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Information technology — Automatic identification and data capture techniques — Bar code symbology specification — EAN/UPC

Technologies de l'information — Techniques d'identification automatique et de capture des données — Spécifications pour les symboles des codes à barres — EAN/UPC

Reference number
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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

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 15420 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 31, *Automatic identification and data capture techniques*.

Annexes A and B form a normative part of this International Standard. Annexes C to G are for information only.

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Introduction

The technology of bar coding is based on the recognition of patterns encoded in bars and spaces of defined dimensions. There are numerous methods of encoding information in bar code form, known as symbologies. EAN/UPC is one such symbology. The rules defining the translation of characters into bar and space patterns, and other essential features of each symbology, are known as the symbology specification.

EAN/UPC bar code symbols are exclusively reserved for encoding identification numbers. The use of the symbology is restricted and subject to compliance with the EAN International (EAN) and Uniform Code Council (UCC) rules and registration procedures. The administration of the numbering system by EAN and UCC ensures that identification codes assigned to particular items are unique world-wide and are defined in a consistent way. The major benefit for the users of the UCC/EAN system is the availability of uniquely defined identification codes for use in their trading transactions. Refer to Annex C for an overview of the UCC/EAN system.

Manufacturers of bar code equipment and users of bar code technology require publicly available standard symbology specifications to which they can refer when developing equipment and software.

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Information technology — Automatic identification and data capture techniques — Bar code symbology specification — EAN/UPC

1 Scope

This International Standard specifies the requirements for the EAN/UPC symbology including data character encodation, symbol formats, dimensions, test specifications, and a reference decoding algorithm.

Data content and the rules governing the use of this symbology are defined in the UCC/EAN system specifications.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this International Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO/IEC 646:1991, *Information technology — ISO 7-bit coded character set for information interchange.*

ISO 1073-2:1976, *Alphanumeric character sets for optical recognition — Part 2: Character set OCR-B — Shapes and dimensions of the printed image.*

ISO/IEC 15416:2000, *Information technology — Automatic identification and data capture techniques — Bar code print quality test specification — Linear symbols.*

ISO/IEC 15424:2000, *Information technology — Automatic identification and data capture techniques — Data Carrier Identifiers (including Symbology Identifiers).*

EN 1556:1996, *Bar coding — Terminology.*

ANSI/UCC-1:1995, *U.P.C. Symbol Specification Manual.*

"*General EAN Specifications*" (EAN International, Brussels).

3 Terms and definitions

For the purposes of this International Standard, the terms and definitions given in EN 1556 and the following apply.

3.1
add-on symbol
A symbol used to encode information supplementary to that in the main symbol.

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3.2
auxiliary pattern
A pattern of bars/spaces representing non-data components of the symbol - e.g. guard patterns and inter-character delineators.

3.3
delineator
An auxiliary pattern used to separate characters within an add-on symbol.

3.4
even parity
A characteristic of the encodation of a symbol character whereby the character contains an even number of dark modules.

3.5
guard pattern
An auxiliary pattern of bars/spaces corresponding to start or stop patterns in other symbologies, or serving to separate the two halves of a symbol.

3.6
magnification factor
A constant multiplier of the nominal dimensions of an EAN/UPC symbol.

3.7
numbering organisation
An agency responsible for the administration of the UCC/EAN system and maintenance of a number bank within a defined territory.

3.8
number set
A series of ten bar/space patterns of either even or odd parity encoding the digits 0 to 9.

3.9
odd parity
A characteristic of the encodation of a symbol character whereby the character contains an odd number of dark modules.

3.10
UCC/EAN System
A system for the unique numbering and identification of products, handling units, assets, locations, and services according to a set of rules maintained by EAN International and the Uniform Code Council. See Annex C.

3.11
variable parity encodation
The process of encoding additional information in a series of symbol characters by using particular combinations of odd and even parity characters to implicitly encode digits or for checking purposes.

3.12
zero-suppression
The process of removing zeroes from specified positions in a UCC-12 data string in order to encode it in UPC-E format.

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4 Requirements

4.1 Symbology characteristics

The characteristics of EAN/UPC are:

a) Encodable character set: numeric (0 to 9) i.e. ASCII characters 48 - 57 inclusive, in accordance with ISO 646;

b) Symbology type: continuous;

c) Elements per symbol character: 4, comprising 2 bars and 2 spaces, each of 1, 2, 3 or 4 modules in width (auxiliary patterns have differing numbers of elements);

d) Character self-checking: yes;

e) Data string length encodable: fixed (8, 12, or 13 characters including check digit depending on specific symbol type);

f) Omni-directionally decodable: yes;

g) Symbol check digit: one, mandatory (see A.1);

h) Symbol character density: 7 modules per symbol character;

i) Non-data overhead including the check digit, but not including quiet zones:

— 18 modules for EAN-13, EAN-8 and UPC-A symbols

— 9 modules for UPC-E symbols

4.2 Symbol types

The four types of the EAN/UPC symbol are:

— EAN-13, UPC-A and UPC-E, all of which may be accompanied by an add-on symbol;

— EAN-8.

The four symbol types are described in 4.4.1 to 4.4.4 and the optional add-on symbols are described in 4.4.5.

4.3 Symbol encodation

4.3.1 Symbol character encodation

Symbol characters shall encode digit values in 7-module characters selected from different number sets known as A, B and C, as in Table 1:

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Table 1: Number sets A, B and C

Digit value	Set A Element Widths				Set B Element Widths				Set C Element Widths			
	S	B	S	B	S	B	S	B	B	S	B	S
0	3	2	1	1	1	1	2	3	3	2	1	1
1	2	2	2	1	1	2	2	2	2	2	2	1
2	2	1	2	2	2	2	1	2	2	1	2	2
3	1	4	1	1	1	1	4	1	1	4	1	1
4	1	1	3	2	2	3	1	1	1	1	3	2
5	1	2	3	1	1	3	2	1	1	2	3	1
6	1	1	1	4	4	1	1	1	1	1	1	4
7	1	3	1	2	2	1	3	1	1	3	1	2
8	1	2	1	3	3	1	2	1	1	2	1	3
9	3	1	1	2	2	1	1	3	3	1	1	2

NOTE S denotes a space (light), B denotes a bar (dark), and the element widths are in modules.

Annex D illustrates Table 1 graphically. The sum of the bar modules in any symbol character determines its parity. Symbol characters in number set A are odd parity characters. Symbol characters in number sets B and C are even parity characters. Number set C characters are mirror images of number set B characters.

Symbol characters in number sets A and B always begin on the left with a light module and end on the right with a dark module. Symbol characters in number set C begin on the left with a dark module and end on the right with a light module.

A data character shall normally be represented by a symbol character. However in certain specific instances defined below (see 4.4.1, 4.4.4, 4.4.5) the combination of number sets in a symbol may itself represent either data or a check value. This technique is referred to as variable parity encodation.

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4.3.2 Auxiliary pattern encodation

Auxiliary patterns shall be composed as shown in Table 2.

Table 2: Auxiliary patterns

Auxiliary pattern	Number of modules	Element widths in modules					
		S	B	S	B	S	B
Normal guard pattern	3		1	1	1		
Centre guard pattern	5	1	1	1	1	1	
Special guard pattern	6	1	1	1	1	1	1
Add-on guard pattern	4		1	1	2		
Add-on delineator	2	1	1				
NOTE: S denotes a space (light) element, B denotes a bar (dark) element.							

Annex D illustrates these patterns graphically.

The normal guard pattern corresponds to the start and stop patterns in other symbologies and the special guard pattern is used as a stop pattern in UPC-E symbols.

4.4 Symbol formats

4.4.1 EAN-13 symbols

The EAN-13 symbol shall be made up as follows, reading from left to right:

— a left quiet zone;

— a normal guard pattern;

— 6 symbol characters from number sets A and B;

— a centre guard pattern;

— 6 symbol characters from number set C;

— a normal guard pattern

— a right quiet zone.

The rightmost symbol character shall encode the check digit calculated in accordance with Annex A.1.

Since the EAN-13 symbol comprises only 12 symbol characters but encodes 13 digits of data (including the check digit), the value of the additional digit, which is the character in the leftmost position in the data string, shall be encoded by the variable parity mix of number sets A and B for the 6 symbol characters in the left half of the symbol. The coding system for values of the leading digit is specified in Table 3. Figure 1 is an example of an EAN-13 bar code symbol.

