

Character Encodings

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Encoding to Represent Characters

- An encoding is needed to represent the displayed/printed/stored value of characters
 - Either in char variables or in strings

History – Morse Code

- Initially used for telegraph communication
- Introduced in the 1840's
- Series of either short or long signals to represent the Latin alphabet, the Arabic numerals, and some special characters
 - Variable length
- Written representation
 - Short signal written as •
 - Long signal written as –
- Examples
 - A is represented by • –
 - B by – • • •
 - 1 by • – – –
 - ? by • • – – • •

History – Baudot Code

- Initially a cipher to encrypt messages
- Introduced in 1870
- Fixed-length five bit code
 - Gray code order of vowels (A, È, E, I, O, U, Y) followed by consonants followed by t, *, and three unused codes
- Later, a shift code was added and codes were modified to be the International Telegraph Alphabet No. 2 (ITA2)
 - Characters in both LTRS and FIGS modes – Control characters
 - Either symmetric or used in pairs (CR/LF)
 - NUL – 00000
 - FIGS – 11011
 - LTRS – 11111
 - CR – 01000
 - LF – 00010
 - SP – 00100
- Paper tape representation
 - LTRS could be overpunched as a delete (DEL)

History – ASCII Code

- Designed as a remote teletype code
- Developed and defined from 1960 to 1986
- Fixed-length seven bit code
 - 128 characters
 - Digits: 0 to 9
 - Lowercase letters: a to z
 - Uppercase letters: A to Z
 - 33 Punctuation symbols
 - 33 Non-printing control codes (originated on Teletype machines)

ASCII Character Code Table

Dec	Hx	Oct	Char	Dec	Hx	Oct	Html	Chr	Dec	Hx	Oct	Html	Chr	Dec	Hx	Oct	Html	Chr
0	0	000	NUL (null)	32	20	040	 	Space	64	40	100	@	@	96	60	140	`	`
1	1	001	SOH (start of heading)	33	21	041	!	!	65	41	101	A	A	97	61	141	a	a
2	2	002	STX (start of text)	34	22	042	"	"	66	42	102	B	B	98	62	142	b	b
3	3	003	ETX (end of text)	35	23	043	#	#	67	43	103	C	C	99	63	143	c	c
4	4	004	EOT (end of transmission)	36	24	044	$	\$	68	44	104	D	D	100	64	144	d	d
5	5	005	ENQ (enquiry)	37	25	045	%	%	69	45	105	E	E	101	65	145	e	e
6	6	006	ACK (acknowledge)	38	26	046	&	&	70	46	106	F	F	102	66	146	f	f
7	7	007	BEL (bell)	39	27	047	'	'	71	47	107	G	G	103	67	147	g	g
8	8	010	BS (backspace)	40	28	050	((72	48	110	H	H	104	68	150	h	h
9	9	011	TAB (horizontal tab)	41	29	051))	73	49	111	I	I	105	69	151	i	i
10	A	012	LF (NL line feed, new line)	42	2A	052	*	*	74	4A	112	J	J	106	6A	152	j	j
11	B	013	VT (vertical tab)	43	2B	053	+	+	75	4B	113	K	K	107	6B	153	k	k
12	C	014	FF (NP form feed, new page)	44	2C	054	,	,	76	4C	114	L	L	108	6C	154	l	l
13	D	015	CR (carriage return)	45	2D	055	-	-	77	4D	115	M	M	109	6D	155	m	m
14	E	016	SO (shift out)	46	2E	056	.	.	78	4E	116	N	N	110	6E	156	n	n
15	F	017	SI (shift in)	47	2F	057	/	/	79	4F	117	O	O	111	6F	157	o	o
16	10	020	DLE (data link escape)	48	30	060	0	0	80	50	120	P	P	112	70	160	p	p
17	11	021	DC1 (device control 1)	49	31	061	1	1	81	51	121	Q	Q	113	71	161	q	q
18	12	022	DC2 (device control 2)	50	32	062	2	2	82	52	122	R	R	114	72	162	r	r
19	13	023	DC3 (device control 3)	51	33	063	3	3	83	53	123	S	S	115	73	163	s	s
20	14	024	DC4 (device control 4)	52	34	064	4	4	84	54	124	T	T	116	74	164	t	t
21	15	025	NAK (negative acknowledge)	53	35	065	5	5	85	55	125	U	U	117	75	165	u	u
22	16	026	SYN (synchronous idle)	54	36	066	6	6	86	56	126	V	V	118	76	166	v	v
23	17	027	ETB (end of trans. block)	55	37	067	7	7	87	57	127	W	W	119	77	167	w	w
24	18	030	CAN (cancel)	56	38	070	8	8	88	58	130	X	X	120	78	170	x	x
25	19	031	EM (end of medium)	57	39	071	9	9	89	59	131	Y	Y	121	79	171	y	y
26	1A	032	SUB (substitute)	58	3A	072	:	:	90	5A	132	Z	Z	122	7A	172	z	z
27	1B	033	ESC (escape)	59	3B	073	;	;	91	5B	133	[[123	7B	173	{	{
28	1C	034	FS (file separator)	60	3C	074	<	<	92	5C	134	\	\	124	7C	174	|	
29	1D	035	GS (group separator)	61	3D	075	=	=	93	5D	135]]	125	7D	175	}	}
30	1E	036	RS (record separator)	62	3E	076	>	>	94	5E	136	^	^	126	7E	176	~	~
31	1F	037	US (unit separator)	63	3F	077	?	?	95	5F	137	_	_	127	7F	177		DEL

History – EBCDIC Code

- Designed as a communication code for computer peripherals
- Developed and defined from 1963 to 1964 for IBM System/360
- Fixed-length eight bit code
- EBCDIC was an Extended BCD Interchange Code
 - BCD – Binary Coded Decimal
- Observations
 - The upper-case letters are not contiguous in the EBCDIC encoding
 - The lower-case letters are not contiguous in the EBCDIC encoding
 - Lower-case letters come before upper-case letters
 - All letters come before digits

Unicode and ISO/IEC 10646

- Maintained by the Unicode Consortium
- Developed and defined from 1987 to 1996 to 2017
 - Based on experience with Xerox Character Code Standard (XCCS)
- Includes 136,755 characters covering 139 modern and historic scripts
- UTF-8, UTF-16, and UTF-32
 - 8-bit, 16-bit, and 32-bit encodings, respectively