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Information technology — Automatic identification and data capture techniques — QR Code 2005 bar code symbology specification

Technologies de l'information — Techniques d'identification automatique et de capture des données — Spécification de la symbologie de code à barres QR Code 2005

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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 18004 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 18004:2000), which has been technically revised.

Introduction

It is necessary to distinguish four technically different, but closely related members of the QR Code family, which represent an evolutionary sequence.

— QR Code Model 1 was the original specification for QR Code and is described in AIM International Symbology Specification 97-001.

— QR Code Model 2 was an enhanced form of the symbology with additional features (primarily the addition of alignment patterns to assist navigation in larger symbols), and was the basis of the first edition of ISO/IEC 18004.

— QR Code 2005 (the basis of this second edition of ISO/IEC 18004) is closely similar to QR Code Model 2 and, in its QR Code format, differs only in the addition of the facility for symbols to appear in a mirror image orientation, for reflectance reversal (light symbols on dark backgrounds) and the option for specifying alternative character sets to the default.

— The Micro QR Code format (also specified in this International Standard), is a variant of QR Code 2005 with a reduced number of overhead modules and a restricted range of sizes, which enables small to moderate amounts of data to be represented in a small symbol, particularly suited to direct marking on parts and components, and to applications where the space available for the symbol is severely restricted.

QR Code 2005 is a matrix symbology. The symbols consist of an array of nominally square modules arranged in an overall square pattern, including a unique finder pattern located at three corners of the symbol (in Micro QR Code symbols, at a single corner) and intended to assist in easy location of its position, size and inclination. A wide range of sizes of symbol is provided for, together with four levels of error correction. Module dimensions are user-specified to enable symbol production by a wide variety of techniques.

QR Code Model 2 symbols are fully compatible with QR Code 2005 reading systems.

Model 1 QR Code symbols are recommended only to be used in closed system applications and it is not a requirement that equipment complying with this International Standard should support Model 1. Since QR Code 2005 is the recommended model for new, open systems application of QR Code, this International Standard describes QR Code 2005 fully, and lists the features in which Model 1 QR Code differs from QR Code 2005 in Annex N.

Information technology — Automatic identification and data capture techniques — QR Code 2005 bar code symbology specification

1 Scope

This International Standard defines the requirements for the symbology known as QR Code 2005. It specifies the QR Code 2005 symbology characteristics, data character encoding methods, symbol formats, dimensional characteristics, error correction rules, reference decoding algorithm, production quality requirements, and user-selectable application parameters, and lists in an informative annex the features of QR Code Model 1 symbols which differ from QR Code 2005.

2 Conformance

QR Code 2005 symbols (and equipment designed to produce or read QR Code 2005 symbols) shall be considered as conforming with this International Standard if they provide or support the features defined in this International Standard.

Symbols complying with the requirements for QR Code Model 1, as defined in ISO/IEC 18004:2000, may not be readable with equipment complying with this International Standard.

Symbols complying with the requirements for QR Code Model 2, as defined in ISO/IEC 18004:2000, are readable with equipment complying with this International Standard.

Reading equipment complying with ISO/IEC 18004:2000 will not be able to read all symbols complying with this International Standard. Symbols that make use of the additional features of QR Code 2005 will not be readable by such equipment.

Printing equipment complying with ISO/IEC 18004:2000 will not be able to print all symbols defined in this International Standard. Symbols that make use of the additional features of QR Code 2005 will not be printable by such equipment.

It should be noted, however, that QR Code 2005 is the form of the symbology recommended for new and open systems applications.

3 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/IEC 8859-1:1998, *Information technology — 8-bit single-byte coded graphic character sets — Part 1: Latin alphabet No. 1*

ISO/IEC 15415, *Information technology — Automatic identification and data capture techniques — Bar code print quality test specification — Two-dimensional symbols*

ISO/IEC 15424, *Information technology — Automatic identification and data capture techniques — Data Carrier Identifiers (including Symbology Identifiers)*

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)*

JIS X 0201, *7-bit and 8-bit coded character sets for information interchange*

JIS X 0208:1997, *7-bit and 8-bit double byte coded KANJI sets for information interchange*

AIM International Technical Specification, *Extended Channel Interpretations:*

— *Part 1, Identification Schemes and Protocols*

— *Part 2, Registration Procedure for Coded Character Sets and Other Data Formats*

— *Character Set Register*

AIM International Symbology Specification 97-001, *QR Code*

GS1 General Specifications, GS1

4 Terms and definitions, mathematical and logical symbols, abbreviations and conventions

4.1 Terms and definitions

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

4.1.1
alignment pattern
fixed reference pattern in defined positions in a matrix symbology, which enables the decode software to re-synchronise the coordinate mapping of the image modules in the event of moderate amounts of distortion of the image

4.1.2
character count indicator
bit sequence which defines the data string length in a mode

4.1.3
data masking
process of XORing the bit pattern in the encoding region with a data mask pattern to provide a symbol with more evenly balanced numbers of dark and light modules, and reduced occurrence of patterns which would interfere with fast processing of the image