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Table 3: Left half of EAN-13 symbol

Leading digit, implicitly encoded	Number sets used for coding left half of EAN-13 symbol					
	Symbol character position					
	1	2	3	4	5	6
0*	A	A	A	A	A	A
1	A	A	B	A	B	B
2	A	A	B	B	A	B
3	A	A	B	B	B	A
4	A	B	A	A	B	B
5	A	B	B	A	A	B
6	A	B	B	B	A	A
7	A	B	A	B	A	B
8	A	B	A	B	B	A
9	A	B	B	A	B	A

NOTE: The leading digit value “0” is reserved for symbols encoding UCC-12 data strings.

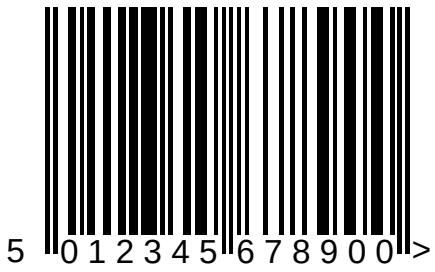


Figure 1: EAN-13 bar code symbol

4.4.2 EAN-8 symbols

The EAN-8 symbol shall be made up as follows, reading from left to right:

— a left quiet zone;

— a normal guard pattern;

— 4 symbol characters from number set A;

— a centre pattern;

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— 4 symbol characters from number set C;

— a normal guard pattern.

— a right quiet zone.

The rightmost symbol character shall encode the check digit calculated in accordance with Annex A.1. Figure 2 shows an example of an EAN-8 bar code symbol.



Figure 2: EAN-8 bar code symbol

4.4.3 UPC-A symbols

The UPC-A symbol shall be made up as follows, reading from left to right:

— a left quiet zone;

— a normal guard pattern;

— 6 symbol characters from number set A;

— a centre pattern;

— 6 symbol characters from number set C;

— a normal guard pattern.

— a right quiet zone.

The rightmost symbol character shall encode the check digit calculated in accordance with Annex A.1. UPC-A symbols may be decoded as a 13 digit number by adding an implied leading zero to the UCC-12 number. Figure 3 shows an example of a UPC-A bar code symbol.

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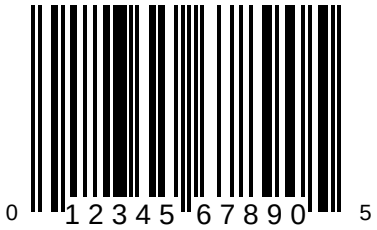


Figure 3: UPC-A bar code symbol

4.4.4 UPC-E symbols

The UPC-E symbol shall be made up as follows, reading from left to right:

— a left quiet zone;

— a normal guard pattern;

— 6 symbol characters from number sets A and B;

— a special guard pattern;

— a right quiet zone.

The UPC-E symbol may only be used to encode UCC-12 data strings which commence with a zero and contain a sequence of four or five zeroes in defined positions, as shown in Table 5. These zeros are removed from the data during encoding by the process of zero suppression described in 4.4.4.1. Figure 4 shows an example of a UPC-E bar code symbol.

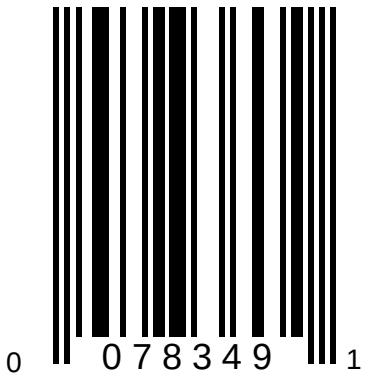


Figure 4: UPC-E bar code symbol (encoding "0 07834 00009 1" by zero suppression)

4.4.4.1 Encodation of a UPC-E symbol

The following algorithm describes the encodation of a data string suitable for zero suppression:

1) Let *D1*, *D2*, *D3*...*D12* denote the UCC-12 data characters (including check digit). *D1* shall always be 0. *D12* shall be the symbol check digit calculated according to the algorithm in Annex A.1. Let *X1*, *X2*...*X6* denote the six symbol characters in the final UPC-E symbol.

2) Convert *D2* through *D11* into a symbol character string by removing zeroes according to the following rules:

   a) if *D11* equals 5, 6, 7, 8 or 9

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and *D7* to *D10* inclusive are all 0

and *D6* is not 0

then *D7* to *D10* are not encoded.

Symbol character:	*X1*	*X2*	*X3*	*X4*	*X5*	*X6*
Data character:	*D2*	*D3*	*D4*	*D5*	*D6*	*D11*

b) if *D6* to *D10* inclusive are all 0

and *D5* is not 0

then *D6* to *D10* are not encoded and *X6* = 4.

Symbol character:	*X1*	*X2*	*X3*	*X4*	*X5*	*X6*
Data character:	*D2*	*D3*	*D4*	*D5*	*D11*	4

c) if *D4* is 0, 1 or 2

and *D5* to *D8* inclusive are all 0

then *D5* to *D8* are not encoded.

Symbol character:	*X1*	*X2*	*X3*	*X4*	*X5*	*X6*
Data character:	*D2*	*D3*	*D9*	*D10*	*D11*	*D4*

d) if *D4* is 3, 4, 5, 6, 7, 8 or 9

and *D5* to *D9* inclusive are all 0

then *D5* to *D9* are not encoded and *X6* = 3.

Symbol character:	*X1*	*X2*	*X3*	*X4*	*X5*	*X6*
Data character:	*D2*	*D3*	*D4*	*D10*	*D11*	3

3) Determine the number sets for the implicit encodation of *D12* from Table 4.

4) Encode symbol characters *X1* to *X6* using number sets A and B as determined in step 3.

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Table 4: Number sets for UPC-E Symbol

Value of check digit *D12*	Number sets used for coding UPC-E symbol					
	Symbol character position					
	1	2	3	4	5	6
0	B	B	B	A	A	A
1	B	B	A	B	A	A
2	B	B	A	A	B	A
3	B	B	A	A	A	B
4	B	A	B	B	A	A
5	B	A	A	B	B	A
6	B	A	A	A	B	B
7	B	A	B	A	B	A
8	B	A	B	A	A	B
9	B	A	A	B	A	B

EXAMPLE 1:	Original data	Zero-suppressed	Rule
	0 1 2 3 4 5 0 0 0 0 5 8	1 2 3 4 5 5	2a
		B A B A A B	
EXAMPLE 2:	Original data	Zero-suppressed	Rule
	0 4 5 6 7 0 0 0 0 0 8 0	4 5 6 7 8 4	2b
		B B B A A A	
EXAMPLE 3:	Original data	Zero-suppressed	Rule
	0 3 4 0 0 0 0 0 5 6 7 3	3 4 5 6 7 0	2c
		B B A A A B	
EXAMPLE 4:	Original data	Zero-suppressed	Rule
	0 9 8 4 0 0 0 0 0 7 5 1	9 8 4 7 5 3	2d
		B B A B A A	

NOTE: The number sets used to implicitly encode the check digit are shown in the zero-suppressed column.

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4.4.4.2 Decoding a UPC-E symbol

Derivation of the 12 digit data string from the characters encoded in the UPC-E symbol can be performed according to Table 5.

