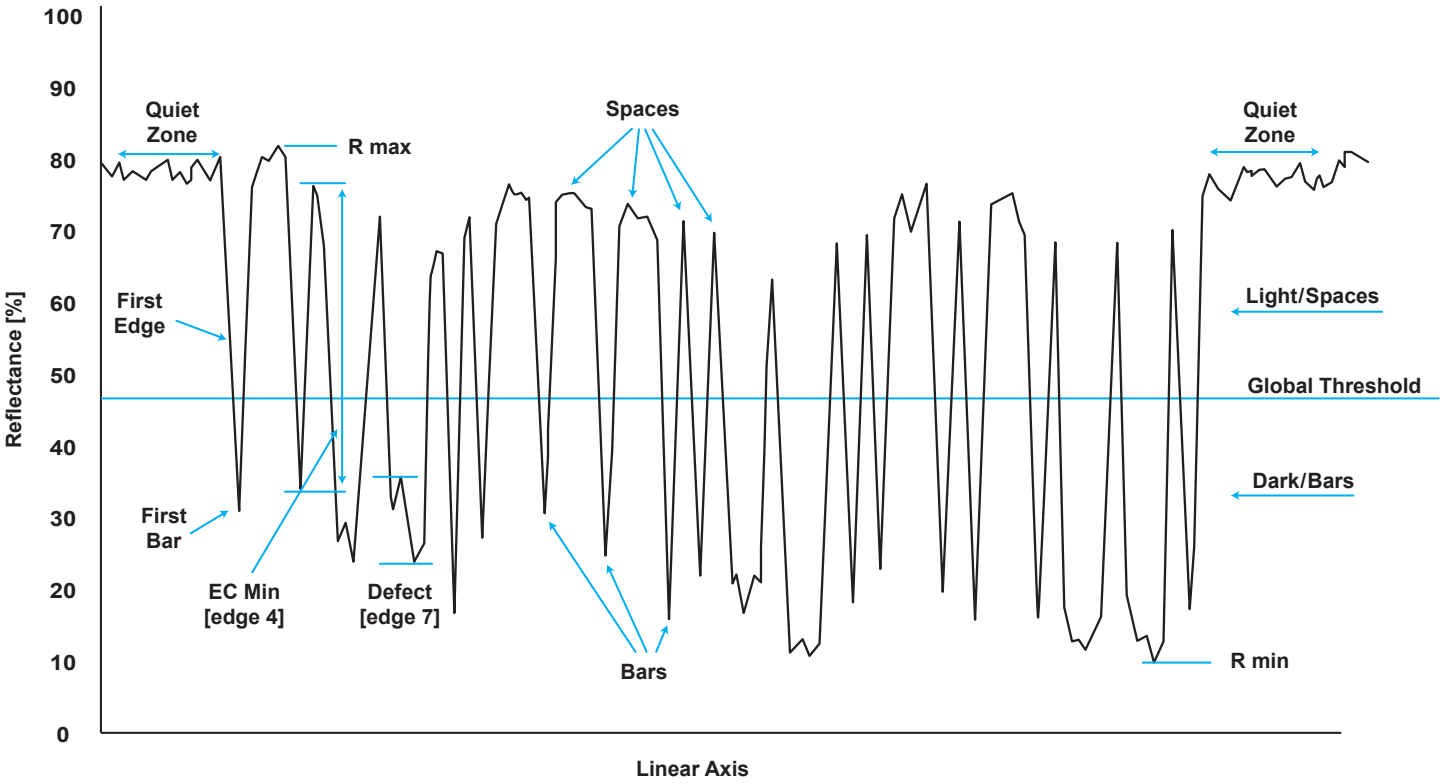

Scan Reflectance Profile of a Bar Code

The barcode scan reflectance profile is a useful tool for detecting quality issues in the barcode.

