

EXPLANATION OF GRADING STANDARDS AND THEIR PARAMETERS

ISO/IEC 15416 (ANSI X3.182) PARAMETERS

The ANSI parameters section lists each of the nine ANSI parameters and gives a summary of the measurements based on all scans taken. Each parameter is completely explained below. Note that some of these parameters are average values over all of the scans, and the averages may skew or alter the apparent results. For a rigorous review of the ANSI process given on each of your codes, you should check the ANSI Matrix for each code, described in the next section.

This section may be very helpful in situations where the barcode cannot even be read. Therefore, the descriptions of each parameter below will explain what is measured in the case where a code is read and not read. When a code is not read, the scan is analyzed for apparent quiet zones, and the bars and spaces in between are used for the ANSI analysis.

1. EDGE: Edge Determination

Checks that each edge between bar and space can be detected and no false bars or spaces appear due to “splitting” of bars or ink splattered into spaces. If at least one scan results in a decoded barcode, the EDGE value is the number of bars and spaces, not including quiet zones, in the code. If no scans result in a decoded barcode then the EDGE value shown is the number of bars and spaces found between quiet zones (or apparent quiet zones) on the scan on which the most bars and spaces were found. The Scan Reflectance Profile graph can also be very helpful in analyzing a code that cannot be decoded.

2. RI/RD: Minimum Reflectance

Checks that the darkness of the bars is sufficient. Strictly speaking, the amount of light reflected by the bars (bar reflectance) must be less than half the light reflected by the spaces (space reflectance). The values shown are the light reflectance and the dark element reflectance separated by a slash. The light reflectance is the maximum reflectivity found in the scan (lightest or best space), and the dark reflectivity is the minimum reflectivity found in the scan (darkest or best bar). The requirement is for the minimum reflectivity to be no more than half the maximum reflectivity. If this requirement is met, the grade will be A, otherwise it will be F.

3. SC: Symbol Contrast

Measures the contrast between the brightest space and darkest bar. The result is assigned a letter grade of A, B, C, D, or F, with A being the highest contrast. The contrast is the difference between the maximum reflectivity (lightest or best space) and the minimum reflectivity (darkest or best bar). Note that Symbol Contrast is the *difference* between light and dark, and RI/Rd above checks the *ratio* of these values.

- A (4) > 70
- B (3) 55-70
- C (2) 40-55
- D (1) 20-40
- F < 20

Note that when grading according to ISO/IEC 15416:2016, the grade will be assigned a number to the closest tenth, between grade levels. For example, a Symbol Contrast value of 30 will be assigned a grade of 1.5. For values less than 20, the continuous grade progresses from 1 to 0 between 20 and 15. Continuous grading applies to SC, MOD, DEF and DEC only.

4. MinEC: Minimum Edge Contrast

Checks that the contrast between adjacent bars and spaces is high enough. When a barcode is scanned, a reading device must locate the edges between each bar and space. If the difference in the light and dark elements is not significant, this may not be achieved. Note that MinEC finds the worst-case contrast difference between each bar to space transition, whereas symbol contrast finds the best-case difference at any point across the barcode.

5. MOD: Modulation

Modulation checks the edge contrast as a fraction of the overall or best case contrast measured in symbol contrast. Modulation is an important measure of minimum edge contrast since most barcode reading devices employ “adaptive thresholding circuits” of some type that are sensitive to a symbol’s contrast in order to detect transitions between bars and spaces. If all bars and spaces were the same brightness, the minimum edge contrast would be equivalent to symbol contrast. In this case, modulation would be 100 percent. If some spaces are less bright than the brightest one, modulation will be some fraction of the overall contrast. Modulation therefore measures the amount of *available* contrast that is manifested in the worst-case bar to space transition. The percentage is assigned a letter grade.

Excessive ink spread or bar growth can result in low modulation because very narrow spaces appear to be filled in by the encroaching bars in the Scan Reflectance Profile. If you have read down to here, you deserve a reward!

- A (4) ≥ 70
- B (3) ≥ 60
- C (2) ≥ 50
- D (1) ≥ 40
- F < 30

6. Def: Defects

The worst-case change in reflectance within a single bar or space is a defect. The largest difference in reflectivity found in a single bar or space is measured as a percentage of the symbol contrast and assigned a letter grade. Defects normally measure breakups or voids within bars, ink spots in spaces, or even the grain of a substrate in spaces. This very serious issue for scanners was not directly addressed by traditional verification techniques.

