OpTEX

Format Based on Plain TEX and OPmac[1]

Version 0.18

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http://petr.olsak.net/optex

OpTEX is LuaTEX format with Plain TEX and OPmac. Only LuaTEX engine is supported.

OpTEX should be a modern Plain TEX with power from OPmac (Fonts Selection System, colors, graphics, references, hyperlinks, indexing, bibliography, ...) with preferred Unicode fonts.

The main goal of OpTEX is:

- OpTEX keeps the simplicity (like in Plain TEX and OPmac macros).
- There is no old obscurities concerning with various 8-bit encodings and various engines.
- OpTEX provides a powerful Fonts Selection System (for Unicode font families, of course).
- OpTEX supports hyphenations of all languages installed in your TEX system.
- All features from OPmac macros are copied. For example sorting words in the Index[2], reading `.bib` files directly[2], syntax highlighting[2], colors, graphics, hyperlinks, references).
- Macros are documented in the same place where code is.
- User name space of control sequences is separated from internal name space of OpTEX and primitives (`\foo` versus `\_foo`). The name spaces for macro writers are designed too.

If you need to customize your document or you need to use something very specific, then you can copy relevant parts of OpTEX macros into your macro file and do changes of these macros here. This is significant difference from LATEX or ConTeXt, which are an attempt to create a new user level with a plenty of non-primitive parameters and syntax hiding TEX internals. The macros from OpTEX are simple and straightforward because they solve only what is explicitly needed, they does not create a new user level for controlling your document. We have TEX. You can use OpTEX macros, understand them an modify them.

OpTEX offers a markup language for authors of texts (like LATEX), i. e. the fixed set of tags to define the structure of the document. This markup is different from the LATEX markup. It may offer to write the source text of the document somewhat clearer and more attractive.

The manual includes two parts: user documentation and technical documentation. The second part is generated directly from the sources of OpTEX. There are many hyperlinks from one part to second and vice versa.

This manual describes OpTEX features only. We suppose that user knows TEX basics. They are described in many books. You can see a short document TEX in nutshell too.

[1] OPmac package is a set of simple additional macros to Plain TEX. It enables users to take advantage of LATEX functionality but keeps Plain TEX simplicity. See http://petr.olsak.net/opmac-e.html for more information about it.

[2] All these features are implemented by TEX macros, no external program is needed.

Contents

Chapter 1
User documentation

1.1 Starting with OpTEX

OpTEX is compiled as a format for LuaTEX. Maybe there is a command `optex` in your TEX distribution. Then you can write into command line

```
optex document
```

You can try to process `optex op-demo` or `optex optex-doc`.

If there is no `optex` command, see more information about installation OpTEX at http://petr.olsak.net/optex.

A minimal document should be

```
\fontfam[LMfonts]
Hello World! \bye
```

The first line `\fontfam[LMfonts]` tells that Unicode Latin Modern fonts (derived from Computer Modern) are used. If you omit this line then preloaded Latin Modern fonts are used but preloaded fonts cannot be in Unicode[1]. So the sentence `Hello World` will be OK without the first line, but you cannot print such sentence in another languages (for example `Ahoj světe!`) where Unicode fonts are needed because of the characters like `ě` are not mapped correctly in preloaded fonts.

A somewhat larger example with common settings should be:

```
\fontfam[Termes]  % selecting Unicode font family Termes (section 1.3.1)
\typosize[11/13]  % setting default font size and baselineskip (sec. 1.3.2)
\margins/1 a4 (1,1,1,1)in % setting A4 paper, 1 in margins (section 1.2.1)
\cslang           % Czech hyphenation patterns (section 1.7.1)

Tady je zkušební textík v českém jazyce.
\bye
```

You can look at `op-demo.tex` file for more complex, but still simple example.

1.2 Page layout

1.2.1 Setting the margins

The `\margins` command declares margins of the document. This command have the following parameters:

```
\margins/⟨pg⟩ ⟨fmt⟩ (⟨left⟩,⟨right⟩,⟨top⟩,⟨bot⟩)⟨unit⟩
  example:
\margins/1 a4 (2.5,2.5,2,2)cm
```

Parameters are:

- ⟨*pg*⟩ ... 1 or 2 specifies one-page or two-pages design.
- ⟨*fmt*⟩ ... paper format (a4, a4l, a5, letter, etc. or user defined).
- ⟨*left*⟩, ⟨*right*⟩, ⟨*top*⟩, ⟨*bot*⟩ ... gives the amount of left, right, top and bottom margins.
- ⟨*unit*⟩ ... unit used for values ⟨*left*⟩, ⟨*right*⟩, ⟨*top*⟩, ⟨*bot*⟩.

[1] This is a technical limitation of LuaTEX for fonts downloaded in formats: only 8bit fonts can be preloaded.

Each of the parameters ⟨*left*⟩, ⟨*right*⟩, ⟨*top*⟩, ⟨*bot*⟩ can be empty. If both ⟨*left*⟩ and ⟨*right*⟩ are nonempty then `\hsize` is set. Else `\hsize` is unchanged. If both ⟨*left*⟩ and ⟨*right*⟩ are empty then typesetting area is centered in the paper format. The analogical rule works when ⟨*top*⟩ or ⟨*bot*⟩ parameter is empty (`\vsize` instead `\hsize` is used). Examples:

```
\margins/1 a4 (,,,)mm   % \hsize, \vsize untouched,
                        % typesetting area centered
\margins/1 a4 (,2,,)cm  % right margin set to 2cm
                        % \hsize, \vsize untouched, vertically centered
```

If ⟨*pg*⟩`=1` then all pages have the same margins. If ⟨*pg*⟩`=2` then the declared margins are true for odd pages. The margins at the even pages are automatically mirrored in such case, it means that ⟨*left*⟩ is replaced by ⟨*right*⟩ and vice versa.

OpTEX declares following paper formats: a4, a4l (landscape a4), a5, a5l, a3, a3l, b5, letter and user can declare another own format by `\sdef`:

```
\sdef{_pgs:b5l}{(250,176)mm}
\sdef{_pgs:letterl}{(11,8.5)in}
```

The ⟨*fmt*⟩ can be also in the form `(`⟨*width*⟩`,`⟨*height*⟩`)`⟨*unit*⟩ where ⟨*unit*⟩ is optional. If it is missing then ⟨*unit*⟩ after margins specification is used. For example:

```
\margins/1 (100,200) (7,7,7,7)mm
```

declares the paper 100×200 mm with all four margins 7 mm. The spaces before and after ⟨*fmt*⟩ parameter are necessary.

The command `\magscale[`⟨*factor*⟩`]` scales the whole typesetting area. The fixed point of such scaling is the upper left corner of the paper sheet. Typesetting (breakpoints etc.) is unchanged. All units are relative after such scaling. Only paper formats dimensions stays unscaled. Example:

```
\margins/2 a5 (22,17,19,21)mm
\magscale[1414] \margins/1 a4 (,,,)mm
```

The first line sets the `\hsize` and `\vsize` and margins for final printing at a5 format. The setting on the second line centers the scaled typesetting area to the true a4 paper while breaking points for paragraphs and pages are unchanged. It may be usable for review printing. After review is done, the second line can be commented out.

1.2.2 Concept of default page

OpTEX uses "output routine" for page design. It is very similar to Plain TEX output routine. There is `\headline` followed by "page body" followed by `\footline`. The `\headline` is empty by default and it can be used for running headers repeated on each page. The `\footline` prints centered page number by default. You can set the `\footline` to empty using `\nopagenumbers` macro.

