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

*Technologies de l'information — Techniques automatiques
d'identification et de capture des données — Spécification de
symbologie de code à barre EAN/UPC*

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Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work. In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of the joint technical committee is to prepare International Standards. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO and IEC shall not be held responsible for identifying any or all such patent rights.

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

This second edition cancels and replaces the first edition (ISO/IEC 15420:2000), which has been technically revised.

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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.

This International Standard serves as a normative reference in the “GS1 General Specifications”. The administration of the numbering system by GS1 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 GS1 system is the availability of uniquely defined identification codes for use in their trading transactions. Annex C gives an overview of the GS1 system.

NOTE GS1 is the worldwide association encompassing the organizations formerly known as EAN International and Uniform Code Council (UCC).

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 — EAN/UPC bar code symbology specification

1 Scope

This International Standard specifies the requirements for the bar code symbology known as EAN/UPC. It specifies EAN/UPC symbology characteristics, data character encodation, dimensions, tolerances, decoding algorithms and parameters to be defined by applications. It specifies the Symbology Identifier prefix strings for EAN/UPC symbols.

Data content and the rules governing the use of this symbology are outside the scope of this International Standard; they are defined in the GS1 General Specifications (see bibliography).

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

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

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

3 Terms and definitions

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

3.1

add-on symbol

symbol used to encode information supplementary to that in the main symbol which it accompanies

3.2

auxiliary pattern

pattern of bars/spaces representing non-data components of the symbol

EXAMPLE guard patterns and inter-character delineators

3.3

delineator

auxiliary pattern used to separate characters within an add-on symbol

3.4

even parity

characteristic of the encodation of a symbol character whereby the character contains an even number of dark modules

3.5

GS1 member organization

agency responsible for the administration of the GS1 system and maintenance of a number bank within a defined territory

3.6

GS1 System

specifications, standards, and guidelines administered by GS1

3.7

GTIN

Global Trade Item Number

number that is used for the unique identification of trade items worldwide and which may be 8, 12, 13 or 14 digits in length

3.8

guard pattern

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

3.9

magnification factor

constant multiplier of the nominal dimensions of an EAN/UPC symbol

3.10

number set

series of ten bar/space patterns of either even or odd parity encoding the digits 0 to 9

3.11

odd parity

characteristic of the encodation of a symbol character whereby the character contains an odd number of dark modules

3.12

variable parity encodation

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

3.13

zero-suppression

process of removing zeroes from specified positions in a GTIN-12 data string in order to encode it in UPC-E format

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/IEC 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 not including the check digit or quiet zones:
 - 11 modules for EAN-13, EAN-8 and UPC-A symbols
 - 9 modules for UPC-E symbols

4.2 Symbol structure

4.2.1 Symbol types

There are four types of the EAN/UPC symbol:

- 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 4.2.3.1 to 4.2.3.4 and the optional add-on symbols are described in 4.2.3.5.

4.2.2 Symbol encodation

4.2.2.1 Symbol characters

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:

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 4.2.3.1, 4.2.3.4 and 4.2.3.5) 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.

4.2.2.2 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. The special guard pattern is used as a stop pattern in UPC-E symbols.

4.2.3 Symbol formats

4.2.3.1 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 in accordance with Table 3;
- 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.

NOTE UPC-A bar patterns (see 4.2.3.3) are a subset of EAN-13, although the human-readable information, the symbol layout and the quiet zone requirements (see 4.3.4) differ.

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
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 13-digit strings printed in EAN-13 begin with a number from 1 to 9. 13-digit strings that begin with 0 (e.g. GTIN-12) are printed using UPC-A or UPC-E.



Figure 1 — EAN-13 bar code symbol

4.2.3.2 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;
- 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.

