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Information technology — Automatic identification and data capture techniques — Bar code print quality test specification — Linear symbols

Technologies de l'information — Techniques d'identification automatique et de capture des données — Spécifications pour essai de qualité d'impression des codes à barres — Symboles linéaires

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. 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 International Standard may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

International Standard ISO/IEC 15416 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 31, *Automatic identification and data capture techniques*.

Annexes A and B form a normative part of this International Standard. Annexes C to J are for information only.

Introduction

The technology of bar coding 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.

The bar code symbol must be produced in such a way as to be reliably decoded at the point of use, if it is to fulfil its basic objective as a machine readable data carrier.

Manufacturers of bar code equipment and the producers and users of bar code symbols therefore require publicly available standard test specifications for the objective assessment of the quality of bar code symbols, to which they can refer when developing equipment and application standards or determining the quality of the symbols. Such test specifications form the basis for the development of measuring equipment for process control and quality assurance purposes during symbol production as well as afterwards.

The performance of measuring equipment is the subject of a separate International Standard, ISO/IEC 15426.

This International Standard is intended to be substantially equivalent in technical content to EN 1635 and ANSI standards X3.182 - 1990 and ANSI/UCC5 on which it has been based. It should be read in conjunction with the symbology specification applicable to the bar code symbol being tested, which provides symbology-specific detail necessary for its application.

There are currently many methods of assessing bar code quality at different stages of symbol production. The methodology provided in this specification is not intended as a replacement for any current process control methods but gives essential additional quality information. This methodology provides a basis for grading the quality of bar code symbols in relation to their expected performance when read and therefore gives symbol producers and their trading partners a universally standardized means for communicating about the quality of bar code symbols after they have been printed. It also provides symbol producers with information enabling them to adjust their production process.

Alternative methods of quality assessment may be agreed between parties or as part of an application specification.

Information technology — Automatic identification and data capture techniques — Bar code print quality test specification — Linear symbols

1 Scope

This International Standard

- specifies the methodology for the measurement of specific attributes of bar code symbols;
- defines a method for evaluating these measurements and deriving an overall assessment of symbol quality;
- gives information on possible causes of deviation from optimum grades to assist users in taking appropriate corrective action.

This International Standard applies to those symbologies for which a reference decode algorithm has been defined, and which are intended to be read using linear scanning methods, but its methodology can be applied partially or wholly to other symbologies.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 7724-2:1984, *Paints and varnishes — Colorimetry — Part 2: Colour measurement.*

EN 1556:1998, *Bar coding — Terminology.*

3 Terms and definitions

For the purposes of this International Standard, the terms and definitions given in EN 1556 and the following apply.

3.1
bar
A dark element corresponding to a region of a scan reflectance profile below the global threshold.

3.2
bar reflectance
The lowest reflectance value of an individual bar element in the scan reflectance profile of that element.

3.3
decodability
The proportion of the available margin (between the ideal dimension of an element or combination of elements and the relevant reference threshold) that has not been consumed by the element or combination of elements, calculated for the element or combination of elements deviating most from its ideal dimension.

3.4
decode
Determination of the information encoded in a bar code symbol.

3.5
edge contrast
The difference between bar reflectance and space reflectance of two adjacent elements.

3.6
element reflectance non-uniformity
The reflectance difference between the highest peak and the lowest valley in the scan reflectance profile of an individual element or quiet zone.

3.7
global threshold
The reflectance level midway between the maximum and minimum reflectance values in a scan reflectance profile used for the initial identification of elements.

3.8
gloss
The propensity of a surface to reflect a proportion of incident light in a specular manner.

3.9
inspection band
The band (usually from 10 % to 90 % of the height of a bar code symbol) across which measurements are taken (see Figure 2).

3.10
measuring aperture
A circular opening which governs the effective sample area of the symbol, and the diameter of which at 1:1 magnification is equal to that of the sample area.

3.11
modulation
The ratio of minimum edge contrast to symbol contrast.

