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Fourth edition

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

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

PROOF/ÉPREUVE

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Foreword

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

This fourth edition cancels and replaces the third edition (ISO/IEC 18004:2015), which has been technically revised.

The main changes are as follows:

— continuous grading according to ISO/IEC 15415 has been adopted for grade fixed pattern damage;

— the reference decoding algorithm has been clarified.

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

There are four technically different, but closely related members of the QR code family, which represent an evolutionary sequence.

— QR code model 1 is the original specification for QR code and is described in AIM ITS 97-001[21].

— QR code model 2 is an enhanced form of the symbology with additional features (primarily, the addition of alignment patterns to assist navigation in larger symbols) and is the basis of the first edition of this document (i.e. ISO/IEC 18004:2000).

— QR code [the basis of the second edition of this document (i.e. ISO/IEC 18004:2006)] is very similar to QR code model 2; 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 is set to the default.

— The micro QR code format [also specified in the second edition of this document (i.e. ISO/IEC 18004:2006)], is a variant of QR code with a reduced number of overhead modules and a restricted range of sizes, which enables small to moderate amount 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 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-specific to enable symbol production by a wide variety of techniques.

QR code model 2 symbols are fully compatible with QR code reading systems.

QR code model 1 symbols are recommended only to be used in closed system applications. Equipment complying with this document are not required to support QR code model 1 symbols. Since QR code is the recommended model for new, open system application of QR code, this document describes QR code fully. This document also lists the features in which QR code model 1 differs from QR code in Annex N.

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

1 Scope

This document specified the requirements for the symbology of a quick response (QR) code. This document specifies the QR code symbology characteristics, data character encoding methods, symbol formats, dimensional characteristics, error correction rules, reference decoding algorithm, production quality requirements and user-selectable application parameters.

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

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 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
character count indicator
bit sequence which defines the data string length in a *mode* (3.10)

3.2
data masking
process of XORing the bit pattern in the *encoding region* (3.4) 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

3.3
data mask pattern reference
3-bit identifier of the *data masking* (3.2) patterns applied to the symbol

3.4
encoding region
region of the symbol not occupied by *function patterns* (3.8) and available for encoding data and error correction codewords, and for *version* (3.20) and *format information* (3.7)

3.5
exclusive subset
subset of characters within the character set of a *mode* (3.10) which are not shared with the more restricted character set of another mode

3.6
extension pattern
function pattern (3.8) in model 1 symbols, which does not encode data

3.7
format information
encoded pattern containing information on symbol characteristics essential to enable the remainder of the *encoding region* (3.4) to be decoded

3.8
function pattern
overhead component of the symbol (finder, *separator* (3.16), *timing patterns* (3.19) and alignment patterns) required for location of the symbol or identification of its characteristics to assist in decoding

3.9
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

3.10
mode
method of representing a defined character set as a bit string

3.11
mode indicator
1-bit to 4-bit identifier (depending on symbol size) indicating in which *mode* (3.10) the following data sequence is encoded

3.12
padding bit
zero bit, not representing data, used to fill empty positions of the final codeword after the *terminator* (3.18) in a data bit string

3.13
remainder bit
zero bit, not representing data, used to fill empty positions of the symbol *encoding region* (3.4) 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

3.14
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

3.15
segment
sequence of data encoded according to the rules of one extended channel interpretation or encoding mode

3.16
separator
function pattern (3.8) of all light modules, one module wide, separating the finder patterns from the rest of the symbol

3.17
symbol number
3-bit field indicating the symbol *version* (3.20) and error correction level applied, used as part of the *format information* (3.7) in micro QR code symbols

3.18
terminator
bit pattern of defined number (depending on the symbol) of all zero bits used to end the bit string representing data

3.19
timing pattern
alternating sequence of dark and light modules enabling module coordinates in the symbol to be determined

3.20
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 1 to entry: The error correction level applied to the symbol can be suffixed to the version designation, e.g. version 4-L or version M3-Q.

3.21
version information
encoded pattern in certain QR code symbols containing information on symbol *version* (3.20) together with error correction bits for this data

4 Mathematical and logical symbols, abbreviated terms and conventions

4.1 Mathematical and logical symbols

div integer division operator

mod integer remainder after division

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

4.2 Abbreviated terms

BCH Bose-Chaudhuri-Hocquenghem

DPM direct part mark

ECI extended channel interpretation

FNC1 function 1 symbol character

RS Reed-Solomon

4.3 Conventions

4.3.1 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. The module (0, 0) is therefore located at the upper left corner of the symbol.

4.3.2 Byte notation

Byte content is shown as a hex value.

4.3.3 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, V identifies the version number (with a range of 1 to 4) and E indicates the error correction level (with values L, M and Q).

5 Symbol description

5.1 Basic characteristics

QR code 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 7.3.5)];

   4) Kanji characters (Kanji characters in QR code 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) for micro QR code symbols: 11 × 11 modules to 17 × 17 modules (versions M1 to M4, increasing in steps of two modules per side);

   2) for 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 the symbol codeword recovery of

- L: 7 %,
- M: 15 %,
- Q: 25 %, ans
- H: 30 %.

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 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.

- Structured append: This allows files of data to be represented logically and continuously in up to 16 QR code symbols. These can 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. ECIs 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 document 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 document 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 in the top left, top right and bottom left corners of the symbol, mirror imaging interchanges the row and column positions of the modules.

a) Normal orientation and normal reflectance arrangement

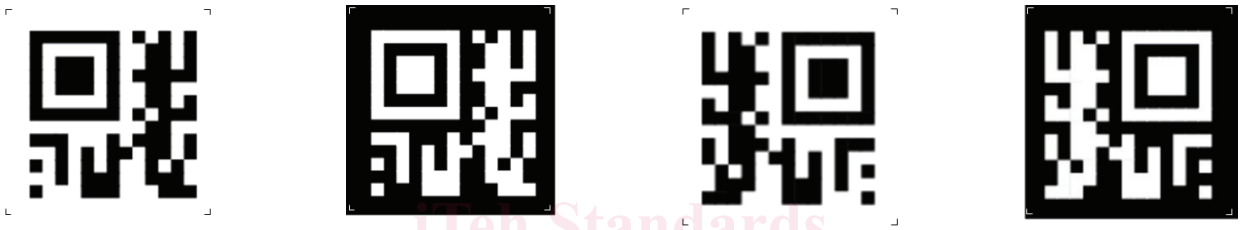
b) Normal orientation and reversed reflectances

c) Mirror image orientation and normal reflectance arrangement

d) Mirror image orientation and reversed reflectances

NOTE The corner marks indicate the extent of the quiet zone.

Figure 1 — Examples of a QR code 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

NOTE The corner marks indicate the extent of the quiet zone.

Figure 2 — Examples of a version M2 micro QR code symbol encoding the text "01234567"

5.3 Symbol structure

5.3.1 General

Each QR code symbol shall be constructed of nominally square modules set out in a regular square array and shall consist of an encoding region and function patterns, namely finder, separator, timing patterns and alignment patterns. Function patterns do not encode data. The symbol shall be surrounded on all four sides by a quiet zone border. Figure 3 illustrates the structure of a version 7 symbol. Figure 4 illustrates the structure of a version M3 symbol.