- A (4) ≤ 15
- B (3) ≤ 20
- C (2) ≤ 25
- D (1) ≤ 30
- F > 30

7. DCD: Decode

The widths of each bar and space are measured and used to interpret the data content of the barcode according to a specific mathematical formula appropriate for the barcode type. If the barcode cannot be decoded according to the formula, the accuracy of the bar and space widths are inadequate. The printout shows the number of scans decoded over the number of scans taken, e.g. 8/10 means 8 out of 10 scans decoded.

8. DEC: Decodability

Determines how accurate the bar and space widths are and how easily the widths can be determined. A perfectly accurate barcode will have 100 percent decodability, but decodability as low as 25 percent is often acceptable. Decodability is always measured in terms of the formula used to interpret the bar and space widths into the data content of the barcode. In order to read barcodes, thresholds between element widths are normally established according to prescribed “decode algorithms”. Decodability is normally the percentage of the overall tolerance range for a bar or space width that is not used up by inaccuracies. See Appendix B for an example.

A (4) ≥ 62

B (3) ≥ 50

C (2) ≥ 37

D (1) ≥ 25

F < 25

9. QZ: Quiet Zone

This refers to a dedicated amount of blank space on the left and right of the barcode. Each symbology specifies a minimum quiet zone. For example, UPC-A barcodes should have at least a nine module quiet zone on each side, whereas an EAN-13 barcode permits legal quiet zones to be as small as seven modules.

ISO/IEC 15415 GRADING PARAMETERS

1. **UEC (Unused Error Correction):** This is the percentage of error correction capability that is available for further incorrect modules. The assignment of grade is according to the following table:

UEC %	Grade
> 62	A
> 50 (but less than 62)	B
> 37 (but less than 50)	C
> 25 (but less than 37)	D
< 25	F

2. **SC (Symbol Contrast):** This is the difference in reflectivity between the brightest module and the darkest module. The assignment of grade is according to the following table:

SC %	Grade
> 70	A
> 55 (but less than 70)	B
> 40 (but less than 55)	C
> 20 (but less than 40)	D
< 20	F

3. **MOD and RM (Modulation):** This is a grade based on the amount of variability in reflectivity of the modules. A multi-step process is used to get the modulation grade. First the reflectivity of each module is compared to the global threshold and the overall symbol contrast according to the following formula:

$$\text{MOD} = 2 * (\text{abs}(R - \text{GT})) / \text{SC}$$

The Global Threshold GT is the midpoint between the reflectance of the brightest module and the reflectance of the darkest module. Next, the grade level for each module is determined from the MOD value according to the following table:

MOD %	Grade
> 50	A
> 40 (but less than 50)	B
> 30 (but less than 40)	C
> 20 (but less than 30)	D
< 20	F

Finally, the value of the grade for the MOD parameter will be the highest modulation level for which the modules meeting that level will result in an Unused Error Correction grade of that level or higher. The module with the lowest MOD is reported as Contrast Uniformity (CU) in General Characteristics to facilitate conformance testing to the requirements of ISO/IEC 15426-2.

4. **ANU (Axial Non-uniformity):** This is the amount of “out of square” a symbol is, or in other words, a measure of the overall aspect ratio of the symbol.

ANU %	Grade
≤ 6	A

< 8	(but more than 6)	B
< 10	(but more than 8)	C
< 12	(but more than 10)	D
> 12		F

5. **GNU (Grid Non-uniformity):** This is the worst-case distance between the calculated center of a module and the ideal location for the center of the module based on perfectly evenly spaced modules. The calculated center of the module is determined using clock tracks. The value is reported as a percentage of a module size.

GNU %	Grade
≤ 38	A
< 50 (but more than 38)	B
< 63 (but more than 50)	C
< 75 (but more than 63)	D
> 75	F

6. **FPD (Fixed Pattern Damage):** This is the overall grade for all the fixed pattern components. This grade is equal to the lowest grade of all the components listed below. The following is a list of components of the finder pattern.
7. **LLS (Left 'L' Side):** This is a grade based on imperfections in the left 'L' side of the finder pattern. There are two checks required to pass. The first requires gaps to be three modules or less and that gaps are separated by stretches of at least four correct modules. The second assigns a grade based on the overall percentage of correct modules according to the following table:

% of incorrect modules	Grade
0	A
< 9 (but more than 0)	B
< 13 (but more than 9)	C
< 17 (but more than 13)	D
> 17	F

The grade is the highest modulation level in which the first (gap test) passes and the correct module percentage results in a grade of that level or higher.

