American National Standard

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code for information interchange

X3.4-1977

american national standards institute, inc.
1430 broadway, new york, new york 10018

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X3.4-1977
Revision of
X3.4-1968

American National Standard
Code for Information Interchange

Secretariat

Computer and Business Equipment Manufacturers Association

Approved June 9, 1977

American National Standards Institute, Inc

American National Standard

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Foreword

(This Foreword is not a part of the American National Standard Code for Information Interchange, X3.4-1977).

This American National Standard presents the standard coded character set to be used for information interchange among information processing systems, communications systems, and associated equipment.

Other standards prescribe the means of implementing this standard in media, such as perforated tape, punched cards, magnetic tape, magnetic tape cassettes and cartridges, and optical character recognition. Further standards deal with error control, data communication formats, keyboards, graphic representation of control characters, code extension techniques, and media labels and file structures.

The 7-bit coded character set was developed from a careful review of past work in the field and after a comprehensive program of original research and code design was completed. Careful consideration has been given to the several conflicting code set requirements, and their resolution is reflected in the standard code.

This standard is a revision of X3.4-1968, which was developed in parallel with its international counterpart, ISO 646-1973. This current revision retains the same technical relationship to ISO 646-1973 as the earlier edition. However, some definitions have been changed to adopt more customary U.S. terminology and to reduce ambiguity. Several previously permitted dualities for specific graphics have been eliminated, based on evolving practice in the United States. The relationship with the American National Standard Code Extension Techniques for Use with the 7-Bit Coded Character Set of American National Standard Code for Information Interchange, ANSI X3.41-1974, has also been included.

Suggestions for improvement of this standard will be welcome. They should be sent to the American National Standards Institute, 1430 Broadway, New York, N.Y. 10018.

This standard was processed and approved for submittal to ANSI by American National Standards Committee on Computers and Information Processing, X3. Committee approval of the standard does not necessarily mean that all committee members voted for its approval. At the time it approved this standard, the X3 Committee had the following members:

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Contents

American National Standard
Code for Information Interchange

1. Scope

This coded character set is to be used for the general interchange of information among information processing systems, communications systems, and associated equipment.

2. Standard Code

b7 b6 b5 / Bits					0 0 0	0 0 1	0 1 0	0 1 1	1 0 0	1 0 1	1 1 0	1 1 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	DLE	SP	0	@	P	`	p
0	0	0	1	1	SOH	DC1	!	1	A	Q	a	q
0	0	1	0	2	STX	DC2	"	2	B	R	b	r
0	0	1	1	3	ETX	DC3	#	3	C	S	c	s
0	1	0	0	4	EOT	DC4	$	4	D	T	d	t
0	1	0	1	5	ENQ	NAK	%	5	E	U	e	u
0	1	1	0	6	ACK	SYN	&	6	F	V	f	v
0	1	1	1	7	BEL	ETB	'	7	G	W	g	w
1	0	0	0	8	BS	CAN	(	8	H	X	h	x
1	0	0	1	9	HT	EM	)	9	I	Y	i	y
1	0	1	0	10	LF	SUB	*	:	J	Z	j	z
1	0	1	1	11	VT	ESC	+	;	K	[	k	{
1	1	0	0	12	FF	FS	,	<	L	\	l	|
1	1	0	1	13	CR	GS	-	=	M	]	m	}
1	1	1	0	14	SO	RS	.	>	N	^	n	~
1	1	1	1	15	SI	US	/	?	O	_	o	DEL

3. Character Representation and Code Identification

The standard 7-bit character representation, with b_7 the high-order bit and b_1 the low-order bit, is shown below:

Example: The bit representation for the character "K," positioned in column 4, row 11, is

b_7	b_6	b_5	b_4	b_3	b_2	b_1
1	0	0	1	0	1	1

The code table for the character "K" may also be represented by the notation "column 4, row 11" or alternatively as "4/11." The decimal equivalent of the binary number formed by bits b_7, b_6, and b_5, collectively, forms the column number, and the decimal equivalent of the binary number formed by bits b_4, b_3, b_2, and b_1, collectively, forms the row number.

The standard code may be identified by the use of of the notation ASCII.

The notation ASCII (pronounced 'as-ˌkey) should ordinarily be taken to mean the code prescribed by the latest edition of this standard. To explicitly designate a particular (perhaps prior) edition, the last two digits of the year of issue may be appended, as, "ASCII 68" or "ASCII 77."

4. Legend

4.1 Control Characters

Col/ Row	*Mnemonic and Meaning*[1]		*Col/ Row*	*Mnemonic and Meaning*[1]	
0/0	NUL	Null	1/0	DLE	Data Link Escape (CC)
0/1	SOH	Start of Heading (CC)	1/1	DC1	Device Control 1
0/2	STX	Start of Text (CC)	1/2	DC2	Device Control 2
0/3	ETX	End of Text (CC)	1/3	DC3	Device Control 3
0/4	EOT	End of Transmission (CC)	1/4	DC4	Device Control 4
0/5	ENQ	Enquiry (CC)	1/5	NAK	Negative Acknowledge (CC)
0/6	ACK	Acknowledge (CC)	1/6	SYN	Synchronous Idle (CC)
0/7	BEL	Bell	1/7	ETB	End of Transmission Block (CC)
0/8	BS	Backspace (FE)	1/8	CAN	Cancel
0/9	HT	Horizontal Tabulation (FE)	1/9	EM	End of Medium
0/10	LF	Line Feed (FE)	1/10	SUB	Substitute
0/11	VT	Vertical Tabulation (FE)	1/11	ESC	Escape
0/12	FF	Form Feed (FE)	1/12	FS	File Separator (IS)
0/13	CR	Carriage Return (FE)	1/13	GS	Group Separator (IS)
0/14	SO	Shift Out	1/14	RS	Record Separator (IS)
0/15	SI	Shift In	1/15	US	Unit Separator (IS)
			7/15	DEL	Delete

[1] (CC) Communication Control; (FE) Format Effector; (IS) Information Separator.

