Guide to p\TeX\ for developers unfamiliar with Japanese

Japanese \TeX\ Development Community*

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\pTeX\ and its variants, up\pTeX, \varepsilon-p\pTeX\ and \varepsilon-up\pTeX, are all \TeX\ engines with native Japanese support. Its output is always a DVI file, which can be processed by several DVI drivers with Japanese support including \texttt{dvips} and \texttt{dvipdfmx}. Formats based on \LaTeX\ is called p\LaTeX when running on \pTeX/\varepsilon-p\pTeX, and called up\LaTeX when running on up\pTeX/\varepsilon-up\pTeX.

Purpose of this document

This document is written for developers of \LaTeX, who aim to support p\LaTeX/\varepsilon-p\LaTeX\ and its variants up\LaTeX/\varepsilon-up\LaTeX. Knowledge of the followings are assumed:

- Basic knowledge of Western \TeX\ (Knuthian \TeX, \varepsilon-\TeX\ and pdf\TeX),
- ... and its programming conventions.

Any knowledge of Japanese (characters, encodings, typesetting conventions etc.) is not assumed; some explanations are provided in this document when needed. We hope that this document helps authors of packages or classes to proceed with supporting \pTeX family smoothly.

Note: This English guide (ptex-guide-en.pdf) is not meant to be a complete translation of Japanese manual (ptex-manual.pdf). For example, this document does not cover issues regarding Japanese typesettings. If you are interested in typesetting conventions of Japanese text, please also refer to japanese.pdf distributed with babel-japanese.

This document is maintained at: \url{https://github.com/texjporg/ptex-manual/}

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Part I

Brief introduction

1 \( p\TeX \) and its variants

The figure below shows the relationship between engines.

\[
\begin{align*}
pdf\TeX & \quad \varepsilon-\TeX \\
p\TeX & \quad \varepsilon-p\TeX \\
p\TeX & \quad \varepsilon-up\TeX \\
up\TeX & \\
\end{align*}
\]

\( p\TeX \) is an old Japanese-specific extension of \( \TeX \)82, which aims to support proper type-setting of Japanese text but only supports a limited character set, JIS X 0208 (6879 characters).

\( up\TeX \) is developed as an extension of \( p\TeX \) to support full Unicode characters. It also includes extensions to overcome the difficulties of \( p\TeX \) in processing 8-bit Latin characters due to conflicts with legacy multibyte Japanese encodings.

\( \varepsilon-p\TeX \) and \( \varepsilon-up\TeX \) are \( \varepsilon-\TeX \) extensions of \( p\TeX \) and \( up\TeX \) respectively. In the current release, some extensions derived from pdf\TeX \( \varepsilon \) and \( \Omega \) are also available.

2 Eminent characteristics of \( p\TeX \) family

The most important characteristics of \( p\TeX \) family can be summarized as follows:

- Japanese characters are interpreted and handled completely apart from Western characters. If a pair of two or more 8-bit codes in the input matches the pattern of Japanese character codes, it is regarded as one Japanese character and given a different \texttt{\catcode} value.
- There are two text directions; horizontal (\textit{yoko-gumi}; 横組) and vertical (\textit{tate-gumi}; 縦組). Two directions can be mixed even within a single document.
3 Compatibility with Western \TeX

\pTeX/\upTeX/ are almost upward compatible with Knuthian \TeX/, however, they do not pass the TRIP test. The most important difference lies in the handling of 8-bit code inputs; some 8-bit Latin characters may be subject to the encoding conversion. There is no difference in handling 8-bit TFM font.

\e-pTeX/\e-upTeX/ are almost upward compatible with \e-\TeX/, however, input handling is similar to \pTeX/\upTeX/. It does not pass the e-TRIP test. That said, please note that “raw \e-\TeX/” is unavailable anymore in \TeX/ Live and derived distributions; they provide a command \texttt{etex} only as “DVI mode of pdf\TeX/.” You should note that \e-pTeX/\e-upTeX/ are not upward compatible with DVI mode of pdf\TeX/, which will be discussed later in Section 5.7.

There is no advantage to choose \pTeX/\upTeX/ over \e-pTeX/\e-upTeX/, so we focus mainly on \e-pTeX/\e-upTeX/.

4 \LaTeX on \pTeX/\upTeX{} — \LaTeX/\upLaTeX

Formats based on \LaTeX/ is called \pLaTeX/ when running on \pTeX/\e-pTeX/, and called \upLaTeX/ when running on \upTeX/\e-upTeX/. In recent versions (around 2011) of \TeX/ Live and its derivatives, the default engines of \pLaTeX/ and \upLaTeX/ are \e-pTeX/ and \e-upTeX/. That is, the command \texttt{platex} starts \e-pTeX/ (not \pTeX/) with preloaded format \texttt{platex.fmt}.

