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Information technology — Automatic identification and data capture techniques — Bar code verifier conformance specification —

Part 2: Two-dimensional symbols

Technologies de l'information — Techniques automatiques d'identification et de capture des données — Spécifications de conformité des vérificateurs de codes à barres —

Partie 2: Symboles bi-dimensionnels

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ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

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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.

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 or www.iec.ch/members_experts/refdocs).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html. In the IEC, see www.iec.ch/understanding-standards.

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

This third edition cancels and replaces the second edition (ISO/IEC 15426-2:2015), which has been technically revised.

The main changes are as follows:

— tolerances for certain parameters have been clarified;

— fixed pattern damage test symbol for Aztec code has been added.

A list of all parts in the ISO/IEC 15426 series can be found on the ISO and IEC websites.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html and www.iec.ch/national-committees.

Introduction

The technology of bar coding is based on the recognition of patterns encoded, in bars and spaces or in a matrix of modules of defined dimensions, according to rules defining the translation of characters into such patterns, known as the symbology specification. Symbology specifications can be categorised into linear symbols, on the one hand, and two-dimensional symbols on the other; the latter can in turn be subdivided into «multi-row bar codes» sometimes referred to as “stacked bar codes”, and “two-dimensional matrix codes”.

Multi-row bar codes are constructed graphically as a series of rows of symbol characters, representing data and overhead components, placed in a defined vertical arrangement to form a (normally) rectangular symbol, which contains a single data message. Each row of the symbol has the characteristics of a linear bar code symbol and can be read by linear symbol scanning techniques.

Two-dimensional matrix symbols are usually rectangular arrangements of modules placed at the intersections of a grid of two (sometimes more) axes; the coordinates of each module need to be known in order to determine its significance, and the symbol must therefore be analysed two-dimensionally before it can be decoded.

Unless the context requires otherwise, the term “symbol” in this document can refer to either type of symbology.

The symbol, as a machine-readable data carrier, 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. Standard methodologies have been developed for measuring and assessing the quality of symbols for process control and quality assurance purposes during symbol production as well as afterwards.

Manufacturers of bar code equipment, the producers of bar code symbols and the users of bar code technology require publicly available standard conformance specifications for measuring equipment applying these methodologies, to ensure the accuracy and consistency of the performance of this equipment.

This document is intended to be similar in technical content (mutatis mutandis) to the linear bar code verifier conformance standard, ISO/IEC 15426-1, on which this document has been based. This document 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.

Information technology — Automatic identification and data capture techniques — Bar code verifier conformance specification —

Part 2: Two-dimensional symbols

1 Scope

This document specifies the test methods for representative samples of the equipment and the minimum accuracy criteria applicable to verifiers using the methodologies of ISO/IEC 15415 for multi-row bar code symbols and two-dimensional matrix symbologies. This document also specifies reference calibration standards for verifier conformance.

NOTE ISO/IEC 15426-1 applies to verifiers for linear bar code symbols.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements 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/IEC 15415, *Information technology — Automatic identification and data capture techniques — Bar code symbol print quality test specification — Two-dimensional symbols*

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

ISO/IEC 19762, *Information technology — Automatic identification and data capture (AIDC) techniques — Harmonized vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/IEC 15415, ISO/IEC 19762 and the following apply.

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

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1
primary reference test symbol
bar code symbol intended for the testing of the accuracy of bar code verifiers and manufactured to close tolerances, much higher than bar code verifiers to be tested, by methods traceable to national standards

4 Symbols

R_b Bar reflectance, as defined in ISO/IEC 15416

R_{max} Maximum reflectance, as defined in ISO/IEC 15416

R_{min} Minimum reflectance, as defined in ISO/IEC 15416

R_s Space reflectance, as defined in ISO/IEC 15416

5 Conformance

The instrument shall be considered to conform with this document if it performs the functions defined in 6.3 and if the results of measurements of primary reference test symbols carried out in accordance with Clause 8 demonstrate that the arithmetic means of the ten measurements (for multi-row bar code symbols) or five measurements (for two-dimensional matrix symbols) of individual reported parameters are within the tolerances shown in Table 1.