Table 5: Decoding of UPC-E symbol

Encoded UPC-E digits									Decoded number											
	P1	P2	P3	P4	P5	P6			*D1*	*D2*	*D3*	*D4*	*D5*	*D6*	*D7*	*D8*	*D9*	*D10*	*D11*	*D12*
(0)	*X1*	*X2*	*X3*	*X4*	*X5*	0	(C)		(0)	*X1*	*X2*	0	0	0	0	0	*X3*	*X4*	*X5*	(C)
(0)	*X1*	*X2*	*X3*	*X4*	*X5*	1	(C)		(0)	*X1*	*X2*	1	0	0	0	0	*X3*	*X4*	*X5*	(C)
(0)	*X1*	*X2*	*X3*	*X4*	*X5*	2	(C)		(0)	*X1*	*X2*	2	0	0	0	0	*X3*	*X4*	*X5*	(C)
(0)	*X1*	*X2*	*X3*	*X4*	*X5*	3	(C)		(0)	*X1*	*X2*	*X3*	0	0	0	0	0	*X4*	*X5*	(C)
(0)	*X1*	*X2*	*X3*	*X4*	*X5*	4	(C)		(0)	*X1*	*X2*	*X3*	X4	0	0	0	0	0	*X5*	(C)
(0)	*X1*	*X2*	*X3*	*X4*	*X5*	5	(C)		(0)	*X1*	*X2*	*X3*	*X4*	*X5*	0	0	0	0	5	(C)
(0)	*X1*	*X2*	*X3*	*X4*	*X5*	6	(C)		(0)	*X1*	*X2*	*X3*	*X4*	*X5*	0	0	0	0	6	(C)
(0)	*X1*	*X2*	*X3*	*X4*	*X5*	7	(C)		(0)	*X1*	*X2*	*X3*	*X4*	*X5*	0	0	0	0	7	(C)
(0)	*X1*	*X2*	*X3*	*X4*	*X5*	8	(C)		(0)	*X1*	*X2*	*X3*	*X4*	*X5*	0	0	0	0	8	(C)
(0)	*X1*	*X2*	*X3*	*X4*	*X5*	9	(C)		(0)	*X1*	*X2*	*X3*	*X4*	*X5*	0	0	0	0	9	(C)

Notes:

— The symbol characters at positions P1, P2 ... P5 of the UPC-E symbol are represented by *X1*, *X2* ... *X5*.

— Re-inserted zeroes are indicated by underlining.

— The leading digit for UPC-E symbols, which is not encoded, is indicated by “(0)”.

— The check digit implicitly encoded in UPC-E is indicated by “(C)”.

4.4.5 Add-on symbols

The add-on symbols were designed for use with EAN/UPC symbols on periodicals and paperback books. Because they provide reduced security their use shall be limited to applications where rules in the application specification governing data format and content provide appropriate safeguards.

4.4.5.1 Two digit add-on symbol

The 2-digit add-on may be used in specific applications, in combination with an EAN-13, UPC-A, or UPC-E symbol. The add-on is positioned following the right quiet zone of the main symbol, and consists of the following:

— add-on guard pattern;

— first digit of the add-on number from number sets A or B;

— add-on delineator;

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— second digit of the add-on number from number sets A or B;

— a right quiet zone.

The add-on has no right guard pattern. It does not have an explicit check digit. Checking is done through the mix of the number sets (A or B) used for the two digits. The choice of number sets is linked to the value of the add-on number as shown by Table 6:

Table 6: Number sets for 2-digit add-on

Value of the add-on number	Left-hand digit	Right-hand digit
Multiple of 4 (00,04,08,…,96)	A	A
Multiple of 4+1 (01,05,…,97)	A	B
Multiple of 4+2 (02,06,…,98)	B	A
Multiple of 4+3 (03,07,…,99)	B	B

Figure 5 shows an example of an UPC-A bar code symbol with 2-digit add-on.

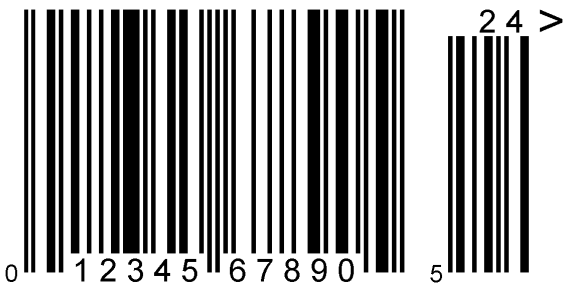


Figure 5: UPC-A bar code symbol with 2-digit add-on

4.4.5.2 Five digit add-on symbol

The 5-digit add-on may be used in specific applications, in combination with an EAN-13, UPC-A, or UPC-E symbol. The add-on is positioned following the right quiet zone of the main symbol, and consists of the following:

— add-on guard pattern;

— first digit of the add-on number from number sets A or B;

— add-on delineator;

— second digit of the add-on number from number sets A or B;

— add-on delineator;

— third digit of the add-on number from number sets A or B;

— add-on delineator;

— fourth digit of the add-on number from number sets A or B;

— add-on delineator;

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— fifth digit of the add-on number from number sets A or B.

— a right quiet zone.

The add-on has no right guard pattern. It does not have an explicit check digit. Checking is done through the mix of the number sets (A or B) used for the five digits. A value v is determined by the following rules:

1) Sum the digits in positions 1, 3 and 5.

2) Multiply the result of step 1 by 3.

3) Sum the remaining digits (positions 2 and 4).

4) Multiply the result of step 3 by 9.

5) Sum the results of steps 2 and 4.

6) The value of v is the units position (lowest-order digit) of the result of step 5.

EXAMPLE: to calculate the value of v for the add-on number 86104:

Step 1: 8 + 1 + 4 = 13

Step 2: 13 x 3 = 39

Step 3: 6 + 0 = 6

Step 4: 6 x 9 = 54

Step 5: 39 + 54 = 93

Step 6: v = 3

The number sets can then be determined by using table 7.

Table 7: Number sets for 5-digit add-on

Value of V	Number sets used for symbol characters				
	1	2	3	4	5
0	B	B	A	A	A
1	B	A	B	A	A
2	B	A	A	B	A
3	B	A	A	A	B
4	A	B	B	A	A
5	A	A	B	B	A
6	A	A	A	B	B
7	A	B	A	B	A
8	A	B	A	A	B
9	A	A	B	A	B

For the example, since v = 3, the sequence of number sets used to encode the value 86104 is B A A A B.

Figure 6 shows an example of an EAN-13 bar code symbol with 5-digit add-on.

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Figure 6: EAN-13 bar code symbol with 5-digit add-on

4.5 Dimensions and Tolerances

The dimensions of an EAN/UPC symbol may be referenced to a defined set of dimensions referred to as the nominal size symbol. Refer to Annex E for dimensioned drawings of nominal size symbols. The nominal size symbol shall use the following dimensions.

4.5.1 Width of narrow element (X)

The nominal width of the narrow element shall be 0,330 mm.

4.5.2 Bar height

The nominal bar height shall be:

— EAN-13, UPC-A and UPC-E symbols: 22,85 mm;

— EAN-8 symbols: 18,23 mm;

— Add-on symbols: 21,9 mm.

In EAN-13, EAN-8, UPC-A, and UPC-E symbols the bars forming the left, centre and right guard patterns shall be extended downwards by 5X, i.e. 1,65 mm. This shall also apply to the bars of the first and last symbol characters of the UPC-A symbol.

4.5.3 Quiet zone

The minimum quiet zone width required by the main symbol types of the symbology is 7X. Various minimum quiet zone dimensions are, however, specified for the various symbol types, due to the size and location of the human readable characters.

Minimum width of quiet zones:

— EAN-13 symbols: left, 11X; right, 7X;

— UPC-A symbols: 9X;

— UPC-E symbols: left, 9X; right, 7X**;**

— EAN-8 symbols: 7X;

— Add-on symbols (all): right 5X.

A useful device to help maintain the quiet zone in some production processes is to include a “less than” (<) and/or “greater than” (>) character in the human readable field the point of which should be aligned with the edge of the quiet zone. If this device is used, the character(s) shall be positioned in accordance with the appropriate drawings in Annex E.

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4.5.4 Positioning of the add-on symbol

The add-on shall not encroach on the right quiet zone of the main symbol. The maximum separation shall be 12X.

The bottom edge of the bars in the add-on symbol shall be horizontally aligned with the bottom edge of the guard bars of the main symbol.

4.5.5 Element widths

The width of each bar and space shall be determined by multiplying the X dimension by the module width of each bar and space (1, 2, 3 or 4). There is an exception for the digit values 1, 2, 7 and 8. For these characters, the bars and spaces shall be reduced or enlarged by 1/13 of a module to improve scanning reliability. This shall be done in such a way that edge to similar edge measurements and the total symbol character width remain unchanged (an example is shown in Annex G.3).

The reduction or enlargement in millimetres of the bars and spaces for the characters 1, 2, 7 and 8 is given in Table 8.