In the kernel level (\texttt{platex.ltx} and \texttt{uplatex.ltx}), \pLaTeX/ and \upLaTeX/ adds some additional commands related to the followings:

- Selection of Japanese fonts,
- Crop marks (called \texttt{tombow}; トumbo) for printings,
- Adjustment for mixing horizontal and vertical texts.

For authors, \pLaTeX/\upLaTeX/ are almost upward compatible with original \LaTeX/, except for the followings:

- Order of float objects; in \pLaTeX/\upLaTeX/, \langle bottom float \rangle is placed above \langle footnote \rangle. That is, the complete order is \langle top float \rangle \rightarrow \langle body text \rangle \rightarrow \langle bottom float \rangle \rightarrow \langle footnote \rangle.

For developers, additional care may be needed, for changes in the kernel macros and/or the absence of pdf\TeX/ features.
Part II
Details

5 Output format — DVI

The output of p\TeX family is always a DVI file. This is in contrast to the mainstream of pdf\TeX in the Western \TeX world.

In case you are not familiar with DVI output processing, first we give some general notice on how to get a “correct” output using \LaTeX in DVI mode.

• The DVI format is, as its name suggests, inherently driver-independent. However, some \LaTeX packages (graphicx, color, hyperref etc.) embed some \special commands into the DVI, which can be interpreted later by some specific DVI driver. Such a DVI is no longer driver-independent, thus those are called driver-dependent packages.

• In almost all major \TeX distributions (of course including \TeX Live), the default DVI driver is set to \texttt{dvips}. When you choose to process the resulting DVI file with a driver other than \texttt{dvips} (e.g. \texttt{dvipdfmx}) after running \LaTeX, you need to pass a proper driver option (e.g. \texttt{[dvipdfmx]}) to all driver-dependent packages.

Now, let’s move on to the situation in Japan, which is slightly complicated due to historical reasons but may also apply to other countries:

• There are two major conventions to pass a proper driver option to all driver-dependent packages:

1. To give a driver option to each driver-dependent package:

\begin{verbatim}
\documentclass{article}
\usepackage[dvipdfmx]{graphicx}
\usepackage[dvipdfmx]{color}
\end{verbatim}

2. To have a driver option as global:

\begin{verbatim}
\documentclass[dvipdfmx]{article}
\usepackage{graphicx}
\usepackage{color}
\end{verbatim}

The former convention has been used for many years since 1990s when the number of driver-dependent packages was limited. But in recent years (around 2010–), there are much more driver-dependent packages available. Thus we (Japanese \TeX experts) advise
a global driver option rather than individual package options for simplicity, but not yet fully widespread.¹

- Many people still see driver options as “optional”; they do without driver options unless really needed. For example, the convention of having a global driver option does no harm even when no driver-dependent package is used, but some users choose to omit a driver option to avoid a warning²:

```
\LaTeX Warning: Unused global option(s): [dvipdfmx].
```

### 5.1 Extensions of DVI format in p\TeX family

The DVI format output by p\TeX family is fully compatible with Knuthian \TeX, as long as the following conditions are met:

- No Japanese characters are typeset.
- There is no portion of vertical text alignment.

However, some additional DVI commands, which are defined in the standard [3] but never used in \TeX82, can come out.

- `set2` (129): Used to typeset a Japanese character with 2-byte code (both p\TeX and up\TeX).
- `set3` (130): Used to typeset a Japanese character with 3-byte code (up\TeX only).

When p\TeX is going to typeset a Japanese character into DVI, it is encoded in JIS, which is always a 2-byte code. For this purpose, `set2` or `put2` are used. When up\TeX is going to output a Japanese character into DVI, it is encoded in UTF-32. If the code is equal to or less than `U+FFFF`, the lower 16-bit is used with `set2` or `put2`. If the code is equal to or greater than `U+10000`, the lower 24-bit is used with `set3` or `put3`.

In addition, p\TeX/up\TeX defines one additional DVI command.

- `dir` (255): Used to change directions of text alignment.

The DVI format in the preamble is always set to 2, as with \TeX82. On the other hand, the DVI ID in the postamble can be special. Normally it is set to 2, as with \TeX82; however, when `dir` (255) appears at least once in a single p\TeX/up\TeX DVI, the `post_post` table of postamble contains ID = 3.

