



The SmartImage Sensor Specialists

Barcode Verification/Grading

Overview

Reading barcodes functionality has been available in FrameWork since version 1.2 and is a key feature in the SmartReader. As an extension to this capability it is desired to add the ability to also verify or grade barcodes. Anyone who deals with barcodes may have a need for verifying the quality of barcodes, however, the most users who would be most interested in this functionality would be

- Those who build systems for barcode printing – for testing of the barcode printing process during development and to ensure the system meets the customer's needs.
- Those who print the barcodes – to ensure quality at the time of printing
- Those who's parts or products have had barcodes printed on them – to ensure quality of the barcodes delivered to them
- Those who handle barcoded parts or products in intermediate stages of distribution – to ensure the barcodes will meet the needs of customers further down the supply chain

The difference between barcode verification and barcode reading is that reading provides only a go/no-go indication of the quality of the barcode while verification follows a specified standard to not only give a finer indication of the quality of the code relative to a "ideal" code but it is also able to give more information on why the quality is suffering.

Scan Reflectance verification (ISO or ANSI)

The method normally referred to when talking about barcode verification is the scan reflectance method first specified in ANSI X3.182 in 1990 (thus the common name of ANSI grading). The method has also been defined in European Standard EN 1635 and an International Standard ISO/IEC 15416 (thus the other common name ISO verification). The methods described in each are technically compatible the main difference being in how they specify the readability standards for individual code types.

Equipment Conformance

Not only are there standards governing the methodology used for barcode verification but also there are standards specifying the conformance of the verification equipment. Two specs exist for this purpose, ENV 12647 and ISO/IEC 15426-1, although the latter will supersede the former. They define the basic requirement of a barcode verifier as giving defined results for a set of test symbols of known grade. This includes not only the



The SmartImage Sensor Specialists

overall symbol grade but also individual parameter measurements (within a given tolerance). ENV 12647 specifies two classes of verifiers based on the information reported while ISO/IEC 15426-1 simply lists required functions and some optional features.

Class A systems, as defined in ENV 12647, are better suited for use in Quality Control labs rather than on the plant floor. They provide a much higher range of measurement accuracy and reporting depth. They often also include multiple optical, lighting, and aperture settings to allow a wider range of operating conditions and increased measurement accuracy. The computation time for the parameters reported by these systems is often quite long, though, this is usually not a problem in laboratory applications.

Class B systems are generally used on the plant or press floor. They include only a single lens, light, aperture combination though some provide simple plug-in scanners to allow changing these for different conditions. The information measured and reported by Class B systems is usually limited to the barcode grade along with measurements useful to the press operator for varying his equipment. Other systems are designed to be mounted on the printing equipment and can provide high speed bar width variance and contrast feedback for process control.

Lighting and Aperture Preconditions

One of the key requirements of a verifier is that it matches the performance of the scanner as closely as possible. In a situation where the scanner and reader will always be the same this is not as big of an issue. Many applications, though, will require verification where the particular scanner used is unknown or will vary. In this case the conditions have been specified to increase compatibility and consistency.

The specifications give an imager/lighting arrangement to use with a flood-type light at a 45° angle and the imager at a 90° angle. This is intended to give the best results in cases where specular reflections may cause problems. Since this is given only as a guideline some verifiers do not follow this exact configuration and still perform well. A SmartReader-like configuration should perform sufficiently well with the camera placed just off of 90° to prevent specular reflections.

Another physical parameter that should be matched to the scanner to be used is the peak wavelength of the lighting source. Most scanners use visible laser diode or LED light sources that operate with a peak wavelength in the 660 – 670 nanometer range. Some older systems use Helium-Neon laser tubes that peak at 633 nanometers although they are becoming increasingly rare. EAN*UCC specifications require 670nm +/- 10nm.

The aperture of the optics is another important parameter for successful verification. With a CCD based sensor aperture translates to image resolution. The rule of thumb is to have



Due to the importance of the aperture size and lighting wavelength on the measurements both values must be given any time the barcode grade is presented.

Element locations

The first part of the analysis presented in the specifications is the definition of the element locations based upon the reflectance measurements along the scan. Figure 1 gives an example of a scan reflectance profile.