4.2 Graphic Characters

Column/Row	*Symbol*	*Name*
2/0	SP	Space (Normally Nonprinting)
2/1	!	Exclamation Point
2/2	"	Quotation Marks (Diaeresis)[2]
2/3	#	Number Sign[3]
2/4	$	Dollar Sign
2/5	%	Percent Sign
2/6	&	Ampersand
2/7	'	Apostrophe (Closing Single Quotation Mark; Acute Accent)[2]
2/8	(	Opening Parenthesis
2/9	)	Closing Parenthesis
2/10	*	Asterisk
2/11	+	Plus
2/12	,	Comma (Cedilla)[2]
2/13	-	Hyphen (Minus)
2/14	.	Period (Decimal Point)
2/15	/	Slant
3/0 to 3/9	0 . . . 9	Digits 0 through 9
3/10	:	Colon
3/11	;	Semicolon
3/12	<	Less Than
3/13	=	Equals
3/14	>	Greater Than
3/15	?	Question Mark
4/0	@	Commercial At[3]
4/1 to 5/10	A . . . Z	Uppercase Latin Letters A through Z
5/11	[	Opening Bracket[3]
5/12	\	Reverse Slant[3]
5/13	]	Closing Bracket[3]
5/14	^	Circumflex[3]
5/15	_	Underline
6/0	`	Opening Single Quotation Mark (Grave Accent)[2,3]
6/1 to 7/10	a . . . z	Lowercase Latin letters a through z
7/11	{	Opening Brace[3]
7/12	|	Vertical Line[3]
7/13	}	Closing Brace[3]
7/14	~	Tilde[2,3]

[2] The use of the symbols in 2/2, 2/7, 2/12, 5/14, 6/0, and 7/14 as diacritical marks is described in A5.2 of Appendix A.

[3] These characters should not be used in international interchange without determining that there is agreement between sender and recipient. (See Appendix B5.)

5. Definitions

5.1 General

Control Character. A character whose occurrence in a particular context initiates, modifies, or stops an action that affects the recording, processing, transmission, or interpretation of data.

Graphic Character. A character, other than a control character, that has a visual representation normally handwritten, printed, or displayed.

(CC) Communication Control. A control character intended to control or facilitate transmission of information over communication networks.

(FE) Format Effector. A control character that controls the layout or positioning of information in printing or display devices.

(IS) Information Separator. A control character that is used to separate and qualify information in a logical sense. There is a group of four such characters, which are to be used in a hierarchical order.

5.2 Control Characters

0/0 NUL (Null). A control character used to accomplish media fill or time fill. Null characters may be inserted into or removed from a stream of data without affecting the information content of that stream. However, the addition or removal of these characters may affect the information layout or the control of equipment.

0/1 SOH (Start of Heading). A communication control character used as the first character of a heading of an information message.

0/2 STX (Start of Text). A communication control character that precedes a text and is used to terminate a heading.

0/3 EXT (End of Text). A communication control character that terminates a text.

0/4 EOT (End of Transmission). A communication control character used to indicate the conclusion of a transmission, which may have contained one or more texts and any associated headings.

0/5 ENQ (Enquiry). A communication control character used in data communication systems as a request for a reponse from a remote station. It may be used as a "Who Are You" (WRU) to obtain identification, or may be used to obtain station status, or both.

0/6 ACK (Acknowledge). A communication control character transmitted by a receiver as an affirmative reponse to a sender.

0/7 BEL (Bell). A control character for use when there is a need to call for attention. It may control alarm or attention devices.

0/8 BS (Backspace). A one-active-position format effector that moves the position backward on the same line.

0/9 HT (Horizontal Tabulation). A format effector that advances the active position to the next predetermined character position on the same line.

0/10 LF (Line Feed). A format effector that advances the active position to the same character position on the next line. Where appropriate, this character may have the meaning "New Line" (NL), a format effector that advances the active position to the first character position on the next line. Use of the NL convention requires agreement between sender and recipient of data.

0/11 VT (Vertical Tabulation). A format effector that advances the active position to the same character position on the next predetermined line. When agreed upon between the interchange parties, VT may advance the active position to the first character position on the next predetermined line.

0/12 FF (Form Feed). A format effector that advances the active position to the same character position on a predetermined line of the next form or page. When agreed upon between the interchange parties, FF may advance the active position to the first character position on a predetermined line of the next form or page.

0/13 CR (Carriage Return (Return)). A format effector that moves the active position to the first character position on the same line.

0/14 SO (Shift Out). A control character that is used in conjunction with Shift In to extend the graphic character set. It may alter the meaning of the bit combinations of columns 2 to 7 that follow it until a Shift In character is reached. However, the characters Space (2/0) and Delete (7/15) are unaffected. The effect of this character is described in American National Standard Code Extension Techniques for Use with the 7-Bit Coded Character Set of American National Standard Code for Information Interchange, ANSI X3.41-1974.

0/15 SI (Shift In). A control character that is used in conjunction with Shift Out to extend the graphic set. It may reinstate the standard meanings of the bit combinations which follow it. The effect of this character is described in American National Standard X3.41-1974.

1/0 DLE (Data Link Escape). A communication control character that will change the meaning of a limited number of contiguously following characters. It is used exclusively to provide supplementary data transmission control functions. Appropriate sequences are defined in American National Standard Procedures for the Use of the Communication Control Characters of American National Standard Code for Information Interchange in Specified Data Communication Links, ANSI X3.28-1976.

1/1–1/4 DC1, DC2, DC3, DC4 (Device Controls). Control characters for the control of ancillary devices associated with data processing or telecommunication systems, more especially switching devices "on" or "off." (If a single "stop" control is required to interrupt or turn off ancillary devices, DC4 is the preferred assignment.)

1/5 NAK (Negative Acknowledge). A communication control character transmitted by a receiver as a negative response to the sender.

1/6 SYN (Synchronous Idle). A communication control character used by a synchronous transmission system in the absence of any other character to provide a signal from which synchronism may be achieved or retained.

1/7 ETB (End of Transmission Block). A communication control character used to indicate the end of a block of data for communication purposes. ETB is used for blocking data where the block structure is not necessarily related to the processing format.

1/8 CAN (Cancel). A control character used to indicate that the data with which it is sent are in error or are to be disregarded. The specific meaning of this character must be defined for each application.

