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Information technology — International symbology specification — MaxiCode

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Foreword

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In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. 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 International Standard may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

International Standard ISO/IEC 16023 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 31, *Automatic identification and data capture techniques*.

International Standard ISO/IEC 16023 was prepared by AIM International (as ANSI/AIM BC10) and was adopted, under a special “fast-track procedure”, by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, in parallel with its approval by national bodies of ISO and IEC.

Annexes A to E form a normative part of this International Standard. Annexes F to L are for information only.

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Information technology — International symbology specification — MaxiCode

Introduction

MaxiCode is a fixed-size matrix symbology which is made up of offset rows of hexagonal modules arranged around a unique finder pattern.

Manufacturers of bar code equipment and users of the technology require publicly available standard symbology specifications to which they can refer when developing equipment and application standards. The publication of Symbology Specifications is designed to achieve this.

1 Scope

This specification defines the requirements for the symbology known as MaxiCode. It specifies the MaxiCode symbology characteristics, data character encodation, symbol formats, dimensions and print quality requirements, error correction rules, decoding algorithm, and user-selectable application parameters.

2 Normative References

This specification incorporates provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed below. The latest edition of the publication referred to applies.

EN796	Bar Coding : Symbology Identifiers
EN1556	Bar Coding : Terminology
ANSI X3.182	Bar Code Print Quality - Guideline (Same as EN1635 - Bar Coding : Test Specifications for Bar Code Symbols)
ANSI X3.4	Coded Character Sets - 7-bit American National Standard Code for Information Interchange (7-bit ASCII) (equivalent to the US national version of ISO 646)
ISO 3166	Codes for the Representation on Names of Countries
ISO/IEC 8859-1	Information Processing - 8-bit Single-byte Coded Graphic Character Sets - Part 1 (Latin Alphabet Number 1)

Guideline on Mode 0 for MaxiCode - AIM USA
ECI Assignments Document - AIM International.

3 Definitions and Mathematical Symbols

3.1 Definitions

For the purposes of this Standard the following definitions in EN1556 (Terminology) shall apply:

algorithm, application standard, ASCII, autodiscrimination, binary, bit, CCD, code page, code set, data character, data codeword, data region, data separator character, decode algorithm, decoder, error correction, finder pattern, human readable character, latch character, leading zeros, matrix symbology, modulo, numeric, omnidirectional, orientation pattern, overhead, pad character, pixel, quiet zone, reference decode algorithm, Reed-Solomon error correction, scanner, shift characters, structured append, symbol character, symbology, symbology identifier, X-dimension

The following definitions also apply to this specification. Although some of the terms below are defined in EN1556, the definitions which follow below are more appropriate for this specification.

3.1.1 Codeword

A symbol character value. An intermediate level of coding between source data and the graphical encodation in the symbol.

3.1.2 Extended Channel Interpretation (ECI)

A protocol used by some symbologies that allows the output data stream to have interpretations other than that of the default character set.

3.1.3 Mode Indicator

A group of modules, in MaxiCode, used to define the symbol structure, for example to specify the level of error correction employed in the symbol.

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3.1.4 Module

A single cell in a matrix symbology used to encode one bit of data. In MaxiCode the module is a regular hexagonal shape.

3.2 Mathematical Symbols and Operations

For the purposes of this specification the mathematical symbols which follow shall apply:

c	codeword
H	vertical distance from the center of a module in the top row to the center of a module in the bottom row
L	distance from the center of the left-most module to the center of the right-most module in the top row
m	message character
n	total number of data codewords
s	symbol character
V	vertical height of a module
W	center to center distance between adjacent modules
X	horizontal width of a module
Y	vertical distance from the center line of modules in one row to the center line of modules in an adjacent row

For the purposes of this specification the mathematical operations which follow shall apply:

div	is the integer division operator
mod	is the integer remainder after division

4 Requirements

4.1 Symbology Characteristics

4.1.1 Basic Characteristics

MaxiCode is a matrix symbology with the following basic characteristics:

a. Encodable character set:

1. The default character set allows 256 international characters to be encoded:

   i. values 0-127, in accordance with ANSI X3.4, i.e. all 128 ASCII characters

   ii. values 128-255 in accordance with ISO 8859-1: Latin Alphabet No. 1

2. Numeric compaction allows 9 digits to be compacted in six codewords.

3. Various symbology control characters, for code switching and other control purposes, are included.

b. Codeword set:

1. The codeword set of 64 (2^6) values is used as an intermediate encodation layer between the data characters and symbol characters. The codewords form the basis for error correction calculations.

