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Information technology — Automatic identification and data capture techniques — Code 128 bar code symbology specification —

Technologies de l'information — Techniques d'identification automatique et de capture des données — Spécifications des symbologies des codes à barres, code 128

Reference number
ISO/IEC 15417:2007(E)

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Foreword

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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 15417 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 15417:2000), 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. Code 128 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.

In the past, symbology specifications were 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 software.

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Information technology — Automatic identification and data capture techniques — Code 128 bar code symbology specification

1 Scope

This International Standard specifies the requirements for the bar code symbology known as Code 128. It specifies Code 128 symbology characteristics, data character encodation, dimensions, decoding algorithms and the parameters to be defined by applications. It specifies the symbology identifier prefix strings for Code 128 symbols.

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 8859-1, *Information technology — 8-bit single-byte coded graphic character sets — Part 1: Latin alphabet No. 1*

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

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

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 and ISO/IEC 19762-2 apply.

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4 Requirements

4.1 Symbology characteristics

The characteristics of Code 128 are as follows.

a) Encodable character set:

   1) All 128 ISO/IEC 646 characters, i.e. characters 0 to 127 inclusive, in accordance with ISO/IEC 646.

   NOTE This version consists of the G0 set of ISO/IEC 646 and the C0 set of ISO/IEC 6429 with values 28 – 31 modified to FS, GS, RS and US respectively.

   2) Characters with byte values 128 to 255 may also be encoded.

   3) 4 non-data function characters.

   4) 4 code set selection characters.

   5) 3 Start characters.

   6) 1 Stop character.

b) Code type: Continuous.

c) Elements per symbol character: 6, comprising 3 bars and 3 spaces, each of 1, 2, 3 or 4 modules in width (Stop character: 7 elements comprising 4 bars and 3 spaces).

d) Character self-checking: Yes.

e) Symbol length: Variable.

f) Bidirectionally decodable: Yes.

g) Symbol check character: One, mandatory (see A.1).

h) Data character density: 11 modules per symbol character (5,5 modules per numeric character).

i) Non-data overhead: Equivalent to 35 modules.

4.2 Symbol structure

Code 128 symbols shall comprise

a) a leading quiet zone,

b) a Start character,

c) one or more characters representing data and special characters,

d) a symbol check character,

e) a Stop character,

f) a trailing quiet zone.

Figure 1 illustrates a Code 128 symbol encoding the text “AIM”.

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Figure 1 — Code 128 symbol

4.3 Character encodation

4.3.1 Symbol character structure

Each symbol character comprises six elements (three bars and three spaces arranged alternately from left to right, commencing with a bar), each of which is 1, 2, 3 or 4 modules wide, with a total width of 11 modules. The sum of the bar modules in any symbol character is always even (even parity) and that of the space modules is therefore always odd. This parity feature enables character self-checking to be carried out. The Stop character comprises an additional bar element two modules wide making its total width 13 modules.

Each symbol character is assigned a numeric value listed in Table 1. This value is used in calculating the symbol check character value. It may also be used to provide a conversion to and from ISO/IEC 646 values (see Annex D). Table 1 defines all the Code 128 character assignments. In the column headed 'Element Widths' the numeric values represent the widths of the elements in modules or multiples of the *X* dimension.

Figure 2 below illustrates Start character A.

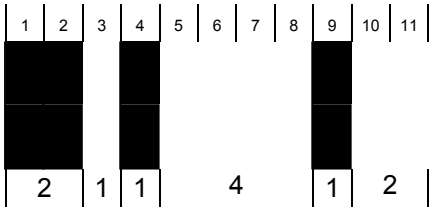

Figure 2 — Code 128 Start character A

Figure 3 below illustrates the encodation of the symbol character value 35, which represents data character ‘C’ in Code Sets A or B or the two digits ‘35’ in Code Set C.

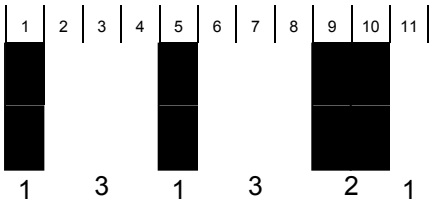

Figure 3 — Code 128 symbol character value 35

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Figure 4 below illustrates the Stop character.

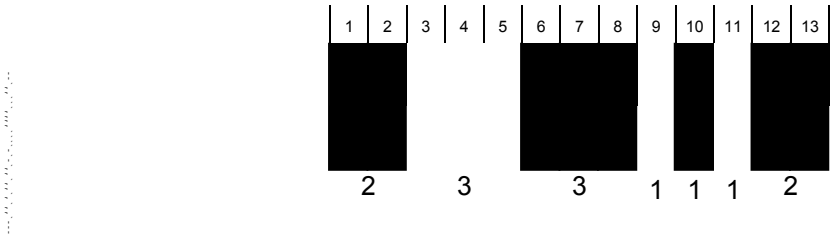

Figure 4 — Code 128 Stop character

4.3.2 Data character encodation

Code 128 has three unique data character code sets shown in Table 1 as Code Sets A, B, and C, each comprising a subset of the ISO/IEC 646 IRV character set together with various auxiliary characters. The symbol character bar and space patterns shown represent the data characters listed in the columns for Code Set A, B, or C. The choice of code set depends on the Start character or, within the symbol, on the use of Code A, Code B or Code C characters or the Shift character. If the symbol begins with Start character A, then Code Set A is defined initially. Code Set B and Code Set C are similarly defined by beginning the symbol with Start character B or C respectively. The code set can be redefined within the symbol by the use of Code A, Code B, and Code C characters or the Shift character (see 4.3.4.1 for the use of these special characters).

The same data may be represented by different Code 128 symbols, through the use of different combinations of Start, Code Set, and Shift characters. An application should not specify the code set to be used. Annex E contains rules to minimize the length of the symbol for any given data. A decoder shall in addition decode symbols which use valid combinations of Start, Code Set, and Shift characters and data other than that derived from the application of the algorithm in Annex E, such as a symbol with a code set or Shift character at the end of the data.

