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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

Reference number
ISO/IEC 18004:2015(E)

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ISO copyright office
Case postale 56 • CH-1211 Geneva 20
Tel. + 41 22 749 01 11
Fax + 41 22 749 09 47
E-mail copyright@iso.org
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Contents

Page

Foreword ... **vi**

Introduction ... **vii**

1 Scope ... **1**

2 Conformance ... **1**

3 Normative references ... **1**

4 Terms and definitions ... **2**

5 Mathematical and logical symbols, abbreviations and conventions ... **4**
5.1 Mathematical and logical symbols ... 4
5.2 Abbreviations ... 4
5.3 Conventions ... 4
5.3.1 Module positions ... 4
5.3.2 Byte notation ... 4
5.3.3 Version references ... 4

6 Symbol description ... **4**
6.1 Basic characteristics ... 4
6.2 Summary of additional features ... 6
6.3 Symbol structure ... 7
6.3.1 General ... 7
6.3.2 Symbol Versions and sizes ... 9
6.3.3 Finder pattern ... 16
6.3.4 Separator ... 17
6.3.5 Timing pattern ... 17
6.3.6 Alignment patterns ... 17
6.3.7 Encoding region ... 17
6.3.8 Quiet zone ... 17

7 Requirements ... **18**
7.1 Encode procedure overview ... 18
7.2 Data analysis ... 20
7.3 Modes ... 20
7.3.1 General ... 20
7.3.2 Extended Channel Interpretation (ECI) mode ... 20
7.3.3 Numeric mode ... 21
7.3.4 Alphanumeric mode ... 21
7.3.5 Byte mode ... 21
7.3.6 Kanji mode ... 21
7.3.7 Mixing modes ... 21
7.3.8 Structured Append mode ... 21
7.3.9 FNC1 mode ... 22
7.4 Data encoding ... 22
7.4.1 Sequence of data ... 22
7.4.2 Extended Channel Interpretation (ECI) mode ... 23
7.4.3 Numeric mode ... 25
7.4.4 Alphanumeric mode ... 26
7.4.5 Byte mode ... 27
7.4.6 Kanji mode ... 29
7.4.7 Mixing modes ... 30
7.4.8 FNC1 modes ... 30
7.4.9 Terminator ... 32
7.4.10 Bit stream to codeword conversion ... 32
7.5 Error correction ... 36
7.5.1 Error correction capacity ... 36
7.5.2 Generating the error correction codewords ... 44

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Provläsningsexemplar / Preview

7.6 Constructing the final message codeword sequence ... 45
7.7 Codeword placement in matrix ... 46
7.7.1 Symbol character representation ... 46
7.7.2 Function pattern placement ... 46
7.7.3 Symbol character placement ... 46
7.8 Data masking ... 50
7.8.1 General ... 50
7.8.2 Data mask patterns ... 50
7.8.3 Evaluation of data masking results ... 53
7.9 Format information ... 55
7.9.1 QR Code symbols ... 55
7.9.2 Micro QR Code symbols ... 57
7.10 Version information ... 58

8 Structured Append ... 59
8.1 Basic principles ... 59
8.2 Symbol Sequence Indicator ... 60
8.3 Parity Data ... 61

9 Symbol printing and marking ... 61
9.1 Dimensions ... 61
9.2 Human-readable interpretation ... 61
9.3 Marking guidelines ... 61

10 Symbol quality ... 62
10.1 Methodology ... 62
10.2 Symbol quality parameters ... 62
10.2.1 Fixed pattern damage ... 62
10.2.2 Scan grade and overall symbol grade ... 62
10.2.3 Grid non-uniformity ... 62
10.3 Process control measurements ... 62

11 Decoding procedure overview ... 62

12 Reference decode algorithm for QR Code ... 63

13 Autodiscrimination capability ... 70

14 Transmitted data ... 70
14.1 General principles ... 70
14.2 Symbology Identifier ... 71
14.3 Extended Channel Interpretations ... 71
14.4 FNC1 ... 72

Annex A (normative) **Error detection and correction generator polynomials ... 73**