2. The codewords have the values 0-63; 000000 to 111111 in binary notation. Within each symbol character the most significant bit is the lowest numbered module as shown in Figures 1 and 5.

c. Representation of codewords in a MaxiCode symbol:

1. Each codeword is represented by 6 modules which are hexagonal in shape.

2. Information is represented in each module as a binary bit. A dark module is a one and a light module is a zero.

3. Generally the six modules are arranged in three rows of two modules, each ordered from upper right to lower left. Figure 1 identifies the modules of a typical symbol character.

4. Because of the structure of the MaxiCode symbol, symbol characters 1 - 9 and 137 - 144 have a different arrangement (See Figure 4).

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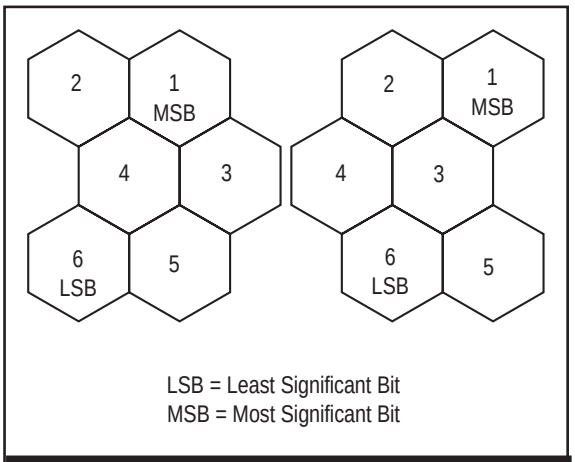

Figure 1: Typical Symbol Character of a MaxiCode Symbol

d. Symbol size:

1. Each MaxiCode symbol is of a fixed size, having 884 hexagonal modules arranged in 33 rows around a central finder pattern. Each row consists of a maximum of 30 modules.

2. Each symbol, including the quiet zone, is of a fixed physical size, nominally 28.14mm wide x 26.91mm high.

3. 864 modules (144 symbol characters) are available for data encodation and error correction. Two modules are unused.

4. Non-data overhead:

   i. 18 modules for orientation per symbol

   ii. equivalent of 90 modules for the finder pattern

e. Maximum data capacity:

1. Alphanumeric characters: 93
2. Numeric characters: 138

f. Error correction:

50 or 66 codewords per MaxiCode symbol.

g. Code type: matrix

h. Orientation independence: Yes

4.1.2 Summary of Additional Features

The following summary is of additional features which are inherent or optional in MaxiCode:

a. Finder Pattern: (Inherent) MaxiCode symbols have a central unique finder pattern, of three concentric dark rings, which is used to locate the MaxiCode symbol within a field of view (see Section 4.2.1.1). The finder pattern and fixed symbol size makes the MaxiCode symbology suitable for high speed scanning applications.

b. Error Correction: (Inherent) MaxiCode symbols have error correction codewords, based on Reed-Solomon error correction algorithms, which can be used not only to detect errors but to correct erroneously decoded or missing codewords (see Section 4.5.1). A user may select one of two error correction levels.

c. Modes: (Inherent) This mechanism allows various structures of the symbol. Seven modes are specified (including 2 obsolete modes, see Section 4.8).

d. Extended Channel Interpretations: (Optional) This mechanism enables characters from other character sets (e.g. Arabic, Cyrillic, Greek, Hebrew) and other data interpretations or industry-specific requirements to be represented.

e. Structured Append: (Optional) This allows files of data to be represented in up to 8 MaxiCode symbols. The original data can be correctly reconstructed regardless of the order in which the symbols are scanned (see Section 4.9).

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"THIS IS A 93 CHARACTER CODE SET A MESSAGE THAT FILLS A MODE 4, UNAPPENDED, MAXICODE SYMBOL..."