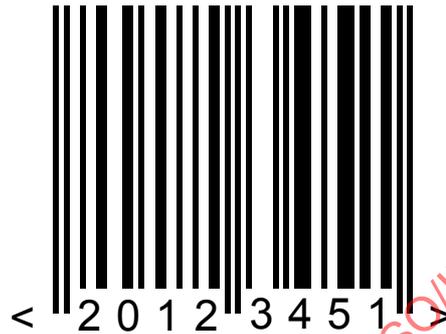


Figure 2 — EAN-8 bar code symbol

4.2.3.3 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. Figure 3 shows an example of a UPC-A bar code symbol.

A UPC-A symbol implicitly encodes a digit zero (0) as a prefix to the GTIN-12 data structure.

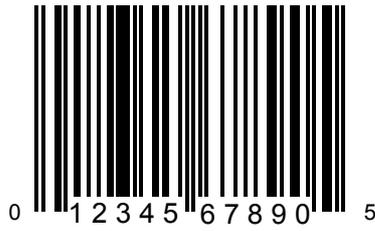


Figure 3 — UPC-A bar code symbol

4.2.3.4 UPC-E symbols

4.2.3.4.1 UPC-E symbol structure

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 in accordance with Table 4;
- a special guard pattern;
- a right quiet zone.

The UPC-E symbol shall only be used to encode GTIN-12 data structures 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 4.2.3.4.2. Figure 4 shows an example of a UPC-E bar code symbol.



Figure 4 — UPC-E bar code symbol (encoding “0 07834 0009 1” by zero suppression). A UPC-E symbol implicitly encodes a digit zero (0) as a prefix to the GTIN-12 data structure.

4.2.3.4.2 Encodation of a UPC-E symbol

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

- 1) Let $D1, D2, D3 \dots D12$ denote the GTIN-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 $X1, X2 \dots X6$ 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
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.

Table 4 — Number sets for UPC-E Symbol

Value of check digit <i>D12</i>	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
Number sets to encode check digit 8											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
Number sets to encode check digit 0											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
Number sets to encode check digit 3											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
Number sets to encode check digit 1											B	B	A	B	A	A		

NOTE The number sets used to implicitly encode the check digit are shown below the digits in the zero-suppressed columns.

4.2.3.4.3 Decoding a UPC-E symbol

Derivation of the 12 digit data structure from the characters encoded in the UPC-E symbol can be performed according to Table 5, using the digit at position P6 as the key.

Table 5 — Decoding of UPC-E symbol

Encoded UPC-E digits ^A								Decoded number ^B												
Leading digit ^C	P1	P2	P3	P4	P5	P6	Check digit ^D	D1	D2	D3	D4	D5	D6	D7	D8	D9	D10	D11	D12	
(0)	X1	X2	X3	X4	X5	0	(C)	(0)	X1	X2	0	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	X3	X4	X5	(C)	
(0)	X1	X2	X3	X4	X5	1	(C)	(0)	X1	X2	1	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	X3	X4	X5	(C)	
(0)	X1	X2	X3	X4	X5	2	(C)	(0)	X1	X2	2	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	X3	X4	X5	(C)	
(0)	X1	X2	X3	X4	X5	3	(C)	(0)	X1	X2	X3	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	X4	X5	(C)	
(0)	X1	X2	X3	X4	X5	4	(C)	(0)	X1	X2	X3	X4	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	X5	(C)	
(0)	X1	X2	X3	X4	X5	5	(C)	(0)	X1	X2	X3	X4	X5	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	5	(C)
(0)	X1	X2	X3	X4	X5	6	(C)	(0)	X1	X2	X3	X4	X5	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	6	(C)
(0)	X1	X2	X3	X4	X5	7	(C)	(0)	X1	X2	X3	X4	X5	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	7	(C)
(0)	X1	X2	X3	X4	X5	8	(C)	(0)	X1	X2	X3	X4	X5	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	8	(C)
(0)	X1	X2	X3	X4	X5	9	(C)	(0)	X1	X2	X3	X4	X5	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	<u>0</u>	9	(C)

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

^B Re-inserted zeroes are shown in underlined bold type, in shaded cells.