Table 1 — Code 128 character encodation

SYMBOL CHAR. VALUE	CODE SET A	ISO/IEC 646 VALUE for Set A	CODE SET B	ISO/IEC 646 VALUE for Set B	CODE SET C	ELEMENT WIDTHS (modules)						ELEMENT PATTERN										
						B	S	B	S	B	S	1	2	3	4	5	6	7	8	9	10	11
0	space	32	space	32	00	2	1	2	2	2	2	■	■		■	■			■	■		
1	!	33	!	33	01	2	2	2	1	2	2	■	■			■	■		■	■		
2	"	34	"	34	02	2	2	2	2	2	1	■	■			■	■			■	■	
3	#	35	#	35	03	1	2	1	2	2	3	■			■			■	■			
4	$	36	$	36	04	1	2	1	3	2	2	■			■				■	■		
5	%	37	%	37	05	1	3	1	2	2	2	■				■			■	■		
6	&	38	&	38	06	1	2	2	2	1	3	■			■	■			■			
7	apos-trophe	39	apos-trophe	39	07	1	2	2	3	1	2	■			■	■				■		
8	(	40	(	40	08	1	3	2	2	1	2	■				■	■			■		
9	)	41	)	41	09	2	2	1	2	1	3	■	■			■			■			
10	*	42	*	42	10	2	2	1	3	1	2	■	■			■				■		
11	+	43	+	43	11	2	3	1	2	1	2	■	■				■			■		
12	comma	44	comma	44	12	1	1	2	2	3	2	■		■	■			■	■	■		
13	-	45	-	45	13	1	2	2	1	3	2	■			■	■		■	■	■		
14	full stop	46	full stop	46	14	1	2	2	2	3	1	■			■	■			■	■	■	
15	/	47	/	47	15	1	1	3	2	2	2	■		■	■	■			■	■		

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SYMBOL CHAR. VALUE	CODE SET A	ISO/IEC 646 VALUE for Set A	CODE SET B	ISO/IEC 646 VALUE for Set B	CODE SET C	ELEMENT WIDTHS (modules)						ELEMENT PATTERN										
						B	S	B	S	B	S	1	2	3	4	5	6	7	8	9	10	11
16	0	48	0	48	16	1	2	3	1	2	2											
17	1	49	1	49	17	1	2	3	2	2	1											
18	2	50	2	50	18	2	2	3	2	1	1											
19	3	51	3	51	19	2	2	1	1	3	2											
20	4	52	4	52	20	2	2	1	2	3	1											
21	5	53	5	53	21	2	1	3	2	1	2											
22	6	54	6	54	22	2	2	3	1	1	2											
23	7	55	7	55	23	3	1	2	1	3	1											
24	8	56	8	56	24	3	1	1	2	2	2											
25	9	57	9	57	25	3	2	1	1	2	2											
26	colon	58	colon	58	26	3	2	1	2	2	1											
27	semi-colon	59	semi-colon	59	27	3	1	2	2	1	2											
28	<	60	<	60	28	3	2	2	1	1	2											
29	=	61	=	61	29	3	2	2	2	1	1											
30	>	62	>	62	30	2	1	2	1	2	3											
31	?	63	?	63	31	2	1	2	3	2	1											
32	@	64	@	64	32	2	3	2	1	2	1											
33	A	65	A	65	33	1	1	1	3	2	3											
34	B	66	B	66	34	1	3	1	1	2	3											
35	C	67	C	67	35	1	3	1	3	2	1											
36	D	68	D	68	36	1	1	2	3	1	3											
37	E	69	E	69	37	1	3	2	1	1	3											
38	F	70	F	70	38	1	3	2	3	1	1											
39	G	71	G	71	39	2	1	1	3	1	3											
40	H	72	H	72	40	2	3	1	1	1	3											
41	I	73	I	73	41	2	3	1	3	1	1											
42	J	74	J	74	42	1	1	2	1	3	3											
43	K	75	K	75	43	1	1	2	3	3	1											
44	L	76	L	76	44	1	3	2	1	3	1											
45	M	77	M	77	45	1	1	3	1	2	3											
46	N	78	N	78	46	1	1	3	3	2	1											
47	O	79	O	79	47	1	3	3	1	2	1											
48	P	80	P	80	48	3	1	3	1	2	1											
49	Q	81	Q	81	49	2	1	1	3	3	1											
50	R	82	R	82	50	2	3	1	1	3	1											
51	S	83	S	83	51	2	1	3	1	1	3											
52	T	84	T	84	52	2	1	3	3	1	1											
53	U	85	U	85	53	2	1	3	1	3	1											
54	V	86	V	86	54	3	1	1	1	2	3											
55	W	87	W	87	55	3	1	1	3	2	1											
56	X	88	X	88	56	3	3	1	1	2	1											
57	Y	89	Y	89	57	3	1	2	1	1	3											
58	Z	90	Z	90	58	3	1	2	3	1	1											
59	[	91	[	91	59	3	3	2	1	1	1											