Annex B (normative) **Error correction decoding steps ... 77**

Annex C (normative) **Format information ... 79**

Annex D (normative) **Version information ... 81**

Annex E (normative) **Position of alignment patterns ... 83**

Annex F (normative) **Symbology Identifier ... 85**

Annex G (normative) **QR Code print quality symbology-specific aspects ... 86**

Annex H (informative) **JIS8 and Shift JIS character sets ... 92**

Annex I (informative) **Symbol encoding examples ... 94**

Annex J (informative) **Optimisation of bit stream length ... 99**

Annex K (informative) **User guidelines for printing and scanning of QR Code symbols ... 108**

Annex L (informative) **Autodiscrimination ... 110**

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Provläsningsexemplar / Preview

Annex M (informative) **Process control techniques** **111**
Annex N (informative) **Characteristics of Model 1 symbols** **113**
Bibliography **116**

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Provläsningsexemplar / Preview

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).

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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*, SC 31, *Automatic identification and data capture techniques*.

This third edition cancels and replaces the second edition (ISO/IEC 18004:2006), which has been technically revised.

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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 ITS 97-001 International Symbology Specification-QR Code.

— 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 (the basis of the second edition of ISO/IEC 18004) is closely 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 sets to the default.

— The Micro QR Code format (also specified in the second edition of ISO/IEC 18004), 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-specified to enable symbol production by a wide variety of techniques.

QR Code Model 2 symbols are fully compatible with QR Code 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 is the recommended model for new, open systems application of QR Code, this International Standard describes QR Code fully, and lists the features in which Model 1 QR Code differs from QR Code in Annex N.

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

1 Scope

This International Standard defines the requirements for the symbology known as QR Code. It 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 Conformance

QR Code symbols (and equipment designed to produce or read QR Code 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 described in ISO/IEC 18004:2006, 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 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 will not be printable by such equipment.

It should be noted, however, that QR Code Model 2 and Micro QR Code are the form of the symbology recommended for new and open systems applications.

3 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. 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 symbol print quality test specification — Two-dimensional symbols*

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

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4 Terms and definitions

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

4.1
character count indicator
bit sequence which defines the data string length in a mode

4.2
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

4.3
data mask pattern reference
three-bit identifier of the data masking patterns applied to the symbol

4.4
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

4.5
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

4.6
extension pattern
function pattern in Model 1 symbols, which does not encode data

4.7
format information
encoded pattern containing information on symbol characteristics essential to enable the remainder of the encoding region to be decoded

4.8
QR Code
pertaining to QR Code symbols identified as versions 1 to 40, as distinct from Micro QR Code symbols

4.9
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

4.10
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

4.11
micro
pertaining to Micro QR Code symbols identified as versions M1 to M4, as distinct from QR Code symbols

4.12
mode
method of representing a defined character set as a bit string

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4.13
mode indicator
four-bit identifier indicating in which mode the following data sequence is encoded

4.14
padding bit
zero bit, not representing data, used to fill empty positions of the final codeword after the terminator in a data bit string

4.15
remainder bit
zero 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

4.16
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

4.17
segment
sequence of data encoded according to the rules of one ECI or encoding mode

4.18
separator
function pattern of all light modules, one module wide, separating the finder patterns from the rest of the symbol

4.19
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

4.20
terminator
bit pattern of defined number (depending on symbol) of all zero bits used to end the bit string representing data

4.21
timing pattern
alternating sequence of dark and light modules enabling module coordinates in the symbol to be determined

4.22
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 may be suffixed to the version designation, e.g. version 4-L or version M3-Q.

4.23
version information
encoded pattern in certain QR Code symbols containing information on the symbol version together with error correction bits for this data

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5 Mathematical and logical symbols, abbreviations and conventions

5.1 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 $\oplus$.

5.2 Abbreviations

BCH Bose-Chaudhuri-Hocquenghem

ECI Extended Channel Interpretation

RS Reed-Solomon

5.3 Conventions

5.3.1 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. Module (0, 0) is therefore located at the upper left corner of the symbol.

