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

*Techniques automatiques d'identification et de capture des
données — Spécifications pour essai de qualité d'impression des codes
à barres — Symboles linéaires*

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Contents

	Page
Foreword	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Symbols and abbreviated terms	2
4.1 Abbreviated terms.....	2
4.2 Symbols.....	3
5 Measurement methodology	4
5.1 General requirements.....	4
5.2 Reference reflectivity measurements.....	4
5.2.1 General.....	4
5.2.2 Measurement light source.....	4
5.2.3 Measuring aperture.....	4
5.2.4 Optical geometry.....	5
5.2.5 Inspection band.....	6
5.2.6 Number of scans.....	7
5.3 Scan reflectance profile.....	7
5.4 Scan reflectance profile assessment parameters.....	8
5.4.1 General.....	8
5.4.2 Element determination.....	9
5.4.3 Edge determination.....	9
5.4.4 Decode.....	10
5.4.5 Symbol contrast (SC).....	10
5.4.6 Edge contrast (EC).....	10
5.4.7 Modulation (MOD).....	10
5.4.8 Defects.....	10
5.4.9 Decodability.....	12
5.4.10 Quiet zone check.....	13
6 Symbol grading	13
6.1 General.....	13
6.2 Scan reflectance profile grading.....	13
6.2.1 Decode.....	14
6.2.2 Reflectance parameter grading.....	14
6.2.3 Decodability.....	14
6.3 Expression of symbol grade.....	15
7 Substrate characteristics	15
Annex A (normative) Decodability	16
Annex B (informative) Example of symbol quality grading	17
Annex C (informative) Substrate characteristics	19
Annex D (informative) Interpretation of the scan reflectance profile and profile grades	23
Annex E (informative) Guidance on selection of light wavelength	26
Annex F (informative) Guidance on number of scans per symbol	28
Annex G (informative) Example of verification report	29
Annex H (informative) Comparison with traditional methodologies	30
Annex I (informative) Process control requirements	33
Bibliography	36

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.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the WTO principles in the Technical Barriers to Trade (TBT) see the following URL: [Foreword - Supplementary information](#)

The committee responsible for this document is 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 15416:2000), which has been technically revised with the following changes, as well as minor editorial modifications:

- the computation of “Defects” was modified in this revision of ISO/IEC 15416 (see Note 3 in [5.4.8](#)); and
- sharp boundaries between grade levels are avoided by assigning grades within grade boundaries to the first decimal place (see the Notes in [6.2.2](#) and [6.2.3](#)).

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 is 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 to 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 standard, ISO/IEC 15426-1.

This document is to 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.

This methodology provides symbol producers and their trading partners a universally standardized means for communicating about the quality of bar code symbols after they have been printed.

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

1 Scope

This document:

- 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; and
- provides information on possible causes of deviation from optimum grades to assist users in taking appropriate corrective action.

This document 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

There are no normative references in this document.

3 Terms and definitions

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

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at <http://www.electropedia.org/>
- ISO Online browsing platform: available at <http://www.iso.org/obp>

3.1

bar reflectance

lowest reflectance value in the scan reflectance profile of a bar element

3.2

decode

determination of the information encoded in a bar code symbol

3.3

edge contrast

difference between *bar reflectance* (3.1) and *space reflectance* (3.14) of two adjacent elements

3.4

element reflectance non-uniformity

reflectance difference between the highest *peak* (3.9) and the lowest *valley* (3.16) in the scan reflectance profile of an individual element or quiet zone

3.5

global threshold

reflectance level midway between the maximum and minimum reflectance values in a scan reflectance profile used for the initial identification of elements

**3.6
inspection band**

band (usually from 10 % to 90 % of the height of a bar code symbol) across which measurements are taken

Note 1 to entry: See [Figure 2](#).

**3.7
measuring aperture**

opening which governs the effective *sample area* ([3.10](#)) of the symbol, and the dimensions of which at 1:1 magnification is equal to that of the sample area

**3.8
modulation**

ratio of minimum *edge contrast* ([3.3](#)) to *symbol contrast* ([3.15](#))

**3.9
peak**

point of higher reflectance in a scan reflectance profile with points of lower reflectance on either side

**3.10
sample area**

effective area of the symbol within the field of view of the measurement device

**3.11
scan path**

line along which the centre of the *sample area* ([3.10](#)) traverses the symbol, including quiet zones

**3.12
show-through**

property of a substrate that allows underlying markings or materials to affect the reflectance of the substrate

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**3.13
space**

light element corresponding to a region of a scan reflectance profile above the *global threshold* ([3.5](#))

**3.14
space reflectance**

highest reflectance value in the scan reflectance profile of a space element or quiet zone

**3.15
symbol contrast**

difference between the maximum and minimum reflectance values in a scan reflectance profile

**3.16
valley**

point of lower reflectance in a scan reflectance profile with points of higher reflectance on either side

4 Symbols and abbreviated terms

4.1 Abbreviated terms

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

4.2 Symbols

A	average achieved width of element or element combinations of a particular type
c	defect adjustment constant
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
F	factor used to soften the effect on defect grades derived from small changes peaks and valleys within an element
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_{max}	maximum reflectance
R_{min}	minimum reflectance
R_s	space 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
Z	average achieved narrow element dimension or module size, as measured

5 Measurement methodology

5.1 General requirements

The measurement methodology defined in this document 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 defined light source (such as a single light wavelength) and a measuring aperture of dimensions defined by the application specification or determined in accordance with [5.2.1](#) and [5.2.2](#). A circular aperture is defined by its diameter in accordance with [Table 1](#). Application specifications may define other aperture diameters or shapes.