Figure 2: MaxiCode Symbol (Actual Size)

4.2 Symbol Description

4.2.1 Symbol Structure

Each MaxiCode symbol consists of a central finder pattern surrounded by a square array of offset rows of hexagonal modules. The 33 rows in the symbol alternate between 30 and 29 modules in width. The symbol shall be surrounded on all four sides by a quiet zone border. Figure 2 illustrates a MaxiCode symbol.

4.2.1.1 Finder Pattern

The finder pattern is made up of 3 dark concentric rings and 3 included light areas, centered on the virtual module specified in Section 4.11.4. Figure 3 shows the finder pattern relative to the adjacent module pattern.

4.2.1.2 Orientation Patterns

The orientation information is provided by 6 patterns of 3 modules. The precise location of the Orientation Patterns are given in Figures 3 - 5.

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B = black or dark modules of the orientation pattern
W = white or light modules of the orientation pattern

= virtual hexagon

Figure 3: MaxiCode Symbol Construction - Finder Pattern and Orientation Modules

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4.2.2 Symbol Character and Module Sequence

A MaxiCode symbol contains 144 symbol characters in the primary and secondary messages. The symbol characters are ordered according to the following rules:

a. Symbol characters in the primary message (1 to 20) are arranged around the finder pattern as shown in Figure 4. Symbol characters in the secondary message (21 to 144) are arranged in a boustrophedonic pattern beginning at the upper left corner proceeding left to right in the first row, right to left in the second row and so forth (See Figure 4).

b. Each hexagonal module is numbered. Figure 5 illustrates the sequence of hexagonal modules within a symbol. Generally, the hexagonal modules of a symbol character are contiguous and are numbered from right to left and top to bottom within the symbol character. In all cases, the lowest numbered module in a symbol character is the Most Significant Bit (See Figure 1). In all cases, module M is the Nth bit of symbol character C (where N=1 is the Most Significant Bit up to N = 6 is the Least Significant Bit) where:

C = ((M - 1) div 6) + 1

N = ((M - 1) mod 6) + 1

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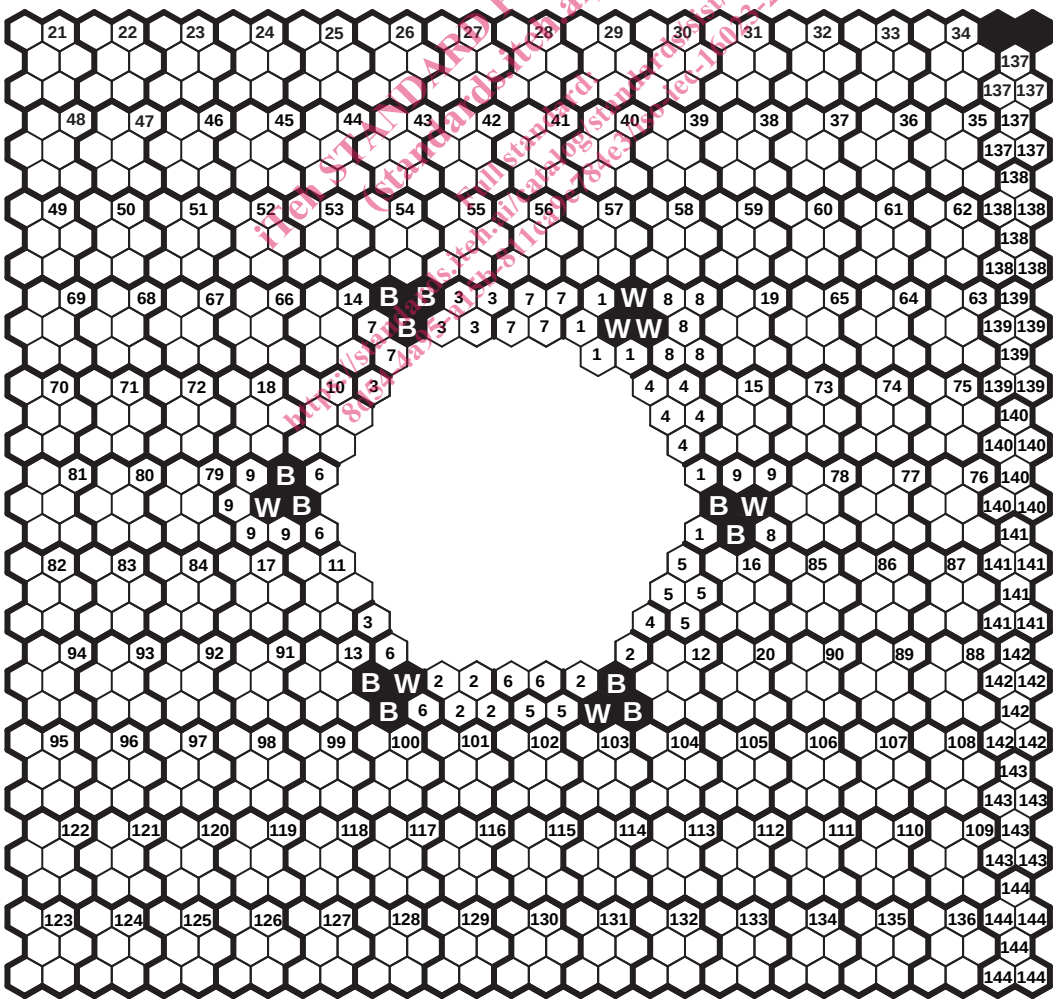

