The Association for Automatic Identification
and Data Capture Technologies

The Layman's Guide to ANSI, CEN, and ISO Bar Code Print Quality Documents

AIM, Inc.
634 Alpha Drive
Pittsburgh, PA 15238-2802
Phone: +1 412 963 8588
Fax: +1 412 963 8753
Web: www.aimglobal.org

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Published by:
AIM, Inc.
634 Alpha Drive
Pittsburgh, PA 15238-2802
USA
Phone: +1 412 963 8588
Fax: +1 412 963 8753
Email: aidc@aimglobal.org
Web: www.aimglobal.org

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1 Introduction

The first published document concerning the issue of printed bar code quality was the Uniform Code Council (UCC) Universal Product Code (U.P.C.) Symbol Specification and U.P.C. Verification manuals. Quality parameters for checking the quality of bar codes had to do with:

- Did the bar code meet the required format for the application?
- Did it have the right characters in the right positions?
- Did it have the correct number of encoded characters?
- Did the background and bar contrast (color) or reflectance meet the correct criteria for a bar code scanner to "see" the bar code? (At that time, scanners were primarily based on helium-neon lasers that "see" everything as if it has red glasses on.)
- Did the widths of the bars and spaces meet the industry specifications?
- Were the quiet zones wide enough?
- Was the height of the bar code correct?

In 1982 the American National Standard Institute (ANSI) X3A1 Technical Sub-committee, with the assistance of other ANSI and industry committees and bar code authorities, began studying the issue of bar code print quality. Through the years, bar codes had been printed that met the existing standards, but would not scan. And often bar codes printed out of specified standards did scan.

This combined group knew that the existing specifications for quality control of bar codes were evaluating criteria based on the dimensional accuracy of the symbols and a contrast measurement based on the way the eye "viewed" the symbol; this ignored some of the quality parameters which were important to the scanners. The ANSI X3A1 group evaluated what factors were important to the many different types of bar code scanners/decoders for high first read rates and readability. After eight years of extensive testing, American National Standard X3.182-1990 Bar Code Print Quality Guideline was published. That document outlines quality parameters based on the optics of bar code scanning systems. Since that time the Committee for European Normalization (CEN) and the International Standards Organizations (ISO) have created their respective documents (EN 1635 Bar code symbol test specification, published 1995, and ISO/IEC 15416 Bar code print quality test specification, published in 2000) which embrace the same methodology as the ANSI Bar Code Print Quality Guideline but have added features designed to give more help to symbol producers and users.

Today many groups including EAN International, the Uniform Code Council, ANSI/Material Handling Institute, the Automotive Industry Action Group (AIAG) and the Health Industry Bar Code Communication Council (HIBCC) have specified conformance to ANSI X3.182 Bar Code Print Quality Guideline and its parallel documents in Europe and the rest of the world.

This guideline will outline the parameters of bar code quality from the ANSI, CEN and ISO Print Quality documents. It will discuss the importance of these parameters and, based on the quality levels achieved for each assessed parameter, what corrective action is necessary to greatly improve bar code print quality.

2 Reflectance, Aperture and Wavelength

Equipment being used to evaluate the quality of the printed bar codes must report the reflectance values in percentages. Equipment should be calibrated to a recognized national standard. (e.g. National Institute of Standards and Technology.) Further, the calibration, as well as, the actual verification should be completed with the light source illuminating the symbol at 45° from perpendicular, and the optical input device that collects diffusely reflected light perpendicular to its surface. The bar code should be verified across the number of scan paths specified through the entire width of the bar code including both left and right quiet zones (see section 3.9). The above optic description certainly falls into that of a contact device. However, in certain cases a laser may need to be used. Bar codes printed on curved surfaces, easily scratched or wrinkled surfaces or wet ink for instance may require the use of a laser type verifier. The caution with using a laser is to make sure that it complies to the ANSI, CEN and ISO quality parameters, and that all parameters are reported.

The aperture size and wavelength has a significant impact on the grade results obtained. For instance, a symbol checked with a 5 mil (0.125 mm) aperture with a 633 nm (red) wavelength light source might achieve a grade of 1/D (poor). The same symbol could be verified with a 10 mil (0.250 mm) aperture at the same wavelength and receive a grade of 3/B (good), and then receive a grade 0/F (fail) if verified with a 10 mil aperture with a 900 nm (non-visible – near infra-red) light source. The wavelength is usually specified in the industry application specification. However, if it is not specified, the wavelength should match the light source wavelength of the scanning equipment as close as possible. The ANSI, CEN, and ISO documents also recommend the aperture diameter based on the "X" dimension of the bar code being verified. The aperture and wavelength specified in the applicable ***Industry Application Standard take precedence over the ANSI, CEN, or ISO documents,*** even if some X dimension ranges do not agree with the ANSI, CEN, or ISO recommendations. It should also be noted that when creating codes for a specific customer, the bar codes should be verified to that customers specifications.

Aperture Diameter (in 0.001") / Aperture Ref. No.	Aperture Diameter (in mm)	"X" Dimension Range (in inches)	"X" Dimension (in mm)
03	0.075	0.004" to 0.007"	0.100 to 0.180
05	0.125	0.0071" to 0.013	0.180 to 0.330
10	0.250	0.0131" to 0.025"	0.330 to 0.635
20	0.500	0.0251" and larger	0.635 and larger

Note that the EAN.UCC General Specifications call for the use of a 6 mil aperture (0.150 mm) for the verification of EAN/UPC symbols within the permitted range of magnification factors (80% to 200%), which corresponds to an X dimension range between 10 mil and 26 mil (0.264 mm to 0.660 mm); this correlates with results of tests on current scanning systems used in that application.

The ANSI, CEN, and ISO documents recommend that the aperture be circular and the reflected light be collected perpendicular to the bars with the illumination at a 45° angle from the surface and parallel to the height of the bars. The recommendation for the number of scans per symbol is 10. These 10 scans should be at equal increments within the height of the bar code. This is to obtain an overall assessment of the quality of the whole symbol, as its quality could vary within the height of the bar code. The individual grades are then averaged together to create an Overall Symbol Grade (See section 5).

3 Scan Reflectance Profile

The ANSI, CEN, and ISO Bar Code Print Quality documents outline several parameters that greatly affect the quality of the printed bar code. To test these parameters, a series of Scan Reflectance Profiles are created and evaluated. A Scan Reflectance Profile is a record of the reflectance values (00% to 100%) measured along a single line across the entire width of the bar code. Figure 1 illustrates a scan line passing through a bar code symbol that would be used to generate the scan reflectance profiles that are illustrated in this document. These values are charted to create an analog representation of the bar code. Each parameter in the Scan Reflectance Profile will either Pass, Fail or be graded as 4/A, 3/B, 2/C, 1/D, OR 0/F, and the Scan Reflectance Profile will then receive a grade *(referred to as a Scan Grade)* which is that of the lowest graded parameter in that profile as described in the ANSI, CEN, and ISO documents, and further explained in this document. Ten Scan Reflectance Profiles are required to determine *Symbol Grade.* Figures 2 and 3 illustrate a Passing profile and a Failing profile respectively.

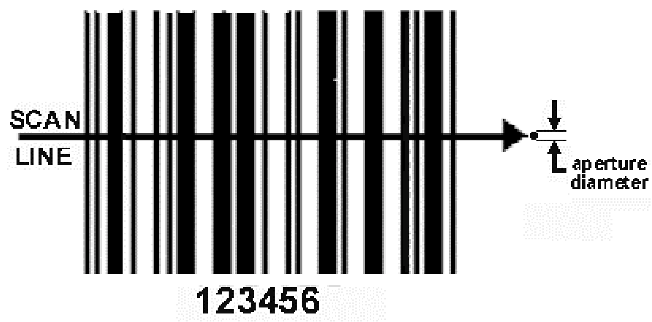

Figure 1 - Scan Line through a Bar Code

After creating the Scan Reflectance Profile, a count of the elements (bars and spaces) referred to as Element Determination is done to confirm that the bar code conforms to some type of symbology. But before this can be accomplished, Edge Determination must be done.

