

L^AT_EX 2_ε font selection

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1 Introduction

This document describes the new font selection features of the L^AT_EX Document Preparation System. It is intended for package writers who want to write font-loading packages similar to `times` or `latexsym`. This document is only a brief introduction to the new facilities and is intended for package writers who are familiar with T_EX fonts and L^AT_EX packages. It is *neither* a user-guide *nor* a reference manual for fonts in L^AT_EX 2_ε.

1.1 L^AT_EX 2_ε fonts

The most important difference between L^AT_EX 2.09 and L^AT_EX 2_ε is the way that fonts are selected. In L^AT_EX 2.09, the Computer Modern fonts were built into the L^AT_EX format, and so customizing L^AT_EX to use other fonts was a major effort.

In L^AT_EX 2_ε, very few fonts are built into the format, and there are commands to load new text and math fonts. Packages such as `times` or `latexsym` allow authors to access these fonts. This document describes how to write similar font-loading packages.

The L^AT_EX 2_ε font selection system was first released as the ‘New Font Selection Scheme’ (NFSS) in 1989, and then in release 2 in 1993. L^AT_EX 2_ε includes NFSS release 2 as standard.

1.2 Overview

This document contains an overview of the new font commands of L^AT_EX.

Section 2 describes the commands for selecting fonts in classes and packages.

It lists the five L^AT_EX font attributes, and lists the commands for selecting fonts. It also describes how to customize the author commands such as `\textrm` and `\textit` to suit your document design.

Section 3 explains the commands for controlling L^AT_EX math fonts. It describes how to specify new math fonts and new math symbols.

Section 4 explains how to install new fonts into L^AT_EX. It shows how L^AT_EX font attributes are turned into T_EX font names, and how to specify your own fonts using font definition files.

Section 5 discusses text font encodings. It describes how to declare a new encoding and how to define commands, such as `\AE` or `\"`, which have different definitions in different encodings, depending on whether ligatures, etc. are available in the encoding.

Section 6 covers font miscellanea. It describes how \LaTeX performs font substitution, how to customize fonts that are preloaded in the \LaTeX format, and the naming conventions used in \LaTeX font selection.

1.3 Further information

For a general introduction to \LaTeX , including the new features of $\LaTeX 2_{\epsilon}$, you should read *\LaTeX : A Document Preparation System*, Leslie Lamport, Addison Wesley, 2nd ed, 1994.

A more detailed description of the \LaTeX font selection scheme is to be found in *The \LaTeX Companion*, Goossens, Mittelbach and Samarin, Addison Wesley, 1994.

The \LaTeX font selection scheme is based on \TeX , which is described by its developer in *The \TeX book*, Donald E. Knuth, Addison Wesley, 1986, revised in 1991 to include the features of $\TeX 3$.

Sebastian Rahtz's `psnffs` software contains the software for using a large number of Type 1 fonts (including the Adobe Laser Writer 35 and the Monotype CD-ROM fonts) in \LaTeX . It should be available from the same source as your copy of \LaTeX .

The `psnffs` software uses fonts generated by Alan Jeffrey's `fontinst` software. This can convert fonts from Adobe Font Metric format into a format readable by \LaTeX , including the generation of the `.fd` files described in Section 4. The `fontinst` software should be available from the same source as your copy of \LaTeX .

Whenever practical, \LaTeX uses the font naming scheme described in *Filenames for fonts*, Karl Berry, *TUGboat* 11(4), 1990.

The class-writer's guide *$\LaTeX 2_{\epsilon}$ for Class and Package Writers* describes the new \LaTeX features for writers of document classes and packages and is kept in `clsguide.tex`.

We are gradually turning the source code for \LaTeX into a \LaTeX document *\LaTeX : the program*. This document includes an index of \LaTeX commands and can be typeset from `source2e.tex`.

For more information about \TeX and \LaTeX , please contact your local \TeX Users Group, or the international \TeX Users Group, P. O. Box 869, Santa Barbara, CA 93102-0869, USA, Fax: +1 805 963 8358, E-mail: tug@tug.org.

2 Text fonts

This section describes the commands available to class and package writers for specifying and selecting fonts.

2.1 Text font attributes

Every text font in \LaTeX has five *attributes*:

encoding This specifies the order that characters appear in the font. The two most common text encodings used in \LaTeX are Knuth's 'T_EX text' encoding, and the 'T_EX text extended' encoding developed by the T_EX Users Group members during a T_EX Conference at Cork in 1990 (hence its informal name 'Cork encoding').

family The name for a collection of fonts, usually grouped under a common name by the font foundry. For example, 'Adobe Times', 'ITC Garamond', and Knuth's 'Computer Modern Roman' are all font families.

series How heavy or expanded a font is. For example, 'medium weight', 'narrow' and 'bold extended' are all series.

shape The form of the letters within a font family. For example, 'italic', 'oblique' and 'upright' (sometimes confusingly called 'roman') are all font shapes.

size The design size of the font, for example '10pt'.

The possible values for these attributes are given short acronyms by \LaTeX . The most common values for the font encoding are:

OT1	T _E X text
T1	T _E X extended text
OML	T _E X math italic
OMS	T _E X math symbols
OMX	T _E X math large symbols
U	Unknown
L $\langle xx \rangle$	A local encoding

The 'local' encodings are intended for font encodings which are only locally available, for example a font containing a university logo in various sizes.