1/9 EM (End of Medium). A control character that may be used to identify the physical end of a medium, the end of the used portion of a medium, or the end of the wanted portion of data recorded on a medium. The position of this character does not necessarily correspond to the physical end of the medium.

1/10 SUB (Substitute). A control character that may be substituted for a character that is determined to be invalid or in error.

1/11 ESC (Escape). A control character intended to provide supplementary characters (code extension). The Escape character itself is a prefix affecting the interpretation of a limited number of contiguous bit patterns. The effect of this character is described in American National Standard X3.41-1974.

1/12–1/15 FS (File Separator), GS (Group Separator), RS (Record Separator), and US (Unit Separator). These information separators may be used with data in optional fashion, except that their hierarchical relationship shall be: FS as the most inclusive, then GS, then RS, and US as least inclusive. (The content and length of a file, group, record, or unit are not specified.)

7/15 DEL (Delete). A character used primarily to erase or obliterate an erroneous or unwanted character in punched tape. DEL characters may also serve to accomplish media fill or time fill. They may be inserted into or removed from a stream of data without affecting the information content of that stream. However, the addition or removal of these characters may affect the information layout or the control of equipment, or both.

5.3 Graphic Characters

NOTE: No specific meaning is prescribed for any of the graphics in the code table except that which is understood by the users. Furthermore, this standard does not specify a type style for the printing or display of the various graphic characters. In specific applications it may be desirable to employ distinctive styling of individual graphics to facilitate their use for specific purposes.

2/10 SP (Space). A graphic character that is usually represented by a blank site in a series of graphics. The space character, though not a control character, has a function equivalent to that of a format effector that causes the active position to move one position forward without producing the printing or display of any graphic. Similarly, the space character may have a function equivalent to that of an information separator.

6. General Considerations

6.1 This standard does not define the means by which the coded set is to be recorded in any physical medium, nor does it include any redundancy or define techniques for error control. Further, this standard does not define data communication character structure, data communication formats, code extension techniques, or graphic representation of control characters.

6.2 Deviations from the standard may create serious difficulties in information interchange and should be used only with full cognizance of the parties involved.

6.3 The relative sequence of any two characters, when used as a basis for collation, is defined by their binary values. The Null character (position 0/0) will be ranked low and the Delete character (position 7/15) will be

ranked high. Other collating sequences may be used by prior agreement between interchanging parties.

6.4 The representation of this 7-bit code in an 8-bit environment is specified in American National Standard X3.41-1974.

6.5 The Appendixes to this standard contain additional information on the design and use of this code.

7. Related Standards

7.1 American National Standards

Perforated Tape Code for Information Interchange, ANSI X3.6-1965 (R1973)

Recorded Magnetic Tape for Information Interchange (200 CPI, NRZI), ANSI X3.14-1973

Bit Sequencing of the American National Standard Code for Information Interchange in Serial-by-Bit Data Transmission, ANSI X3.15-1976

Character Structure and Character Parity Sense for Serial-by-Bit Data Communication in the American National Standard Code for Information Interchange, ANSI X3.16-1976

Character Set and Print Quality for Optical Character Recognition (OCR-A), ANSI X3.17-1977

Recorded Magnetic Tape for Information Interchange (800 CPI, NRZI), ANSI 3.22-1973

Character Structure and Character Parity Sense for Parallel-by-Bit Communication in the American National Standard Code for Information Interchange, ANSI X3.25-1976

Hollerith Punched Card Code, ANSI X3.26-1970

Magnetic Tape Labels and File Structure for Information Interchange, ANSI X3.27-1977

Procedures for the Use of the Communication Control Characters of American National Standard Code for Information Interchange in Specified Data Communication Links, ANSI X3.28-1976

Graphic Representation of the Control Characters of American National Standard Code for Information Interchange, ANSI X3.32-1973

Recorded Magnetic Tape for Information Interchange (1600 CPI, PE), ANSI X3.39-1973

Code Extension Techniques for Use with the 7-Bit Coded Character Set of American National Standard Code for Information Interchange, ANSI X3.41-1974

Specifications for Character Set for Handprinting, ANSI X3.45-1974

Magnetic Tape Cassettes for Information Interchange (3.810-mm [0.015-in] Tape at 32 bpmm [800 bpi], PE), ANSI X3.48-1977

Character Set for Optical Character Recognition (OCR-B), ANSI X3.49-1975

Recorded Magnetic Tape for Information Interchange (6250 CPI, Group-Coded Recording), ANSI X3.54-1976

Recorded Magnetic Tape Cartridge for Information Interchange (4 Track, 0.250 in [6.30 mm], 1600 bpi [63 bpmm], PE), ANSI X3.56-1977

Structure for Formulating Message Headings for Information Interchange Using the American National Standard Code for Information Interchange for Data Communication System Control, ANSI X3.57-1977

Alphanumeric Keyboard Arrangements Accommodating the Character Sets of American National Standard Code for Information Interchange and American National Standard Character Set for Optical Character Recognition, ANSI X4.14-1971

7.2 International Standards[4]

7- Bit Coded Character Set for Information Processing Interchange, ISO 646-1973

Information Processing – Basic Mode Control Procedures for Data Communication Systems, ISO 1745-1975

Code Extension Techniques for Use with the ISO 7-Bit Coded Character Set, ISO 2022-1973

[4] Publications of the International Organization for Standardization are available from the American National Standards Institute, 1430 Broadway, New York, N.Y. 10018.

Appendixes

(These Appendixes are not a part of American National Standard Code for Information Interchange, X3.4-1977, but are included for information purposes only.)

Appendix A
Design Considerations for the Coded Character Set

A1. Introduction

The standard coded character set is intended for the interchange of information among information processing systems, communication systems, and associated equipment.

A2. Considerations Affecting the Code

There were many considerations that determined the set size, set structure, character selection, and character placement of the code. Among these were (not listed in order of priority):

(1) Need for adequate number of graphic symbols
(2) Need for adequate number of device controls, format effectors, communication controls, and information separators
(3) Desire for a nonambiguous code, that is, one in which every code combination has a unique interpretation
(4) Physical requirements of media and facilities
(5) Error control considerations
(6) Special interpretation of the all-zeros and all-ones characters
(7) Ease in the identification of classes of characters
(8) Data manipulation requirements
(9) Collating conventions
  (a) Logical
  (b) Historical
(10) Keyboard conventions
  (a) Logical
  (b) Historical
(11) Other set sizes
(12) International considerations
(13) Programming Languages
(14) Existing coded character sets

A3. Set Size

A 7-bit set is the minimum size that will meet the requirements for graphics and controls in applications involving general information interchange.