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SYMBOL CHAR. VALUE	CODE SET A	ISO/IEC 646 VALUE for Set A	CODE SET B	ISO/IEC 646 VALUE for Set B	CODE SET C	ELEMENT WIDTHS (modules)						ELEMENT PATTERN										
						B	S	B	S	B	S	1	2	3	4	5	6	7	8	9	10	11
60	\	92	\	92	60	3	1	4	1	1	1											
61	]	93	]	93	61	2	2	1	4	1	1											
62	^	94	^	94	62	4	3	1	1	1	1											
63	_	95	_	95	63	1	1	1	2	2	4											
64	NUL	00	grave accent	96	64	1	1	1	4	2	2											
65	SOH	01	a	97	65	1	2	1	1	2	4											
66	STX	02	b	98	66	1	2	1	4	2	1											
67	ETX	03	c	99	67	1	4	1	1	2	2											
68	EOT	04	d	100	68	1	4	1	2	2	1											
69	ENQ	05	e	101	69	1	1	2	2	1	4											
70	ACK	06	f	102	70	1	1	2	4	1	2											
71	BEL	07	g	103	71	1	2	2	1	1	4											
72	BS	08	h	104	72	1	2	2	4	1	1											
73	HT	09	i	105	73	1	4	2	1	1	2											
74	LF	10	j	106	74	1	4	2	2	1	1											
75	VT	11	k	107	75	2	4	1	2	1	1											
76	FF	12	l	108	76	2	2	1	1	1	4											
77	CR	13	m	109	77	4	1	3	1	1	1											
78	SO	14	n	110	78	2	4	1	1	1	2											
79	SI	15	o	111	79	1	3	4	1	1	1											
80	DLE	16	p	112	80	1	1	1	2	4	2											
81	DC1	17	q	113	81	1	2	1	1	4	2											
82	DC2	18	r	114	82	1	2	1	2	4	1											
83	DC3	19	s	115	83	1	1	4	2	1	2											
84	DC4	20	t	116	84	1	2	4	1	1	2											
85	NAK	21	u	117	85	1	2	4	2	1	1											
86	SYN	22	v	118	86	4	1	1	2	1	2											
87	ETB	23	w	119	87	4	2	1	1	1	2											
88	CAN	24	x	120	88	4	2	1	2	1	1											
89	EM	25	y	121	89	2	1	2	1	4	1											
90	SUB	26	z	122	90	2	1	4	1	2	1											
91	ESC	27	{	123	91	4	1	2	1	2	1											
92	FS	28	|	124	92	1	1	1	1	4	3											
93	GS	29	}	125	93	1	1	1	3	4	1											
94	RS	30	~	126	94	1	3	1	1	4	1											
95	US	31	DEL	127	95	1	1	4	1	1	3											
96	FNC3		FNC3		96	1	1	4	3	1	1											
97	FNC2		FNC2		97	4	1	1	1	1	3											
98	SHIFT		SHIFT		98	4	1	1	3	1	1											
99	CODE C		CODE C		99	1	1	3	1	4	1											
100	CODE B		FNC4		CODE B	1	1	4	1	3	1											

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SYMBOL CHAR. VALUE	CODE SET A	ISO/IEC 646 VALUE for Set A	CODE SET B	ISO/IEC 646 VALUE for Set B	CODE SET C	ELEMENT WIDTHS (modules)						ELEMENT PATTERN										
						B	S	B	S	B	S	1	2	3	4	5	6	7	8	9	10	11
101	FNC4		CODE A		CODE A	3	1	1	1	4	1	■	■	■		■		■	■	■	■	
102	FNC1		FNC1		FNC1	4	1	1	1	3	1	■	■	■	■		■		■	■	■	
103			Start A			2	1	1	4	1	2	■	■		■					■		
104			Start B			2	1	1	2	1	4	■	■		■			■				
105			Start C			2	1	1	2	3	2	■	■		■			■	■	■		

SYMBOL CHAR. VALUE	CODE SET A	CODE SET B	CODE SET C	ELEMENT WIDTHS (modules)							ELEMENT PATTERN												
				B	S	B	S	B	S	B	1	2	3	4	5	6	7	8	9	10	11	12	13
-	Stop			2	3	3	1	1	1	2	■	■				■	■	■		■		■	■

NOTE The Stop character comprises 13 modules in four bars and three spaces. Every other character is 11 modules wide, starts with a bar and ends with a space and comprises six elements, each of which varies from one to four modules in width. The numeric values in the B and S columns represent the number of modules in each bar or space element respectively in the symbol characters.

4.3.3 Code Sets

4.3.3.1 Code Set A

Code Set A includes all of the standard upper case alphanumeric characters and punctuation characters together with the control characters, i.e. characters with values from 00 to 95 inclusive, as defined in ISO/IEC 646, and seven special characters.

4.3.3.2 Code Set B

Code Set B includes all of the standard upper case alphanumeric characters and punctuation characters together with the lower case alphabetic characters (i.e. characters with values from 32 to 127 inclusive, as defined in ISO/IEC 646) and seven special characters.

4.3.3.3 Code Set C

Code Set C includes the set of 100 digit pairs from 00 to 99 inclusive, as well as three special characters. This allows numeric data to be encoded as two data digits per symbol character.

4.3.4 Special characters

The last seven characters of Code Sets A and B (character values 96 - 102) and the last three characters of Code Set C (character values 100 - 102) are special non-data characters with no ISO/IEC 646 character equivalents, which have particular significance to the bar code reading device.

4.3.4.1 Code Set and shift characters

Code Set and Shift characters shall be used to change from one code set to another within a symbol. They shall not be transmitted by the decoder.

a) **Code Set characters** — Code A, B or C characters change the symbol code set from the code set defined previously to the new code set defined by the code character. This change applies to all

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characters following the Code Set character until either the end of the symbol, another Code Set character or the Shift character is encountered.

b) **Shift character** — The Shift character changes the code set from A to B or B to A for the single character following the shift character. Characters following the affected character shall revert to the Code Set A or B defined prior to the Shift character. The shifted symbol character shall not be a Code Set or Shift character.