There are far too many font families to list them all, but some common ones are:

cmr Computer Modern Roman
cmss Computer Modern Sans
cmtt Computer Modern Typewriter
cmm Computer Modern Math Italic
cmsy Computer Modern Math Symbols
cmex Computer Modern Math Extensions
ptm Adobe Times
phv Adobe Helvetica
pcr Adobe Courier

The most common values for the font series are:

m Medium
b Bold
bx Bold extended
sb Semi-bold
c Condensed

The most common values for the font shape are:

n Normal (that is ‘upright’ or ‘roman’)
it Italic
sl Slanted (or ‘oblique’)
sc Caps and small caps

The font size is specified as a dimension, for example **10pt** or **1.5in** or **3mm**. These five parameters specify every \LaTeX font, for example:

<i>\LaTeX specification</i>	<i>Font</i>	<i>$T_{E}X$ font name</i>
OT1 cmr m n 10pt	Computer Modern Roman 10pt	cmr10
OT1 cmss m sl 12pt	Computer Modern Sans Oblique 12pt	cmssi12
OML cmm m it 10pt	Computer Modern Math Italic 10pt	cmmi10
T1 ptm b it 18pt	Adobe Times Bold Italic 18pt	ptmbq at 18pt

These five parameters are displayed whenever \LaTeX gives an overfull box warning, for example:

```
Overfull \hbox (3.80855pt too wide) in paragraph at lines 314--318
[]\OT1/cmr/m/n/10 Normally [] and [] will be iden-ti-cal,
```

The author commands for fonts set the five attributes:

<i>Author command</i>	<i>Attribute</i>	<i>Value in article class</i>
<code>\textrm{..}</code> or <code>\rmfamily</code>	family	cmr
<code>\textsf{..}</code> or <code>\sffamily</code>	family	cmss
<code>\texttt{..}</code> or <code>\ttfamily</code>	family	cmtt
<code>\textmd{..}</code> or <code>\mdseries</code>	series	m
<code>\textbf{..}</code> or <code>\bfseries</code>	series	bx
<code>\textup{..}</code> or <code>\upshape</code>	shape	n
<code>\textit{..}</code> or <code>\itshape</code>	shape	it
<code>\textsl{..}</code> or <code>\slshape</code>	shape	sl
<code>\textsc{..}</code> or <code>\scshape</code>	shape	sc
<code>\tiny</code>	size	5pt
<code>\scriptsize</code>	size	7pt
<code>\footnotesize</code>	size	8pt
<code>\small</code>	size	9pt
<code>\normalsize</code>	size	10pt
<code>\large</code>	size	12pt
<code>\Large</code>	size	14.4pt
<code>\LARGE</code>	size	17.28pt
<code>\huge</code>	size	20.74pt
<code>\Huge</code>	size	24.88pt

The values used by these commands are determined by the document class, using the parameters defined in Section 2.4.

Note that there are no author commands for selecting new encodings. These should be provided by packages, such as the `fontenc` package.

This section does not explain how L^AT_EX font specifications are turned into T_EX font names. This is described in Section 4.

2.2 Selection commands

The low-level commands used to select a text font are as follows.

<code>\fontencoding {<i>encoding</i>}</code>
<code>\fontfamily {<i>family</i>}</code>
<code>\fontseries {<i>series</i>}</code>
<code>\fontshape {<i>shape</i>}</code>
<code>\fontsize {<i>size</i>} {<i>baselineskip</i>}</code>

Each of these commands sets one of the font attributes; `\fontsize` also sets `\baselineskip`. The actual font in use is not altered by these commands, but the current attributes are used to determine which font to use after the next `\selectfont` command.

`\selectfont`

Selects a text font, based on the current values of the font attributes.

Warning: there *must* be a `\selectfont` command immediately after any settings of the font parameters by (some of) the five `\font⟨parameter⟩` commands, before any following text. For example, it is legal to say:

```
\fontfamily{ptm}\fontseries{b}\selectfont Some text.
```

but it is *not* legal to say:

```
\fontfamily{ptm} Some \fontseries{b}\selectfont text.
```

You may get unexpected results if you put text between a `\font⟨parameter⟩` command and a `\selectfont`.

`\usefont {⟨encoding⟩} {⟨family⟩} {⟨series⟩} {⟨shape⟩}`

A short hand for the equivalent `\font...` commands followed by a call to `\selectfont`.

2.3 Internals

The current values of the font attributes are held in internal macros.

```
\f@encoding  
\f@family  
\f@series  
\f@shape  
\f@size  
\f@baselineskip  
\tf@size  
\sf@size  
\ssf@size
```

These hold the current values of the encoding, the family, the series, the shape, the size, the baseline skip, the main math size, the script math size and the scriptscript math size. The last four are accessible only within a formula; outside of it they may contain arbitrary values.

For example, to set the size to 12 without changing the baseline skip:

```
\fontsize{12}{\f@baselineskip}
```

However, you should *never* alter the values of the internal commands directly; they must only be modified using the low-level commands like `\fontfamily`, `\fontseries`, etc. If you disobey this warning you might produce code that loops.

2.4 Parameters for author commands

The parameter values set by author commands such as `\textrm` and `\rmfamily`, etc. are not hard-wired into L^AT_EX; instead these commands use the values of a number of parameters set by the document class and packages. For example, `\rmdefault` is the name of the default family selected by `\textrm` and `\rmfamily`. Thus to set a document in Adobe Times, Helvetica and Courier, the document designer specifies:

```
\renewcommand{\rmdefault}{ptm}
\renewcommand{\sfdefault}{phv}
\renewcommand{\ttdefault}{pcr}
```

<code>\encodingdefault</code>
<code>\familydefault</code>
<code>\seriesdefault</code>
<code>\shapedefault</code>

The encoding, family, series and shape of the main body font. By default these are OT1, `\rmdefault`, m and n. Note that since the default family is `\rmdefault`, this means that changing `\rmdefault` will change the main body font of the document.

<code>\rmdefault</code>
<code>\sfdefault</code>
<code>\ttdefault</code>

The families selected by `\textrm`, `\rmfamily`, `\textsf`, `\sffamily`, `\texttt` and `\ttfamily`. By default these are `cmr`, `cmss` and `cmtt`.