A4. Set Structure

A4.1 In discussing the set structure it is convenient to divide the set into eight columns and sixteen rows as indicated in this standard.

A4.2 It was considered essential to have a dense subset that contained only graphics. For ease of identification this graphic subset was placed in six contiguous columns.

A4.3 The first two columns were chosen for the controls for the following reasons:

(1) The character NUL by its definition has the location 0/0 in the code table. NUL is broadly considered a control character.

(2) The representations in column 7 were felt to be most susceptible to simulation by a particular class of transmission error – one that occurs during an idle condition on asynchronous systems.

(3) To permit the considerations of graphic subset structure described in Section A6 to be satisfied, the two columns of controls had to be adjacent.

A4.4 The character set was structured to enable the easy identification of classes of graphics and controls.

A5. Choice of Graphics

A5.1 Included in the set are the digits 0 through 9, uppercase and lowercase Latin letters A through Z, and those punctuation, mathematical, and business symbols considered most useful. The set includes a number of characters commonly encountered in programming languages. In particular, all the COBOL and FORTRAN graphics are included.

A5.2 In order to permit the representation of languages other than English, two diacritical (or accent) marks have been included, and provision has been made for the use of four punctuation symbols alterna-

Table A1
Punctuation and Diacritical Marks

Col/ Row	Code Table Symbol	Use	
		Puncutation	Diacritical
2/2	"	Quotation marks	Diaeresis
2/7	'	Apostrophe	Acute accent
2/12	,	Comma	Cedilla
5/14	^	(None)	Circumflex
6/0	`	Opening single quotation mark	Grave accent
7/14	~	(None)	Tilde

tively as diacritical marks in conjunction with backspace. The pairing of these punctuation symbols with their corresponding diacritical marks was done to facilitate the design of a typeface that would be acceptable for both uses.

These arrangements are given in Table A1.

A6. Graphic Subset Structure

A6.1 The basic structure of the dense graphic subset was influenced by logical collating considerations, the requirements of simply related 6-bit sets, and the needs of typewriter-like devices. For information processing it is desirable that the characters be arranged in such a way as to minimize both the operating time and the hardware components required for ordering and sequencing operations. This requires that the relative order of characters, within classes, be such that a simple comparison of the binary codes will result in information being ordered in a desired sequence.

A6.2 Conventional usage requires that SP (Space) be ahead of any other symbol in a collatable set. This permits a name such as "JOHNS" to collate ahead of a name such as "JOHNSON." The requirement that punctuation symbols such as *comma* also collate ahead of the alphabet ("JOHNS, A" should also collate before "JOHNSON") establishes the special symbol locations, including SP, in the first column of the graphic subset.

A6.3 To simplify the design of typewriter-like devices, it is desirable there be only a common 1-bit difference between characters to be paired on keytops. This, together with the requirements for a contiguous alphabet and the collating requirements outlined above, resulted in the placement of the alphabet in the last four columns of the graphic subset and the placement of the digits in the second column of the graphic subset.

A6.4 It is expected that devices having the capability of printing only 64 graphic symbols will continue to be important. It may be desirable to arrange these devices to print one symbol for the bit pattern of both uppercase and lowercase of a given alphabetic letter. To facilitate this, there should be a single-bit difference between the uppercase and lowercase representations of any given letter. Combined with the requirement that a given case of the alphabet be contiguous, this dictated the assignment of the alphabet, as shown in columns 4 through 7.

A6.5 To minimize ambiguity caused by the use of a 64-graphic device as described above, it is desirable, to the degree possible, that each character in column 6 or 7 differ little in significance from the corresponding character in column 4 or 5. In certain cases this was not possible.

A6.6 The assignment of *reverse slant* and *vertical line*, the *brackets* and *braces*, and the *circumflex* and *tilde* were made with a view to the considerations of A6.5.

A6.7 The resultant structure of "specials" (S), "digits" (D), and "alphabetics" (A) does not conform to the most prevalent collating convention (S-A-D) because of other code requirements.

A6.8 The need for a simple transformation from the set sequence to the prevalent collating convention was recognized, and it dictated the placement of some of the "specials" within the set. Specifically, those special symbols, namely, *ampersand* (&), *asterisk* (*), *comma* (,), *hyphen* (-), *period* (.), and *slant* (/), that are most often used as identifiers for ordering information and normally collate ahead of both the alphabet and the digits were not placed in the column containing the digits. Thus the entire numeric column could be rotated via a relatively simple transformation to a position higher than the alphabet. The sequence of the aforementioned "specials" were also established to the extent practical to conform to the prevalent collating convention.

A6.9 The need for a useful 4-bit numeric subset also played a role in the placement of characters. Such a 4-bit subset, including the digits and the symbols *asterisk*, *plus* (+), *comma*, *hyphen*, *period*, and *slant*, can easily be derived from the code.

A6.10 Considerations of other domestic code sets, including the Department of Defense former standard 8-bit data transmission code ("Fieldata"-1961), as well as international requirements, played an important role in deliberations that resulted in the code. The selection

and grouping of the symbols *dollar sign* ($), *percent sign* (%), *ampersand* (&), *apostrophe* ('), *Less than* (<), *equals* (=), and *greater than* (>) facilitate contraction to either a business or scientific 6-bit subset. The position of these symbols, and of the symbols *comma, hyphen, period,* and *slant,* facilitates achievement of commonly accepted pairing on a keyboard. The historic pairing of question mark and slant is preserved and the *less than* and *greater than* symbols, which have comparatively low usage, are paired with period and comma, so that in dual-case keyboard devices where it is desired to have period and comma in both cases, the *less than* and *greater than* symbols are the ones displaced. Provision was made for the accommodation of alphabets containing more than 26 letters and for 6-bit contraction by the location of low-usage characters in the area following the alphabet.