3.12
(n, k) symbology
A class of bar code symbologies in which each symbol character is n modules in width and is composed of k bar and space pairs.

3.13
peak
A point of higher reflectance in a scan reflectance profile with points of lower reflectance on either side.

3.14
sample area
The effective area of the symbol within the field of view of the measurement device.

3.15
scan reflectance profile
Plot of variations in reflectance with linear distance along a scan path.

3.16
scan path
The line along which the centre of the sample area traverses the symbol, including quiet zones.

3.17
space
A light element corresponding to a region of a scan reflectance profile above the global threshold.

3.18
space reflectance
The highest reflectance value of an individual space element or quiet zone in the scan reflectance profile of that element or quiet zone.

3.19
two-width symbology
A bar code symbology in which symbol characters consist only of narrow and wide elements the widths of which are in a constant ratio to each other.

3.20
valley
A point of lower reflectance in a scan reflectance profile with points of higher reflectance on either side.

3.21
vertical redundancy
The property of a bar code symbol whereby there exist multiple possible scan paths as a result of the symbol being significantly higher than the height of a single scan line.

4 Symbols and abbreviated terms

4.1 Abbreviations

EC: Edge contrast

EC_{min}: Minimum value of EC

ERN: Element reflectance non-uniformity

ERN_{max}: Maximum value of ERN

GT: Global threshold

MOD: Modulation

PCS: Print contrast signal

RT: Reference threshold

SC: Symbol contrast

SRD: Static reflectance difference

4.2 Symbols

A: Average achieved width of element or element combinations of a particular type

e: Width of widest narrow element

E: Width of narrowest wide element

e_i: i^{th} edge to similar edge measurement, counting from leading edge of symbol character

K: Smallest absolute difference between a measurement and a reference threshold

k: number of element pairs in a symbol character in a (n, k) symbology

M: Width of element showing greatest deviation from A

m: Number of modules in a symbol character

N: Average achieved wide to narrow ratio

n: number of modules in a symbol character in a (n, k) symbology

R_b: Bar reflectance

R_D: Dark reflectance

R_L: Light reflectance

R_s: Space reflectance

R_{max}: Maximum reflectance

R_{min}: Minimum reflectance

RT_j: Reference threshold between measurements j and (j+1) modules wide

S: Total width of a character

V: Decodability value

V_C: Decodability value for a symbol character

X: Nominal narrow element dimension

Z: Average achieved narrow element dimension

5 Measurement methodology

5.1 General requirements

The measurement methodology defined in this standard is designed to maximize the consistency of both reflectivity and bar and space width measurements of bar code symbols on various substrates. This methodology is also intended to correlate with conditions encountered in bar code scanning hardware.

Measurements shall be made with a single light wavelength and a measurement aperture of a diameter defined by the application specification or determined in accordance with 5.2.1 and 5.2.2.

Whenever possible, measurements shall be made on the bar code symbol in its final configuration, i.e. the configuration in which it is intended to be scanned. If this is impossible, refer to annex D for the method to be used for measuring reflectance for non-opaque substrates.

The sampling method should be based on a statistically valid sample size within the lot or batch being tested. A minimum grade for acceptability shall be established prior to quality control inspection. In the absence of a sampling plan defined in formal quality assurance procedures or by bilateral agreement, a suitable plan may be based on the recommendations in ISO 2859 or ISO 3951.

5.2 Reference reflectivity measurements

Equipment for assessing the quality of bar code symbols in accordance with this standard shall comprise a means of measuring and analysing the variations in the diffuse reflectivity of a bar code symbol on its substrate along a number of scan paths which shall traverse the full width of the symbol including both quiet zones. The basis of this methodology is the measurement of diffuse reflectance from the symbol.

All measurements on a bar code symbol shall be made within the inspection band defined in accordance with 5.2.4.

The measured reflectance values shall be expressed in percentage terms either with reference to the reflectance of a barium sulphate or magnesium oxide reference sample complying with the requirements of ISO 7724, which shall be taken as 100 %, or by means of calibration and reference to recognised national standards laboratories for samples illuminated at 45° with the diffusely reflected light being collected perpendicular to the surface.

