INTERNATIONAL STANDARD

ISO/IEC 15419

Second edition
2009-06-01

Information technology — Automatic identification and data capture techniques — Bar code digital imaging and printing performance testing

Technologies de l'information — Techniques automatiques d'identification et de capture des données — Test de performance de la numérisation digitale et l'impression des codes à barres

Reference number
ISO/IEC 15419:2009(E)

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Published in Switzerland

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

ISO/IEC 15419 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 31, *Automatic identification and data capture techniques*.

This second edition cancels and replaces the first edition (ISO/IEC 15419:2001), which has been technically revised.

Introduction

Bar code technology is based on the recognition of patterns encoded in bars and spaces of defined dimensions according to rules defining the translation of characters into such patterns, known as the symbology specification.

Bar code digital imaging systems must be capable of reliably converting the information to be encoded into a bar code symbol meeting the symbology specification and application requirements if the technology is to fulfil its basic objective. Such systems comprise two major components, namely the hardware device which produces the physical image of the bar code symbol on paper, photographic film, printing plate, or other substrate, and the associated software which converts the input data into digital instructions used to drive the hardware device. Each component can take many forms and perform differing functions.

Manufacturers of bar code equipment, the producers of bar code symbols and the users of bar code technology therefore require publicly available standard test specifications for bar code digital imaging systems to ensure the accuracy and consistency of performance of these systems. This International Standard is intended to lay down general principles governing the bar code image generation function in each component, supplemented by more specific details applicable to certain major categories of software and hardware.

Information technology — Automatic identification and data capture techniques — Bar code digital imaging and printing performance testing

1 Scope

This International Standard describes the characteristics and defines categories of bar code digital imaging systems, identifies the attributes of each system which are required to be controlled, and specifies minimum requirements for those attributes. It defines test methods for assessing the conformance of those attributes with this International Standard. It is intended to be used in conjunction with International Standards which detail the methodology for assessing the quality of a bar code symbol, such as ISO/IEC 15416. This International Standard does not apply to Bar Code Masters, which are covered by ISO/IEC 15421.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 2859-1, *Sampling procedures for inspection by attributes — Part 1: Sampling schemes indexed by acceptance quality limit (AQL) for lot-by-lot inspection*

ISO/IEC 15416, *Information technology — Automatic identification and data capture techniques — Bar code print quality test specification — Linear symbols*

ISO/IEC 15420, *Information technology — Automatic identification and data capture techniques — Bar code symbology specification — EAN/UPC*

ISO/IEC 15426-1, *Information technology — Automatic identification and data capture techniques — Bar code verifier conformance specification — Part 1: Linear symbols*

ISO/IEC 19762-1, *Information technology — Automatic identification and data capture (AIDC) techniques — Harmonized vocabulary — Part 1: General terms relating to AIDC*

ISO/IEC 19762-2, *Information technology — Automatic identification and data capture (AIDC) techniques — Harmonized vocabulary — Part 2: Optically readable media (ORM)*

3 Terms, definitions, and abbreviated terms

For the purposes of this document, the terms, definitions and abbreviated terms given in ISO/IEC 19762-1, ISO/IEC 19762-2 and the following apply.

3.1
addressable imaging resolution
maximum number of image positions per unit length along a straight line that can be addressed by the bar code designer

NOTE 1 An example of image positions per unit length is dots per millimetre.

NOTE 2 This resolution would exclude further resolution enhancing techniques performed by the imaging device or software, which are beyond the control of the designer.

3.2
adjusted BWC
value of bar width compensation (BWC) after adjustment to match addressable imaging resolution

3.3
bit map
electronic representation of the individual pixels making up the image to be output by the imaging device

3.4
consumables
print media, i.e. materials that need to be supplied by the user on a regular basis

NOTE Examples of consumables include ribbons, labels or printing substrates, toner and ink.

3.5
dedicated bar code printer
printing device with the resident intelligence capable of converting data into bar code symbols

3.6
digital bar code file
bar code which is designed and stored in a digitized format

3.7
digital bar code imaging system
system which comprises the necessary software and hardware components to produce a bar code image

3.8
distortion
process by which the height to width ratio of a piece of artwork is modified to compensate for the dimensional change that is introduced to an image when a flexible relief printing plate is wrapped around the print cylinder of a rotary printing press

3.9
DPMM
dots per millimetre
measure of printing resolution, in particular the number of individual dots of ink a printer or toner can produce within a linear one-millimetre space

3.10
general purpose printer
printing device without the resident processing ability to convert data sequences into a valid bar code symbol

NOTE An example of a general purpose printer is an office printer.

3.11
imagesetter
device used to output a computer image at an addressable resolution onto a photographic film, paper or printing plate

3.12
imaging tool
mechanism that transfers an image directly or indirectly to a printed substrate

3.13
rounding errors
allocation of imaging device dots to bar or space modules in an inconsistent manner, i.e. where all of the modules based on the user's target dimensions fail to be composed of a consistent number of dots

4 Bar code design software

4.1 General requirements

The testing procedures in this section are intended to report the conditions under which software, in conjunction with a printing device, is capable of producing quality symbols. The tests performed under the reported conditions will typically be performed in a controlled setting. Ongoing verification of symbols produced in an operational setting should be performed using the methodology contained in ISO/IEC 15416. In addition, visual checks should be performed to confirm the correct formatting of the symbol in accordance with the symbology and other applicable specifications. Further guidance on equipment maintenance and supplies is found in Annex C.

4.1.1 Data input

The human-readable text and symbol characters for all symbols should, wherever possible, be generated from the same key entry input. The software should apply appropriate formatting algorithms to meet relevant application standards.

The input process should also allow for the input of relevant symbol parameters such as target X dimension or magnification factor, wide:narrow ratio, and bar height, where these are user-definable according to the symbology specification; such input shall be subject to the capabilities of the imaging or printing system, in particular the adjustment of target element dimensions as described in the subclauses of 4.2.

Check characters for encoded data shall either be calculated or verified by the software. For example, if the software prompts for the entry of only twelve digits for an EAN-13 symbol, the software shall automatically calculate the check character. Alternatively, the software might prompt for the entry of thirteen digits and indicate an error if the check character input is incorrect. The latter approach assures that valid data has been entered.

It is desirable for the input data to be displayed when the label or layout is designed, subject to the limitations of the display device, to enable the operator to validate it. Optionally, the software may also display the symbol characters encoded.

4.1.2 Quiet zones

The software should indicate, either graphically or in text, the appropriate area surrounding the symbol required for quiet zones.

NOTE In order to ensure that the minimum quiet zones are respected when printing or positioning the symbol, if for example print growth or variations in print to substrate register are expected, adjustment of the position of any graphical mark on the digital image adjacent to the quiet zone boundary, or of the position of the symbol relative to the edges of the area in which, or substrate on which, it is to be printed, may be required.