^C The leading zero digit for UPC-E symbols, which is not directly encoded, is indicated by "(0)".

^D The GTIN-12 check digit implicitly encoded in UPC-E (by the mix of number sets) is indicated by "(C)".

4.2.3.5 Add-on symbols

4.2.3.5.1 General

The add-on symbols were originally 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.

4.2.3.5.2 Two digit add-on symbol

The 2-digit add-on may be used 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;
- 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

4.2.3.5.3 Five digit add-on symbol

The 5-digit add-on may be used 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;
- 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:

$$\text{Step 1: } 8 + 1 + 4 = 13$$

$$\text{Step 2: } 13 \times 3 = 39$$

$$\text{Step 3: } 6 + 0 = 6$$

$$\text{Step 4: } 6 \times 9 = 54$$

$$\text{Step 5: } 39 + 54 = 93$$

$$\text{Step 6: } v = 3$$

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.



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

4.3 Dimensions and tolerances

4.3.1 Measurement basis

The dimensions of an EAN/UPC symbol may be referenced to a defined set of dimensions referred to as the nominal size symbol. Historically, the predecessors of GS1 (see Annex C) specified the nominal size symbol in terms of both inch-based and metric-based dimensions, with X dimensions of 0,013 inch (0,3302 mm) and 0,33 mm respectively. The precise conversion of the inch-based dimensions into metric units differs by less than 0,1% from the nominal metric dimensions. Either basis of measurement, applied consistently to all dimensions of a symbol, is acceptable for the purposes of this International Standard, although only the metric-based dimensions are shown in the following sub-clauses and in Annex E. Refer to Annex E for dimensioned drawings of nominal size symbols.

4.3.2 Width of narrow element (X)

The nominal width of the narrow element of the nominal size symbol shall be 0,33 mm.

4.3.3 Bar height

The nominal bar height of the nominal size symbol shall be:

- EAN-13, UPC-A and UPC-E symbols: 22,85 mm;
- EAN-8 symbols: 18,23 mm;
- Add-on symbols: 21,90 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.

4.3.4 Quiet zone

Various minimum quiet zone dimensions are 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 optional 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.

4.3.5 Positioning of the add-on symbol

The add-on symbol shall not encroach on the minimum right quiet zone of the main symbol. The maximum separation between the rightmost guard bar of the main symbol and the first bar of the add-on symbol 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.

4.3.6 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.

4.3.7 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

4.3.8 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.

Note: In applications defined by the GS1 General specifications, 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. Under the exceptional circumstances defined in the GS1 General Specifications, the range is extended to 0,75 to 2,0. When the magnification factor is reduced below 0,8 in these applications, the minimum quiet zones and bar height shall not be reduced below the dimensions applicable to a 0,8 magnification symbol.

4.3.9 Dimensional Tolerances

The historical element tolerances shown in Annex F have been superseded by the test specifications in 4.5.

4.4 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 4.5.

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 and b values according to Table 10.

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. The values $b1$ and $b2$ are the measurement from the leading edge of a bar to the trailing edge of the same 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 the bars is treated as the leading edge, as shown in Figure 7.