<code>\bfdefault</code>
<code>\mddefault</code>

The series selected by `\textbf`, `\bfseries`, `\textmd` and `\mdseries`. By default these are `bx` and `m`. These values are suitable for the default families used. If other fonts are used as standard document fonts, for example, some PostScript fonts, it might be necessary to adjust the value of `\bfdefault` to `b` since only a few such families have ‘bold extended’ series. An alternative (taken for the fonts provided by `psnfss`) is to define silent substitutions from `bx` series to `b` series with special `\DeclareFontShape` declarations and the `ssub` size function, see Section 4.4.

```
\itdefault
\sldefault
\scdefault
\updefault
```

The shapes selected by `\textit`, `\itshape`, `\textsl`, `\slshape`, `\textsc`, `\scshape`, `\textup` and `\upshape`. By default these are `it`, `sl`, `sc` and `n`.

Note that there are no parameters for the size commands. These should be defined directly in class files, for example:

```
\renewcommand{\normalsize}{\fontsize{10}{12}\selectfont}
```

More elaborate examples (setting additional parameters when the text size is changed) can be found in `classes.dtx` the source documentation for the classes `article`, `report`, and `book`.

2.5 Special font declaration commands

```
\DeclareFixedFont {<cmd>} {<cdp>} {<family>} {<series>} {<shape>} {<size>}
```

Declares command `<cmd>` to be a font switch which selects the font that is specified by the attributes `<cdp>`, `<family>`, `<series>`, `<shape>`, and `<size>`.

The font is selected without any adjustments to baselineskip and other surrounding conditions.

This example makes `\picturechar .` select a small dot very quickly:

```
\DeclareFixedFont{\picturechar}{OT1}{cmr}{m}{n}{5}
```

```
\DeclareTextFontCommand {<cmd>} {<font-switches>}
```

Declares command `<cmd>` to be a font command with one argument. The current font attributes are locally modified by `<font-switches>` and then the argument of `<cmd>` is typeset in the resulting new font.

Commands defined by `\DeclareTextFontCommand` automatically take care of any necessary italic correction (on either side).

The following example shows how `\textrm` is defined by the kernel.

```
\DeclareTextFontCommand{\textrm}{\rmfamily}
```

To define a command that always typeset its argument in the italic shape of the main document font you could declare:

```
\DeclareTextFontCommand{\normalit}{\normalfont\itshape}
```

This declaration can be used to change the meaning of a command; if $\langle cmd \rangle$ is already defined, a log that it has been redefined is put in the transcript file.

```
\DeclareOldFontCommand { $\langle cmd \rangle$ } { $\langle text-switch \rangle$ } { $\langle math-switch \rangle$ }
```

Declares command $\langle cmd \rangle$ to be a font switch (i.e. used with the syntax $\{\langle cmd \rangle \dots\}$) having the definition $\langle text-switch \rangle$ when used in text and the definition $\langle math-switch \rangle$ when used in a formula. Math alphabet commands, like $\backslash\mathit$, when used within $\langle math-switch \rangle$ should not have an argument. Their use in this argument causes their semantics to change so that they here act as a font switch, as required by the usage of the $\langle cmd \rangle$.

This declaration is useful for setting up commands like $\backslash\rm$ to behave as they did in L^AT_EX 2.09. We strongly urge you *not* to misuse this declaration to invent new font commands.

The following example defines $\backslash\it$ to produce the italic shape of the main document font if used in text and to switch to the font that would normally be produced by the math alphabet $\backslash\mathit$ if used in a formula.

```
\DeclareOldFontCommand{\it}{\normalfont\itshape}{\mathit}
```

This declaration can be used to change the meaning of a command; if $\langle cmd \rangle$ is already defined, a log that it has been redefined is put in the transcript file.

3 Math fonts

This section describes the commands available to class and package writers for specifying math fonts and math commands.

3.1 Math font attributes

The selection of fonts within math mode is quite different to that of text fonts.

Some math fonts are selected explicitly by one-argument commands such as $\backslash\mathsf{\max}$ or $\backslash\mathbf{\vec}$: these are called *math alphabets*. These math alphabet commands affect only the font used for letters and symbols of type $\backslash\mathalpha$ (see Section 3.6); other symbols within the argument will be left unchanged. The predefined math alphabets are:

<i>Alphabet</i>	<i>Description</i>	<i>Example</i>
<code>\mathnormal</code>	default	<i>abcXYZ</i>
<code>\mathrm</code>	roman	<i>abcXYZ</i>
<code>\mathbf</code>	bold roman	abcXYZ
<code>\mathsf</code>	sans serif	<i>abcXYZ</i>
<code>\mathit</code>	text italic	<i>abcXYZ</i>
<code>\mathtt</code>	typewriter	abcXYZ
<code>\mathcal</code>	calligraphic	<i>ℳℴℵ</i>

Other math fonts are selected implicitly by \TeX for symbols, with commands such as `\oplus` (producing \oplus) or with straight characters like $>$ or $+$. Fonts containing such math symbols are called *math symbol fonts*. The predefined math symbol fonts are:

<i>Symbol font</i>	<i>Description</i>	<i>Example</i>
<code>operators</code>	symbols from <code>\mathrm</code>	[+]
<code>letters</code>	symbols from <code>\mathnormal</code>	$< * >$
<code>symbols</code>	most \LaTeX symbols	$\leq * \geq$
<code>bigsymbols</code>	large symbols	$\Sigma \Pi f$

Some math fonts are both *math alphabets* and *math symbol fonts*, for example `\mathrm` and `operators` are the same font, and `\mathnormal` and `letters` are the same font.