3.1 Edge Determination (Pass/Fail)

GT	=	Global Threshold
R_{min}	=	Reflectance Minimum
SC	=	Symbol Contrast

Formula: $GT = R_{min} + SC/2$

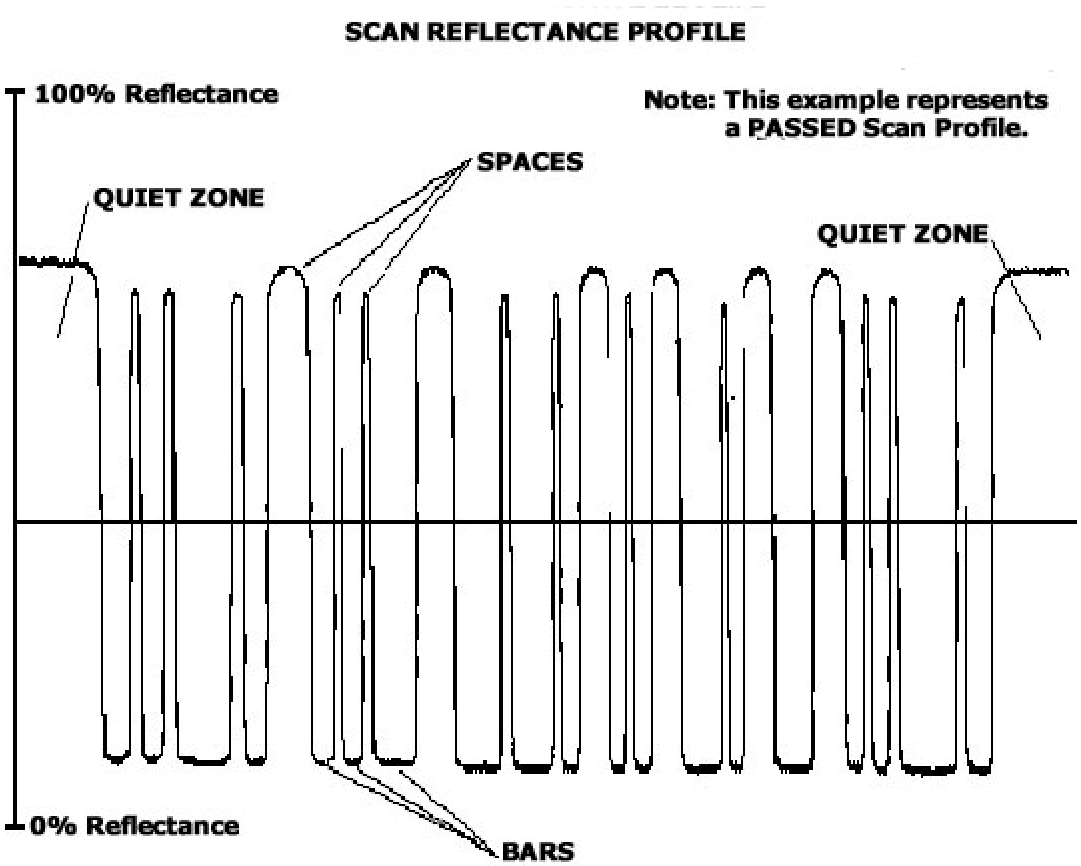

Figure 2 - Passing Scan Reflectance Profile

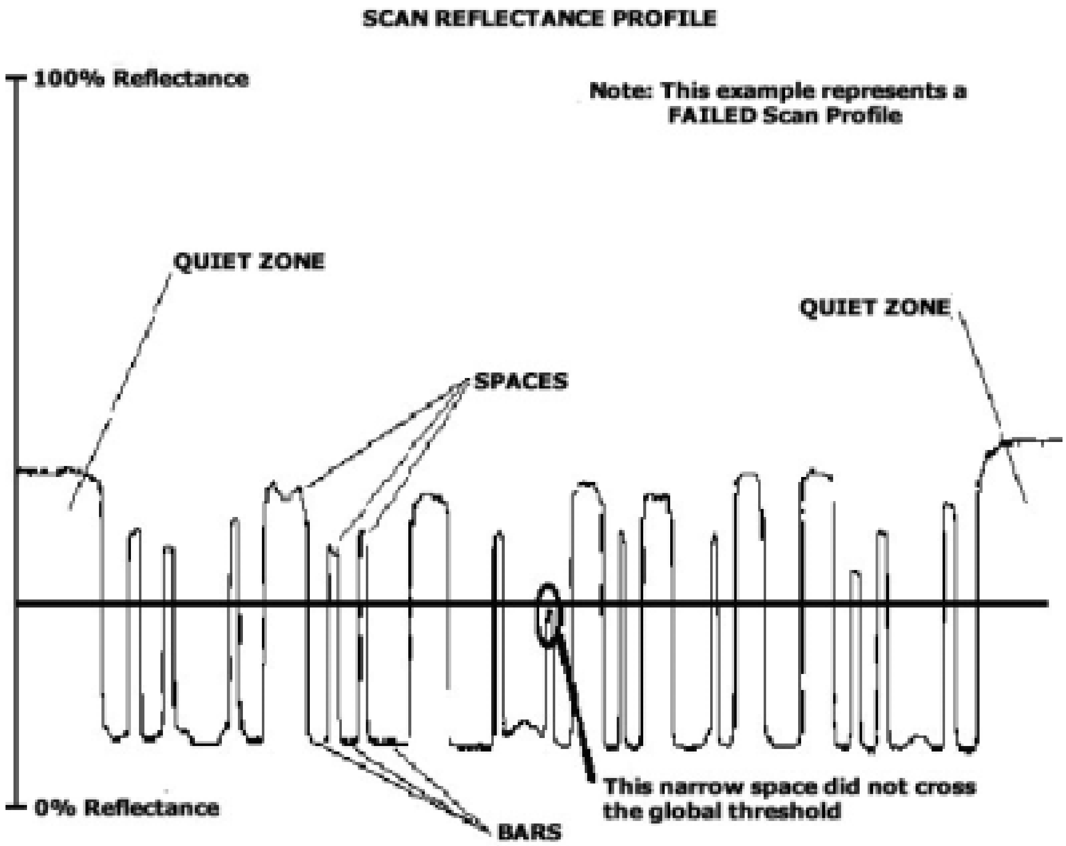

Figure 3 - Failed Scan Reflectance Profile

Definition:
In order to discern bars and spaces, a Global Threshold is established on the scan reflectance profile by drawing a horizontal line half way between the highest reflectance value and the lowest reflectance value seen in the profile. Edge Determination can then be done by counting the number of crossings at the Global Threshold confirming whether the count conforms to or is considered non-conforming to a known bar code symbology. If the bar code conforms it passes if it is considered non-conforming it fails. See Figure 4 for a pass on Edge Determination and Figure 5 for a fail on Edge Determination.

Note that in the CEN and ISO documents, Edge Determination is not graded; a failure on this parameter is shown as a Fail on the Decode parameter (see 3.8). The effect on the scan grade and the overall symbol grade is identical.

After the bar code has passed Edge Determination, there are eight parameters that must be tested. Of these parameters four are either Pass or Fail (and are given grades 4/A or 0/F respectively) and four are graded 4/A, 3/B, 2/C, 1/D or 0/F, where 4/A is the best and 0/F equals a Fail. These parameters basically emulate the different methods that scanner technologies use in converting the obtained signal to the final series of characters for the host. The testing of these parameters is done in sequence as is shown in the flow chart in Figure 18.