The margins declared by `\margins` macro (documented in the previous section 1.2.1) is concerned to the page body, i.e. the `\headline` and `\footline` are placed to the top and bottom margins.

The distance between the `\headline` and the top of the page body is given by the `\headlinedist` register. The distance between bottom of the page body and the `\footline` is given by `\footlinedist`. The default values are:

```
\headline = {}
\footline = {\_hss\_rmfixed \_folio \_hss} % \folio expands to page number
\headlinedist = 14pt % from baseline of \headline to top of page body
\footlinedist = 24pt % from last line in pagebody to baseline of footline
```

The page body should be divided to top insertions (floating tables and figures) followed by a real text and followed by footnotes. Typically, only real text is here.

The `\pgbackground` tokens list is empty by default but it can be used for creating background of each page (colors, picture, watermark for example). The macro `\draft` uses this register and puts big text DRAFT as watermark to each page. You can try it.

More about the page layout is documented in sections 2.7.4 and 2.18.

1.2.3 Footnotes and marginal notes

The Plain TEX's macro `\footnote` can be used as usual. But a new macro `\fnote{`⟨*text*⟩`}` is defined. The footnote mark is added automatically and it is numbered on each chapter from one[2]. The ⟨*text*⟩ is scaled to 80 %. User can redefine footnote mark or scaling, as shown in the section 2.34.

The `\fnote` macro is fully applicable only in "normal outer" paragraph. It doesn't work inside boxes (tables, for example). If you are solving such case then you can use the command `\fnotemark`⟨*numeric-label*⟩ inside the box: only the footnote mark is generated here. When the box is finished you can use `\fnotetext{`⟨*text*⟩`}`. This macro puts the ⟨*text*⟩ to the footnote. The ⟨*numeric-label*⟩ have to be `1` if only one such command is in the box. Second `\fnotemark` inside the same box have to have the parameter `2` etc. The same number of `\fnotetext`s have to be written after the box as the number of `\fnotemark`s inserted inside the box. Example:

```
Text in a paragraph\fnote{First notice}...    % a "normal" footnote
\table{...}{...\fnotemark1...\fnotemark2...}  % two footnotes in a box
\fnotetext{Second notice}
\fnotetext{Third notice}
...
\table{...}{...\fnotemark1...}                % one footnote in a box
\fnotetext{Fourth notice}
```

The marginal note can be printed by the `\mnote{`⟨*text*⟩`}` macro. The ⟨*text*⟩ is placed to the right margin on the odd pages and it is placed to the left margin on the even pages. This is done after second TEX run because the relevant information is stored in an external file and read from it again. If you need to place the notes only to the fixed margin write `\fixmnotes\right` or `\fixmnotes\left`.

The ⟨*text*⟩ is formatted as a little paragraph with the maximal width `\mnotesize` ragged left on the left margins or ragged right on the right margins. The first line of this little paragraph has its vertical position given by the position of `\mnote` in the text. The exceptions are possible by using the `up` keyword: `\mnote up`⟨*dimen*⟩`{`⟨*text*⟩`}`. You can set such ⟨*dimen*⟩ to each `\mnote` manually in final printing in order to margin notes do not overlap. The positive value of ⟨*dimen*⟩ shifts the note up and negative value shifts it down. For example `\mnote up 2\baselineskip{`⟨*text*⟩`}` shifts this marginal note two lines up.

1.3 Fonts

1.3.1 Font families

You can select the font family by `\fontfam[`⟨*Family-name*⟩`]`. The argument ⟨*Family-name*⟩ is case insensitive and spaces are ignored in it. For example, `\fontfam[LM Fonts]` is equal to `\fontfam[LMfonts]` and it is equal to `\fontfam[lmfonts]`. Several aliases are prepared, thus `\fontfam[Latin Modern]` can be used for loading Latin Modern family too.

If you write `\fontfam[?]` then all font families registered in OpTEX are listed on the terminal and in the log file. If you write `\fontfam[catalog]` then a catalog of all fonts registered in

[2] You can declare `\fnotenumglobal` if you want footnotes numbered in whole document from one or `\fnotenumpages` if you want footnotes numbered at each page from one. Default setting is `\fnotenumchapters`

OpTEX and available in your TEX system is printed. The instructions how to register your own font family is appended in such catalog.

If the family is loaded then *font modifiers* applicable in such font family are listed on the terminal: (`\caps`, `\cond` for example). And there are four basic *variant selectors* (`\rm`, `\bf`, `\it`, `\bi`). The usage of variant selectors is the same as in Plain TEX: `{\it italics text}`, `{\bf bold text}` etc.

The font modifiers (`\caps`, `\cond` for example) can be used before a variant selector and they can be (independently) combined: `\caps\it` or `\cond\caps\bf`. The modifiers keeps their internal setting until group ends or until another modifier which negates the previous feature is used. So `{\caps \rm First text \it Second text}` gives FIRST TEXT *SECOND TEXT*.

The font modifier without following variant selector does not change the font actually, it only prepares data used by next variant selectors. There is one special variant selector `\currvar` which does not change the selected variant but reloads the font due to (maybe newly specified) font modifier(s).

The context between variants `\rm` ↔ `\it` and `\bf` ↔ `\bi` is kept by the `\em` macro (emphasize text). It switches from current `\rm` to `\it`, from current `\it` to `\rm`, from current `\bf` to `\bi` and from current `\bi` to `\bf`. The italics correction `\/` is inserted automatically, if needed. Example:

```
This is {\em important} text.     % = This is {\it important\/} text.
\it This is {\em important} text. % = This is\/ {\rm important} text.
\bf This is {\em important} text. % = This is {\bi important\/} text.
\bi This is {\em important} text. % = This is\/ {\bf important} text.
```

More about the OpTEX Font Selection System is written in the technical documentation in the section 2.13. You can mix more font families in your document, you can declare your own variant selectors or modifiers etc.

1.3.2 Font sizes

The command `\typosize[`⟨*fontsize*⟩`/`⟨*baselineskip*⟩`]` sets the font size of text and math fonts and baselineskip. If one of these two parameters is empty, the corresponding feature stays unchanged. Don't write the unit of these parameters. The unit is internally set to `\ptunit` which is 1pt by default. You can change the unit by the command `\ptunit=`⟨*something-else*⟩, for instance `\ptunit=1mm` enlarges all font sizes declared by `\typosize`. Examples:

```
\typosize[10/12]   % default of Plain TeX
\typosize[11/12.5] % font 11pt, baseline 12.5pt
\typosize[8/]      % font 8pt, baseline unchanged
```

The commands for font size setting described in this section have local validity. If you put them into a group, the settings are lost when the group is finished. If you set something relevant with paragraph shape (baselineskip given by `\typosize` for example) then you must first finalize the paragraph before closing the group: `{\typosize[12/14] ...`⟨*text of paragraph*⟩`... \par}`.

The command `\typoscale[`⟨*font-factor*⟩`/`⟨*baselineskip-factor*⟩`]` sets the text and math fonts size and baselineskip as a multiple of the current fonts size and baselineskip. The factor is written in "scaled"-like way, it means that 1000 means factor one. The empty parameter is equal to the parameter 1000, i.e. the value stays unchanged. Examples:

```
\typoscale[800/800]    % fonts and baselineskip re-size to 80 %
\typoscale[\magstep2/] % fonts bigger 1,44times (\magstep2 expands to 1440)
```

First usage of `\typosize` or `\typoscale` macro in your document sets so called *main values*, i. e. main font size and main baselineskip. They are internally saved in registers `\mainfosize` and `\mainbaselineskip`.