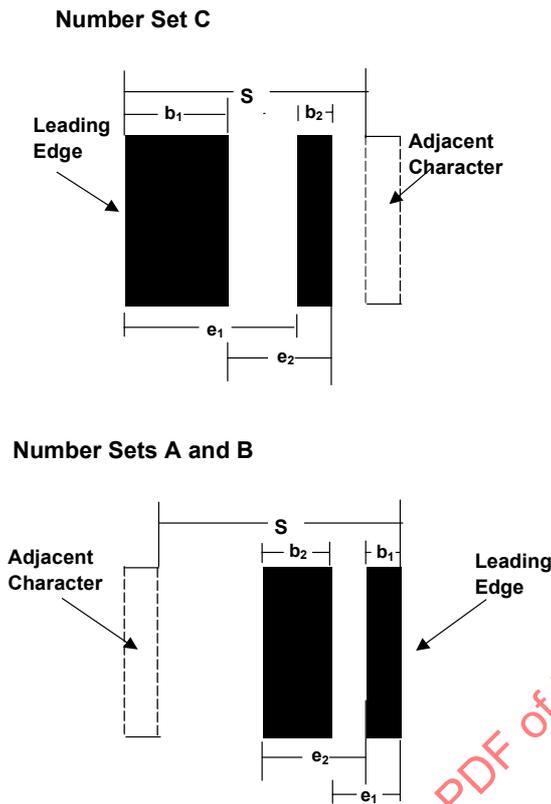


Figure 7 — Symbol character decode measurements

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:

$$\text{If } RT1 \leq e_i < RT2, E_i = 2;$$

$$\text{If } RT2 \leq e_i < RT3, E_i = 3;$$

$$\text{If } RT3 \leq e_i < RT4, E_i = 4;$$

$$\text{If } RT4 \leq e_i < RT5, E_i = 5.$$

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 7(b ₁ + b ₂)/S See Note.
		E1	E2	
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 b₁ and b₂ are the widths of the two bar elements, see Figure 7.

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

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: $7 \times (b_1 + b_2) / S \leq 4$;

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

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

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

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: $7 \times (b_1 + b_2) / S \leq 3$.

For $E1 = 3$ and $E2 = 3$:

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

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

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.

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 E_i 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.