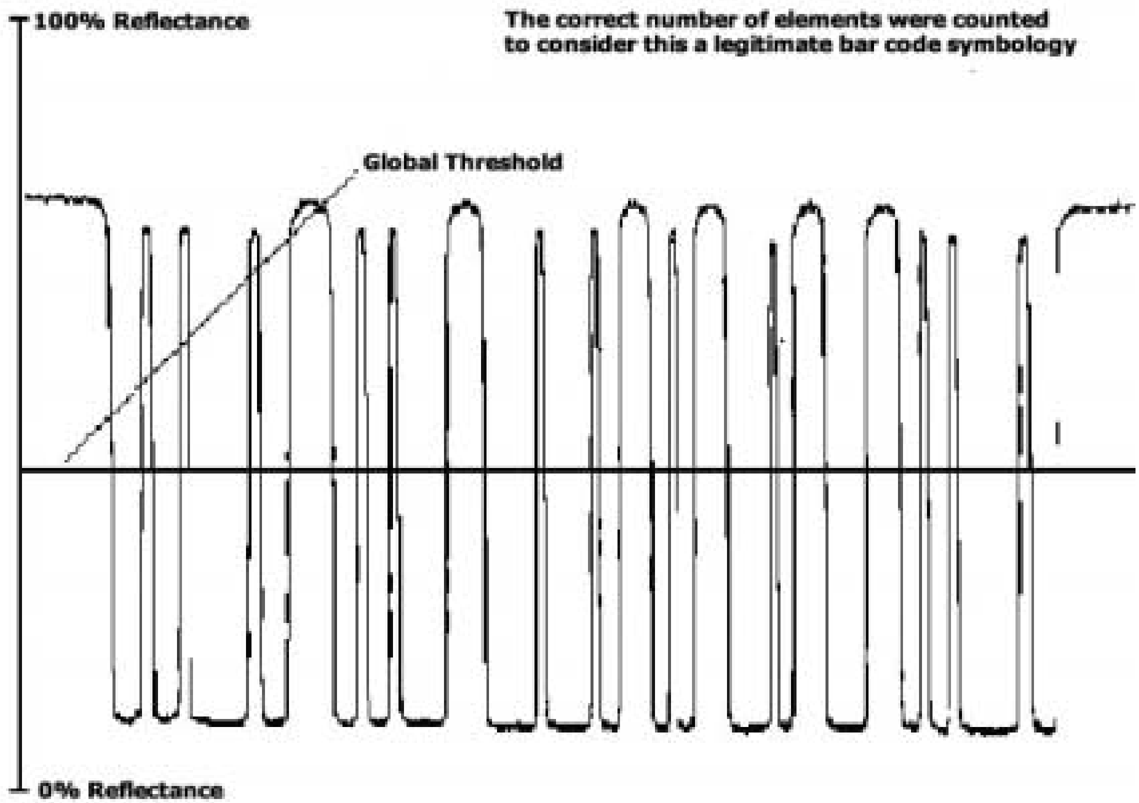

Figure 4 - Passed Edge Determination

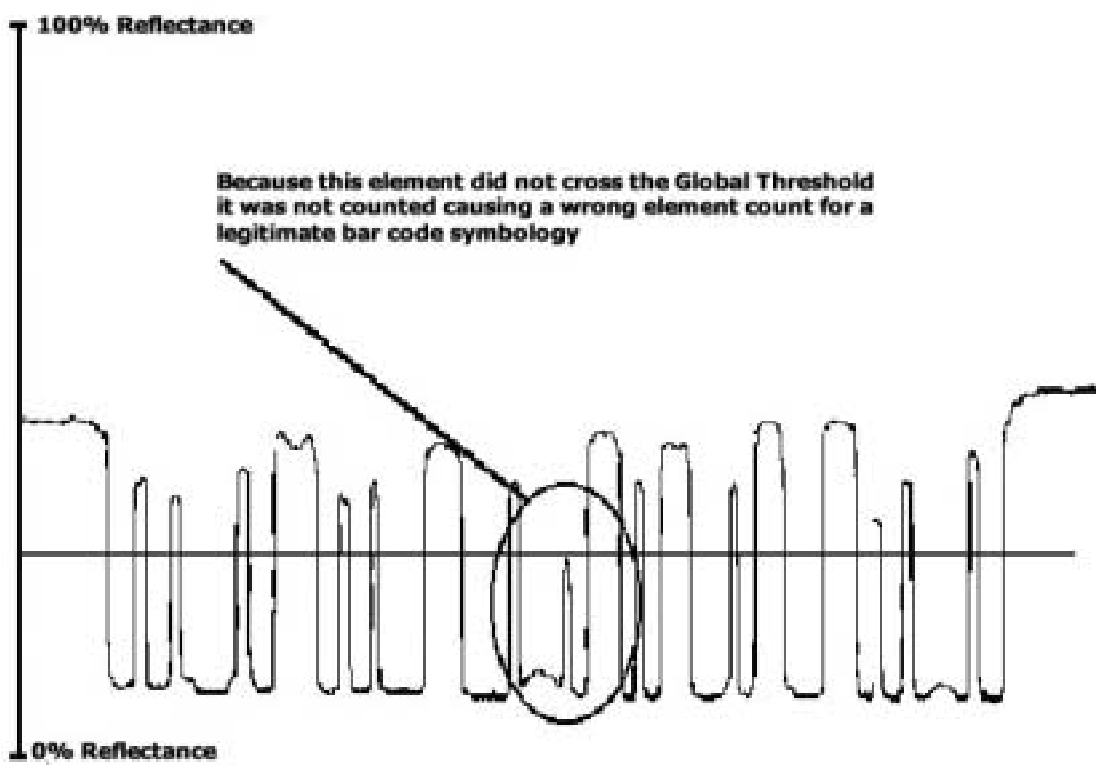

Figure 5 - Failed Edge Determination

3.2 Minimum Reflectance (Pass/Fail)

R_{min} = REFLECTANCE MINIMUM
R_{max} = REFLECTANCE MAXIMUM

Formula:
$R_{min} \leq .5\, R_{max}$ = Pass which equals a grade of A or 4
$R_{min} > .5\, R_{max}$ = Fail which equals a grade of F or 0

Definition:
The reflectance value for at least one bar must be equal to or less than half the highest reflectance value for a space. If the highest space reflectance value is equal to 80% the reflectance value of at least one bar in the profile must be 40% or less. See Figure 6 for a Passing Minimum Reflectance and Figure 7 for a Failing Minimum Reflectance.

3.2.1 Suggestions for improving Minimum Reflectance

- Making bars darker, i.e. darker ink
- Thermal printing, increasing heat.