¹The fact that there had been a mismatch in option names ([dvipdfm] vs. [dvipdfmx]) between packages may also have been part of it; geometry did not understand [dvipdfmx] option until 2018!
²Since \LaTeX2ε 2020-02-02, this warning is effectively gone. This is due to preloading of expl3 into the format, and the driver-dependent code of expl3 interprets the global driver option.
5.2 DVI drivers with Japanese support

There are some DVI drivers with Japanese support. The most eminent drivers are `dvips` and `dvipdfmx`. Nowadays most of casual Japanese users are using `dvipdfmx` as a DVI driver. On the other hand, users of `dvips` are unignorable, especially those working in publishing industry. In recent years, most of major driver-dependent packages support both two drivers.

5.2.1 Using `dvipdfmx`

A DVI file which is output by p\TeX can be converted directly to a PDF file using dvipdfmx. For Japanese fonts to be used in the output PDF, dvipdfmx refers to `kanjix.map` generated by the command `updmap`. You can use the script `kanji-config-updmap` to change font settings; please refer to its help message or documentation.

5.2.2 Using `dvips`

A DVI file which is output by p\TeX can be converted to a PostScript file using dvips. For Japanese fonts to be used in the output PostScript, dvips refers to `psfonts.map` generated by the command `updmap`. You can use the script `kanji-config-updmap` to change font settings; please refer to its help message or documentation.

The resulting PostScript file can then be converted to a PDF file using Ghostscript (ps2pdf) or Adobe Distiller. When using Ghostscript, a proper setup of Japanese font must be done before converting PostScript into PDF. An easy solution for the setup is to run a script `cjk-gs-integrate` developed by Japanese \TeX Development Community.

6 Programming on p\TeX family

We focus on programming aspects of p\TeX and its variants.

6.1 Number of registers and marks

p\TeX and up\TeX have exactly the same number (= 256) of registers (count, dimen, skip, muskip, box, and token) as Knuthian \TeX. \textepsilon\-p\TeX and \textepsilon\-up\TeX in extended mode have more registers; there are 65536, which is twice as many as 32768 of \textepsilon\-\TeX. Similarly \textepsilon\-p\TeX and \textepsilon\-up\TeX have 65536 mark classes, which is twice as many as 32768 of \textepsilon\-\TeX.

The following code presents an example of detecting the number of registers and mark classes available:

```
\ifx\eTeXversion\undefined
% Knuthian \TeX, p\TeX, up\TeX:
% 256 registers, 1 mark
```
Here a primitive \omathchar, which is derived from Ω, is used as a marker of a change file fam256.ch.3

6.2 Number of math families

In p\TeX and up\TeX, the number of math fonts is restricted to 16, each of which can contain 256 characters (same as Knuthian \TeX). In \varepsilon-p\TeX and \varepsilon-up\TeX, a change file fam256.ch, which is derived from Ω, extends the upper limit to 256. As a consequence, \varepsilon-p\TeX and \varepsilon-up\TeX allows 256 math fonts, each of which can contain 256 characters.4 For p\LaTeX/up\LaTeX users to use more than 16 math fonts, it is necessary to use macros which exploit Ω-derived primitives such as \omathchar. Recent (u)p\LaTeX (since 2016/11/29) partially supports this, and the maximum number of math alphabets that can be defined by \DeclareMathAlphabet is extended to 256 (\e@mathgroup@top) without needing any extension package. However, symbol fonts are restricted to 16 as \DeclareMathSymbol etc still use the standard \mathchar etc. A simple solution to use more symbol fonts as well as math alphabets is to load a package mathfam2565 though it’s still preliminary.

6.3 Additional primitives and keywords

Here we provide only complete lists of additional primitives of p\TeX family in alphabetical order. The features of each primitive can be found in Japanese edition.

6.3.1 p\TeX additions (available in p\TeX, up\TeX, \varepsilon-p\TeX, \varepsilon-up\TeX)

► \autospacing
► \autoxspacing

3There is another p\TeX-derived engine named p\TeX-ng (or Asiatic p\TeX) https://github.com/clerkma/ptex-ng, it is based on \varepsilon-\TeX and up\TeX, but currently does not adopt fam256.ch so it has the same number of registers and mark classes as \varepsilon-\TeX.

4Ω allows 256 math fonts, each of which can contain 65536 characters.