4.1.4
data mask pattern reference
three-bit identifier of the data masking patterns applied to the symbol

4.1.5
encoding region
region of the symbol not occupied by function patterns and available for encoding of data and error correction codewords, and for Version and format information

4.1.6
exclusive subset
subset of characters within the character set of a mode which are not shared with the more restricted character set of another mode

4.1.7
Extension Pattern
function pattern in Model 1 symbols, which does not encode data

4.1.8
format information
encoded pattern containing information on symbol characteristics essential to enable the remainder of the encoding region to be decoded

4.1.9
QR Code
pertaining to QR Code 2005 symbols identified as Versions 1 to 40, as distinct from Micro QR Code symbols

4.1.10
function pattern
overhead component of the symbol (finder, separator, timing patterns, and alignment patterns) required for location of the symbol or identification of its characteristics to assist in decoding

4.1.11
masking
process of XORing the bit pattern in an area of the symbol with a mask pattern to reduce the occurrence of patterns which would interfere with fast processing of the image

4.1.12
Micro
pertaining to QR Code 2005 symbols identified as Versions M1 to M4, as distinct from QR Code symbols

4.1.13
mode
method of representing a defined character set as a bit string

4.1.14
mode indicator
four-bit identifier indicating in which mode the following data sequence is encoded

4.1.15
Padding Bit
0 bit, not representing data, used to fill empty positions of the final codeword after the Terminator in a data bit string

4.1.16
finder pattern
one of three identical components of the finder pattern in QR Code symbols

4.1.17
Remainder Bit
0 bit, not representing data, used to fill empty positions of the symbol encoding region after the final symbol character, where the area of the encoding region available for symbol characters does not divide exactly into 8-bit symbol characters

4.1.18
Remainder Codeword
pad codeword, placed after the error correction codewords, used to fill empty codeword positions to complete the symbol if the total number of data and error correction codewords does not exactly fill its nominal capacity

4.1.19
segment
sequence of data encoded according to the rules of one ECI or encoding mode

4.1.20
separator
function pattern of all light modules, one module wide, separating the finder patterns from the rest of the symbol

4.1.21
symbol number
three-bit field indicating the symbol version and error correction level applied, used as part of the Format Information in Micro QR Code symbols

4.1.22
Terminator
bit pattern of defined number (depending on symbol) of all zero bits used to end the bit string representing data

4.1.23
timing pattern
alternating sequence of dark and light modules enabling module coordinates in the symbol to be determined

4.1.24
Version
size of the symbol represented in terms of its position in the sequence of permissible sizes for Micro QR Code symbols from 11 × 11 modules (Version M1) to 17 × 17 modules (Version M4) or, for QR Code symbols, from 21 × 21 modules (Version 1) to 177 × 177 (Version 40) modules

NOTE The error correction level applied to the symbol may be suffixed to the version designation, e.g. Version 4-L or Version M3-Q.

4.1.25
version information
encoded pattern in certain QR Code 2005 symbols containing information on the symbol version together with error correction bits for this data

4.2 Mathematical and logical symbols

Mathematical symbols used in formulae and equations are defined after the formula or equation in which they appear.

For the purposes of this document, the following mathematical operations apply.

div is the integer division operator

mod is the integer remainder after division

XOR is the exclusive-or logic function whose output is one only when its two inputs are not equivalent. It is represented by the symbol ⊕.

4.3 Abbreviations

BCH Bose-Chaudhuri-Hocquenghem

ECI Extended Channel Interpretation

RS Reed-Solomon

4.4 Conventions

4.4.1 Module positions

For ease of reference, module positions are defined by their row and column coordinates in the symbol, in the form (*i, j*) where *i* designates the row (counting from the top downwards) and *j* the column (counting from left to right) in which the module is located, with counting commencing at 0. Module (0, 0) is therefore located at the upper left corner of the symbol.

4.4.2 Byte notation

Byte contents are shown as hex values.

4.4.3 Version references

For QR Code symbols, symbol versions are referred to in the form Version V-E where V identifies the version number (1 to 40) and E indicates the error correction level (L, M, Q, H).

For Micro QR Code symbols, symbol versions are referred to in the form Version MV-E where the letter M indicates the Micro QR Code format and V (with a range of 1 to 4) and E (with values L, M and Q) have the meanings defined above.

