

# L<sup>A</sup>T<sub>E</sub>X font encodings

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# 1 Introduction

This document explains the ideas that underpin L<sup>A</sup>T<sub>E</sub>X font encodings and the constraints that apply when defining a new encoding; it also lists the encodings that have already been defined.

## 1.1 Encodings in T<sub>E</sub>X

T<sub>E</sub>X (the program) implicitly recognises three sorts of encoding, and all are (in a sense) discussed in the T<sub>E</sub>Xbook [16]:

1. The input encoding, which specifies the meanings of characters in files presented to T<sub>E</sub>X for processing. The T<sub>E</sub>Xbook suggests that ‘your version of T<sub>E</sub>X will recognise the characters you type on your keyboard’ (T<sub>E</sub>X the program has provision for static translations of input characters).

Such direct use of T<sub>E</sub>X’s facilities is not the way modern L<sup>A</sup>T<sub>E</sub>X (or indeed any other T<sub>E</sub>X macro package) is likely to deal with input encodings. This document does not address the topic of input encodings; the interested reader should examine the L<sup>A</sup>T<sub>E</sub>X base package `inputenc` [21, sec. 7.5.2, p. 357].

2. The token stream that T<sub>E</sub>X processes internally. This stream of T<sub>E</sub>X’s consciousness is discussed in great detail in the T<sub>E</sub>Xbook.

Again, this document does not address the topic. L<sup>A</sup>T<sub>E</sub>X’s internal character representation (LICR) is well discussed in [21, sec. 7.11.2, p. 442].

3. The font encoding—i.e., the mapping of character codes to glyphs in the fonts that are used to typeset T<sub>E</sub>X’s output. Again, a set of font encodings is enumerated in the T<sub>E</sub>Xbook, but that set has proved inadequate to the needs of modern multilingual use of L<sup>A</sup>T<sub>E</sub>X.

This document explains *why* Knuth’s original set of encodings is inadequate to modern conditions, and discusses the issues that surround the design and definition of new font encodings.

Font encodings are important for more than their rôle in mapping the glyphs of the fonts to be used for typesetting: their glyph tables are also the context in which T<sub>E</sub>X’s hyphenation algorithm operates. There are constraints imposed by T<sub>E</sub>X that affect the way in which new font encodings, for use in a multi-lingual environment, may be structured (see section 3 for details).

## 1.2 The history of T<sub>E</sub>X font encodings

Little attention was paid to font encodings prior to the arrival of T<sub>E</sub>X 3. Up to that time, one used Donald Knuth’s fonts (the Computer Modern family, using the encodings we now refer to as OT1 and the OM series), or one was on one’s own.

The Computer Modern text encoding raises problems in unmodified T<sub>E</sub>X, because hyphenation cannot break words containing `\accent` commands. Even in those Western European languages for which the OT1 encoding has symbols for the necessary `\accent`-based diacritics, this shortcoming ruins typesetting of running text.

With the advent of  $\text{T}_{\text{E}}\text{X}$  3, with its ability to switch between hyphenation pattern sets, it was clear that the situation could not continue. Thus a group at the TUG Annual General Meeting in Cork, Ireland, specified a uniform encoding for 256-glyph fonts, that contains accented letters and non-ASCII letters necessary to express most Western European languages (and some Eastern European ones) without recourse to the `\accent` command.

This “Cork” encoding has since been realised in a series of fonts designed with Metafont, in at least one font series that is available both in Adobe Type 1 format and in OpenType format, and in a number of virtual-font mappings of other font series.

Since the time of the Cork meeting, much effort has been devoted to the design of encodings for text fonts to use with  $\text{T}_{\text{E}}\text{X}$ , and the Cork encoding influenced the design of many such encodings.

Encodings for mathematical fonts have, in contrast, changed little since Knuth’s contributions. A TUG Technical Working Group was established at the Cork meeting, whose aim was to define a set of 256-glyph encodings to regularise and extend Knuth’s originals, using ideas from several other fonts that had appeared since, and from the known needs of researchers in mathematics and the mathematical sciences.

Independently, a first proposal (the so-called *Aston proposal*) was worked out by Justin Ziegler together with Frank Mittelbach and other members of the  $\text{L}^{\text{A}}\text{T}_{\text{E}}\text{X}$  Project team [24]. A first implementation of this proposal was realized by Matthias Clasen und Ulrik Vieth [6, 7].

However, the slow progress of these Mathematical encodings has been overtaken by the addition (in the last decade or so) of a large number of mathematical symbols to Unicode [3]; one can expect further changes so that new public mathematical font encodings will most likely be delayed still further.

### 1.3 Further information

For a general introduction to  $\text{L}^{\text{A}}\text{T}_{\text{E}}\text{X}$ , including the new features of  $\text{L}^{\text{A}}\text{T}_{\text{E}}\text{X} 2_{\varepsilon}$ , you should read *L<sup>A</sup>T<sub>E</sub>X: A Document Preparation System*, Leslie Lamport, Addison Wesley, 2nd ed, 1994.

A more detailed description of the new features of  $\text{L}^{\text{A}}\text{T}_{\text{E}}\text{X}$ , including an overview of more than 200 packages and nearly 1000 ready to run examples, is to be found in *The L<sup>A</sup>T<sub>E</sub>X Companion second edition* by Frank Mittelbach and Michel Goossens [21].

The  $\text{L}^{\text{A}}\text{T}_{\text{E}}\text{X}$  project sponsored a report on Mathematical font encodings, which is worth reading for its insight into the problems of defining the way in which math is used: see [24, 6, 7].

The  $\text{L}^{\text{A}}\text{T}_{\text{E}}\text{X}$  font selection scheme is based on  $\text{T}_{\text{E}}\text{X}$ , which is described by its developer in *The T<sub>E</sub>Xbook*, Donald E. Knuth, Addison Wesley, 1986, revised in 1991 to include the features of  $\text{T}_{\text{E}}\text{X}$  3.

For more information about  $\text{T}_{\text{E}}\text{X}$  and  $\text{L}^{\text{A}}\text{T}_{\text{E}}\text{X}$ , please contact your local  $\text{T}_{\text{E}}\text{X}$  Users Group, or the international  $\text{T}_{\text{E}}\text{X}$  Users Group (<http://www.tug.org>).

## 2 Existing font encodings

This section lists the encodings currently assigned; for each encoding, we list the registered ( $\text{L}^{\text{A}}\text{T}_{\text{E}}\text{X}$ ) name, the assigned purpose of the encoding, and the

author. Further details may list the code positions used in the encoding, the *variable slots* (see below), an example font (for which a listing will be provided later in the document if the relevant fonts are present), and a source for further reference.

While the characteristic feature of an encoding is that each font encoded according to the encoding should have the same glyph set, there are some encodings (notably OT1 and its descendants) in which a few glyph code slots differ in their contents in different fonts.

## 2.1 Naming conventions

Names for encoding schemes are strings of up to three letters (all upper case) plus digits.

The L<sup>A</sup>T<sub>E</sub>X Project reserves the use of encoding names starting with the following letters: T (standard 256-long text encodings), TS (symbols that are designed to extend a corresponding T encoding), X (text encodings that do not conform to the strict requirements for T encodings), M (standard 256-long mathematical encodings), S (other symbol encodings), A (other special applications), OT (standard 128-long text encodings), and OM (standard 128-long mathematical encodings).

Please do not use the above starting letters for non-portable encodings. If new standard encodings emerge then we shall add them in a later release of L<sup>A</sup>T<sub>E</sub>X.

Encoding schemes which are local to a site or a system should start with L, experimental encodings intended for wide distribution will start with E, whilst U is for Unknown or Unclassified encodings.

*We recommend that new encoding names should not be introduced unless careful consideration and discussion in the user community has confirmed the need for the encoding. If encodings have to change from font to font, a number of problems arise, so it is best to develop encodings that can be used with a large number of fonts in parallel. This allows documents to be typeset using different fonts without problems.*

*The TS1 encoding is a good example of a bad encoding (even though it was developed with the best intentions) as a huge number of fonts can only implement parts of it. Similarly, the fact that the few sets of available mathematical fonts (beside Computer Modern Math) nearly all implement slightly different encodings is a huge source of problems. Don't add to this if possible!*

## 2.2 128<sup>+</sup> glyph encodings (text)

The ‘OT’ series of font encodings start with Donald Knuth’s original text encoding, that used for the text fonts in the earliest releases of T<sub>E</sub>X itself. The ‘O’ of the encoding designator may be taken as signifying ‘original’, or just ‘old’.

L <sup>A</sup> T <sub>E</sub> X name:	OT1
Public name:	T <sub>E</sub> X text
Author:	Donald Ervin Knuth
Glyph slots used:	0x00–0x7F
Variable slots:	0x0B–0x0F, 0x24, 0x3C, 0x3E, 0x5C, 0x7B–0x7D
Font example:	cmr10 ; encoding table on page 19
Further reference:	[16, p.427]

Donald Knuth designed his font encoding (and hence his fonts) in a very different environment from that which now pervades the  $\text{\TeX}$  world: his (mainframe) computer had very little memory, there was little experience in (or demand for) for multilingual technical typesetting, and as a result it was appropriate to sacrifice uniformity for efficiency.

Thus Knuth's original fonts differ slightly in some encoded slots: for example, the glyphs `<`, `>`, `\`, `{`, and `}` are only available in the typewriter fonts and the `$` and `£` signs share the same position (in different font shapes).

This means that direct selection of these slots can produce unpredictable results, e.g., typing `<` or `\symbol{'74}` in a document can yield `'¿'`.

$\text{\LaTeX}$  name: `OT2`  
Public name: UW cyrillic encoding  
Author: University of Washington  
Glyph slots used: `0x00–0x7F`  
Variable slots: —  
Font example: `wnr10` ; encoding table on page 20  
Further reference: [2]

Support for this encoding is available in the Cyrillic bundle although for all practical purposes it is better to use one of the `T2` encodings.

$\text{\LaTeX}$  name: `OT3`  
Public name: UW IPA encoding  
Author: University of Washington  
Glyph slots used: `0x00–0x7f`  
Variable slots: —  
Font example: `wsuipa10` ; encoding table on page 20  
Further reference: [8, p.149]

The `OT3` encoding was never really used with  $\text{\LaTeX} 2_{\epsilon}$  following the introduction of the TIPA system which offers much better support for IPA. In particular, no `ot3enc.def` file was ever produced.

$\text{\LaTeX}$  name: `OT4`  
Public name: Polish text encoding  
Author: B. Jackowski and M. Ryćko  
Glyph slots used: `0x00–0x7F`, `0x81`, `0x82`, `0x86`, `0x8A`, `0x8B`, `0x91`, `0x99`, `0x9B`, `0xA1`, `0xA2`, `0xA6`, `0xAA`, `0xAB`, `0xAE`, `0xAF`, `0xB1`, `0xB9`, `0xBB`, `0xD3`, `0xF3`, `0xFF`  
Variable slots: `0x0B–0x0F`, `0x24`, `0x3C`, `0x3E`, `0x5C`, `0x7B–0x7D`  
Font example: `p1r10` ; encoding table on page 21  
Further reference: —

While Knuth included the means of typesetting the 'lost L' (`Ł`) in his `OT1` encoding, he omitted the ogonek (`ł`), a diacritic mark that is also needed in Polish text; hence the appearance, well before the `T1` encoding, of fonts using this encoding.