4.3.4.2 Function characters

Function Characters (FNC) define instructions to the bar code reading device to allow for special operations and applications.

a) FNC1 shall be subject to the special considerations defined in Annex B.

b) FNC2 (Message Append) instructs the bar code reader to store temporarily the data from the symbol containing the FNC2 character and transmit it as a prefix to the data of the next symbol. This may be used to concatenate several symbols before transmission. This character may occur anywhere in the symbol. Where the sequence of data is significant, provision should be made to ensure reading of the symbols in the correct sequence.

c) FNC3 (Initialise) instructs the bar code reader to interpret the data from the symbol containing the FNC3 character as instructions for initialization or reprogramming of the bar code reader. The data from the symbol shall not be transmitted by the bar code reader. This character may occur anywhere in the symbol.

d) FNC4 is used to represent an extended character set (byte values 128 to 255) as specified in ISO/IEC 8859-1 or otherwise in an application specification. If a single FNC4 character is used, the value 128 is added to the ISO/IEC 646 value of the following data character in the symbol. A Shift character may follow the FNC4 character if it is necessary to change code set for the following data character. Subsequent data characters revert to the standard ISO/IEC 646 set. If two consecutive FNC4 characters are used, the value 128 is added to the ISO/IEC 646 value of all following data characters until two further consecutive FNC4 characters are encountered or the end of the symbol is reached. If during this sequence of extended encodation a single FNC4 character is encountered it is used to revert to standard ISO/IEC 646 encodation for the next data character only. Shift and code set characters shall have their normal effect during such a sequence. The default reference character set for extended values 128 - 255 is the corresponding half of ISO/IEC 8859-1, Latin Alphabet 1, as shown in Annex F, but application specifications may define or reference alternative sets corresponding to byte values 128 to 255.

4.3.4.3 Start and Stop characters

Start characters A, B and C define the corresponding code set to be used initially in the symbol.

The Stop character is common to all code sets.

Start and Stop characters shall not be transmitted by the decoder.

4.3.5 Symbol check character

The symbol check character shall be included as the last symbol character before the Stop character. The algorithm for its calculation is defined in A.1. The symbol check character shall not be represented in the human readable interpretation, nor shall it be transmitted by the decoder.

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4.4 Dimensions

4.4.1 Nominal module width (*X*)

The width of a module should be defined by the application specification, having due regard to the availability of equipment for the production and reading of symbols and complying with the general requirements of the application. See 4.7.1.

The *X* dimension shall be constant throughout a given symbol.

4.4.2 Quiet zone

Minimum width of the quiet zone (to the left and right of the Code 128 symbol): 10*X*

4.4.3 Symbol width

The width, *W* (in millimetres), of a Code 128 symbol, including quiet zones, can be calculated from the following expression:

$$W = \left[11(C+2)+2\right]X + 2Q$$

where

W is the symbol width;

C is the number of symbol characters (including symbol check character);

X is the width of a narrow element in millimetres;

Q is the width of the quiet zone in millimetres.

NOTE It is necessary to apply the rules in Annex E, or another algorithm, to determine the number of symbol characters before this expression can be evaluated.

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.

The algorithm contains the following steps to decode each bar coded character.

1. Calculate eight width measurements p, e_1, e_2, e_3, e_4, b_1, b_2, and b_3 (Figure 5).

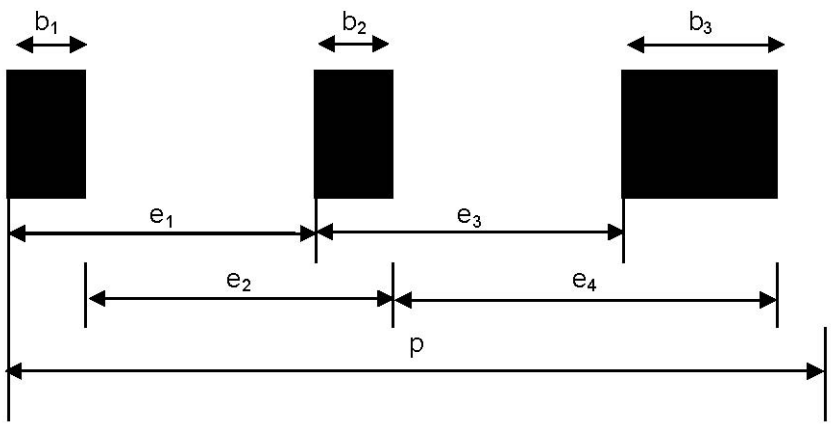

Figure 5 — Decode measurements

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2. Convert measurements e_1, e_2, e_3, and e_4 to normalized values E_1, E_2, E_3, and E_4 which will represent the integral module width (E_i) of these measurements. The following method is used for the i-th value.

   If $1{,}5p / 11 \le e_i < 2{,}5p / 11$, then $E_i = 2$.

   If $2{,}5p / 11 \le e_i < 3{,}5p / 11$, then $E_i = 3$.

   If $3{,}5p / 11 \le e_i < 4{,}5p / 11$, then $E_i = 4$.

   If $4{,}5p / 11 \le e_i < 5{,}5p / 11$, then $E_i = 5$.

   If $5{,}5p / 11 \le e_i < 6{,}5p / 11$, then $E_i = 6$.

   If $6{,}5p / 11 \le e_i < 7{,}5p / 11$, then $E_i = 7$.

   Otherwise the character is in error.

3. Look up character in decode table using the four values E_1, E_2, E_3, and E_4 as the key. (See Table 2.)

4. Retrieve character self-checking value V which is stored in the table with the character. The value V is equal to the sum of the modules for the bars as defined for that character.

5. Verify that

$$\frac{(V-1{,}75)p}{11} < (b_1 + b_2 + b_3) < \frac{(V+1{,}75)p}{11}$$

   Otherwise the character is in error.

   The calculation indirectly uses character parity to detect all decode errors caused by single non-systematic one-module edge errors.

Using these five steps, decode the first character. If it is a Start character, continue decoding the symbol in the normal forward direction. If it is not a Start character but decodes as a Stop character, attempt to decode all subsequent characters in the reverse direction.

After all characters have been decoded, make sure there is a valid Start character, a valid Stop character, and that the symbol check character is correct.

Translate the symbol characters into the appropriate data characters from Code Set A, B, or C according to the Start character, code characters, and shift characters used in the symbol.

