WR #	GSCN Name	Ratification Date
23-112	Magnificaztion Factor, Figure 5.2.6.7	Jun 2023

Associated Work Request (WR) Number:

Background:

This GSCN looks to remove some of the explanation of magnification factor in section 5.2.6, particularly removal of figure 5.2.6.7-1 which suggests a specific magnification factor. Depending on the printer used the size may or may not be possible. The GSCN removes this table and replaces it with a cross reference to the appropriate symbol specification table. Additionally, previous text was added to section 5.12.4.1.3 to indicate deprecation of magnification factor that had already been called out in section 5.2.3.3.

Disclaimer:

5.2.3.3 X-dimension (magnification factor)

In the past the term "magnification factor" was extensively used to specify the size of a barcode. This technique relied upon setting a nominal size (100 percent) that was directly related to a given X-dimension. Since January 2000, the ~~more precise~~ term "X-dimension" has been used to specify permissible symbol sizes (see section 5.12). The X-dimension of an add-on symbol SHALL be the same as the X-dimension of its associated main symbol.

5.2.3.4 Quiet Zone

The minimum Quiet Zone width required by the main symbol is 7x. However, other minimum Quiet Zone dimensions are specified for some symbol types due to the size and location of their human readable interpretation. These dimensions are noted in figure 5.2.3.4-1.

Figure 5.2.3.4-1. Quiet Zone widths by version

Symbol version	Left Quiet Zone		Right Quiet Zone	
	Modules	mm*	Modules	mm
EAN-13	11	3.63	7	2.31
EAN-8	7	2.31	7	2.31
UPC-A	9	2.97	9	2.97
UPC-E	9	2.97	7	2.31
Add-ons (EAN)	7-12	2.31-3.96	5	1.65
Add-ons (U.P.C.)	9-12	2.97-3.96	5	1.65
* This is an example using an X-dimension of 0.330 millimetres.				

Note: A useful device to help maintain the Quiet Zone in some production processes is to include a less than (<) and/or greater than (>) character in the human readable interpretation field, with its apex aligned with the edge of the Quiet Zone. If this device is used, the character(s) SHALL be positioned in accordance with the appropriate drawings in section 5.2.6.6.

5.2.3.5 Symbol length

The symbol length in modules, including the minimum Quiet Zones, SHALL be as indicated in the figure below.

Figure 5.2.3.5-1. Symbol length in modules

Symbol type	Length
EAN-13	113
UPC-A	113
EAN-8	81
UPC-E	67
Two-digit add-on	25
Five-digit add-on	52
EAN-13 or UPC-A and two-digit add-on	138
UPC-E and two-digit add-on	92
EAN-13 or UPC-A and five-digit add-on	165
UPC-E and five-digit add-on	119

5.2.3.6 Positioning of the add-on symbol

The add-on symbol SHALL NOT encroach on the right Quiet Zone of the main symbol. The maximum separation SHALL be 12X. The bottom edge of the bars (dark bars) in the add-on symbol SHALL be horizontally aligned with the bottom edge of the guard bars of the main symbol.

5.2.6.7 Dimensions of modules and symbols ~~at different levels of magnification~~

Minimum, target, and maximum module size are detailed in the GS1 symbol specification tables, section 5.12.3. The module size chosen SHOULD be selected with the recommendations offered in section 5.12.4.1.3. Symbol size will depend on the module size chosen.