Table 1 — Tolerances for measured parameter values

Parameter	Symbology type	Tolerance
R_{max} and/or R_s	Both	±5 % reflectance
R_{min} and/or R_b	Both	±3 % reflectance
Unused error correction (UEC)	Both	±0 (see A.3.3)
Decodability	Multi-row	±0,08
Defects	Multi-row	±0,08
Codeword yield	Multi-row	±0,08
Grid nonuniformity	Matrix	±0,06
Axial nonuniformity	Matrix	±0,02
Contrast uniformity (modulation)	Matrix	±0,08 for the contrast uniformity value described in A.3.2
Fixed pattern damage	Matrix	Within calibrated grade boundaries
NOTE The tolerances are additional to any tolerances stated by the supplier of the primary reference test symbols.		

6 Functional requirements

6.1 General requirements

The general requirement of a two-dimensional symbol verifier is that it shall provide assessments of the quality of a bar code symbol which are accurate and consistent, both in relation to measurements of a specific symbol made with the same instrument over a period of time and in relation to measurements of a specific symbol made by different instruments. Such consistency is essential to enable valid comparisons to be made of assessments of a symbol verified at two different times or on two different instruments.

6.2 Reflectance calibration

Verifiers shall have means of calibration and adjustment where necessary of reflectance values against reference reflectance calibration samples. Two calibration points should be used, one as near the high reflectance end of the range and the other as near the low reflectance end of the range as possible.

ISO/IEC 15415 defines the reference reflectance material against which these samples shall be calibrated.

6.3 Mandatory functions

6.3.1 Verifiers for multi-row bar code symbols

A verifier for multi-row bar code symbols applying the methodology defined in ISO/IEC 15415 shall be capable of:

— collecting reflectance measurements from points along multiple scan paths across a bar code symbol;

— establishing scan reflectance profiles from these measurements;

— analysing the scan reflectance profiles;

— reporting individual scan reflectance profile parameter grades and profile grades;

— reporting the codeword yield value and grade;

— reporting the unused error correction value and grade;

— determining and reporting an overall symbol grade;

— reporting the decoded data.

6.3.2 Verifiers for two-dimensional matrix symbols

A verifier for two-dimensional matrix symbols applying the methodology defined in ISO/IEC 15415 shall be capable of:

— collecting reflectance measurements from a sample area framing the test symbol and its quiet zones, extending for certain symbol sizes 20X (where X is the specified width of the narrow elements in a bar code symbol or the specified width of a single element in a two-dimensional symbol) beyond the quiet zones (see Clause 10);

— establishing a reference grey-scale image and a binarized image as described in ISO/IEC 15415;

— decoding these images in accordance with the applicable reference decode algorithm;

— reporting individual values and grades for each of the parameters listed in ISO/IEC 15415;

— determining and reporting an overall symbol grade;

— reporting the decoded data.

The method of reporting is not specified but may be by means of, for example, a display screen in the instrument, a printed report or an electronic communication with another device such as a computer.

6.4 Optional functions

Users of verifiers have differing requirements for the amount of the details reported by the instrument, and a verifier may therefore perform additional functions, for example:

— reporting of number of scan reflectance profiles or images on which the overall symbol grade is based;

— reporting of symbology verified;

— reporting all decoded symbol characters or codewords;

— print-out or display of all or, at the user's option, selected scan reflectance profiles or images.

7 General constructional and operational requirements

7.1 Installation, operation and maintenance

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 document is installed, operated and maintained in accordance with the above conditions, it shall be capable of operating as specified.

7.2 Power supply

The manufacturer shall indicate the minimum and maximum parameters of the power supply at which the device is able to operate in accordance with its specifications. The accuracy of the bar code verifier shall not be adversely affected by fluctuations in supply voltage and frequency within the range specified by the manufacturer.

In the case of battery-powered equipment, the instrument shall either give a warning signal to the operator or shall cease to operate when approaching the battery power limit at which the reliable performance of the instrument can no longer be guaranteed. For equipment powered by rechargeable batteries, the manufacturer shall indicate the requirements for recharging the batteries.

7.3 Temperature

7.3.1 Operating temperature range

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

7.3.2 Storage temperature range

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

7.4 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.

7.5 Ambient light immunity

The characteristics of ambient light vary very widely and should be taken into consideration. Some examples of typical light sources which can cause problems are: high-efficiency fluorescent lighting, sodium vapour lamps, mercury vapour lamps, red neon lights and direct sunlight.

The manufacturer shall state the recommended ambient light conditions under which the equipment is intended to be used.