Math fonts in \LaTeX have the same five attributes as text fonts: encoding, family, series, shape and size. However, there are no commands that allow the attributes to be individually changed. Instead, the conversion from math fonts to these five attributes is controlled by the *math version*. For example, the `normal` math version maps:

<i>Math font</i>		<i>External font</i>
<i>Alphabets</i>	<i>Symbol fonts</i>	<i>Attributes</i>
<code>\mathnormal</code>	<code>letters</code>	OML cmm m it
<code>\mathrm</code>	<code>operators</code>	OT1 cmr m n
<code>\mathcal</code>	<code>symbols</code>	OMS cmsy m n
	<code>bigsymbols</code>	OMX cmex m n
<code>\mathbf</code>		OT1 cmr bx n
<code>\mathsf</code>		OT1 cmss m n
<code>\mathit</code>		OT1 cmr m it
<code>\mathtt</code>		OT1 cmtt m n

The `bold` math version is similar except that it contains bold fonts. The command `\boldmath` selects the `bold` math version.

Math versions can only be changed outside of math mode.

The two predefined math versions are:

`normal` the default math version
`bold` the bold math version

Packages may define new math alphabets, math symbol fonts, and math versions. This section describes the commands for writing such packages.

3.2 Selection commands

There are no commands for selecting symbol fonts. Instead, these are selected indirectly through symbol commands like `\oplus`. Section 3.6 explains how to define symbol commands.

```
\mathnormal{⟨math⟩}  
\mathcal{⟨math⟩}  
\mathrm{⟨math⟩}  
\mathbf{⟨math⟩}  
\mathsf{⟨math⟩}  
\mathit{⟨math⟩}  
\mathtt{⟨math⟩}
```

Each math alphabet is a command which can only be used inside math mode. For example, `$x + \mathsf{y} + \mathcal{Z}$` produces $x + y + \mathcal{Z}$.

```
\mathversion{⟨version-name⟩}
```

This command selects a math version; it can only be used outside math mode. For example, `\boldmath` is defined to be `\mathversion{bold}`.

3.3 Declaring math versions

```
\DeclareMathVersion {⟨version-name⟩}
```

Defines `⟨version-name⟩` to be a math version.

The newly declared version is initialized with the defaults for all symbol fonts and math alphabets declared so far (see the commands `\DeclareSymbolFont` and `\DeclareMathAlphabet`).

If used on an already existing version, an information message is written to the transcript file and all previous `\SetSymbolFont` or `\SetMathAlphabet` declarations for this version are overwritten by the math alphabet and symbol font defaults, i.e. one ends up with a virgin math version.

Example:

```
\DeclareMathVersion{normal}
```

3.4 Declaring math alphabets

```
\DeclareMathAlphabet {⟨math-α⟩} {⟨cđ⟩} {⟨family⟩} {⟨series⟩} {⟨shape⟩}
```

Defines $\langle math-α \rangle$ to be a new math alphabet.

The arguments $\langle cđ \rangle$ $\langle family \rangle$ $\langle series \rangle$ $\langle shape \rangle$ are the default values for this math alphabet in all math versions; these can be reset later for a particular math version by a `\SetMathAlphabet` command. If $\langle shape \rangle$ is empty then the $\langle math-α \rangle$ is declared to be invalid in all versions, unless it is set by a later `\SetMathAlphabet` command.

Checks that $\langle math-α \rangle$ can be used and that $\langle cđ \rangle$ is a valid encoding scheme.

In these examples, `\foo` is defined everywhere but `\baz`, by default, is defined nowhere.

```
\DeclareMathAlphabet{\foo}{OT1}{cmtt}{m}{n}
\DeclareMathAlphabet{\baz}{OT1}{-}{-}{-}
```

```
\SetMathAlphabet {⟨math-α⟩} {⟨version-name⟩}
                {⟨cđ⟩} {⟨family⟩} {⟨series⟩} {⟨shape⟩}
```

Changes, or sets, the font for the math alphabet $\langle math-α \rangle$ in math version $\langle version-name \rangle$ to $\langle cđ \rangle \langle family \rangle \langle series \rangle \langle shape \rangle$.

Checks that $\langle math-α \rangle$ is a math alphabet, $\langle version-name \rangle$ is a math version and $\langle cđ \rangle$ is a known encoding scheme.

This example defines `\baz` for the ‘normal’ math version only:

```
\SetMathAlphabet\baz{normal}{OT1}{cmss}{m}{n}
```

Note that this declaration is not used for all math alphabets: Section 3.5 describes `\DeclareSymbolFontAlphabet`, which is used to set up math alphabets contained in fonts which have are declared as symbol fonts.

3.5 Declaring symbol fonts

```
\DeclareSymbolFont {⟨sym-font-name⟩} {⟨cđ⟩} {⟨family⟩} {⟨series⟩} {⟨shape⟩}
```

Defines $\langle sym-font-name \rangle$ to be a new symbol font.

The arguments $\langle cđ \rangle$ $\langle family \rangle$ $\langle series \rangle$ $\langle shape \rangle$ are the default values for this symbol font in all math versions; these can be reset later for a particular math version by a `\SetSymbolFont` command.

Checks that $\langle sym\text{-font-name} \rangle$ can be used and that $\langle cdp \rangle$ is a declared encoding scheme.

For example, the following sets up the first four standard math symbol fonts:

```
\DeclareSymbolFont{operators}{OT1}{cmr}{m}{n}
\DeclareSymbolFont{letters}{OML}{cmm}{m}{it}
\DeclareSymbolFont{symbols}{OMS}{cmsy}{m}{n}
\DeclareSymbolFont{largesymbols}{OMX}{cmex}{m}{n}
```

```
\SetSymbolFont { $\langle sym\text{-font-name} \rangle$ } { $\langle version\ name \rangle$ }
               { $\langle cdp \rangle$ } { $\langle family \rangle$ } { $\langle series \rangle$ } { $\langle shape \rangle$ }
```

Changes the symbol font $\langle sym\text{-font-name} \rangle$ for math version $\langle version\ name \rangle$ to $\langle cdp \rangle$ $\langle family \rangle$ $\langle series \rangle$ $\langle shape \rangle$.