Figure 4: MaxiCode Symbol Character Sequence

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c. Modules 1 to 120, i.e. 20 symbol characters, shall contain information from the Primary Message, including data, error correction and mode information. Modules 121 to 864, i.e. 124 symbol characters, shall contain information from the Secondary Message.

The two rightmost modules in the top row are not utilized (See Figure 5). They shall be encoded as dark modules.

4.3 General Encodation Procedures

The following steps are required to convert data into the encoded form represented in a MaxiCode symbol. The following sections of this specification specify the rules and procedures.

1. For transportation applications, determine if a structured carrier message is appropriate; if so, special encoding rules apply to the primary message.

2. Data from a 256 character set may be encoded in MaxiCode. This data needs to be presented in a data stream reading from left to right.

3. Each character of data is translated into a codeword (0-63). Additional codewords are

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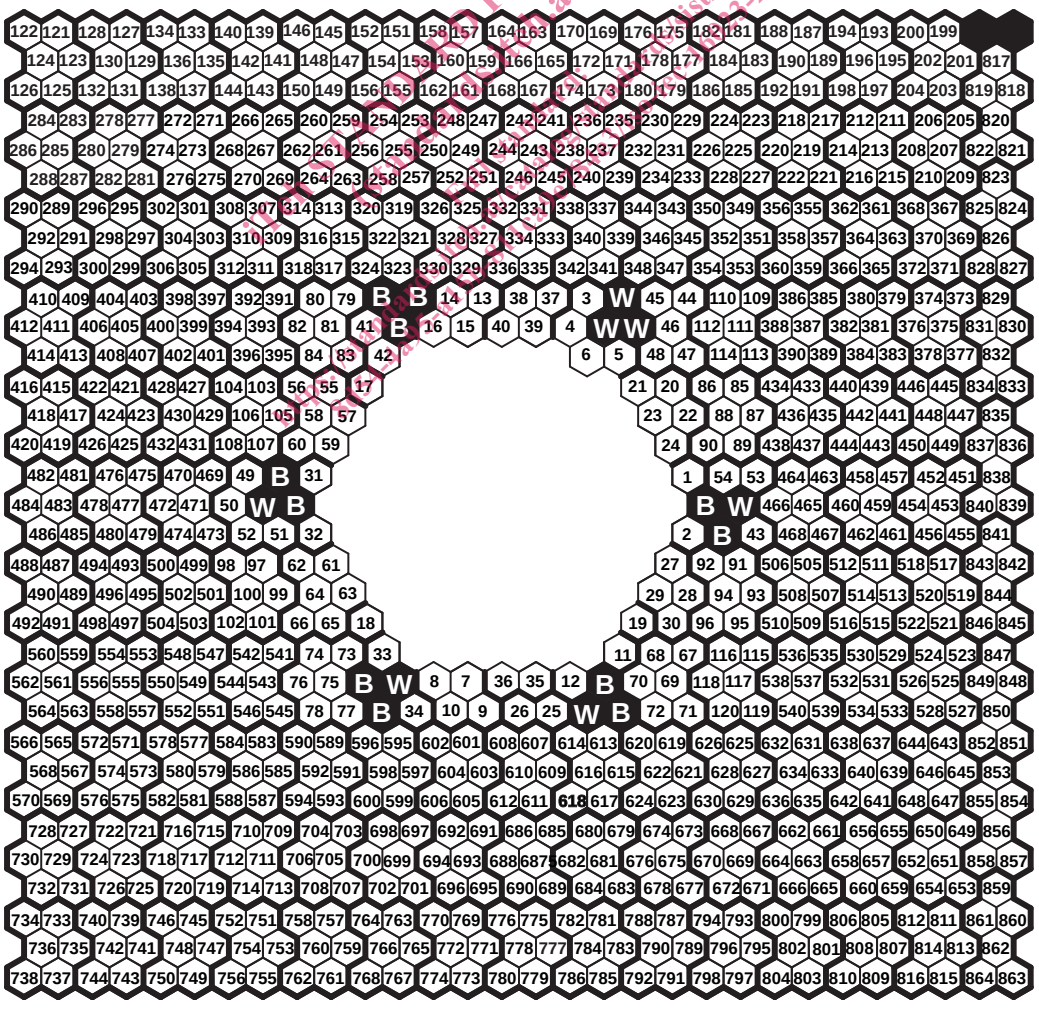