In addition, perform such other secondary checks on quiet zones, beam acceleration, absolute timing, dimensions, etc., as are deemed prudent and appropriate considering the specific reading device and intended application environment.

NOTE In this algorithm the symbol is decoded using "edge to similar edge" measurements (e), plus an additional measurement of the sum of the three bar widths.

Table 2 — Edge differences for decoding Code 128

Char. value	E_1	E_2	E_3	E_4	V	Char. value	E_1	E_2	E_3	E_4	V
00	3	3	4	4	6	54	4	2	2	3	6
01	4	4	3	3	6	55	4	2	4	5	6
02	4	4	4	4	6	56	6	4	2	3	6
03	3	3	3	4	4	57	4	3	3	2	6
04	3	3	4	5	4	58	4	3	5	4	6
05	4	4	3	4	4	59	6	5	3	2	6

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Char. value	E_1	E_2	E_3	E_4	V	Char. value	E_1	E_2	E_3	E_4	V
06	3	4	4	3	4	60	4	5	5	2	8
07	3	4	5	4	4	61	4	3	5	5	4
08	4	5	4	3	4	62	7	4	2	2	6
09	4	3	3	3	4	63	2	2	3	4	4
10	4	3	4	4	4	64	2	2	5	6	4
11	5	4	3	3	4	65	3	3	2	3	4
12	2	3	4	5	6	66	3	3	5	6	4
13	3	4	3	4	6	67	5	5	2	3	4
14	3	4	4	5	6	68	5	5	3	4	4
15	2	4	5	4	6	69	2	3	4	3	4
16	3	5	4	3	6	70	2	3	6	5	4
17	3	5	5	4	6	71	3	4	3	2	4
18	4	5	5	3	6	72	3	4	6	5	4
19	4	3	2	4	6	73	5	6	3	2	4
20	4	3	3	5	6	74	5	6	4	3	4
21	3	4	5	3	6	75	6	5	3	3	4
22	4	5	4	2	6	76	4	3	2	2	4
23	4	3	3	4	8	77	5	4	4	2	8
24	4	2	3	4	6	78	6	5	2	2	4
25	5	3	2	3	6	79	4	7	5	2	6
26	5	3	3	4	6	80	2	2	3	6	6
27	4	3	4	3	6	81	3	3	2	5	6
28	5	4	3	2	6	82	3	3	3	6	6
29	5	4	4	3	6	83	2	5	6	3	6
30	3	3	3	3	6	84	3	6	5	2	6
31	3	3	5	5	6	85	3	6	6	3	6
32	5	5	3	3	6	86	5	2	3	3	6
33	2	2	4	5	4	87	6	3	2	2	6
34	4	4	2	3	4	88	6	3	3	3	6
35	4	4	4	5	4	89	3	3	3	5	8
36	2	3	5	4	4	90	3	5	5	3	8
37	4	5	3	2	4	91	5	3	3	3	8
38	4	5	5	4	4	92	2	2	2	5	6
39	3	2	4	4	4	93	2	2	4	7	6
40	5	4	2	2	4	94	4	4	2	5	6
41	5	4	4	4	4	95	2	5	5	2	6
42	2	3	3	4	6	96	2	5	7	4	6
43	2	3	5	6	6	97	5	2	2	2	6
44	4	5	3	4	6	98	5	2	4	4	6
45	2	4	4	3	6	99	2	4	4	5	8
46	2	4	6	5	6	100	2	5	5	4	8
47	4	6	4	3	6	101	4	2	2	5	8
48	4	4	4	3	8	102	5	2	2	4	8
49	3	2	4	6	6	103	3	2	5	5	4
50	5	4	2	4	6	104	3	2	3	3	4
51	3	4	4	2	6	105	3	2	3	5	6
52	3	4	6	4	6	$Stop_A$	5	6	4	2	6
53	3	4	4	4	8	$Stop_B$	3	2	2	4	6

NOTE $Stop_A$ values are for decoding in forward direction. $Stop_B$ values apply to the first six elements of the Stop character starting at the rightmost side, when scanned in reverse direction.

4.6 Symbol quality

4.6.1 Test specification

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 4.6.2 and 4.6.3. ISO/IEC 15416 lays down conditions under which measurements should be made; and defines methods of determining an overall quality

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grade based on the attributes of the bar code symbol. The reference decode algorithm defined in 4.5 shall be used for the assessment of the "decode" and "decodability" parameters under ISO/IEC 15416.

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.

ISO/IEC 15416 allows for additional pass/fail criteria to be stipulated by a symbology specification. For Code 128, the additional criterion is given in 4.6.3. Any individual scan profile which does not meet this requirement shall receive a grade of 0.

4.6.2 Decodability

For the calculation of the decodability value *V* the following provisions apply, which supplement those in ISO/IEC 15416.

Substitute *V*1 for V_C in the formula $V_C = \frac{K}{\left(\frac{S}{2n}\right)}$ and calculate *V*1.

Calculate *V*2:

$$V2 = \frac{1{,}75 - ABS\left[\left(W_b \times \frac{11}{S}\right) - M\right]}{1{,}75}$$

where

W_b is the sum of the bar widths in the character;

S is the total width of the character;

M is the number of dark modules in the character.

NOTE 1 W_b and *S* must be in the same units of measurement.

V_C is the lesser of *V*1 and *V*2.

NOTE 2 The Stop character comprises an additional terminating bar. For the purpose of measuring decodability, the Stop character should be checked twice, first using the six leftmost elements and then the six rightmost elements from right to left. Both sets of six elements are equivalent in width to a standard character.

4.6.3 Additional parameter — Quiet zones

ISO/IEC 15416 allows for additional pass/fail criteria to be stipulated by a symbology specification. The quiet zone at each end of the symbol shall be a minimum of 10*Z*. Both left and right quiet zones on each scan reflectance profile under ISO/IEC 15416 shall be measured and graded as follows.