Table 8: Reduction/enlargement for symbol characters 1, 2, 7 and 8

Character value	Number set A		Number sets B and C	
	Bar	Space	Bar	Space
1	-0,025	+0,025	+0,025	-0,025
2	-0,025	+0,025	+0,025	-0,025
7	+0,025	-0,025	-0,025	+0,025
8	+0,025	-0,025	-0,025	+0,025

NOTE: Existing equipment and artwork for the generation of symbols which use a value of 0,030 mm for the reduction/enlargement factor may continue to do so.

4.5.6 Symbol width

The symbol width in modules (including the minimum quiet zones) shall be as indicated in Table 9.

Table 9: Symbol width in modules

Symbol type	Width
EAN-13	113
UPC-A	113
EAN-8	81
UPC-E	67
2-digit add-on	25
5-digit add-on	52
EAN-13 or UPC-A + 2-digit add-on	138
UPC-E + 2-digit add-on	92
EAN-13 or UPC-A + 5-digit add-on	165
UPC-E + 5-digit add-on	119

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4.5.7 Magnification factors

Symbols may be reduced or enlarged from the nominal size by applying a constant magnification factor in the range 0,8 to 2,0 to all dimensions.

The magnification factor of the add-on symbol shall be the same as the magnification factor of the associated main symbol.

4.5.8 Dimensional Tolerances

The historical element tolerances shown in Annex F.1 are superseded by the test specifications in 4.7.

4.6 Reference decode algorithm

Bar code reading systems are designed to read imperfect symbols to the extent that practical algorithms permit. This section describes the reference decode algorithm used to determine decode and decodability in symbol verification in accordance with 4.7.

For each symbol character, let *S* equal the total measured width of the character. The value *S* is used to determine reference threshold (*RT*) values. Individual edge to similar edge measurements (*e*) are then compared to the Reference Threshold (*RT*) to determine *E* values. Character values are determined from *E* values.

Value *e1* is defined as the measurement from the leading edge of a bar to the leading edge of the adjacent bar. Value *e2* is defined as the measurement from the trailing edge of a bar to the trailing edge of the adjacent bar. For number sets A and B the right edge of each of the two bars is considered to be leading, while for number set C the left edge of each bar is considered to be leading. These relationships are illustrated in Figure 7.

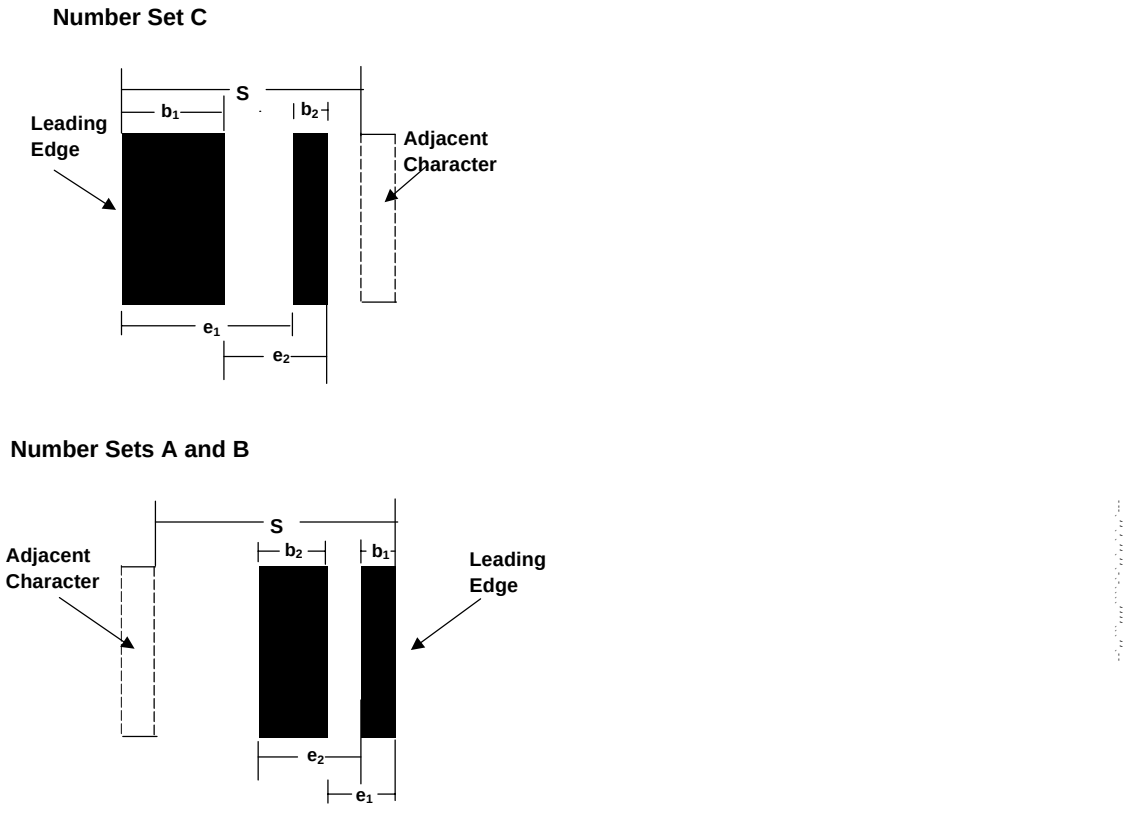


Figure 7: Symbol character decode measurements

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Reference thresholds *RT1*, *RT2*, *RT3*, *RT4* and *RT5* are given by:

RT1 = (1,5/7)*S*;

RT2 = (2,5/7)*S*;

RT3 = (3,5/7)*S*;

RT4 = (4,5/7)*S*;

RT5 = (5,5/7)*S*.

Within each character, the measurements *e1* and *e2* are compared with the reference thresholds. The corresponding integer values *E1* and *E2* are considered to be equal to 2, 3, 4 or 5 as follows:

If $RT1 <= e_i < RT2$, $E_i = 2$;

If $RT2 <= e_i < RT3$, $E_i = 3$;

If $RT3 <= e_i < RT4$, $E_i = 4$;

If $RT4 <= e_i < RT5$, $E_i = 5$.

Otherwise the character is in error.

In Table 10, use the values of *E1* and *E2* as the primary determinant for the symbol character value.

Table 10: EAN/UPC decoding table

Character	Number set	Primary Determinant		Secondary Determinant
		E1	E2	$7(b_1 + b_2)/S$
0	A	2	3	
1	A	3	4	<= 4
2	A	4	3	<= 4
3	A	2	5	
4	A	5	4	
5	A	4	5	
6	A	5	2	
7	A	3	4	>4
8	A	4	3	>4
9	A	3	2	
0	B and C	5	3	
1	B and C	4	4	>3
2	B and C	3	3	>3
3	B and C	5	5	
4	B and C	2	4	
5	B and C	3	5	
6	B and C	2	2	
7	B and C	4	4	<= 3
8	B and C	3	3	<= 3
9	B and C	4	2	

NOTE: b_1 and b_2 are the widths of the two bar elements

The character is uniquely determined for all combinations of *E1* and *E2* except for the following four cases:

--`,,```,,,,````-`-`,,`,,`,`,,`---

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E1 = 3 and *E2* = 4 (Characters 1 and 7 in number set A);

E1 = 4 and *E2* = 3 (Characters 2 and 8 in number set A);

E1 = 4 and *E2* = 4 (Characters 1 and 7 in number sets B and C);

E1 = 3 and *E2* = 3 (Characters 2 and 8 in number sets B and C).

These cases require that the combined width of the two bars be tested as follows:

For *E1* = 3 and *E2* = 4:

Character is "1" if: $7 \times (b_1 + b_2) / S <= 4$;

Character is "7" if: $7 \times (b_1 + b_2) / S > 4$.

For *E1* = 4 and *E2* = 3:

Character is "2" if: $7 \times (b_1 + b_2) / S <= 4$;

Character is "8" if: $7 \times (b_1 + b_2) / S > 4$.

For *E1* = 4 and *E2* = 4:

Character is "1" if: $7 \times (b_1 + b_2) / S > 3$;

Character is "7" if: $7 \times (b_1 + b_2) / S <= 3$.

For *E1* = 3 and *E2* = 3:

Character is "2" if: $7 \times (b_1 + b_2) / S > 3$;

Character is "8" if: $7 \times (b_1 + b_2) / S <= 3$.

