
**Information technology — Automatic
identification and data capture
techniques — Bar code symbology
specifications — Interleaved 2 of 5**

*Technologies de l'information — Techniques automatiques d'identification
et de capture des données — Spécifications des symbologies des codes à
barres — Code 2 parmi 5 entrelacé*

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Contents

| | |
|---|-----------|
| 1 Scope | 1 |
| 2 Normative references | 1 |
| 3 Definitions | 1 |
| 4 Requirements | 1 |
| 4.1 Symbology characteristics | 1 |
| 4.2 Symbol structure | 2 |
| 4.3 Character encodation | 2 |
| 4.3.1 Data character encodation | 2 |
| 4.3.2 Start and stop patterns | 3 |
| 4.3.3 Optional symbol check character | 4 |
| 4.4 Dimensions | 4 |
| 4.5 Reference decode algorithm | 5 |
| 4.6 Application-defined parameters | 5 |
| 4.6.1 Symbology and dimensional characteristics | 5 |
| 4.6.2 Optical specifications | 6 |
| 4.6.3 Test specifications | 6 |
| Annex A (informative) Additional features | 7 |
| Annex B (informative) Guidelines for the use of Interleaved 2 of 5 | 9 |
| Annex C (informative) Symbology identifier | 10 |
| Annex D (informative) Examples of application-defined parameters | 11 |

Foreword

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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 16390 was prepared by BSI and was adopted, under a special "fast-track procedure", by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, in parallel with its approval by national bodies of ISO and IEC.

Annexes A to D of this International Standard 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 is a number of methods of encoding information in bar code form, known as symbologies, and the rules defining the translation of characters into bar and space patterns and other essential features are known as the symbology specification. Interleaved 2 of 5 is one such symbology.

Previously, symbology specifications have been developed and published by a number of organizations, resulting in certain instances in conflicting requirements for certain symbologies.

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 application standards.

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Information technology — Automatic identification and data capture techniques — Bar code symbology specifications — Interleaved 2 of 5

1 Scope

This International Standard specifies the requirements for the bar code symbology known as Interleaved 2 of 5; it specifies Interleaved 2 of 5 symbology characteristics, data character encodation, dimensions, tolerances, decoding algorithms and application-defined parameters.

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 646:1983, *Information technology — ISO 7-bit coded character set for information interchange*.

ISO 7064:1983, *Data processing — Check character systems*.

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

ISO/IEC 15424, *Automatic identification and data capture techniques — Data carrier/symbology identifiers*.

EN 1556:1997, *Bar Coding — Terminology*.

3 Definitions

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

4 Requirements

4.1 Symbology characteristics

The characteristics of Interleaved 2 of 5 are:

- 1) Encodable character set: numeric 0 to 9 (ASCII characters 48 - 57 inclusive, in accordance with ISO 646);
- 2) Code type: continuous;
- 3) Elements per symbol character: 5, of which 2 wide and 3 narrow, encoded as either five bars or five spaces;
- 4) Character self-checking: yes;
- 5) Data string length encodable: variable (even number of digits);

- 6) Bidirectionally decodable: yes;
- 7) Symbol check character: one, optional (see annex A);
- 8) Symbol character density: 14 to 18 modules per symbol character pair, depending on wide/narrow ratio;
- 9) Non-data overhead: 8 to 9 modules, depending on wide/narrow ratio.

4.2 Symbol structure

Interleaved 2 of 5 symbols shall comprise:

- 1) leading quiet zone;
- 2) start pattern;
- 3) one or more pairs of symbol characters representing data (inclusive of optional symbol check character);
- 4) stop pattern;
- 5) trailing quiet zone.

4.3 Character encodation

4.3.1 Data character encodation

Table 1 defines the Interleaved 2 of 5 character encodation. In the column headed "Binary representation" the character 1 is used to represent a wide element and 0 a narrow element.