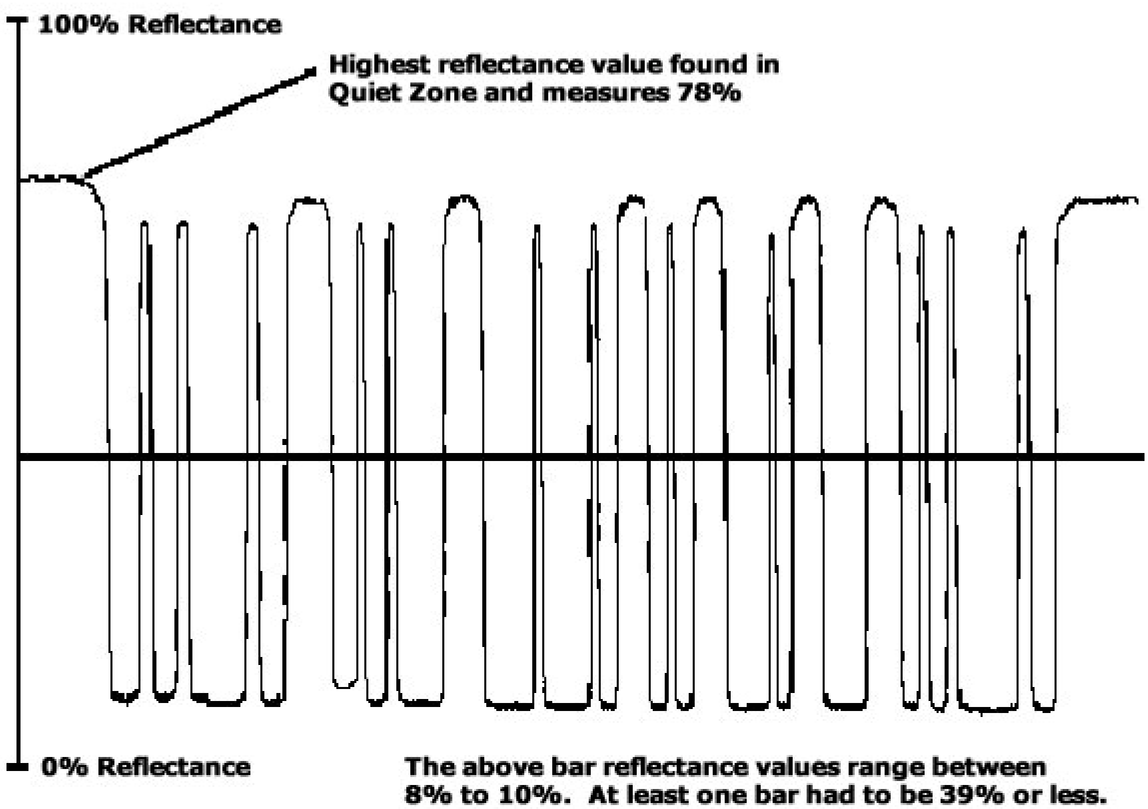

Figure 6 - Passing Minimum Reflectance Test

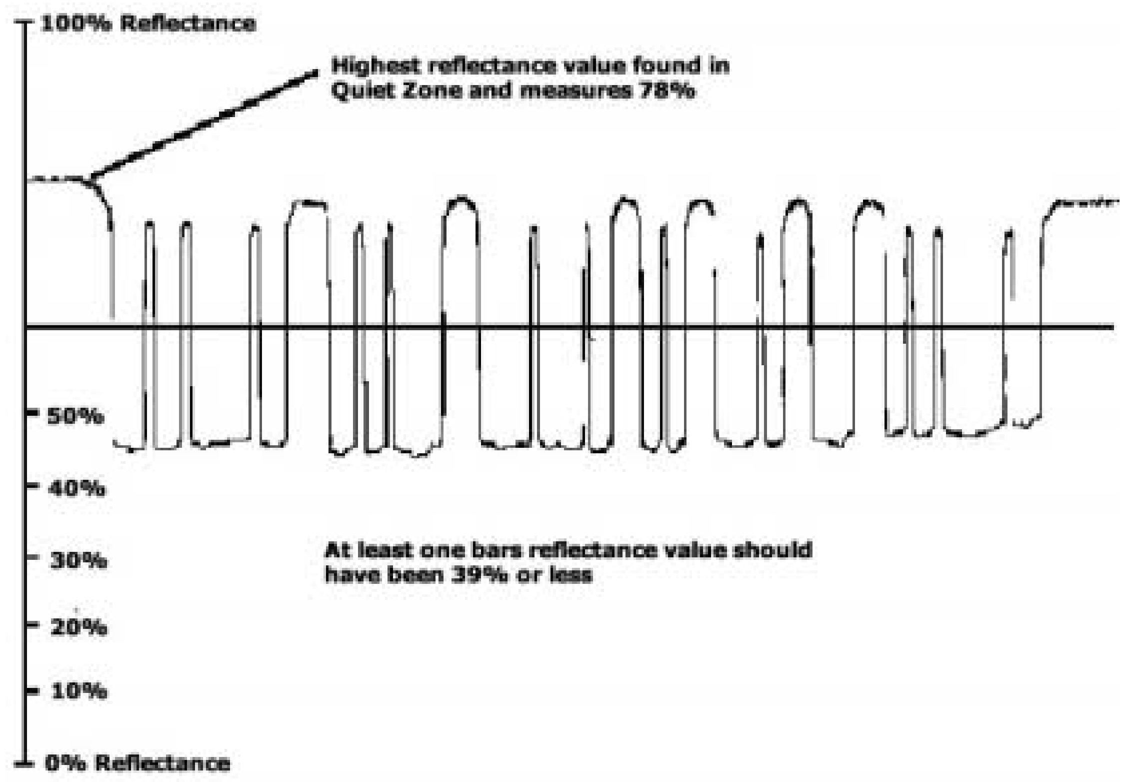

Figure 7 - Failing Minimum Reflectance Test

3.3 Minimum Edge Contrast, EC_{min} (Pass/Fail)

Rs = Space Reflectance
Rb = Bar Reflectance

Formula:
$EC_{min} = Rs_{min} - Rb_{max}$ (worst pair)
$\geq$ 15% = Pass which equals a grade of A or 4
$<$ 15% = Fail which equals a grade of F or 0

Definition:
Each transition from a bar to a space, or a space to a bar, treating the quiet zones as spaces, is an "edge" whose contrast is determined as the difference between the peak values of space reflectance and bar reflectance in that space and that bar. Each edge in the scan profile is measured, and the edge that has the smallest change between adjacent elements gives the value for the Minimum Edge Contrast or EC_{min}. (See Figure 8 for a Pass on EC_{min} and Figure 9 for a Fail on EC_{min})

3.3.1 Suggestions for improving Minimum Edge Contrast (EC_{min})

- Using a "lighter" substrate and darker ink, or increasing the X dimension (minimum element width), assuming the appropriate aperture size is used.
- Adjusting the printing or reproduction process to achieve an X dimension which is closer to the ideal X dimension for a symbol of that size.

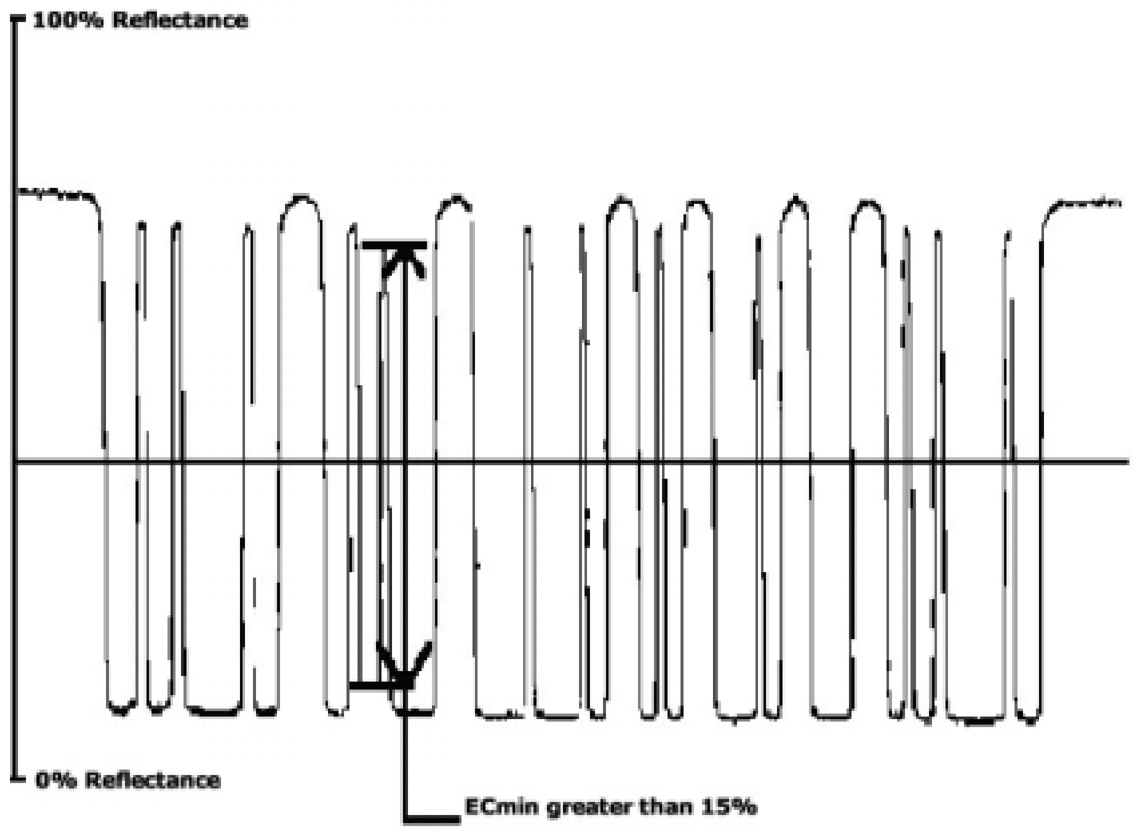

Figure 8 - Passing Minimum Edge Contrast

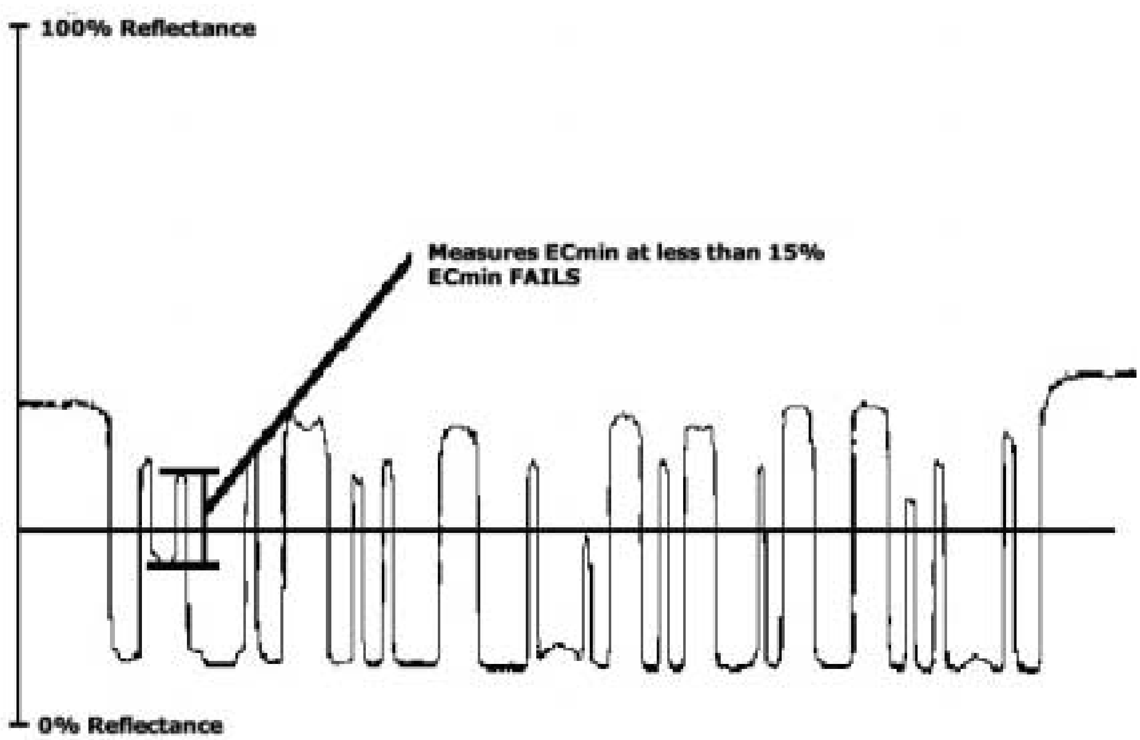

Figure 9 Failing Minimum Edge Contrast

3.4 Symbol Contrast, SC (Graded)

SC = Symbol Contrast
R_{max} = Reflectance Maximum
R_{min} = Reflectance Minimum

Formula:

$SC = R_{max} - R_{min}$
$\geq$ 70% = 4/A
$\geq$ 55% = 3/B
$\geq$ 40% = 2/C
$\geq$ 20% = 1/D
$<$ 20% = 0/F

Definition:
Symbol Contrast is the difference between the highest reflectance value and the lowest reflectance value anywhere in the scan reflectance profile, including the quiet zones. The higher the value the better the grade. See Figure 10 for a grade 4/A Symbol Contrast and Figure 11 for a grade 0/F Symbol Contrast.