These requirements on $(b_1 + b_2)$ are shown in Table 10.

The same procedures shall be used to decode the symbol characters in any add-on symbol.

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Using Figure 8, determine the appropriate S measurement for calculating the reference threshold values *RT1* and *RT2* applicable to the auxiliary patterns of the main symbol. For each symbol or half symbol the measurements of the appropriate auxiliary pattern e_i values are then compared to the reference thresholds to establish the integer *Ei* values. The determined values of *E1, E2, E3,* and *E4* shall match those of valid auxiliary patterns as shown in Table 11. Otherwise the symbol is in error.

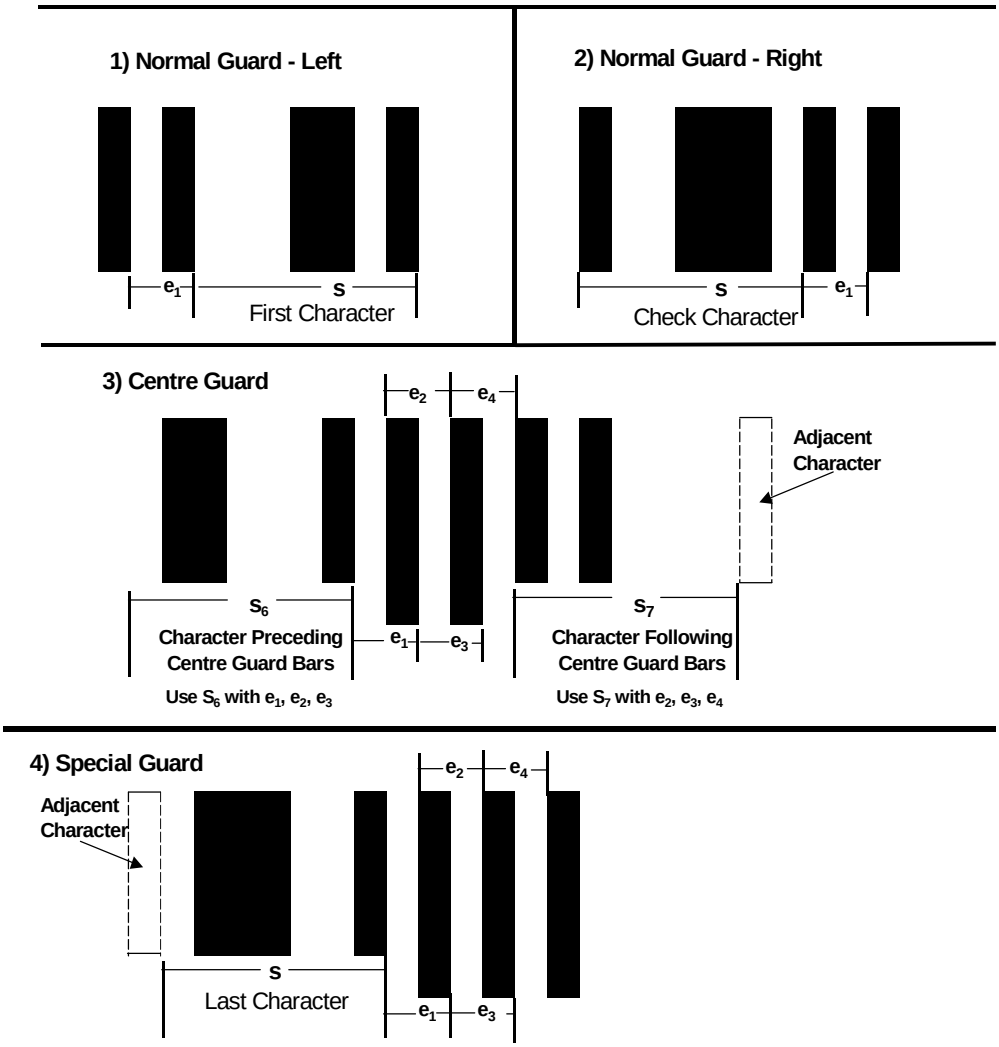


Figure 8: Auxiliary Pattern Measurements

Table 11: Main symbol auxiliary pattern E values

Auxiliary guard patterns	***E1***	***E2***	***E3***	***E4***
Normal guard pattern	2			
Centre (left half)	2	2	2	
Centre (right half)		2	2	2
Special guard pattern	2	2	2	2

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4.7 Symbol quality

ISO 15416 specifies conditions under which measurements should be made and methods of measuring dimensions and other attributes of the bar code symbol. In order to verify whether a symbol meets the specifications in this standard it shall be tested using ISO/IEC 15416.

In accordance with EAN International and Uniform Code Council specifications, the minimum symbol grade shall be 1,5/06/670, where:

— The minimum print quality grade is 1,5;

— The measurement aperture is number 06 (0,15 mm);

— The inspection wavelength is 670 +/- 10 nm.

Note: The minimum grade of 1,5/06/670 applies to the final symbol at its point of use. It is appropriate to strive for a higher symbol grade at the point of printing to allow for process variations and possible degradation from packaging, storage, and handling. Wherever practical, it is recommended that the symbol grade as printed should equal or exceed 2,5/06/670.

4.7.1 Decodability

For the calculation of the decodability value V, the following provisions apply, which are additional to those in ISO/IEC 15416:

Character Decodability for 1, 2, 7, and 8

A decodability value V is calculated for each character.

For i = 1 and 2 and j = 2, 3, 4:

K = smallest {|ei - RTj|}

V1 = K/(S/14)

For odd parity characters 1, 2, 7, or 8 the value V2 is given by:

V2 =[|(7/S)(combined width of both bars)-4|] / (15/13)

For even parity characters 1, 2, 7, or 8 the value V2 is given by:

V2 =[|(7/S)(Combined width of both bars)-3|] / (15/13)

For each character 1, 2, 7, or 8 the decodability value V equals the smaller of V1 or V2.

4.7.1.1 Decodability for the Auxiliary Patterns

The decodability value V for the auxiliary patterns shall be calculated as for standard (n, k) symbol characters but using the values of n, k and S below. The outermost bar of the left and right guard patterns shall not be included in the calculation.

For the left and right normal guard patterns of EAN-13, EAN-8 and UPC-A symbols, n = 2, k = 1; S shall be the value of S for the symbol character immediately to the right or left respectively of the normal guard pattern. For the special guard pattern on the right end of UPC-E symbols, n = 4, k = 2; S shall be the value of S for the symbol character immediately to the left of the special guard pattern.

For the centre guard pattern of EAN-13 and UPC-A symbols, n = 4, k = 2. First, calculate V1 for the first four elements (space-bar-space-bar) using the value of S for the symbol character immediately to the left of the centre

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guard pattern; then calculate V2 for the last four elements (bar-space-bar-space) using the value of S for the symbol character immediately to the right of the centre guard pattern. The value of V for the centre guard pattern shall be the lower of V1 and V2.

4.7.2 Additional Criteria

ISO 15416 allows for additional pass/fail criteria to be stipulated by a symbology specification. For the EAN/UPC symbology, the minimum quiet zone dimensions are given in 4.5.3. Any individual scan profile which does not meet these requirements shall receive a grade of "0".

The original UCC and EAN specifications defined the optical conditions under which an EAN/UPC symbol should be scanned. These traditional conditions are stated in Annex F.2 but they are superseded by the test specification given in this section.

4.8 Application-defined parameters

The only application defined for EAN/UPC symbols is specified by EAN International and Uniform Code Council. The UCC/EAN system specifications define the following parameters:

— Data content;

— The choice of symbol type and the use of add-on symbols.

4.9 Human-readable interpretation

The human readable interpretation is specified in Annex A.2.

4.10 Transmitted data

The majority of applications for EAN/UPC utilise system dependent protocols for data transmitted from the reader to a point of sale terminal or other device.

In the absence of a predefined transmission protocol between the reader and the application, the transmission of symbology identifiers shall be enabled in the reading device. The transmitted data shall consist of the symbology identifier followed by the decoded data as specified in Annex B.

4.11 Implementation guidelines

Practical advice for implementing this symbology is given in Annex G.