A7. Control Subset Content and Structure

A7.1 The control characters included in the set are those required for the control of terminal devices, input and output devices, format, or communication transmission and switching, and are general enough to justify inclusion in a standard set.

A7.2 Many control characters may be considered to fall into the following categories:

(1) Communication Controls
(2) Format Effectors
(3) Device Controls
(4) Information Separators

To the extent that was practical, controls of each category were grouped in the code table.

A7.3 The information separators (FS, GS, RS, US) identify boundaries of various elements of information, but differ from punctuation in that they are primarily intended to be machine sensible. They were arranged in accordance with an expected hierarchical use, and the lower end of the hierarchy is contiguous in binary order with SP (Space), which is sometimes used as a machine-sensible separator. Subject to this hierarchy, the exact nature of their use within data is not specified.

A7.4 The character SYN (Synchronous Idle) was located so that its binary pattern in serial transmission was unambiguous as to character framing, and also to optimize certain other aspects of its communication usage.

A7.5 ACK (Acknowledge) and NAK (Negative Acknowledge) were located so as to gain the maximum practical protection against mutation of one into the other by transmission errors.

A7.6 The function "New Line" (NL) was associated with LF (rather than with CR or with a separate character) to provide the most useful combinations of functions through the use of only two character positions, and to allow the use of a common end of line format for printers having separate CR-LF functions as well as for printers having a combined (that is, NL) function. This sequence would be CR-LF, producing the same result on printers of both classes, and would be useful during conversion of a system from one method of operation to the other.

A7.7 This standard is enhanced by the inclusion of the option "New Line" which conforms to traditional electric typewriter practice. Data processing keyboard implementors are cautioned of a potential confusion between the use of the terms "Return" and "New Line." The large key on the right side of keyboards has often been marked "Return," although it sometimes accomplishes a "New Line" function, rather than a "Return" function (which according to this standard only has a horizontal motion).

A7.8 The function "Vertical Tabulation" (VT) and "Form Feed" (FF) are defined to advance the active position to the same character position of the subsequent line similarly to "Line Feed." By agreement, these functions may also return the active position to the first character position on the subsequent line. The practice of preceding either of these characters with "CR" may be useful during conversion, as with "LF."

A8. Collating Sequence

This supplements the consideration of collating sequence in Section A6.

It is recognized that the collating sequence defined in 6.3 of this standard cannot be used in many specific applications that define their own sequence. In some applications, groups of characters may be assigned exactly equal collating weight to preserve an initial ordering. In other applications a different sequence may be desired to meet the needs of the particular application. Nonetheless, it was deemed essential to define a standard sequence and standard results for comparisons of two items of data, to serve the needs of many applications.

The standard sequence will facilitiate, but will not provide directly by means of simple sorting, the ordering of items customarily found in (1) algebraically

signed data, in which the largest positive value is high and the largest negative value is low, and (2) complex alphabetic listings, such as those found in telephone directories, library catalogs, or dictionaries. However, general use of these standard collating sequences and standard comparison evaluations will facilitate the transfer of programs and the general interchange of data among various computer systems.

Appendix B
Notes on Application

B1. Introduction

B1.1 The standard code was developed to provide for information interchange among information processing systems, communications systems, and associated equipment. In a system consisting of equipment with several local or native codes, maximum flexibility will be achieved if each of the native codes is translated to the standard code whenever information interchange is desired.

B1.2 Within any particular equipment, system, or community of activity, it may be necessary to substitute characters. For example, some systems may require special graphic symbols, and some devices may require special control codes. (Design efforts on the standard code included consideration of these types of adaptations.) So-called "secular sets" produced by such substitutions, though not conforming to this standard, may nonetheless be consonant with it if substitutions are made in accordance with the guidelines of Section B2.

B1.3 In recognition of these requirements for control and graphic characters, additional national and international standardization efforts beyond those provided in this standard are in progress to extend the 7-bit code. The techniques for this extension are provided by International Standard ISO 2022-1973, Code Extension Techniques for Use with the ISO 7-Bit Coded Character Set, and by American National Standard X3.41-1974. Standards for additional graphic character sets and for control character sets for displays and enhanced printing devices are currently under development.

B2. Character Substitutions

B2.1 Any character substitution will result in a coded character set that does not conform to this standard.

B2.2 It is recommended that when a character is substituted in the code table for a standard character, the standard character should not be reassigned elsewhere in the table. Such a substitute character, once assigned, should not be subsequently reassigned elsewhere.

B2.3 It is recommended that graphic substitutions be made only in the graphic area and control substitutions only in the control area. Any substitution involving a control should be made only with full cognizance of all possible operational effects.

B2.4 It should be noted that this standard specifies, for each position of the code table, the information represented by the character and not necessarily the precise action taken by the recipient when the character is received. In the case of graphics, considerable variation in the actual shape printed or displayed may be appropriate to different units, systems, or fields of application. In the case of controls, the action performed is dependent upon the use for which the particular system is intended, the application to which it is being put, and a number of conventions established by the user or designer – some system-wide and some unique to a particular unit.

B2.5 Typical examples of diversity in execution not necessarily contrary to this standard are:

(1) A number of graphic symbols, other than those used in the code table, are used for *ampersand* in various type styles; still other symbols may be more appropriate to electronic display devices. The use of such alternate symbols does not in itself constitute deviation from the standard as long as *ampersand* is the concept associated with the character. Note that this does not necessarily restrict the use of such an alternate symbol design to mean "*and*"; in any type style *ampersand* may, of course, be used with arbitrary meaning.

(2) A card punch in one application may "skip" when the character HT (Horizontal Tabulation: used as skip) is presented to it; in another application the character HT may be recorded in the card without further action.

B3. Interoperation of "LF" and "NL" ASCII Equipment

Several bit pattern sequences in ASCII will cause a device receiving these sequences to move its active position to the first (leftmost) column and also move the active position down one row. Some of these sequences are:

Using "Line Feed" convention:
CR LF
CR CR LF
CR CR LF DEL

Using "New Line" option:
NL
CR NL
CR CR NL
CR CR NL DEL

where DEL (Delete) is merely a "time waster" to accommodate mechanical devices. The functions involving only horizontal motion are shown preceding those involving vertical motion for the reason that mechanical devices may require more time to accomplish the horizontal motion.