5.3.2 Byte notation

Byte contents are shown as hex values.

5.3.3 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 and V (with a range of 1 to 4) and E (with values L, M and Q) have the meanings defined above.

6 Symbol description

6.1 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;

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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 6.2 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.

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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 6.2), 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 6.2), in both normal and mirror image orientations.

6.2 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 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.

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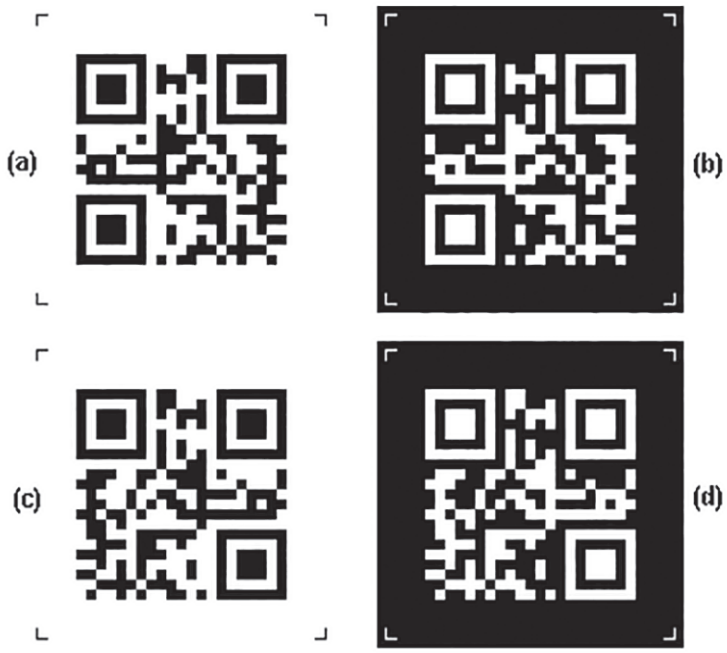

Figure 1 — Examples of QR Code symbol encoding the text "QR Code Symbol" – (a) normal orientation and normal reflectance arrangement; (b) normal orientation and reversed reflectances; (c) mirror image orientation and normal reflectance arrangement; (d) mirror image orientation and reversed reflectances

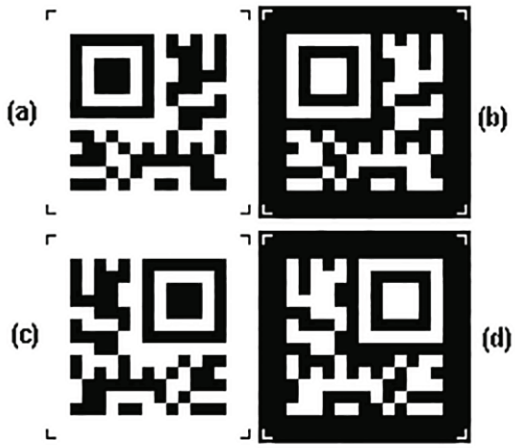

Figure 2 — Examples of Version M2 Micro QR Code symbol encoding the text "01234567" – (a) normal orientation and normal reflectance arrangement; (b) normal orientation and reversed reflectances; (c) mirror image orientation and normal reflectance arrangement; (d) mirror image orientation and reversed reflectances

NOTE The corner marks in Figures 1 and 2 indicate the extent of the quiet zone.

6.3 Symbol structure

6.3.1 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,

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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.