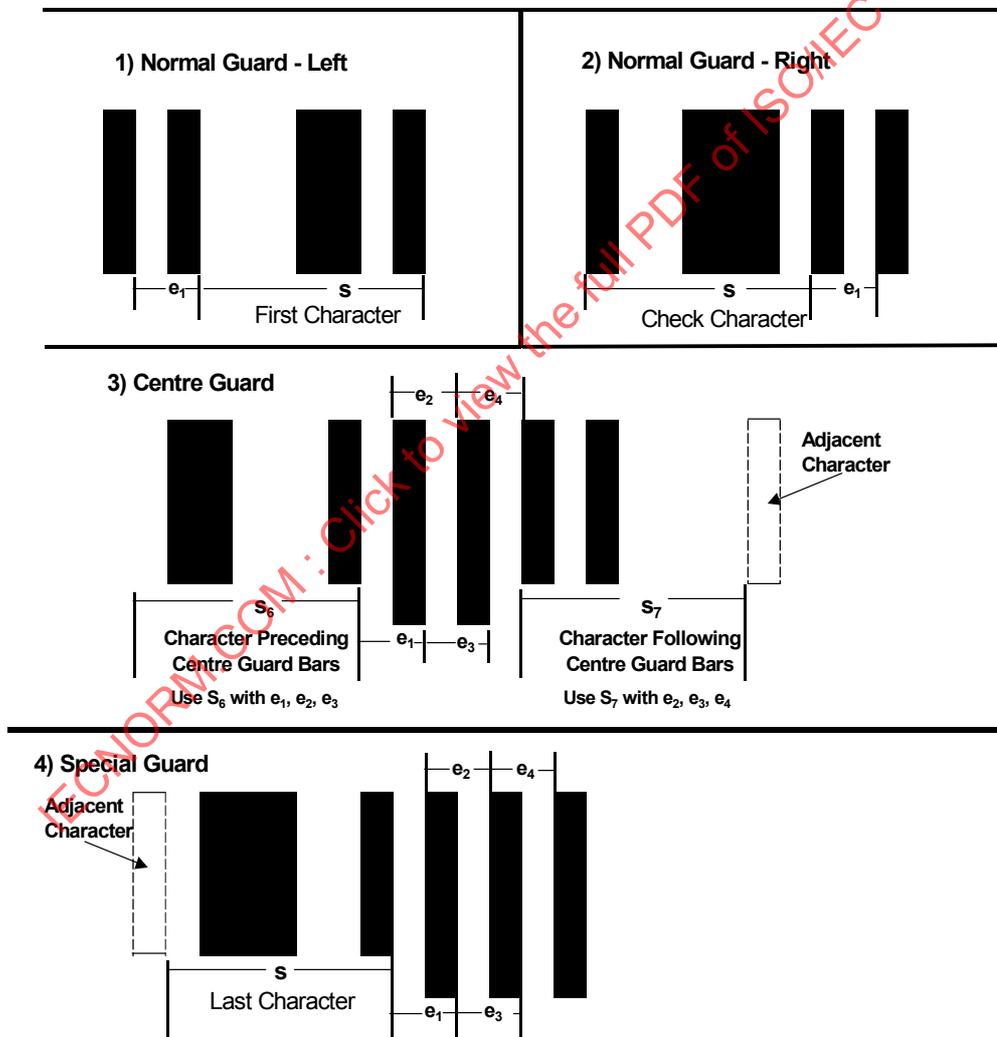


Figure 8 — Auxiliary Pattern Measurements

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

When all symbol characters and auxiliary patterns have been decoded, verify that the mix of parity patterns conforms to the requirements for the symbol type. For EAN-13, generate the implied leading digit from the parity values of the first six symbol characters, in accordance with Table 3. For UPC-E symbols, generate the implied check digit from the parity values of the six symbol characters in accordance with Table 4 and restore the GTIN-12 data structure. For all symbols, check that the symbol check digit is correct.

4.5 Symbol quality

4.5.1 Test methodology

In order to verify whether a symbol meets the specifications in this International Standard it shall be tested using the test specification defined in ISO/IEC 15416, which defines a standardized methodology for measuring and grading bar code symbols, as supplemented in 4.5.2. ISO/IEC 15416 lays down conditions under which measurements should be made; and defines methods of determining an overall quality grade based on the attributes of the bar code symbol. The reference decode algorithm defined in sub-clause 4.4 of this specification shall be used for the assessment of the "decode" and "decodability" parameters under ISO/IEC 15416.

ISO/IEC 15416 allows for additional pass/fail criteria to be stipulated by a symbology specification. For EAN/UPC, the additional criterion is given in 4.5.3. Any individual scan profile which does not meet this requirement shall receive a grade of 0.

ISO/IEC 15416 specifies that the overall symbol grade shall be expressed in the form shown in the following example:

1,5 / 10 / 660

where 1,5 is the overall symbol quality grade

10 is the measuring aperture reference number (in this example 0,25 mm diameter)

660 is the peak response wavelength in nanometers.

In accordance with GS1 specifications, the minimum symbol grade for EAN/UPC symbols shall be 1,5/06/670.

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.

The original UCC and EAN specifications defined optical conditions under which an EAN/UPC symbol should be scanned. These traditional conditions have been superseded by the test specification given in this section.

4.5.2 Decodability

4.5.2.1 Character decodability for standard symbol characters

A decodability value V shall be calculated for each symbol character in the set {0, 3, 4, 5, 6, 9} as described in ISO/IEC 15416.

4.5.2.2 Character decodability for 1, 2, 7, and 8

A decodability value V is calculated for each symbol character in the set {1, 2, 7, 8}

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

$K = \text{smallest } \{ |e_i - RT_j| \}$

$V1 = K/(S/14)$

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

$V2 = [|(7/S) (\text{combined width of both bars}) - 4|] / (15/13)$

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

$V2 = [|(7/S) (\text{Combined width of both bars}) - 3|] / (15/13)$

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

4.5.2.3 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 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 $V2$.

4.5.3 Additional Criteria

ISO/IEC 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 4.3.4. Any individual scan profile which does not meet these requirements allowing for the following tolerances shall receive a grade of "0".