Interoperation of equipment conforming to the ASCII control conventions of CR (Carriage Return) and LF (Line Feed) with equipment conforming to the optional control NL (New Line) in position 0/10 can be assured if the operational sequences CR NL or CR CR NL or CR NL DEL or CR CR NL DEL are always used to move the active position to the first position of the next line. The sequence CR NL sent from an "option" device will be received by a "conventional" device as CR LF, and the reaction will be the desired one. Likewise, the sequence CR LF sent from a "conventional" device will be received as CR NL on an "option" device, and reaction will be as desired.

B4. Related Larger and Smaller Sets

Consideration has been given to the relationship between the standard set and sets of other sizes. A number of straightforward logical transformations are possible, which result in a variety of sets related to the standard. None of the transformed sets is recognized by this standard, except through the related standards concerning code extension.

B5. International Considerations

B5.1 General. This standard conforms to the recommendations of the International Organization for Standardization (ISO), and the International Telegraph and Telephone Consultative Committee (CCITT)[5] for a 7-bit code. It includes all the character assignments specified by those bodies for international standardization. Their recommendations, however, permit national standardization by the various countries in seven code table positions. Also, the characters in three additional positions have been designed as "supplementary" use positions, which are replaceable by national characters in only those countries having an extraordinary requirement in this regard.

The ten National Use positions and their assignments in this standard are as follows:

Column/Row	*Character (U.S.)*
National use:	
4/0	@
5/11	[
5/12	\
5/13	]
7/11	{
7/12	|
7/13	}
Supplementary national use:	
5/14	^
6/0	`
7/14	~

[5] An international body that establishes standards and conventions for international telecommunications, especially where the public telegraph and telephone services are governmentally owned and operated. Their recommendations are often embodied in the regulations applying to such services.

In international interchange of information these ten characters should not be used except where it is determined that there is agreement between sender and recipient. In such an interchange, where accented letters are to be formed via combinations of graphics and backspace, users are cautioned that other standards prescribe the syntax of such constructs rigidly.

In addition, in other countries, the number sign (#) (in position 2/3) may be replaced by "£", and the dollar sign ($) (in position 2/4) may be replaced by the currency symbol (¤).

B5.2 International Reference Version. The related standard, ISO 646-1973, describes an "International Reference Version" (IRV). The IRV is the default case of ISO 646-1973 in the lack of need of a defined national version. The CCITT permits international interchange using the IRV.

The graphic characters of this standard (ASCII) are consistent with the IRV with the exception of the following two positions:

Column/Row	*Character (U.S.)*	*Character (IRV)*
2/4	$	(currency sign)
7/14	~	(overline)

B5.3 International Terminology Differences. Where practical, this standard has adopted terminology in use in the English version of associated international standards. Variations from this are due to the demands of common American usage and the desire for consistency with prior versions of this standard.

B6. Communication Considerations

Certain control characters are designated as "Communication Controls." They are:

SOH (Start of Heading)
STX (Start of Text)
ETX (End of Text)
EOT (End of Transmission)
ENQ (Enquiry)
ACK (Acknowledge)
DLE (Data Link Escape)
NAK (Negative Acknowledge)
SYN (Synchronous Idle)
ETB (End of Transmission Block)

These may be used by communication systems for their internal signaling or for the exchange of information relating to the control of the communication system between that system and its end terminals. Some such systems may impose restrictions on the use of these communication control characters by the end terminals. For example, the use of some of them may be completely prohibited; others may be restricted to use in conformity with the formats and procedures required by the communication system for its operation.

Appendix C
Original Criteria

C1. Introduction

C1.1 This Appendix contains the original criteria upon which the design of the code was based. Not all criteria have been entirely satisfied. Some are conflicting, and the characteristics of the set represent accepted compromises of these divergent criteria.

C1.2 The criteria were drawn from communication, processing, and media recording aspects of information interchange.

C2. Criteria

C2.1 Every character of the code set shall be represented by the same number of bits.

C2.2 The standard set shall be so structured as to facilitate derivation of logically related larger or smaller sets.

C2.3 In a code of n bits, all possible 2^n patterns of ones and zeros will be permitted and considered valid.

C2.4 The number of bits, n, shall be sufficient to provide for the alphabetic and numeric characters, commonly used punctuation marks, and other special symbols, along with those control characters required for interchange of information.

C2.5 The digits 0 through 9 shall be included within a 4-bit subset.

C2.6 The digits 0 through 9 shall be so represented that the four low-order bits shall be the binary-coded-decimal form of the particular digit that the code represents.

C2.7 The interspersion of control characters among the graphic characters shall be avoided. The characters devoted to controls shall be easily separable from those devoted to graphics.

C2.8 Within the standard set, each character shall stand by itself and not depend on surrounding characters for interpretation.

C2.9 An entire case of the Latin alphabet (A through Z) shall be included within a 5-bit subset. Consideration shall be given to the need for more than 26 characters in some alphabets.

C2.10 The letters of each case of the alphabet shall be assigned, in conventional order (A through Z), to successive, increasing binary representations.

C2.11 Suitable control characters required for communication and information processing shall be included.

C2.12 Escape functions that provide for departures from the standard set shall be incorporated.

C2.13 A simple binary comparison shall be sufficient to determine the order within each class of characters. (In this regard, the special graphics, the digits, and the alphabet are each defined as distinct classes.) Simple binary rules do not necessarily apply between classes when ordering information.

C2.14 Space must collate ahead of all other graphics.

C2.15 Special symbols used in the ordering of information must collate ahead of both the alphabet and the digits.

C2.16 Insofar as possible, the special symbols shall be grouped according to their functions; for example, punctuation and mathematical symbols. Further, the set shall be so organized that the simplest possible test shall be adequate to distinguish and identify the basic alphabetic, numeric, and special symbol subsets.

C2.17 Special symbols shall be placed in the set so as to simplify their generation by typewriters and similar keyboard devices. This criterion means, in effect, that the codes for pairs of characters that normally appear on the same keytops on a typewriter shall differ only in a common single-bit position.

C2.18 The set shall contain the graphic characters of the principal programming languages.

C2.19 The codes for all control characters shall contain a common, easily recognizable bit pattern.