A. Linear Barcode Parameters graded in ISO15416 barcode inspection

1. **Parameter: Edge Determination (also called Edge Contrast or EC)**

   Definition:

   Edge Contrast Minimum is the worst-case reflectance difference between bars and spaces. This is how sharp the transition is from bars and spaces. Soft or fuzzy edges will degrade the Edge Contrast Minimum.

   Possible Causes:

   - Bars are too light
   - Bar edges are not well defined
   - Substrate material or background color is too dark
   - Substrate is glossy
   - Substrate is porous or absorbent
   - Ink is excessively viscous

   Possible Corrections:

   - Improve reflectance difference by darkening bars or lightening the background
   - Thicken ink viscosity
   - Select lighter or less glossy substrate material or background color
   - Use a conforming bar code design file

2. **Parameter: Reference Decode (also called Decode)**
   Definition:
   This confirms the barcode is correctly structured. The verifier counts the light-to-dark element transitions and element widths against the relevant bar code specification for data characters, start/stop patterns, and check characters. This is a pass/fail parameter. Examples include UPC code, ITF-14, and GS1 DataMatrix.

   Possible Causes:
   - The barcode design file was made incorrectly.
   - A pixel in a thermal printing process is out
   - An inkjet nozzle is clogged
   - Quiet zone is infringed
   - Package contents how-through or a pattern in the background

   Possible Corrections:
   - Source a correct design file from Symbology.
   - Maintain or replace thermal print head
   - Maintain inkjet nozzles
   - Examine printed image for quiet zone infringement

3. **Parameter: Symbol Contrast (SC)** : SC = Rmax minus Rmin.
4. **Rmin** and **Rmax** must provide at least a minimum amount of reflectance difference.

   Definition: Symbol Contrast grades the reflectance difference between the brightest space (including the quiet zone) and the darkest bar.

   Possible Causes:
   A background with low reflectance, or bars with high reflectance, causes Symbol Contrast to degrade or fail. See how to correct both of these ISO/ANSI parameters below.

   Note: Linear barcodes must use dark bars and light backgrounds, in compliance with the PCS (Print Contrast Signal) rule.

3a. Parameter: Minimum Reflectance (Rmin)

Definition: This is the amount of light that is reflected to the verifier from the **bars** of the barcode. Rmin bar reflectance must be less than half the Rmax spaces reflectance. This is a pass / fail parameter.

Formula: Rmin must not be greater than .5 Rmax

Possible Causes:
- Bar color is too light
- Bar ink is glossy
- Bars are red or a reddish color
- Poor ink coverage

Possible Corrections:
- Use darker ink color for bars
- Thicken ink viscosity or add pigment
- Increase plate impression

3b. Parameter: Reflectance Maximum (Rmax)

Definition:

This is the amount of light that is to the verifier from the **background** of the bar code. Nominally, the amount of light reflected by the spaces must be more than twice the light reflected by the bars.

Possible Causes:

- Background color is too dark. Black, blue or green backgrounds can be problematic.
- Background is glossy or metallic, which can refract rather than reflect light.
- Background is transparent vs. opaque. This absorbs light instead of reflecting it, lowering its RMax value.
- Possible Corrections:
  - Use a background color which is red/orange/yellow vs. black/blue.
  - Put a high RMax patch behind the bar code.
  - Print a "light" color behind the bar code. Make sure it is large enough to accommodate the quiet zones.

5. **Parameter: Modulation**

Definition:

Modulation grades the uniformity of the RMin and RMax values of the bars and spaces in the bar code. The Modulation grade is the worst case of the lowest space reflectance and the highest bar reflectance. If all the bars and spaces are the same brightness, then Modulation equals Symbol Contrast. Modulation is visible the Scan Reflectance Profile and the Global Threshold.

Possible Causes:

- Incorrect plate impression
- Bad or worn impression plate
- Graphics design file made with inadequate bar width adjustment
- Barcode is printed smaller than ANSI allows for the symbology used
- Bad dimensional quality (bar code is too large or small for symbology)

Possible Corrections:

- Change plate impression
- Replace impression plates
- Make narrow spaces slightly wider than narrow bars on bar code film master
- Verify barcode size is acceptable within ISO/ANSI standards
- Verify correct aperture size is being used during inspection
- Verify correct bar width adjustment is being used

6. **Parameter: Defects**

Definition:

Defects are artifacts in RMax areas or voids in RMin areas.