4.2 Considerations by software and imaging device categories

Refer to Annex D for a review of software categories and Annex E for a review of imaging device categories.

4.2.1 Direct bar code imaging devices

This section provides software design requirements for imaging devices that create the final bar code symbol on the substrate. This category is divided into the two sub-categories, dedicated bar code printer software and general-purpose printer software.

4.2.1.1 Dedicated bar code printers

This section provides software requirements for dedicated bar code printers. Dedicated bar code printers contain all of the low-level software required to generate bar code symbols. This means that various symbol formats are stored in the firmware specific to the printer. The bar code design software simply sends commands to address the firmware in the printer to create the symbol. These commands typically relate to data characters, element sizes (typically expressed as a multiple of addressable dots), symbol orientation, and symbol placement.

4.2.1.1.1 Adjustment of target element dimensions

This procedure is intended to produce symbols with a revision in the target module width of the symbol to eliminate rounding errors. The software must be able to make adjustments to symbol character element widths based on the output resolution specified. This means the overall symbol width will be adjusted to produce an integer number of addressable dots consistently across all element widths. For symbols with a fixed aspect ratio, a proportional adjustment should be applied to the module height (Y-dimension).

These adjustments should be made by rounding down to the closest integer value, provided the value falls within the range of widths prescribed by the symbology specification or application standard. Rounding down is preferred because rounding up could cause reduction of or interference in the area allocated to the quiet zone. Quiet zone reduction could result from selecting a label width that is very close to the target symbol width. Quiet zone interference could result from adjacent graphic layout images remaining constant as the symbol width expands. When symbol module widths are rounded up, the software should clearly indicate the required quiet zone area to the designer.

Refer to Annex F for a programmer's example for an illustration of this procedure.

4.2.1.1.2 Record of design attributes

Digital bar code files for dedicated bar code printers are generally created for a specific printer make and model at a specific resolution. It is wise for the party printing the symbol to create the bar code at the production stage closest to the symbol output. When this is not possible and the digital bar code file is transferred between two parties, certain design attributes should be communicated. The following design attributes should be communicated for dedicated bar code printers to ensure symbol quality in the output stage:

— The output resolution specified for symbol output

— The adjusted symbol module dimensions based on the specified output resolution (see 4.2.1.1.1)

4.2.1.2 General purpose printers

This section provides software requirements for general-purpose printers. General-purpose printers do not contain low-level software for generating bar code symbols.

4.2.1.2.1 Adjustment of target element dimensions

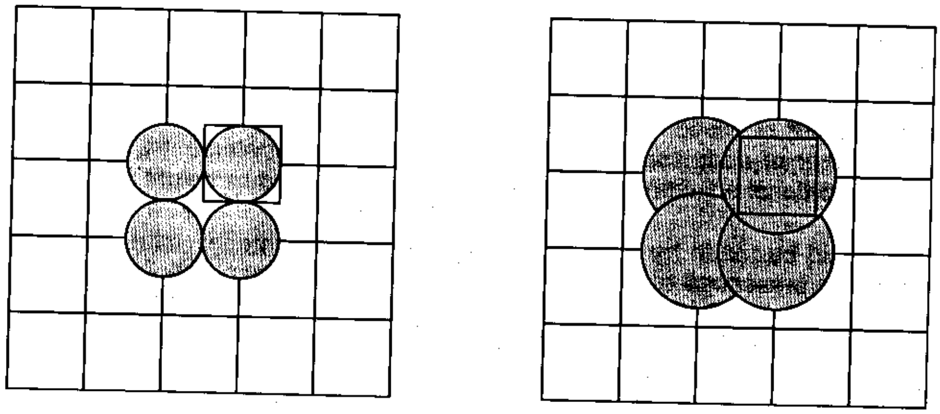
This procedure is intended to produce symbols with a revision in the target module width of the symbol to eliminate rounding errors. The software must be able to make adjustments to symbol character element widths based on the output resolution specified. This means the overall symbol width will be adjusted to produce an integer number of addressable dots consistently across all element widths. For symbols with a fixed aspect ratio, a proportional adjustment should be applied to the module height (Y-dimension).

These adjustments should be made by rounding down to the closest integer value, provided the value falls within the range of widths prescribed by the symbology specification or application standard. Rounding down is preferred because rounding up could cause reduction or interference in the area allocated to the quiet zone. Quiet zone reduction could result from selecting a label width that is very close to the target symbol width. Quiet zone interference could result from adjacent graphic layout images remaining constant as the symbol width expands. When symbol module widths are rounded up, the software should clearly indicate the required quiet zone area to the designer.

Refer to Annex F for a programmer's example for an illustration of this procedure.

4.2.1.2.2 Adjusted BWC

The printed dot width for general-purpose printers is typically larger than the measurement between the centres of two adjacent dots (pixel dimension) as shown on the right grid in Figure 1.



NOTE Dot width equal to pixel width (left) and dot width oversize compared to pixel width (right).

Figure 1 — General purpose printer dot / pixel comparison

This enlarged dot size causes the bars to be printed wider and the spaces narrower than nominal, unless the software driving the printer corrects for this condition. BWC is a procedure that is commonly performed during bar code design, which compensates for the bar width gain or loss experienced in the printing process.

Adjusted BWC is the result of a procedure, which has been introduced to make BWC result in a consistent, integer number of addressable imaging device dots based on the specified output resolution. The two types of BWC are BWR and BWI. When print gain is anticipated, BWR is used. Adjustments to BWR should be made by rounding up to the closest integer value. Rounding up is preferred because slightly narrower bars are preferred to slightly narrower spaces. When print loss is anticipated, BWI is used. Adjustments to BWI should be made by rounding down to the closest integer value. Rounding down is preferred because slightly narrower bars are preferred to slightly narrower spaces.

Refer to Annex F for a programmer's example for an illustration of this procedure.

4.2.1.2.3 Record of design attributes

If the printer supplies are appropriate and the printer's operating condition is maintained, the printer should provide quality symbols when the output conditions match the specified design attributes and the symbol has not been distorted by importing it into a secondary illustration or page layout software package. It is wise for the party printing the symbol to create the bar code at the production stage closest to the symbol output. When this is not possible and the digital bar code file is transferred between two parties, certain design attributes should be communicated. The following design attributes should be communicated for general-purpose printers to ensure symbol quality in the output stage:

— The output resolution specified for symbol output

— The adjusted symbol module dimensions based on the specified output resolution

— The adjusted BWC (bar width compensation) based on the specified output resolution

4.2.2 Indirect bar code imaging devices

This section provides software requirements for indirect imaging devices (e.g. imagesetters). Imagesetters commonly process and produce photographic film or paper, which is then used to produce imaging tools (e.g. printing plates) for traditional printing presses. Imagesetters may be used to produce bar code symbols directly where high-resolution symbols are required. Imagesetters can also be used to produce printing plates directly (e.g. direct-to-plate imaging).