**L<sup>A</sup>T<sub>E</sub>X** name: OT5  
Public name: Not currently allocated  
Author: —  
Glyph slots used: —  
Variable slots: —  
Font example:  
Further reference: —

**L<sup>A</sup>T<sub>E</sub>X** name: OT6  
Public name: Armenian text encoding  
Author: Serguei Dachian  
Glyph slots used: 0x03–0x0F, 0x13–0x7F  
Variable slots: —  
Font example: **artmr10**  
Further reference: —

This encoding was allocated to permit use of Dachian’s Armenian fonts in a standard **L<sup>A</sup>T<sub>E</sub>X** environment.

Because of license issues the **artmr** fonts are not necessarily included in distributed **T<sub>E</sub>X** installations (and for this reason the corresponding encoding table is not shown below). However, the fonts and the support macros can be found on the CTAN archives (look for **armtex**).

### 2.3 256 glyph encodings (text)

**L<sup>A</sup>T<sub>E</sub>X** name: T1  
Public name: Cork encoding  
Author: Euro **T<sub>E</sub>X** conference at Cork  
Glyph slots used: 0x00–0xFF  
Variable slots: —  
Font example: **ecrm1000** ; encoding table on page [22](#)  
Further reference: [\[10, p.514\]](#), [\[15, p.99\]](#)

The Cork encoding was developed so that advantage could be taken of the (then) new facilities of **T<sub>E</sub>X** 3, allowing hyphenation of most Western European (and some Eastern European) languages in an unmodified version of **T<sub>E</sub>X**.

The encoding was developed in the absence of any extant effort at font design, but instances written in Metafont (the ‘EC’ fonts), and more recently Adobe Type 1 instances of the same fonts have become available.

Substantial (but incomplete) instances have also been developed, which use virtual fonts. These latter instances map either Knuth’s original (OT1-encoded) fonts, or commercial fonts that contain the Adobe ‘standard’ set of 224 glyphs.

**L<sup>A</sup>T<sub>E</sub>X** name: T2A, T2B, T2C  
Public name: Cyrillic encodings  
Author: The CyrTUG font team  
Glyph slots used: 0x00–0xFF  
Variable slots: — (within each encoding)  
Font example: `larm1000` ; encoding table on page 23  
Further reference: [4]

There are too many glyphs in the full Cyrillic complement of languages for all of them to be covered by a single L<sup>A</sup>T<sub>E</sub>X-compliant encoding (the lower half of each T2 encoding is identical to that of T1, in order that each should be a conforming L<sup>A</sup>T<sub>E</sub>X encoding — see section 3). The approach taken is therefore to develop a single encoding, X2 (see 2.5) which contains all the glyphs needed for the full set of languages, and then to derive the three L<sup>A</sup>T<sub>E</sub>X-compliant T2-family encodings using the X2 set together with that of T1.

**L<sup>A</sup>T<sub>E</sub>X** name: T3  
Public name: IPA encoding  
Author: FUKUI Rei, University of Tokyo  
Glyph slots used: 0x00–0xFF  
Variable slots: —  
Font example: `tipa10` ; encoding table on page 26  
Further reference: [12, p.102]

The T3 encoding (and associated macros) provides the glyphs required in phonetic description according to current International Phonetic Association recommendations [18].

The T3 encoding does *not fulfil* the requirements for T encodings—the name is a historical accident. The correct name would be X3, but due to the fact that this font family has been used under its current encoding name for a long time, the name will not change for compatibility reasons.

**L<sup>A</sup>T<sub>E</sub>X** name: T4  
Public name: African Latin (fc)  
Author: Jörg Knappen  
Glyph slots used: 0x00–0xFF  
Variable slots: 0x24  
Font example: `fcr10` ; encoding table on page 27  
Further reference: [14]

The African Latin fonts contain in their lower half (0–127) the same characters as the European Latin (T1-encoded) Fonts, while in their upper half (128–255) they contain letters and symbols for African languages that use extended Latin alphabets. Due to lack of space, Jörg had to play the unfortunate trick of assigning `\textdollar` and `\textsterling` the same position; users should take these characters from the text companion font, if they are needed. Instead of defining a lot of new control sequences for the single letters, there are three accent-like control sequences with general purpose: `\m` (Modified-1), `\M` (Modified-2) and `\B` (Barred). Most standard L<sup>A</sup>T<sub>E</sub>X encoding-dependent commands work. However, the Icelandic special letters

are not available and ‘best replacements’ for `\Th`, `\th`, and `\dh` are used (barred T and d resp.).

**L<sup>A</sup>T<sub>E</sub>X** name: **T5**  
Public name: Vietnamese encoding  
Author: Werner Lemberg and Vladimir Volovich  
Glyph slots used: 0x00–0xFF  
Variable slots: —  
Font example: `vnr10` ; encoding table on page 28  
Further reference: [17]

The **T5** encoding was developed for Vietnamese. Again, this encoding *does not* conform to the requirements for a T-encoding because its large number of accented letters prevent the `\lccode` and `\uccode` mapping requirements for T encodings from being fulfilled. However, since the Vietnamese language does not use word division in typesetting so that this requirement is actually not important for this particular language. Since every glyph used in Vietnamese text is internally represented as LICR macros, the commands `\MakeUppercase` and `\MakeLowercase` still work as expected (as they change the case of the ASCII characters in LICR definitions).

**L<sup>A</sup>T<sub>E</sub>X** name: **T6**  
Public name: Armenian  
Author: —  
Glyph slots used: —  
Variable slots: —  
Font example: —  
Further reference: —

This encoding is reserved to permit future expansion of Armenian **T<sub>E</sub>X** to use 256-character (hyphenatable) fonts.

**L<sup>A</sup>T<sub>E</sub>X** name: **T7**  
Public name: Greek encoding  
Author: —  
Glyph slots used: —  
Variable slots: —  
Font example: —  
Further reference: —

The name is already reserved for a 256 glyph greek encoding. The encoding itself hasn’t been defined so far.



## 2.4 256<sup>-</sup> glyph encodings (text symbols)

**L<sup>A</sup>T<sub>E</sub>X** name: TS1  
Public name: Text Companion encoding (Cork)  
Author: Jörg Knappen  
Glyph slots used: 0x00–0x0D, 0x12, 0x15, 0x16, 0x18–0x1D, 0x20, 0x24, 0x27, 0x2A, 0x2C–0x3A, 0x3C–0x3E, 0x4D, 0x4F, 0x57, 0x5B, 0x5D–0x60, 0x62–0x64, 0x6C–0x6E, 0x7E–0xBF, 0xD6, 0xF6  
Variable slots: —  
Font example: `tcrm1000` ; encoding table on page 29  
Further reference: [15]

The text symbol encoding offers access to symbolic glyphs that are commonly used in text (for a variety of reasons), and whose style should vary with the text that surrounds them.

Unfortunately, the TS1 encoding was developed without reference to the glyphs available in existing commercial fonts. As a result, only font families explicitly developed for T<sub>E</sub>X (i.e., typically originating with METAFONT) actually contain all glyphs required by the TS1 encoding. Most other font families (whether free or commercial) often only provide half of the set (compare the two tables for TS1 on pages 29 and 30). To improve this situation somewhat, NFSS provides a way to define encoding subsets on a per family basis in the `textcomp` package (which package offers support for the TS1 encoding).

**L<sup>A</sup>T<sub>E</sub>X** name: TS3  
Public name: IPA symbol encoding  
Author: FUKUI Rei, University of Tokyo  
Glyph slots used: 0x00–0x0A, 0x20–0x49, 0x50–0x56, 0x70–0x7B  
Variable slots: —  
Font example: `tipx10` ; encoding table on page 31  
Further reference: [12]

The TS3 encoding (together with the T3 encoding) provides the glyphs for typesetting phonetic transcriptions following the guidelines of the International Phonetic Association [18]. Support is offered through the `tipa` package.

## 2.5 256 glyph encodings (text extended)

**L<sup>A</sup>T<sub>E</sub>X** name: X2  
Public name: Cyrillic glyph container  
Author: The CyrTUG font team  
Glyph slots used: 0x00–0xFF  
Variable slots: —  
Font example: `rxrm1000` ; encoding table on page 32  
Further reference: [4]

This encoding specifies the glyph container for Cyrillic characters, which is used in specifying the T2A, T2B and T2C encodings.

## 2.6 128<sup>+</sup> glyph encodings (mathematics)

**L**<sup>A</sup>T<sub>E</sub>X name: OML  
Public name: T<sub>E</sub>X math italic  
Author: Donald Ervin Knuth  
Glyph slots used: 0x00–0x7F  
Variable slots: —  
Font example: `cmmi10` ; encoding table on page 33  
Further reference: [16, p.430]

The OML encoding contains italic Latin and Greek letters for use in mathematical formulas (typically used for variables) together with some symbols.

**L**<sup>A</sup>T<sub>E</sub>X name: OMS  
Public name: T<sub>E</sub>X math symbol  
Author: Donald Ervin Knuth  
Glyph slots used: 0x00–0x7F  
Variable slots: —  
Font example: `cmsy10` ; encoding table on page 33  
Further reference: [16, p.431]

The OMS encoding contains basic mathematical symbols, together with an uppercase “calligraphic” Latin alphabet.

**L**<sup>A</sup>T<sub>E</sub>X name: OMX  
Public name: T<sub>E</sub>X math extension  
Author: Donald Ervin Knuth  
Glyph slots used: 0x00–0x7F  
Variable slots: —  
Font example: `cmex10` ; encoding table on page 34  
Further reference: [16, p.432]

OMS encodes mathematical symbols with variable sizes, such as the  $\sum$  sign, which changes its size if used in displayed formulas, and the construction parts for brackets, braces and radicals, etc., which can stretch to accommodate the thing they’re enclosing.

## 2.7 256 glyph encodings (mathematics)

So far there are no 256 glyph mathematical encodings. A proposal is given in [24].

## 2.8 Other encodings

**L**<sup>A</sup>T<sub>E</sub>X name: C. .  
Public name: CJK encodings  
Author: Werner Lemberg  
Glyph slots used: 0x00–0xFF  
Variable slots: —  
Font example:  
Further reference: [5]

The CJK package defines a number of encodings which access Chinese, Japanese and Korean fonts.

**L**<sub>A</sub>T<sub>E</sub>X name: E.  
Public name: Experimental encodings  
Author: —  
Glyph slots used: 0x00–0xFF  
Variable slots: all  
Font example:  
Further reference: [21, p.416]

As the name indicates, encodings starting with the letter E are intended for experimental encodings, that are still likely to change.