3.4.1 Suggestions for improving Symbol Contrast

Make the bars darker and the spaces lighter or less shiny. In the spaces of the symbol, shiny materials such as laminates, polished metals and high gloss are a special case as they usually fail to reflect much diffused light in the direction of the light collecting part of the instrument. The reflected light is scattered causing reflectance values to be lower.

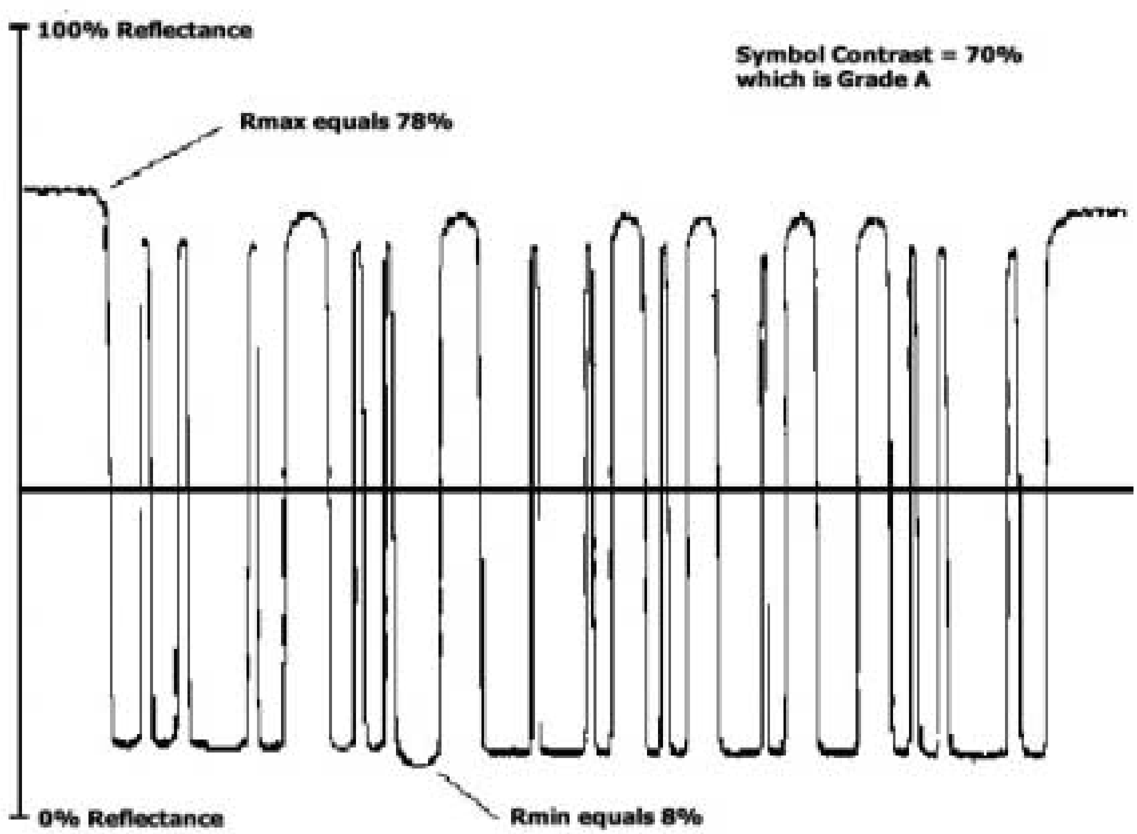

Figure 10 - Grade 4/A Symbol Contrast

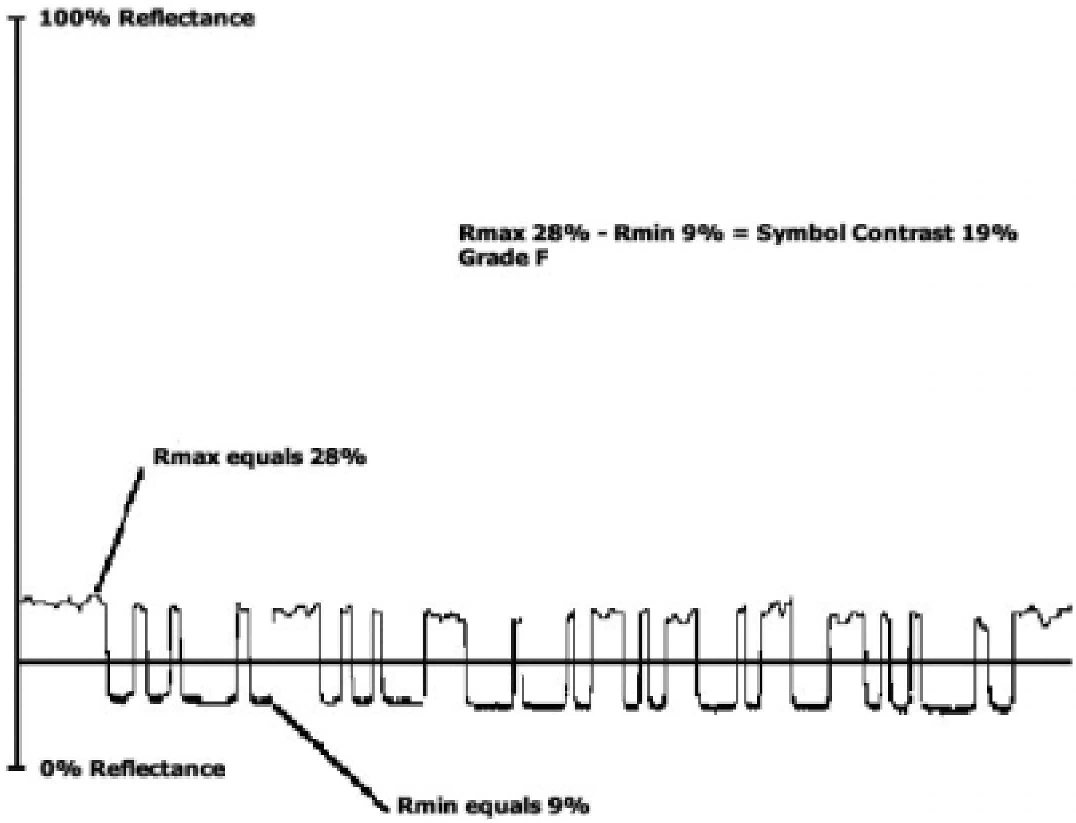

Figure 11 - Grade 0/F Symbol Contrast

3.5 Modulation (Graded)

EC_{min} = Edge Contrast Minimum
SC = Symbol Contrast

Formula:

EC_{min}/SC

- $\geq$ .70 = 4/A
- $\geq$ .60 = 3/B
- $\geq$ .50 = 2/C
- $\geq$ .40 = 1/D
- $<$ .40 = 0/F

Definition:
Modulation has to do with how a scanner “sees” wide elements (bars or spaces) relative to narrow elements, as represented by reflectance values in the scan profile. For the same element widths scanners usually “see” spaces narrower than bars, and they also "see" narrow elements as being less distinct than wide ones. The scan reflectance profile typically shows narrow spaces being less intense or not as reflective as wide spaces, and narrow bars as being less dark than wide bars. See Figure 12 for grade 4/A on Modulation and Figure 13 for a grade 0/F on Modulation.

3.5.1 Suggestions for improving Modulation grade

Making narrow spaces slightly wider than the narrow bars will usually increase the Modulation grade. Although measuring with a smaller aperture will often increase the Modulation grade, the measurement aperture should always be the correct one for the application. In the case of conventional wet ink printing such as lithography or flexography, the bar code image should contain the proper Bar Width Reduction to allow for gain or loss during the reprographic and printing processes. In Demand printing such as thermal transfer, make sure that the ribbon and substrate are not too shiny or glossy.