4.2.2.1 Adjustment of target element dimensions

This procedure is intended to produce symbols with a revision in the target module width of the symbol to eliminate rounding errors. The software must be able to make adjustments to symbol character element widths based on the output resolution specified. This means the overall symbol width will be adjusted to produce an integer number of addressable dots consistently across all element widths. For symbols with a fixed aspect ratio, a proportional adjustment should be applied to the module height (Y-dimension).

These adjustments should be made by rounding down to the closest integer value, provided the value falls within the range of widths prescribed by the symbology specification or application standard. Rounding down is preferred because rounding up could cause reduction or interference in the area allocated to the quiet zone. Quiet zone reduction could result from selecting a label width that is very close to the target symbol width. Quiet zone interference could result from adjacent graphic layout images remaining constant as the symbol width expands. When symbol module widths are rounded up, the software should clearly indicate the required quiet zone area to the designer.

Refer to Annex F for a programmer's example for an illustration of this procedure.

4.2.2.2 Adjusted BWC (Bar Width Compensation)

BWC refers to a procedure in bar code design, which compensates for the bar width gain or loss experienced in the printing process. For instance, if a press prints a 0,254 mm bar width as 0,330 mm wide, it would have print gain of 0,038 mm on both sides of the bar. In order to print a bar close to the 0, 254 mm target, a BWR of 0,076 mm would be applied to the bar on the final film and imaging tool. In this example, every bar is reduced in width by 0,076 mm and every adjacent space is increased by 0,076 mm.

Adjusted BWC is the result of a procedure, which has been introduced to make BWC result in a consistent, integer number of addressable imaging device dots based on the specified output resolution. The two types of BWC are BWR and BWI. When print gain is anticipated, BWR is used. Adjustments to BWR should be made by rounding up to the closest integer value. Rounding up is preferred because slightly narrower bars are preferred to slightly narrower spaces. When print loss is anticipated, BWI is used. Adjustments to BWI should be made by rounding down to the closest integer value. Rounding down is preferred because slightly narrower bars are preferred to slightly narrower spaces.

Refer to Annex F for a programmer's example for an illustration of this procedure.

4.2.2.3 Adjustments for planned distortion (disproportioning)

Bar codes are typically imaged in an orientation where the bars run parallel to the press feed direction (picket fence orientation). In certain cases, running a symbol's bars perpendicular to the press direction (ladder orientation) is unavoidable and requires distortion of the image in the web direction based on the specified plate roll circumference. The following software procedure can be used in the bar code design stage to eliminate rounding errors when the symbol will be distorted at a later production stage:

1) Determine the percentage of distortion required to compensate for the plate elongation as it wraps around the cylinder.

2) Multiply the distortion factor (factor from step 1) by the desired printed symbol X-dimension to determine the target X-dimension of the distorted image.

3) Adjust the target X-dimension of the distorted image (result of step 2) by rounding down to the closest integer of imagesetter dots per module.

4) Divide the adjusted target X-dimension (result of step 3) by the distortion factor to determine the X-dimension to use for designing the bar code in the pre-distorted artwork.

These four steps, together with BWR and any special compensation for the symbol characters described in 4.2.2.4, correspond to the steps in the programmers' example shown in Annex F.3.

4.2.2.4 Adjustments for special EAN/UPC symbol characters

The four EAN/UPC symbol characters, which encode the digits 1, 2, 7, and 8, involve "undersize" or "oversize" bars and spaces as shown in ISO/IEC 15420. These adjustments are independent of BWR, which is required to compensate for uniform print gain. For the characters 1 and 2 in the left half of the EAN/UPC symbol and characters 7 and 8 in the right half of the EAN/UPC symbol, the bar elements are decreased in width by 1/13 of the X-dimension (1/13X). For the characters 7 and 8 in the left half of the symbol and characters 1 and 2 in the right half of the symbol, the bar elements are increased in width by 1/13 of the X-dimension (1/13X).

Adjustment for special EAN/UPC symbol characters is a procedure to adjust for the bar width corrections made to symbol characters representing the digits 1, 2, 7, or 8. The amount of adjustment should be the number of addressable imagesetter dots which provides the closest approximation to (1/13)X, (rounded up for ⩾ 0.5 of dot width and down for < 0.5 of dot width). The software should modify the module widths of symbol characters representing the digits 1, 2, 7, & 8 based on ISO/IEC 15420.

Refer to Annex F for a programmer's example for an illustration of this procedure.

4.2.2.5 Record of design attributes

The bar code design process prescribed in 4.2.2.1 through 4.2.2.4 will provide quality symbols when the output conditions match the specified design attributes and the digital bar code file has not been distorted by importing it into a secondary illustration or page layout software package. It is wise to create the bar code at the production point when output resolution is known. When this is not possible and the digital bar code file is transferred between two parties, certain design attributes should be communicated. The following design attributes should be communicated for indirect imaging devices (e.g. imagesetters) to ensure symbol quality in the output stage:

1) The output resolution specified for symbol output

2) The adjusted symbol module dimensions based on the specified output resolution

3) The adjusted BWC based on the specified output resolution

4) Intended printing process and symbol orientation

5) Name and company name of the digital bar code designer

6) Symbol design package used

7) Symbol origination date

8) Where applicable, bar coded item description and name of company specifying (ordering) the bar code

4.3 Test requirements

4.3.1 System configuration

For each configuration to be tested, the software shall be installed in accordance with the supplier's instructions, and the following information on the configuration shall be recorded together with the test results:

— Hardware configuration and associated parameters (computer, interface, make and model of printer, resolution of output)

— Identification of software under test including version and revision numbers;

— Additional software, firmware or hardware components needed to enable the functions of the software under test to be tested;

— Any other constraints or requirements (e.g. consumables) which may affect the test results.

4.3.2 Test procedure

The production system shall be set up and the software under test installed in the configuration defined in accordance with 4.3.1. Using the Test Layout in Annex A, for each symbology supported, the following parameters for each symbology should be tested:

— Random data strings in accordance with the character set of the symbology

— Data string lengths

— Optional symbology features (e.g. "EAN/UPC" add-on symbols, optional check character, full ASCII encodation, specific subsets such as "GS1-128")

— X-dimensions (at least two values)

— In the case of two width symbologies

— Where available as a user option, BWC

If practicable, the entire character set should be tested, if necessary over a series of tests. In addition, the test should include data and parameter values expected to be outside the capabilities of the software or symbology, in order to test handling and reporting of errors. At least one test of each parameter shall be performed but it shall not be required to test every possible combination of options.