**L**<sub>A</sub>T<sub>E</sub>X name: L.  
Public name: Local encoding (site dependent)  
Author: —  
Glyph slots used: 0x00–0xFF  
Variable slots: all  
Font example:  
Further reference: [21, p.416]

‘Local’ encodings provide the means to develop representation techniques that are suited to a particular T<sub>E</sub>X environment. While the developer has freedom to specify their encoding as he or she pleases, there is a strong incentive to obey the **L**<sub>A</sub>T<sub>E</sub>X rules for encodings, since it will otherwise be difficult to compose text using the encoding.

At least it was the intention that L. encodings are local and site dependent. However, a number of such encodings became generally used without ever getting a different name allocated.

**L**<sub>A</sub>T<sub>E</sub>X name: LY1  
Public name: Y&Y 256 glyph encoding  
Author: Berthold Horn  
Glyph slots used: 0x00–0x08, 0x0C, 0x10, 0x12–0xFF  
Variable slots: *believed none*  
Font example: **ptmr8y** ; encoding table on page 35  
Further reference: [21, p.416]

This is an alternative to the T1 encoding developed by Y&Y and used in their commercial T<sub>E</sub>X implementation.

**L**<sub>A</sub>T<sub>E</sub>X name: LV1  
Public name: MicroPress encoding  
Author: Michael Vulis  
Glyph slots used: *unknown*  
Variable slots: *unknown*  
Font example:  
Further reference: [21, p.416]

This is an encoding developed by MicroPress and used for some of their fonts.

**L**A<sub>T</sub>E<sub>X</sub> name: LGR  
Public name: Greek 256 glyph encoding  
Author: *unknown*  
Glyph slots used: 0x00–0xFF  
Variable slots: *believed none*  
Font example: **grmn1000** ; encoding table on page 36  
Further reference: [21, p.575]

Currently the main encoding in use for the Greek language.

This encoding doesn't conform to the restrictions for T-encodings described in section 3 on page 13 as it doesn't have ASCII glyphs at all.

**L**A<sub>T</sub>E<sub>X</sub> name: PD1  
Public name: PDF DocEncoding  
Author: Adobe  
Glyph slots used: 0x08–0x0A, 0x0C, 0x0D, 0x18–0x7E, 0x80–0x9E, 0xA0–0xAE, 0xB0–0xFF  
Variable slots: —  
Font example:  
Further reference: [1], [13]

The PD1 encoding is a virtual encoding with 256 glyphs needed to produce bookmarks and similar text in PDF document generated with pdf<sub>L</sub>A<sub>T</sub>E<sub>X</sub>. The encoding is “virtual” because by design there are no <sub>T</sub>E<sub>X</sub> fonts that cover PD1. Details can be found in appendix D.1 of [1].

**L**A<sub>T</sub>E<sub>X</sub> name: PU  
Public name: PDF Unicode Encoding  
Author: Adobe  
Glyph slots used: —  
Variable slots: —  
Font example:  
Further reference: [1], [13]

Another virtual encoding (with more than 600 characters) for Unicode-encoded bookmarks in PDF documents.

**L**A<sub>T</sub>E<sub>X</sub> name: U  
Public name: Unknown encoding  
Author: —  
Glyph slots used: potentially 0x00–0xFF  
Variable slots: all  
Font example: **wasy10** ; encoding table on page 37  
Further reference: [21, p.416]

This encoding should be used for fonts that resist classification, e.g., when it is clear that there will never be more than one font using the same encoding.

## 3 Restrictions

### 3.1 Required glyphs for general text encodings

Encodings that are supposed to be used with L<sup>A</sup>T<sub>E</sub>X for ‘general purpose text fonts’ need to have certain fixed glyphs in certain encoding slots. A ‘general purpose text font’ is one intended for arbitrary natural language text and not just within special environments (such as the phonetic alphabet) or just for typesetting individual symbols (e.g., the text companion font with encoding TS1).

This is the case for the following glyphs that have to be in their ASCII positions for general purpose text encodings:

Glyph	Position	Glyph	Position	Glyph <sup>1</sup>	Position
!	33	:	58	<	60
,	39	;	59	>	62
(	40	=	61		124
)	41	?	63		
*	42	@	64		
+	43	A ... Z	65 to 90		
,	44	[	91		
-	45	]	93		
.	46	‘	96		
/	47	a ... z	97 to 122		
0 ... 9	48 to 57				

In addition the following glyphs have to be present somewhere<sup>2</sup> in the encoding together with corresponding ligature programs to generate them:

Glyph	Ligature program
“	‘ ‘
”	’ ’
—	--
---	---

This is  $33 + 2 * 26 = 85$  positions “required”, which leaves 171 positions free.

If there are free slots available then adding all or some of the diacritics would be the best way to fill them.

If there are insufficient slots for the characters needed, a possible technique is to create a subsidiary encoding, and to move non-letter characters to it. Since only “letters” take part in the hyphenation algorithm, this technique doesn’t affect the appearance of the typeset result.

### 3.2 The constraints on upper/lower case tables

Due to some technical restrictions of T<sub>E</sub>X related to hyphenation it is not possible in L<sup>A</sup>T<sub>E</sub>X to use more than one `\lccode` or `\uccode` table. Therefore all encodings need to share these two tables which are defined to be those of the T1 encoding.

<sup>1</sup>The requirement for these three glyphs is violated in the Latin alphabet OT encodings.

<sup>2</sup>The position in this case is not important as they are generated from ligature programs.

The T1 encoding has some nasty peculiarities which make certain slot positions more or less unusable for other encodings if this restriction is to be obeyed. This is unfortunate but since T1 is well established and the basis for a large number of languages it seemed better to live with this situation instead of trying to replace T1 with a slightly better standard (with the result that for a long time different L<sup>A</sup>T<sub>E</sub>X installations would not be able to communicate with each other because of incompatible font sets).

The positions that are problematic are as follows.

25 (i)	uppercase maps strangely (same as for 105, i)
26 (j)	uppercase maps strangely (same as for 106, j)
27 (ff)	lowercase maps to itself which makes this slot subject to hyphenation (used to support OT1 encoding)
157 (İ)	lowercase maps strangely (same as for 73, I)
158 (đ)	uppercase maps strangely (same as for 240, ð)

One way to use such slots is to fill them with ligature glyphs as T<sub>E</sub>X will not consult these tables for glyphs constructed through ligatures programs but instead uses the entries for the individual glyphs used to produce the ligature.

A complete listing of the uppercase/lowercase mapping tables is to be found in section B (page 38).

## 4 Encoding specific commands

An encoding specific command is one that generates a glyph (or glyphs), to produce a graphic effect that may be implemented differently in different encodings. The encoding specific command automatically changes its implementation when the encoding changes in the course of the document. Encoding specific commands figure in L<sup>A</sup>T<sub>E</sub>X's internal character representation (LICR) and are also discussed in [21, sec. 7.11.2, p. 442].

The following table only covers the encoding specific commands from the OT1 and T1 encodings. Other encodings may specify additional encoding specific commands. In the table, the first 15 commands are ‘accent-like’ and need as an argument the character to be accented. For example, `\v{c}` is the LICR for ‘č’.

<code>\‘</code>	OT1,T1	˘	(grave)
<code>\’</code>	OT1,T1	ˆ	(acute)
<code>\ˆ</code>	OT1,T1	ˆ	(circumflex)
<code>\~</code>	OT1,T1	˜	(tilde)
<code>\" </code>	OT1,T1	¨	(umlaut)
<code>\H</code>	OT1,T1	”	(Hungarian umlaut)
<code>\r</code>	OT1,T1	◦	(ring)
<code>\v</code>	OT1,T1	ˇ	(haček)
<code>\u</code>	OT1,T1	˘	(breve)
<code>\t</code>	OT1,T1	ˆ	(tie)
<code>\=</code>	OT1,T1	–	(macron)
<code>\.</code>	OT1,T1	·	(dot)
<code>\b</code>	OT1,T1	–	(underbar)
<code>\c</code>	OT1,T1	¸	(cedilla)
<code>\d</code>	OT1,T1	·	(dot under)
<code>\k</code>	T1	˘	(ogonek)
<code>\AE</code>	OT1,T1	Æ	

<code>\DH</code>	T1	Ð	
<code>\DJ</code>	T1	Đ	
<code>\L</code>	OT1,T1	Ł	
<code>\NG</code>	T1	Ŋ	
<code>\OE</code>	OT1,T1	Œ	
<code>\O</code>	OT1,T1	Ø	
<code>\SS</code>	OT1,T1	Š	
<code>\TH</code>	T1	Þ	
<code>\ae</code>	OT1,T1	æ	
<code>\dh</code>	T1	ð	
<code>\dj</code>	T1	đ	
<code>\guillemotleft</code>	T1	«	(guillemet)
<code>\guillemotright</code>	T1	»	(guillemet)
<code>\guilsinglleft</code>	T1	‹	(guillemet)
<code>\guilsinglright</code>	T1	›	(guillemet)
<code>\i</code>	OT1,T1	ı	
<code>\j</code>	OT1,T1	ĵ	
<code>\l</code>	OT1,T1	ł	
<code>\ng</code>	T1	ŋ	
<code>\oe</code>	OT1,T1	œ	
<code>\o</code>	OT1,T1	ø	
<code>\quotedblbase</code>	T1	”	
<code>\quotesinglbase</code>	T1	‘	
<code>\ss</code>	OT1,T1	ß	
<code>\textasciicircum</code>	OT1,T1	^	
<code>\textasciitilde</code>	OT1,T1	~	
<code>\textbackslash</code>	OT1,T1	\	
<code>\textbar</code>	OT1,T1		
<code>\textbraceleft</code>	OT1,T1	{	
<code>\textbraceright</code>	OT1,T1	}	
<code>\textcompwordmark</code>	OT1,T1		(invisible)
<code>\textdollar</code>	OT1,T1	\$	
<code>\textemdash</code>	OT1,T1	—	
<code>\textendash</code>	OT1,T1	–	
<code>\textexclamdown</code>	OT1,T1	¡	
<code>\textgreater</code>	OT1,T1	>	
<code>\textless</code>	OT1,T1	<	
<code>\textquestiondown</code>	OT1,T1	¿	
<code>\textquotedbl</code>	T1	”	
<code>\textquotedblleft</code>	OT1,T1	“	
<code>\textquotedblright</code>	OT1,T1	”	
<code>\textquoteleft</code>	OT1,T1	‘	
<code>\textquoteright</code>	OT1,T1	’	
<code>\textregistered</code>	OT1,T1	®	
<code>\textsection</code>	OT1,T1	§	
<code>\textsterling</code>	OT1,T1	£	
<code>\texttrademark</code>	OT1,T1	™	
<code>\textunderscore</code>	OT1,T1	—	
<code>\textvisiblespace</code>	OT1,T1	□	
<code>\th</code>	T1	þ	

## 5 Encodings for Unicode based $\TeX$ systems

The preceding text has assumed a classic  $\TeX$  system that is restricted to the use of fonts with at most 256 characters. In order to accommodate all the characters needed for different languages and mathematics it is necessary to have multiple encodings as described above, and  $\LaTeX$  needs to be aware of the encoding used for each font.