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 C](#) 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 2859-1.

5.2 Reference reflectivity measurements

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5.2.1 General

Equipment for assessing the quality of bar code symbols in accordance with this document 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 by means of calibration and reference to recognized national standards laboratories, where 100 % should correspond to the reflectance of a barium sulphate or magnesium oxide reference sample.

5.2.2 Measurement light source

The light source used for measurements should be specified in the application specification to suit the intended scanning environment. When the light source is not specified in the application specification, measurements should be made using the light source that approximates most closely to the light source expected to be used in the scanning process. Light sources may include narrow band or broad band illumination. Refer to [Annex E](#) for guidance on the selection of the light source.

5.2.3 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
$0,100 \leq X < 0,180$	0,075	03
$0,180 \leq X < 0,330$	0,125	05
$0,330 \leq X < 0,635$	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.

NOTE The measuring aperture is not to be confused with the F-number of a lens.

5.2.4 Optical geometry

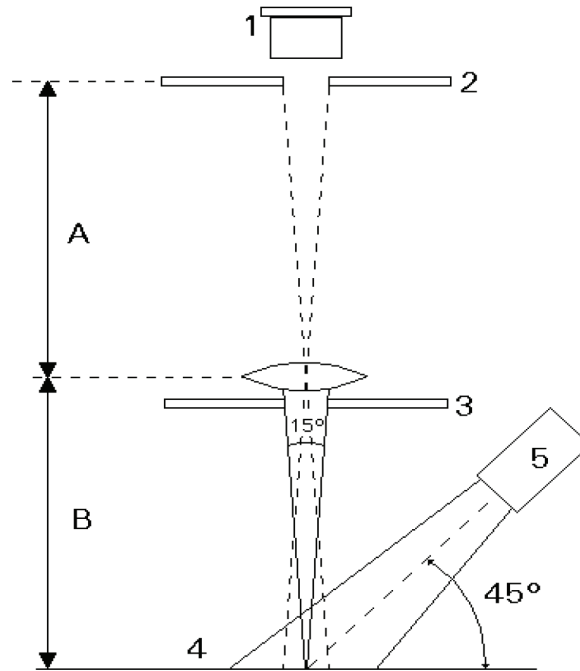
The reference optical geometry for reflectivity measurements shall consist of the following:

- 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;
- 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 minimize the effects of specular reflection and to maximize 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 subclause.



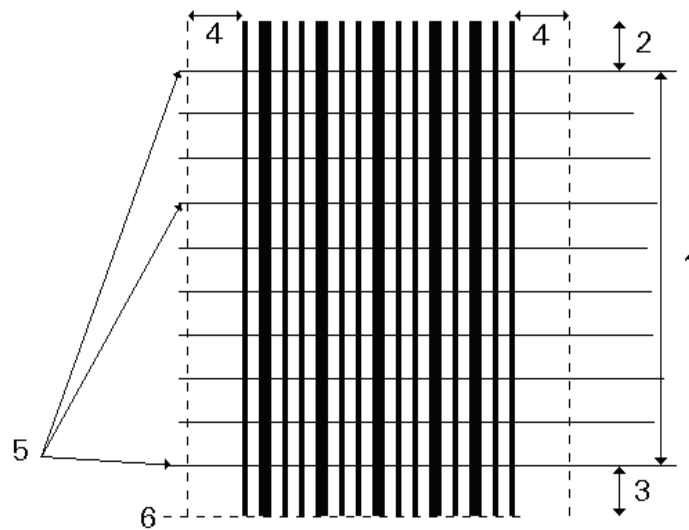
Key

- 1 light sensing element
- 2 aperture at 1:1 magnification (measurement A = measurement B)
- 3 baffle
- 4 sample
- 5 light source

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Figure 1 — Reference optical arrangement

5.2.5 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 while the upper line shall be positioned 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.



Key

- 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

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 Figure 2 — Inspection band

5.2.6 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 10 or the height of the inspection band divided by the measuring aperture diameter, whichever is lower. Refer to [Annex F](#) 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 of acceleration or deceleration. If the plot is not a continuous analogue profile, the measurement intervals should be sufficiently small to ensure that no significant detail is lost and that dimensional accuracy is adequate.

[Figure 3](#) is a graphical representation of a scan reflectance profile. The vertical axis represents reflectance and the horizontal axis linear position. The high-reflectance areas are spaces and the low-reflectance areas are bars. The high-reflectance areas on the extreme left and right are the quiet zones. The important features of the scan reflectance profile can be determined by manual graphical