The resulting symbols shall be verified using an instrument conforming with ISO/IEC 15426.

4.4 Conformance

The software is in conformance with this International Standard if:

— The symbols conform to the relevant symbology specification;

— The decoded data on all test symbols corresponds with the input;

— Where the software is used as a component of a direct bar code printing system, at least ten samples shall be tested, all of which shall achieve not less than 62 % for decodability according to ISO 15416 for the conditions reported;

— The symbol dimensions have been adjusted in accordance with user inputs to eliminate pixel-rounding errors. If the software does not provide for the X-dimension or N (the wide to narrow bar width ratio) to be matched automatically to the printer resolution, the instructions supplied to the user shall provide clear guidance on how to achieve such adjustments.

4.4.1 Certification

The manufacturer shall include with the software documentation a declaration that the software has been tested in conformity with this International Standard. This documentation shall include a reference(s) to the relevant test report and shall give information as to its availability.

4.4.2 Software specification

The supplier shall make available to bona fide enquirers on request a specification of the bar code-related features and functions, which conform with this International Standard, including a copy of the test report and (as applicable), the following:

— System configuration(s) on which the software has been tested for conformance;

— Symbologies and optional features thereof supported;

— Range of X and Y dimensions and values of N (wide to narrow bar width ratios) supported;

— Data input methods/options;

— Other user-selectable symbol parameters including ranges of values of such parameters;

— Other bar code-related features and functions performed.

Annex G gives a list of the more common functions some or all of which may be performed by bar code production software.

The specification shall also indicate clearly if any additional elements or operations must be performed by the user in order for the software to perform correctly as part of a system, for example:

— Calculation of symbol check character;

— Specific input of overhead components such as start/stop characters;

— Code subset selection and optimization.

— Symbol format optimizations (e.g. symbol length for "Code 128")

4.5 Test report

The test report shall identify the software under test clearly (including version or revision numbers) and shall give the following information:

— Hardware, software, and consumable configuration as defined in 4.3.1;

— Symbologies tested and whether the results conform with the symbology specification;

— Symbology optional features tested and whether the results conform with the symbology specification;

— Input data and user-selected parameter values;

— Decoded output data and whether it matches the input data and values;

— Values of Z and N compared with intended values of X and N;

— Decodability grade obtained in accordance with International standards such as ISO/IEC 15416;

— Results of error handling tests, (e.g. error message reported, failure to output a symbol);

5 Dedicated bar code printers

The testing procedures in this section are intended to report the conditions under which dedicated bar code printers are capable of producing quality symbols. The tests performed under the reported conditions will typically be performed in a controlled setting. Ongoing verification of symbols produced in an operational setting should be performed using the methodology contained in ISO/IEC 15416. Further guidance on equipment maintenance and supplies are found in Annex C.

5.1 Data input requirements

Check characters for encoded data shall either be calculated or verified by the software resident within the printer. For example, if the software prompts for the entry of only twelve digits for an EAN-13 symbol, the software resident within the printer shall automatically calculate the check character. Alternatively, the software might prompt for the entry of thirteen digits and indicate an error if the check character input is incorrect. The latter approach assures that valid data has been entered.

5.2 Test requirements

5.2.1 Selection of equipment for testing

Printing tests shall be carried out on at least one printer which has been selected from a production batch in accordance with the manufacturer's own quality control sampling scheme.

NOTE It is in the manufacturer's own interest to ensure that the printer selected is representative of its type. Guidance on sampling is given in ISO 2859-1.

5.2.2 Test conditions

5.2.2.1 Environment

Tests on bar code printing systems shall be executed under the following conditions:

Power supply:	test under rated conditions
Temperature:	within a range to be defined by manufacturer; if not specified, 23 ± 5° C
Relative humidity:	to be defined by manufacturer; if not specified, 50 ± 10 %

Consumable materials to be used shall have been stored under the temperature and humidity conditions specified for a sufficient time to ensure their dimensional stability during the test period.

The conditions prevailing at the time of testing shall be recorded with the test results.

5.2.2.2 Equipment configuration

The equipment under test shall be installed in a configuration representative of the expected conditions of application and the following information shall be recorded with the test results:

— The means of controlling the printer (necessary to verify that the printed image corresponds to the intended bar code symbol);

— Physical conditions, e.g. type of interface;

— Logical conditions such as the type of data sent to the printer, e.g. ASCII string, bit map.

If the printer under test uses external software, then the software in the host computer should generate symbols capable of conforming with the symbology specification, and should be identified.

5.2.3 Test procedure

The manufacturer shall select at least one symbology for testing from the range of symbologies, which the printing system is capable of printing, together with data strings in accordance with the character set of the symbology. The test layout in Annex A will then be used to determine two results for each symbol orientation.

The first result shall be the determination of the smallest X dimension at which a quality grade of not less than 1,5 in accordance with ISO/IEC 15416 can be attained in a test run carried out under the following conditions:

— The printer shall have been turned off for a minimum of two hours prior to the test;

— The samples shall be printed in a continuous run of five minutes duration, or sufficient time to produce 100 samples, if longer;

— The symbols in the test layout shall have a range of X dimensions selected by the manufacturer;

— The speed at which the samples are printed shall be reported by the printer manufacturer with the test result;

— The first 50 samples and the last 50 samples from the test run shall be measured in accordance with ISO/IEC 15416;

— The X dimension reported shall be the smallest that receives the grade of 1,5 for 95 of the 100 samples measured.

The second result shall be the determination of the maximum speed at which a quality grade of not less than 1,5 in accordance with ISO/IEC 15416 can be attained in a number of test runs carried out under the following conditions:

— The printer shall have been turned off for a minimum of two hours prior to the test;

— The samples shall be printed in a continuous run of five minutes duration, or sufficient time to produce 100 samples, if longer;

— The test runs shall be carried out at a range of speeds selected by the manufacturer

— The X-dimension of the samples in the test run shall be the smallest as determined in the test above and shall be reported by the manufacturer with the test result

— The first 50 samples and the last 50 samples from the test run shall be measured in accordance with ISO/IEC 15416;

— The speed reported shall be the highest that receives the grade of 1,5 for 95 of the 100 samples measured.

If the manufacturer wishes to report additionally the values of the minimum X-dimension and the maximum speed that receive other quality grades, he should perform a similar set of tests under the conditions defined, substituting the desired grade for 1,5.