Unicode aims to provide a single encoding that removes most of the need to switch encodings, apart from very specialist use for non-standard characters. Rather than assign codes in the range 0–256 (hex FF) Unicode codes are in the range 0–1,114,111 (hex 10FFFF), although not all slots are available for distinct characters for technical reasons. Unicode offers the possibility to use a single input encoding (usually UTF-8) for all documents and to use essentially the same Unicode encoding for all fonts, so removing the need to switch encodings in different contexts.

Omega was perhaps the first widely used  $\TeX$  extension that supported Unicode. Currently the two actively supported systems that are present in most modern  $\TeX$  distributions are Xe $\TeX$  and Lua $\TeX$ .

When used with these extended  $\TeX$  engines,  $\LaTeX$ 's font system can refer to Unicode fonts (typically OpenType fonts installed system-wide on your operating system rather than fonts specifically encoded/installed for  $\TeX$ ). Currently the usual method of accessing these fonts is through the contributed `fontspec` package. This uses as encoding TU: “ $\TeX$  Unicode” (historically two experimental encodings EU1 and EU2 were used, depending on the engine, but these are deprecated). The exact rules for  $\LaTeX$  encodings for Unicode engines have not yet been finalised in terms of the (usual) requirement that each slot should be defined. (This is not realistic for a Unicode font, as almost all fonts address subsets of the full range.) It is rare to need to specify the TU encoding a document as the `fontspec` package sets up the correct encoding when loaded.

The restrictions described in section 3 do not apply, or need to be modified in a Unicode based engine. Clearly the lowercase table (and hyphenation patterns) can not be restricted to the values used for T1 and do only refer to the first 256 characters.

When the  $\LaTeX$  format is made  $\LaTeX$  sets up the lowercase table and classifies characters as letter- or non-letter-based on T1 if a classic  $\TeX$  or pdf $\TeX$  is being used. If a Unicode based  $\TeX$  is detected, the values are instead based on the classification and lower-case mappings provided by the Unicode Character Database [23]. The  $\LaTeX$  team have written a generic loader bundle, `unicode-data`, which provides the mechanism to load this information directly from the Unicode Character Database data files and which is read when a Unicode-compliant engine is detected during format-building.

Similarly in the default configuration files used by modern  $\TeX$  distribution, the hyphenation files for each supported language are written in UTF-8 encoding, using Unicode code points for all letters, then if a classic  $\TeX$  system is detected, some additional macros are loaded to convert these files to 256-character encodings where possible, and assuming the T1 lowercase table. For Unicode engines no conversion takes place. (The hyphenation patterns for a small number of languages require that some punctuation characters have non-zero c values. This are set during pattern reading, and may at some stage in the future use the e- $\TeX$  `\savingshyphcodes` mechanism to avoid any need to manipulate `\lccode` in the document.)



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# Appendices

## A Example code tables

This appendix contains a table of each font mentioned as an “example” font above, providing that the font was available when the document was processed with L<sup>A</sup>T<sub>E</sub>X. (L<sup>A</sup>T<sub>E</sub>X generates a warning message for each font it fails to find.)

### A.1 Text encodings

<b>cmr10, OT1</b>	'0	'1	'2	'3	'4	'5	'6	'7	
'00x	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ	"0x
'01x	Φ	Ψ	Ω	ff	fi	fl	ffi	ffl	
'02x	ı	ı	`	´	˘	˙	-	°	"1x
'03x	ı	ß	æ	œ	ø	Æ	Œ	Ø	"2x
'04x	-	!	"	#	\$	%	&	'	
'05x	(	)	*	+	,	-	.	/	"3x
'06x	0	1	2	3	4	5	6	7	
'07x	8	9	:	;	i	=	ı	?	"4x
'10x	@	A	B	C	D	E	F	G	
'11x	H	I	J	K	L	M	N	O	"5x
'12x	P	Q	R	S	T	U	V	W	
'13x	X	Y	Z	[	"	]	^	·	"6x
'14x	‘	a	b	c	d	e	f	g	
'15x	h	i	j	k	l	m	n	o	"7x
'16x	p	q	r	s	t	u	v	w	
'17x	x	y	z	-	—	"	~	..	
	"8	"9	"A	"B	"C	"D	"E	"F	

<b>wnr10, OT2</b>	'0	'1	'2	'3	'4	'5	'6	'7	
'00x	Ѓ	Ѕ	Ц	Э	І	Є	Ђ	Ѓ	"0x
'01x	њ	љ	ц	э	і	є	ђ	ѓ	
'02x	Ю	Ж	Й	Ё	V	Θ	S	Я	"1x
'03x	ю	ж	й	ё	v	θ	s	я	
'04x	"	!	"	Ђ	ˆ	%	'	,	"2x
'05x	(	)	*	Ђ	,	-	.	/	
'06x	0	1	2	3	4	5	6	7	"3x
'07x	8	9	:	;	«	ı	»	?	
'10x	ˆ	A	B	Ц	Д	E	Ф	Г	"4x
'11x	X	И	J	K	Л	M	H	O	
'12x	П	Ч	P	C	T	У	B	Щ	"5x
'13x	Ш	Ы	З	[	"	]	Ђ	Ђ	
'14x	'	a	b	ц	д	e	ф	г	"6x
'15x	x	и	j	k	л	m	h	o	
'16x	п	ч	p	c	t	y	b	щ	"7x
'17x	ш	ы	з	-	—	№	ь	ь	
	"8	"9	"A	"B	"C	"D	"E	"F	

<b>wsuipa10, OT3</b>	'0	'1	'2	'3	'4	'5	'6	'7	
'00x	e	a	α	v	λ	b	b	∅	"0x
'01x	β	β	ϕ	ε	С	đ	đ	đ	
'02x	d	d	đ	đ	D	ə	ə	ə	"1x
'03x	ε	з	з	з	g	g	G	γ	
'04x	γ	γ	h	h	fi	fi	u	i	"2x
'05x	ı	ı	ı	ı	J	ı	ı	ı	
'06x	ı	ı	λ	λ	ıı	ıı	ıı	ıı	"3x
'07x	ıı	ıı	N	⊙	ə	ə	ω	ω	
'10x	∞	∞	∅	φ	r	r	ı	ı	"4x
'11x	ı	ı	R	B	ş	ş	ı	σ	
'12x	t	t	ı	θ	ıı	ıı	ıı	U	"5x
'13x	ıı	ıı	M	χ	ıı	ıı	ıı	ıı	
'14x	ıı	ıı	ıı	ıı	ıı	ıı	ıı	ıı	"6x
'15x	'	'	'	ı	ı	ı	ı	ı	
'16x	ı	ı	ıı	ı	ı	ı	ı	ı	"7x
'17x	ı	ı	ı	ı	ı	ı	ı	ı	
	"8	"9	"A	"B	"C	"D	"E	"F	

plr10, OT4	'0	'1	'2	'3	'4	'5	'6	'7	
'00x	Γ	Δ	Θ	Λ	Ξ	Π	Σ	Υ	"0x
'01x	Φ	Ψ	Ω	ff	fi	fl	ffi	fff	
'02x	ı	ı	`	'	˘	˙	-	°	"1x
'03x	ı	ß	æ	œ	ø	Æ	Œ	Ø	
'04x	-	!	"	#	\$	%	&	'	"2x
'05x	(	)	*	+	,	-	.	/	
'06x	0	1	2	3	4	5	6	7	"3x
'07x	8	9	:	;	i	=	ı	?	
'10x	@	A	B	C	D	E	F	G	"4x
'11x	H	I	J	K	L	M	N	O	
'12x	P	Q	R	S	T	U	V	W	"5x
'13x	X	Y	Z	[	"	]	^	.	
'14x	'	a	b	c	d	e	f	g	"6x
'15x	h	i	j	k	l	m	n	o	
'16x	p	q	r	s	t	u	v	w	"7x
'17x	x	y	z	-	—	"	~	..	
'20x		Ą	Ć				Ę		"8x
'21x			Ł	Ń					
'22x		Ś							"9x
'23x		Ż		Ż					
'24x		ą	ć				ę		"Ax
'25x			ł	ń			«	»	
'26x		ś							"Bx
'27x		ż		ż					
'30x									"Cx
'31x									
'32x				Ó					"Dx
'33x									
'34x									"Ex
'35x									
'36x				ó					"Fx
'37x								"	
	"8	"9	"A	"B	"C	"D	"E	"F	

<b>ecrm1000, T1</b>	'0	'1	'2	'3	'4	'5	'6	'7	
'00x	`	´	^	~	¨	˘	◦	ˇ	"0x
'01x	˘	–	·	˙	˚	˛	◁	▷	
'02x	“	”	„	«	»	–	—		"1x
'03x	◊	ı	ı	ff	fi	fl	ffi	ffl	
'04x	˘	!	"	#	\$	%	&	'	"2x
'05x	(	)	*	+	,	-	.	/	
'06x	0	1	2	3	4	5	6	7	"3x
'07x	8	9	:	;	<	=	>	?	
'10x	@	A	B	C	D	E	F	G	"4x
'11x	H	I	J	K	L	M	N	O	
'12x	P	Q	R	S	T	U	V	W	"5x
'13x	X	Y	Z	[	\	]	^	_	
'14x	‘	a	b	c	d	e	f	g	"6x
'15x	h	i	j	k	l	m	n	o	
'16x	p	q	r	s	t	u	v	w	"7x
'17x	x	y	z	{		}	~	-	
'20x	Ă	Ą	Ć	Č	Ď	Ě	Ę	Ĝ	"8x
'21x	Ł	Ĺ	Ľ	Ń	Ñ	Đ	Ŏ	Ř	
'22x	Ŕ	Ś	Š	Ş	Ť	Ț	Ŭ	Ū	"9x
'23x	Ÿ	Ž	Ž	Ž	IJ	ı	đ	§	
'24x	ă	ą	ć	č	ď	ě	ę	ğ	"Ax
'25x	ł	ł	ł	ń	ñ	đ	ŏ	ř	
'26x	ř	ś	š	ş	ť	ț	ű	ű	"Bx
'27x	ÿ	ž	ž	ž	ij	ı	đ	£	
'30x	À	Á	Â	Ã	Ä	Å	Æ	Ç	"Cx
'31x	È	É	Ê	Ë	Ì	Í	Î	Ï	
'32x	Đ	Ñ	Ò	Ó	Ô	Õ	Ö	Œ	"Dx
'33x	Ø	Ù	Ú	Û	Ü	Ý	Þ	ŠŠ	
'34x	à	á	â	ã	ä	å	æ	ç	"Ex
'35x	è	é	ê	ë	ì	í	î	ï	
'36x	ð	ñ	ò	ó	ô	õ	ö	œ	"Fx
'37x	ø	ù	ú	û	ü	ý	þ	š	
	"8	"9	"A	"B	"C	"D	"E	"F	