Table 1 — Binary representation of character encodation

| Data character | Binary representation | | | | |
|----------------|-----------------------|---|---|---|---|
| 0 | 0 | 0 | 1 | 1 | 0 |
| 1 | 1 | 0 | 0 | 0 | 1 |
| 2 | 0 | 1 | 0 | 0 | 1 |
| 3 | 1 | 1 | 0 | 0 | 0 |
| 4 | 0 | 0 | 1 | 0 | 1 |
| 5 | 1 | 0 | 1 | 0 | 0 |
| 6 | 0 | 1 | 1 | 0 | 0 |
| 7 | 0 | 0 | 0 | 1 | 1 |
| 8 | 1 | 0 | 0 | 1 | 0 |
| 9 | 0 | 1 | 0 | 1 | 0 |

Table 1 uses a modified binary coded decimal encoding scheme. The four left-most bit positions for each character are assigned weights of 1, 2, 4 and 7, from left to right; the fifth position is used for an even parity bit. The sum of the positional weights of the '1' bits is equivalent to the data character value, except in the case of the data

character 0, where the weights 4 and 7 are applied. The parity bit ensures that there are always two '1' bits per character.

The following algorithm defines the rules to convert numeric data into the symbol characters of an Interleaved 2 of 5 symbol:

| Step in Algorithm | Example |
|--|-------------------|
| 1) Calculate check character if required by the application standard. See 4.6; | |
| 2) If the data string, including check characters, has an odd number of digits, add a leading zero; | 367 0367 |
| 3) Subdivide the numeric string into digit pairs; | 0367 03 and 67 |
| 4) Encode the digit pairs as follows: | |
| a) Encode the leading digit of each pair into bar patterns as shown in Table 1; | 0 and 6 |
| b) Encode the second digit of each pair into space patterns as shown in Table 1; | 3 and 7 |
| 5) Form each symbol character pair by taking the bar and space elements alternately from the patterns derived from steps 4 a) and 4 b), commencing with the first bar of the pattern for the first digit, followed by the first space of the pattern for the second digit. | |

Figure 1 illustrates the sequence of bar and space elements corresponding to the data character pairs "03 67".

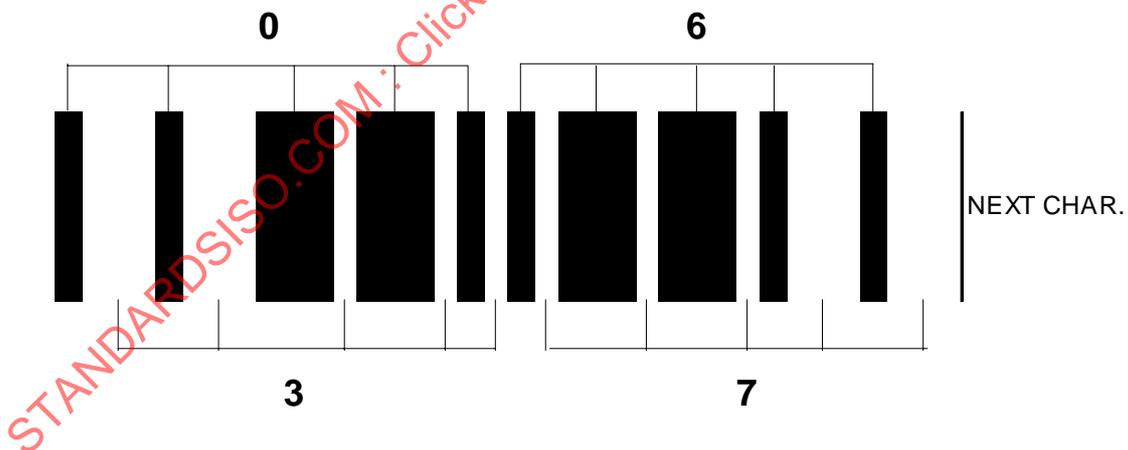


Figure 1 — Interleaved 2 of 5 character pairs, encoding "03 67"

4.3.2 Start and stop patterns

The start pattern shall consist of four narrow elements in the sequence bar - space - bar - space. The stop pattern shall consist of a wide bar - narrow space - narrow bar sequence.

The start pattern shall be positioned at the normal left end of the data symbol characters adjacent to the first bar of the most significant digit. The stop pattern shall be positioned at the normal right end of the data symbol characters adjacent to the final space of the least significant digit.

There is no assigned human readable interpretation of the start and stop patterns and they shall not be transmitted by the decoder.

Figure 2 illustrates the start and stop patterns and their relationship to the symbol data characters.