For systems incorporating the ability to increment or decrement data fields consecutively, at least one bar code symbol on the test layout shall consist of the following elements:

— It shall be accompanied by its human-readable interpretation;

— The data encoded shall be incremented or decremented in steps of 1 (or another value, to be reported with the test results);

— A starting number selected at random which together with leading zeroes or other prefix if appropriate will result in a symbol of a desired length, and which will also allow for the finishing number to remain within the capacity of the symbol.

5.3 Conformance

The printing system shall be in conformance with this International Standard if:

— The symbols conform with the relevant symbology specification, and

— the decoded data on all test symbols corresponds with that input, and

— at least 95 % of the printed symbols achieve the minimum quality grade specified, and the remainder achieve Grade 1 or better.

5.3.1 Certification and labelling

The manufacturer shall include with the printer documentation a declaration that the equipment has been tested in conformity with this International Standard. This documentation shall include a reference(s) to the relevant test report and give information as to its availability.

The manufacturer may affix labels to the equipment indicating that the printer has been tested in accordance with this International Standard. No requirements are defined for this labelling.

5.3.2 Equipment specification

The manufacturer shall specify the following in documentation available to users of the equipment.

— The test results from 5.2.3;

— The type and number of interfaces;

— Interface connectors;

— Baud rate(s);

— Communication "handshake" protocols;

— Programming language(s) supported;

— Symbologies and optional features thereof supported;

— (Optionally) the nominal printhead resolution, e.g. 8 dots per mm;

— The X dimensions which it can accommodate;

— The wide/narrow ratios that it is capable of printing within the range specified by the symbology specification, for two-width symbologies.

In addition to the requirements above, the printer manufacturer may also choose to provide details on configuration and interface options.

5.4 Test report

The test conditions, equipment and software configuration and set-up parameters, test layout, sample size and consumables used shall be recorded together with the following:

— Symbologies tested and whether the results conform with the symbology specification;

— Symbology optional features tested, e.g. "EAN/UPC" add-on symbols, optional check character, full ASCII encodation, specific subsets such as "GS1-128" and whether the results conform with the symbology specification;

— Dimensional specifications: X and Y dimensions (these should be expressed in mm or in inches and mm, but may be in pixels or integer multiples of the nominal printing resolution provided that this in turn is defined in mm or in inches and mm), wide/narrow bar width ratio where applicable;

— Data strings encoded;

— For each value of X-dimension and symbol orientation, the mean Z dimension and the percentages of symbol grades in accordance with ISO/IEC 15416 achieved within each sample;

— Any other limiting factors which may affect the symbol grading, e.g. speed, duty cycle, throw distance, symbol length or height.

If the incrementation/decrementation test has been performed, the following information shall also be recorded:

— Symbology;

— Starting number(s);

— Increment/decrement step(s);

— Finishing number(s);

— Confirmation that the intended sequence(s) was/(were) adhered to.

A copy of the test report that includes the parameters in Annex B shall be made available to bona fide enquirers on request.

Annex A
(normative)

Sample test layout

The minimum requirement is a layout comprising a single bar code symbol, printed in picket fence and ladder orientations, together with a human-readable interpretation of the data encoded (the latter is optional in the case of multi-row or matrix code symbols encoding more than 50 characters of data).

The layout shown in Figure A.1 indicates a suggested arrangement of test bar code symbols on a test label. The label is not dimensioned and its width should suit the printing width of the particular printer under test, and the number, symbologies and relative positioning of the bar code symbols may be adjusted. The full printing width should be covered, subject to leaving the required quiet zones before the start pattern and after the stop pattern of test symbols.

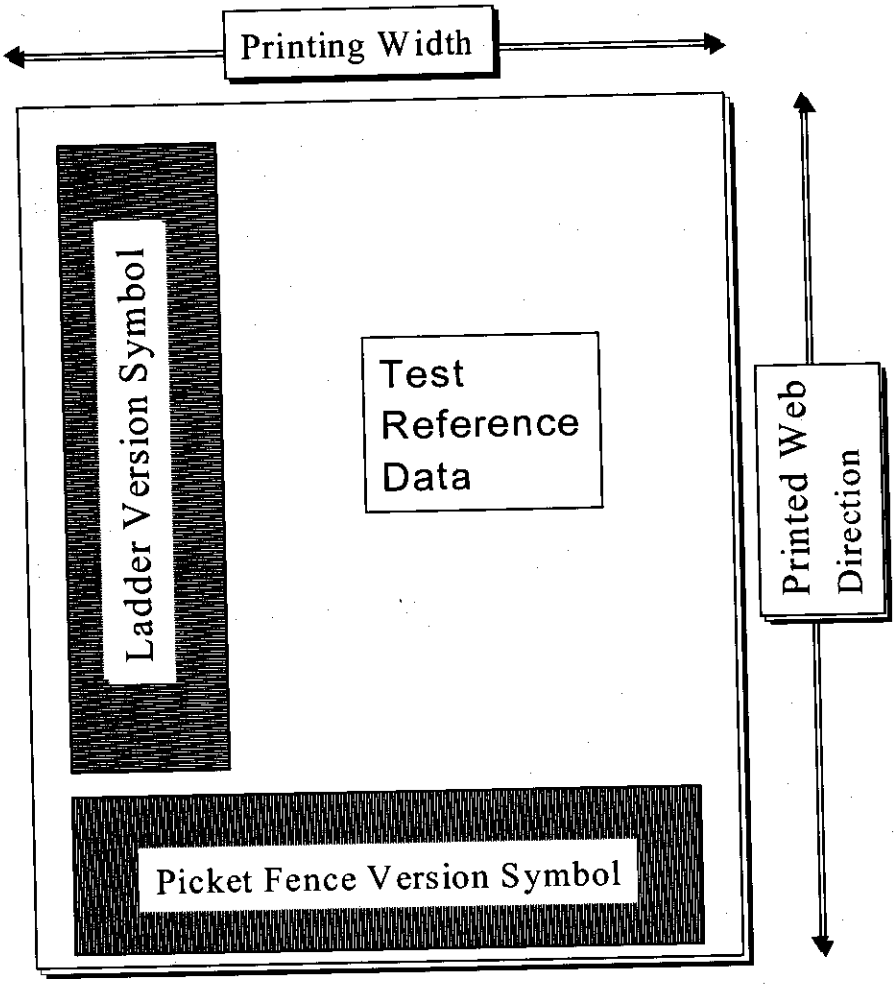


Figure A.1 — Sample test layout

Annex B
(normative)

General constructional and operational requirements

B.1 Installation, operation, and maintenance - general

The manufacturer shall specify in documentation provided for or available to the installer, user and maintainer of the equipment the conditions for installation, operation and maintenance of the equipment. These documents shall indicate the recommended extent and frequency of maintenance, if any. When equipment, which is the subject of this International Standard, is installed, operated or maintained in accordance with the above conditions, it shall be capable of operating as specified.