8 Test requirements

8.1 Test methods

8.1.1 General

The test method describes how to test a verifier for conformance with the methodology defined in ISO/IEC 15415.

8.1.2 Selection of equipment for testing

Tests shall be carried out on at least one verifier which has been selected from a production batch in accordance with the manufacturer's own quality control sampling scheme. The manufacturer should implement a quality programme to assure that all similar devices will satisfy the requirements of this document.

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

8.1.3 Scanning parameters

During the tests, the scanning and other equipment operating parameters shall fall within the range specified by the manufacturer of the equipment.

8.1.4 Test measurements

The overall symbol grade and the values for the individually measured parameters reported by the instrument, shall be compared with the actual measurements supplied with the test symbols.

If conformance for symbologies other than those listed in Annex A are to be tested, appropriate test symbols shall be used which conform with the relevant symbology specifications. They shall include descriptions of or sample pictures of symbols that test these symbologies for decode (for all symbols), decodability (for multi-row bar code symbols), unused error correction and fixed pattern damage (for two-dimensional matrix symbols), to ensure that the verifier applies the reference decode algorithm defined in the symbology specification. In addition, a symbology specification can specify other conformance tests as necessary for parameters applicable to the symbology.

8.2 Test environment

Tests on bar code verifiers shall be conducted under manufacturer-specified environmental conditions. These should, as a minimum, include the power supply, temperature, relative humidity and ambient light conditions.

8.3 Primary reference test symbols

All tests for conformance with this document shall be carried out using a selection of primary reference test symbols. Primary reference test symbols are used because their scan reflectance profiles or images present known values of specific parameters to the manufacturer or user of a verifier. The values are determined by a measurement device that mimics the commercial verification device methodology and has national standard traceable performance on the reflectance and on the linear distance axes at a magnitude of ten times better than the commercial verification device. An appropriate set of primary reference test symbols in accordance with Annex A shall be used for testing. Primary reference test symbols shall meet the requirements described in Annex B.

If multiple light sources with different spectral characteristics or measuring apertures/effective resolutions are commonly used within the scanning environment for the symbol in question, a primary reference test symbol with multiple spectral and aperture/effective resolution calibration points can be required. In all cases, the primary reference test symbols shall conform with the relevant symbology

specification (national, regional or International standard if one exists, or a recognised industry specification, for the symbology in question) and shall be supplied with a statement of:

— the symbology used;

— the data encoded;

— measurement aperture(s) or effective resolution and spectral characteristics [e.g. peak wavelength(s) or colour temperature(s)] of light used for calibration;

— overall symbol grade in accordance with ISO/IEC 15416 or ISO/IEC 15415;

— an individual parameter grade and value in accordance with ISO/IEC 15416 or ISO/IEC 15415 (if the primary reference test symbol variation is designed to emphasise a particular parameter within the scan reflectance profile or image).

Primary reference test symbols shall be used for the purposes of type testing of verification equipment by conformance testing laboratories, and by manufacturers of verification equipment for the purpose of self-declaration of conformity with this document. A subset of the primary reference test symbols may be compiled for verifier users. This subset of primary reference test symbols would provide the users with the means for periodic calibration checks of their verifier and for training in the proper use of their instrument.

Primary reference test symbols shall be produced on materials which show negligible dimensional variation with changes in temperature and humidity under ambient conditions of 10 °C to 30 °C and 30 % to 70 % RH. Consideration should be given to the use of materials that will retain or return to their original dimensions after being transported under conditions that can be outside these ranges.

Verification device manufacturers and users may choose to use, as part of their routine quality assurance procedures, secondary test symbols. The parameter values for secondary test symbols shall have been determined through the use of a verifier the calibration of which has been checked against primary reference test symbols. While secondary test symbols may be used for routine quality assurance procedures, they do not provide the basis for a statement of conformance with this document.

8.4 Test report

The test environment, equipment configuration, scanning parameters and primary reference test symbols used shall be recorded together with the following:

— symbology(ies) tested;

— overall symbol grade as measured and reported by the instrument and as defined for the primary reference test symbol in question;

— the values for the individually measured parameters;

— confirmation that the values measured are within the tolerances defined in Clause 5.

Copies of the reports output by the verifier under test, if available, shall be attached to the test report. These may, for example, be printed reports or prints of the screen display of a computer to which the verifier is connected. A copy of the test report shall be made available to bona fide enquirers on request.