larm1000, T2A	'0	'1	'2	'3	'4	'5	'6	'7	
'00x	`	´	^	~	¨	˘	◦	ˇ	"0x
'01x	˘	ˉ	·	˙	˚	I	<	>	
'02x	“	”	ˆ	˜	˚	–	—		"1x
'03x	o	ı	j	ff	fi	fl	ffi	ffl	
'04x	˘	!	"	#	\$	%	&	'	"2x
'05x	(	)	*	+	,	-	.	/	
'06x	0	1	2	3	4	5	6	7	"3x
'07x	8	9	:	;	<	=	>	?	
'10x	@	A	B	C	D	E	F	G	"4x
'11x	H	I	J	K	L	M	N	O	
'12x	P	Q	R	S	T	U	V	W	"5x
'13x	X	Y	Z	[	\	]	^	_	
'14x	‘	a	b	c	d	e	f	g	"6x
'15x	h	i	j	k	l	m	n	o	
'16x	p	q	r	s	t	u	v	w	"7x
'17x	x	y	z	{		}	~	-	
'20x	Г	Ғ	Ђ	Ѓ	Һ	Ж	Џ	Љ	"8x
'21x	Ї	Қ	К	К	Æ	Ң	Ң	Ѕ	
'22x	Ө	Ҫ	Ӣ	Ү	Ү	Х	Ц	Ч	"9x
'23x	Ч	Є	Ә	Ң	Ё	№	□	§	
'24x	г	ғ	ђ	ѓ	һ	ж	џ	љ	"Ax
'25x	ї	қ	к	к	æ	ң	ң	ѕ	
'26x	ө	ç	ӓ	ү	ү	х	ц	ч	"Bx
'27x	ч	є	ә	њ	ё	„	«	»	
'30x	А	Б	В	Г	Д	Е	Ж	З	"Cx
'31x	И	Й	К	Л	М	Н	О	П	
'32x	Р	С	Т	У	Ф	Х	Ц	Ч	"Dx
'33x	Ш	Щ	Ъ	Ы	Ь	Э	Ю	Я	
'34x	а	б	в	г	д	е	ж	з	"Ex
'35x	и	й	к	л	м	н	о	п	
'36x	р	с	т	у	ф	х	ц	ч	"Fx
'37x	ш	щ	ъ	ы	ь	э	ю	я	
	"8	"9	"A	"B	"C	"D	"E	"F	

lbrm1000, T2B	'0	'1	'2	'3	'4	'5	'6	'7	
'00x	`	´	^	~	¨	˘	◦	ˇ	"0x
'01x	˘	–	·	˙	˚	I	<	>	
'02x	“	”	ˆ	˜	˚	–	—		"1x
'03x	o	ı	j	ff	fi	fl	ffi	ffl	
'04x	˘	!	"	#	\$	%	&	'	"2x
'05x	(	)	*	+	,	-	.	/	
'06x	0	1	2	3	4	5	6	7	"3x
'07x	8	9	:	;	<	=	>	?	
'10x	@	A	B	C	D	E	F	G	"4x
'11x	H	I	J	K	L	M	N	O	
'12x	P	Q	R	S	T	U	V	W	"5x
'13x	X	Y	Z	[	\	]	^	_	
'14x	‘	a	b	c	d	e	f	g	"6x
'15x	h	i	j	k	l	m	n	o	
'16x	p	q	r	s	t	u	v	w	"7x
'17x	x	y	z	{		}	~	-	
'20x	Ғ	Ғ	Ғ	Ѓ	Һ	Ж	δ	З	"8x
'21x	Љ	Қ	Д	Ѓ	Ј	Ң	Н	Ң	
'22x	Ө	С	Ў	У	Х	Х	Х	Ҷ	"9x
'23x	Ҷ	Ң	Ә	Е	Ё	№	□	§	
'24x	ғ	ғ	ғ	ѓ	һ	ж	δ	з	"Ax
'25x	љ	қ	д	ѓ	ј	ң	н	ң	
'26x	ө	с	ў	у	х	х	х	ҷ	"Bx
'27x	ҷ	њ	ә	е	ё	„	«	»	
'30x	А	Б	В	Г	Д	Е	Ж	З	"Cx
'31x	И	Й	К	Л	М	Н	О	П	
'32x	Р	С	Т	У	Ф	Х	Ц	Ч	"Dx
'33x	Ш	Щ	Ъ	Ы	Ь	Э	Ю	Я	
'34x	а	б	в	г	д	е	ж	з	"Ex
'35x	и	й	к	л	м	н	о	п	
'36x	р	с	т	у	ф	х	ц	ч	"Fx
'37x	ш	щ	ъ	ы	ь	э	ю	я	
	"8	"9	"A	"B	"C	"D	"E	"F	



<b>lcrm1000, T2C</b>	'0	'1	'2	'3	'4	'5	'6	'7	
'00x	`	´	^	~	¨	˘	◦	ˇ	"0x
'01x	˘	ˉ	·	˙	˚	I	<	>	
'02x	“	”	ˆ	˜	˚	–	—		"1x
'03x	o	l	j	ff	fi	fl	ffi	ffl	
'04x	˘	!	"	#	\$	%	&	'	"2x
'05x	(	)	*	+	,	-	.	/	
'06x	0	1	2	3	4	5	6	7	"3x
'07x	8	9	:	;	<	=	>	?	
'10x	@	A	B	C	D	E	F	G	"4x
'11x	H	I	J	K	L	M	N	O	
'12x	P	Q	R	S	T	U	V	W	"5x
'13x	X	Y	Z	[	\	]	^	_	
'14x	‘	a	b	c	d	e	f	g	"6x
'15x	h	i	j	k	l	m	n	o	
'16x	p	q	r	s	t	u	v	w	"7x
'17x	x	y	z	{		}	~	-	
'20x	Ѓ	Ќ	В	Ђ	ћ	Ѓ	Ѓ	Ѓ	"8x
'21x	Ѓ	Ѓ	Ѓ	Ѓ	Ѓ	Ѓ	Ѓ	Ѓ	
'22x	Ө	ё	ё	Ъ	Й	Х	Ц	Q	"9x
'23x	Ч	Н	Ә	Ѓ	Ё	№	Q	§	
'24x	ц	ц	т	б	h	р	р	з	"Ax
'25x	м	қ	л	к	л	ң	м	ң	
'26x	ө	е	ё	Ъ	Й	Х	Ц	Q	"Bx
'27x	ч	н	ә	Ѓ	ё	„	«	»	
'30x	А	Б	В	Г	Д	Е	Ж	З	"Cx
'31x	И	Й	К	Л	М	Н	О	П	
'32x	Р	С	Т	У	Ф	Х	Ц	Ч	"Dx
'33x	Ш	Щ	Ъ	Ы	Ь	Э	Ю	Я	
'34x	а	б	в	г	д	е	ж	з	"Ex
'35x	и	й	к	л	м	н	о	п	
'36x	р	с	т	у	ф	х	ц	ч	"Fx
'37x	ш	щ	ъ	ы	ь	э	ю	я	
	"8	"9	"A	"B	"C	"D	"E	"F	

<b>tipa10, T3</b>	'0	'1	'2	'3	'4	'5	'6	'7	
'00x	`	'	^	~	¨	ˆ	˚	ˇ	"0x
'01x	˘	-	·	˙	˚	˛	˜	˝	
'02x	ˆ	˜	˘	˙	˚	˛	˜	˝	"1x
'03x	×	1	J	+	±	τ	±	±	
'04x	/	!	'	ˆ	˘	˙	˜	˝	"2x
'05x	(	)	*	+	,	-	.	/	
'06x	h	i	Λ	3	u	e	D	γ	"3x
'07x	θ	ϑ	:	˙	˘	=	˘	?	
'10x	ə	ɑ	β	ε	ð	ε	ϕ	γ	"4x
'11x	fi	r	j	ʁ	ʌ	ŋ	ŋ	ɔ	
'12x	ʔ	f	r	f	θ	υ	υ	u	"5x
'13x	χ	γ	3	[	'	]	˘	˘	
'14x	'	a	b	c	d	e	f	g	"6x
'15x	h	i	j	k	l	m	n	o	
'16x	p	q	r	s	t	u	v	w	"7x
'17x	x	y	z			‡	˘	,	
'20x	-	˘	˘	˘	˘	˘	˘	˘	"8x
'21x	/	-	˘	˘	˘	˘	˘	˘	
'22x	/	/			↓	↑	↗	↘	"9x
'23x	˘	˘	˘	˘	'	"	˘	˘	
'24x	b	d	d	d	E	g	l	l	"Ax
'25x	J	ʁ	ʔ	λ	λ	ʔ	u	æ	
'26x	ω	Ω	ʔ	ʔ	ʔ	ts	u	u	"Bx
'27x	3	ε	ʔ	ʔ	?	<	>		
'30x	A	C	C	ϕ	ø	ε	ε	3	"Cx
'31x	ʁ	C	ʔ	H	u	J	k	L	
'32x	ʔ	ω	β	d	r	I	t	æ	"Dx
'33x	ʔ	ʔ	u	ʔ	ʔ	ʔ	z	p	
'34x	B	b	d	d	g	G	æ	ç	"Ex
'35x	h	J	f	ʔ	ʔ	l	u	u	
'36x	N	u	O	u	ı	ı	R	œ	"Fx
'37x	ø	ʔ	t	u	z	z	p	lv	
	"8	"9	"A	"B	"C	"D	"E	"F	

<b>fcr10, T4</b>	'0	'1	'2	'3	'4	'5	'6	'7	
'00x	`	´	ˆ	˜	¨	˘	◊	˙	"0x
'01x	˘	-	·	˘	˘	,	<	>	
'02x	“	”	„	«	»	-	—		"1x
'03x	o	l	j	ff	fi	fl	ffi	ffl	
'04x	□	!	"	#	\$	%	&	'	"2x
'05x	(	)	*	+	,	-	.	/	
'06x	0	1	2	3	4	5	6	7	"3x
'07x	8	9	:	;	<	=	>	?	
'10x	@	A	B	C	D	E	F	G	"4x
'11x	H	I	J	K	L	M	N	O	
'12x	P	Q	R	S	T	U	V	W	"5x
'13x	X	Y	Z	[	\	]	^	_	
'14x	‘	a	b	c	d	e	f	g	"6x
'15x	h	i	j	k	l	m	n	o	
'16x	p	q	r	s	t	u	v	w	"7x
'17x	x	y	z	{		}	~	-	
'20x	Ɔ	Ɖ	Ɛ	Ǝ	Ƒ	Ɠ	ƕ	Ɔ	"8x
'21x	Ƒ	Ƒ	Ɔ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	
'22x	Ɔ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	"9x
'23x	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	
'24x	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	"Ax
'25x	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	
'26x	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	"Bx
'27x	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	
'30x	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	"Cx
'31x	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	
'32x	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	"Dx
'33x	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	
'34x	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	"Ex
'35x	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	
'36x	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	"Fx
'37x	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	Ƒ	
	"8	"9	"A	"B	"C	"D	"E	"F	