5https://www.ctan.org/pkg/mathfam256
\begin{itemize}
  \item \texttt{\textbackslash inhibitglue} — New primitive since p3.8.2 (\TeX\ Live 2019)
  \item \texttt{\textbackslash dtou}
  \item \texttt{\textbackslash euc}
  \item \texttt{\textbackslash ifdbox} — New primitive since p3.2 (\TeX\ Live 2011)
  \item \texttt{\textbackslash ifddir} — New primitive since p3.2 (\TeX\ Live 2011)
  \item \texttt{\textbackslash ifjfont} — New primitive since p3.8.3 (\TeX\ Live 2020)
  \item \texttt{\textbackslash ifmbox} — New primitive since p3.7.1 (\TeX\ Live 2017)
  \item \texttt{\textbackslash ifmdir}
  \item \texttt{\textbackslash iftbox}
  \item \texttt{\textbackslash iftdir}
  \item \texttt{\textbackslash ifftfont} — New primitive since p3.8.3 (\TeX\ Live 2020)
  \item \texttt{\textbackslash ifybox}
  \item \texttt{\textbackslash ifydir}
  \item \texttt{\textbackslash inhibitglue}
  \item \texttt{\textbackslash inhibitxspcode}
  \item \texttt{\textbackslash jcharwidowpenalty}
  \item \texttt{\textbackslash jfam}
  \item \texttt{\textbackslash jfont}
  \item \texttt{\textbackslash jis}
  \item \texttt{\textbackslash kanjiskip}
  \item \texttt{\textbackslash kansuji}
  \item \texttt{\textbackslash kansujichar}
  \item \texttt{\textbackslash kcatcode}
  \item \texttt{\textbackslash kuten}
  \item \texttt{\textbackslash noautospacing}
  \item \texttt{\textbackslash noautoxspacing}
  \item \texttt{\textbackslash postbreakpenalty}
  \item \texttt{\textbackslash prebreakpenalty}
  \item \texttt{\textbackslash ptexfontname} — New primitive since p4.1.0 (\TeX\ Live 2023)
  \item \texttt{\textbackslash ptexlineendmode} — New primitive since p4.0.0 (\TeX\ Live 2022)
\end{itemize}
\ptexminorversion — New primitive since p3.8.0 (\TeX\ Live 2018)
\ptexrevision — New primitive since p3.8.0 (\TeX\ Live 2018)
\ptextracingfonts — New primitive since p4.1.0 (\TeX\ Live 2023)
\ptexversion — New primitive since p3.8.0 (\TeX\ Live 2018)
\scriptbaselineshiftfactor — New primitive since p3.7 (\TeX\ Live 2016)
\scriptscriptbaselineshiftfactor — New primitive since p3.7 (\TeX\ Live 2016)
\showmode
\sjis
\tate
\tbaselineshift
\textbaselineshiftfactor — New primitive since p3.7 (\TeX\ Live 2016)
\tfont
\tojis — New primitive since p4.1.0 (\TeX\ Live 2023)
\toucs — New primitive since p3.10.0 (\TeX\ Live 2022)
\ucs — Imported from up\TeX, since p3.10.0 (\TeX\ Live 2022)\(^6\)
\xkanjiskip
\xsrcode
\ybaselineshift
\yoko
\H
\Q
\zh
\zw

6.3.2 \textit{up\TeX\ additions (available in up\TeX, \$\varepsilon$-up\TeX)}

\disablecjktoken
\enablecjktoken
\forcecjktoken

\(^6\)The primitive \texttt{\ucs} was part of “up\TeX\ additions” until \TeX\ Live 2021.
6.3.3 \texttt{\v -p\TeX} additions (available in \texttt{\v -p\TeX}, \texttt{\v-up\TeX})