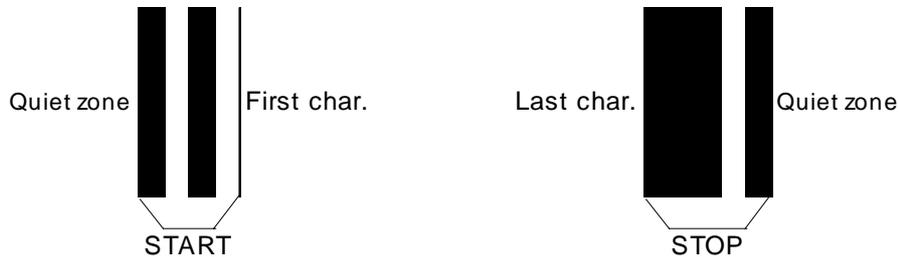


Figure 2 — Start and stop patterns

Figure 3 illustrates a complete bar code symbol for the number 1234 showing the necessary quiet zones.



Figure 3 — Interleaved 2 of 5 symbol inclusive of quiet zones

4.3.3 Optional symbol check character

Annex A defines the check character position and calculation.

4.4 Dimensions

Interleaved 2 of 5 symbols shall use the following nominal dimensions:

- width of narrow element (X): the X dimension of Interleaved 2 of 5 symbols may be defined by the application specification in accordance with the needs of the application in question. See 4.6.1;
- wide/narrow ratio (N): 2,0:1 to 3,0:1;
- minimum width of quiet zone: $10X$;
- recommended minimum bar code height for manual scanning: 5,0 mm or 15 % of symbol width excluding quiet zones, whichever is greater.

The width, W (in millimetres) of an Interleaved 2 of 5 symbol, including quiet zones, can be calculated from the following expression:

$$W=(P(4N+6)+N+6)X+2Q$$

where:

P is the number of character pairs;

N is the wide/narrow ratio;

X is the width of a narrow element in millimetres;

Q is the width of the quiet zone in millimetres.

4.5 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 in the computation of the decodability value described in ISO/IEC 15416.

- 1) Confirm presence of a leading quiet zone.
- 2) Confirm presence of a valid start pattern by checking that the initial four elements are each less than $7/64$ the sum of the next ten elements (if this fails, reverse decoding may be attempted).
- 3) Decode the exact number of character pairs specified by the application as follows:
 - (1) Record the widths of the ten elements of a character pair and accumulate their sum, S ;
 - (2) Compute a threshold, $T = (7/64)S$;
 - (3) Compare the individual widths with the threshold: if element width is greater than T , assume element is wide; if not, assume it is narrow;
- 4) Confirm the valid decoding of the character pairs;
- 5) After decoding the proper number of character pairs, confirm the presence of a valid stop pattern by checking that the next element width is greater than or equal to the T of the previous symbol character and that the following two elements widths are less than T ;
- 6) Confirm the presence of a trailing quiet zone.

4.6 Application-defined parameters

Application standards shall define parameters of Interleaved 2 of 5 symbols specified in this International Standard as variable, as follows:

4.6.1 Symbology and dimensional characteristics

In order for an Interleaved 2 of 5 symbol to be printed and to be scannable in a given application it is necessary for the following symbology and dimensional parameters to be specified:

- 1) The number of data characters in the symbol, which may be fixed, variable or variable up to a defined maximum (see A.1);
- 2) Whether the weighted modulo 10 complement symbol check character is to be used (see A.2) and whether it is to be transmitted by the decoder;
- 3) Whether a data check character is to be used and if so the algorithm for its calculation;
- 4) Range of X dimension;
- 5) Range of nominal wide/narrow ratio;
- 6) Minimum bar height.

NOTE 1 For applications wishing to take advantage of enhanced data security, a symbol check character should be used.

NOTE 2 The wide/narrow ratio should be as high as possible within the range specified in 4.4 to maximize reading performance.

An example is given in annex D.

4.6.2 Optical specifications

In order for a bar code symbol to be scannable in a given application, it is necessary to specify certain optical parameters. The selection of the parameters shall be made in the application standard and shall include the specification of:

- 1) peak response wavelength;
- 2) spectral half power band width with which the symbol and the scanner shall conform;
- 3) the spot size of the scanner;
- 4) the parameters for reflectance of the bars and spaces;
- 5) the conditions under which optical measurements shall be made;
- 6) the extent of permissible imperfections within the bar code symbol.

An example is provided in annex D.

4.6.3 Test specifications

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 lays down conditions under which measurements should be made; it defines methods of determining an overall quality grade based on the attributes of the bar code symbol and determining its conformity with this International Standard. This grade shall be expressed in the form:

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.

Optionally, an alternative decode algorithm may be substituted for the reference decode algorithm for the purposes of evaluating the decodability of the symbol.