The \typoscale command does scaling in respect to current values by default. If you want to do it in respect to main values, type \scalemain immediately before \typoscale command.

```
\typosize[12/14.4] % first usage in document, sets main values internally
\typosize[15/18]   % bigger font
\scalemain \typoscale[800/800] % reduces from main values, no from current.
```

The \typosize and \typoscale macros initialize the font family by \rm. You can re-size only the current font by the command \thefontsize[⟨*font-size*⟩] or the font can be rescaled by \thefontscale[⟨*factor*⟩]. These macros don't change math fonts sizes nor baselineskip.

There is "low level" \setfontsize{⟨*size-spec*⟩} command which behaves like a font modifier and sets given font size used by next variant selectors. It doesn't change the font size immediately, but following variant slelector does it. For example \setfontsize{at15pt}\currvar sets current variant to 15pt.

If you are using a font family with "optical sizes feature" (i. e. there are more recommended sizes of the same font which are not scaled linearly; good example is Computer Modern aka Latin Modern fonts) then the recommended size is selected by all mentioned commands automatically.

More information about resizing of fonts is documented in the section 2.12.

1.3.3 Typesetting math

See the additional document Typesetting Math with OpTEX for more details about this issue.

OpTEX preloads a collection of 7bit Computer Modern math fonts and AMS fonts in its format for math typesetting. You can use them in any size and in the \boldmath variant. Most declared text font families (see \fontfam in the section 1.3.1) are configured with recommended Unicode math font. This font is automatically loaded unless you specify \noloadmath before first \fontfam command. See log file for more information about loading text font family and Unicode math fonts. If you prefer another Unicode math font, specify it by \loadmath{[⟨*font-file*⟩]} or \loadmath{⟨*font-name*⟩} before first \fontfam command.

Hundreds math symbols and operators like in AMSTEX are accessible. For example \alpha α, \geq $\geq$, \sum $\sum$, \sphericalangle $\sphericalangle$, \bumpeq, $\bumpeq$. See AMSTEX manual or Typesetting Math with OpTEX for complete list of math symbols.

The following math alphabets are available:

\mit	% mathematical variables	$abc{-}xyz, ABC{-}XYZ$
\it	% text italics	$abc{-}xyz, ABC{-}XYZ$
\rm	% text roman	abc–xyz, ABC–XYZ
\cal	% normal calligraphics	$\mathcal{ABC}{-}\mathcal{XYZ}$
\script	% script	$\mathscr{ABC}{-}\mathscr{XYZ}$
\frak	% fracture	$\mathfrak{abc}{-}\mathfrak{xyz}, \mathfrak{ABC}{-}\mathfrak{XYZ}$
\bbchar	% double stroked letters	$\mathbb{ABC}{-}\mathbb{XYZ}$
\bf	% sans serif bold	$\mathbf{abc{-}xyz, ABC{-}XYZ}$
\bi	% sans serif bold slanted	$\boldsymbol{abc{-}xyz, ABC{-}XYZ}$

The last two selectors \bf and \bi select the sans serif fonts in math regardless the current text font family. This is common notation for vectors and matrices. You can re-declare them, see section 2.16.2 where definitions of Unicode math variants of \bf and \bi selectors are documented.

The math fonts can be scaled by \typosize and \typoscale macros. Two math fonts collections are prepared: \normalmath for normal weight and \boldmath for bold. The first one is set by default, the second one is usable for math formulae in titles typeset in bold, for example.

You can use \mathbox{⟨*text*⟩} inside math mode. It behaves as {\hbox{⟨*text*⟩}} (i.e. the ⟨*text*⟩ is printed in horizontal non-math mode) but the size of the ⟨*text*⟩ is adapted

to the context of math size (text or script or scriptscript). Moreover, there is the macro `\mathstyles{`⟨*math list*⟩`}` which depends on the current math style. It is documented at the end of the section 2.15.

1.4 Typical elements of document

1.4.1 Chapters and sections

The documents can be divided into chapters (`\chap`), sections (`\sec`), subsections (`\secc`) and they can be titled by `\tit` command. The parameters are separated by the end of current line (no braces are used):

`\tit Document title` ⟨*end of line*⟩
`\chap Chapter title` ⟨*end of line*⟩
`\sec Section title` ⟨*end of line*⟩
`\secc Subsection title` ⟨*end of line*⟩

The chapters are automatically numbered by one number, sections by two numbers (chapter.section) and subsections by three numbers. If there are no chapters then section have only one number and subsection two.

The implicit design of the titles of chapter etc. are implemented in the macros `\_printchap`, `\_printsec` and `\_printsecc`. A designer can simply change these macros if he/she needs another behavior.

The first paragraph after the title of chapter, section and subsection is not indented but you can type `\let\_firstnoindent=\relax` if you need all paragraphs indented.

If a title is so long then it breaks to more lines in the output. It is better to hint the breakpoints because TEX does not interpret the meaning of the title. User can put the `\nl` (means newline) to the breakpoints.

If you want to arrange a title to more lines in your source file then you can use `^^J` at the end of each line (except the last one). When `^^J` is used, then reading of the title continues at the next line. The "normal" comment character `%` doesn't work in titles. You can use `\nl␣^^J` if you want to have corresponding lines in the source and in the output.

The chapter, section or subsection isn't numbered if the `\nonum` precedes. And the chapter, section or subsection isn't delivered to the table of contents if `\notoc` precedes. You can combine both prefixes.

1.4.2 Another numbered objects

Apart from chapters, sections and subsections, there are another automatically numbered objects: equations, captions for tables and figures. The user can declare more numbered objects.

If the user writes the `\eqmark` as the last element of the display mode then this equation is numbered. The equation number is printed in brackets. This number is reset in each section by default.

If the `\eqalignno` is used, then user can put `\eqmark` to the last column before `\cr`. For example:

```
\eqalignno{
    a^2+b^2 &= c^2 \cr
          c &= \sqrt{a^2+b^2} & \eqmark \cr}
```

Another automatically numbered object is a caption which is tagged by `\caption/t` for tables and `\caption/f` for figures. The caption text follows. The `\cskip` can be used between `\caption` text and the real object (table or figure). You can use two orders: ⟨*caption*⟩`\cskip` ⟨*object*⟩ or ⟨*object*⟩`\cskip` ⟨*caption*⟩. The `\cskip` creates appropriate vertical space between them. Example:

```
\caption/t The dependency of the computer-dependency on the age.
\cskip
\noindent\hfil\table{rl}{
    age   & value \crl\noalign{\smallskip}
    0--1  & unmeasured \cr
    1--6  & observable \cr
    6--12 & significant \cr
   12--20 & extremal \cr
   20--40 & normal \cr
   40--60 & various \cr
   60--$\infty$ & moderate}
```

This example produces:

Table 1.4.1 The dependency of the computer-dependency on the age.

age	value
0–1	unmeasured
1–6	observable
6–12	significant
12–20	extremal
20–40	normal
40–60	various
60–∞	moderate

You can see that the word "Table" followed by a number is added by the macro `\caption/t`. The caption text is centered. If it occupies more lines then the last line is centered.

The macro `\caption/f` behaves like `\caption/t` but it is intended for figure captions with independent numbering. The word (Table, Figure) depends on the actual selected language (see section 1.7.1 about languages).