- \texttt{\currentspacingmode} — New primitive since 191112 (\TeX\ Live 2020)
- \texttt{\currentxspacingmode} — New primitive since 191112 (\TeX\ Live 2020)
- \texttt{\epTeXinputencoding} — New primitive since 160201 (\TeX\ Live 2016)
- \texttt{\epTeXversion} — New primitive since 180121 (\TeX\ Live 2018)
- \texttt{\expanded} — New primitive since 180518 (\TeX\ Live 2019)
- \texttt{\hfi}
- \texttt{\ifincsname} — New primitive since 190709 (\TeX\ Live 2020)
- \texttt{\ifpdfprimitive} — New primitive since 150805 (\TeX\ Live 2016)
- \texttt{\lastnodechar} — New primitive since 141108 (\TeX\ Live 2015)
- \texttt{\lastnodefont} — New primitive since 220214 (\TeX\ Live 2022)
- \texttt{\lastnodesubtype} — New primitive since 180226 (\TeX\ Live 2018)
- \texttt{\odelcode}
- \texttt{\odelimiter}
- \texttt{\omathaccent}
- \texttt{\omathchar}
- \texttt{\omathchardef}
- \texttt{\omathcode}
- \texttt{\oradical}
- \texttt{\pagefistretch}
- \texttt{\pdfcreationdate} — New primitive since 130605 (\TeX\ Live 2014)
- \texttt{\pdfelapsedtime} — New primitive since 161114 (\TeX\ Live 2017)
- \texttt{\pdffiledump} — New primitive since 140506 (\TeX\ Live 2015)
- \texttt{\pdffilemoddate} — New primitive since 130605 (\TeX\ Live 2014)
- \texttt{\pdffilesze} — New primitive since 130605 (\TeX\ Live 2014)
\pdflastxpos
\pdflastypos
\pdfmdfivesum — New primitive since 150702 (\TeX\ Live 2016)
\pdfnormaldeviate — New primitive since 161114 (\TeX\ Live 2017)
\pdfpageheight
\pdfpagewidth
\pdfprimitive — New primitive since 150805 (\TeX\ Live 2016)
\pdfrandomseed — New primitive since 161114 (\TeX\ Live 2017)
\pdfresettimer — New primitive since 161114 (\TeX\ Live 2017)
\pdfsavepos
\pdfsetrandomseed — New primitive since 161114 (\TeX\ Live 2017)
\pdfshellescape — New primitive since 141108 (\TeX\ Live 2015)
\pdfstrcmp
\pdfuniformdeviate — New primitive since 161114 (\TeX\ Live 2017)
\readpapersizespecial — New primitive since 180901 (\TeX\ Live 2019)
\suppresslongerror — New primitive since 211207 (\TeX\ Live 2022)
\suppressmathparerror — New primitive since 211207 (\TeX\ Live 2022)
\suppressoutererror — New primitive since 211207 (\TeX\ Live 2022)
\Uchar — New primitive since 191112 (\TeX\ Live 2020)
\Ucharcat — New primitive since 191112 (\TeX\ Live 2020)
\vadjust pre — New keyword since 210701 (\TeX\ Live 2022)
\vfi
\fi

6.3.4  \textit{\varepsilon}\textit{-up\TeX} additions (available in \textit{\varepsilon}\textit{-up\TeX})

\currentcjktoken — New primitive since 191112 (\TeX\ Live 2020)

6.3.5  Other cross-engine additions

Sync\TeX\ extension (available in p\TeX, up\TeX, \textit{\varepsilon}\textit{-p\TeX}, \textit{\varepsilon}\textit{-up\TeX}):

\synctex
\TeX\ Live additions (available in p\TeX, up\TeX, \varepsilon-p\TeX, \varepsilon-up\TeX):

\begin{itemize}
  \item \texttt{\partokencontext} — New primitive since \TeX\ Live 2022
  \item \texttt{\partokenname} — New primitive since \TeX\ Live 2022
  \item \texttt{\showstream} — New primitive since \TeX\ Live 2022
  \item \texttt{\special \shipout} — New keyword since 230214 (\TeX\ Live 2023)
  \item \texttt{\tracingstacklevels} — New primitive since \TeX\ Live 2021
\end{itemize}

6.4 Omitted primitives and unsupported features

Compared to Knuthian \TeX\ and \varepsilon-\TeX, some primitives and extensions are omitted due to conflict with Japanese handling.

- The enc\TeX\ extension, including the primitives \texttt{\mubyte} etc., is unavailable.
- The ML\TeX\ extension, such as \texttt{\charsubdef}, is not enabled by default. It becomes available with the command-line option \texttt{-mltex}, but not well-tested.

6.5 Behavior of Western \TeX\ primitives

Here we provide some notes on behavior of Knuthian \TeX\ and \varepsilon-\TeX\ primitives when used within p\TeX family.

6.5.1 Primitives with limitations in handling Japanese

Each of the following primitives allows only character codes 0–255; other codes will give an error “! Bad character code.”

\begin{itemize}
  \item \texttt{\catcode}, \texttt{\sfcode}, \texttt{\mathcode}, \texttt{\delcode}, \texttt{\lccode}, \texttt{\uccode}.
\end{itemize}

Each of the following primitives has \ldots\texttt{\char} in its name, however, the effective values are restricted to 0–255.

\begin{itemize}
  \item \texttt{\endlinechar}, \texttt{\newlinechar}, \texttt{\escapechar}, \texttt{\defaulthyphenchar}, \texttt{\defaultskeewchar}.
\end{itemize}

6.5.2 Primitives capable of handling Japanese

The following primitives are extended to support Japanese characters:

\begin{itemize}
  \item \texttt{\char \langle character code \rangle}, \texttt{\chardef \langle control sequence \rangle=\langle character code \rangle}
\end{itemize}