Checks that $\langle sym\text{-font-name} \rangle$ is a symbol font, $\langle version\ name \rangle$ is a known math version and $\langle cdp \rangle$ is a declared encoding scheme.

For example, the following come from the set up of the ‘bold’ math version:

```
\SetSymbolFont{operators}{bold}{OT1}{cmr}{bx}{n}
\SetSymbolFont{letters}{bold}{OML}{cmm}{b}{it}
```

```
\DeclareSymbolFontAlphabet { $\langle math\text{-alph} \rangle$ } { $\langle sym\text{-font-name} \rangle$ }
```

Allows the previously declared symbol font $\langle sym\text{-font-name} \rangle$ to be also the math alphabet $\langle id \rangle$ (in all math versions).

This declaration should be used in preference to `\DeclareMathAlphabet` and `\SetMathAlphabet` when a math alphabet is the same as a symbol font; this is because it makes better use of the limited number (only 16) of T_EX’s math groups.

Checks that $\langle math\text{-alph} \rangle$ can be defined and that $\langle sym\text{-font-name} \rangle$ is a symbol font.

Example:

```
\DeclareSymbolFontAlphabet{\mathrm}{operators}
\DeclareSymbolFontAlphabet{\mathcal}{symbols}
```

3.6 Declaring math symbols

```
\DeclareMathSymbol { $\langle symbol \rangle$ } { $\langle type \rangle$ } { $\langle sym\text{-font-name} \rangle$ } { $\langle slot \rangle$ }
```

The $\langle symbol \rangle$ can be either a single character such as ‘>’, or a macro name, such as `\sum`.

Defines the $\langle symbol \rangle$ to be a math symbol of type $\langle type \rangle$ in slot $\langle slot \rangle$ of symbol font $\langle sym-font-name \rangle$. The $\langle type \rangle$ can be given as a number or as a command:

<i>Type</i>	<i>Meaning</i>	<i>Example</i>
0 or <code>\mathord</code>	Ordinary	α
1 or <code>\mathop</code>	Large operator	\sum
2 or <code>\mathbin</code>	Binary operation	\times
3 or <code>\mathrel</code>	Relation	\leq
4 or <code>\mathopen</code>	Opening	\langle
5 or <code>\mathclose</code>	Closing	\rangle
6 or <code>\mathpunct</code>	Punctuation	$;$
7 or <code>\mathalpha</code>	Alphabet character	A

Only symbols of type `\mathalpha` will be affected by math alphabet commands: within the argument of a math alphabet command they will produce the character in slot $\langle slot \rangle$ of that math alphabet's font. Symbols of other types will always produce the same symbol (within one math version).

`\DeclareMathSymbol` allows a macro $\langle symbol \rangle$ to be redefined only if it was previously defined to be a math symbol. It also checks that the $\langle sym-font-name \rangle$ is a declared symbol font.

Example:

```
\DeclareMathSymbol{\alpha}{0}{letters}{"OB}
\DeclareMathSymbol{\lessdot}{\mathbin}{AMSb}{"OC}
\DeclareMathSymbol{\foo}{\mathalpha}{AMSb}{"OC}
```

```
\DeclareMathDelimiter{\langle cmd \rangle}{\langle type \rangle}{\langle sym-font-name-1 \rangle}{\langle slot-1 \rangle}
{\langle sym-font-name-2 \rangle}{\langle slot-2 \rangle}
```

Defines $\langle cmd \rangle$ to be a math delimiter where the small variant is in slot $\langle slot-1 \rangle$ of symbol font $\langle sym-font-name-1 \rangle$ and the large variant is in slot $\langle slot-2 \rangle$ of symbol font $\langle sym-font-name-2 \rangle$. Both symbol fonts must have been declared previously.

Checks that $\langle sym-font-name-i \rangle$ are both declared symbol fonts.

If \TeX is not looking for a delimiter, $\langle cmd \rangle$ is treated just as if it had been defined with `\DeclareMathSymbol` using $\langle type \rangle$, $\langle sym-font-name-1 \rangle$ and $\langle slot-1 \rangle$. In other words, if a command is defined as a delimiter then this automatically defines it as a math symbol.

Example:

```
\DeclareMathDelimiter{\langle langle \rangle}{\mathopen}{symbols}{"68}
{\largesymbols}{"0A}
```

```
\DeclareMathAccent <cmd> <type> <sym-font-name> <slot>
```

Defines $\langle cmd \rangle$ to act as a math accent.

The accent character comes from slot $\langle slot \rangle$ in $\langle sym-font-name \rangle$. The $\langle type \rangle$ can be either `\mathord` or `\mathalpha`; in the latter case the accent character changes font when used in a math alphabet.

Example:

```
\DeclareMathAccent{\acute}{\mathalpha}{operators}{"13}
\DeclareMathAccent{\vec}{\mathord}{letters}{"7E}
```

```
\DeclareMathRadical <cmd> <sym-font-name-1> <slot-1>
                    <sym-font-name-2> <slot-2>
```

Defines $\langle cmd \rangle$ to be a radical where the small variant is in slot $\langle slot-1 \rangle$ of symbol font $\langle sym-font-name-1 \rangle$ and the large variant is in slot $\langle slot-2 \rangle$ of symbol font $\langle sym-font-name-2 \rangle$. Both symbol fonts must have been declared previously.

Example (probably the only use for it!):

```
\DeclareMathRadical{\sqrt}{symbols}{"70}{largesymbols}{"70}
```

3.7 Declaring math sizes

```
\DeclareMathSizes <t-size> <mt-size> <s-size> <ss-size>
```

Declares that $\langle mt-size \rangle$ is the math text size, $\langle s-size \rangle$ is the script size and $\langle ss-size \rangle$ the scriptscript size to be used in math, when $\langle t-size \rangle$ is the current text size. For text sizes for which no such declaration is given the script and scriptscript size will be calculated and then fonts are loaded for the calculated sizes or the best approximation (this may result in a warning message).