Figure 5: MaxiCode Module Sequence

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inserted in the process to switch between subsets of character sets.

4. The user or application selects one of two error correction levels.

5. Pad characters are added as needed to fill out the capacity of the symbol.

6. The codeword stream is subdivided into two messages: Primary and Secondary.

7. The error correction codewords are generated for the Primary Message and for the Secondary Message. The result of this process expands the codeword stream by the number of error correction codewords, either 50 or 66.

8. The codeword stream is converted into two bit streams for the Primary and Secondary Messages.

9. The primary and secondary bit streams are mapped bit by bit to the sequence of hexagonal modules in the MaxiCode symbol (See Figure 5).

4.4 Character Assignments

MaxiCode has a 64 codeword set which is used to encode up to 256 different character values, to provide numeric compaction and to encode particular structured messages (see Section 4.7.3, for a description of Modes 2 and 3). The rules for encoding data are defined in the following sections.

In order to encode all 256 characters, five Code Sets (A to E) are defined. Annexe A shows the encodable character set and the arrangement of characters in the five Code Sets. Characters are grouped into Code Sets according to likely use. Code Set A contains the characters assessed to be most commonly used; in many applications it may not be necessary to switch from this basic character set. To select other data characters, it is necessary to use Latch and Shift characters (see Section 4.4.4.1 to 4.4.4.5).

4.4.1 Codeword Representation

The codewords, or symbol character values, in MaxiCode range from 0 to 63. The binary equivalent of the codeword (i.e. 000000 to 111111) shall be directly represented in six hexagonal modules in the MaxiCode symbol.

The sequence of modules in a codeword is normally represented in a MaxiCode symbol character as illustrated in Figure 1, and the entire data shall follow the module pattern sequence as defined in Figure 5.

4.4.2 Default Character Interpretation

The default character interpretation for character values 0 to 127 shall conform to ANSI X3.4. The default character interpretation for character values 128 to 255 shall conform to ISO 8859-1: Latin Alphabet No. 1. The graphical representation of data characters shown throughout this document complies with the default interpretation. This interpretation can be changed using Extended Channel Interpretation (ECI) escape sequences, see Section 4.6. The default interpretation corresponds to ECI 000003.

4.4.3 Code Sets

4.4.3.1 Code Set A

Code Set A is the default code set at the start of every MaxiCode symbol.

Code Set A contains all the standard uppercase alphabetic characters, the numerals 0 to 9, 15 common punctuation symbols, the space character, and the control characters [CR], [FS], [GS] and [RS] used for data syntax. In addition, it contains 8 symbology control characters.

4.4.3.2 Code Set B

Code Set B contains all the lowercase alphabetic characters and additional punctuation characters. In addition, it includes the control characters [FS], [GS], [RS], and [DEL] used for data syntax and 12 symbology control characters.

4.4.3.3 Code Set C

Code Set C contains multilingual uppercase alphabetic characters and additional punctuation and other graphic characters. It also includes the control characters [FS], [GS] and [RS] used for data syntax and 10 of the characters (values 128 to 137) not assigned a graphic representation in ISO 8859. In addition, it includes 7 symbology control characters.

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