If you wish to make the table or figure as floating object, you need to use Plain TEX macros `\midinsert` or `\topinsert` terminated by `\endinsert`. Example:

```
\topinsert  % table and its caption printed at the top of the current page
   <caption and table>
\endinsert
```

The pair `\midinsert`...`\endinsert` prefers to put the enclosed object to the current place. Only if this is unable due to page breaking, it behaves like `\topinsert`...`\endinsert`.

There are five prepared counters `A`, `B`, `C`, `D` and `E`. They are reset in each chapter and section[3]. They can be used in context of `\numberedpar` ⟨*letter*⟩`{`⟨*text*⟩`}` macro. For example:

```
\def\theorem    {\numberedpar A{Theorem}}
\def\corollary  {\numberedpar A{Corollary}}
\def\definition {\numberedpar B{Definition}}
\def\example    {\numberedpar C{Example}}
```

Three independent numbers are used in this example. One for Theorems and Corollaries second for Definitions and third for Examples. The user can write `\theorem Let $M$ be...` and the new paragraph is started with the text: **Theorem 1.4.1.** Let M be... You can add an optional parameter in brackets. For example, `\theorem [(L'Hôpital's rule)] Let $f$, $g$ be...` is printed like **Theorem 1.4.2 (L'Hôpital's rule).** Let f, g be...

[3] This feature can be changed, see the section 2.26 in the technical documentation.

1.4.3 References

Each automatically numbered object documented in sections 1.4.1 and 1.4.2 can be referenced if optional parameter `[⟨label⟩]` is appended to `\chap`, `\sec`, `\secc`, `\caption/t`, `\caption/f` or `\eqmark`. The alternative syntax is to use `\label[⟨label⟩]` before mentioned commands (not necessarily directly before). The reference is realized by `\ref[⟨label⟩]` or `\pgref[⟨label⟩]`. Example:

```
\sec[beatle] About Beatles

\noindent\hfil\table{rl}{...} % the table
\cskip
\caption/t [comp-depend] The dependency of the comp-dependency on the age.

\label[pythagoras]
$$ a^2 + b^2 = c^2 \eqmark $$

Now we can point to the section~\ref[beatle] on the page~\pgref[beatle]
or write something about the equation~\ref[pythagoras]. Finally there
is an interesting Table~\ref[comp-depend].
```

If there are forward referenced objects then user have to run TEX twice. During each pass, the working `*.ref` file (with references data) is created and this file is used (if it exists) at the beginning of the document.

You can use the `\label[⟨label⟩]` before the `\theorem`, `\definition` etc. (macros defined with `\numberedpar`) if you want to reference these numbered objects. You can't use `\theorem[⟨label⟩]` because the optional parameter is reserved to another purpose here.

You can create a reference to whatever else by commands `\label[⟨label⟩]\wlabel{⟨text⟩}`. The connection between ⟨*label*⟩ and ⟨*text*⟩ is established. The `\ref[⟨label⟩]` will print ⟨*text*⟩.

By default, labels are not printed, of course. But if you are preparing a draft version of your document then you can declare `\showlabels`. The labels are printed at their destination places after such declaration.

1.4.4 Hyperlinks, outlines

If the command `\hyperlinks` ⟨*color-in*⟩ ⟨*color-out*⟩ is used at the beginning of the document, then the following objects are hyperlinked in the PDF output:

- numbers and texts generated by `\ref` or `\pgref`,
- numbers of chapters, sections, subsections and page numbers in the table of contents,
- numbers or marks generated by `\cite` command (bibliography references),
- texts printed by `\url` or `\ulink` commands.

The last object is an external link and it is colored by ⟨*color-out*⟩. Others links are internal and they are colored by ⟨*color-in*⟩. Example:

```
\hyperlinks \Blue \Green % internal links blue, URLs green.
```

You can use another marking of active links: by frames which are visible in the PDF viewer but invisible when the document is printed. The way to do it is to define the macros `\_pgborder`, `\_tocborder`, `\_citeborder`, `\_refborder` and `\_urlborder` as the triple of RGB components of the used color. Example:

```
\def\_tocborder {1 0 0}  % links in table of contents: red frame
\def\_pgborder {0 1 0}   % links to pages: green frame
\def\_citeborder {0 0 1} % links to references: blue frame
```

By default, these macros are not defined. It means that no frames are created.

The hyperlinked footnotes can be activated by `\fnotelinks` ⟨*color-fnt*⟩ ⟨*color-fnf*⟩ where footnote marks in the text have ⟨*color-fnt*⟩ and the same footnote marks in footnotes have ⟨*color-fnf*⟩. You can define relevant borders `\_fntborder` and `\_fnfborder` analogically as `\_pgborder` (for example).

There are "low level" commands to create the links. You can specify the destination of the internal link by `\dest[`⟨*type*⟩`:`⟨*label*⟩`]`. The active text linked to the `\dest` can be created by `\ilink[`⟨*type*⟩`:`⟨*label*⟩`]{`⟨*text*⟩`}`. The ⟨*type*⟩ parameter is one of the `toc`, `pg`, `cite`, `ref` or another special for your purpose. These commands create internal links only when `\hyperlinks` is declared.

The `\url` macro prints its parameter in `\tt` font and creates a potential breakpoints in it (after slash or dot, for example). If `\hyperlinks` declaration is used then the parameter of `\url` is treated as an external URL link. An example: `\url{http://www.olsak.net}` creates http://www.olsak.net. The characters `%`, `\`, `#`, `{` and `}` have to be protected by backslash in the `\url` argument, the other special characters `~`, `^`, `&` can be written as single character[4]. You can insert the `\|` command in the `\url` argument as a potential breakpoint.

If the linked text have to be different than the URL, you can use `\ulink[`⟨*url*⟩`]{`⟨*text*⟩`}` macro. For example: `\ulink[http://petr.olsak.net/optex]{\OpTeX/ page}` outputs to the text OpTEX page.

The PDF format provides *outlines* which are notes placed in the special frame of the PDF viewer. These notes can be managed as structured and hyperlinked table of contents of the document. The command `\outlines{`⟨*level*⟩`}` creates such outlines from data used for table of contents in the document. The ⟨*level*⟩ parameter gives the level of opened sub-outlines in the default view. The deeper levels can be opened by mouse click on the triangle symbol after that.

If you are using a special unprotected macro in section titles then `\outlines` macro may crash. You must declare variant of the macro for outlines case which is expandable. Use `\regmacro` in such case. See the section 1.5.1 for more information about `\regmacro`.

The command `\insertoutline{`⟨*text*⟩`}` inserts next entry into PDF outlines at the main level 0. These entries can be placed before table of contents (created by `\outlines`) or after it. Theirs hyperlink destination is in the place where the `\insertoutline` macro is used.