~~**Figure 5.2.6.7-1.** Dimensions of EAN/UPC symbols and their modules at different levels of magnification~~

~~Magnification factor~~	~~Ideal module width [mm] (inches)~~	~~EAN-13/UPC-A dimensions [mm] (inches)~~		~~EAN-8 dimensions [mm] (inches)~~	
		~~Width~~	~~Height~~	~~Width~~	~~Height~~
~~0.80~~	~~0.264 (0.010)~~	~~29.83 (1.174)~~	~~18.28 (0.720)~~	~~21.38 (0.842)~~	~~14.58 (0.574)~~
~~0.85~~	~~0.281 (0.011)~~	~~31.70 (1.250)~~	~~19.42 (0.765)~~	~~22.72 (0.894)~~	~~15.50 (0.610)~~
~~0.90~~	~~0.297 (0.011)~~	~~33.56 (1.321)~~	~~20.57 (0.810)~~	~~24.06 (0.947)~~	~~16.41 (0.646)~~
~~0.95~~	~~0.314 (0.012)~~	~~35.43 (1.395)~~	~~21.71 (0.855)~~	~~25.39 (1.000)~~	~~17.32 (0.682)~~
~~1.00~~	~~0.330 (0.013)~~	~~37.29 (1.468)~~	~~22.85 (0.900)~~	~~26.73 (1.052)~~	~~18.23 (0.718)~~
~~1.05~~	~~0.347 (0.013)~~	~~39.15 (1.541)~~	~~23.99 (0.944)~~	~~28.07 (1.105)~~	~~19.14 (0.753)~~
~~1.10~~	~~0.363 (0.014)~~	~~41.02 (1.615)~~	~~25.14 (0.990)~~	~~29.40 (1.157)~~	~~20.05 (0.789)~~
~~1.15~~	~~0.380 (0.014)~~	~~42.88 (1.688)~~	~~26.28 (1.035)~~	~~30.74 (1.210)~~	~~20.96 (0.825)~~
~~1.20~~	~~0.396 (0.015)~~	~~44.75 (1.762)~~	~~27.42 (1.080)~~	~~32.08 (1.263)~~	~~21.88 (0.861)~~
~~1.25~~	~~0.413 (0.016)~~	~~46.61 (1.835)~~	~~28.56 (1.124)~~	~~33.41 (1.315)~~	~~22.79 (0.897)~~
~~1.30~~	~~0.429 (0.016)~~	~~48.48 (1.909)~~	~~29.71 (1.170)~~	~~34.75 (1.368)~~	~~23.70 (0.933)~~
~~1.35~~	~~0.446 (0.017)~~	~~50.34 (1.982)~~	~~30.85 (1.215)~~	~~36.09 (1.421)~~	~~24.61 (0.969)~~
~~1.40~~	~~0.462 (0.018)~~	~~52.21 (2.056)~~	~~31.99 (1.259)~~	~~37.42 (1.473)~~	~~25.52 (1.005)~~
~~1.45~~	~~0.479 (0.017)~~	~~54.07 (2.129)~~	~~33.13 (1.304)~~	~~38.76 (1.526)~~	~~26.43 (1.041)~~
~~1.50~~	~~0.495 (0.019)~~	~~55.94 (2.202)~~	~~34.28 (1.350)~~	~~40.10 (1.579)~~	~~27.35 (1.077)~~
~~1.55~~	~~0.512 (0.020)~~	~~57.80 (2.276)~~	~~35.42 (1.394)~~	~~41.43 (1.631)~~	~~28.26 (1.113)~~
~~1.60~~	~~0.528 (0.020)~~	~~59.66 (2.349)~~	~~36.56 (1.439)~~	~~42.77 (1.683)~~	~~29.17 (1.148)~~
~~1.65~~	~~0.545 (0.021)~~	~~61.53 (2.422)~~	~~37.70 (1.484)~~	~~44.10 (1.736)~~	~~30.08 (1.184)~~
~~1.70~~	~~0.561 (0.022)~~	~~63.39 (2.496)~~	~~38.85 (1.530)~~	~~45.44 (1.789)~~	~~30.99 (1.220)~~
~~1.75~~	~~0.578 (0.022)~~	~~65.26 (2.569)~~	~~39.99 (1.574)~~	~~46.78 (1.842)~~	~~31.90 (1.256)~~
~~1.80~~	~~0.594 (0.023)~~	~~67.12 (2.643)~~	~~41.13 (1.619)~~	~~48.11 (1.894)~~	~~32.81 (1.292)~~
~~1.85~~	~~0.611 (0.024)~~	~~68.99 (2.716)~~	~~42.27 (1.664)~~	~~49.45 (1.947)~~	~~33.73 (1.328)~~
~~1.90~~	~~0.627 (0.024)~~	~~70.85 (2.789)~~	~~43.42 (1.709)~~	~~50.79 (2.000)~~	~~34.64 (1.364)~~
~~1.95~~	~~0.644 (0.025)~~	~~72.72 (2.863)~~	~~44.56 (1.754)~~	~~52.12 (2.052)~~	~~35.55 (1.400)~~
~~2.00~~	~~0.660 (0.026)~~	~~74.58 (2.936)~~	~~45.70 (1.800)~~	~~53.46 (2.105)~~	~~36.46 (1.435)~~