Normally, $\langle t-size \rangle$ and $\langle mt-size \rangle$ will be identical; however, if, for example, PostScript text fonts are mixed with bit-map math fonts then you may not have available a $\langle mt-size \rangle$ for every $\langle t-size \rangle$.

Example:

```
\DeclareMathSizes{13.82}{12.4}{10}{7}
```

4 Font installation

This section explains how L^AT_EX's font attributes are turned into T_EX font specifications.

4.1 Font definition files

The description of how L^AT_EX font attributes are turned into T_EX fonts is usually kept in a *font definition* (`.fd`) file. The `.fd` file for family $\langle family \rangle$ in encoding $\langle cdp \rangle$ is called $\langle cdp \rangle \langle family \rangle .fd$, for example `OT1cmr.fd` for Computer Modern Roman or `T1ptm.fd` for Adobe Times.

Whenever L^AT_EX encounters an encoding/family combination that it does not know (e.g. if the document designer says `\fontfamily{ptm}\selectfont`) then L^AT_EX attempts to load the appropriate `.fd` file. “Not known” means: there was no `\DeclareFontFamily` declaration issued for this encoding/family combination.

The declarations in the `.fd` file are then responsible for telling L^AT_EX how to load fonts for that encoding/family combination. If the `.fd` file could not be found, a warning is issued and font substitutions are made.

The `.fd` files should contain only commands from the next section. Note that those commands can also be used outside an `.fd` file: they can be put in package or class files, or even in the preamble of a document.

4.2 Font definition file commands

```
\ProvidesFile{<file-name>}[<release-info>]
```

The `.fd` file should announce itself with a `\ProvidesFile` command, as described in *L^AT_EX 2_ε for Class and Package Writers*. For example:

```
\ProvidesFile{T1ptm.fd}[1994/06/01 Adobe Times font definitions]
```

```
\DeclareFontFamily {<cdp>} {<family>} {<loading-settings>}
```

Declares a font family $\langle family \rangle$ to be available in encoding scheme $\langle cdp \rangle$.

The $\langle loading-settings \rangle$ are executed immediately after loading any font with this encoding and family.

Checks that $\langle cdp \rangle$ was previously declared.

This example refers to the Computer Modern Typewriter font family in the Cork encoding:

```
\DeclareFontFamily{T1}{cmtt}{\hyphenchar\font=-1}
```

Each `.fd` file should contain exactly one `\DeclareFontFamily` command, and it should be for the appropriate encoding/family combination.

$\backslash\text{DeclareFontShape} \{ \langle cdp \rangle \} \{ \langle family \rangle \} \{ \langle series \rangle \} \{ \langle shape \rangle \} \{ \langle loading-info \rangle \} \{ \langle loading-settings \rangle \}$

Declares a font shape combination; here $\langle loading-info \rangle$ contains the information that combines sizes with external fonts. The syntax of $\langle loading-info \rangle$ is complex and is described in Section 4.3 below.

The $\langle loading-settings \rangle$ are executed after loading any font with this font shape. They are executed immediately after the ‘loading-settings’ which were declared by $\backslash\text{DeclareFontFamily}$ and so they can be used to overwrite the settings made at the family level.

$\backslash\text{DeclareFontShape} \{ \langle cdp \rangle \} \{ \langle family \rangle \} \{ \langle series \rangle \} \{ \langle shape \rangle \} \{ \langle loading-info \rangle \} \{ \langle loading-option \rangle \}$

Declares a font shape combination; here $\langle loading-info \rangle$ contains the information that combines sizes with external fonts. The syntax is complex and is described in Section 4.3 below.

The $\langle loading-options \rangle$ are used as above; they allow overwriting, for this particular shape, of the general loading options made at the family level.

Checks that $\langle cdp \rangle + \langle family \rangle$ was previously declared via $\backslash\text{DeclareFontFamily}$.

Example:

```

\DeclareFontShape{OT1}{cmr}{m}{sl}{%
  <5-8> sub * cmr/m/n
  <8> cmsl8
  <9> cmsl9
  <10> <10.95> cmsl10
  <12> <14.4> <17.28> <20.74> <24.88> cmsl12
}{}

```

An $.fd$ file can contain any number of $\backslash\text{DeclareFontShape}$ commands, which should be for the appropriate $\langle cdp \rangle$ and $\langle family \rangle$.

4.3 Font file loading information

The information which tells L^AT_EX exactly which font ($.tfm$) files to load is contained in the $\langle loading-info \rangle$ part of a $\backslash\text{DeclareFontShape}$ declaration. This part consists of one or more $\langle fontshape-decl \rangle$ s, each of which has the following form:

$$\begin{aligned} \langle fontshape-decl \rangle &::= \langle size-infos \rangle \langle font-info \rangle \\ \langle size-infos \rangle &::= \langle size-infos \rangle \langle size-info \rangle \mid \langle size-info \rangle \\ \langle size-info \rangle &::= "<" \langle number-or-range \rangle ">" \\ \langle font-info \rangle &::= [\langle size-function \rangle "*"] ["[" \langle optarg \rangle "]"] \langle fontarg \rangle \end{aligned}$$

The $\langle number-or-range \rangle$ denotes the size or size-range for which this entry applies.

If it contains a hyphen it is a range: lower bound on the left (if missing, zero implied), upper bound on the right (if missing, ∞ implied). For ranges, the upper bound is *not* included in the range and the lower bound is.

Examples:

$\langle 10 \rangle$	simple size	10pt only
$\langle -8 \rangle$	range	all sizes less than 8pt
$\langle 8-14.4 \rangle$	range	all sizes greater than or equal to 8pt but less than 14.4pt
$\langle 14.4- \rangle$	range	all sizes greater than or equal 14.4pt

If more than one $\langle size-info \rangle$ entry follows without any intervening $\langle font-info \rangle$, they all share the next $\langle font-info \rangle$.