In addition to 0–255, internal codes of Japanese characters are allowed. For putting Japanese characters, a Japanese font is chosen. More information can be found in Chapter 6.6.3.
\font, \fontname, \fontdimen
\accent \textlangle character code\textrangle = \textlangle character\textrangle
\if \langle token_1 \rangle \langle token_2 \rangle, \ifcat \langle token_1 \rangle \langle token_2 \rangle \\
Japanese character token is also allowed. In that case,
\begin{itemize}
\item \textbackslash if tests the internal character code of the Japanese character.
\item \textbackslash ifcat tests the \textbackslash kcatcode of the Japanese character.
\end{itemize}
\textTeXbook describes the behavior of \textbackslash if and \textbackslash ifcat as follows;
If either token is a control sequence, \TeX considers it to have character code 256
and category code 16, unless the current equivalent of that control sequence has
been \textbackslash let equal to a non-active character token.
However, this includes a lie; in the real implementation of \texttt{tex.web}, a control sequence is
considered to have a category code 0.

6.6 Case study
Here we provide some code examples which may be useful for package developers.

6.6.1 Detecting \texttt{p\TeX}
Since the primitive \texttt{ptexversion} is rather new (added in 2018), the safer solution for detecting \texttt{p\TeX} is to test if a primitive \texttt{kanjiskip} is defined.
\begin{verbatim}
\ifx\kanjiskip\undefined
  \else
    \% p\TeX / up\TeX / e-p\TeX / e-up\TeX
  \fi
\end{verbatim}

6.6.2 Detecting \texttt{up\TeX}
\texttt{up\TeX}/\texttt{e-up\TeX} are almost upward compatible with \texttt{p\TeX}/\texttt{e-p\TeX} respectively, however, there are two major differences:
\begin{enumerate}
\item Improvements in the \texttt{kcatcode} business, mainly for better handling of Latin-1 characters
  and CJK tokens.
\item Unicode as the default internal kanji encoding, for direct use of its huge character set.
\end{enumerate}
The first difference can be detected by checking if \texttt{\ldots cjktoken} primitive is defined.
The second difference can be detected by checking if the character \texttt{0x2121} (fullwidth space in JIS encoding) is stored as "3000 internally.

Please note that the format-build setting of \texttt{-kanji-internal=(sjis|euc)} with up\TeX makes it effectively p\TeX regarding the character set, which means that only JIS X 0208 character set is supported.

6.6.3 Defining large integer constants

According to \cite{2} (Section 3.3),

A control sequence that has been defined with a \texttt{\chardef} command can also be used as a \langle number \rangle. This fact is used in allocation commands such as \texttt{\newbox}. Tokens defined with \texttt{\mathchardef} can also be used this way.

Here is the list of primitives which can be used for this purpose in p\TeX family:

- \texttt{\chardef \langle control sequence \rangle = \langle character code \rangle}
  
  Defines a control sequence to be a synonym for \texttt{\char \langle character code \rangle}.

- \texttt{\kchardef \langle control sequence \rangle = \langle character code \rangle (for up\TeX/e-up\TeX)}

  Defines a control sequence to be a synonym for \texttt{\kchar \langle character code \rangle}.

- \texttt{\mathchardef \langle control sequence \rangle = \langle 15-bit number \rangle}

  Defines a control sequence to be a synonym for \texttt{\mathchar \langle 15-bit number \rangle}.

- \texttt{\omathchardef \langle control sequence \rangle = \langle 27-bit number \rangle (for \epsilon-p\TeX/e-up\TeX)}

  Defines a control sequence to be a synonym for \texttt{\omathchar \langle 27-bit number \rangle}.
The first two (\chardef and \kchardef) are usable only when the integer being defined is in the range of valid character codes, which is not necessarily continuous (see \ref{8.1}). The most efficient and convenient way of defining integer constants is as follows:

- 0–255: \chardef
- 256–32767: \mathchardef
- 32768–134217727: \omathchardef (only for \varepsilon-p\TeX/\varepsilon-up\TeX)
- (optional) 256–2147483647: \chardef (only for up\TeX/\varepsilon-up\TeX)

6.6.4 Creating a Japanese character token with a specified code

Short version:

- With \varepsilon-p\TeX 191112 or later (\TeX Live 2020), you can use expandable primitives \Uchar and \Ucharcat.
- Otherwise, use the “\kansuji trick”.

\textbf{The “\kansuji trick”}

This is a modified version of the “\lowercase trick” available in \TeX family.

\begin{verbatim}
\bgroup
\lccode`?=`mycount
\lowercase{\egroup \def\X{?}}
\end{verbatim}

defines \X which expands to a character number \mycount while the \catcode of \? (12) is preserved. However, the trick cannot be applied to Japanese characters, since \p\TeX family does not support \lccode outside 0–255.