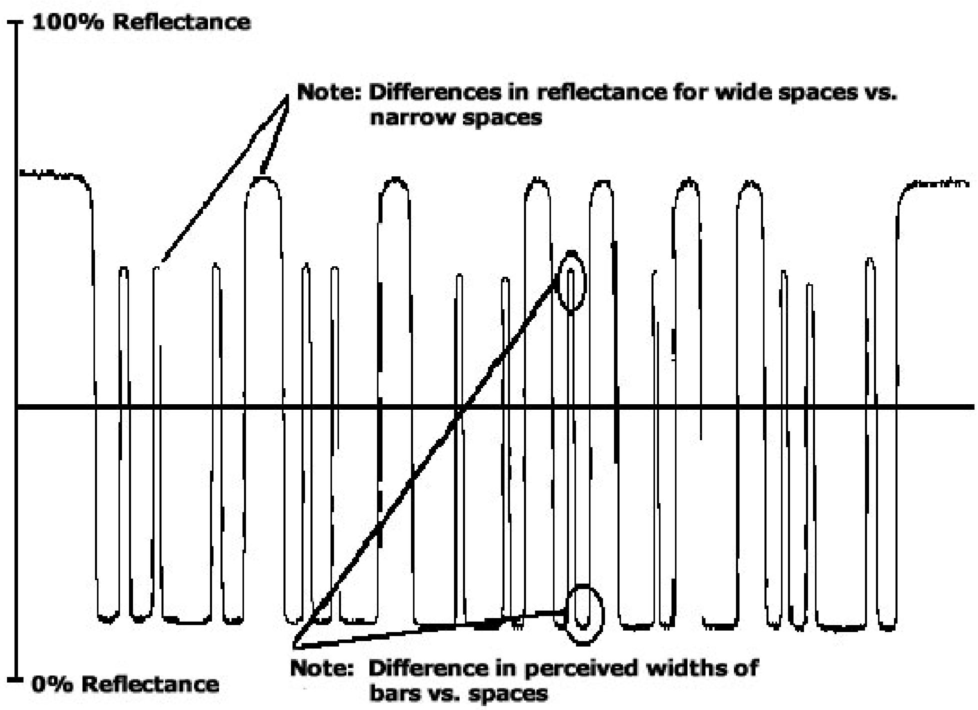

Figure 12 - Grade 4/A Modulation

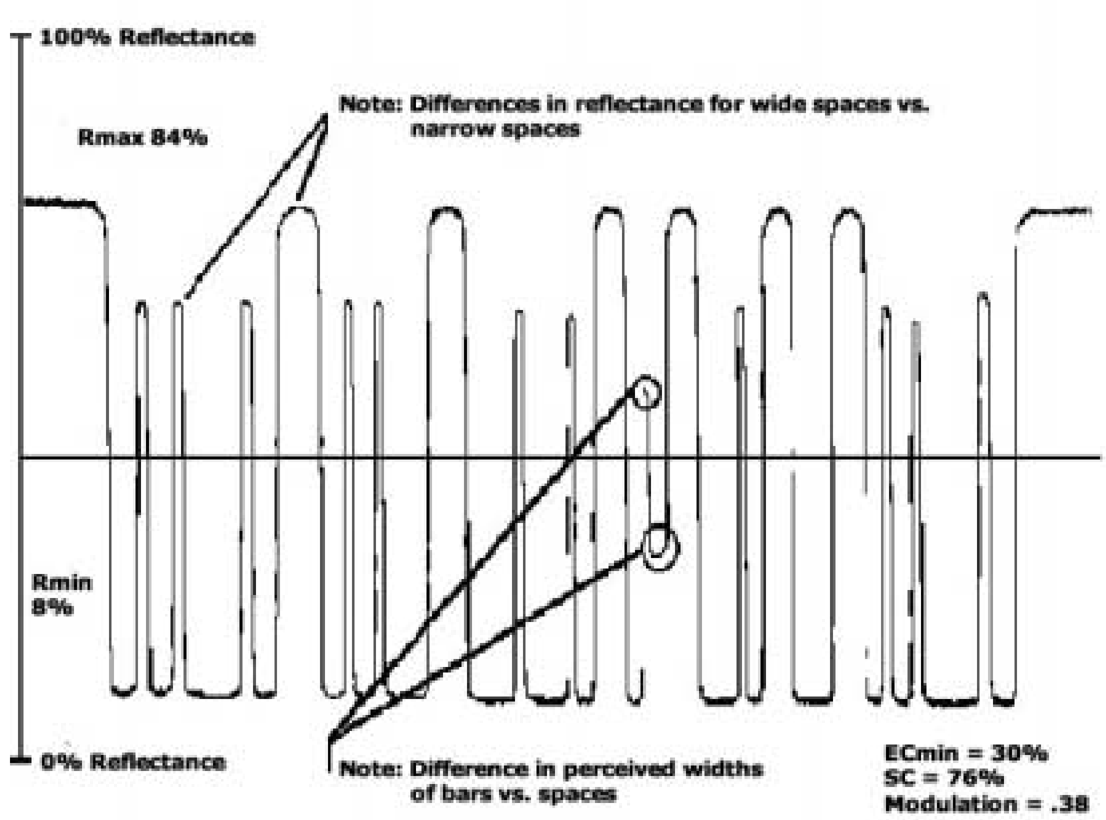

Figure 13 - Grade 0/F Modulation

3.6 Defects (Graded)

ERN_{max} = Element Reflectance Non-uniformity
SC = Symbol Contrast

Formula:

ERN_{max}/SC
$\leq .15$ = 4/A
$\leq .20$ = 3/B
$\leq .25$ = 2/C
$\leq .30$ = 1/D
$>.30$ = 0/F

Definition:
Defects are voids found in bars or spots found in the spaces and quiet zones of the code, and show as an irregularity in the reflectance profile of the bar or space. Each element is individually evaluated for its reflectance non-uniformity. Element reflectance non-uniformity is the difference between the highest reflectance value and the lowest reflectance value found within a given element. Many elements may have zero non-uniformity. See Figure 14 for grade 4/A in Defects and Figure 15 for grade 0/F in Defects. The use of a measuring aperture smaller than the recommended diameter for the application will exaggerate the effects of a defect and increase reflectance non-uniformity. Conversely, the use of too large an aperture will smooth the irregularities and allow a higher grade, which may mask poor scanning performance.

Some materials such as kraft lined corrugated case materials, have inherently high levels of defects in the substrate, which may reduce overall symbol grade.

3.6.1 Suggestions for improving Defects

In on-demand printing, check for a dirty print head or fuser. Improper media match or low heat settings on thermal printers may also increase defects. In conventional wet ink printing, check for worn or dirty printing plates. Use the recommended measuring aperture.
If the defects are inherent in the substrate, it may be necessary to improve the substrate quality.