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Annex A
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Additional features

A.1 Check digit

The mandatory EAN/UPC check digit is the rightmost digit in EAN-13, UCC-12, and EAN-8. To calculate the check digit or to verify a check digit which is already present, the following algorithm may be used:

1) Set up a table with the number of columns equal to the length of the EAN or UCC-12 number:

   — 13 for EAN-13;

   — 12 for UCC-12;

   — 8 for EAN-8.

NOTE UPC-A and UPC-E symbols both encode the UCC-12 number.

2) Assign weighting factors:

For EAN-13:	1	3	1	3	1	3	1	3	1	3	1	3	1
For UCC-12:		3	1	3	1	3	1	3	1	3	1	3	1
For EAN-8:						3	1	3	1	3	1	3	1

3) Position all the digits of the number in their correct columns. If a check digit is not present, leave the rightmost column empty.

4) Multiply each digit of the EAN or UCC-12 number by its weighting factor.

5) Sum the products.

6) Divide the sum by the modulus number (10) to find the remainder. If a check digit has been entered in the rightmost column, the remainder should be 0. (If it is not 0 then either there is an error in the data or the calculation has been carried out incorrectly.) If there is no check digit, carry out step 7.

7) Determine the check digit.

   i) If remainder equals 0, the check digit equals 0.

   ii) If remainder does not equal 0, the check digit equals 10 minus the remainder.

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EXAMPLE: for EAN-8

Step 2	3	1	3	1	3	1	3	1
Step 3	5	4	4	9	0	1	0	
Step 4	15	4	12	9	0	1	0	
Step 5	Sum = 41							
Step 6	41 divided by 10 = 4 remainder 1							
Step 7	10 - 1 = 9; therefore check digit = 9							
	Full EAN-8 number = 54490109							

A.2 Human-readable interpretation

The human readable digits shall be printed underneath the main symbol and above the add-on**.** A clearly legible font shall be used for the human readable digits, such as OCR-B as defined in ISO 1073-2. This font is referenced only as a convenient standard typeface and it is not intended that these characters be machine read or verified. Reasonable alternative type fonts and character sizes are acceptable provided the interpretation is clearly legible.

All the encoded digits for EAN-13, UPC-A, EAN-8, and the add-on symbols shall be shown in human readable form. For UPC-E symbols, the six digits directly encoded together with the leading zero and the implicitly encoded check digit shall be shown in human readable form. Figures 1, 2, 3, 4, 5, and 6 illustrate each type of symbol including the human readable digits.

The height of the digits in the nominal size symbol is 2,75 mm. The minimum space between the top of the digits and the bottom of the bars shall be 0,5X.

In the EAN-13 symbol, the leftmost digit, which is encoded by variable parity, is printed to the left of the start guard pattern in line with the other digits.

For UPC-A and UPC-E symbols, the size of the first and last digits should be reduced to a maximum width equivalent to 4 modules. The height is reduced proportionally. The right hand side of the first digit is positioned 5 module widths to the left of the leftmost guard bar. The left hand side of the last digit is positioned 5 module widths to the right of the rightmost guard bar for UPC-A symbols and 3 module widths for UPC-E symbols. The bottom edge of the first and last digit shall be aligned with the remaining full size digits.

The human readable interpretation of the add-on symbol shall be above it. The digits shall be the same height as those of the main symbol. The upper edges of the digits are aligned with the upper edges of the bars of the main symbol. The minimum space between the bottom of the digits and the top of the bars shall be 0,5X.

Some industries use specific variations to the recommended human readable interpretation such as inserted hyphens to segment the number field. One example of this is shown in Annex E.

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Annex B
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Symbology identifier

A symbology identifier may be added as a preamble to the decoded data by a suitably programmed reader. The symbology identifier allocated to EAN/UPC in ISO/IEC 15424 "*Information technology — Automatic identification and data capture techniques — Data Carrier Identifiers (including Symbology identifiers*)" is:

]E*m*

where:] represents ASCII character 93,

E is the code character for the EAN/UPC symbology and

m is a modifier character from Table B.1 below. Permissible values of *m* are 0,1,2,3,4.

NOTE: EAN/UPC symbols with add-ons may be considered either as two separate symbols, each of which is transmitted separately with its own symbology identifier, or as a single data packet. The user shall select one of these methods.

All data shall be transmitted as ASCII data in accordance with ISO/IEC 646.

Table B.1: Values of *m* for EAN/UPC

Value of *m*	Option
0	Standard data packet in full EAN format, i.e. 13 digits for EAN-13, UPC-A and UPC-E (does not include add-on data)
1	Two digit add-on data only
2	Five digit add-on data only
3	Combined data packet comprising 13 digits from EAN-13, UPC-A or UPC-E symbol and 2 or 5 digits from add-on symbol
4	EAN-8 data packet

The symbology identifier is not encoded in the bar code symbol, but is generated by the decoder after decoding and transmitted as a preamble to the data message.

Previously assigned values of *m* (8, 9, A, B, C) are now obsolete.

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Annex C
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Overview of the UCC/EAN system

EAN and UCC are world-wide coding management organisations for identification numbers. The UCC/EAN system is maintained through a network of national and pluri-national agencies called numbering organisations.The most common use of UCC/EAN identification numbers is in the area of product identification. The numbers may, however, be used to identify other items within the prevailing rules of the UCC/EAN system.

A basic principle of the identification standard is that the numbers are non-significant. The number by itself does not carry any information about the entity which is identified. It does not identify the country of origin, the supplier, the type or the price of the item.

The numbers are, however, structured to allow the administrative control of the system and to ensure the uniqueness of the numbers worldwide. The UCC identification standards are fully compatible with the EAN International standards.

Detailed information on the UCC/EAN system may be obtained from the numbering organisations, EAN International, or the Uniform Code Council:

EAN International

rue Royale 145,

B-1000 BRUSSELS

Belgium

Tel: +32 2 227 1020

Uniform Code Council

7887 Washington Village Drive

Suite 300

Dayton, OH 45459

USA

Tel: +1 937 435 3870

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Annex D
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Illustration of number sets A, B and C and auxiliary patterns

Value of Character	number set A (odd)	number set B (even)	number set C (even)
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			

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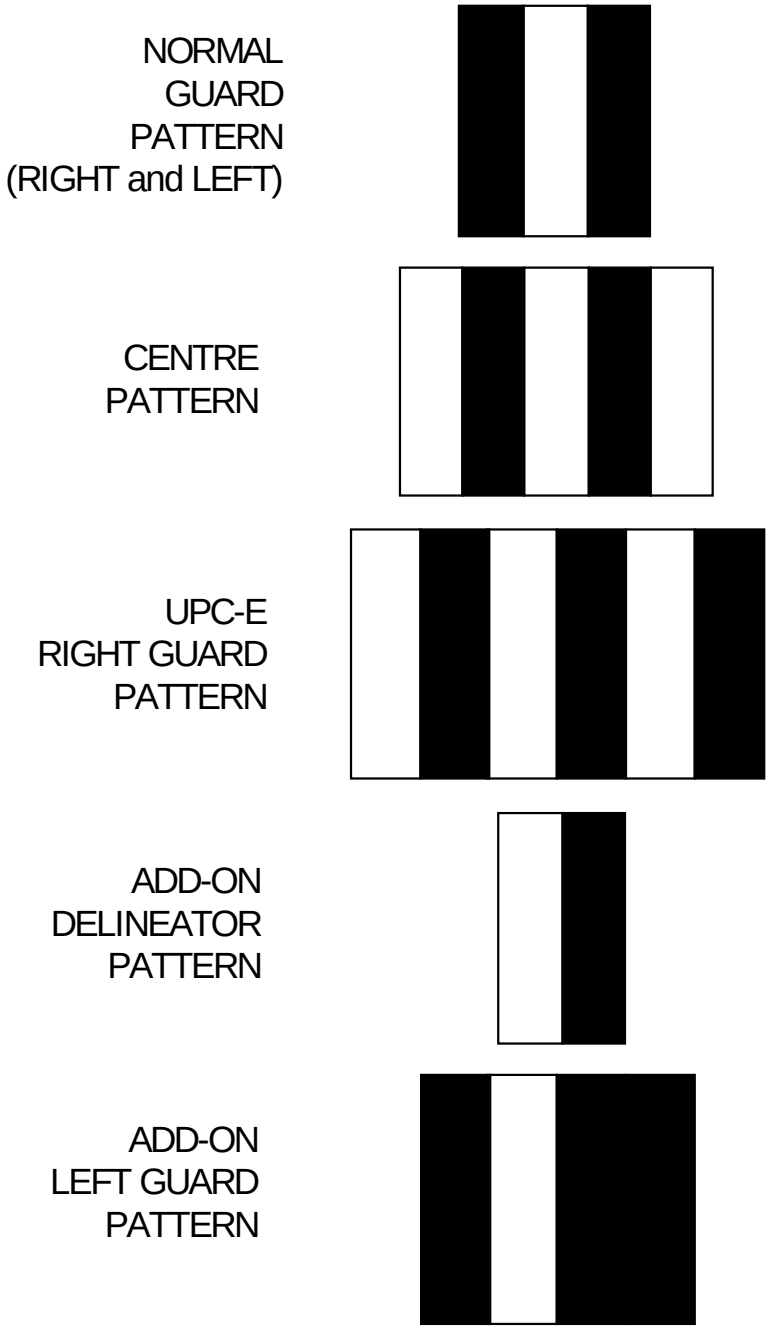


