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Information processing — Guide for the definition of 4-bit character sets derived from the 7-bit coded character set for information processing interchange

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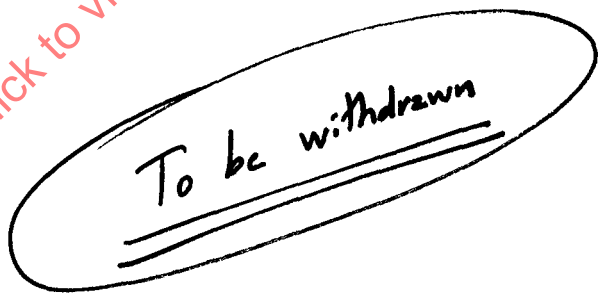

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FOREWORD

ISO (the International Organization for Standardization) is a worldwide federation of national standards institutes (ISO Member Bodies). The work of developing International Standards is carried out through ISO Technical Committees. Every Member Body interested in a subject for which a Technical Committee has been set up has the right to be represented on that Committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

Prior to 1972, the results of the work of the Technical Committees were published as ISO Recommendations; these documents are now in the process of being transformed into International Standards. As part of this process, Technical Committee ISO/TC 97, *Computers and information processing*, has reviewed ISO Recommendation R 963-1969 and found it technically suitable for transformation. International Standard ISO 963 therefore replaces ISO Recommendation R 963-1969, which was approved by the Member Bodies of the following countries :

Australia	Germany	Portugal
Belgium	Israel	Sweden
Canada	Italy	Switzerland
Czechoslovakia	Japan	United Kingdom
Denmark	Korea, Rep. of	Turkey
Egypt, Arab Rep. of	Netherlands	U.S.A.
France	New Zealand	U.S.S.R.

No Member Body expressed disapproval of the Recommendation.

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0 INTRODUCTION

The need has been expressed for 4-bit character sets derived from the 7-bit code for information interchange. There are economic reasons which require a 4-bit set for private or regional organizations with multiple terminals where the use of the full 7-bit code is not justified.

The representation of decimal numbers in packed numerics form according to ISO . . .[1] does not constitute a 4-bit character set in the sense of this guide.

1 SCOPE

The multiplicity and the diversity of the possible applications make it impossible to define a unique 4-bit character set or even a family of a limited number of sets. The purpose of this International Standard is therefore to set up rules for the definition of such sets so that

a) a given selection of characters from the 7-bit code shall be uniquely arranged in a 4-bit set;

b) the subsets are as similar to and as compatible with each other as possible;

c) the rules given should make conversion possible at minimum cost to and from 7-bit coded information.

2 FIELD OF APPLICATION

This International Standard applies to the definition of 4-bit character sets derived from the 7-bit code for information interchange which is the subject of ISO 646, *7-bit coded character set for information processing interchange.*[2]

3 CHARACTER SET

The characters available to a 4-bit set are

a) all the characters of the 7-bit code table;

b) other characters whose meaning and graphical representation must be agreed between sender and recipient of the data.

4 DEFINITION OF A 4-BIT CHARACTER SET

4.1 A 4-bit set comprises the ten numerals 0 to 9 and six further characters allocated as described in clause 5.

4.2 These characters are coded in increasing binary order and referenced position 0 to position 15, the numerals being allocated to positions 0 to 9.

Position	Character	Coded representation
0	0	0000
1	1	0001
2	2	0010
3	3	0011
4	4	0100
5	5	0101
6	6	0110
7	7	0111
8	8	1000
9	9	1001
10		1010
11		1011
12		1100
13		1101
14		1110
15		1111

1) At present at the stage of draft proposal.

2) To facilitate the use of this International Standard, the basic code table of ISO 646 has been reproduced in annex C.

5 RULES FOR THE ALLOCATION OF CHARACTERS TO POSITIONS 10 TO 15

5.1 Decide which characters from the 7-bit code are required for the 4-bit set.

NOTE – It is important that no attempt be made at this stage to foresee the graphical representation of characters from columns 0 and 1 of the 7-bit code table.

5.2 Consider any characters required from row 10 of the 7-bit code table.

5.3 Allocate to position 10 the first one encountered when taken in the order of columns : 3 2 1 0 7 6 5 4.

5.4 Leave any remaining characters in row 10 to be dealt with under 5.6, below.

5.5 Repeat the procedure prescribed in 5.2 to 5.4 for each of the rows 11 to 15, with the exception that in the case of row 15 the columns are taken in the order : 7 3 2 1 0 6 5 4.