~~**Note**: Refer to section 5.12 for the minimum, nominal and maximum X-dimensions and symbol heights for barcodes.~~

5.3 Linear barcodes - ITF-14 symbology specifications

5.3.1 Symbology characteristics

In the GS1 system, the characteristics of ITF-14 symbols are:

- Encodable character set: digits 0 through 9, in accordance with *ISO/IEC 646*. Refer to figure 7.11-1 for more details.
- Code type: continuous.

- Maintenance and supplies, from informative reference Annex C of *ISO/IEC 15419.*

5.12.4.1.2 Dedicated barcode printers

Section 5 of *ISO/IEC 15419* contains information on dedicated barcode printers and includes the following topics:

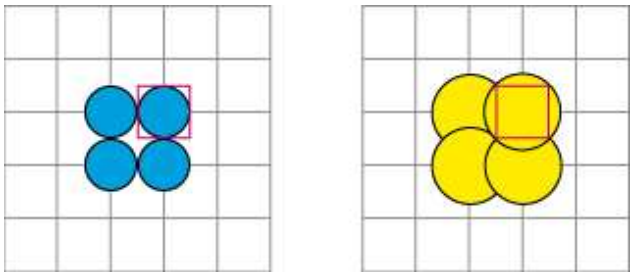
- Data input requirements.
- Test requirements.
- Selection of equipment for testing.
- Test conditions; environment, equipment configuration.
- Test procedure.
- Conformance.
- Test report.
- Certification and labelling.
- Equipment specification.

5.12.4.1.3 EAN/UPC on-demand printed symbols at minimum size

In the past the term "magnification factor" was extensively used to specify the size of a barcode. This technique relied upon setting a nominal size (100 percent) that was directly related to a given X-dimension. Since January 2000, the term "X-dimension" has been used to specify permissible symbol sizes (see section 5.12).

It is more difficult for the user to create high quality barcodes with general-purpose printers than it is with direct thermal transfer label printers. There are two reasons for this difficulty. First, the printed dot size for general-purpose printers is appreciably larger than the pixel dimension, as shown in the figure below. This causes the bars (dark bars) to be printed wider and the spaces (light bars) to be narrower than nominal, unless the software driving the printer corrects for this distortion. Second, the software that constructs the barcode may itself introduce dimensional errors.

Figure 5.12.4.1.3-1. Example of digital printing



Pixel-sized dot **Typical general-purpose printer dot**

The most common printing densities used by on-demand, barcode printers are 200 and 300 dpi. However, due to the constraints of the dot pitch, these printers cannot print a minimum X-dimension of 0.264 mm (0.0104 inch) or 80 percent magnification symbol correctly. The closest to 80 percent that these printers can print is 75.7 percent or 76.9 percent depending on the exact dot geometry (see figure below).