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Quiet Zone ≥ 10Z: Grade 4.

Quiet Zone < 10Z: Grade 0.

NOTE In this subclause 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.

4.7 User-defined application parameters

User-defined application parameters are discussed below and in Annex G.

4.7.1 Symbology and data characteristics

Application specifications should consider the following parameters.

a) Selection of a subset of the encodable character set if required.

NOTE It is recommended by this International Standard that a restriction to a single Code Set should not be specified, e.g. the use of Code Set A exclusively, when structuring a symbol, since this confers no practical advantages. However, it is permissible for the set of valid data characters for an application to be restricted, e.g. to numeric data.

b) The number of data characters in the symbol, which may be fixed, variable or variable up to a defined maximum.

c) Whether a data check character (in addition to the mandatory symbol check character) is to be used and if so the algorithm for its calculation. A standard reader will not validate a data check character but will simply transmit it as standard data.

d) Minimum *X* dimension or range of *X* dimensions may or may not be specified provided that an appropriate minimum symbol quality grade (with measuring aperture and wavelength stated) is specified.

e) Minimum bar height.

f) Minimum quiet zone width larger than the 10*X* minimum, if expected scanning conditions require it, e.g. wand scanning of symbols with *X* dimension below a certain value.

g) Reference extended character set for use with FNC4.

h) The use of symbology identifiers in data transmission (see 4.8).

4.7.2 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 the following:

— peak response wavelength;

— spectral half power band width with which the symbol and the scanner should conform;

— the spot size of the scanner;

— the parameters for reflectance of the bars and spaces;

— the conditions under which optical measurements should be made;

— the extent of permissible imperfections within the bar code symbol.

An example is provided in Annex G.

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4.7.3 Test specification

Application specifications should define the minimum overall symbol grade for acceptability (including minimum grade level, required measurement aperture and peak response wavelength) when symbols are measured in accordance with ISO/IEC 15416.

EXAMPLE

1,5 / 10 / 660

where

1,5 is the overall symbol quality grade;

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

660 is the peak response wavelength in nanometers.

4.8 Transmitted data

Transmitted data from a decoded Code 128 symbol shall comprise the byte values of the data characters. It shall be prefixed by the symbology identifier defined in Annex C, if required by the application. The Start and Stop characters, function characters, code set and shift characters and symbol check character shall not be included in the transmitted data, except as specified for FNC1 in B.4.

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Annex A
(normative)

Additional features of Code 128

A.1 Symbol check character

The Code 128 symbol check character shall be calculated according to the following algorithm.

1. Retrieve the symbol character value from Table 1.

2. Each symbol character position is given a weighting. The Start character position is weighted 1. Then, beginning on the left with the first symbol character following the Start character, the weights are 1, 2 ,3, 4, ... , n, for all following symbol character positions up to, but not including, that of the symbol check character itself; n denotes the number of symbol characters representing data or special information in the symbol, exclusive of the Start/Stop characters and symbol check character.

   NOTE Both the Start character and the first symbol character following the Start character are weighted "1".

3. Multiply each symbol character value by its weighting.

4. Sum the products of the calculation in step 3.

5. Divide the sum of the products by 103.

6. The remainder derived from the calculation in step 5 is the symbol character value of the symbol check character.

For example, to calculate the symbol check character value for the data "AIM1234":

Characters	**Start B**	**A**	**I**	**M**	**Code C**	**12**	**34**
Character Values (Step 1)	104	33	41	45	99	12	34
Weights (Step 2)	1	1	2	3	4	5	6
Products (Step 3)	104	33	82	135	396	60	204
Sum of Products (Step 4)		1014					
Divide by 103 (Step 5)		1014 / 103 = 9					
Remainder = symbol check character value		**87**					

The symbol check character shall be positioned immediately following the final data or special character and before the Stop character.

The symbol check character shall not be shown in the human-readable interpretation, and it shall not be transmitted by a decoder.

A.2 Human readable interpretation

A human-readable interpretation of the data characters (which should correspond with the characters transmitted by the decoder) should be printed with the Code 128 symbol encoding them. Start/Stop and special characters shall not be printed. Character size and font are not specified, and the interpretation may be printed anywhere in the area surrounding the symbol, as long as quiet zone boundaries are not violated (see 4.4.2).

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Annex B
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Special considerations relating to Function Code 1 (FNC1)

B.1 FNC1 in the first position — Reserved use for EAN.UCC system

By agreement between AIM, Inc. and GS1 (formerly EAN International and the Uniform Code Council (UCC)), the use of FNC1 in Code 128 symbols in the first symbol character position following the Start character has been reserved exclusively for the GS1 system. In such symbols the data content immediately following the FNC1 character shall comply with the data structures defined by GS1, which have developed a coherent international application standard for the use of Code 128 for the encodation of data in a wide range of specific categories. This standard is described fully in the GS1 General Specifications.

The addresses of the GS1 global offices are:

GS1
Blue Tower, Avenue Louise 326, bte 10,
B-1050 BRUSSELS
Belgium

GS1
Princeton Pike Corporate Center
1009 Lennox Drive, Suite 202
Lawrenceville, NJ 08648
USA

The latest version of the GS1 General Specifications may be obtained from this body, or its affiliated Member Organisations (referred to as GS1 followed by the country name, e.g. GS1 US, GS1 Netherlands).

Use of FNC1 in the second character position is not permitted in these symbols.

B.2 FNC1 in the second position — Reserved use by AIM Global

By agreement between AIM Global and other bodies, the use of FNC1 in Code 128 symbols in the second symbol character position following the Start character has been reserved to denote symbols complying with specific applications, where the need for such symbols to be unambiguously distinguished from other Code 128 symbols has been demonstrated. Permissible characters in the first symbol character position are 00 to 99 in Code Set C, A to Z, and a to z. Any other character renders the symbol invalid.