5.6 Sort any character left from rows 10 to 15 together with any other characters required from row 0 to 9 (other than numerals) into ascending order of their 7-bit binary coded representation and insert them into unfilled position of the subset in order of position number.

5.7 If a control (i.e. a character from column 0 or 1 of the 7-bit code table) has been used, decide whether a graphical representation of it is required. If so, allocate either the graphic from column 3 of the 7-bit code corresponding to the position the control now occupies in the 4-bit set, or a graphic not included in the 7-bit code.

5.8 Allocate any required characters not included in the 7-bit code to the remaining vacant positions. If a graphical representation is required of such a character, allocate either the graphic from column 3 of the 7-bit code corresponding to the position which the character occupies in the 4-bit set, or a graphic not included in the 7-bit code.

NOTE – For the selection of characters, it is recommended to proceed as follows :

a) select the non-numeric characters of the 4-bit set from the 7-bit code, even though other characters are not prohibited;

b) select the characters in positions 10 to 15 of column 3 of the 7-bit code table (see annex C) to represent the controls allocated to these positions, when the graphical representation is unimportant to the application. However, these graphics must not be used with the meaning of another graphic of the 7-bit code;

c) use, as far as possible, one but no more than one character from each of rows 10 to 15 of the 7-bit set table (see annex C).

ANNEX A

BACKGROUND AND DEVELOPMENT OF THE RULES FOR FORMULATING 4-BIT CHARACTER SETS DERIVED FROM THE ISO 7-BIT CODE

A.1 NEED FOR 4-BIT CHARACTER SETS

The need has been expressed for 4-bit sets derived from the 7-bit code, comprising 0 to 9 and some additional characters. There are economic reasons which require a 4-bit character set (or 4 information bits plus parity) for private and regional organizations with multiple terminals where the full 7-bit code is not justified. Nevertheless, such systems require a logical relationship to the 7-bit code since they must exchange information with general-purpose systems using the 7-bit code. Examples of such areas of application which have become prominent are numeric control and data collection with particular field of application such as those described by UIC (Union Internationale des Chemins de fer). Many of the potential fields of application require data to pass across national boundaries, which makes it desirable to reach an international understanding.

The purpose of this 4-bit standardization is not to set up another code for interchange between computers; that is recognized to be the ISO 7-bit code. It is to permit simple closed systems to communicate with each other at the 4-bit level in such a way that, when conversion to 7-bit is necessary, it can be achieved easily and with the minimum of cost.

A.2 MEDIA CONSIDERATION

Examples of the media involved are punched tape, communication channels and certain classes of printed documents. The devices likely to be involved in such applications will probably require a minimum keyboard (to reduce cost). Where punched tape and/or communication channels are involved, a parity bit may be added to provide a check against malfunctioning of the terminal device and for simple protection of the transmission links. In order to allow the use of the all zeros combination in the four data bits, it would be essential to use odd parity to distinguish it from unpunched tape.

A.3 CHARACTER SETS REQUIRED

Consideration of the different 4-bit sets desired shows that other characters besides the numerals are required by a number of different applications. For example, Space and New Line are commonly required controls and − (minus) and . (full stop) common graphics. They are, however, not universally needed. Sometimes controls or graphics not in the 7-bit code table are required, such as programmed start in numeric control or the abstract symbols specifically wanted for character recognition. There are indeed so many different requirements that no fixed standardization of a unique set is possible. Consequently it is considered necessary to make provision for a user to select any combination of the non-numeric characters from the 7-bit code for inclusion in positions 10 to 15 of the 4-bit set. Furthermore, this International Standard should define a unique way of allotting the selected characters to these positions. Naturally the resulting 4-bit sets should be as similar and compatible as the other requirements will permit.

A.4 CONVERSION PHILOSOPHY

Since the essence of a 4-bit system is low cost, and it is likely to be used with a multiplicity of terminals, it is clearly undesirable to require each terminal to provide elaborate conversion into 7-bit form. It would be convenient if such converters were merely to add three bits, in a simple uniform manner, solely to convert the 4-bit form into one acceptable to the 7-bit medium.