9 Declaration and labelling

The manufacturer shall include with the verifier documentation a declaration that the equipment has been tested in accordance with this document.

The manufacturer may affix labels to the equipment indicating that the verifier conforms to this document. No requirements are defined for this labelling.

10 Equipment specification

The manufacturer should specify the following in documentation available to users of the equipment:

— which symbologies the verifier is capable of verifying, including the identification of optional features of the symbologies which are supported,

— the measuring apertures or effective resolutions available,

— the overall sizes of symbols (relative to ranges of X dimension) that can be verified,

— the specification of the illumination source, including the peak light wavelength or colour temperature,

— the means of reflectance calibration,

— the means of reporting and, if available, of recording verification results,

— the optional functions which can be performed (in addition to the mandatory functions) as shown in 6.4,

— the ability to average results from repeated scans,

— interfacing capabilities with other equipment such as a personal computer or printer, and

— programming and configuration specifications.

Annex A
(normative)

Primary reference test symbols

A.1 General requirements

Sets of primary reference test symbols shall comprise sets of symbols with varying grades for the individual parameters analysed in the ISO/IEC 15416 scan reflectance profile or the ISO/IEC 15415 image assessment. In each case, the parameter value shall be sufficiently far from a grade transition to avoid introducing uncertainty, as illustrated for the various parameters in Table A.1.

A.2 Test symbols for multi-row symbologies

A.2.1 Symbologies with row crossing ability

These symbols shall be PDF417 symbols in accordance with ISO/IEC 15438, with varying parameter grades (two sets, one with X dimension 0,200 mm, the other with X dimension 0,500 mm):

— symbol contrast grades 4 and 1;

— modulation grades 4 and 1;

— defects (both spots and voids) grades 4 and 1;

— decodability (edge to similar edge) grades 4 and 1;

— unused error correction grades 4 and 1;

— codeword yield grades 4 and 1.

A.2.2 Symbologies without row crossing ability

Test symbols for verifiers for multi-row symbologies without row crossing capability shall be those defined in ISO/IEC 15426-1.

A.2.3 Recommended parameter values for test symbols

Table A.1 illustrates the recommended range of values of the individual parameters which will meet the requirement stated in A.2.1.

Table A.1 — Parameter values for primary reference test symbols (multi-row symbols)

Parameter	Grade 4	Grade 1
Symbol contrast	≥73,75 %	Greater than or equal to 25 %, and lesser than or equal to 35 %
Defects	≤0,1375	Greater than or equal to 0,2625, and lesser than or equal to 0,2875
Decodability	0,65	Greater than or equal to 0,28, and lesser than or equal to 0,34
Codeword yield	≥72,75 %	Greater than or equal to 51,75, and lesser than or equal to 55,25 %
Unused error correction	≥0,65	Greater than or equal to 0,28, and lesser than or equal to 0,34

A.3 Test symbols for matrix symbologies

A.3.1 Test symbols for symbol contrast, grid non-uniformity and axial non-uniformity

Data matrix symbols according to ISO/IEC 16022, with varying parameter grades (two sets, one with X dimension 0,200 mm, the other with X dimension 0,500 mm) are:

— symbol contrast grades 4 and 1;

— grid non-uniformity grades 4 and 1;

— axial non-uniformity grades 4 and 1.

The above selection, together with the symbols described in A.3.2, A.3.3 and A.3.4, provide a representative set of test symbols which will enable all essential parameters to be compared as measured with the actual values certified by the supplier of the symbols and confirm conformity with this document. Although it is permissible for a single symbol with all parameters graded 4 to be used in place of individual symbols for grade 4 symbol contrast, grid non-uniformity etc., separate symbols shall be used to test the lower grade parameter measurements (with all parameters other than the one under test achieving grade 3,0 or higher).

A.3.2 Test symbols for contrast uniformity (modulation)

Modulation is a grade that is computed based on the reflectivity, relative to symbol contrast, of the modules in each code word and also in consideration of the error correction capacity of a symbol. To test for conformance the following test using a specific contrast uniformity value, called contrast uniformity, is defined.

The test symbol for modulation for matrix symbols is illustrated in Figure A.1 and encodes "///00".