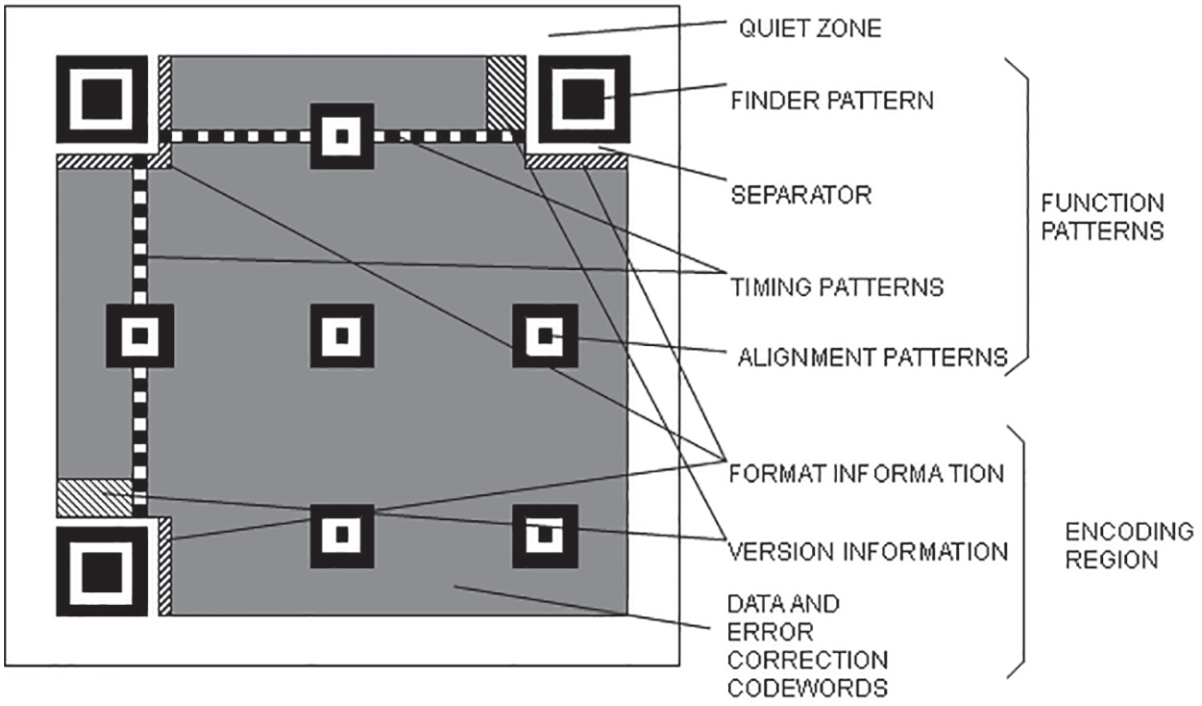

Figure 3 — Structure of a QR Code symbol

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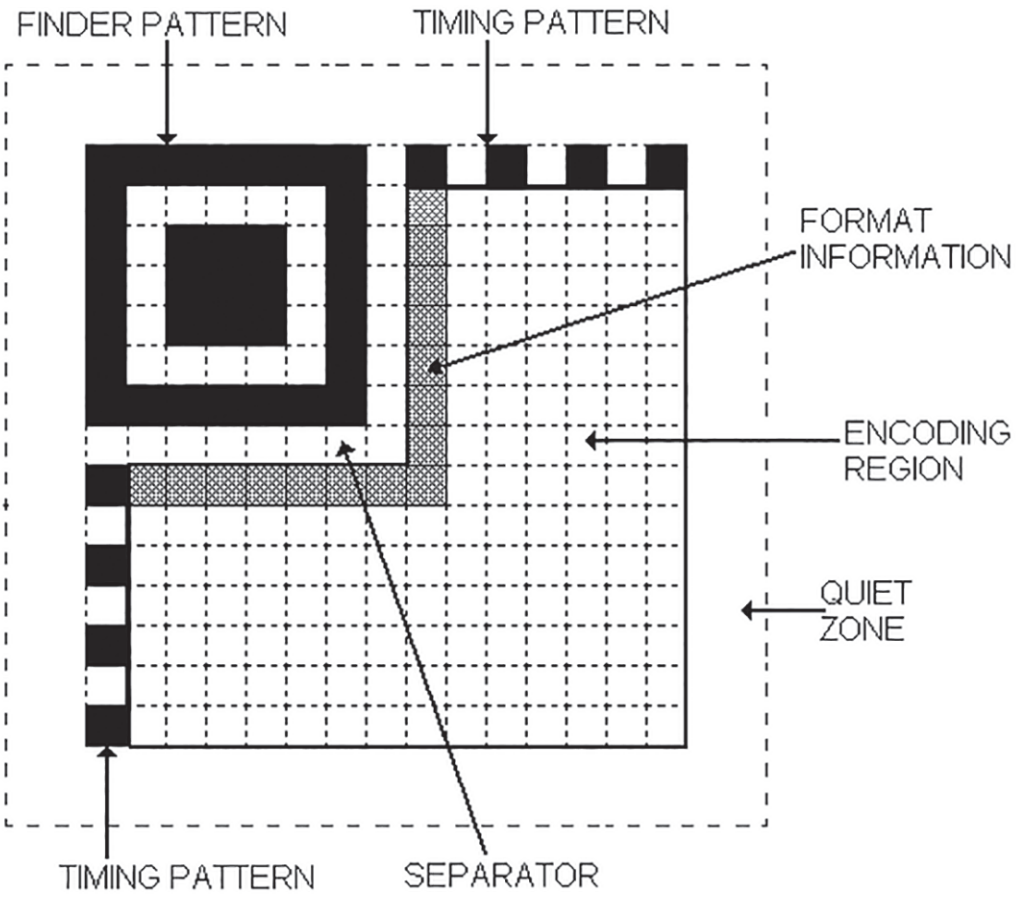