ISO/IEC 15416 allows for additional pass/fail criteria to be stipulated by a symbology specification. For Interleaved 2 of 5, the additional criteria are given in 4.6.3.1 to 4.6.3.2. Any individual scan profile which does not meet these requirements shall receive a grade of 0.

NOTE In the following subclauses the requirements are based on the actual, rather than intended, measurements of the parameter; for this reason the Z dimension is appropriate rather than the X dimension.

4.6.3.1 Wide/narrow ratio

Symbols shall be produced with a nominal N from 2,0 to 3,0 inclusive. The measured value of N in any scan profile shall be in the range of 1,8 to 3,4 inclusive.

4.6.3.2 Quiet zone

The minimum quiet zone at each end of the symbol shall be a minimum of $10Z$, where Z is the measured narrow element width.

Annex A (informative) Additional features

A.1 Protection against short scans

In Interleaved 2 of 5 symbols, the bar patterns of the start and stop patterns may be found as the respective end and beginning of certain encoded symbol characters within the code. There is therefore no guarantee that a partial scan of the symbol will not produce a valid read for an embedded symbol having fewer characters. There are two additional measures which should be taken to minimize the risk of such partial read.

A.1.1 Fixed length symbols

In any application standard the number of characters encoded in an Interleaved 2 of 5 symbol should be fixed for that application and reading or data processing equipment should be programmed only to accept messages of that defined length.

A.1.2 Bearer bars

Where fixed length symbols cannot be used in an application, bearer bars should be used. The purpose of bearer bars is to reduce the probability of a valid but erroneous short read of the symbol where a scanning beam enters and/or leaves the symbol at the top or bottom. Bearer bars should be added unless technical constraints prevent it or unless the reading or data processing equipment is programmed for fixed length symbols.

Bearer bars should be placed perpendicular to the bars in the symbol, abutting the top and the bottom of the symbol bars over the full length of the symbol. They may extend over the quiet zones and their ends may be joined by vertical bars, provided that quiet zones of no less than the minimum width defined in 4.4 should be available between the inside edge of the vertical bearer bars and the first and last symbol bars respectively. The width of the bearer bar shall be between two and five times the X dimension of the symbol.

A.2 Check characters

A.2.1 Symbol check character

For applications requiring enhanced data security, a symbol check character should be used, in which case the symbol check character shall be encoded as the second character of the final digit pair, immediately following the final data character and before the stop pattern. The number of characters to be encoded, including the check character, should be even, a leading zero being inserted if required. The inclusion of the symbol check character should be determined by the application standard.

When included, the following symbol check character algorithm shall be used:

- 1) Starting with the digit on the right of the number (excluding the check character), sum all the alternate digit values, reading from right to left;
- 2) Multiply the result of step 1) by 3;
- 3) Sum all the remaining digit values;
- 4) Add the result of step 2) to the result of step 3);
- 5) The check character is the smallest number, which, when added to the result of step 4), produces a multiple of 10.

EXAMPLE: To calculate the check digit for the data 1937:

| | | | | | | | | | |
|---------|---------------------------------|--|----|---|---|--|-----|---|----|
| | 1 | | 9 | | 3 | | 7 | | |
| Step 1: | | | 9 | + | | | 7 | = | 16 |
| Step 2: | | | | | × | | 3 | = | 48 |
| Step 3: | 1 | | + | | 3 | | | = | 4 |
| Step 4: | | | 4 | + | | | 48 | = | 52 |
| Step 5: | (next multiple of 10 is 60): | | 60 | - | | | 52, | = | 8 |

therefore C = 8

The full number is thus 19378, to which a leading zero now requires to be added to make an even number of digits for encodation purposes, i.e. the data encoded will be 019378.

The weighted modulo 10 complement symbol check character should be transmitted by the decoder.

A.2.2 Data check character

An algorithm as described in ISO 7064, or another algorithm defined in the application specification, may be used to calculate a data check character, provided that suitable provision for its calculation and verification is included in the symbol generation and message processing software. Such a data check character shall be transmitted by the decoder.

A.3 Human-readable interpretation

A human-readable interpretation of the data characters (and symbol check character, if used) should normally be printed with the "Interleaved 2 of 5" symbol encoding them. Start/stop patterns have no human-readable interpretation. Character size and font are not specified, and the interpretation may be printed anywhere in the area surrounding the symbol, as long as quiet zones are not encroached upon.