\texttt{\kansuji} is an expandable primitive like \number or \romannumeral, and it converts an integer into its corresponding kanji notation called \textit{kansuji} (漢数字). The important point here is that the number-kanji mapping can be altered by \kansujichar.

Example 1: equivalent to \def\X{あ} (JIS code 0x2422 is “あ”):

\begin{verbatim}
\bgroup
\kansujichar1=\jis"2422 \xdef\X{\kansuji1}
\end{verbatim}

Example 2: equivalent to \def\日本{Japan}.
Since \kansujichar accepts only Japanese character code, the “\kansuji trick” and the “\lowercase trick” should be used complementarily.

\begin{itemize}
\item \textbf{\Uchar}
\end{itemize}

The “\kansuji trick” above includes an assignment of \kansujichar which is unexpandable. \e-p\TeX\ 191112 or later (\mbox{T\TeX\ Live 2020}) provides expandable primitives \Uchar and \Ucharcat, which are derived from \Xe\TeX. Regardless of their names, and unlike \Xe\TeX\ or \Lua\TeX, these primitives do not necessarily take a Unicode value as an argument. These primitives in \e-p\TeX\ and \e-up\TeX take a valid character code (see \S\ref{sec:ej}) based on the internal kanji encoding.

\begin{itemize}
\item \textbf{\Uchar} \textit{(character code)}
\end{itemize}

Expands to a character token with specified slot \textit{(character code)}.

\begin{itemize}
\item When an 8-bit number (0–255) is given, it expands to a Latin character token with category code 12, except for a space character (32) which has category code 10.
\item When a Japanese character code greater than 255 is given, it expands to a Japanese character token with its current category code; 16–18 for \e-p\TeX, 16–19 for \e-up\TeX.
\end{itemize}

\begin{itemize}
\item \textbf{\Ucharcat} \textit{(character code)} \textit{(category code)}
\end{itemize}

Expands to a character token with slot \textit{(character code)} and \textit{(category code)} specified.

\begin{itemize}
\item With \e-p\TeX:
\begin{itemize}
\item Only 8-bit number (0–255) are allowed for \textit{(character code)}; that is, only Latin characters can be generated.
\item The values allowed for \textit{(category code)} are 1–4, 6–8, 10–13.
\end{itemize}
\item With \e-up\TeX:
\begin{itemize}
\item When \textit{(character code)} is between 0–127, only Latin characters can be generated. Thus, the values allowed for \textit{(category code)} are 1–4, 6–8, 10–13.
\item When \textit{(character code)} is between 128–255, both Latin and Japanese characters can be generated depending on the specified \textit{(category code)}; 1–4, 6–8, 10–13: Latin character, 16–19: Japanese character.
\item When \textit{(character code)} is greater than 255, only Japanese characters can be generated. Thus, the values allowed for \textit{(category code)} are 16–19.
\end{itemize}
\end{itemize}
6.7 Difference from pdf\TeX in DVI mode

As stated in Section 3, \varepsilon-p\TeX/\varepsilon-up\TeX are not upward compatible with DVI mode of pdf\TeX, which is available as the etex command in \TeX Live. Here we list some important differences:

First, some pdf\TeX-specific primitives are absent. Examples:

- All primitives specific to PDF output: \texttt{\pdfoutput}, \texttt{\pdfinfo}, \texttt{\pdfobj} etc.\footnote{\varepsilon-p\TeX/\varepsilon-up\TeX has primitives \texttt{\pdffwidth} and \texttt{\pdffheight}; this is just because they were convenient for implementing \texttt{\pdfsavepos}, and their behavior is somewhat different from that of pdf\TeX. Also note that \varepsilon-p\TeX/\varepsilon-up\TeX does not have \texttt{\pdfhorigin} and \texttt{\pdfvorigin}.}
- All primitives related to micro-typography: \texttt{\pdffontexpand}, \texttt{\pdfprotrudechars}, etc.
- Some primitives related to handling of strings: \texttt{\pdfescapestring}, \texttt{\pdfescapehex} etc.

6.8 Recommendation for file encoding

6.9 Input handling

For simplicity, first we introduce of input handling of \varepsilon-up\TeX.

6.10 Japanese tokens

7 Basic introduction to Japanese typesetting

This section does not aim to explain Japanese typesetting completely; here we provide a minimum requirement for “getting away” with Japanese.

7.1 Automatic insertion of glue and penalties

Sometimes p\TeX family automatically inserts glue and penalties between characters.