8. **BLS (Bottom 'L' Side):** This is a grade based on imperfections in the bottom 'L' side of the finder pattern (see Left 'L' Side).
9. **LQZ (Left Quiet Zone):** This is a grade based on imperfections in the quiet zone, which is a one-module area to the left of the left 'L' side. The grade is based on the percentage of modules, which are correct using the same grading table as for the 'L' sides.
10. **BQZ (Bottom Quiet Zone):** This is a grade based on imperfections in the quiet zone, which is a one-module area below the bottom 'L' side.
11. **TQZ (Top Quiet Zone):** This is a grade based on imperfections in the quiet zone, which is a one-module area above the top clock track.
- a. **ULQZ (Upper Left Quiet Zone):** This is the top quiet zone above the upper left quadrant (Used only for 2 and 4 quadrant symbols, this is the grade based on the segment of the quiet zone above the top clock track of the left quadrant).

- b. URQZ (Upper Right Quiet Zone):** This is the top quiet zone above the upper right quadrant (Used only for 2 and 4 quadrant symbols, this is the grade based on the segment of the quiet zone above the top clock track of the right quadrant).

12. RQZ (Right Quiet Zone): This is a grade based on imperfections in the quiet zone, which is a one-module area to the right of the Right Clock Track.

- a. RUQZ (Right Quiet Zone to the right of the upper right quadrant):** Only for 2 and 4 quadrant symbols, this is the grade based on the segment of the quiet zone to the right of the upper right quadrant.
- b. RLQZ (Right Quiet Zone to the right of the lower right quadrant):** Only for 4 quadrant symbols, this is the grade based on the segment of the quiet zone to the right of the lower left quadrant.

13. TTR (Top Transition Ratio): This is a grade based on imperfections in the top clock track, with relation to its adjoining quiet zone. The ratio is the number of transitions from light to dark or dark to light in the quiet zone divided by the number of transitions in the clock track. Since the number of transitions in the quiet zone should be zero, the ideal value for this parameter is zero. However, a small number of transitions can be tolerated as long as the ratio remains relatively low. As the number of teeth in the clock track increases (larger symbols) more transitions in the quiet zone can be tolerated. Also, more transitions in the clock track (which are really imperfections) will tend to improve this measurement. The grading scheme for this transition ratio is:

Transition Ratio %	Grade
< 6	A
< 8 (but more than 6)	B
< 10 (but more than 8)	C
< 12 (but more than 10)	D
> 12	F

The value of the grade will be the highest modulation level for which the ratio gives a grade from the above table of that modulation level or higher.

- a. ULQTTR (Transition ratio for Upper Left Quadrant Top Clock Track):** Only for 4 quadrant symbols, this is the grade based on the clock track segment at the top of the upper left quadrant. For a 2 quadrant symbol, this will be labeled LQTTR.
- b. URQTTR (Transition ratio for Upper Right Quadrant Top Clock Track):** Only for 4 quadrant symbols, this is the grade based on the clock track segment at the top of the upper right quadrant. For a 2 quadrant symbol this will be labeled RQTTR.
- c. LLQTTR (Transition ratio for Lower Left Quadrant Top Clock Track):** Only for 4 quadrant symbols, this is the grade based on the clock track segment at the top of the lower left quadrant.
- d. LRQTTR (Transition ratio for Lower Right Quadrant Top Clock Track):** Only for 2 and 4 quadrant symbols, this is the grade based on the clock track segment at the top of the lower right quadrant.

14. RTR (Right Transition Ratio): Transition ratio (see Top Transition Ratio) for the right clock track in relation to the right quiet zone.

- a. ULQRTR (Transition ratio for Upper Left Quadrant Right Clock Track):** Only for 2 and 4 quadrant symbols, this is the grade based on the clock track segment to the right of the upper left quadrant. For a 2 quadrant symbol, this will be labeled LQRTR.

- b. URQRTR (Transition ratio for Upper Right Quadrant Right Clock Track):** Only for 2 and 4 quadrant symbols, this is the grade based on the clock track segment to the right of the upper right quadrant. For 2 quadrant symbols, this will be labeled RQRTR.
- c. LLQRTR (Transition ratio for Lower Left Quadrant Right Clock Track):** Only for 4 quadrant symbols, this is the grade based on the clock track segment to the right of the lower left quadrant.
- d. LRQRTR (Transition ratio for Lower Right Quadrant Right Clock Track):** Only for 4 quadrant symbols, this is the grade based on the clock track segment to the right of the lower right quadrant.

15. TCT (Top Clock Track): This is a grade based on imperfections in the top clock track. Some imperfections in the clock track can be tolerated. However, the rule that must be maintained for a passing grade is that three out of every five modules (on a consecutively rolling window of five modules) must be correct. The value of the grade will be the highest modulation level for which this test passes.