1.4.5 Lists

The list of items is surrounded by `\begitems` and `\enditems` commands. The asterisk (`*`) is active within this environment and it starts one item. The item style can be chosen by the `\style` parameter written after `\begitems`:

```
\style o % small bullet
\style O % big bullet (default)
\style - % hyphen char
\style n % numbered items 1., 2., 3., ...
\style N % numbered items 1), 2), 3), ...
\style i % numbered items (i), (ii), (iii), ...
\style I % numbered items I, II, III, IV, ...
\style a % items of type a), b), c), ...
\style A % items of type A), B), C), ...
\style x % small rectangle
\style X % big rectangle
```

For example:

[4] More exactly, there are the same rules as for `\code` command, see section 1.4.7.

```
\begitems
* First idea
* Second idea in subitems:
  \begitems \style i
  * First sub-idea
  * Second sub-idea
  * Last sub-idea
  \enditems
* Finito
\enditems
```

produces:

- First idea
- Second idea in subitems:
  (i) First sub-idea
  (ii) Second sub-idea
  (iii) Last sub-idea
- Finito

Another style can be defined by the command `\sdef{_item:`⟨*style*⟩`}{`⟨*text*⟩`}`. Default item can be set by `\defaultitem={`⟨*text*⟩`}`. The list environments can be nested. Each new level of items is indented by next multiple of `\iindent` value which is set to `\parindent` by default. The `\ilevel` register says what level of items is currently processed. Each `\begitems` starts `\everylist` tokens register. You can set, for example:

```
\everylist={\ifcase\ilevel\or \style X \or \style x \else \style - \fi}
```

You can say `\begitems \novspaces` if you don't want vertical spaces above and below the list. The nested item list are without vertical spaces automatically. More information about design of lists of items should be found in the section 2.27.

1.4.6 Tables

The macro `\table{`⟨*declaration*⟩`}{`⟨*data*⟩`}` provides similar ⟨*declaration*⟩ of tables as in LaTeX: you can use letters `l`, `r`, `c`, each letter declares one column (aligned to left, right, center, respectively). These letters can be combined by the `|` character (vertical line). Example

```
\table{||lc|r||}{                  \crl
   Month    & commodity  & price   \crli \tskip2pt
   January  & notebook   & \$ 700  \cr
   February & skateboard & \$ 100  \cr
   July     & yacht      & k\$ 170 \crl}
```

generates the following result:

Month	commodity	price
January	notebook	$ 700
February	skateboard	$ 100
July	yacht	k$ 170

Apart from `l`, `r`, `c` declarators, you can use the `p{`⟨*size*⟩`}` declarator which declares the column with paragraphs of given width. More precisely, a long text in the table cell is printed as a multiline paragraph with given width. By default, the paragraph is left-right justified. But there are alternatives:

- `p{`⟨*size*⟩`\fL}` fit left, i.e. left justified, ragged right,
- `p{`⟨*size*⟩`\fR}` fit right, i.e. right justified, ragged left,
- `p{`⟨*size*⟩`\fC}` fit center, i.e. ragged left plus right,
- `p{`⟨*size*⟩`\fS}` fit special, short one-line pararaph centered, long paragraph normal,
- `p{`⟨*size*⟩`\fX}` fit extra, left-right justified but last line centered.

You can use `(`⟨*text*⟩`)` in the ⟨*declaration*⟩. Then this text is applied in each line of the table. For example `r(\kern10pt)l` adds more 10 pt space between `r` and `l` rows.

An arbitrary part of the ⟨*declaration*⟩ can be repeated by a ⟨*number*⟩ prefixed. For example `3c` means `ccc` or `c 3{|c}` means `c|c|c|c`. Note that spaces in the ⟨*declaration*⟩ are ignored and you can use them in order to more legibility.

The command `\cr` used in the ⟨*data*⟩ part of the table is generally known from Plain TEX. It marks the end of each row in the table. Moreover OpTEX defines following similar commands:

- `\crl` ... the end of the row with a horizontal line after it.
- `\crll` ... the end of the row with a double horizontal line after it.
- `\crli` ... like `\crl` but the horizontal line doesn't intersect the vertical double lines.
- `\crlli` ... like `\crli` but horizontal line is doubled.
- `\crlp{`⟨*list*⟩`}` ... like `\crli` but the lines are drawn only in the columns mentioned in comma separated ⟨*list*⟩ of their numbers. The ⟨*list*⟩ can include ⟨*from*⟩`-`⟨*to*⟩ declarators, for example `\crlp{1-3,5}` is equal to `\crlp{1,2,3,5}`.

The `\tskip`⟨*dimen*⟩ command works like the `\noalign{\vskip`⟨*dimen*⟩`}` immediately after `\cr*` commands but it doesn't interrupt the vertical lines.

You can use following parameters for the `\table` macro. Default values are listed too.

```
\everytable={}       % code used in \vbox before table processing
\thistable={}        % code used in \vbox, it is removed after using it
\tabiteml={\enspace} % left material in each column
\tabitemr={\enspace} % right material in each column
\tabstrut={\strut}   % strut which declares lines distance in the table
\tablinespace=2pt    % additional vert. space before/after horizontal lines
\vvkern=1pt          % space between lines in double vertical line
\hhkern=1pt          % space between lines in double horizontal line
\tabskip=0pt         % space between columns
\tabskipl=0pt \tabskipr=0pt % space before first and after last column
```

Example: if you do `\tabiteml={$\enspace}\tabitemr={\enspace$}` then the `\table` acts like LATEX's array environment.

If there is an item which spans to more than one column in the table then the macro `\multispan{`⟨*number*⟩`}` (from Plain TEX) can help you. Another alternative is the command `\mspan`⟨*number*⟩`[`⟨*declaration*⟩`]{`⟨*text*⟩`}` which spans ⟨*number*⟩ columns and formats the ⟨*text*⟩ by the ⟨*declaration*⟩. The ⟨*declaration*⟩ must include a declaration of only one column with the same syntax as common `\table` ⟨*declaration*⟩. If your table includes vertical rules and you want to create continuous vertical rules by `\mspan`, then use rule declarators `|` after `c`, `l` or `r` letter in `\mspan` ⟨*declaration*⟩. The exception is only in the case when `\mspan` includes first column and the table have rules on the left side. The example of `\mspan` usage is below.

The `\frame{`⟨*text*⟩`}` makes a frame around ⟨*text*⟩. You can put the whole `\table` into `\frame` if you need double-ruled border of the table. Example:

```
\frame{\table{|c||l||r|}{ \crl
  \mspan3[|c|]{\bf Title} \crl   \noalign{\kern\hhkern}\crli
  first & second & third  \crlli
  seven & eight  & nine   \crli}}
```

creates the following result:

Title		
first	second	third
seven	eight	nine

The \vspan⟨*number*⟩{⟨*text*⟩} shifts the ⟨*text*⟩ down in order it looks like to be in the center of the ⟨*number*⟩ lines (current line is first). You can use this for creating tables like in the following example:

```
\thistable{\tabstrut={\vrule height 20pt depth10pt width0pt}
          \baselineskip=20pt \tablinespace=0pt \rulewidth=.8pt}
\table{|8{c|}}{\crlp{3-8}
   \mspan2[c|]{}      & \mspan3[c|]{Singular}         & \mspan3[c|]{Plural} \crlp{3-8}
   \mspan2[c|]{}      & Neuter & Masculine & Feminine & Masculine & Feminine & Neuter \crl
   \vspan2{I}   & Inclusive & \mspan3[c|]{\vspan2{O}} & \mspan3[c|]{X} \crlp{2,6-8}
                & Exclusive & \mspan3[c|]{}           & \mspan3[c|]{X} \crl
   \vspan2{II}  & Informal  & \mspan3[c|]{X}          & \mspan3[c|]{X} \crlp{2-8}
                & Formal    & \mspan6[c|]{X} \crl
   \vspan2{III} & Informal  & \vspan2{O} & X & X      & \mspan2[c|]{X} &\vspan2{O} \crlp{2,4-7}
                & Formal    &                         & \mspan4[c|]{X} & \crl
}
```

		Singular			Plural		
		Neuter	Masculine	Feminine	Masculine	Feminine	Neuter
I	Inclusive	O			X		
	Exclusive				X		
II	Informal	X			X		
	Formal	X					
III	Informal	O	X	X	X		O
	Formal		X				

The ⟨*number*⟩ parameter of \vspan must be one-digit number. If you want to set more digits then use braces. You can use non-integer values too if you feel that the result is better, for example \vspan{2.1}{text}.