5.2.1 Measurement wavelength(s)

The peak light wavelength used for measurements should be specified in the application specification to suit the intended scanning environment. When the wavelength is not specified in the application specification, measurements should be made using the wavelength of light that approximates most closely to the wavelength expected to be used in the scanning process. Refer to annex F for guidance on the selection of the wavelength of light.

5.2.2 Measuring aperture

The nominal diameter of the measuring aperture should be specified by the user application specification, to suit the intended scanning environment. When the measuring aperture diameter is not specified in the application specification, Table 1 should be used as a guide. In an application where a range of X dimensions will be encountered, all measurements shall be made with the aperture appropriate to the smallest X dimension to be encountered.

In the absence of a defined X dimension, the Z dimension shall be substituted.

The effective measuring aperture diameter may vary slightly from its nominal dimension due to manufacturing tolerances and optical effects. Note that the measured width of some of the narrow elements may be smaller than the measuring aperture diameter.

Table 1 — Guideline for diameter of measuring aperture

X Dimension mm	Aperture diameter mm	Reference number
0,100 ≤ X < 0,180	0,075	03
0,180 ≤ X < 0,330	0,125	05
0,330 ≤ X < 0,635	0,250	10
0,635 < X	0,500	20
NOTE The aperture reference number approximates to the measuring aperture diameter in thousandths of an inch; this reference number is used for consistency with the ANSI standard X3.182.		

5.2.3 Optical geometry

The reference optical geometry for reflectivity measurements shall consist of:

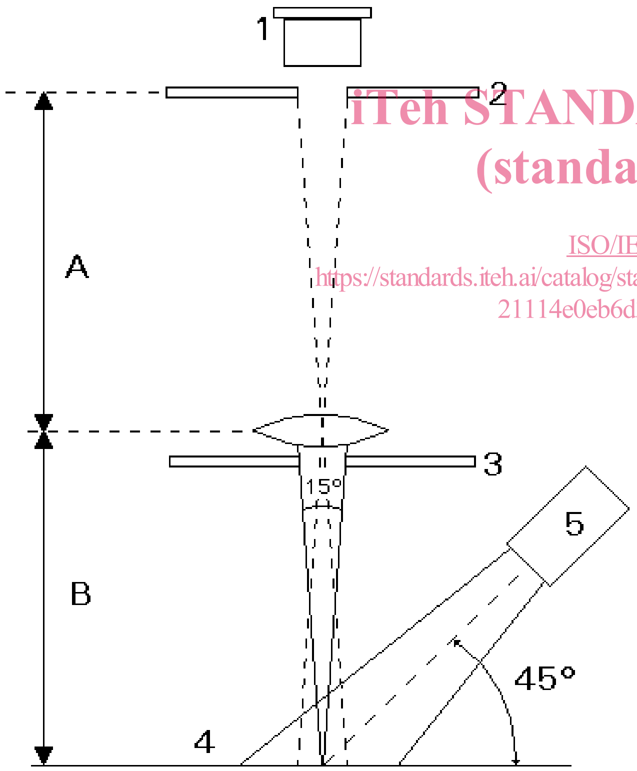
a) a source of incident illumination which is uniform across the sample area at 45° from a perpendicular to the surface, and in a plane containing the illumination source that shall be both perpendicular to the surface and parallel to the bars, and

b) a light collection device, the axis of which is perpendicular to the surface.

The light reflected from a circular sample area of the surface shall be collected within a cone, the angle at the vertex of which is 15°, centred on the perpendicular to the surface, through a circular measuring aperture, the diameter of which at 1:1 magnification shall be equivalent to that of the sample area.

NOTE Figure 1 illustrates the principle of the optical arrangement, but is not intended to represent an actual device.