- a. ULQTCT (Top Clock Track for Upper Left Quadrant):** Only for 2 and 4 quadrant symbols, this is the grade based on the clock track segment at the top of the upper left quadrant. For 2 quadrant symbols this will be labeled LQTCT.
- b. URQTCT (Top Clock Track for Upper Right Quadrant):** Only for 2 and 4 quadrant symbols, this is the grade based on the clock track segment at the top of the upper right quadrant. For 2 quadrant symbols this will be labeled RQTCT.
- c. LLQTCT (Top Clock Track for Lower Left Quadrant):** Only for 4 quadrant symbols, this is the grade based on the clock track segment at the top of the lower left quadrant.
- d. LRQTCT (Top Clock Track for Lower Right Quadrant):** Only for 4 quadrant symbols, this is the grade based on the clock track segment at the top of the lower right quadrant.

16. RCT (Right Clock Track): This is a grade based on imperfection in the right clock track (see Top Clock Track).

- a. ULQRCT (Right Clock Track for Upper Left Quadrant):** Only for 2 and 4 quadrant symbols, this is the grade based on the clock track segment to the right of the upper left quadrant. For 2 quadrant symbols, this will be labeled LQRCT.
- b. URQRCT (Right Clock Track for Upper Right Quadrant):** Only for 2 and 4 quadrant symbols, this is the grade based on the clock track segment to the right of the upper right quadrant. For 2 quadrant symbols, this will be labeled RQRCT.
- c. LLQRCT (Right Clock Track for Lower Left Quadrant):** Only for 4 quadrant symbols, this is the grade based on the clock track segment to the right of the lower left quadrant.
- d. LRQRCT (Right Clock Track for Lower Right Quadrant):** Only for 4 quadrant symbols, this is the grade based on the clock track segment to the right of the lower right quadrant.

- 17. AG (Average Grade of Damage across many parts of the Finder Pattern):** This is a grade that considers the accumulated effect of damage to several parts of the finder pattern. Five values are averaged together. One of these is the lowest of all the grades associated with all the clock track segments, namely TCT, TTR, TQZ and RCT, RTR, RQZ. The other four are LLS, BLS, LQZ, and BQZ. The average must fall in the range of 0.0 through 4.0 and is given a grade according to the following:

Ave Grade	Grade
Equals 4.0	A
≥ 3.5 (but less than 4.0)	B
≥ 3.0 (but less than 3.5)	C
≥ 2.5 (but less than 3.0)	D
< 2.5	F

NOTE: The effect of the AG parameter is to lower the overall grade of symbols, which have several individual parameters at or near the same level. For instance, with enough B grades in individual parameters, the overall grade may come out as a C grade rather than a B.

- 18. DECODE –** Report whether the 2D Symbol was decoded in accordance with the reference decode algorithm with the specified aperture. Note that when Auto Aperture or Auto 80% is selected for Aperture, it is possible for decoded results to be reported, but for a failure to occur when decoding using the selected aperture. In this case, the DECODE grade will be F and a message will be reported in the grade section of the report.
- 19. CONTRAST UNIFORMITY (CU):** This is the value of MOD (modulation) for the worst-case module selected from a 2D Matrix symbol. This is useful for process control, as way of measuring the drift in reflectivity consistency, and more importantly for testing conformance to ISO/IEC 15426-2 which requires the modulation of a specific module within a conformance test symbol to be reported. This parameter is not graded, nor listed in the Quality Detail tab. Rather, it is reported in General Characteristics.

AIM-DPM 2006 GRADING PARAMETERS

The AIM-DPM method of grading data matrix symbols modifies the process of ISO-15415 and is more appropriate for direct part marking applications. This standard was developed to be more representative of the scanning performance of modern readers that in some cases are specifically designed for these demanding applications.

In this method, the image brightness is adjusted to produce an image of the symbol that fills most or all of the dynamic range of the imager, resulting in an image that is easier to see. Additionally, the threshold between dark and light is calculated from the statistics of the image brightness histogram. Thus, the measurements calculated by AIM-DPM differ from those of ISO 15415 significantly.

Some of the parameters reported in ISO 15415 are changed so drastically that in order to remove the possibility of confusion between these two methods, the parameters have been renamed. These parameters are:

AIM-DPM Parameter Name	ISO 15415 Parameter Name	Summary of Change(s)
CC (Cell Contrast)	SC (Symbol Contrast)	Made relative to light background
CM (Cell Modulation)	MOD (Modulation)	Threshold calculated from statistics rather than the maximum and minimum reflectance. Grading scale range set to Mean of distribution, rather than maximum and minimum reflectance
DD (Distributed Damage)	AG (Average Grade)	Modulation overlay uses only A, B, and F levels instead of A, B, C, D, and F.
MR (Minimum Reflectance)	Not necessary since SC is measured on an absolute scale	An absolute limit on SC of 5% added to temper the relative nature of CC.