C2.20 The Null (0000000) and Delete (1111111) characters shall be provided.

Appendix D
Revision Criteria and Guidelines

D1. Introduction

D1.1 This Appendix has been added to assist users of the standard. The criteria used in coming to a given revision are briefly stated in this Appendix. Also included are guidelines now in use as well as recommended guidelines for successive revisions (at the mandatory 5-year intervals).

D1.2 The criteria listed here have been adopted from many sources. Primarily they have come from users of the 1968 edition of this standard or from suggestions by others involved in international standards.

D2. The 1977 Revision

D2.1 General. The 1968 edition was reviewed and revised to bring terminology into more consistent U.S. practice.

D2.2 Graphics. The primary considerations in revision of the graphics area of the standard were:

(1) Elimination of formerly recognized dualities (positions 2/1, 5/14). These allowed stylization of these characters to reflect their possible usage as logical OR and NOT, respectively. Evolving practice has shown these to be unnecessary.

(2) Elimination of a formerly recognized duality (position 2/3), which allowed substitution of the "Pound Sterling" symbol. Evolving practice has shown this to be unnecessary.

(3) Clarification of conflict between graphic shape and description (position 7/12).

D2.3 Controls. The primary considerations in revision of the controls area of the standard were:

(1) To adopt definitions consistent with associated standards (positions 0/14, 0/15, and 1/11).

(2) To make no change of substance to the communications controls without the explicit request of the group responsible for data communication procedures.

(3) To accommodate the definitions of the controls of ISO 646-1973 wherever domestic conflicts did not exist.

(4) To clarify definitions where use application had given indications of need for clarification.

(5) To recognize evolving practice aimed at providing an "optional implicit CR" function with all three vertical movement Format Effectors (positions 0/10, 0/11, 0/12).

D3. Succeeding Revisions

D3.1 General. A review will be made for domestic and international consistency of use.

D3.2 Controls. A study will be made in the following areas:

(1) Communications Controls
(2) Information Separators
(3) Format Effectors
(4) Device Controls

Each group will be evaluated from the viewpoint of current usage, suitability of the definitions, possible improvement of definitions, potential replacement by more desirable functions, or any combinations thereof.

D3.3 Graphics. A study will be made concerning the following positions:

(1) 5/12
(2) 5/14
(3) 6/0
(4) 7/14

If characters of more frequent usage emerge in U.S. practice, these positions will be evaluated for potential replacement. This is entirely consistent with the cautions described in Appendix B, wherein the national use considerations were introduced.

Appendix E
Terminology

This Appendix is intended to clarify the sense in which certain terms are used.

Active Position. That character position in which the character about to be processed would appear. The active position normally advances one character position at a time.

Bit. Contraction of "binary digit."

Bit Pattern. The binary representation of a character.

Character. A member of a coded character set; the binary representation of such a member and its graphic symbol or control function.

Code. A system of discrete representations of a set of symbols and functions.

X3.115-1984 Unformatted 80 Megabyte Trident Pack for Use at 370 tpi and 6000 bpi (General, Physical, and Magnetic Characteristics)

X3.117-1984 Printable/Image Areas for Text and Facsimile Communication Equipment

X3.118-1984 Financial Services – Personal Identification Number – PIN Pad

X3.119-1984 Contact Start/Stop Storage Disk, 158361 Flux Transitions per Track, 8.268 Inch (210 mm) Outer Diameter and 3.937 inch (100 mm) Inner Diameter

X3.120-1984 Contact Start/Stop Storage Disk

X3.121-1985 Two-Sided, Double-Density, Unformatted 5.25-inch (130-mm), 48-tpi (1,9-tpmm), Flexible Disk Cartridge for 7958 bpr Use

X11.1-1977 Programming Language MUMPS

IEEE 416-1978 Abbreviated Test Language for All Systems (ATLAS)

IEEE 716-1982 Standard C/ATLAS Language

IEEE 717-1982 Standard C/ATLAS Syntax

IEEE 770X3.97-1983 Programming Language PASCAL

IEEE 771-1980 Guide to the Use of ATLAS

MIL-STD-1815A-1983 Reference Manual for the Ada Programming Language

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X3/TRI-82 Dictionary for Information Processing Systems (Technical Report)