The $\langle size-function \rangle$, if present, handles the use of $\langle font-info \rangle$. If not present, the ‘empty’ $\langle size-function \rangle$ is assumed.

All the $\langle size-info \rangle$ s are inspected in the order in which they appear in the font shape declaration. If a $\langle size-info \rangle$ matches the requested size, its $\langle size-function \rangle$ is executed. If $\backslash external@font$ is non-empty afterwards this process stops, otherwise the next $\langle size-info \rangle$ is inspected. (See also $\backslash DeclareSizeFunction$.)

If this process does not lead to a non-empty $\backslash external@font$, L^AT_EX tries the nearest simple size. If the entry contains only ranges an error is returned.

4.4 Size functions

L^AT_EX provides the following size functions, whose ‘inputs’ are $\langle fontarg \rangle$ and $\langle optarg \rangle$ (when present).

“ **(empty)** Load the external font $\langle fontarg \rangle$ at the user-requested size. If

$\langle optarg \rangle$ is present, it is used as the scale-factor.

s Like the empty function but without terminal warnings, only loggings.

gen Generates the external font from $\langle fontarg \rangle$ followed by the user-requested size, e.g. $\langle 8 \rangle \langle 9 \rangle \langle 10 \rangle$ **gen** * **cmtt**

s**gen** Like the ‘gen’ function but without terminal warnings, only loggings.

sub Tries to load a font from a different font shape declaration given by $\langle fontarg \rangle$ in the form $\langle family \rangle / \langle series \rangle / \langle shape \rangle$.

ssub Silent variant of ‘sub’, only loggings.

subf Like the empty function but issues a warning that it has to substitute the external font $\langle fontarg \rangle$ because the desired font shape was not available in the requested size.

ssubf Silent variant of ‘subf’, only loggings.

fixed Load font $\langle fontarg \rangle$ as is, disregarding the user-requested size. If present, $\langle optarg \rangle$ gives the “at . . . pt” size to be used.

sfixed Silent variant of ‘fixed’, only loggings.

Examples for the use of most of the above size functions can be found in the file `cmfonts.fdd`—the source for the standard `.fd` files describing the Computer Modern fonts by Donald Knuth.

<code>\DeclareSizeFunction {$\langle name \rangle$} {$\langle code \rangle$}</code>

Declares a size-function $\langle name \rangle$ for use in `\DeclareFontShape` commands. The interface is still under development but there should be no real need to a define new size functions.

The $\langle code \rangle$ is executed when the size or size-range in `\DeclareFontShape` matches the user-requested size.

The arguments of the size-function are automatically parsed and placed into `\mandatory@arg` and `\optional@arg` for use in $\langle code \rangle$. Also available, of course, is `\f@size`, which is the user-requested size.

To signal success $\langle code \rangle$ must define the command `\external@font` to contain the external name and any scaling options (if present) for the font to be loaded.

This example sets up the ‘empty’ size function (simplified):

```
\DeclareSizeFunction{}
{\edef\external@font{\mandatory@arg\space at\f@size}}
```

5 Encodings

This section explains how to define new encodings.

5.1 Encoding definition files

Users can select new font encodings using the `fontenc` package. The `fontenc` package has options for encodings; the last option becomes the default encoding. For example, to use the OT2 (Washington University Cyrillic encoding) and T1 encodings, with T1 as the default, an author types:

```
\usepackage[OT2,T1]{fontenc}
```

This package loads the *encoding definition files* ($\langle ENC \rangle$ enc.def files) for each font encoding given as an option but not already declared; it also sets `\encodingdefault` to be the last encoding in the option list.

L^AT_EX currently predefines the OT1 and T1 text encodings, and provides the files OT1enc.def and T1enc.def. Other encoding set-ups might be added to the distribution at a later stage.

Thus the example above loads the file OT2enc.def and sets `\encodingdefault` to T1.

The $\langle ENC \rangle$ enc.def files should contain only commands from Section 5.2. As with the font definition file commands, it is also possible (although normally not necessary) to use these declarations directly

within a class or package file.

5.2 Encoding definition file commands

```
\ProvidesFile{<file-name>}[<release-info>]
```

The $\langle ENC \rangle$ enc.def file should announce itself with a `\ProvidesFile` command, described in *L^AT_EX 2_ε for Class and Package Writers*. For example:

```
\ProvidesFile{OT2enc.def}
[1994/06/01 Washington Univ. Cyrillic encoding]
```

```
\DeclareFontEncoding {<cdp>} {<text-settings>} {<math-settings>}
```

Declares a new encoding scheme $\langle cdp \rangle$.

The $\langle text-settings \rangle$ are declarations which are executed every time `\selectfont` changes the encoding to be $\langle cdp \rangle$.

The $\langle math-settings \rangle$ are similar but are for math alphabets. They are executed whenever a math alphabet with this encoding is called.

Spaces within the arguments are ignored to avoid surplus spaces in the document. If a real space is necessary use `\space`.

Example:

```
\DeclareFontEncoding{OT1}{-}{-}
```

Some author commands need to change their definition depending on which encoding is currently in use. For example, in the OT1 encoding, the letter ‘Æ’

is in slot "1D, whereas in the T1 encoding it is in slot "C6. So the definition of `\AE` has to change depending on whether the current encoding is OT1 or T1. The following commands allow this to happen.

```
\DeclareTextCommand {<cmd>} {<cdp>} [ <num> ] [ <default> ] {<definition>}
```

This command is like `\newcommand`, except that it defines a command which is specific to one encoding. For example, the definition of `\aa` in the OT1 encoding is:

```
\DeclareTextCommand{\aa}{OT1}{\accent23a}
```

`\DeclareTextCommands` takes the same optional arguments as `\newcommand`.