All of the Fixed Pattern Damage grading (other than AG shown above) are not renamed but are functionally different since the global threshold and modulation grading scale are different. In general, symbols will obtain a significantly higher grade according to AIM-DPM than ISO 15415. Therefore, grading according to AIM-DPM is appropriate only when called for in an application specification.

Another significant difference is the allowance for a variety of illumination options. These include the four-sided 45° light that is the default for ISO 15415. Additional lighting angles allowed are: 30° lighting from four sides, 30° from two sides (which can be either North/South or East/West), and 90° diffuse on-axis lighting. The light source that is used is reported using a notation that includes the angle, and a letter (Q for 4, T for two).

AIM-DPM also varies the size of the aperture until the symbol is decoded, and then the grading is repeated with two different aperture sizes (50% and 80%) and the better of the two grades is reported as the final grade. Note that when the reference decode algorithm fails to decode a symbol with both 50% and 80% aperture, the DECODE grade will be “F” and a note will be printed on the grade section of the report, even if the symbol is recognized and decoded with a different aperture size in an earlier phase of the grading procedure.

The parameters, which are new or significantly modified for AIM-DPM, are explained below:

1. **CC (Cell Contrast):** This is the relative contrast value between bars and spaces, taken from the means of the light and dark element $CC = (Lmean - Dmean) / Lmean$

CC %	Grade
≥ 30%	4
≥ 25%	3
≥ 20%	2
≥ 15%	1
< 15%	0

2. **CMOD (Cell Modulation):** Similar to MOD in ISO 15415, this parameter measures the deviation in the reflectivity of dark and light elements. A range for each group (light and dark) is created from the global threshold to the mean reflectance of the elements. Each module is graded along this range, then error correction capability is considered to “discount” the effect of one or a few elements with low values, and a final grade for this parameter is computed.
3. **DDG (Distributed Damage Grade):** Similar to AG in ISO 15415, this parameter takes into account the effect of multiple segments of the fixed pattern having imperfections. Where multiple segments have a low grade, the effect of this “distributed damage” is reflected in a lower grade for DDG than the lowest of the individual segments.
4. **MR (Minimum Reflectance):** This is a requirement for at least 5% reflectance difference between light and dark elements, as a restraint on the purely relative CC parameter.
5. **Decode:** Decode grade A or F depending upon whether the reference decode algorithm succeeds in decoding the symbol with the required final aperture size.

AS9132 PARAMETERS

1. **Distortion Angle (DA):** The angle between the left side and the bottom side of the ‘L’ finder pattern should be 90 degrees. The distortion angle is the deviation from 90 degrees exhibited by the ‘L’ in this symbol. A distortion angle of 7 degrees or less will Pass, while a larger distortion angle will Fail.
2. **Cell Fill (Size):** The size of the cells must be printed at least 60% of the cell spacing, and no more than 105% of the cell spacing.
3. **Ovality:** For dot peen symbols (where the cells are allowed to be round) the cells should be circular. As a measure of ovality, the ratio of the widest diameter to the smallest diameter is checked and must be less than 20% different in order to Pass.
4. **Center Offset:** The center of each cell must not be offset from its correct grid location by more than 20% of the cell spacing in order to Pass.
5. **Symbol Contrast:** Symbol contrast should be at least 20% to Pass.

```
AS9132 Quality Parameters:
DA(Degrees): 0.44          Pass
Symbol Contrast:86
Total Modules:484
Total Modules failed:2
Total Modules failed:0.4
Size failed:0.4
```

ISO 16022 DATA MATRIX PARAMETERS

AIM (ISO16022) Quality Parameters:		
1. DCD:	A	Pass
2. SC:	86% A	Pass
3. BWG:	20% A	Pass
4. ANU:	0% A	Pass
5. UEC:	100% A	Pass

ISO 16022 Parameters:

Decode (DCD), Symbol Contrast (SC), Bar Width Growth (BWG), Axial Non-Uniformity (ANU), Unused Error Correction (UEC)

DCD: Indicates whether the symbol was decoded by the reference decode algorithm.

Symbol Contrast: Represents the difference between reflectance of light and dark elements.

BWG: Represents the bar width growth as defined in ISO 16022.