This would only yield a true 7-bit code representation if the 4-bit set consisted of column 3 of the 7-bit code table. In view of the diverse character requirements this would not normally be so, but it would not matter if the recipient of the information were aware of its source. He would be aware of the special meaning of the sixteen 7-bit combinations (011 XXXX). Alternatively, if interchange of information of the standard 7-bit code were required, conversion from the pseudo 7-bit form would be needed and would be carried out in the 7-bit medium.

A.5 RECOMMENDED 4-BIT CHARACTER SETS

To be considered as a set derived from the 7-bit code, a 4-bit set should have ten numerals (0 to 9) coded in binary. Since the numerals 0 to 9 are allocated to column 3 of the 7-bit code table, the conversion between 4-bit and 7-bit numerals requires the systematic addition or deletion of bits 7, 6 and 5 (011). The remaining six characters cannot necessarily be dealt with in such a simple way since they need to be selected from various parts of the 7-bit code table.

The requirements stated in A.2 and A.3 may be summarized as follows :

a) code conversion within the 7-bit environment should be made as simple as possible;

b) any combination of non-numeric characters must be available for positions 10 to 15 and a unique way of allocating the selected characters must be defined;

c) the various subsets should be as similar and compatible as possible.

As a result of a) and the requirement to include the numerals, it is most desirable to define the 4-bit representation of a character as the four least significant bits of its representation in the 7-bit code (in the same order).

Another way of regarding this is that the position a character occupies within the 4-bit set should ideally be the same as it occupies within its column in the 7-bit set. If this rule were followed faithfully, two characters having the same position within different columns of the 7-bit table (i.e. having the same least significant 4-bits) could not be included in the same 4-bit set.

For many applications this restriction is not overwhelming, though for others (for example, if "Space" is required) it can be. Accordingly, the best method of standardization is to set down some rules which are considered binding, together with recommendations which users are asked to obey if at all possible.

Requirements a) and c), above, lead to the following recommendation : because of their location in column 3 of the 7-bit table, if any or all of the characters : ; < = > ? are required they *must* occupy the same position in the 4-bit code as they do in the said column 3.

In some applications characters not included in the 7-bit code are required but the precise graphical representation is unimportant. To prevent unnecessarily arbitrary choices being made, users in this situation are urged to choose graphics from within the said column 3 of the 7-bit code. Thus "Bank Code Number" could be represented by "Colon". Since this meaning is different from the intrinsic meaning of "Colon" it must be agreed between sender and recipient.

It should be emphasized, however, that a graphic in the said column 3 cannot be used to represent another graphic in the 7-bit code. Thus if addition is required, the plus sign must be used, not semicolon.

Requirement b) is, of course, in conflict with c). If the latter were of no importance, one might frame the rule for allocating characters to positions 10 to 15 to be determined by their binary order within the 7-bit code. This would mean, however, that most of the non-numeric characters could occupy any of the six positions in the various 4-bit sets which would arise.

In order to try to provide some standardization for those applications which can submit to the concomitant restrictions, the rules are in fact a blend of those described in the previous paragraphs. Namely, to fill positions 10 to 15 users are encouraged to use the characters in column 3 of the table if possible. If this is not acceptable, they are recommended to use only one character from each row of the 7-bit table. Moreover, provisions are made for the foregoing recommendations to be followed in part, if not universally.

It is realized that there are many applications for which the resulting rules yield sets which for one reason or another could be improved upon. Nevertheless, it was felt that simple although rather arbitrary rules which were easily applied and which went part of the way to standardization were most desirable for the majority.

ANNEX B

EXAMPLES OF 4-BIT CHARACTER SETS

B.1 EXAMPLES OF ALLOCATING CHARACTERS

To demonstrate the method of allocating characters to positions 10 to 15 of a 4-bit set, the following two examples are given.

B.1.1 Example 1

Characters required are : Asterisk, Equals, Line Feed, Plus and Space.

Rule 5.1 All these characters are from the 7-bit code.

Rules 5.2 to 5.5

These allocate

* ——→ Position 10
\+ ——→ Position 11
= ——→ Position 13

Rule 5.6 The binary values of the remaining characters are :

Line Feed	0001010
Minus	0101101
Space	0100000

They therefore are allotted as follows :

Line Feed ——→ Position 12
Space ——→ Position 14
Minus ——→ Position 15

Rule 5.7 We may now choose to represent Line Feed by < but by no other graphic from the 7-bit code.