Minimum width of measured quiet zones:

- EAN-13 symbols: left, 10X; right, 6.2X;
- UPC-A symbols: 8X;
- UPC-E symbols: left, 8X; right, 6.2X;

- EAN-8 symbols: 6.2X;
- Add-on symbols (all): right 4.2X.

Symbols that fall below range defined in 4.3.8 Magnification factors shall receive a grade of 0.

Note: The choice of tolerances was based on the historical U.P.C. Quality Guideline. Since EAN-13 and EAN-8 were not included, tolerances similarly derived were chosen for those symbols.

4.6 Application-defined parameters

The only application defined for EAN/UPC symbols is specified by GS1. The GS1 system specifications define the following parameters:

- Data content;
- The choice of symbol type and the use of add-on symbols;
- Permissible X dimension ranges and symbol heights.

4.7 Human-readable interpretation

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

4.8 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.

4.9 Implementation guidelines

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

Annex A (normative)

Additional features

A.1 Check digit

The mandatory EAN/UPC check digit is the rightmost digit encoded in EAN-13, UPC-A, and EAN-8 symbols. 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 number:

13 for GTIN-13;

12 for GTIN-12;

8 for GTIN-8.

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

2) Assign weighting factors:

For GTIN-13:	1	3	1	3	1	3	1	3	1	3	1	3	1
For GTIN-12:	3	1	3	1	3	1	3	1	3	1	3	1	
For GTIN-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 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.

EXAMPLE for GTIN-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 GTIN-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.

Annex B (normative)

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 is:

$]Em$

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.

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.

UPC-A and UPC-E symbols implicitly encode a leading zero and are transmitted as 13-digit strings. 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 , 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	Data packet comprising 8 digits from EAN-8 symbol

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.

Annex C (informative)

Overview of the GS1 system

GS1 is a world-wide coding management organisation for identification numbers, encompassing the associations previously known as EAN International and Uniform Code Council. The GS1 system is maintained through a network of national and pluri-national agencies known as member organisations, named GS1 followed by the country name, for example, GS1 France or GS1 US. The most common use of GS1 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 GS1 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 application specifications are contained in the GS1 General Specifications available from any GS1 member organisation.

The address of the GS1 head office is:

GS1
Blue Tower
Avenue Louise, 326
BE1050 BRUSSELS
Belgium
Tel: + 32 2 788 78 00
www.gs1.org

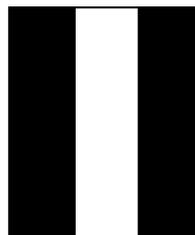
Annex D
(informative)

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

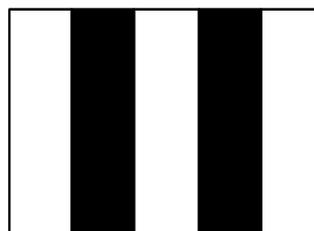
Value of Character	number set A (odd)	number set B (even)	number set C (even)
0			
1			
2			
3			
4			
5			
6			
7			
8			
9			

Figure D.1 — Graphical representation of number sets A B and C

NORMAL
GUARD
PATTERN
(RIGHT and LEFT)



CENTRE
PATTERN



UPC-E
RIGHT GUARD
PATTERN



ADD-ON
DELINEATOR
PATTERN



ADD-ON
LEFT GUARD
PATTERN

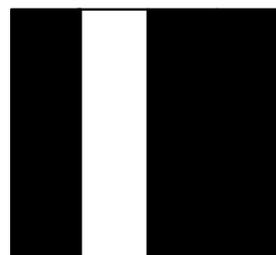


Figure D.2 — Graphical representation of auxiliary patterns

Annex E (informative)

Dimensioned drawings of the nominal size symbols

NOTE 1 As referred to in 4.3.1, the dimensions used in the figures in this Annex are based on the metric X dimension of 0,33 mm.

NOTE 2 For the variants 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 4.3 of this International Standard.



Figure E.1 — EAN-13