data string.

Rotated Symbols

In some packaging applications, operators may have little or no control over label placement, which can lead to unexpected symbol orientations. Symbol reconstruction allows the scanner to decode tilted symbols that would otherwise result in No Reads.

The image below shows single-line laser scanners decoding rotated symbols. A single-line scan beam is preferable to a fixed raster when performing symbol reconstruction on rotated symbols.

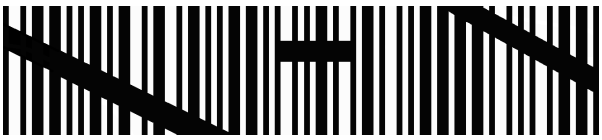


Damaged Symbols

Track-and-trace applications have the potential for symbol damage as parts move through the manufacturing process. Symbol damage can take many forms, including torn labels, eroded ink from friction or moisture, or unintended markings that partially obscure the symbol. Microscan's X-Mode symbol reconstruction algorithm is able to identify multiple undamaged areas of a symbol and then piece together those areas to create the equivalent of a complete scan line. The complete data string from that scan line is then sent to the host.

Code 39 with Tilted and Partially-Obscured Elements

The Code 39 symbol shown above was successfully decoded by a QX-830 despite the tilted and partially-obscured elements (bars). The reconstruction algorithm enabled the scanner to "work around" the tilted and blocked elements by combining multiple decodable segments into a complete symbol decode.



Code 39 with Multiple Areas of Interference

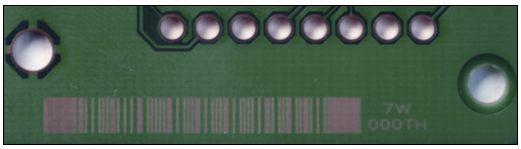
The Code 39 symbol shown above was decoded by a QX-830 using symbol reconstruction. The reconstruction algorithm enabled the scanner to decode the symbol as a whole, despite the multiple locations of interference in the upper right and lower left corners of the symbol, and the mark intersecting several of the middle bars.

Low Aspect Ratio Symbols

Symbols with low aspect ratio are often difficult for traditional laser scanners to decode, due in part to the fact that placement cannot always be controlled to ensure that the scanner will be able to achieve a continuous scan line through the entire symbol.

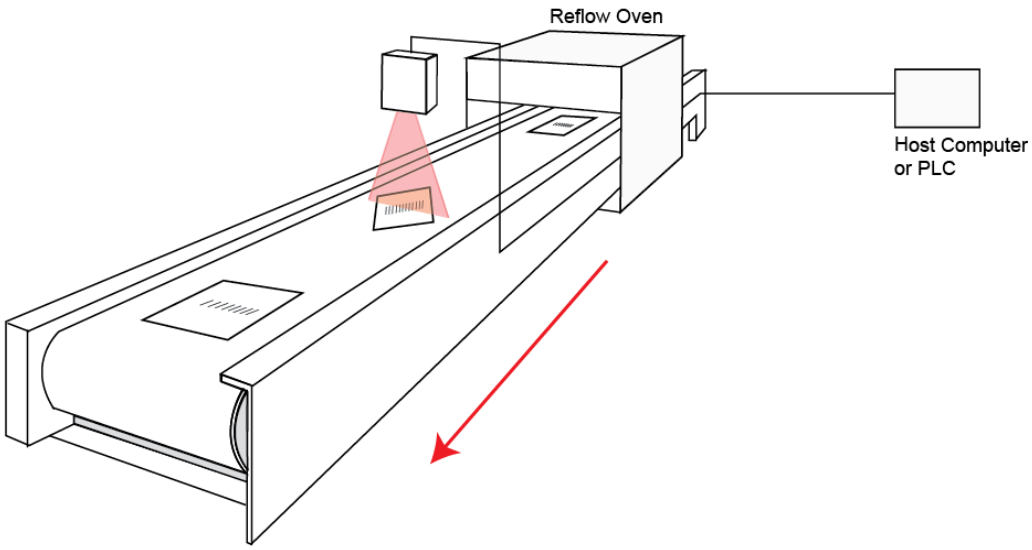
- In applications where there is little or no ability to control the rotation of symbols, a single-line laser scanner will provide the best decode performance.
- In applications where control of symbol rotation is possible, a fixed raster scanner will provide the best decode performance.