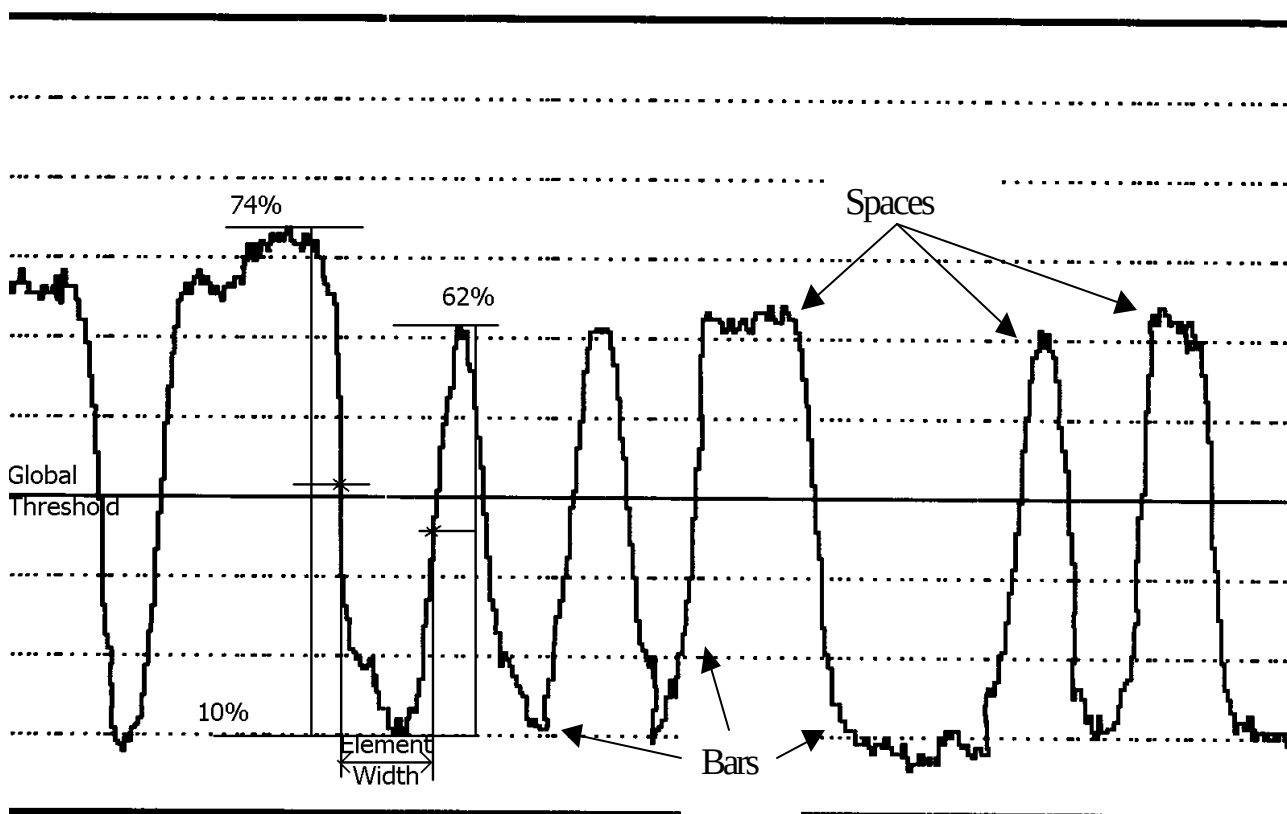


Figure 1: Sample scan reflectance profile showing edge locations

The Global Threshold is selected as halfway between the maximum and minimum intensity values across the whole scan. This is similar to the Percent of Path contrast being set at 50%. This is illustrated in Figure 1.



The SmartImage Sensor Specialists

Parameters Measured

Several key values are measured to come to the final grade determination for a particular barcode. Figure 2 shows another sample scan reflectance profile with several of the values shown.