The rule width of tables and implicit width of all \vrules and \hrules can be set by the command \rulewidth=⟨*dimen*⟩. The default value given by TEX is 0.4 pt.

The c, l, r and p are default "declaration letters" but you can define more such letters by \def_tabdeclare⟨*letter*⟩{⟨*left*⟩##⟨*right*⟩}. More about it is in technical documentation in section 2.30.5. See the definition of the \tabdeclarec macro, for example.

The : columns boundary declarator is described in section 2.30.1. The tables with given width can be declared by to⟨*size*⟩ or pxto⟨*size*⟩. More about it is in section 2.30.3 Many tips about tables can be seen on the site http://petr.olsak.net/optex/optex-tricks.html.

1.4.7 Verbatim

The display verbatim text have to be surrounded by the \begtt and \endtt couple. The in-line verbatim have to be tagged (before and after) by a character which is declared by \activettchar⟨*char*⟩. For example \activettchar` declares the character ` for in-line verbatim markup. And you can use `\relax` for verbatim \relax (for example). Another alternative of printing in-line verbatim text is \code{⟨*text*⟩} (see below).

If the numerical register \ttline is set to the non-negative value then display verbatim will number the lines. The first line has the number \ttline+1 and when the verbatim ends then the \ttline value is equal to the number of last line printed. Next \begtt...\endtt environment will follow the line numbering. OpTEX sets \ttline=-1 by default.

The indentation of each line in display verbatim is controlled by \ttindent register. This register is set to the \parindent by default. User can change values of the \parindent and \ttindent independently.

The \begtt command starts internal group in which the catcodes are changed. Then the \everytt tokens register is run. It is empty by default and user can control fine behavior by it.

For example the catcodes can be re-declared here. If you need to define active character in the \everytt, use \adef as in the following example:

```
\everytt={\adef!{?}\adef?{!}}
\begtt
Each occurrence of the exclamation mark will be changed to
the question mark and vice versa. Really? You can try it!
\endtt
```

The \adef command sets its parameter as active *after* the parameter of \everytt is read. So you don't have to worry about active categories in this parameter.

There is an alternative to \everytt named \everyintt which is used for in-line verbatim surrounded by an \activettchar or processed by the \code command.

The \everytt is applied to all \begtt...\endtt environments (if it is not declared in a group). There are tips for such global \everytt definitions here:

```
\everytt={\typosize[9/11]}  % setting font size for verbatim
\everytt={\ttline=0}        % each listing will be numbered from one
\everytt={\visiblesp}       % visualization␣of␣spaces
```

If you want to apply a special code only for one \begtt...\endtt environment then don't set any \everytt but put desired material at the same line where \begtt is. For example:

```
\begtt   \adef!{?}\adef?{!}
Each occurrence of ? will be changed to ! and vice versa.
\endtt
```

The in-line verbatim surrounded by an \activettchar doesn't work in parameter of macros and macro definitions. (It works in titles declared by \chap, \sec etc. and in \fnotes, because these macros are specially defined in OpTEX). You can use more robust command \code{⟨*text*⟩} in problematic situations, but you have to escape following characters in the ⟨*text*⟩: \, #, %, braces (if the braces are unmatched in the ⟨*text*⟩), and space or ^ (if there are more than one subsequent spaces or ^ in the ⟨*text*⟩). Examples:

```
\code{\\text, \%\#} ... prints \text, %#
\code{@{..}*&^$ $}  ... prints @{..}*&^$ $ without escaping, but you can
                        escape these characters too, if you want.
\code{a \ b}        ... two spaces between a  b, second one must be escaped
\code{xy\{z}        ... xy{z ... unbalanced brace must be escaped
\code{^\^M}         ... prints ^^M, the second ^ must be escaped
```

You can print verbatim listing from external files by the \verbinput command. Examples:

```
\verbinput (12-42) program.c  % listing from program.c, only lines 12-42
\verbinput (-60) program.c    % print from begin to the line 60
\verbinput (61-) program.c    % from line 61 to the end
\verbinput (-) program.c      % whole file is printed
\verbinput (70+10) program.c  % from line 70, only 10 lines printed
\verbinput (+10) program.c    % from the last line read, print 10 lines
\verbinput (-5+7) program.c   % from the last line read, skip 5, print 7
\verbinput (+) program.c      % from the last line read to the end
```

You can insert additional commands for the \verbinput before first opening bracket. They are processed in the local group. For example, \verbinput \hsize=20cm (-) program.c.

The \ttline influences the line numbering by the same way as in \begtt...\endtt environment. If \ttline=-1 then real line numbers are printed (this is default). If \ttline<-1 then no line numbers are printed.

The \verbinput can be controlled by \everytt, \ttindent just like in \begtt...\endtt.

The \begtt...\endtt pair or \verbinput can be used for listings of codes. Automatic syntax highlighting is possible, for example \begtt \hisyntax{C} activates colors for C programs. Or \verbinput \hisyntax{HTML} (-) file.html can be used for HTML or XML codes. OpTEX implements C, Python, TEX, HTML and XML syntax highlighting. More languages can be declared, see the section 2.28.2.

If the code is read by \verbinput and there are comment lines prefixed by two characters then you can set them by \commentchars⟨*first*⟩⟨*second*⟩. Such comments are fully interpreted by TEX (i.e. not verbatim). Section 2.28.1 (page 124) says more about this feature.

1.5 Autogenerated lists

1.5.1 Table of contents

The \maketoc command prints the table of contents of all \chap, \sec and \secc used in the document. These data are read from external *.ref file, so you have to run TEX more than once (typically three times if the table of contents is at the beginning of the document).

Typically, we don't want to repeat the name of the section "table of contents" in the table of contents again. The direct usage of \chap or \sec isn't recommended here because the table of contents is typically not referenced to itself. You can print the unnumbered and unreferenced title of the section like this:

```
\nonum\notoc\sec Table of Contents
```

If you need a customization of the design of the TOC, read the section 2.24.

If you are using a special macro in section or chapter titles and you need different behavior of such macro in other cases then use \regmacro{⟨*case-toc*⟩}{⟨*case-mark*⟩}{⟨*case-outline*⟩}. The parameters are applied locally in given cases. The \regmacro can be used repeatedly: then its parameters are accumulated (for more macros). If a parameter is empty then original definition is used in given case. For example:

```
% default value of \mylogo macro used in text and in the titles:
\def\mylogo{\leavevmode\hbox{{\Red\it My}{\setfontsize{mag1.5}\rm Lo}Go}}
% another variants:
\regmacro {\def\mylogo{\hbox{\Red My\Black LoGo}}} % used in TOC
          {\def\mylogo{\hbox{{\it My}\/LoGo}}}     % used in running heads
          {\def\mylogo{MyLoGo}}                    % used in PDF outlines
```

1.5.2 Making the index

The index can be included into document by the \makeindex macro. No external program is needed, the alphabetical sorting are done inside TEX at macro level.