Figure 4 — Structure of Version M3 Micro QR Code symbol

6.3.2 Symbol Versions and sizes

6.3.2.1 QR Code symbols

There are forty sizes of QR Code symbol referred to as Version 1, Version 2 ... Version 40. Version 1 measures 21 modules × 21 modules, Version 2 measures 25 modules × 25 modules and so on increasing in steps of 4 modules per side up to Version 40 which measures 177 modules × 177 modules. Figures 5 to 10 illustrate the structure of Versions 1, 2, 6, 7, 14, 21 and 40.

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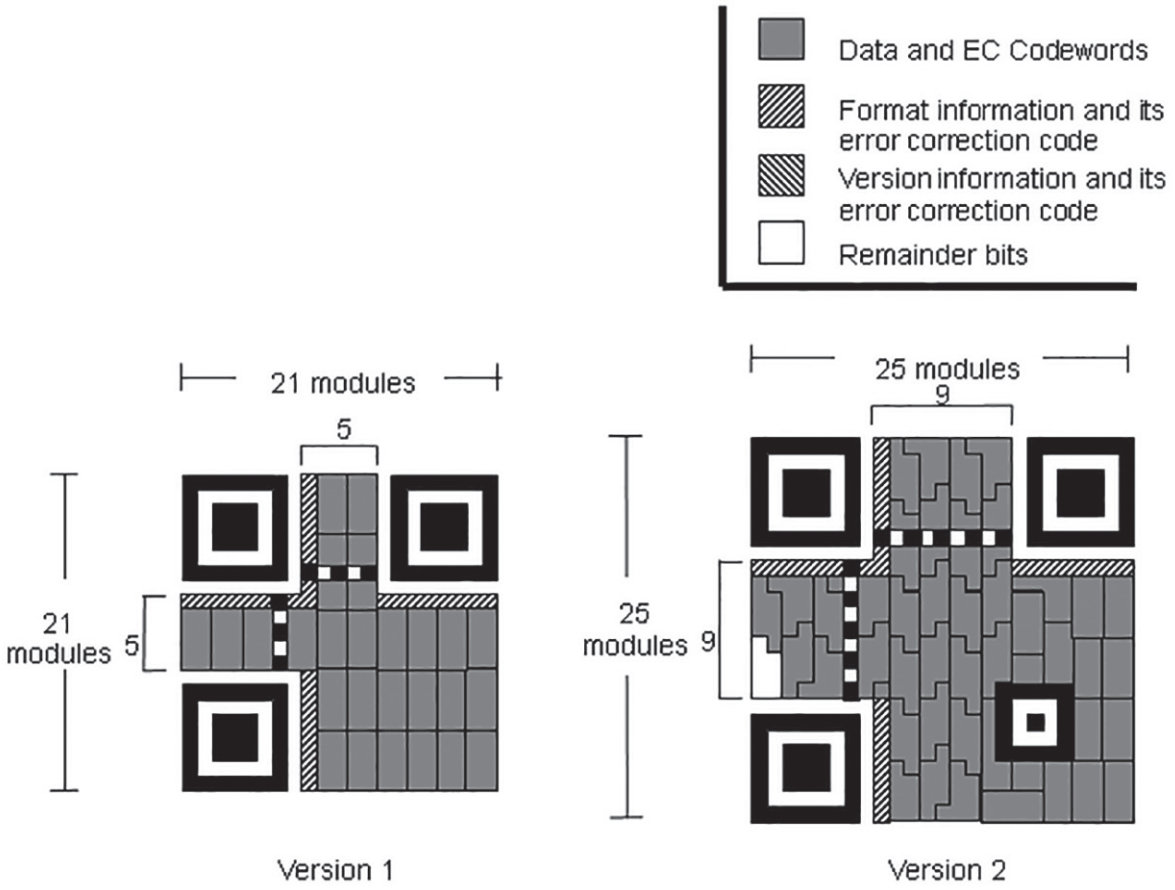