ANU: Represents Axial Non-Uniformity, which represents non-square aspect ratio of the modules in the symbol.

UEC: Represents Unused Error Correction, which indicates the amount of error correction used out of the budget for error correction available in the symbol.

TRADITIONAL (NON-GRADED) PARAMETERS

PCS, MRD, SC, MinEC and MOD – Ways of Quantifying Contrast: PCS, Print Contrast Signal, is an older and largely no longer used measure of contrast. Contrast is intended to quantify the difference between the bars and the spaces in reflectance. PCS is defined mathematically as:

$$PCS = (R_{max} - R_{min}) / R_{max}$$

In other words, the percentage of the light background accounted for by the difference between the bars and spaces. This measure was defined as a measure of perceived contrast by the human eye, long before and outside the context of measuring barcode contrast. Notice that the measurement is made relative to the brightness of the background. The fact that it is relative to the background means that the darker (worse) the background color is, the higher (supposedly better) the value of PCS. This may correspond with the way people view things, but not really, how scanners work. Rather, scanners are sensitive to the absolute difference between the reflectance of bars and spaces. Scanners are especially sensitive to variations in contrast within the same scan.

Another measurement, called MRD (minimum reflectance difference) quantifies the minimum difference anywhere across the barcode. MRD considers the brightest (worst) bar and the darkest (worst) space anywhere in the barcode. These worst-case bar and space need not be adjacent to one another.

NOTE: ANSI grading system defines yet a different way of measuring contrast: SC (symbol contrast) and MinEC (Minimum Edge Contrast.) SC is the difference between the brightest (best) space and darkest (best) bar. Minimum Edge Contrast is the smallest difference occurring between adjacent bars and spaces (across a single edge). MOD (Modulation) is simply the ratio between MinEC and SC, in other words, the percentage of available contrast that is manifest in the worst-case edge.

Bar Width Growth: Bar Width Growth is a measure of ink spread. The measurement of bar width growth is different on each symbology and requires at least one successful decode of the symbol for measurement. Generally, bar width growth is taken on groups of bars and spaces, sometimes large groups. This results in stable results when bar width growth is uniform but does not catch isolated cases of a single bar widening or shrinking. In fact, it is possible to have a very low (good) reading of bar width growth when in fact a large

number of even all the bars and spaces are incorrectly grown or reduced, as these may tend to cancel each other out. Such bar width inaccuracies will normally be detected by low grades of Decodability.

SYMBOLGY SPECIFIC VERIFICATIONS

This section contains information about specific symbolgies and points out specific parameters that will be reported particular to that symbolgy.

UPC/EAN



UPC/EAN is a family of linear barcodes used at point of sale. The structure of a UPC/EAN barcode consists of leading guard bars, central guard bars, and trailing guard bars. The data characters consist of 4 elements comprising 7 unit modules, which encode digits 0-9. UPC codes encode 12 digits and EAN codes encode 13 digits. The first digit in an EAN barcode determines the GS1 country code of the country that the company is based.

It is customary to report the size of a UPC/EAN symbol in terms of magnification, not by X dimension. Therefore, when UPC/EAN symbols are verified, the General Information section will contain a parameter called "Magnification". (Note: A 100% Magnification UPC symbol has an X dimension of 13 MILS, or .013 inch).

CODE 128



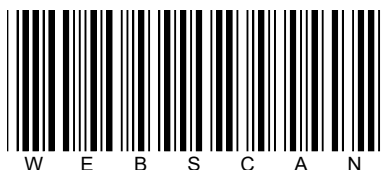
Code 128 is a very common and popular linear symbolgy. It has been adapted for use with the GS1 system, and barcodes utilizing the GS1 format of Code 128 are known as either UCC/EAN-128 or now GS1-128. A GS1-128 barcode contains a Function-1 character immediately after the start character.

The structure of a Code 128 barcode consists of a start character, a variable number of data characters, a check digit character and a stop character. Each character consists of 6 elements (3 bars and 2 spaces) comprising 11 modules, except the stop character which contains an extra bar at the end which serves to close off the last space of the stop character. Data is encoded in one of three character sets (referred to as character Set A, B, and C), allowing for double density numeric encodation as well as encoding all possible ASCII characters (ASCII values 0 through 127). Code 128 is embodied in many application specifications, including barcode GS1-128 symbolgy (formerly UCC/EAN-128).

The Code 128 symbolgy can encode data using three different "character sets" or more specifically, mappings between symbol characters and data characters known as Character Set A, Character Set B, and Character Set C. The Data Detail Tab will show the encodation of Code 128 symbols, displaying each symbol character and the corresponding data encoded. The particular start character that was used, control characters that switch between character sets, check digit, and stop characters are all shown. The data encoded uses the two-character notation for unprintable ASCII characters defined in Decoded Data ASCII Code Representation.