The \ii command (insert to index) declares the word separated by the space as the index item. This declaration is represented as invisible item on the page connected to the next visible word. The page number of the page where this item occurs is listed in the index entry. So you can type:

```
The \ii resistor resistor is a passive electrical component ...
```

You cannot double the word if you use the \iid instead \ii:

```
The \iid resistor is a passive electrical component ...
or:
Now we'll deal with the \iid resistor .
```

Note that the dot or comma have to be separated by space when \iid is used. This space (before dot or comma) is removed by the macro in the current text.

The multiple-words entries are commonly arranged in the index as follows:

linear dependency 11, 40–50
— independency 12, 42–53
— space 57, 76
— subspace 58

To do this you have to declare the parts of the index entries by the `/` separator. Example:

```
{\bf Definition.}
\ii linear/space,vector/space
{\em Linear space} (or {\em vector space}) is a nonempty set of...
```

The number of the parts of one index entry (separated by `/`) is unlimited. Note, that you can spare your typing by the comma in the `\ii` parameter. The previous example is equivalent to `\ii linear/space \ii vector/space` .

Maybe you need to propagate to the index the similar entry to the linear/space in the form space/linear. You can do this by the shorthand `,@` at the end of the `\ii` parameter. Example:

```
\ii linear/space,vector/space,@
is equivalent to:
\ii linear/space,vector/space \ii space/linear,space/vector
```

If you really need to insert the space into the index entry, write `~`.

The `\ii` or `\iid` commands can be preceded by `\iitype` ⟨*letter*⟩, then such reference (or more references generated by one `\ii`) has specified type. The page numbers of such references should be formatted specially in the index. OpTEX implements only `\iitype b`, `\iitype i` and `\iitype u`: the page number in bold or in italics or underlined is printed in the index when these types are used. Default index type is empty, which prints page numbers in normal font. The TEXbook index is good example.

The `\makeindex` creates the list of alphabetically sorted index entries without the title of the section and without creating more columns. OpTEX provides another macros `\begmulti` and `\endmulti` for more columns:

`\begmulti` ⟨*number of columns*⟩
⟨*text*⟩
`\endmulti`

The columns will be balanced. The Index can be printed by the following code:

```
\sec Index
\begmulti 3 \makeindex \endmulti
```

Only “pure words” can be propagated to the index by the `\ii` command. It means that there cannot be any macro, TEX primitive, math selector etc. But there is another possibility to create such complex index entry. Use “pure equivalent” in the `\ii` parameter and map this equivalent to the real word which is printed in the index. Such mapping is done by `\iis` command. Example:

```
The \ii chiquadrat $\chi$-quadrat method is ...
If the \ii relax `\relax` command is used then \TeX/ is relaxing.
...
\iis chiquadrat {$\chi$-quadrat}
\iis relax {\code{\\relax}}
```

The `\iis` ⟨*equivalent*⟩ `{`⟨*text*⟩`}` creates one entry in the “dictionary of the exceptions”. The sorting is done by the ⟨*equivalent*⟩ but the ⟨*text*⟩ is printed in the index entry list.

The sorting rules when `\makeindex` runs depends on the current language. See section 1.7.1 about languages selection.

1.5.3 BibTEXing

The command `\cite[`⟨*label*⟩`]` (or `\cite[`⟨*label-1*⟩`,`⟨*label-2*⟩`,...,`⟨*label-n*⟩`]`) creates the citation in the form [42] (or [15, 19, 26]). If `\shortcitations` is declared at the beginning of the document then continuous sequences of numbers are re-printed like this: [3–5, 7, 9–11]. If `\sortcitations` is declared then numbers generated by one `\cite` command are sorted upward.

If `\nonumcitations` is declared then the marks instead numbers are generated depending on the used bib-style. For example the citations look like [Now08] or [Nowak, 2008].

The `\rcite[`⟨*labels*⟩`]` creates the same list as `\cite[`⟨*labels*⟩`]` but without the outer brackets. Example: `[\rcite[tbn], pg.~13]` creates [4, pg. 13].

The `\ecite[`⟨*label*⟩`]{`⟨*text*⟩`}` prints the ⟨*text*⟩ only, but the entry labeled ⟨*label*⟩ is decided as to be cited. If `\hyperlinks` is used then ⟨*text*⟩ is linked to the references list.

You can define alternative formating of `\cite` command. Example:

```
\def\cite[#1]{(\rcite[#1])}    % \cite[<label>] creates (27)
\def\cite[#1]{$^{\rcite[#1]}$} % \cite[<label>] creates^{27}
```

The numbers printed by `\cite` correspond to the same numbers generated in the list of references. There are two possibilities to generate this references list:

- Manually using `\bib[`⟨*label*⟩`]` commands.
- By `\usebib/`⟨*type*⟩ `(`⟨*style*⟩`)` ⟨*bib-base*⟩ command which reads `*.bib` files directly.

Note that another two possibilities documented in OPmac (using external BibTEX program) isn't supported because BibTEX is old program which does not support Unicode. And Biber seems to be not compliant with Plain TEX.

References created manually using `\bib[`⟨*label*⟩`]` command.

```
\bib [tbn] P. Olšák. {\it\TeX{}book naruby.} 468~s. Brno: Konvoj, 1997.
\bib [tst] P. Olšák. {\it Typografický systém \TeX.}
           269~s. Praha: CSTUG, 1995.
```

If you are using `\nonumcitations` then you need to declare the ⟨*marks*⟩ used by `\cite` command. To do it you must use long form of the `\bib` command in the format `\bib[`⟨*label*⟩`] = {`⟨*mark*⟩`}`. The spaces around equal sign are mandatory. Example:

```
\bib [tbn] = {Olšák, 2001}
    P. Olšák. {\it\TeX{}book naruby.} 468~s. Brno: Konvoj, 2001.
```

Direct reading of `.bib` files is possible by `\usebib` macro. This macro reads and uses macro package `librarian.tex` by Paul Isambert. The usage is:

```
\usebib/c (<style>) <bib-base> % sorted by \cite-order (c=cite),
\usebib/s (<style>) <bib-base> % sorted by style (s=style).
% example:
\nocite[*] \usebib/s (simple) op-biblist  % prints all from op-biblist.bib
```

The ⟨*bib-base*⟩ is one or more `*.bib` database source files (separated by spaces and without extension) and the ⟨*style*⟩ is the part of the filename `bib-`⟨*style*⟩`.opm` where the formatting of the references list is defined. OpTEX supports `simple` or `iso690` styles. The features of the `iso690` style is documented in the section 2.32.5 in detail. The `\usebib` command is more documented in section 2.32.2.

Not all records are printed from ⟨*bib-base*⟩ files: the command `\usebib` selects only such bib-records which were used in `\cite` or `\nocite` commands in your document. The `\nocite` behaves as `\cite` but prints nothing. It tells only that mentioned bib-record should be printed in the reference list. If `\nocite[*]` is used then all records from ⟨*bib-base*⟩ are printed.

1.6 Graphics

1.6.1 Colors

OpTEX provides a small number of color selectors: \Blue, \Red, \Brown, \Green, \Yellow, \Cyan, \Magenta, \White, \Grey, \LightGrey and \Black. User can define more such selectors by setting four CMYK components or three RGB components. For example

```
\def \Orange {\setcmykcolor{0 0.5 1 0}}
\def \Purple {\setrgbcolor{1 0 1}}
```

The command \morecolors reads more definitions of color selectors from the LaTeX file x11nam.def. There is about 300 color names like \DeepPink, \Chocolate etc. If there are numbered variants of the same name, then the letters B, C, etc. are appended to the name in OpTEX. For example \Chocolate is Chocolate1, \ChocolateB is Chocolate2 etc.