7.2 Japanese fonts

p\TeX family can have 3 different “current” fonts at the same time; a Latin font, a Japanese font for horizontal writing (\textit{yoko-gumi}), and a Japanese font for vertical writing (\textit{tate-gumi}). The first one is the same as in the Knuthian \TeX, which is defined in a standard TFM format. The latter two are specific to p\TeX family, which are defined in a JFM (Japanese \TeX font metric) format.\footnote{A JFM is a modified version of the standard TFM. It can be created by \texttt{(u)p\L toTF}, and decoded by \texttt{(u)pTFtoPL}. Please also refer to the man pages of these programs (\texttt{ppltotf.man1.pdf} and \texttt{ptftopl.man1.pdf}).}

While typesetting, p\TeX family automatically switches between these 3 fonts, depending on the character code and the writing direction:
• For typesetting Latin characters, the current Latin font shown by \texttt{\textbackslash the\textbackslash font} is selected.

• For typesetting Japanese characters, the current Japanese font suitable for the current writing direction is selected. It is shown by \texttt{\textbackslash the\textbackslash jfont} for horizontal writing and \texttt{\textbackslash the\textbackslash tfont} for vertical writing.

In Knuthian \TeX, the primitive \texttt{\textbackslash nullfont} refers to an “empty font” in which all characters are undefined. However in \texttt{p\TeX} family, this is regarded as a Latin font and there is no equivalent to “Japanese \texttt{\textbackslash nullfont}” by design. To elaborate, it is possible \emph{only} when no Japanese font is set globally, i.e. in ini\TeX mode. Once a valid Japanese font is selected, there is no way of selecting “Japanese \texttt{\textbackslash nullfont}” to discard all characters.

Moreover, \texttt{p\TeX} and friends assume that each Japanese font (except “Japanese \texttt{\textbackslash nullfont}” in ini\TeX mode) contains all valid Japanese character code. In other words, all Japanese fonts share the same character set corresponding to the whole valid Japanese character code range.

8 Other strange beasts

8.1 Internal kanji encodings

The \langle character code \rangle is a union of the following two:

• Range of numbers between 0–255, and

• Numbers allowed for internal code of Japanese characters.

The former is the same as Knuthian \TeX, but the latter is a problem. In up\TeX/$\epsilon$-up\TeX with -kanji-internal=uptex (default on), the range is very simple:

\[ c \geq 0 \]

However in p\TeX/$\epsilon$-p\TeX, only legacy encodings (EUC-JP as \texttt{euc}, or Shift-JIS as \texttt{sjis}) are available for -kanji-internal. In this case, the range can be represented as follows:

\[ c = 256c_1 + c_2 \ (c_i \in C_i) \]

where

\[
\begin{aligned}
C_1 &= C_2 = \{"a1,\ldots,"fe\} \quad \text{(euc)}, \\
C_1 &= \{"81,\ldots,"9f\} \cup \{"e0,\ldots,"fc\}, \quad C_2 = \{"40,\ldots,"7e\} \cup \{"80,\ldots,"fc\} \quad \text{(sjis)}. \\
\end{aligned}
\]

Therefore, the overall range of \langle character code \rangle is \textit{not} continuous.

To check whether an integer is a valid Japanese character code or not, you can use \texttt{\iffontchar} with \texttt{$\epsilon$-p\TeX} 190709 or later (\TeX Live 2020). Suppose a count register \texttt{\mycount} stores an integer, you can do it as follows:

\begin{verbatim}
20
\end{verbatim}
Here the primitive $\jfont$ is used merely as a representative non-empty$^9$ Japanese font containing all valid Japanese character code (see 7.2).

Note that p\TeX{} (not including up\TeX{} with internal Unicode) does not support typesetting characters outside JIS X 0208, which is a subset of accepted range of (character code) described above. To check if an integer is in the range of JIS X 0208, you can use $\toucs$ with p\TeX{} p3.10.0 or later (\TeX{} Live 2022):

\begin{verbatim}
\ifnum\toucs\mycount>0
  \% \mycount is in the range of JIS X 0208
\fi
\end{verbatim}

The primitive $\toucs$ converts an integer value from an internal kanji code to a Unicode. This conversion is based on JIS-Unicode mapping table,$^{10}$ and returns $-1$ if no mapping is available for the input integer.

---

$^9$This assumption is always safe after one of the standard p\TeX{} formats (e.g. plain p\TeX{}, palatinate) is loaded.

$^{10}$Defined in jisx0208.h of pte\text{enc} library.
References

https://ctan.org/pkg/dvistd

https://www.eijkhout.net/texbytopic/texbytopic.html
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