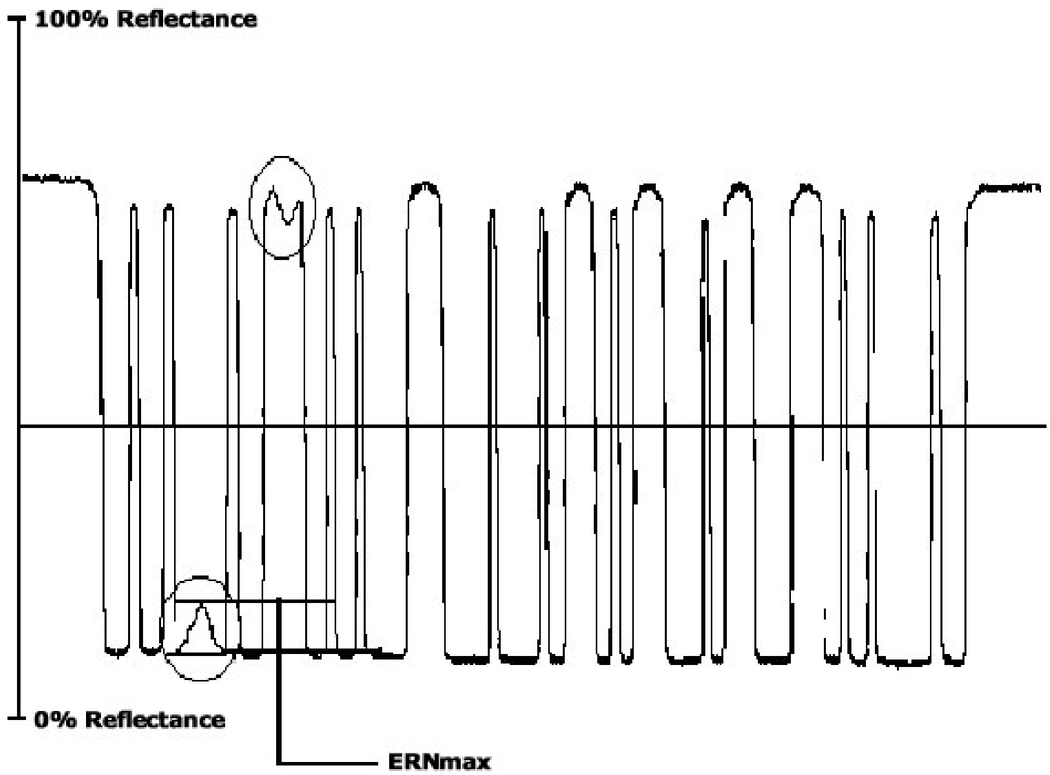

Figure 14 - Grade 4/A Defects

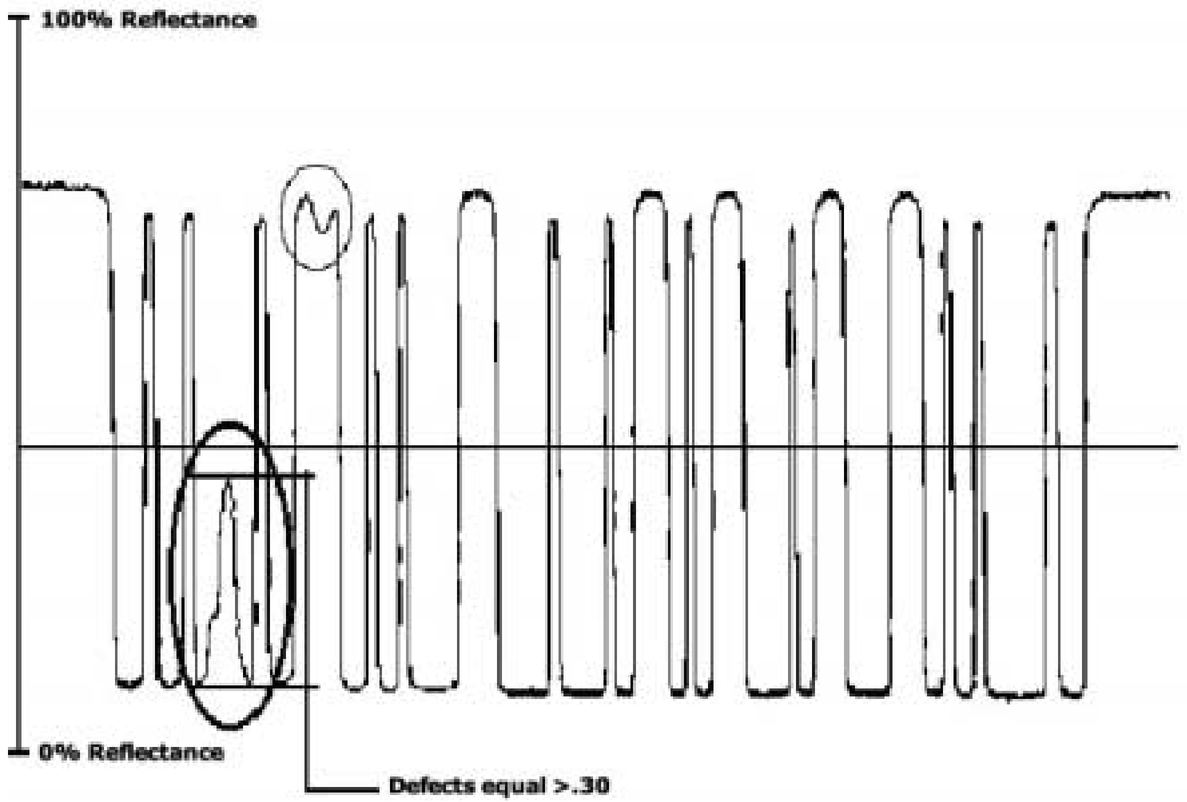

Figure 15 - Grade 0/F Defects

3.7 Decodability (Graded)

Formula:
Different decodability calculation formulas are used for each symbology being tested. Please refer to the ANSI/CEN/ISO Bar Code Print Quality documents, and the ISO symbology standards, for these.

Definition:
Decodability is the measure of the accuracy of the printed bar code against the appropriate reference decode algorithm. Each symbology has published dimensional relationships for element widths and its decode algorithm provides margins or tolerances for errors in the printing and reading process. Decodability measures the amount of margin left for the reading process after printing the bar code, in the widths of elements or element combinations that are measured by the symbology decode algorithm. It does not necessarily correspond to bar width gain or loss although, depending on the symbology, these may well lead to a lower decodability value. Decodability may also be greatly affected by improper use of the contact optical input device on a verifier. Uneven scanning, acceleration or deceleration in the scan when verifying may cause the obtained grade to be lower than the actual grade.

3.7.1 Suggestions for improving decodability

Ensure element widths are correct, e.g. by applying correct amount of Bar Width Adjustment in wet ink printing or checking that head temperatures are correct with thermal on-demand printers. For on-demand printing and electronic origination, software must round pixel counts correctly for all elements. Some software packages allow for screen sizing and stretching of the bar code. When software allows any size bar code to be created, the bars and spaces are not even multiple of the printer pixels causing an arithmetic rounding to occur. This causes a decodability problem especially in bar codes that contain multiple bar and space widths. Users can learn to obtain the proper even speed for verifying by practicing scanning symbols with known characteristics and comparing the results obtained.

3.8 Decode (Pass/Fail)

Definition:

A bar code will Pass on Decode when the established bar and space widths can be converted into the correct series of valid characters using the standard Reference Decode algorithm (in the AIM technical specification or ANSI/CEN/ISO documents) for a given symbology and or application.

3.9 Quiet Zones

Definition:

Bar codes require a quiet zone to the left and right of the bar/space pattern. This area is to be clear of all text or other graphics. The scanning equipment requires quiet zones to be able to successfully read the bar code. The quiet zones should be 10 times the ‘X’ dimension or .25 inches (6.35mm) whichever is greater. Application specifications should always be consulted to determine exact dimension requirements.

4 Scan Grade

The Scan Grade is the lowest grade obtained for any of the quality parameter in the scan reflectance profile. For example, if a grade of 4/A or Pass is received for all quality parameters except for Modulation, which received a grade of 2/C, the overall Scan Grade is 2/C. The lowest of the grades for the following parameters equals the Scan Reflectance Profile Grade.

Edge Determination (ANSI)
Decode
Symbol Contrast
Minimum Reflectance
Minimum Edge Contrast
Modulation
Defects
Decodability
Any additional requirements imposed by the industry application or symbology application.

5 Overall Symbol Grade

ANSI/CEN/ISO states that the Overall Symbol Grade is based on ten scan profiles, and the average of their resultant scan grades as defined above. The reason for averaging ten scans is for vertical redundancy, to reduce the effect of a single scan through a part of the symbol which is unusually good or unusually bad - due to a large defect, for example. Quality levels could vary within the height of the bar code being verified. See Figure 17 showing ten scan averaging for vertical redundancy.

In production processes subject to a relatively low incidence of quality variations, and where documented formal quality assurance procedures are followed according to ISO 9000 and related standards are followed, the number of scans per symbol may be reduced. This is normally the case with the printing of long runs of packaging. (See Annex J of ISO/IEC 15416 for further information.)

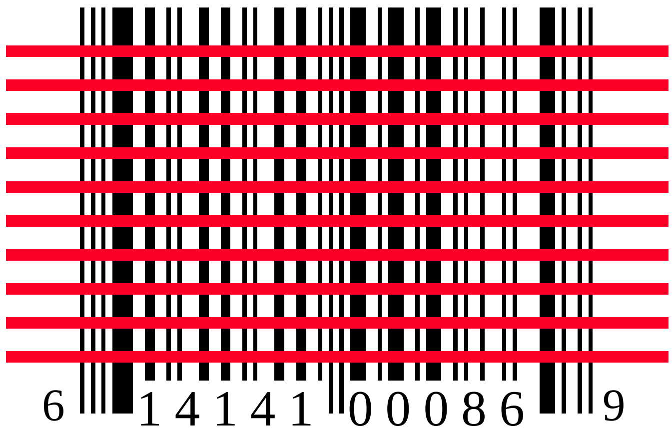

Figure 17 - Ten scan paths for vertical redundancy

6 Numeric Conversion

It is necessary to convert the alphabetic Overall Symbol Grade used in the ANSI guideline to a Numeric grade to enable the averaging process to be carried out. Since a grade A equates to a Grade 4, and the average of ten scans will yield a value with one decimal place, the threshold between a grade A and a grade B symbol is 3.5; that between grade B and C is 2.5 and so on, the decimal value shows how close a given symbol is to achieving either a grade higher or grade lower. The table below shows the equivalence of the alphabetic and numeric grades.

Alphabetic grade	Numeric grade (average)
A	3.5 to 4.0
B	2.5 to just less than 3.5
C	1.5 to just less than 2.5
D	0.5 to just less than 1.5
F	Less than 0.5

7 Significance of Grade Level

Bar code systems can provide good performance with differing symbol grades because of the following:

a) vertical redundancy;
b) tolerances built into decoding algorithms;
c) the ability of operators to rescan if the first read is unsuccessful;
d) the availability of scanning devices that provide for multiple, unique scan paths across the code.

The different symbol grades indicate print quality. Not every application uses the same scanning environment and conditions, and the last two factors in particular may not always be present, so the grade required to ensure acceptable performance will vary between applications.

The application specification must therefore identify the minimum acceptable grade level including the measuring aperture and the nominal wavelength(s). This is indicated in the form 1.5/10/660 or C/10/660. This means that a grade C is the minimum acceptable when measured with a 10 mil aperture (0.250 mm) in light with a peak wavelength of 660 nm.

Symbols with a grade 4/A (average 3.5 or higher) are the best quality and will in general give the best performance. In general, this grade symbol is appropriate for systems in which the reader crosses the symbol once or is limited to a single path, i.e. there is only a single opportunity to read the symbol with no opportunity to re-scan.