For Code 128, the element widths will contain a summary showing minimum, average, and maximum values for one, two, three, and four module bars and spaces separately, as well as the measured elements' widths and deviations from nominal.

CODE 3 OF 9



Code 39 is a discrete two-width symbology composed of characters containing nine elements, three of these nine being wide elements. The wide elements are a fixed multiple of the narrow element width. The multiple should be in the range of 2 to 3. This multiple is commonly referred to as the "Ratio" and is reported in General Characteristics. The TruCheck also supports TLC 39. TLC 39 is a variant of Code 39 created to support a linked composite component for Telecom applications.

INTERLEAVED 2 OF 5 (I2OF5)



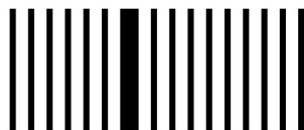
Interleaved 2 of 5 is a continuous two-width barcode symbology. ITF 14 is a GS1 form of I 2 of 5, and the TruCheck™ USB software will evaluate symbols encoded according to selected standards, either I 2 of 5 standard, or GS1 – ITF14. In order to select which standard is applied, there is a drop down menu box in the decode options of the settings window. Since Interleaved 2 of 5 is a two-width symbology, ratio will be reported in General Characteristics.

CODE 93



Code 93 is a linear symbology composed of characters made up of six elements fit into 9 modules.

PHARMACODE



Pharmacode symbols (also known as "Laetus Pharmacode") are linear symbols that contain no start/stop characters. By default, the TruCheck™ verifier will not detect Pharmacode symbols, so if Pharmacode symbols are to be verified, there is an option in the "type of code" section of the settings menu that must be checked. It is recommended that you activate this setting only when needed, because stray marks and other types of symbols can sometimes have the proper spacing to qualify as a valid Pharmacode symbol. This issue can be avoided by turning off Pharmacode whenever Pharmacode symbols are not being verified.

Due to the lack of any start character or other means to determine the forward direction of the symbol, a Pharmacode symbol can read differently in each direction. Therefore, the data in a Pharmacode symbol is reported twice, in both the data field of the main screen, as well as the data detail tab. An "F", expressing the data as interpreted by a foreword scan, indicates the first. The second is indicated by an "R", indicating the data as interpreted by a reverse scan.

MSI/PLESSEY



MSI and Plessey codes are continuous binary symbologies in which data is encoded by groups of 4 bars and four spaces. Each bar/space pair represents a one or zero based on whether the bar or space is wide while the other is opposite. Groups of four such "bits", form a character. There is a check digit at the end, which can be displayed or removed from the data on the report depending on a settings choice.

PDF 417



The design of PDF 417 provides for the symbol being "line scannable". First, each row is composed of self-clocking characters, much the same way as an ordinary linear barcode. The '417' in the name of the symbology comes from the structure of each character. It is 8 elements (4 bars and 4 spaces) arranged within 17 unit modules. (The 'PDF' part of the name stands for 'portable data file' and suggests that the data capacity of the symbol is large enough to represent all of the data associated with the item that the label is on, as opposed to a

number that refers to a record in a non-portable data file (such as a price look table) in a computer database.

Each row can be read in a way that is similar to the process of reading a linear barcode. However, each row further contains a special character at each end (adjacent to the start and stop characters) which identify the row number within the symbol for this row. There is also other information in these special characters, including the total number of rows and the total number of columns in the symbol. In this way, a scan of a PDF 417 symbol can yield part of the decode information of the symbol which can be combined with other scans (of the other rows) to result in a complete decode. Thus, PDF 417, like other multi-row stacked symbologies are "line scannable".

For PDF 417, the number of rows and columns (in the data section, not including the row indicator columns) will be given in the General Characteristic's section, along with Error Correction information, such as Error Correction Level (which can be 0 through 8), Error correction budget, number of errors and erasures. In addition, the scan-reflectance-profile grade for the start and stop characters is given in General Characteristics for each in tracing the cause of the final grade. General Characteristics will also contain the Aspect Ratio which is the row height divided by the module size. (Thus, a symbol with row height that is 3X will have aspect ratio of 3). Also, a Compact PDF 417 symbol (one with its right row indicator and stop character) will be noted in General Characteristics.