Figure 5 — Version 1 and 2 symbols

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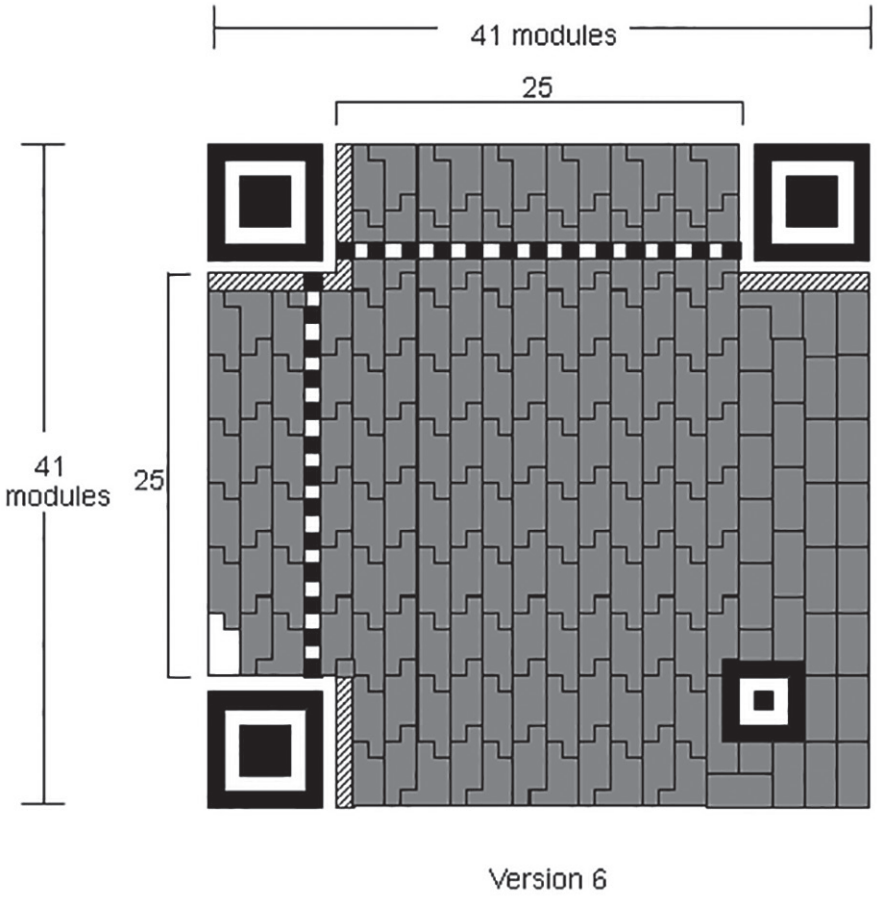

Figure 6 — Version 6 symbol

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