<b>vnr10, T5</b>	'0	'1	'2	'3	'4	'5	'6	'7	
'00x	`	'	^	~	..	.	°	˘	"0x
'01x	˘	-	·	˙	˚	,	<	>	
'02x	“	”	„	«	»	-	—	■	"1x
'03x	◦	ı	Ÿ	ÿ	Ÿ	ÿ	Đ	đ	
'04x	˘	!	"	#	\$	%	&	'	"2x
'05x	(	)	*	+	,	-	.	/	
'06x	0	1	2	3	4	5	6	7	"3x
'07x	8	9	:	;	<	=	>	?	
'10x	@	A	B	C	D	E	F	G	"4x
'11x	H	I	J	K	L	M	N	O	
'12x	P	Q	R	S	T	U	V	W	"5x
'13x	X	Y	Z	[	\	]	^	_	
'14x	'	a	b	c	d	e	f	g	"6x
'15x	h	i	j	k	l	m	n	o	
'16x	p	q	r	s	t	u	v	w	"7x
'17x	x	y	z	{		}	~	-	
'20x	À	Á	Ã	Ả	Ạ	Â	À	Á	"8x
'21x	Ã	Ẃ	Ạ	Ả	Ằ	Ẳ	Ẵ	Ẳ	
'22x	Ạ	È	É	Ê	Ë	È	Ê	Ë	"9x
'23x	É	Ë	Ẽ	Ê	Ì	Í	Ī	Ī	
'24x	à	á	ã	ả	ạ	â	à	á	"Ax
'25x	ã	Ẃ	ạ	ả	Ằ	Ẳ	Ẵ	Ẳ	
'26x	ă	è	é	ê	ë	ẹ	ê	ë	"Bx
'27x	é	ẽ	ẽ	ê	ì	í	ī	ī	
'30x	Ị	Ò	Ó	Õ	Ỏ	Ọ	Ô	Ồ	"Cx
'31x	Ố	Ỗ	Ỗ	Ỗ	Ỗ	Ỗ	Ỗ	Ỗ	
'32x	Ỗ	Ỗ	Ừ	Ứ	Ữ	Ự	Ự	Ự	"Dx
'33x	Ừ	Ứ	Ữ	Ự	Ự	Ỡ	Ỡ	Ỡ	
'34x	ì	ò	ó	õ	ỏ	ọ	ô	ồ	"Ex
'35x	ố	ỗ	ỗ	ộ	ơ	ờ	ớ	ờ	
'36x	ỗ	ợ	ù	ú	ũ	ủ	ụ	ư	"Fx
'37x	ừ	ứ	ữ	ự	ự	ỳ	ý	ỷ	
	"8	"9	"A	"B	"C	"D	"E	"F	

## A.2 Text symbol encodings

The full table for TS1 as provided by European Computer Modern family:

tcrm1000, TS1	'0	'1	'2	'3	'4	'5	'6	'7	
'00x	˘	˙	ˆ	˜	¨	˘	˚	ˇ	"0x
'01x	˘	˘	˙	˚	˛	˜			
'02x			"			—	—		"1x
'03x	←	→	ˆ	ˆ	ˆ	ˆ			
'04x	ˆ				\$			'	"2x
'05x			*		,	=	.	/	
'06x	0	1	2	3	4	5	6	7	"3x
'07x	8	9			<	—	>		
'10x									"4x
'11x						U		○	
'12x								Ω	"5x
'13x				∥		∥	↑	↓	
'14x	˘		*	o o	†				"6x
'15x					♣	∞	♩		
'16x									"7x
'17x							˘	=	
'20x	˘	˘	"	"	†	‡	∥	‰	"8x
'21x	•	°C	\$	¢	f	©	W	₯	
'22x	€	₧	£	₹	₺	₳	₴	™	"9x
'23x	‰	₧	₺	₳	₴	₵	₶	₷	
'24x	{	}	¢	£	₴	₵	₶	₷	"Ax
'25x	¨	©	ª	©	¬	®	®	—	
'26x	°	±	²	³	´	µ	¶	·	"Bx
'27x	※	¹	º	√	¼	½	¾	€	
'30x									"Cx
'31x									
'32x							×		"Dx
'33x									
'34x									"Ex
'35x									
'36x							÷		"Fx
'37x									
	"8	"9	"A	"B	"C	"D	"E	"F	

In contrast typical PostScript fonts usually have incomplete implementations of TS1 sometimes missing more than half of the glyphs:

<b>ptmr8c, TS1</b>	'0	'1	'2	'3	'4	'5	'6	'7	
'00x	`	´	^	~	¨	˘	°	˘	"0x
'01x	˘	-	·	‚	˙	‚			
'02x			„			—	—		"1x
'03x	■	■	■	■	■	■			
'04x	■				\$			'	"2x
'05x			*		,	■	.	/	
'06x	■	■	■	■	■	■	■	■	"3x
'07x	■	■			■	-	■		
'10x									"4x
'11x						■		■	
'12x								■	"5x
'13x				[		]	■	■	
'14x	`		■	■	■				"6x
'15x					■	■	■		
'16x									"7x
'17x							~	■	
'20x	˘	˘	˘	˘	‡	‡		%o	"8x
'21x	·	°C	■	■	f	■	■	■	
'22x	■	■	■	■	■	■	■	™	"9x
'23x	■	■	■	■	■	■	■	■	
'24x	■	■	¢	£	¤	¥	¦	§	"Ax
'25x	¨	©	ª	■	¬	■	®	-	
'26x	°	±	²	³	´	µ	¶	·	"Bx
'27x	■	¹	º	■	¼	½	¾	€	
'30x									"Cx
'31x									
'32x							×		"Dx
'33x									
'34x									"Ex
'35x									
'36x							÷		"Fx
'37x									
	"8	"9	"A	"B	"C	"D	"E	"F	

<b>tipx10, TS3</b>	'0	'1	'2	'3	'4	'5	'6	'7	
'00x	˘	˙	˚	˛	˜	˝	˞	˟	"0x
'01x	↑	→	↔						
'02x									"1x
'03x									
'04x	ä	ɑ	æ	ɤ	ç	ĸ	ç	ɻ	"2x
'05x	ɖ	ɔ	ɛ	ɛ	γ	γ	γ	ɦ	
'06x	ħ	ı	ı	ı	ı	ı	ı	ı	"3x
'07x	φ	⊖	ρ	ϖ	ρ	φ	ı	ı	
'10x	ı	ı	ı	ı	ı	ı	ı	ı	"4x
'11x	ı	ı							
'12x	ı	ı	ı	ı	ı	ı	ı		"5x
'13x									
'14x									"6x
'15x									
'16x	v	ɖ	Δ	F	K	κ	ı	M	"7x
'17x	P	Q	я	п					
	"8	"9	"A	"B	"C	"D	"E	"F	

### A.3 Extended text encodings

<b>rxrm1000, X2</b>	'0	'1	'2	'3	'4	'5	'6	'7	
'00x	`	´	^	˘	¨	˜	˚	ˇ	"0x
'01x	˘	ˉ	˙	˚	¸	ı	‹	›	
'02x	“	”	ˆ	˜	˘	–	—		"1x
'03x	◊	˘	˙	˚	δ	δ	Ɀ	Ɀ	
'04x	˘	!	"	#	\$	%	&	'	"2x
'05x	(	)	*	+	,	-	.	/	
'06x	0	1	2	3	4	5	6	7	"3x
'07x	8	9	:	;	<	=	>	?	
'10x	@	Æ	Ђ	Ђ	€	€	К	К	"4x
'11x	Ѓ	Ѓ	Ѓ	Ѓ	Ѓ	Ѓ	Ѓ	Ѓ	
'12x	Р	Q	Т	S	Ц	Ц	Ч	W	"5x
'13x	Ђ	Ђ	V	[	\	]	^	_	
'14x	‘	æ	ђ	ђ	е	е	к	к	"6x
'15x	л	i	j	љ	м	њ	џ	џ	
'16x	р	q	т	s	ц	ц	ч	w	"7x
'17x	ђ	Ђ	v	{		}	~	-	
'20x	Г	F	Г	Ђ	h	Ж	З	З	"8x
'21x	Ѓ	К	К	Ѓ	Ј	Ѓ	Н	Ѓ	
'22x	Ө	Ç	ÿ	Y	Y	X	X	Ч	"9x
'23x	Ч	€	Ə	ε	Ě	№	□	§	
'24x	г	ф	г	ђ	h	ж	з	з	"Ax
'25x	ї	қ	к	қ	л	ң	н	ң	
'26x	ө	ç	ÿ	Y	Y	x	x	Ч	"Bx
'27x	ч	е	ə	ε	ě	„	«	»	
'30x	A	B	B	Г	Д	E	Ж	З	"Cx
'31x	И	Й	К	Л	М	Н	О	П	
'32x	Р	С	Т	У	Ф	Х	Ц	Ч	"Dx
'33x	Ш	Щ	Ъ	Ы	Ь	Э	Ю	Я	
'34x	a	b	v	г	д	e	ж	з	"Ex
'35x	и	й	к	л	м	н	о	п	
'36x	р	с	т	у	ф	х	ц	ч	"Fx
'37x	ш	щ	ъ	ы	ь	э	ю	я	
	"8	"9	"A	"B	"C	"D	"E	"F	



## A.4 Mathematical encodings

<b>cmmi10, OML</b>	'0	'1	'2	'3	'4	'5	'6	'7	
'00x	$\Gamma$	$\Delta$	$\Theta$	$\Lambda$	$\Xi$	$\Pi$	$\Sigma$	$\Upsilon$	"0x
'01x	$\Phi$	$\Psi$	$\Omega$	$\alpha$	$\beta$	$\gamma$	$\delta$	$\epsilon$	
'02x	$\zeta$	$\eta$	$\theta$	$\iota$	$\kappa$	$\lambda$	$\mu$	$\nu$	"1x
'03x	$\xi$	$\pi$	$\rho$	$\sigma$	$\tau$	$\upsilon$	$\phi$	$\chi$	
'04x	$\psi$	$\omega$	$\varepsilon$	$\vartheta$	$\varpi$	$\varrho$	$\varsigma$	$\varphi$	"2x
'05x	$\leftarrow$	$\longleftarrow$	$\rightarrow$	$\longrightarrow$	$\leftarrow$	$\rightarrow$	$\triangleright$	$\triangleleft$	
'06x	0	1	2	3	4	5	6	7	"3x
'07x	8	9	.	,	<	/	>	*	
'10x	$\partial$	$A$	$B$	$C$	$D$	$E$	$F$	$G$	"4x
'11x	$H$	$I$	$J$	$K$	$L$	$M$	$N$	$O$	
'12x	$P$	$Q$	$R$	$S$	$T$	$U$	$V$	$W$	"5x
'13x	$X$	$Y$	$Z$	$\flat$	$\natural$	$\sharp$	$\smile$	$\frown$	
'14x	$\ell$	$a$	$b$	$c$	$d$	$e$	$f$	$g$	"6x
'15x	$h$	$i$	$j$	$k$	$l$	$m$	$n$	$o$	
'16x	$p$	$q$	$r$	$s$	$t$	$u$	$v$	$w$	"7x
'17x	$x$	$y$	$z$	$\imath$	$j$	$\wp$	$\neg$	$\sim$	
	"8	"9	"A	"B	"C	"D	"E	"F	