Details of these applications are available from AIM, Inc. whose address is:

AIM Global
125 Warrendale-Bayne Road
Suite 100
Warrendale, PA 15086
USA

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B.3 Other uses

The FNC1 symbol character may validly occur as the symbol check character.

FNC1 may be used in the third or subsequent character position as a data field separator, and is then transmitted as the ISO/IEC 646 character 29 (GS).

B.4 Transmitted data

Any application which utilizes Code 128 symbols with FNC1 in the first or second data position should require the transmission of symbology identifiers to be enabled. When FNC1 is used in the first or second position it shall not be represented in the transmitted message, although its presence is indicated by the use of modifier values 1 or 2 respectively in the symbology identifier.

When FNC1 is used in the second data position the symbol characters immediately preceding and following it shall be transmitted exactly as though the FNC1 character were not present.

FNC1 in the third or subsequent character position is transmitted as the control character GS (value 29).

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Annex C
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Symbology identifiers

The symbology identifier allocated to Code 128 in ISO/IEC 15424, which may be added as a preamble to the decoded data by a suitably programmed bar code decoder, is

]Cm

where

] represents ISO/IEC 646 character 93;

C is the code character assigned to the Code 128 symbology;

m is a modifier value from Table C.1 below.

Table C.1 — Modifier values for Code 128

m	Option
0	Standard data packet. No function code 1 in first or second symbol character position after Start character
1	GS1-128 (also known as UCC/EAN-128) data packet — function code 1 in first symbol character position after Start character
2	Function code 1 in second symbol character position after Start character
4	Concatenation according to International Society for Blood Transfusion ISBT-128 specifications has been performed — concatenated data follows

This information shall not be encoded in the bar code symbol, but should be generated by the decoder after decoding and transmitted as a preamble to the data message.

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Annex D
(informative)

Relationship of symbol character value to ASCII value

In order to convert symbol character value (S) to ASCII decimal value or vice versa, the following relationships are applicable for Code Set A and Code Set B.

Code Set A

If $S \geq 63$,
ASCII value = S + 32.

If $64 \geq S \geq 95$,
ASCII value = S – 64.

Code Set B

If $S \geq 95$,
ISO/IEC value = S + 32.

The resulting values are shown in Table 1.

NOTE As described in 4.3.4.3 d), the presence of the FNC4 character has the effect of adding 128 to the ASCII value of the following data character or characters derived from the rules given above.

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Annex E
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Use of Start, Code Set and Shift characters to minimize symbol width

The same data may be represented by different Code 128 symbols through the use of different combinations of Start, Code Set and Shift characters.

The following rules to minimize the number of symbol characters needed to represent a given data string (and therefore the overall symbol width) should normally be implemented in printer control software.

1. Determine the Start character:

    1a. If the data consists of 2 digits, use Start character C.
    1b. If the data begins with 4 or more numeric data characters, use Start character C.
    1c. If a control character (e.g. NUL) occurs in the data before any lower case character, use Start character A.
    1d. Otherwise, use Start character B.

2. If Start character C is used and the data begins with an odd number of numeric data characters, insert a Code Set A or Code Set B character before the last digit, following rules 1c and 1d above to determine between Code Sets A and B.

3. If 4 or more numeric data characters occur together when in Code Sets A or B:

    3a. If there is an even number of numeric data characters, insert a Code Set C character before the first numeric digit to change to Code Set C.
    3b. If there is an odd number of numeric data characters, insert a Code Set C character immediately after the first numeric digit to change to Code Set C.

4. When in Code Set B and a control character occurs in the data:

    4a. If following that character, a lower case character occurs in the data before the occurrence of another control character, insert a Shift character before the control character.
    4b. Otherwise, insert a Code Set A character before the control character to change to Code Set A.

5. When in Code Set A and a lower case character occurs in the data:

    5a. If following that character, a control character occurs in the data before the occurrence of another lower case character, insert a Shift character before the lower case character.
    5b. Otherwise, insert a Code Set B character before the lower case character to change to Code Set B.

6. When in Code Set C and a non-numeric character occurs in the data, insert a Code Set A or Code Set B character before that character, following rules 1c and 1d to determine between Code Sets A and B.

NOTE 1 In these rules the term 'lower case' is used for convenience to mean precisely any Code Set B character with Code 128 character values 64-95 (ISO/IEC 646 values 96-127), i.e. all lower case alphabetic characters plus `{|}~DEL. The term 'control character' means any Code Set A character with Code 128 character values 64-95 (ISO/IEC 646 values 00-31).

NOTE 2 If the Function 1 character occurs in the first position following the Start character, or in an odd-numbered position in a numeric field, it should be treated as two digits for the purpose of determining the appropriate code set.

NOTE 3 If the data contains characters whose ISO/IEC 646 value exceeds 127, subtract 128 from their ISO/IEC 646 value for the purpose of determining the appropriate Code Set A or B and apply the rules below. Where there are from 1 to 4 consecutive such characters (1 or 2 at the end of the data string) it is most efficient to precede each of them with the FNC4 character. For 5 (3 at the end of the data string) or more such characters, it is more efficient to latch into Extended ISO/IEC 646 mode using pairs of FNC4 characters.

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Annex F
(informative)

ISO/IEC 8859-1 (Latin Alphabet no. 1) character set

Table F.1 below shows the mapping of the characters in the upper half of this set to byte values 160 to 255 inclusive. There are no graphical representations for values 128 to 159 inclusive. The mapping is equivalent to that in row 00 (decimal), cell positions 160 to 255 of the ISO/IEC 10646 Basic Multilingual Plane.

In accordance with 4.3.4.2 d), these characters can be represented in Code 128 in conjunction with the FNC4 character, based on the relationship

C = (D − 128)

where

C is the ISO/IEC 646 value of symbol character;

D is the value of data character from table F.1.