B.2 Power supply

The manufacturer shall indicate the minimum and maximum parameters of the power supply at which the device is able to operate according to its specifications.

B.3 Temperature

B.3.1 Operating temperature range

The manufacturer shall state the range of temperatures in degrees Celsius within which the equipment will operate.

B.3.2 Storage temperature range

The manufacturer shall state the range of temperatures in degrees Celsius, which the equipment including removable batteries shall be capable of withstanding during storage and transportation, without loss of performance.

B.4 Humidity

The manufacturer shall state the range of values of relative humidity (RH) of the air within which the equipment will operate and whether the environment is condensing or non-condensing.

Annex C
(informative)

Maintenance and supplies

C.1 Thermal printers

Direct thermal and thermal transfer printers require different settings for best results on different combinations of label and ribbon materials. Manufacturers' recommendations should be followed for making the necessary changes and adjustments.

After any change, (e.g. printed format, ribbon type, label type, print speed, or printhead heat intensity), it is advisable to print a test symbol and verify it using an ISO/IEC 15416 based verifier. If printing a long run of identical symbols, it would be appropriate to verify one symbol to determine the symbol quality. If you are printing symbols that will vary in data content, a UPC-A symbol containing the digits, 4 12785 12783 2, is recommended for the verification process.

When verifying a test symbol produced by a thermal transfer printer, a quality grade < 2.5 is typical. If this grade is not achieved, it is likely that a problem exists with printer adjustments, cleanliness, or some malfunction. With some direct thermal label materials, it may not be possible to achieve a quality grade better than 2.5.

The quality of thermal printed symbols tends to degrade as deposits build up on the thermal print head. Regular cleaning of the print head and guide surfaces in accordance with manufacturer recommendations is strongly advised.

Thermal print heads eventually wear out to the point where one or more dot elements fail to heat properly. When this occurs, the printed symbols may no longer be scannable. One solution to this problem is frequent verification to assure continuing quality. Some printers can be equipped with on-line verification devices, which will indicate when a problem is detected. Although such on-line verifiers may not test all of the parameters for ISO/IEC 15416, they can be very useful for monitoring the printing process. An alternative method for detecting dot burnout is to print a line across the width of the symbol, as shown in Figure C.1. Any dot failure will be immediately visible to the operator as a small break in the line.

Figure C.1 — Line for detecting print head element burnout

C.2 General purpose office printers

Once the required software, hardware, and consumable materials are in place, determine the symbol magnification and other parameters that will be used to produce bar code labels or tags. Next, print two test UPC-A symbols with the following test symbol data:

0 12345 01234 1

6 78912 56789 0

Then verify both test UPC-A symbols per ISO/IEC 15416. It is desirable to achieve a quality grade of 2.5 or better in this initial setup. If one or both of the test symbols are below grade 2.5, it may be possible to improve the quality by changing some of the software or printer variables. In addition to verification, the test symbols should be examined for adequate quiet zones, bar height, and legibility of the human-readable interpretation. Finally, whenever any changes are made in software parameters, the initial setup procedures should be repeated.

All printers require periodic maintenance. Laser printers, for example, not only consume toner, but also require periodic replacement of components such as drums, developers, fusers, and brushes. Consumables and replaceable parts may be contained in a single replacement cartridge, or they may be separately installed, depending on the make and model of printer. Because bar code labels contain a higher percentage of black printing than occurs in ordinary text, fewer pages can be printed between maintenance intervals.

Printed symbols should be checked visually for consistent appearance and verified whenever they appear doubtful. Symbol verification, whether conducted on-site or off-site, can be an effective tool for maintaining quality. This is particularly true after any supplies replacement or printer maintenance occurs.

Annex D
(informative)

Classification of software categories

This Annex describes the more common categories into which bar code production software may be classified.

D.1 Bar code fonts

These may exist in the form of "soft fonts" resident in a host computer or printer, or downloaded to the printer from the host computer as needed for a particular task, or as firmware (e.g. a plug-in cartridge or similar device) fitted to the printer. They normally generate a pattern of bars and spaces corresponding to a symbol character for each character or codeword transmitted from the host system.

D.2 General purpose label design

Software of this nature may have numerous features outside the scope of this International Standard. Its main function is to create (or recall from memory) a complete layout for a label with text, graphic and other elements, accept input of variable data from a variety of sources, and issue instructions to the printer which will result in the printing of the desired label. Bar code symbols may be incorporated in the layout in a variety of symbologies, sizes and orientations. The software may incorporate drivers for a specific printer or for a range of printers or may send its output to separate printer driver software.

D.3 Printer drivers

Printer driver software is normally specific to a model or range of models of printer and performs the function of converting commands from other general-purpose software into graphic commands, which will result in the desired image being printed. They may therefore contain their own bar code and text fonts, but may also perform certain intermediate processing functions on the input data to convert it to a bar code symbol.

D.4 General purpose software (e.g. word processing, database)

This type of software comes within the scope of this International Standard if it performs functions resulting in the output of a bar code symbol, e.g. through selection of an internal bar code font.

D.5 Bar code controller

These are devices which intercept defined sequences of data characters coming from the computer and convert them into graphic commands which will result in a bar code symbol being printed and are typically contained either:

— in an external device (interface box) connected between the data output port of the host computer and the input port of the printer, or

— on an additional circuit board or component fitted within the host computer or printer.

D.6 Bar code origination software

Software intended to generate bar code images on intermediary imaging tools for subsequent reproduction by conventional printing processes. Reference should be made to 4.2.2 for a description of the functions to be performed by this software.

Annex E
(informative)

Classification of imaging categories

A dedicated bar code printer is a printing device with the resident intelligence capable of converting data into bar code symbols. 4.2.1.1 provides software requirements for dedicated bar code printing devices. These devices typically have a range of addressable resolution between 4 DPMM (dots per millimetre) and 24 DPMM at the time of this printing (see Figure E.1 below). Direct thermal and thermal transfer printers used to print bar code labels or tags on a factory floor, shipping dock, or warehouse would be typical devices within this category.

A general-purpose printer is a printing device without the resident processing ability to convert data sequences into valid bar code symbols. It may be referred to as a "dumb" printer with respect to bar code printing. 4.2.1.2 provides software requirements for general-purpose printers with a range of resolutions typically between 9,45 DPMM and 48 DPMM at the time of this printing (see Figure E.1 below). This category of software may be used by those printing labels or tags directly with a printer in the office or at home. Laser and ink-jet office printers are good examples of general-purpose printers.

An indirect imaging device is used to create a bar code image onto an imaging tool (e.g. printing plate, screen, or cylinder) that in turn is used to print the final bar code symbol. This is accomplished through a device most often called an imagesetter. 4.2.2 provides software requirements for imagesetter devices with typical resolutions of 40 DPMM and higher (see Figure E.1 below). Designers and prepress staff within the graphic arts industry typically use this category of software.