Formula: Defects = ERNmax / SC

Possible Causes:

- Text/Graphics in the quiet zone
- Quiet zones are too small
- Ink splatter
- Substrate too porous or fiber showing through the bars.
- Poor ink viscosity
- Incompatible thermal label /ribbon combination
- Burned-out thermal pixel

Possible Corrections:

- Increase quiet zones
- Clean, blemish-free substrate
- Adjust ink viscosity
- Eliminate extraneous images or patterns in the background

7. **Parameter: Decodability**

Definition:

Decodability is the dimensional accuracy of bars and spaces. Bar and space widths and positions must conform to design specifications.

Possible Causes:

- Printing process (DPI) is not capable of printing the X dimension in the master barcode graphic
- Incompatibility of design file resolution to printer resolution
- Jagged edges
- Bad dimensional quality (barcode too large or small for symbology)
- Inaccurate bar width adjustment
- Excessive or non-uniform bar or space growth

Possible Corrections:

- Remake the graphics design file with X dimension suitable to DPI in the printing process
- Remake the barcode graphic with correct bar width adjustment

B. Additional parameters are used to verify 2D barcodes

a. Unused Error Correction (UEC) - The percentage of remaining error correction capacity after compensation for errors and damage. UEC indicates the remaining margin before the code becomes unreadable.
b. Axial and Grid Nonuniformity - Measures squareness deviations of the modules in a 2D barcode symbol. It evaluates the X and Y axis accuracy of the symbol
c. Fixed pattern damage - evaluates the accuracy of the non-data areas that are used for locating, orienting, and decoding a 2D barcode symbol. Included are finder patterns, quiet zones, and clock tracks.
d. Quiet zones – Detects Damage in the surrounding quiet zones
e. Print Growth – module increases due to print gain

C. Barcode Inspection terms and definitions

a. ISO/ANSI Grade The ISO/ANSI grade is determined by the lowest grade measured for any of the ISO/ANSI parameters. The ISO standard requires 10 scans of a linear barcode. The symbol grade is the lowest of the parameter grades.

b. X Dimension / Module size: This is the narrow bar in a linear barcode, or the square in a 2D barcode. All linear barcode bars and spaces are multiples of the X dimension.

c. Dots per inch (DPI). The print resolution of the design file and printing technology. DPI is measured in dots or pixels. For example, in 300 DPI printing, three dots is .0099" or .003" per pixel.
d. Resolution: The DPI of file design and printing technology. The higher the dots per inch, the greater the resolution.
e. Scan Reflectance Profile: An analog profile of the bar code
f. Global Threshold. The demarcation line between RMax and RMin reflectance values
g. **Bar width adjustment**
h. 10 scan average The verifier takes 10 horizontal, evenly spaced scans across the height of the linear barcode. The lowest parameter grade determines an overall symbol grade.
i. Aperture: The verifier point size for verification of a barcode. The Aperture must be 80% the size of the X dimension so it fits inside the spaces.

Aperture Requirements per X Dimension

X Dimension	Aperture Size
.004 = X ‹ .007	03 (3 mil)
.007 = X ‹ .013	06 (6 mil)
.013 = X ‹ .025	10 (10 mil)
.025 =X	20 (20 mil)

j. Quiet Zone: The blank space surrounding a barcode or 2D symbol, typically the RMax value that allows scanners to distinguish the code from surrounding text, graphics, or packaging. Without this, scanners often cannot identify the start/end points, causing failing reads.
k. Print Gain or Bar width Growth: The spreading of ink during the printing process, making the bars wider than nominal. Print growth can cause barcode scanner failures, as it reduces the white spaces between the black bars. Excessive print gain can negatively affect Decodability and Modulation parameters.