<b>cmsy10, OMS</b>	'0	'1	'2	'3	'4	'5	'6	'7	
'00x	-	.	$\times$	$*$	$\div$	$\diamond$	$\pm$	$\mp$	"0x
'01x	$\oplus$	$\ominus$	$\otimes$	$\oslash$	$\odot$	$\bigcirc$	$\circ$	$\bullet$	
'02x	$\asymp$	$\equiv$	$\subseteq$	$\supseteq$	$\leq$	$\geq$	$\preceq$	$\succeq$	"1x
'03x	$\sim$	$\approx$	$\subset$	$\supset$	$\ll$	$\gg$	$\prec$	$\succ$	
'04x	$\leftarrow$	$\rightarrow$	$\uparrow$	$\downarrow$	$\leftrightarrow$	$\nearrow$	$\searrow$	$\cong$	"2x
'05x	$\Leftrightarrow$	$\Rightarrow$	$\Uparrow$	$\Downarrow$	$\Leftrightarrow$	$\nearrow$	$\searrow$	$\propto$	
'06x	$\iota$	$\infty$	$\in$	$\exists$	$\Delta$	$\nabla$	/	'	"3x
'07x	$\forall$	$\exists$	$\neg$	$\emptyset$	$\Re$	$\Im$	$\top$	$\perp$	
'10x	$\aleph$	$\mathcal{A}$	$\mathcal{B}$	$\mathcal{C}$	$\mathcal{D}$	$\mathcal{E}$	$\mathcal{F}$	$\mathcal{G}$	"4x
'11x	$\mathcal{H}$	$\mathcal{I}$	$\mathcal{J}$	$\mathcal{K}$	$\mathcal{L}$	$\mathcal{M}$	$\mathcal{N}$	$\mathcal{O}$	
'12x	$\mathcal{P}$	$\mathcal{Q}$	$\mathcal{R}$	$\mathcal{S}$	$\mathcal{T}$	$\mathcal{U}$	$\mathcal{V}$	$\mathcal{W}$	"5x
'13x	$\mathcal{X}$	$\mathcal{Y}$	$\mathcal{Z}$	$\cup$	$\cap$	$\uplus$	$\wedge$	$\vee$	
'14x	$\vdash$	$\dashv$	$\lfloor$	$\rfloor$	$\lceil$	$\rceil$	$\{$	$\}$	"6x
'15x	$\langle$	$\rangle$	$ $	$\parallel$	$\updownarrow$	$\Updownarrow$	$\backslash$	$\wr$	
'16x	$\surd$	$\amalg$	$\nabla$	$\int$	$\sqcup$	$\sqcap$	$\sqsubseteq$	$\sqsupseteq$	"7x
'17x	$\S$	$\dagger$	$\ddagger$	$\clubsuit$	$\clubsuit$	$\diamond$	$\heartsuit$	$\spadesuit$	
	"8	"9	"A	"B	"C	"D	"E	"F	

cmex10, OMX	'0	'1	'2	'3	'4	'5	'6	'7	
'00x	(	)	[	]	[	]	[	]	"0x
'01x	{	}	<	>			/	\	
'02x	(	)	(	)	[	]	[	]	"1x
'03x	[	]	{	}	<	>	/	\	
'04x	(	)	[	]	[	]	[	]	"2x
'05x	{	}	<	>	/	\	/	\	
'06x	/	\	[	]	[	]			"3x
'07x	(	)	(	)	{	}	.		
'10x	\	/			<	>	⊔	⊔	"4x
'11x	§	§	⊙	⊙	⊕	⊕	⊗	⊗	
'12x	∑	∏	∫	∪	∩	⊕	∧	∨	"5x
'13x	∑	∏	∫	∪	∩	⊕	∧	∨	
'14x	∏	∏	ˆ	ˆ	ˆ	˜	˜	˜	"6x
'15x	[	]	[	]	[	]	{	}	
'16x	√	√	√	√	√		[		"7x
'17x	↑	↓	↖	↘	↙	↗	↕	↕	
	"8	"9	"A	"B	"C	"D	"E	"F	

## A.5 Other encodings

ptmr8y, LY1	'0	'1	'2	'3	'4	'5	'6	'7	
'00x					/	.	~	˘	"0x
'01x	fi				fi				
'02x	ı		˘	˘	˘	˘	-	ˆ	"1x
'03x	,	ß	æ	œ	ø	Æ	Œ	Ø	
'04x		!	"	#	\$	%	&	'	"2x
'05x	(	)	*	+	,	-	.	/	
'06x	0	1	2	3	4	5	6	7	"3x
'07x	8	9	:	;	<	=	>	?	
'10x	@	A	B	C	D	E	F	G	"4x
'11x	H	I	J	K	L	M	N	O	
'12x	P	Q	R	S	T	U	V	W	"5x
'13x	X	Y	Z	[	\	]	^	_	
'14x	‘	a	b	c	d	e	f	g	"6x
'15x	h	i	j	k	l	m	n	o	
'16x	p	q	r	s	t	u	v	w	"7x
'17x	x	y	z	{		}	~	..	
'20x	Ł	'	,	f	„	...	†	‡	"8x
'21x	^	%o	Š	<	Œ	Ž	^	-	
'22x	ł	‘	’	“	”	•	-	—	"9x
'23x	~	™	š	>	œ	ž	~	ÿ	
'24x		ı	ç	£	¤	¥	ı	§	"Ax
'25x	..	©	ª	«	¬		®	-	
'26x	°	±	²	³	´	µ	¶	·	"Bx
'27x	,	ı	°	»	¼	½	¾	¿	
'30x	À	Á	Â	Ã	Ä	Å	Æ	Ç	"Cx
'31x	È	É	Ê	Ë	Ì	Í	Î	Ï	
'32x	Ð	Ñ	Ò	Ó	Ô	Õ	Ö	×	"Dx
'33x	Ø	Ù	Ú	Û	Ü	Ý	Þ	ß	
'34x	à	á	â	ã	ä	å	æ	ç	"Ex
'35x	è	é	ê	ë	ì	í	î	ï	
'36x	ð	ñ	ò	ó	ô	õ	ö	÷	"Fx
'37x	ø	ù	ú	û	ü	ý	þ	ÿ	
	"8	"9	"A	"B	"C	"D	"E	"F	

grmn1000, LGR	'0	'1	'2	'3	'4	'5	'6	'7	
'00x	–	ˆ	⊠	⊡	⊢	⊣	⊤	⊥	"0x
'01x	ı	Aı	Hı	Ωı	A	Ÿ	α	ü	
'02x	,	\	ı	ı	ı	ı	ı	ı	"1x
'03x	€	% <sub>00</sub>	ə	ɳ	‘	’	˘	–	
'04x	˜	!	..	ˆ	ˆ	%	.	’	"2x
'05x	(	)	*	+	,	-	.	/	
'06x	0	1	2	3	4	5	6	7	"3x
'07x	8	9	:	.	˘	=	˘	;	
'10x	˜	A	B	ˆ	Δ	E	Φ	Γ	"4x
'11x	H	I	Θ	K	Λ	M	N	O	
'12x	Π	X	P	Σ	T	Υ	˘	Ω	"5x
'13x	Ξ	Ψ	Z	[	˘	]	˘	ˆ	
'14x	`	α	β	ς	δ	ε	φ	γ	"6x
'15x	η	ι	θ	κ	λ	μ	ν	ο	
'16x	π	χ	ρ	σ	τ	υ		ω	"7x
'17x	ξ	ψ	ζ	«	.	»	˘	—	
'20x	à	á	â	ã	ä	å	ä	ä	"8x
'21x	á	ă	ă	ă	ă	ă	ă	ă	
'22x	ã	ă	ă	F	ă	ă	ă	˘	"9x
'23x	ĥ	ĥ	ĥ		ĥ	ĥ	ĥ		
'24x	ĥ	ĥ	ĥ	ĥ	ĥ	ĥ	ĥ	ĥ	"Ax
'25x	ĥ	ĥ	ĥ	ĥ	ĥ	ĥ	ĥ	ĥ	
'26x	ò	ó	ò	ò	ò	ò	ò	ò	"Bx
'27x	ó	ǒ	ǒ	ǒ	ó	ǒ	ǒ	ǒ	
'30x	ǒ	ǒ	ǒ	F	ǒ	ǒ	ǒ		"Cx
'31x	ì	í	ì	ì	ù	ù	ù	ù	
'32x	í	ĩ	ĩ	ĩ	ú	ú	ú	ú	"Dx
'33x	ĩ	ĩ	ĩ	İ	ü	ü	ü	Ÿ	
'34x	è	é	è	è	ò	ó	ó	ò	"Ex
'35x	é	ě	ě	ě	ó	ǒ	ǒ	ò	
'36x	ï	ì	ì	ĩ	ü	ù	ú	ü	"Fx
'37x	φ	η	φ	ř	ř		’	’	
	"8	"9	"A	"B	"C	"D	"E	"F	

wasy10, U	'0	'1	'2	'3	'4	'5	'6	'7	
'00x	Δ	◁	◁	▷	▷	∴	∅	☎	"0x
'01x	✓	♠	♠	♠	♠	♠	♠	♠	
'02x	◀	▶	⚡	Ω	∪	∩	⊗	∩	"1x
'03x	┌	♀	♂	⊗	⊕	∞	↔	∅	
'04x	●	♻	♻	○	☾	☽	♂	♀	"2x
'05x	◁	▷	^	∨	☺	☹	⚙	☹	
'06x	∪	⊗	□	◇	⊗	⊗	✦	○	"3x
'07x	○	◊	~	~	□	□	≈	≈	
'10x	≈	✦	✦	✦	◊	✦	∇	☾	"4x
'11x	◐	◑	◑	▲	▼	§	€	₩	
'12x	∂	∩	∩	⌘	f	ə	♂	♂	"5x
'13x	♁	♂	♂	♂	♂	♂	♂	♂	
'14x	♁	♂	♂	♂	♂	♂	♂	♂	"6x
'15x	% <sub>0</sub>	♂	♂	♂	♂	♂	♂	♂	
'16x	⊞	⊞	∫	∫	∫	∫	∫	∫	"7x
'17x	∫	∫	∫	∫	∫	∫	∫	∫	
	"8	"9	"A	"B	"C	"D	"E	"F	

logo10, U	'0	'1	'2	'3	'4	'5	'6	'7	
'00x									"0x
'01x									
'02x									"1x
'03x									
'04x									"2x
'05x									
'06x									"3x
'07x									
'10x		A				E	F		"4x
'11x						M	N	O	
'12x	P			S	T				"5x
'13x									
'14x									"6x
'15x									
'16x									"7x
'17x									
	"8	"9	"A	"B	"C	"D	"E	"F	

## B Uppercase and lowercase tables

The following two sets of tables list the `\uppercase` and `\lowercase` values for each position in the L<sup>A</sup>T<sub>E</sub>X standard 256-character tables.