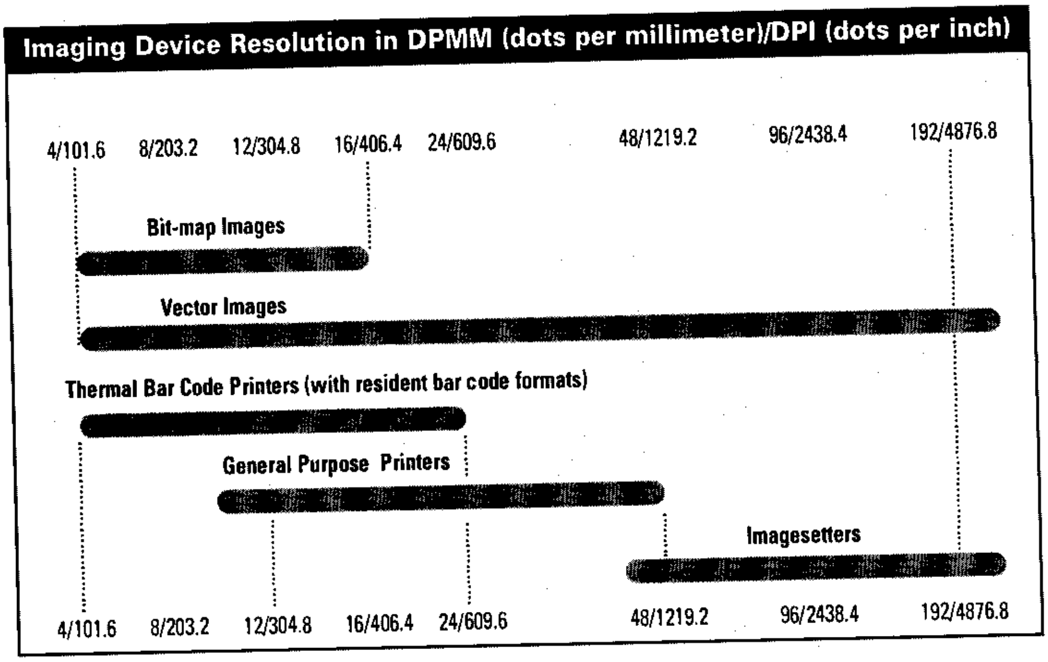


Figure E.1 — Imaging device categories

There are imaging devices, which do not fit neatly into these categories. These would include digital printing presses, high speed on-press digital print engines, direct-to-plate equipment, and printer devices that combine feed rate to print rate ratios or impact pin movements to overlap dots. Programmers writing software for these applications will find a review of 4.2.1.1, 4.2.1.2, and 4.2.2 beneficial.

3) Convert 1/13 module 1, 2, 7, & 8 compensation to an integer number of dots for desired imaging resolution;

4) Apply the calculated dot parameters to each symbol character element, guard bar pattern element, and quiet zone.

Starting conditions:

User's target magnification: 80 % magnification (0,330 mm * 0,8 = 0,264 mm)

User's target BWR: 0,05 mm

Addressable imagesetter resolution: 47,25 DPMM

1a) The module size (47,25 dots per mm * 0,80 magnification * 0,330 mm = 12,47) rounded down to 12 dots per module produces a symbol with 76,96 % magnification (12 / 47,25 / 0,330).

1b) The 76,9 magnification (result of 1a) is below the minimum 80 % specified by the application standard or symbology specification and so rounding up to 13 dots is required. The module size (47,25 dots per mm * 0,8 magnification * 0,330 mm = 12,47) rounded up to 13 dots per module produces a symbol with 83,3 % magnification (13 / 47,25 / 0,330).

2) The BWR (47,25 dots per mm * 0,050 mm) equals 2,36 dots rounding up to 3 dots per element.

3) The 1,2,7,8 compensation is at (1/13) * 13 dots = 1 dot per element.

Table F.2 on the following page illustrates the "adjustment" of a UPC-E symbol encoding the data characters 00783491 using the foregoing parameters. The leading zero is always zero, and therefore not encoded into symbol characters. The last digit, "1", is not encoded into a symbol character. Its value is derived from the parity permutation of the six encoded characters, (for more details, see ISO/IEC 15420).

Table F.2 — Adjustments of a UPC-E symbol for addressable resolution (bar element digits in bold)

UPC-E symbol encoding (00783491)	**Beginning element string (module widths in dots)**	**Dots per element after adjusting magnification (13 dots/module)**	**Dots per element after adjusting BWR (± 3 dots)**	**Dots per element after adjusting 1s, 2s, 7s, & 8s (± 1 dot)**
Left Quiet Zone (9X)	9	117	117	119
Left guard pattern	**1** –1 –**1**	**13** –13 –**13**	**10** –16 –**10**	**10** –16 –**10**
0 *The leading zero is always zero and not encoded into symbol elements*				
0	1 –**1** –2 –**3**	13 –**13** –26 –**39**	16 –**10** –29 –**36**	16 –**10** – 29 –**36**
7	2 –**1** –3 –**1**	26 –**13** –39 –**13**	29 –**10** –42 –**10**	30 –**9** –43 –**9**
8	1 –**2** –1 –**3**	13 –**26** –13 –**39**	16 –**23** –16 –**36**	15 –**24** –15 –**37**
3	1 –**1** –4 –**1**	13 –**13** –52 –**13**	16 –**10** –55 –**10**	16 –**10** –55 –**10**
4	1 –**1** –3 –**2**	13 –**13** –39 –**26**	16 –**10** –42 –**23**	16 –**10** –42 –**23**
9	3 –**1** –1 –**2**	39 –**13** –13 –**26**	42 –**10** –16 –**23**	42 –**10** –16 –**23**
1 *This digit is derived from*				

the parity encodation of the six encoded characters				
Right guard pattern	1-1 -1-1-1-1	13-13-13-13-13-13	16-10-16-10-16-10	16-10-16-10-16-10
Right Quiet Zone (7X)	7	91	91	92

F.3 Programmer's example for symbols distorted for plate roll circumference

Starting conditions for the programmers' example:

EAN/UPC symbol with a nominal X-dimension of 0,330 mm

Target EAN/UPC symbol magnification of 85 % (X-dimension at 0,85 magnification is 0.2805 mm)

Addressable imagesetter resolution is 50 DPMM

Desired BWR is 0,075 mm

Desired distortion factor is 0,97 (97 %)

Steps for the programmers' example:

1) Considering the plate thickness and cylinder diameter, the appropriate distortion factor is 0,97