The data region contains a dark module surrounded completely by light modules, known as a dark widow. The dark widow is located two modules below the upper alternating finder pattern and four modules to the right of the left "L" finder pattern. The width and height of this module are each reduced to five ninths of the nominal X dimension. The X dimension shall be 0,27 mm for the high resolution modulation test symbol and 0,36 mm for the low resolution modulation test symbol. Similar values may be used that enable the resolution of the generating device to create the dark widow at five ninths of the X dimension. The test symbol shall be measured using 0,8 % of the measured module size as the effective aperture to provide a reference value for modulation. The tolerance on the measured contrast uniformity value of the dark widow shall be ±0,08 for the calibrated contrast uniformity value of this reduced module. For example, if the calibrated contrast uniformity value is 0,30, then the allowed tolerance would permit a measured value in the range from 0,22 through 0,38. The verifier shall output modulation information so that the contrast uniformity value of the module containing the dark widow can be determined for conformance verification. As with all primary reference test symbols, this modulation test symbol must be in good condition so that no other module in the symbol

is measured with a lower contrast uniformity value than the reduced module. The location of the module represented by contrast uniformity shall be established so that this can be confirmed.

NOTE This figure illustrates the construction of the symbol but is not an accurate representation of the dimensions of the modules or defects.

Figure A.1 — Example test symbol for modulation

A.3.3 Test symbols for unused error correction

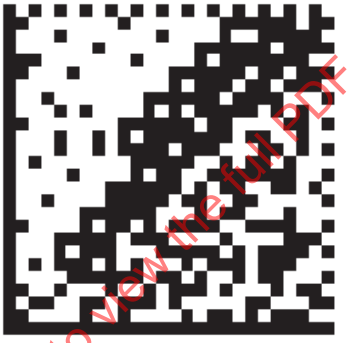

Figure A.2 — Test symbol for unused error correction

Figure A.2 encodes the data "gibgibgibgibgibgibgibgibgibgibgibgibgibybiybiybiybiybiybiybiybi" but has had eight errors introduced by reversing the colour of a single module in each of eight codewords in the data region. The symbol has 44 data codewords and 28 error correction codewords, giving an error correction capacity of 14 errors. The errors in the symbol yield an unused error correction value of 1 – 16/28 = 0,4286 (which may be reported as 0,43 for convenience) which is graded as 2,4 (because grades are rounded down to the nearest 0,1). There is no tolerance on the value computed for UEC because it is derived from an exact and discrete number of errors (16 in the case of Figure A.2), each of which derives from a module that is decoded as the wrong colour by a wide margin, particularly fully modulated with the wrong colour.

A.3.4 Test symbols for fixed pattern damage and additional parameters

Since the evaluation of fixed pattern damage varies for each symbology, and in some cases additional parameters are assessed, a separate test symbol is required for each symbology that the verifier is capable of verifying.

As examples, test symbols for data matrix (see ISO/IEC 16022), QR code (see ISO/IEC 18004) and Aztec code (see ISO/IEC 24778) are defined. Figure A.3 shows a data matrix symbol with the following damage to each of the five segments as shown in Table A.2.

Table A.2 — Fixed pattern damage grading of Figure A.3

Segment	Module errors	Grade
L1	2	3,3
L2	1	3,3
QZL1	1	3,3
QZL2	2	3,3
Clock track and adjacent solid pattern	1 and 1	3,5
Average grade is equal to 3,34	—	2,6
The grade for fixed pattern damage is 2,6.		

Figure A.3 — Test symbol with fixed pattern damage (data matrix)

Figure A.4 shows a QR code symbol with the following damage to the fixed pattern segments and the format information as shown in Table A.3.

Table A.3 — Fixed pattern damage grading and format information grading of Figure A.4

Segment	Module errors %	Grade
A3: Lower left position detection pattern	1	1,0
A3: Separator	2	
Total for segment A3	3	
B1	1 (5,88 %)	3,1
B2	2 (11,76 %)	1,6
Fixed pattern damage grade for test symbol	—	1,0
Format information 1	4	0,0
Format information 2	2	2,0
Mean of format information grades	—	1,0

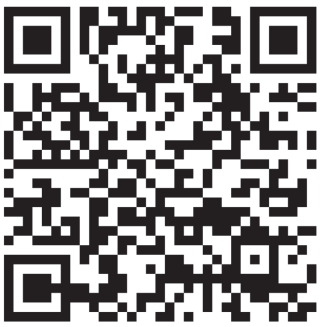

Figure A.4 — QR code symbol with fixed pattern damage