This reference geometry is intended to minimise the effects of specular reflection and to maximise those of diffuse reflection from the symbol. It is intended to provide a reference basis to assist the consistency of measurement. It may not correspond with the optical geometry of individual scanning systems. Alternative optical geometries and components may be used, provided that their performance can be correlated with that of the reference optical arrangement defined in this section.

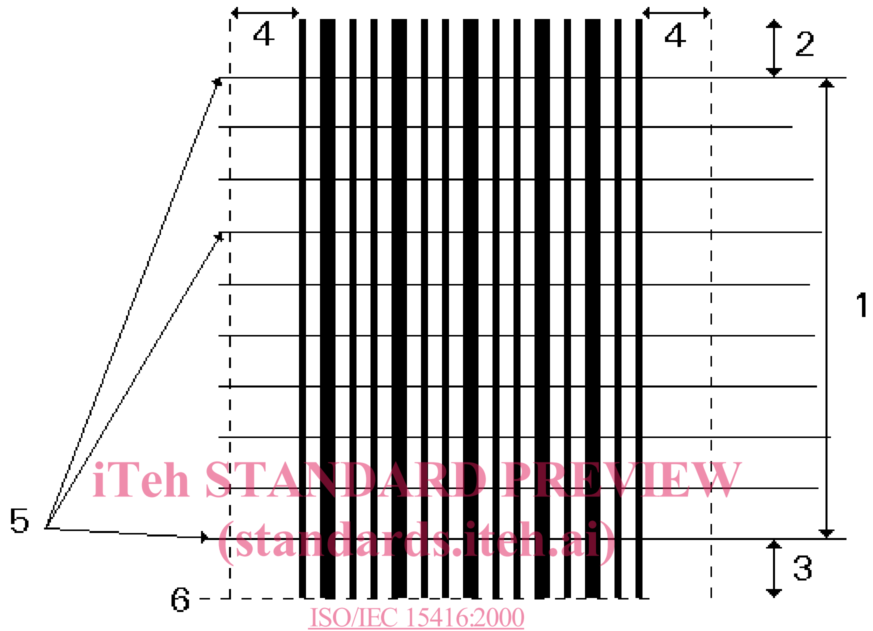


1 - Light sensing element
2 - Aperture at 1:1 magnification (measurement A = measurement B)
3 - Baffle
4 - Sample
5 - Light source

Figure 1 — Reference optical arrangement

5.2.4 Inspection band

The area within which all measurement scan paths shall lie shall be contained between two lines perpendicular to the height of the bars of the symbol, as illustrated in Figure 2. The lower line shall be positioned at a distance above the average lower edge of the bar pattern of the symbol, and the upper line at the same distance below the average upper edge of the bar pattern of the symbol. This distance shall be equal to 10 % of the average bar height, or the measuring aperture diameter, whichever is greater. The inspection band shall extend to the full width of the symbol including quiet zones.



1 - Inspection band (normally 80 % of average bar height)
2 - 10 % of average bar height, or aperture diameter if greater, above inspection band
3 - 10 % of average bar height, or aperture diameter if greater, above average bar bottom edge
4 - Quiet zones
5 - Scanning lines
6 - Average bar bottom edge

Figure 2 — Inspection band

5.2.5 Number of scans

In order to provide for the effects of variations in symbol characteristics at different positions in the height of the bars, a number of scans shall be performed across the full width of the symbol including both quiet zones with the appropriate measuring aperture and a light source of defined nominal wavelength. These scans shall be approximately equally spaced through the height of the inspection band. The minimum number of scans per symbol should normally be ten, or the height of the inspection band divided by the measuring aperture diameter, whichever is lower. Refer to annex G for guidance on the number of scans.

The overall quality grade of the symbol is determined by averaging the quality grades of the individual scans, in accordance with clause 6.

5.3 Scan reflectance profile

Bar code symbol quality assessment shall be based on an analysis of the scan reflectance profiles. The scan reflectance profile is a plot of reflectance against linear distance across the symbol. If scanning speed is not constant, measuring devices plotting reflectance against time should make provision to compensate for the effects