Since this yields values of C in the range 32 - 127, which corresponds to the Code Set B character code set, the following relationship is also true when applied to Code Set B:

S = (D − 160)

where

S is the symbol character value from Table 1 (Code Set B);

D is the value of data character from Table F.1.

Table F.1 — Upper part of ISO/IEC 8859-1 character set

160 NBSP	161 ¡	162 ¢	163 £	164 ¤	165 ¥	166 ¦	167 §	168 ¨	169 ©	170 ª	171 «
172 ¬	173 SHY	174 ®	175 ¯	176 °	177 ±	178 ²	179 ³	180 ´	181 µ	182 ¶	183 ·
184 ¸	185 ¹	186 º	187 »	188 ¼	189 ½	190 ¾	191 ¿	192 À	193 Á	194 Â	195 Ã
196 Ä	197 Å	198 Æ	199 Ç	200 È	201 É	202 Ê	203 Ë	204 Ì	205 Í	206 Î	207 Ï
208 Ð	209 Ñ	210 Ò	211 Ó	212 Ô	213 Õ	214 Ö	215 ×	216 Ø	217 Ù	218 Ú	219 Û
220 Ü	221 Ý	222 Þ	223 ß	224 à	225 á	226 â	227 ã	228 ä	229 å	230 æ	231 ç
232 è	233 é	234 ê	235 ë	236 ì	237 í	238 î	239 ï	240 ð	241 ñ	242 ò	243 ó
244 ô	245 õ	246 ö	247 ÷	248 ø	249 ù	250 ú	251 û	252 ü	253 ý	254 þ	255 ÿ

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Annex G
(informative)

User-defined application parameters

G.1 Quality grade

Application standards should specify a minimum quality grade in accordance with ISO/IEC 15416.

By reference to ISO/IEC 15416, the minimum values of measured symbol parameters associated with the overall grade can be determined.

G.2 Dimensional characteristics

As guidance to the user the application specification may recommend a value or a range of values of *X* dimension, having regard to the general application needs and to the availability of suitable symbol production and reading equipment. Non-compliance with any minimum *X* dimension should not, by itself, be a reason for rejection of a symbol under these standards.

It is recommended for manual scanning that the minimum *Y* dimension should be 5 mm or 15 % of the symbol length, whichever is greater.

The width *W* of a Code 128 symbol, including minimum quiet zones, may be calculated from the following expression:

$$W = 11X\left[C + \left(\frac{D}{2}\right)\right] + 22X$$

where

W is the width of the symbol;

X is the width of a narrow element;

C is the number of Start, special, symbol check and Stop characters plus the number of data characters not included in D;

D is the number of numeric data characters encoded in double density (Code Set C).

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Annex H
(informative)

Guidelines for the use of Code 128

H.1 Autodiscrimination compatibility

Code 128 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.

H.2 System considerations

It is important that the various components (printers, labels, scanners) 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. The characteristics of the printer, symbol and scanner should be matched to achieve the desired performance.

H.3 Printing considerations

This section describes considerations for printing Code 128 using pixel-based printers, however these same considerations are applicable to all symbologies.

H.3.1 Pixel-based printing

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 edge to similar edge decodable symbologies like Code 128 the number of pixels comprising each symbol character must be a fixed and constant integer multiple of the number of modules in the symbol character. For Code 128, the number of modules is 11 for symbol character values 0 to 105, and 13 for the Stop character. Therefore, a given printer can only print a certain set of *X* dimensions.

Compensation for uniform bar width growth (or loss) must be in equal offsetting amounts on all bars and spaces in the symbol. This may be accomplished by changing an integer number of pixels from dark to light or light to dark in the same manner for each bar-space pair in the symbol and for the last bar in the symbol. For example, all pixels along the same edge of every bar in the symbol could be changed from dark to light, or pixels along both edges of every bar in the symbol could be changed from dark to light, provided that the printer resolution is sufficient to allow this to be performed satisfactorily. Any set of dark to light or light to dark pixel changes is acceptable provided the adjustment is performed consistently across the whole symbol and does not change 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.

General purpose printing software designed to support a wide range of printers should provide the user the capability of adjusting the *X* dimension and bar width growth or loss.

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Programmer's example

These principles can be reduced to the following rules for digital bar code design files.

1. Convert the desired magnification or *X* dimension to a module size in pixels rounded down to the nearest integer.

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

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

EXAMPLE

Using digital bar code design files with a printing device with 24 dots per mm, create a 0,27 mm × dimension symbol with 0,06 mm of bar width reduction.

— The module size is 24 dots/mm × 0,27 mm/module = 6,5 pixels, which rounds down to 6 pixels per module.

— The bar growth compensation is 0,06 mm × 24 pixels/mm = 1,4 pixels, which rounds up to 2 pixels.

This process results in the following pixel count for bars and spaces as illustrated in Table H.1.

Table H.1 — Correcting pixels for imaging resolution and bar width reduction

Module count	Pixel count	
	Bars	Spaces
1	4	8
2	10	14
3	16	20
4	22	26

H.3.2 Guidance to users of pixel-based printing software

When printing a symbol for the first time on a printing system consisting of the bar code printing software and the printing device, a user should verify according to ISO/IEC 15416 that the printed symbol meets the required print quality grade and *X* dimension. If the resulting symbol does not achieve the required symbol quality grade the user may need to increase the *X* dimension or change the bar width growth or loss. If the *X* dimension is increased the user should verify that the minimum quiet zones are maintained. This process may need to be repeated until the required symbol grade is achieved. Not all printing systems are capable of producing acceptable symbols at small *X* dimensions.

H.3.3 Process control considerations

For process control purposes, the assessment of average bar width gain or loss, and the application of corrective action to reduce this, are appropriate. The "decodability" parameter measured in accordance with ISO/IEC 15416 is affected both by systematic bar width gain or loss and by variations in edge to similar edge measurements.

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