It is also important to note that slow-to-average line speeds (1 - 15 inches per second) offer greater flexibility and reliability when choosing the ideal laser scanner for a given application.



Code 39 with Low Aspect Ratio
This Code 39 symbol on a printed circuit board is an example of low aspect ratio (short bars). A QX-830 with a fixed raster was able to locate the symbol and decode it successfully.

The image below shows a laser scanner decoding a low aspect ratio symbol on a printed circuit board in an electronics manufacturing application.



Configurable Symbol Reconstruction Parameters

Symbol Reconstruction parameters allow the user to determine the level of **redundancy** (the degree of redundancy check that will be used to qualify the reconstruction results) and **effort** (the amount of processing that will be applied to the reconstruction process) that will be used by the QX-830 in attempting to decode a candidate symbol.

Symbol Reconstruction Redundancy

The purpose of redundancy checking is to ensure that the symbol has been decoded correctly. The redundancy check is used to qualify the result of the symbol reconstruction process. The QX-830 can be set to **Low**, **Medium**, or **High** redundancy, depending on the quality of symbols being used in the application. If the application is using high quality symbols, the **Low** setting provides satisfactory redundancy checking. A higher level of redundancy ensures greater data integrity, but may also require a higher level of effort to decode.

Symbol Reconstruction Effort

The purpose of the effort parameter is to determine the amount of time the system will spend identifying candidate symbols and the amout of processing that will be applied in reconstructing and decoding those symbols. The QX-830 can be set to **Minimum**, **Moderate**, or **Maximum** effort. A higher effort level may slow decode performance as the scanner runs through all options for reconstructing and decoding the symbol.

Aggressive Decoding "Out of the Box"

The symbol reconstruction capabilities of the QX-830's X-Mode are a significant industrial automation advantage, but X-Mode's benefits are not limited to symbol reconstruction. The QX-830's default settings are designed to provide maximum decode performance with a minimum of configuration required.

Most Symbologies Enabled by Default

The most widely-used industrial symbologies are enabled by default (Code 39, Code 128, Interleaved 2 of 5, Codabar, UPC/EAN, Code 93, DataBar Limited, and DataBar Omnidirectional). Pharmacode, DataBar Expanded, Stacked Symbologies, and Composite Symbologies are not enabled by default, but can be configured as required by the application.

Narrow Margin Status Enabled by Default

Narrow Margin Status is also enabled by default. This allows more symbols to qualify for a decode attempt.

Depth of Field Enhance

The **Depth of Field Enhance** command allows the user to control the scanner's depth of field through the extra processing of symbol elements. These settings are intended to increase decoding performance in situations where symbols are poorly printed, and where the scanner must be at a greater-than-ideal distance from candidate symbols because of an application's physical requirements.

Aggressive Decoding Algorithm

Code 128, UPC/EAN, and Code 93 are all set to a **Both Standard and Edge** algorithm by default. The **Standard** decoding algorithm analyzes each bar and space of a symbol individually, which is ideal if only grade-A symbols (not overprinted or underprinted) are being used in the application. **Edge-to-Edge** algorithms analyze each bar and adjacent space simultaneously, so that even overprinted or underprinted symbols can be decoded successfully. The QX-830 is defaulted to **Both Standard and Edge** so that symbols will be decoded rapidly and successfully regardless of printing inconsistencies.

Real-Time Decoding

The QX-830 Compact Industrial Laser Scanner features "real-time decoding", which means that the decode rate equals the scan rate, even at the fastest scan rates. For example, if the scan rate is 1,400 scans per second, the decode rate is 1,400 decodes per second.