B.1.2 Example 2

Characters required are : Acknowledge, Cancel, Start of Data Block, End of Data Block, Line Feed, Space.

Rule 5.1 Characters from the 7-bit code are : Acknowledge, Cancel, Line Feed, Space.

Rules 5.2 to 5.5

These allocate Line Feed ——→ Position 10

Rule 5.6 Binary values of the remaining characters of the 7-bit code are :

Acknowledge	0000110
Cancel	0011000
Space	0100000

They are therefore allotted as follows :

Acknowledge ——→ Position 11
Cancel ——→ Position 12
Space ——→ Position 13

Rule 5.7 This permits us to allocate the following graphics to 7-bit code controls :

Line Feed	:
Acknowledge	;
Cancel	<

Rule 5.8 Start of Data Block and End of Data Block are allocated positions 14 and 15. They may be represented by > and ? respectively.

B.2 A FEW EXAMPLE 4-BIT SETS[1)]

Position Number	*Example 1*	*Example 2*	*Example 3*	*Example 4*	*Example 5 Forwards*	*Example 5 Backwards*	*Example 6*
0 – 9	0 – 9	0 – 9	0 – 9	0 – 9	0 – 9	0 – 9	0 – 9
10	:	*	NL	*	NL	NL	NL (:)
11	;	+	+	+	;	ENQ(;)	SP
12	<	,	SP	NL	SP	SP	Progr. Start (<)
13	=	–	–	=	–	–	Tape End (=)
14	>	.	.	SP	EOB (>)	EOB (>)	End of Block (>)
15	?	/	DEL	–	DESTROY	ERROR	DEL

These examples illustrate two things :

a) a character from the 7-bit code can occupy different positions in different 4-bit sets. Thus, the minus sign in examples 3 and 4 and "space" in examples 3, 4, 5 and 6 are differently placed. This is regrettable but unavoidable;

b) a graphic can be used to represent different things quite apart from its intrinsic meaning (e.g. < and > in examples 5 and 6).

1) Example 5 (Forwards and Backwards) was provided by the UIC; Example 6 may be applied to numerical control of machines.

ANNEX C

BASIC CODE TABLE

(reproduced from ISO 646)

b_7	0	0	0	0	1	1	1	1
b_6	0	0	1	1	0	0	1	1
b_5	0	1	0	1	0	1	0	1
b_4 b_3 b_2 b_1 \ column / row	0	1	2	3	4	5	6	7
0 0 0 0	0	NUL	TC_7 (DLE)	SP	0	③	P	` ④	p
0 0 0 1	1	TC_1 (SOH)	DC_1	!	1	A	Q	a	q
0 0 1 0	2	TC_2 (STX)	DC_2	" ⑥	2	B	R	b	r
0 0 1 1	3	TC_3 (ETX)	DC_3	£(#) ②	3	C	S	c	s
0 1 0 0	4	TC_4 (EOT)	DC_4	$(¤) ②	4	D	T	d	t
0 1 0 1	5	TC_5 (ENQ)	TC_8 (NAK)	%	5	E	U	e	u
0 1 1 0	6	TC_6 (ACK)	TC_9 (SYN)	&	6	F	V	f	v
0 1 1 1	7	BEL	TC_{10} (ETB)	' ⑥	7	G	W	g	w
1 0 0 0	8	FE_0 (BS)	CAN	(	8	H	X	h	x
1 0 0 1	9	FE_1 (HT)	EM	)	9	I	Y	i	y
1 0 1 0	10	FE_2 (LF) ①	SUB	*	:	J	Z	j	z
1 0 1 1	11	FE_3 (VT) ①	ESC	+	;	K	③	k	③
1 1 0 0	12	FE_4 (FF) ①	IS_4 (FS)	, ⑥	<	L	③	l	③
1 1 0 1	13	FE_5 (CR) ①	IS_3 (GS)	-	=	M	③	m	③
1 1 1 0	14	SO	IS_2 (RS)	.	>	N	^ ④⑤	n	- ④⑤
1 1 1 1	15	SI	IS_1 (US)	/	?	O	_	o	DEL