Even though a minimum X-dimension of 0.264 mm (0.0104) inch or 80 percent magnification) is the minimum value specified, users of on-demand printers have used magnifications between 75 percent and 80 percent in point-of-sale (POS) scanning environments for years. They have done so with no significant reduction in scan rate, as compared to symbols printed precisely at 80 percent. Because larger in-specification symbols are always easier to scan, 80 percent symbols and larger

5.12.5.10 Special considerations for verification of GS1 system symbologies

5.12.5.10.1 General

Since ISO verification does not measure dimensions, it is part of the additional visual checking that has to be carried out to ensure that, for example, the symbol height meets the application requirements.

With better digital imaging software, element dimensions can only be adjusted automatically to the nearest integer number of pixels in the output device, be it imagesetter or printer, enabling element width ratios to be maintained with allowance duly made, for example, for bar gain/loss and adjustment of element widths for digits 1, 2, 7 and 8 in EAN/UPC symbols. This means that symbol sizes may not match those input as target dimensions, but will vary in discrete steps within the permitted range, which will result in a more accurate symbol overall.

Note: For a list of international standards pertaining to GS1 system symbologies, see section 5.1.2

5.12.5.10.2 Acceptance criteria

The acceptance criteria are intended to confirm that symbols adhere to all the requirements in the symbol specification tables with an allowance for a small measurement variation between commercial verifiers or operators:

- X-dimension is to have an Acceptance Criteria of 2% (-2% on the minimum specified X-dimension and +2% on the maximum specified X-dimension).
- The measurements for height and each Quiet Zone have an Acceptance Criteria of 5% (-5% on the minimum specified dimension and +5% on the maximum specified dimension).

5.12.5.10.3 EAN/UPC symbology

The main characteristic of the EAN/UPC symbology that affects verification is the different treatment of the three sets of symbol characters for digits 1, 2, 7 and 8 from the remaining digits (0, 3, 4, 5, 6 and 9). The reference decode algorithm uses the combined width of both bars in these characters to discriminate between a 1 and a 7, and between a 2 and an 8, which are ambiguously decodable since they share the same set of edge-to-similar-edge modular dimensions. The addition to or subtraction from the element widths of 1/13 module is intended to increase the differences between the sums of the bar widths for each pair of ambiguous characters. The decodability parameter for these characters takes account of bar gain and loss whereas it does not for the remaining symbol characters. Consequently, a symbol not containing any of these four symbol characters may suffer substantial bar gain or loss without degrading its decodability, whereas a symbol that does contain one or more of them is likely to have a lower decodability grade, with the same amount of bar gain or loss. However, the laws of probability suggest that only some 6.9 percent of symbols would not be affected by this, so it is wise to be cautious and assume that bar gain or loss is a possible cause of a poor decodability grade for EAN/UPC symbols. It is also wise (for process control purposes) not to assume that the decodability grade correlates with bar width deviation, but it is far safer and easier to rely on the traditional measurement of bar width deviation for adjusting the production process.

The measuring aperture for EAN/UPC symbols is either 6 or 10 mils, depending on the application, as specified by the symbol specification tables.

Additional EAN/UPC symbol grading criteria

ISO/IEC 15416 Bar code print quality test specification - Linear symbols allows for additional pass/fail criteria to be stipulated by a symbology specification. For the EAN/UPC symbology, the minimum Quiet Zone dimensions are given in 5.2.3.4. Any individual scan profile which does not meet these requirements allowing for the following tolerances SHALL receive a grade of "0".

Figure 5.12.5.10.3-1. Minimum width of measured Quiet Zones

Symbol version	Left Quiet Zone	Right Quiet Zone
EAN-13	10X	6.2X
EAN-8	6.2X	6.2X
UPC-A	8X	8X
UPC-E	8X	6.2X
Add-ons (EAN)	EAN 13/8 right QZ	4.2X
Add-ons (U.P.C.)	UPC A/E right QZ	4.2X

Symbols that fall below range defined in 5.2.6.7 ~~magnification factors~~ SHALL receive a grade of 0 (see 5.12.6.3 for exception).