2) Target magnification of the distorted symbol image: 0,85 * 0,97 = 0,82450

3) Adjusted dots per module:

a) 0,330 mm (nominal EAN/UPC X-dimension) * 50 * 0,82450 = 13,60 - 13 dots (rounded down)
(Adjusted target magnification: 13 dots / (50 * 0,330) = 0,79)

b) Target BWR in dots: 0,075 mm * 0,97 * 50 = 3,64, or 4 dots
(Because rounding BWR up is referred, 4 dots of BWR should result after distortion)

c) Target 1, 2, 7, & 8 compensation: 0,0254 mm * 0,7874016 * 50 = 1 dot
(Because 1, 2, 7, & 8 are rounded to the closest dot, 1 dot should result after distortion)

4) Final parameters for bar code design

a) Magnification to use when designing the bar code: 0,79 / 0,97 = 0,81

b) BWR to use when designing the bar code: 4/(50 * 0,97) = 0,08247 mm

c) 1, 2, 7, 8 compensation to use when designing the bar code: 1/(50 * 0,97) = 0,0194 mm

Summary: At the time of bar code design as a vector graphic image, the designer should be prompted for the starting conditions and the software should provide the adjusted magnification of 0.811754 corresponding to an X-dimension of 0,2679 mm. When the image is distorted in a subsequent production stage, the X-dimension will become 0,260 mm, which corresponds to 13 addressable imagesetter dots exclusive of rounding errors.

The final magnification of the printed symbol should return to approximately 0,81 (81 %).

Annex F
(informative)

Programmer's examples

F.1 Programmer's example for general-purpose printers

Background on starting conditions:

- A UPC-E symbol with sixty-seven modules including quiet zones
- The UPC-E symbol has a nominal X-dimension of 0,330 mm
- The UPC-E symbol has an allowable magnification range from 80 to 200 percent of nominal
- The magnification must be ⩾ 0,80 (after adjustments are made based on addressable resolution)
- Module size is rounded down (unless adjusted dimensions drop the magnification below 0,80)
- BWR is rounded up (preferred rounding method)

General procedures

1) Convert the target magnification or X-dimension to a module size in dots for the desired imaging resolution;
2) Convert the target BWR to an integer number of dots for the desired imaging resolution;
3) Apply the calculated dot parameters to each symbol character element, guard bar pattern element, and quiet zone.

Starting conditions:

User target X-dimension: 0,355 mm

User target BWR: 20 % of the X-dimension

Addressable imagesetter resolution: 24 DPMM

1) To calculate the number of dots per module in a 0,355 mm X-dimension symbol, multiply by the printer DPMM, 24 DPMM * 0,355 mm = 8,52, then round down to 8 dots per module.
2) The BWR of 20 % is 0,2 * 8 = 1,6 dots, rounded up to 2 dots per element.

Table F.1 illustrates the "adjustment" of a UPC-E symbol encoding the data characters 00783491 using the foregoing parameters. The leading zero is always zero, and therefore not encoded into symbol characters. The last digit, "1", is not encoded into a symbol character. Its value is derived from the parity permutation of the six encoded characters, (for more details, see ISO/IEC 15420).

Table F.1 — Adjustments of a UPC-E symbol for addressable resolution (bar element digits in bold)

UPC-E symbol encoding (00783491)	**Beginning element string (module widths in dots)**	**Dots per element after adjusting magnification (8 dots/module)**	**Dots per element after adjusting BWR (± 2 dots)**
Left Quiet Zone (9X)	9	72	73
Left guard pattern	**1** –1 –**1**	**8** –8 –**8**	**6** –10 –**6**
0 *The leading zero is always zero and not encoded into symbol elements*			
0	1 –**1** –2 –**3**	8 –**8** –16 –**24**	10 –**6** –18 –**22**
7	2 –**1** –3 –**1**	16 –**8** –24 –**8**	18 –**6** –26 –**6**
8	1 –**2** –1 –**3**	8 –**16** –8 –**24**	10 –**14** –10 –**22**
3	1 –**1** –4 –**1**	8 –**8** –32 –**8**	10 –**6** –34 –**6**
4	1 –**1** –3 –**2**	8 –**8** –24 –**16**	10 –**6** –26 –**14**
9	3 –**1** –1 –**2**	24 –**8** –8 –**16**	26 –**6** –10 –**14**
1 *This digit is derived from the parity encodation of the six encoded characters*			
Right guard pattern	1 –**1** –1 –**1** –1 –**1**	8 –**8** –8 –**8** –8 –**8**	10 -**6**- 10 –**6** –10 –**6**
Right Quiet Zone (7X)	7	56	57

F.2 Programmer's example for indirect bar code imaging devices

Background on starting conditions:

- A UPC-E symbol with sixty-seven modules including quiet zones
- The UPC-E symbol has a nominal X-dimension of 0,330 mm
- The UPC-E symbol has an allowable magnification range from 80 to 200 percent of nominal
- The magnification must be ⩾ 0,80 (after adjustments are made based on addressable resolution)
- Module size is rounded down (unless adjusted dimensions drop the magnification below 0,80)
- BWR is rounded up (preferred rounding method)
- 1, 2, 7, & 8 symbol character adjustments are rounded up for ⩾ 0.5 and down for < 0.5

General procedures

1) Convert the target magnification or X-dimension to a module size in dots for the desired imaging resolution;

2) Convert the target BWR to an integer number of dots for the desired imaging resolution;

Annex G
(informative)

Functions of bar code production software

The steps to be performed by the software components of a total bar code production system may be generalized as follows:

1) Receipt of input data (source to be specified, e.g. keyboard, database, other application)
2) Receipt of formatting instructions
3) Data analysis and validation
4) Error message generation
5) Symbol length or aspect ratio optimization
6) Conversion to codewords including special characters
7) Calculation of (data and) symbol check characters
8) Error correction codeword generation
9) Addition of overhead components
10) Incorporation of traceability information either in printed output or as a stored log
11) Codeword and overhead to symbol character element pattern conversion
12) Determination of final symbol structure
13) Element pattern to graphic command conversion.

It is important to note that these functions are not all applicable to all symbologies and that they may be performed by different components of the system. For example a "Code 128" bar code font will require to receive as its input data a series of symbol character values and some dimensional instructions from which it will perform only the last one or two steps in the above procedure, the necessary preceding steps having been carried out by a previous component of the system. For the evaluation of conformance with this International Standard, therefore, it is assumed that other components of the system perform their required function correctly.

Bibliography

[1] ISO/IEC Directives, Part 2, *Rules for the structure and drafting of International Standards* (2004, 5th edition)

[2] ISO/IEC 15421, *Information technology — Automatic identification and data capture techniques — Bar code master test specifications*

ICS 35.040

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