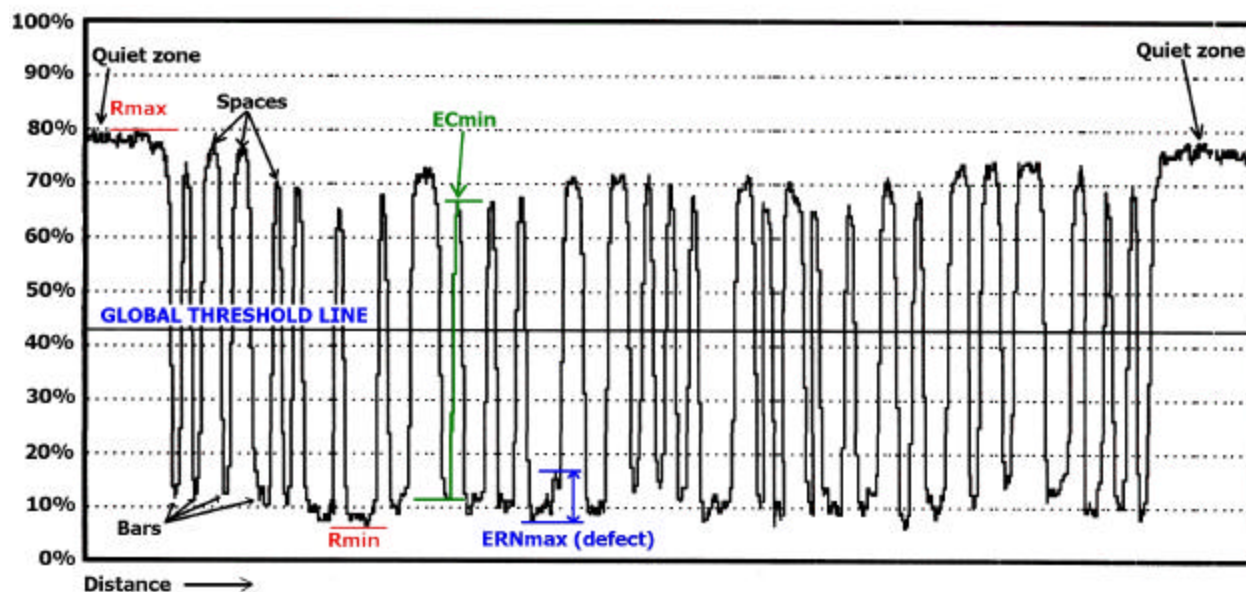


Figure 2: Sample scan reflectance profile showing several key parameters

Symbol Contrast (SC)

The symbol contrast is the difference between the maximum and minimum intensity values along the entire scan ($R_{\max}$ and $R_{\min}$). If the SC is greater than 70% this parameter is graded A (4) while an SC measurement below 20% is given a grade of F (0).

Minimum Reflectance ($R_{\min}$)

The minimum reflectance must have a value no higher than half of the $R_{\max}$ value. The grade for this measurement is either A (4) if it passes or F (0) if it fails. This is a separate measurement from the Symbol Contrast due to many scanners performing poorly when the bars are on a high reflectance background instead of a relatively low reflectance background. This is only likely to come into play, though, with lower graded SC values.



The SmartImage Sensor Specialists

Edge Contrast (EC)

Edge contrast is the measurement of the maximum intensity difference between two adjacent elements. If the minimum EC across the scan is less than 15% the measurement is graded as F(0), otherwise it is given a grade of A(4).

Modulation (MOD)

Modulation is the ratio of the minimum Edge Contrast to the Symbol Contrast. If the value is greater than 0.70 the parameter is given a grade of A(4) while a value less than 0.40 will receive a grade of F(0). The presence of this parameter is due to a low Edge Contrast value having a greater risk of causing poor reading when the overall Symbol Contrast is high than if it is lower.

Defects

Defects in the barcode result in ripples in the intensity measurements within a bar or space. This is reflected in the Element Reflectance Non-uniformity (ERN) measurement. ERN (shown in Figure 3) is defined as the size of the largest peak in a bar (or valley in a space). The Defects measurement is the ratio of the maximum ERN in the scan to the Symbol Contrast. A Defects value below 0.15 will be graded at A(4) while a value greater than 0.30 will be given an F(0). Correct selection of the system aperture is critical to the effects of defects not being over- or underrated.

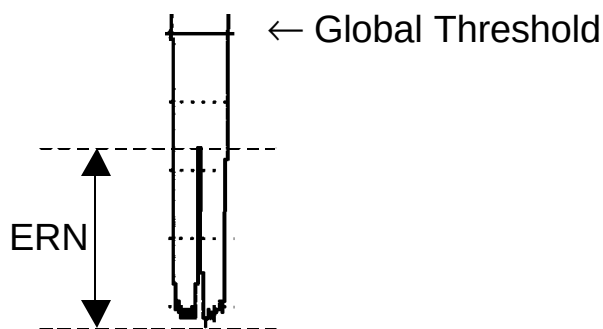


Figure 3: Illustration of the ERN measurement for a bar

Decodability

Decodability is a ratio between the minimum difference between the maximum allowed element width variance and the actual measured variance and the maximum allowed element width variance. For instance, consider if a code specification says that if an element measurement between 2.5 and 3.5 it should be called a width of 3. The maximum allowed element width variance is 0.5 in this case. If a bar measurement is made of 2.7 the measured variance is 0.3 giving difference of 0.2. The decodability



The SmartImage Sensor Specialists

measurement is then 0.2/0.5 or 40%. This is basically a measurement of the padding available before a scanner miscategorizes a width. Values over 0.62 receive a grade of A(4) while those below 0.25 are graded as F(0). The decodability measurements must reference each symbology specification to ensure the correct method is used.

Decode

The scan reflectance profile is passed to the decode algorithm to see if it is able to read it using the methods specified in the symbology specification. The element locations defined previously should be used for this step. If the code can not be read this step is given a grade of F(0) otherwise it receives a grade of A(4).

Multiple Scans

While a barcode reader is satisfied with being able to read the barcode at any location along its height, a verifier must be concerned with checking the quality of the barcode at various points along the height to ensure readability by scanners down the line. For this reason, the verification specifications require that measurements be made along 10 scans and the overall grades be averaged. The scans are equally spaced starting at 90% of the barcode height and ending at 10% of the height.

Bibliography

1. "ANSI X3.182-1990 for Information Systems: Bar Code Print Quality Guideline", American National Standards Institute, NY,NY, 1990.
2. "Bar Code Verification: A detailed technical overview for EAN Member Organisations", EAN International, Brussels, Belgium, August 2000.