5 Symbol description

5.1 Basic characteristics

QR Code 2005 is a matrix symbology with the following characteristics:

a) Formats:

   1) QR Code, with full range of capabilities and maximum data capacity;

   2) Micro QR Code, with reduced overhead, some restrictions on capabilities and reduced data capacity (compared with QR Code symbols).

b) Encodable character set:

   1) numeric data (digits 0 - 9);

   2) alphanumeric data (digits 0 - 9; upper case letters A -Z; nine other characters: space, $ % * + - . / :);

   3) byte data (default: ISO/IEC 8859-1; or other sets as otherwise defined (see 6.3.4));

   4) Kanji characters. Kanji characters in QR Code 2005 can be compacted into 13 bits.

c) Representation of data:

   A dark module is nominally a binary one and a light module is nominally a binary zero. However, see 5.2 for details of reflectance reversal.

d) Symbol size (not including quiet zone):

   1) Micro QR Code symbols: 11 × 11 modules to 17 × 17 modules (Versions M1 to M4, increasing in steps of two modules per side);

2) QR Code symbols: 21 × 21 modules to 177 × 177 modules (Versions 1 to 40, increasing in steps of four modules per side).

e) Data characters per symbol

1) maximum Micro QR Code symbol size, Version M4-L):

— numeric data: 35 characters

— alphanumeric data: 21 characters

— Byte data: 15 characters

— Kanji data: 9 characters

2) maximum QR Code symbol size, Version 40-L:

— numeric data: 7 089 characters

— alphanumeric data: 4 296 characters

— Byte data: 2 953 characters

— Kanji data: 1 817 characters

f) Selectable error correction:

Four levels of Reed-Solomon error correction (referred to as L, M, Q and H in increasing order of capacity) allowing recovery of:

— L 7%

— M 15%

— Q 25%

— H 30%

of the symbol codewords.

For Micro QR Code symbols, error correction level H is not available. For Version M1 Micro QR Code symbols, the RS capacity is limited to error detection only.

g) Code type:

Matrix

h) Orientation independence:

Yes (both rotation and reflection)

Figure 1 illustrates a Version 1 QR Code 2005 symbol in normal colour and with reflectance reversal (see 5.2), in both normal and mirror image orientations.

Figure 2 illustrates a Version M2 Micro QR Code symbol in normal colour and with reflectance reversal (see 5.2), in both normal and mirror image orientations.

5.2 Summary of additional features

The use of the following additional features is optional in QR Code 2005:

— Structured append

This allows files of data to be represented logically and continuously in up to 16 QR Code 2005 symbols. These may be scanned in any sequence to enable the original data to be correctly reconstructed. Structured Append is not available with Micro QR Code symbols.

— Extended Channel Interpretations

This mechanism enables data using character sets other than the default encodable set (e.g. Arabic, Cyrillic, Greek) and other data interpretations (e.g. compacted data using defined compression schemes) or other industry-specific requirements to be encoded. Extended Channel Interpretations other than the default interpretation are not available in Micro QR Code symbols.

— Reflectance reversal

Symbols are intended to be read when marked so that the image is either dark on light or light on dark (see Figures 1 and 2). The specifications in this International Standard are based on dark images on a light background, therefore in the case of symbols produced with reflectance reversal references to dark or light modules should be taken as references to light or dark modules respectively.

— Mirror imaging

The arrangement of modules defined in this International Standard represents the "normal" orientation of the symbol. It is, however, possible to achieve a valid decode of a symbol in which the arrangement of the modules has been laterally transposed. When viewed with the finder patterns at the top left, top right and bottom left corners of the symbol, the effect of mirror imaging is to interchange the row and column positions of the modules.

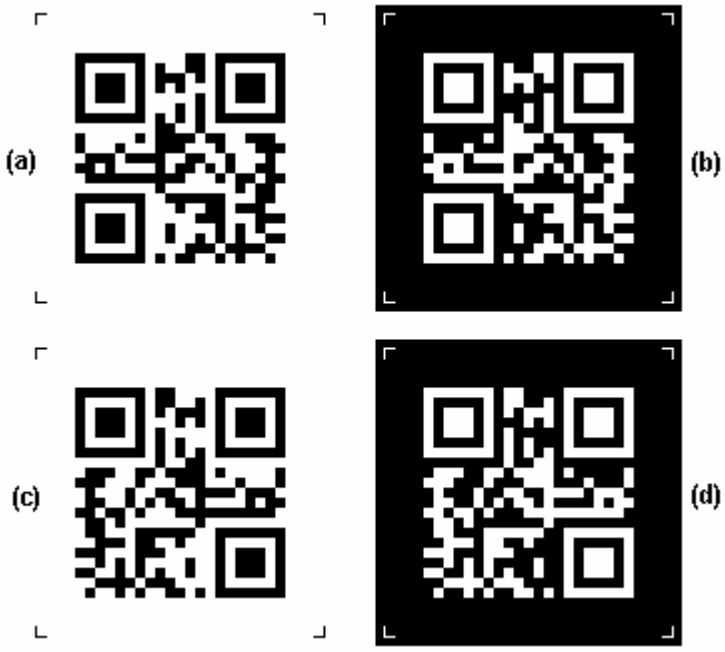

Figure 1 — Examples of QR Code 2005 symbol encoding the text "QR Code Symbol" – (a) normal orientation and normal reflectance arrangement; (b) normal orientation and reversed reflectances; (c) mirror image orientation and normal reflectance arrangement; (d) mirror image orientation and reversed reflectances