GS1 DATABAR (FORMERLY) RSS



GS1 DataBar is a linear symbology that can be printed in multi-row stacked forms in many cases. Even GS1 symbols that have only 1 linear component should be treated as stacked symbols for the purposes of setting up a scan region. GS1 DataBar must be enabled in the "type of code" section of the settings menu. The "# of scans" option in the settings menu has no effect on GS1 DataBar symbols; the appropriate number of scans will be decoded according to the technical specifications, and is typically ten per row, or composite section of the overall code.

The reporting for RSS symbols is different from other symbologies when there is more than one component. Each component has its own grade. The grade of each component will affect the grade for the whole symbol,

where the overall symbol grade is the lowest grade scored by any of its components. It is important to note that there is a special flag inside the data of RSS codes that identifies the presence of a secondary component. If this flag is set when there is no composite component found, the grade for the symbol is reported as “F” even if all other parameters receive high grades. This is reported as “link flag set, but composite component not found” in the primary report. The report will contain “Link Flag On” or “Link Flag Off”. The report will also indicate whether the symbol is printed in one row, or “stacked”.

QR



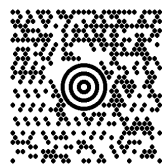
QR Code, or Quick Response Code, is capable of encoding Japanese Kanji characters and is widely used in Asia. It contains easy to decode finder patterns, alignment patterns, and clock tracks. A small amount of version information is specified by a group of modules surrounding the finder patterns, such as the size of the matrix and the selected level of error correction. QR Code symbols can have varying amounts of error correction, allowing a tradeoff between symbol size and error correction capability to be made when the symbol is created. The general characteristics section will include information specific to QR Code, including the error correction mode and the masking pattern.

DATA MATRIX CODE



The Data Matrix symbology is probably the most common 2D Matrix. It allows for the highest density of data per module, especially for small symbols, so data matrix grading is essential. The finder pattern consists of solid left and bottom sides, which form an “L” pattern and a horizontal and vertical clock track on opposite sides of the “L”. The clock track tells the number of modules in the matrix and is used to decode the grid on which the modules are placed. There is no version information encoded explicitly within the Data Matrix symbology; all the information about the symbol size, encoding and error correction is determined from the size of the matrix. The matrix size shown in the general description section of the report will give the size of the matrix including the “L” patterns and clock tracks, and the size of the inner matrix of data encoding modules in parenthesis.

MAXICODE



MaxiCode is a 2D hexagonal grid symbology. “MaxiCode” must be selected in the “type of code” section of the settings menu to decode MaxiCode symbols. Unlike most other barcoding symbologies, all MaxiCode symbols have a necessary specified size. Magnification or shrinkage of the symbol can cause a symbol to become unreadable, even if all elements are properly sized relative to each other. Magnification is not a graded parameter; however, magnification percentage will be reported in the general characteristics tab, along with a warning if the symbol is of a size not allowed in the specification.

Data in MaxiCode symbols is encoded across 3 different channels, each with its own independent error correction budget, and each with a different intended interpretation. These three channels are referred to as the high priority message, and the first and second low priority messages. The error detection and correction information for each channel will be listed separately in the general characteristics tab.

MaxiCode symbols can be encoded in any of 5 modes:

Mode 2—Mode 2 is often used in the shipping industry and it uses the high priority message to store structured information, including a numeric postal code, a country code, and a service class. The two low priority channels interleave to form an accompanying message. The high priority channel uses “enhanced” error correction, and both low priority channels use “standard”.

Mode 3— Mode 3 is often used in the shipping industry and it uses the high priority message to store structured information including an alphanumeric postal code, a country code, and a service class. The two low priority channels interleave to form an accompanying message. The high priority channel uses “enhanced” error correction, and both low priority channels use “standard”.

Mode 4—Mode 4 uses the full data capacity (including the high priority message channel) to encode a message. The high priority channel uses “enhanced” error correction, and both low priority channels use “standard”.

Mode 5—Mode 5 uses the full data capacity (including the high priority message) to encode a message. In mode 5, all channels use “enhanced” error correction. This means that mode 5 symbols have a greater error detection and correction capacity, but at the cost of a smaller data capacity compared to mode 4 symbols.

Mode 6—Mode 6 symbols encode data used to reprogram reading devices. The high priority channel uses “enhanced” error correction, and both low priority channels use “standard”.

AZTEC



Aztec Code is a 2D symbol with a bull's-eye pattern at the center to locate the code. The orientation marks at the corners of the code allow the code to be read if rotated in any direction. With an Aztec Code reader, the amount of Reed-Solomon error correction is between 20% and 40% of the data in the code. Like other 2D Matrix symbologies, the size of the Aztec Code depends on the amount of data contained within the code.