A symbol with a grade of 3/B (average 2.5 to nearly 3.5) may not perform to the same level as one with a grade of 4/A. Some of these 3/B symbols may need to be rescanned. In general, this grade is best suited for applications which require symbols to be read most of the time in a single pass of a bar code scanner but allow for re-scan.

Symbols of grade 2/C (average 1.5 to nearly 2.5) may require more rescans than those of grade 3/B. In general, these grade 2/C symbols may need more frequent rescanning and for best read performance a device that provides for multiple, unique scan paths across the code should be used. This is the grade specified by the EAN.UCC General Specifications for most situations.

An obtained symbol of grade of 1/D (average 0.5 to nearly 1.5) is best read by bar code readers that provide for multiple, unique scan paths across the symbol. There may be symbols with a 1/D grade that certain readers can not read. Prior to selection of a grade 1/D symbol for a particular application, it is advised that the symbol(s) should be tested with the type of bar code reader that will be used for that particular application. The test(s) will establish that the read results are within acceptable limits and expectations.

A symbol with a grade of 0/F (average less than 0.5) is unlikely to read acceptably on most types of scanning system in use, or is likely to yield a high proportion of non-reads, and manual entry of the data will therefore probably be necessary in many cases.

The ANSI/CEN/ISO grading methodology, utilizing grades 4/A, 3/B, 2/C, 1/D, and 0/F is intended to give an idea as to the first pass read rate to be expected, based on 'real world' average reading and decoding technology. It is conceivable that bar codes obtaining scan profile grades of F may have very good first pass read rates when being read with readers/decoders that are very aggressive. The grading structure does not necessarily mean that a lower grade is bad or that the bar code will not read, but rather that, when used with 'average' scanner/decoder technology, the first pass read rate of lower-graded symbols will be lower.

It should be further explained that the evaluation of bar code quality must match the application. Bar codes going through multiple processes such as laminating, shrink wrapping, etc. should be verified after all such processes have been completed. Further, translucent substrates (i.e. plastic films, plastic bottles) should have the bar code verified twice, once with black behind the symbol and once with white behind it. The lower of the two grades obtained should be taken as the result based on the ANSI/CEN/ISO guidelines. Dependent on the application, higher grades might be required at the intermediate process stages to obtain the final acceptable grade for the reading environment.

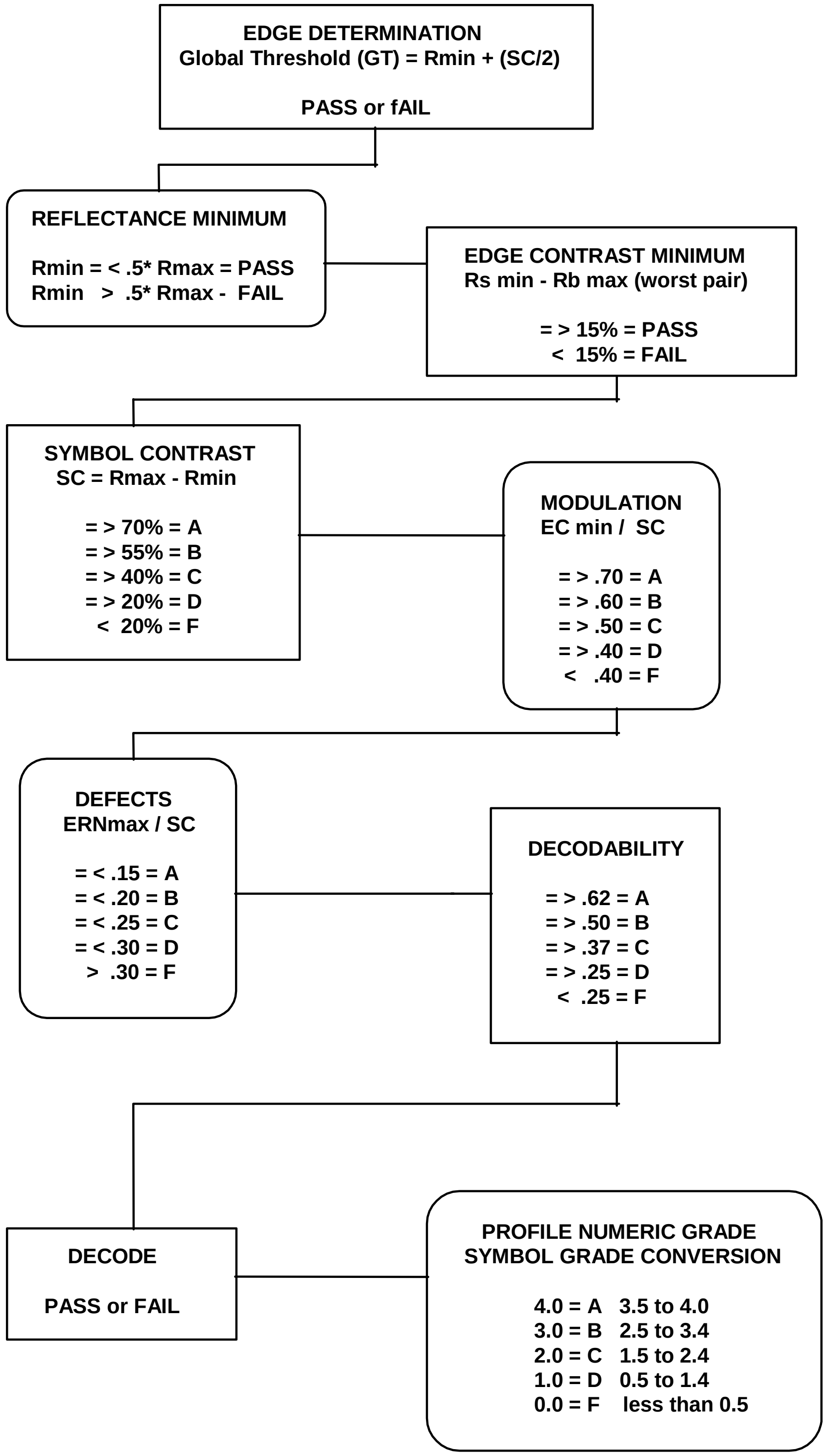

Figure 18 - ANSI and CEN Grading Flow Chart

8 Substrate Considerations

8.1 Opacity

The effects of show-through on some substrates should be considered when verifying. On materials such as plastic films, etc. the bar code should be verified using both white and black behind the bar code. The black background should not be more than 5% reflectance. The lowest grade obtained from testing on both white and black should be considered as the overall symbol grade.

8.2 Spot Reflectance Measurement

The reflectance values for highly reflective substrates, where the bar codes will be over-laminated, or low reflectance values as kraft material, etc. should be taken into account prior to printing the bar code. Spot reflectance measurements may be done on these substrates and the ink color before printing to determine if the desired results are achievable. Symbol contrast may be estimated from color patches of the ink and substrate. In order to estimate minimum edge contrast, the spot measurement should be taken on a strip of the substrate or ink color approximately the same width as the narrow element (the X dimension in width), with an area of the ink or substrate color respectively adjacent to it. The spot reflectance measurements should be done with a properly calibrated device of the specified wavelength, aperture size and optical arrangement specified by the application standard or symbology standard. After obtaining the reflectance values, calculations may be done to determine expected symbol contrast, minimum edge contrast, etc. but the results must be treated as indicative and not a definitive prediction of the values which will be given by verifying an actual symbol. A safety margin should be allowed.

9 Software Considerations

As discussed in section 3.7.1, software may greatly affect the quality of the bar code being generated. Software packages should not allow the user to create a bar code which are not even multiple of printer pixels. Any sizing or stretching on the screen may introduce dimensional errors.   Data structure and format are another consideration. Some software will automatically force the proper data structuring necessary for particular industry applications. The quality of the bar code image itself may be good, however, if the data structure is incorrect it will fail the verification step and typically produces a no scan.

Reference Documents

ISO/IEC 15416 - Bar Code Print Quality Test Specification – Linear Symbols
Available from:
International Organization for Standardization (ISO)
1, rue de Varembé, Case postale 56
CH-1211 Geneva 20, Switzerland
Phone: + 41 22 749 01 11
Fax: + 41 22 733 34 30
E-mail: central@iso.org
Web: http://www.iso.org

ANSI X3.182 - Bar Code Print Quality Guideline
Available from:
American National Standards Institute
25 West 43nd Street
New York, NY 10036
Phone: + 1 212 642 4900
Fax: + 1 212 398 0023
Web: http://www.ansi.org

EN 1635 Bar Coding – Bar Code Symbol Test Specifications
Available from:
Commission for European Normalization
Avenue Herrmann-Debroux 40-42 B-1160
Brussels, Belgium
Phone: + 32 2 661 1951
Web: http//www.cen.be

AIM Specifications
Available from:
AIM, Inc.
634 Alpha Drive
Pittsuburgh, PA 15238
Phone: +1 412 963 8588
Fax: +1 412 963 8753
Email: info@aimglobal.org
Web: www.aimglobal.org