American National Standards for Information Processing

X3.1-1976 Synchronous Signaling Rates for Data Transmission
X3.2-1970 Print Specifications for Magnetic Ink Character Recognition
X3.4-1977 Code for Information Interchange
X3.5-1970 Flowchart Symbols and Their Usage
X3.6-1965 Perforated Tape Code
X3.9-1978 Programming Language FORTRAN
X3.11-1969 General Purpose Paper Cards
X3.14-1983 Recorded Magnetic Tape (200 CPI, NRZI)
X3.15-1976 Bit Sequencing of the American National Standard Code for Information Interchange in Serial-by-Bit Data Transmission
X3.16-1976 Character Structure and Character Parity Sense for Serial-by-Bit Data Communication in the American National Standard Code for Information Interchange
X3.17-1981 Character Set for Optical Character Recognition (OCR-A)
X3.18-1974 One-Inch Perforated Paper Tape
X3.19-1974 Eleven-Sixteenths-Inch Perforated Paper Tape
X3.20-1967 Take-Up Reels for One-Inch Perforated Tape
X3.21-1967 Rectangular Holes in Twelve-Row Punched Cards
X3.22-1983 Recorded Magnetic Tape (800 CPI, NRZI)
X3.23-1974 Programming Language COBOL
X3.25-1976 Character Structure and Character Parity Sense for Parallel-by-Bit Data Communication in the American National Standard Code for Information Interchange
X3.26-1980 Hollerith Punched Card Code
X3.27-1978 Magnetic Tape Labels and File Structure
X3.28-1976 Procedures for the Use of the Communication Control Characters of American National Standard Code for Information Interchange in Specified Data Communication Links
X3.29-1971 Specifications for Properties of Unpunched Oiled Paper Perforator Tape
X3.30-1971 Representation for Calendar Date and Ordinal Date
X3.31-1973 Structure for the Identification of the Counties of the United States
X3.32-1973 Graphic Representation of the Control Characters of American National Standard Code for Information Interchange
X3.34-1972 Interchange Rolls of Perforated Tape
X3.36-1975 Synchronous High-Speed Data Signaling Rates between Data Terminal Equipment and Data Communication Equipment
X3.37-1980 Programming Language APT
X3.38-1972 Identification of States of the United States (Including the District of Columbia)
X3.39-1973 Recorded Magnetic Tape (1600 CPI, PE)
X3.40-1983 Unrecorded Magnetic Tape (9-Track 800 CPI, NRZI; 1600 CPI, PE; and 6250 CPI, GCR)
X3.41-1974 Code Extension Techniques for Use with the 7-Bit Coded Character Set of American National Standard Code for Information Interchange
X3.42-1975 Representation of Numeric Values in Character Strings
X3.43-1977 Representations of Local Time of the Day
X3.44-1974 Determination of the Performance of Data Communication Systems
X3.45-1982 Character Set for Handprinting
X3.46-1974 Unrecorded Magnetic Six-Disk Pack (General, Physical, and Magnetic Characteristics)
X3.47-1977 Structure for the Identification of Named Populated Places and Related Entities of the States of the United States for Information Interchange
X3.48-1977 Magnetic Tape Cassettes (3.810-mm [0.150-Inch] Tape at 32 bpmm [800 bpi], PE)
X3.49-1975 Character Set for Optical Character Recognition (OCR-B)
X3.50-1976 Representations for U.S. Customary, SI, and Other Units to Be Used in Systems with Limited Character Sets
X3.51-1975 Representations of Universal Time, Local Time Differentials, and United States Time Zone References
X3.52-1976 Unrecorded Single-Disk Cartridge (Front Loading, 2200 BPI) (General, Physical, and Magnetic Requirements)
X3.53-1976 Programming Language PL/I
X3.54-1976 Recorded Magnetic Tape (6250 CPI, Group Coded Recording)
X3.55-1982 Unrecorded Magnetic Tape Cartridge, 0.250 Inch (6.30 mm), 1600 bpi (63 bpmm), Phase encoded
X3.56-1977 Recorded Magnetic Tape Cartridge, 4 Track, 0.250 Inch (6.30 mm), 1600 bpi (63 bpmm), Phase Encoded
X3.57-1977 Structure for Formatting Message Headings Using the American National Standard Code for Information Interchange for Data Communication Systems Control
X3.58-1977 Unrecorded Eleven-Disk Pack (General, Physical, and Magnetic Requirements)
X3.59-1981 Magnetic Tape Cassettes, Dual Track Complementary Return-to-Bias (CRB) Four-States Recording on 3.81-mm (0.150-Inch) Tape
X3.60-1978 Programming Language Minimal BASIC
X3.61-1978 Representation of Geographic Point Locations
X3.62-1979 Paper Used in Optical Character Recognition (OCR) Systems
X3.63-1981 Unrecorded Twelve-Disk Pack (100 Megabytes) (General, Physical, and Magnetic Requirements)
X3.64-1979 Additional Controls for Use with American National Standard Code for Information Interchange
X3.66-1979 Advanced Data Communication Control Procedures (ADCCP)
X3.72-1981 Parallel Recorded Magnetic Tape Cartridge, 4 Track, 0.250 Inch (6.30 mm), 1600 bpi (63 bpmm), Phase Encoded
X3.73-1980 Single-Sided Unformatted Flexible Disk Cartridge (for 6631-BPR Use)
X3.74-1981 Programming Language PL/I, General-Purpose Subset
X3.76-1981 Unformatted Single-Disk Cartridge (Top Loading, 200 tpi 4400 bpi) (General, Physical, and Magnetic Requirements)
X3.77-1980 Representation of Pocket Select Characters
X3.78-1981 Representation of Vertical Carriage Positioning Characters in Information Interchange
X3.79-1981 Determination of Performance of Data Communications Systems That Use Bit-Oriented Communication Procedures
X3.80-1981 Interfaces between Flexible Disk Cartridge Drives and Their Host Controllers
X3.82-1980 One-Sided Single-Density Unformatted 5.25-Inch Flexible Disk Cartridge (for 3979-BPR Use)
X3.83-1980 ANSI Sponsorship Procedures for ISO Registration According to ISO 2375
X3.84-1981 Unformatted Twelve-Disk Pack (200 Megabytes) (General, Physical, and Magnetic Requirements)
X3.85-1981 1/2-Inch Magnetic Tape Interchange Using a Self Loading Cartridge
X3.86-1980 Optical Character Recognition (OCR) Inks
X3.88-1981 Computer Program Abstracts
X3.89-1981 Unrecorded Single-Disk, Double-Density Cartridge (Front Loading, 2200 bpi, 200 tpi) (General, Physical, and Magnetic Requirements)
X3.91M-1982 Storage Module Interfaces
X3.92-1981 Data Encryption Algorithm
X3.93M-1981 OCR Character Positioning
X3.95-1982 Microprocessors — Hexadecimal Input/Output, Using 5-Bit and 7-Bit Teleprinters
X3.96-1983 Continuous Business Forms (Single-Part)
X3.98-1983 Text Information Interchange in Page Image Format (PIF)
X3.99-1983 Print Quality Guideline for Optical Character Recognition (OCR)
X3.100-1983 Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment for Packet Mode Operation with Packet Switched Data Communications Network
X3.101-1984 Interfaces Between Rigid Disk Drive(s) and Host(s)
X3.102-1983 Data Communication Systems and Services — User-Oriented Performance Parameters
X3.103-1983 Unrecorded Magnetic Tape Minicassette for Information Interchange, Coplanar 3.81 mm (0.150 in)
X3.104-1983 Recorded Magnetic Tape Minicassette for Information Interchange, Coplanar 3.81 mm (0.150 in), Phase Encoded
X3.105-1983 Data Link Encryption
X3.106-1983 Modes of Operation for the Data Encryption Algorithm
X3.110-1983 Videotex/Teletext Presentation Level Protocol Syntax
X3.112-1984 14-in (356-mm) Diameter Low-Surface-Friction Magnetic Storage Disk
X3.114-1984 Alphanumeric Machines; Coded Character Sets for Keyboard Arrangements in ANSI X4.23-1982 and X4.22-1983

(continued on reverse)