Figure D.1: Number sets A, B, and C, and auxiliary patterns

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Annex E
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Dimensioned drawings of the nominal size symbols



Figure E.1: EAN-13

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Figure E.2: UPC-A



Figure E.3: UPC-A Example Variation

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Figure E.4: EAN-8

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Figure E.5: UPC-E

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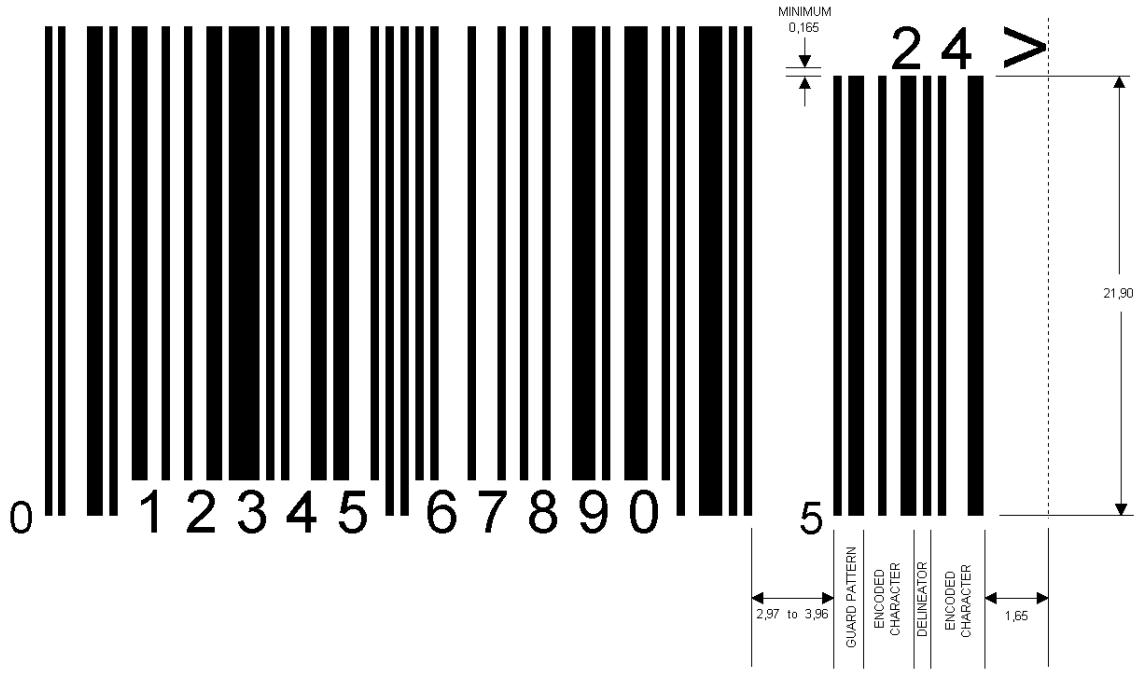


Figure E.6: UPC-A with 2-digit add-on



Figure E.7: EAN -13 with 5-digit add-on

Informative Note: For the variance of the family of EAN/UPC symbols illustrated in this annex, a particular dimension may be shown only in one of the figures. All dimensions can be derived from 4,5 of this International Standard. Dimensions related to human readable characters are based on Annex A.2. If a human readable font other than OCR B is used, some dimensions may vary from those shown in this annex.

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Annex F
(informative)

Traditional Measurement Methods

F.1 Dimensional Tolerances

The tolerances stated in this section were originally published as Appendix A to the “U.P.C. Symbol Specification Manual” and were applicable to “Type 1 Symbol Printers Only”. The subsequently published “EAN Specifications” adopted these tolerances as “ Tolerances to be respected by in-store marking equipment.” Although these tolerances remain useful for process control or to guide the development of printing equipment, they are superseded by the test specifications of section 4.7.

There are three different tolerances which apply to EAN/UPC. These are illustrated in Figure F.1 and are defined as follows:

— *Tb* is the tolerance on bar and space widths (shown as the three dimensions indicated 'b' in Figure F.1);

— *Te* is the tolerance on abutting bars and spaces within a symbol character and illustrated as the two dimensions indicated 'e' in Figure F.1. These dimensions are measured from the leading edge of a bar to the leading edge of the following bar, or the trailing edge of a bar to the trailing edge of the following bar;

— *Tp* is the tolerance applied to the total width of a symbol character (shown as the dimension indicated 'p' in Figure F.1).

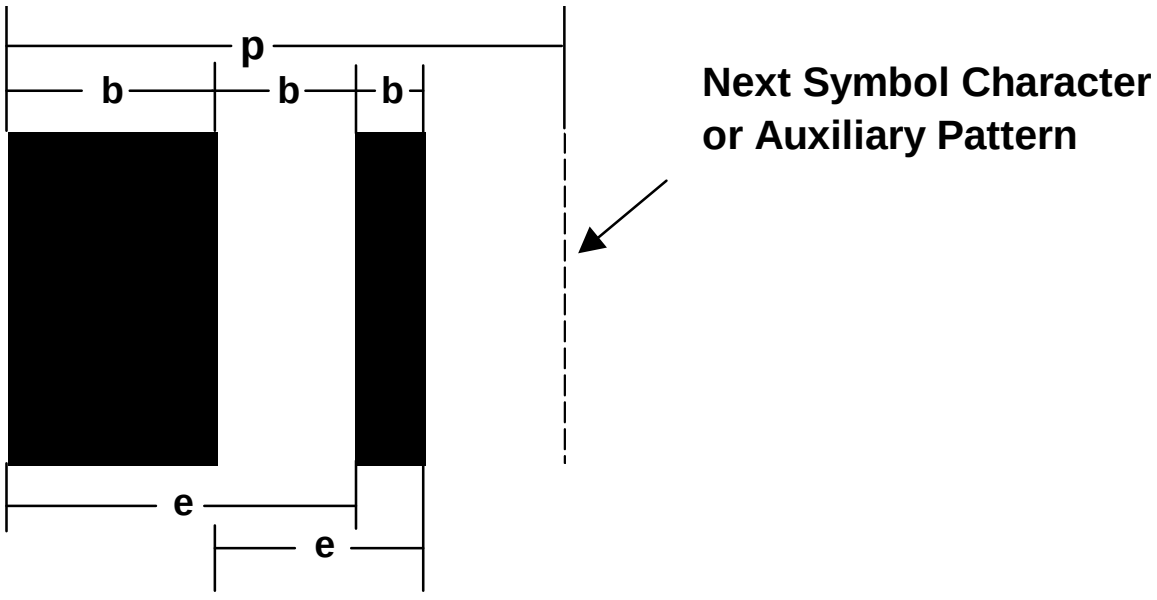


Figure F.1: Tolerance measurements

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The values of tolerances *Tb*, *Te*, and *Tp* for a given magnification factor *M* are defined as:

— if $M <= 1$, $Tb = \pm(X - 0{,}229)$ mm;

— if $M > 1$, $Tb = \pm(0{,}470X - 0{,}055)$ mm;

— $Te = \pm 0{,}147X$;

— $Tp = \pm 0{,}290X$.