Each row of each table lists:

- pos      The position in the table (0-255)
- lc        The value in the `\lowercase` table at the position  
(note that value 0 here means that `\lowercase` is ineffective for this character, and hyphenation does not apply to it)
- uc        The value in the `\uppercase` table at the position  
(note that value 0 here means that `\uppercase` is ineffective for this character)
- glyphs   The glyphs specified for the T1 encoding for this position, laid out as `<glyph>(<lowercase glyph>/<uppercase glyph>)`

pos	lc	uc	glyphs	pos	lc	uc	glyphs	pos	lc	uc	glyphs	pos	lc	uc	glyphs
0	0	0	`(-/-)	32	0	0	␣(-/-)	64	0	0	@(-/-)	96	0	0	'(-/-)
1	0	0	´(-/-)	33	0	0	!(-/-)	65	97	65	A(a/A)	97	97	65	a(a/A)
2	0	0	ˆ(-/-)	34	0	0	"(-/-)	66	98	66	B(b/B)	98	98	66	b(b/B)
3	0	0	˘(-/-)	35	0	0	#(-/-)	67	99	67	C(c/C)	99	99	67	c(c/C)
4	0	0	¨(-/-)	36	0	0	\$(-/-)	68	100	68	D(d/D)	100	100	68	d(d/D)
5	0	0	¨(-/-)	37	0	0	%(-/-)	69	101	69	E(e/E)	101	101	69	e(e/E)
6	0	0	°(-/-)	38	0	0	&(-/-)	70	102	70	F(f/F)	102	102	70	f(f/F)
7	0	0	˘(-/-)	39	0	0	'(-/-)	71	103	71	G(g/G)	103	103	71	g(g/G)
8	0	0	˘(-/-)	40	0	0	((-/-)	72	104	72	H(h/H)	104	104	72	h(h/H)
9	0	0	˘(-/-)	41	0	0	)(-/-)	73	105	73	I(i/I)	105	105	73	i(i/I)
10	0	0	˘(-/-)	42	0	0	*(-/-)	74	106	74	J(j/J)	106	106	74	j(j/J)
11	0	0	˘(-/-)	43	0	0	+(-/-)	75	107	75	K(k/K)	107	107	75	k(k/K)
12	0	0	˘(-/-)	44	0	0	,(-/-)	76	108	76	L(l/L)	108	108	76	l(l/L)
13	0	0	˘(-/-)	45	45	0	-(-/-)	77	109	77	M(m/M)	109	109	77	m(m/M)
14	0	0	˘(-/-)	46	0	0	.(-/-)	78	110	78	N(n/N)	110	110	78	n(n/N)
15	0	0	˘(-/-)	47	0	0	/(-/-)	79	111	79	O(o/O)	111	111	79	o(o/O)
16	0	0	˘(-/-)	48	0	0	0(-/-)	80	112	80	P(p/P)	112	112	80	p(p/P)
17	0	0	˘(-/-)	49	0	0	1(-/-)	81	113	81	Q(q/Q)	113	113	81	q(q/Q)
18	0	0	˘(-/-)	50	0	0	2(-/-)	82	114	82	R(r/R)	114	114	82	r(r/R)
19	0	0	˘(-/-)	51	0	0	3(-/-)	83	115	83	S(s/S)	115	115	83	s(s/S)
20	0	0	˘(-/-)	52	0	0	4(-/-)	84	116	84	T(t/T)	116	116	84	t(t/T)
21	0	0	˘(-/-)	53	0	0	5(-/-)	85	117	85	U(u/U)	117	117	85	u(u/U)
22	0	0	˘(-/-)	54	0	0	6(-/-)	86	118	86	V(v/V)	118	118	86	v(v/V)
23	23	0	/(-/-)	55	0	0	7(-/-)	87	119	87	W(w/W)	119	119	87	w(w/W)
24	0	0	o(-/-)	56	0	0	8(-/-)	88	120	88	X(x/X)	120	120	88	x(x/X)
25	25	73	ı(ı/I)	57	0	0	9(-/-)	89	121	89	Y(y/Y)	121	121	89	y(y/Y)
26	26	74	ı(ı/J)	58	0	0	:(-/-)	90	122	90	Z(z/Z)	122	122	90	z(z/Z)
27	27	0	ff(ff/-)	59	0	0	;-(-/-)	91	0	0	[(-/-)	123	0	0	{(-/-)
28	0	0	fi(fi/-)	60	0	0	<(-/-)	92	0	0	\(-/-)	124	0	0	(-/-)
29	0	0	fl(fl/-)	61	0	0	=(-/-)	93	0	0	](-/-)	125	0	0	}(-/-)
30	0	0	ffi(ffi/-)	62	0	0	>(-/-)	94	0	0	˘(-/-)	126	0	0	˘(-/-)
31	0	0	ffl(ffl/-)	63	0	0	?(-/-)	95	0	0	_(-/-)	127	127	0	-(-/-)

pos	lc	uc	glyphs	pos	lc	uc	glyphs	pos	lc	uc	glyphs	pos	lc	uc	glyphs
128	160	128	À(à/À)	160	160	128	ă(ă/Ă)	192	224	192	À(à/À)	224	224	192	à(à/À)
129	161	129	Ȧ(ȧ/Ȧ)	161	161	129	ȧ(ȧ/Ȧ)	193	225	193	Á(á/Á)	225	225	193	á(á/Á)
130	162	130	Ć(ć/Ć)	162	162	130	ć(ć/Ć)	194	226	194	Â(â/Â)	226	226	194	â(â/Â)
131	163	131	Č(č/Č)	163	163	131	č(č/Č)	195	227	195	Ã(ã/Ã)	227	227	195	ã(ã/Ã)
132	164	132	Ď(d/Ď)	164	164	132	ď(d/Ď)	196	228	196	Ä(ä/Ä)	228	228	196	ä(ä/Ä)
133	165	133	Ě(ě/Ě)	165	165	133	ě(ě/Ě)	197	229	197	Å(å/Å)	229	229	197	å(å/Å)
134	166	134	Ɛ(ɛ/Ɛ)	166	166	134	ɛ(ɛ/Ɛ)	198	230	198	Æ(æ/Æ)	230	230	198	æ(æ/Æ)
135	167	135	Ǧ(ǧ/Ǧ)	167	167	135	ǧ(ǧ/Ǧ)	199	231	199	Ç(ç/Ç)	231	231	199	ç(ç/Ç)
136	168	136	Í(í/Í)	168	168	136	í(í/Í)	200	232	200	È(è/È)	232	232	200	è(è/È)
137	169	137	Ĺ(ĺ/Ĺ)	169	169	137	ĺ(ĺ/Ĺ)	201	233	201	É(é/É)	233	233	201	é(é/É)
138	170	138	Ł(ł/Ł)	170	170	138	ł(ł/Ł)	202	234	202	Ê(ê/Ê)	234	234	202	ê(ê/Ê)
139	171	139	Ń(ń/Ń)	171	171	139	ń(ń/Ń)	203	235	203	Ë(ë/Ë)	235	235	203	ë(ë/Ë)
140	172	140	Ň(ň/Ň)	172	172	140	ň(ň/Ň)	204	236	204	İ(ı/İ)	236	236	204	ı(ı/İ)
141	173	141	Ɖ(ɖ/Ɖ)	173	173	141	ɖ(ɖ/Ɖ)	205	237	205	Í(í/Í)	237	237	205	í(í/Í)
142	174	142	Ǫ(ǫ/Ǫ)	174	174	142	ǫ(ǫ/Ǫ)	206	238	206	Î(î/Î)	238	238	206	î(î/Î)
143	175	143	Ŕ(ř/Ŕ)	175	175	143	ř(ř/Ŕ)	207	239	207	Ï(ï/Ï)	239	239	207	ï(ï/Ï)
144	176	144	Ř(ř/Ř)	176	176	144	ř(ř/Ř)	208	240	208	Ð(ð/Ð)	240	240	208	ð(ð/Ð)
145	177	145	Ś(ś/Ś)	177	177	145	ś(ś/Ś)	209	241	209	Ń(ń/Ń)	241	241	209	ń(ń/Ń)
146	178	146	Ŝ(ŝ/Ŝ)	178	178	146	ŝ(ŝ/Ŝ)	210	242	210	Ò(ò/Ò)	242	242	210	ò(ò/Ò)
147	179	147	Ș(ș/Ș)	179	179	147	ș(ș/Ș)	211	243	211	Ó(ó/Ó)	243	243	211	ó(ó/Ó)
148	180	148	Ț(ț/Ț)	180	180	148	ț(ț/Ț)	212	244	212	Ô(ô/Ô)	244	244	212	ô(ô/Ô)
149	181	149	Ț(ț/Ț)	181	181	149	ț(ț/Ț)	213	245	213	Õ(õ/Õ)	245	245	213	õ(õ/Õ)
150	182	150	Ů(ů/Ů)	182	182	150	ů(ů/Ů)	214	246	214	Ö(ö/Ö)	246	246	214	ö(ö/Ö)
151	183	151	Ű(ű/Ű)	183	183	151	ű(ű/Ű)	215	247	215	Ɔ(œ/Ɔ)	247	247	215	œ(œ/Ɔ)
152	184	152	Ỳ(ỳ/Ỳ)	184	184	152	ỳ(ỳ/Ỳ)	216	248	216	Ø(ø/Ø)	248	248	216	ø(ø/Ø)
153	185	153	Ž(ž/Ž)	185	185	153	ž(ž/Ž)	217	249	217	Ù(ù/Ù)	249	249	217	ù(ù/Ù)
154	186	154	Ž(ž/Ž)	186	186	154	ž(ž/Ž)	218	250	218	Ú(ú/Ú)	250	250	218	ú(ú/Ú)
155	187	155	Ž(ž/Ž)	187	187	155	ž(ž/Ž)	219	251	219	Û(û/Û)	251	251	219	û(û/Û)
156	188	156	IJ(ij/IJ)	188	188	156	ij(ij/IJ)	220	252	220	Ü(ü/Ü)	252	252	220	ü(ü/Ü)
157	105	157	Í(i/Í)	189	0	0	ı(-/-)	221	253	221	Ý(ý/Ý)	253	253	221	ý(ý/Ý)
158	158	208	đ(đ/Đ)	190	0	0	ı(-/-)	222	254	222	Ɔ(ɓ/Ɔ)	254	254	222	ɓ(ɓ/Ɔ)
159	0	0	§(-/-)	191	0	0	£(-/-)	223	255	223	SS(ß/SS)	255	255	223	ß(ß/SS)