The resulting command is robust, even if its *<definition>* is fragile.

It does not produce an error if the command has already been defined but logs the redefinition in the transcript file.

```
\DeclareTextSymbol {<cmd>} {<cdp>} {<slot>}
```

This command defines a text symbol with slot *<slot>* in the encoding. For example, the definition of `\ss` in the OT1 encoding is:

```
\DeclareTextSymbol{\ss}{OT1}{25}
```

It does not produce an error if the command has already been defined but logs the redefinition in the transcript file.

```
\DeclareTextAccent {<cmd>} {<cdp>} {<slot>}
```

This command declares a text accent, with the accent taken from slot *<slot>* in the encoding. For example, the definition of `\"` in the OT1 encoding is:

```
\DeclareTextAccent{\"}{OT1}{127}
```

It does not produce an error if the command has already been defined but logs the redefinition in the transcript file.

```
\DeclareTextComposite {<cmd>} {<cdp>} {<letter>} {<slot>}
```

This command declares that the composite letter formed from applying *<cmd>* to *<letter>* is defined to be simply slot *<slot>* in the encoding. The *<letter>* should be a single letter (such as `a`) or a single command (such as `\i`).

For example, the definition of `\'a` in the T1 encoding could be declared like this:

```
\DeclareTextComposite{\'}{T1}{a}{225}
```

The *cmd* should have been previously declared with `\DeclareTextAccent`, or as a one-argument `\DeclareTextCommand`.

5.3 Encoding defaults

```
\DeclareFontEncodingDefaults {<text-settings>} {<math-settings>}
```

Declares *<text-settings>* and *<math-settings>* for all encoding schemes. These are executed before the encoding scheme dependent ones are executed so that one can use the defaults for the major cases and overwrite them if necessary using `\DeclareFontEncoding`.

If `\relax` is used as an argument, the current setting of this default is left unchanged.

This example is used by `amsfonts.sty` for accent positioning; it changes only the math settings:

```
\DeclareFontEncodingDefaults{\relax}{\def\accentclass@{7}}
```

```
\DeclareFontSubstitution {<cdp>} {<family>} {<series>} {<shape>}
```

Declares the default values for font substitution which will be used when a font with encoding *<cdp>* should be loaded but no font can be found with the current attributes.

These substitutions are local to the encoding scheme because the encoding scheme is never substituted! They are tried in the order *<shape>* then *<series>* and finally *<family>*.

If no defaults are set up for an encoding, the values given by `\DeclareErrorFont` are used.

The font specification for *<cdp><family><series><shape>* must have been defined by `\DeclareFontShape` before the `\begin{document}` is reached.

Example:

```
\DeclareFontSubstitution{T1}{cmr}{m}{n}
```

6 Miscellanea

This section covers the remaining font commands of L^AT_EX.

6.1 Font substitution

`\DeclareErrorFont {<cdp>} {<family>} {<series>} {<shape>} {<size>}`

Declares `<cdp><family><series><shape>` to be the font shape used in cases where the standard substitution mechanism fails (i.e. would loop). For the standard mechanism see the command `\DeclareFontSubstitution` above.

The font specification for `<cdp><family><series><shape>` must have been defined by `\DeclareFontShape` before the `\begin{document}` is reached.

Example:

```
\DeclareErrorFont{OT1}{cmr}{m}{n}{10}
```

`\fontsubfuzz`

This parameter is used to decide whether or not to produce a terminal warning if a font size substitution takes place. If the difference between the requested and the chosen size is less than `\fontsubfuzz` the warning is only written to the transcript file. The default value is 0.4pt. This can be redefined with `\renewcommand`, for example:

```
\renewcommand{\fontsubfuzz}{0pt} % always warn
```

6.2 Preloading

`\DeclarePreloadSizes {<cdp>} {<family>} {<series>} {<shape>} {<size-list>}`

Specifies the fonts that should be pre-loaded by the format. These commands should be put in a `preload.cfg` file, which is read in when the \LaTeX format is being built. Read `preload.dtx` for more information on how to build such a configuration file.

Example:

```
\DeclarePreloadSizes{OT1}{cmr}{m}{sl}{10,10.95,12}
```

6.3 Naming conventions

- Math alphabet commands all start with `\math...`: examples are `\mathbf`, `\mathcal`, etc.
- The text font changing commands with arguments all start with `\text...`: e.g. `\textbf` and `\textrm`. The exception to this is `\emph`, since it occurs very commonly in author documents and so deserves a shorter name.

- Names for encoding schemes are strings of up to three letters, all upper case. The $\text{\LaTeX}3$ project reserves the use of encodings starting with T (standard 256-long text encodings), M (standard 256-long math encodings), S (standard 256-long symbol encodings), OT (standard 128-long text encodings) and OM (standard 128-long math encodings). Please do not use the above starting letters for non-portable encodings. If new standard encoding emerge then we shall add them in a later release of \LaTeX .

Encoding schemes which are local to a site should start with L.

- Font family names should contain up to five lower case letters. Where possible, these should conform to the *Filenames for fonts* font naming scheme.
- Font series names should contain up to four lower case letters.
- Font shapes should contain up to two letters lower case.
- Names for symbol fonts are built from lower and upper case letters with no restriction.

Whenever possible, you should use the series and shape names suggested in *The \LaTeX Companion* since this will make it easier to combine new fonts with existing fonts.

References

- [1] Michel Goossens, Frank Mittelbach and Alexander Samarin. *The \LaTeX Companion*. Addison-Wesley, Reading, Massachusetts, 1994.
- [2] Donald E. Knuth. Typesetting concrete mathematics. *TUGboat*, 10(1):31–36, April 1989.
- [3] Leslie Lamport. *\LaTeX : A Document Preparation System*. Addison-Wesley, Reading, Massachusetts, second edition, 1994.