In the case of the leading space of a character from number sets A or B, or the trailing space of a character from number set C, tolerance Tb does not apply. However, the width of this space shall never be less than 0,200 mm.

Figure F.2 illustrates the three tolerances calculated for various values of *X*.

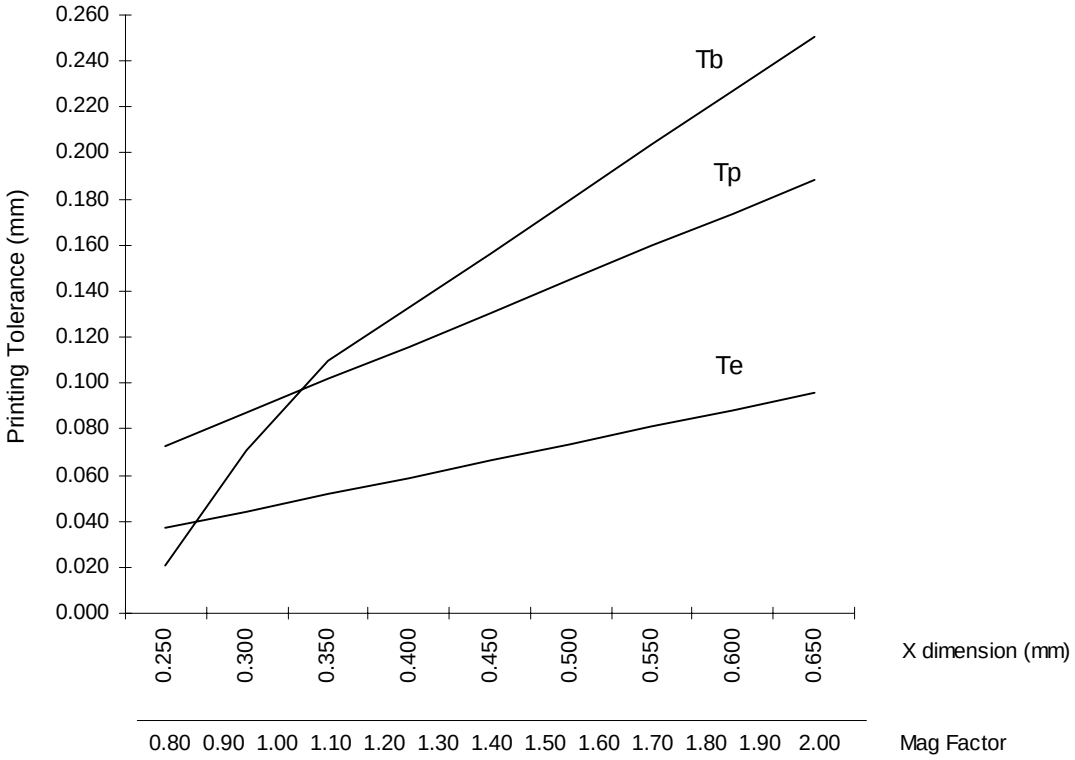


Figure F.2: Tolerances calculated for various values of *X*

F.2 Optical parameters

The optical parameters described in this section date from the first publication of the UCC and EAN specifications. These parameters were based on a scanner's use of the helium neon gas laser, the predominant technology at the time. Currently scanners and verifiers primarily utilise light emitting diodes and visible laser diode light sources that operate at somewhat longer wavelengths than the gas laser. This specification (see 4.7) requires the use of verifiers that operate in the range of 670 +/- 10 nm and utilise a 0,15 mm aperture. Extensive scanner to verifier correlation testing has confirmed that verification using these parameters provides reliable assurance of scanner performance for the large installed base of scanners as well as current scanners of all types.

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The "General EAN Specifications" use traditional methods of defining the acceptable reflectance of bars and spaces. The requirements of this specification (see 4.7) differ from the traditional parameters defined below:

— Peak response wavelength: 633 nm (this means that the symbol will be scanned in the visible (red) spectrum);

— Spectral half power band width: 100 nm (this means that the response curve of the light source shall fall to 50% of the peak light output at 50 nm above and below the peak wavelength);

— Scanner spot size or measuring aperture: 0,200 mm (this means that the minimum value of the X dimension minus its tolerance should be greater than the spot size of 0,200 mm);

— Reflectance of space elements (R_L): R_L greater than 30%;

— Reflectance of bar elements (R_D): R_D less than 50%;

— Symbol reflectance: For a given light space reflectance, the following expression defines the acceptable maximum value of the dark (bar) reflectances:

  — $\log_{10} R_D <= 2,6 (\log_{10} R_L) - 0,3$

NOTE In the expression the values R_D and R_L are not percentages but are on a scale from 0 to 1.

EXAMPLE: R_L = 0,65 (65%) and R_D = 0,20 (20%) would not result in an acceptable symbol reflectance. For R_L = 65%, R_D shall be equal to or less than 16,4%.

— There are no specific parameters for: minimum edge contrast, modulation and defects. Scanner performance can be impaired by low edge contrast, low modulation, and high defects.

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Annex G
(informative)

Guidelines for reading and printing

G.1 Autodiscrimination compatibility

EAN/UPC may be read by suitably programmed bar code decoders which have been designed to autodiscriminate it from other symbologies.

The decoder's valid set of symbologies should be limited to those needed by a given application to maximize reading security.

G.2 System considerations

It is important that the various components (printers, labels, readers, and data bases) making up a bar code installation operate together as a system. A failure in any component, or a mismatch between them, can compromise the performance of the overall system.

G.3 Printing considerations

Graphics software used to create bar codes on pixel-based printers must scale each bar and space exactly to the pixel pitch of the printer being used. For the EAN/UPC symbology, the number of pixels comprising every module must be a fixed and consistent integer value. Therefore a given printer can only print a certain set of symbol magnifications.

The reduction or enlargement for the bars and spaces in symbol characters 1, 2, 7, and 8 (see 4,5,5) is performed by changing an integer number of pixels at trailing bar/space boundaries from dark to light or vice versa provided the printer resolution is sufficient to perform this function satisfactorily. Similarly, compensation for uniform bar width growth (or reduction) is performed by changing an integer number of pixels at every bar-to-space boundary from dark to light (or from light to dark). Neither of these adjustments changes the edge to similar edge measurements or the total symbol character width. Failure to follow these principles results in degraded symbol quality and often results in unreadable symbols.

G.4 Programmer's Example

The principles stated in G.3 can be reduced to the following rules for vector based digital bar code design files:

1) Convert the desired magnification to a module size in pixels rounded down to the nearest integer provided the minimum symbol magnification is met.

2) Divide the integer number of pixels per module by 13 and round the quotient to the nearest integer. This value will be used to reduce or enlarge the bars and spaces in symbol characters 1, 2, 7, and 8.

3) Determine the number of pixels corresponding to the desired compensation for uniform bar width growth and round up to the next larger integer.

4) Apply the above results to determine the pixel count of every bar and space in the symbol.

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For example:

Using vector based digital bar code design files with an imaging device with 50 dots per mm, create a 90% magnification symbol with 0,11 mm of bar width reduction.

— The module size of 50 dots/mm * 0,9 mag * 0,330 mm/module = 14,85, which rounds down to 14 pixels per module. Actual magnification becomes 0,8480.

— The 1, 2, 7, 8 compensation is (14 pixels/module) / 13 = 1,077, which rounds to 1 pixel.

— The bar growth compensation is 0,11mm * 50 pixels/mm = 5,5, which rounds up to 6 pixels.

This process results in the following pixel count for bars and spaces in the auxiliary patterns and symbol characters 0, 3, 4, 5, 6, and 9 as illustrated in Table G.1.

Table G.1: Correcting pixels for imaging resolution and bar width reduction

Module Count	Pixel Count	
	Bars	Spaces
1	8	20
2	22	34
3	36	48
4	50	62

For symbol characters 1, 2, 7, and 8, the pixel count of each bar and space, illustrated in Table G.1 is changed by one pixel in the direction indicated by the + and - signs in Table 8. For example, the symbol character 1 in number set B (See Table 1) will have pixel counts shown in Table G.2.

Table G.2: Correcting pixels for symbol character 1, number set B

Space	Bar	Space	Bar
19	23	33	23

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