Note: The choice of minimum Quiet Zone dimension was based on the historical U.P.C. Quality Guideline. Since EAN-13 and EAN-8 were not included, minimum Quiet Zone dimension similarly derived were chosen for those symbols.

5.12.5.10.4 GS1-128 symbology

The important aspects to verify for a GS1-128 symbol are its print quality, which is assessed in the standard way, and its formatting, which may need to be visually checked from the information output by the verifier. The Code 128 symbology is an edge-to-similar- edge decodable symbology, but its reference decode algorithm also requires a check of the sum of the widths of the three bars in each character as part of its parity checking process. Consequently, its decodability is affected by bar gain or loss.

Measuring apertures for GS1-128 symbols are 6 or 10 mils depending on the application and are specified in the symbol specification tables.

Data contained in GS1-128 symbols must be formatted according to these specifications for the use of GS1 Application Identifiers (AIs). Specific features to check are:

- Presence of Function 1 Symbol Character (FNC1) as a flag for the GS1 system subset of the Code 128 symbol, in the first position after the start character.
- Use of FNC1 or the control character <GS> (ASCII value 29 (decimal), 1D (hexadecimal)) as a separator character following non-predefined length element strings.
- Sequencing of AIs, with predefined length AIs preceding non-predefined length ones.
- Length of data fields with fixed length AIs.
- Correct formatting of data in all AI fields.
- Absence of encoded parentheses around AIs.
- The extent to which a verifier can do this automatically will vary greatly among devices, even those that have GS1-128 symbols as a specific symbology option.

5.12.5.10.5 ITF-14 symbology

ITF-14 barcodes are, unlike the others used in the GS1 system, two-width (narrow/wide) symbols that cannot be decoded by the edge-to-similar-edge technique, but all element widths must be measured. They are, therefore, more subject to the problems caused by bar gain or loss.

The standard ISO verification technique is fully applicable to these symbols. However, in the GS1 system application, additional checks must be made to ensure that the X-dimension ~~(magnification factor)~~ is within the permitted range.

Measuring apertures for the ITF-14 symbol SHALL be 10 mils for symbols with an X-dimension less than 0.635 millimetre (0.0250 in) and SHALL be 20 mils for symbols with an X-dimension equal to or greater than 0.635 millimetre (0.0250 in).

The minimum acceptable grade for symbols printed with the higher range of X-dimension (above 0.635 millimetre or 0.0250 in) SHALL be 0.5/20/660. This is because the brown corrugated

- Local variations in background reflectance (e.g., fragments of darker material in a recycled material): Use a more consistent substrate or one with higher reflectance.
- Local variations in inking of the bars: Adjust press settings to ensure even or darker inking.
- Show-through of contents: Use more opaque material for package, or print opaque white underlay prior to printing symbol.
- Element(s) adjoining the edge in question appear excessively narrow relative to the measuring aperture used: Increase X-dimension; ensure correct measuring aperture is used; apply correct BWA when originating symbol; print bars marginally narrower than spaces of same modular dimension.

5.12.5.12 Other parameters

Decode is graded on a pass/fail basis by applying the reference decode algorithm to the edge positions and element widths determined for the symbol. A failure to decode may be evidence of the symbol being incorrectly encoded, which may include an incorrect check digit. It also may indicate either that the bars and spaces initially identified by the global threshold are too many or too few for a valid symbol or that one or more edge positions are ambiguous. The possible causes of decode failure and possible remedies are:

- Symbol incorrectly encoded: Re-originate symbol; over-label with correctly encoded symbol.
- Check digit incorrectly calculated: Correct software error in origination system; re-originate symbol; over-label with correctly calculated symbol.
- Gross element width errors due to excessive bar gain or loss, or to defects: Apply correct bar width adjustment (BWA) when originating symbol; adjust press or printer settings.
- Too many elements detected due to defects: Correct cause of defects; adjust press (relief printing processes) to reduce haloing; replace print head (thermal/ink-jet printing).
- Too few elements detected (failure to cross global threshold): Refer to solutions for edge contrast (EC).

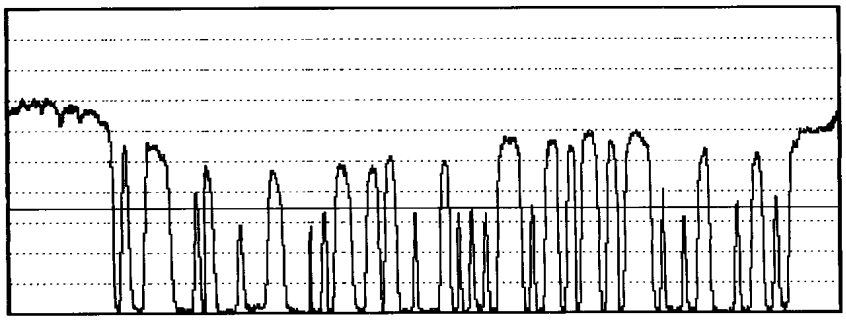
In the ISO standard, a decode failure occurs because an incorrect number of elements has been perceived to be present, either because the profile of one or more elements has failed to cross the global threshold or because a gross defect has caused one element to be seen as three or more, corresponding to the separately graded Edge Determination failure in the ANSI standard, which may also be reported by some verifiers following the ANSI methodology.

Figure 5.12.5.12–1 shows a symbol in which the narrow spaces have been partly filled in, reducing their contrast below the global threshold and causing an edge determination or decode failure. This could also be interpreted as an extreme example of modulation (MOD).

Figure 5.12.5.12-1. Symbol with edge determination problem

Figure 5.12.5.12-2 illustrates a Scan Reflectance Profile (SRP) showing narrow space profiles failing to reach the global threshold, giving an (ISO) decode failure or (ANSI) edge determination failure.

Figure 5.12.5.12-2. Scan Reflectance Profile with narrow space profiles



Decodability grades are influenced by bar gain or loss in most symbologies and by distortion of the symbol. Distortion can occur with relief printing processes, such as flexography, when the printing plate is stretched around the press cylinder with the bars parallel to the cylinder axis (e.g., at right angles to the print direction). A common reason for distortion with digitally-originated images is that they have been rescaled in graphics software, resulting in uneven addition or removal of pixels to or from the element widths. Print processes that tend to produce irregular bar edges, such as ink-jet and photogravure, will also be likely to give lower decodability grades. The causes of a low value of decodability and the possible remedies are:

- Bar gain/loss (systematic): Apply correct bar width adjustment (BWA) when originating symbol; adjust press settings.
- Element width gain/loss (non-systematic): Correct missing pixels (burnt-out print head elements, blocked ink-jet nozzles); rectify cause of defects.
- Distortion of symbol (uneven stretching of flexographic plate; non-linear disproportioning in plate-making process): Print symbol with height of bars parallel to direction of printing; do not disproportion barcode image in plate-making.
- Rescaling of digitally-originated images: Ensure symbol is created in correct size; ensure software matches module widths to integer number of pixels after all adjustments.
- Irregular element edges (ink-jet, photogravure, screen process printing): Change print technology; increase X-dimension~~/magnification factor~~; re-orient symbol relative to cylinder engraving angle/screen mesh.

The symbol in figure 5.12.5.12-3 is taken from the *GS1 Calibrated Conformance Standard Test Card* and has an engineered low decodability grade of 50 percent. As may be determined from the accompanying Scan Reflectance Profile (SRP), just to the left of halfway across the symbol, the width of a two-module bar has been increased in the sixth digit (and since the character is a 1, its decodability is affected by bar width). Although the original symbol has a very consistent image density, the profile also shows the effect of modulation (MOD), most noticeably on the narrow spaces.

Figure 5.12.5.12-3. Calibration symbol with engineered low decodability grade