The color selectors work locally in groups by default but with limitations. See the technical documentation, section 2.20 for more information.

The basic colors \Blue, \Red, \Cyan, \Yellow etc. are defined with CMYK components using \setcmykcolor. On the other hand, you can define a color with three RGB components and \morecolors defines such RGB colors. By default, the color model isn't converted but only stored to PDF output for each used color. Thus, there may be a mix of color models in the PDF output which is not good idea. You can overcome this problem by declaration \onlyrgb or \onlycmyk. Then only selected color model is used for PDF output and if a used color is declared by another color model then it is converted. The \onlyrgb creates colors more bright (usable for computer presentations). On the other hand CMYK makes colors more true[5] for printing.

You can define your color by a linear combination of previously defined colors using \colordef. For example:

```
\colordef \myCyan {.3\Green + .5\Blue}  % 30 % green, 50 % blue, 20% white
\colordef \DarkBlue {\Blue + .4\Black}  % Blue mixed with 40 % of black
\colordef \myGreen{\Cyan+\Yellow}       % exact the same as \Green
\colordef \MyColor {.3\Orange+.5\Green+.2\Yellow}
```

The linear combination is done in CMYK substractive color space by default (RGB colors used in \colordef argument are converted first). If the resulting component is greater than 1 then it is truncated to 1. If a convex linear combination (as in the last example above) is used then it emulates color behavior on a painter's palette. You can use \rgbcolordef instead \colordef if you want to mix colors in the additive RGB color space.

The following example defines the macro for the colored text on the colored background. Usage: \coloron⟨*background*⟩⟨*foreground*⟩{⟨*text*⟩}

The \coloron can be defined as follows:

```
\def\coloron#1#2#3{%
   \setbox0=\hbox{{#2#3}}%
   \leavevmode \rlap{#1\strut \vrule width\wd0}\box0
}
\coloron\Yellow\Brown{The brown text on the yellow background}
```

1.6.2 Images

The \inspic {⟨*filename*⟩.⟨*extension*⟩} or \inspic ⟨*filename*⟩.⟨*extension*⟩⟨*space*⟩ inserts the picture stored in the graphics file with the name ⟨*filename*⟩.⟨*extension*⟩ to the document. You

[5] Printed output is more equal to the monitor preview specially if you are using ICC profile for your printer.

can set the picture width by `\picw=`⟨*dimen*⟩ before `\inspic` command which declares the width of the picture. The image files can be in the PNG, JPG, JBIG2 or PDF format.

The `\picwidth` is an equivalent register to `\picw`. Moreover there is an `\picheight` register which denotes the height of the picture. If both registers are set then the picture will be (probably) deformed.

The image files are searched in `\picdir`. This token list is empty by default, this means that the image files are searched in the current directory. Example: `\picdir={img/}` supposes that image files are in `img` subdirectory. Note: the directory name must end by `/` in the `\picdir` declaration.

Inkscape[6] is able to save a picture to PDF and labels of the picture to another file[7]. This second file should be read by TEX in order to print labels in the same font as document font. OpTEX supports this feature by `\inkinspic {`⟨*filename*⟩`.pdf}` command. It reads and displays both: PDF image and labels generated by Inkscape.

If you want to create a vector graphics (diagrams, schema, geometry skicing) then you can do it by Wysiwyg graphics editor (Inkscape, Geogebra for example), export the result to PDF and include it by `\inspic`. If you want to "programm" such pictures then Tikz package is recommended. It works in Plain TEX and OpTEX.

1.6.3 PDF transformations

All typesetting elements are transformed by linear transformation given by the current transformation matrix. The `\pdfsetmatrix {`⟨*a*⟩ ⟨*b*⟩ ⟨*c*⟩ ⟨*d*⟩`}` command makes the internal multiplication with the current matrix so linear transformations can be composed. One linear transformation given by the `\pdfsetmatrix` above transforms the vector $[0,1]$ to $[\langle a\rangle,\langle b\rangle]$ and $[1,0]$ to $[\langle c\rangle,\langle d\rangle]$. The stack-oriented commands `\pdfsave` and `\pdfrestore` gives a possibility of storing and restoring the current transformation matrix and the position of the current point. This position have to be the same from TEX's point of view as from transformation point of view when `\pdfrestore` is processed. Due to this fact the `\pdfsave\rlap{`⟨*transformed text*⟩`}\pdfrestore` or something similar is recommended.

OpTEX provides two special transformation macros `\pdfscale` and `\pdfrotate`:

`\pdfscale{`⟨*horizontal-factor*⟩`}{`⟨*vertical-factor*⟩`}`
`\pdfrotate{`⟨*angle-in-degrees*⟩`}`

These macros simply calls the properly `\pdfsetmatrix` command.

It is known that the composition of transformations is not commutative. It means that the order is important. You have to read the transformation matrices from right to left. Example:

```
First: \pdfsave \pdfrotate{30}\pdfscale{-2}{2}\rlap{text1}\pdfrestore
      % text1 is scaled two times and it is reflected about vertical axis
      % and next it is rotated by 30 degrees left.
second: \pdfsave \pdfscale{-2}{2}\pdfrotate{30}\rlap{text2}\pdfrestore
      % text2 is rotated by 30 degrees left then it is scaled two times
      % and reflected about vertical axis.
third: \pdfsave \pdfrotate{-15.3}\pdfsetmatrix{2 0 1.5 2}\rlap{text3}%
       \pdfrestore % first slanted, then rotated by 15.3 degrees right
```

This gives the following result. First:  second: third: text3

You can see that TEX knows nothing about dimensions of transfomed material, it treats it as with a zero dimension object. The `\transformbox{`⟨*transformation*⟩`}{`⟨*text*⟩`}` macro solves

[6] A powerfull and free wysiwyg editor for creating vector graphics.
[7] Chose "Omit text in PDF and create LaTeX file" option.

the problem. This macro puts the transformed material to a box with relevant dimension. The ⟨*transfromation*⟩ parameter includes one or more transfromation commands `\pdfsetmatrix`, `\pdfscale`, `\pdfrotate` with their parameters. The ⟨*text*⟩ is transformed text.

Example: `\frame{\transformbox{\pdfscale{1}{1.5}\pdfrotate{-10}}{moj}}` creates  .

The `\rotbox{`⟨*deg*⟩`}{`⟨*text*⟩`}` is shortcut for `\transformbox{\pdfrotate{`⟨*deg*⟩`}}{`⟨*text*⟩`}`.

1.6.4 Ovals, circles

The `\inoval{`⟨*text*⟩`}` creates a box like this: text. Multiline text can be put in an oval by the command `\inoval{\vbox{`⟨*text*⟩`}}`. Local settings can be set by `\inoval[`⟨*settings*⟩`]{`⟨*text*⟩`}` or you can re-declare global settings by `\ovalparams={`⟨*settings*⟩`}`. The default settings are:

```
\ovalparams={\roundness=2pt           % diameter of circles in the corners
             \fcolor=\Yellow          % color used for filling oval
             \lcolor=\Red             % line color used in the border
             \lwidth=0.5bp            % line width in the border
             \shadow=N                % use a shadow effect
             \overlapmargins=N        % ignore margins by surrounding text
             \hhkern=0pt \vvkern=0pt} % left-righ margin, top-bottom margin
```

The total distance from text to oval boundary is `\hhkern+\roundness` at the left and right sides and `\vvkern+\roundness` at the top and bottom sides of the text.

If you need to set a parameters for the ⟨*text*⟩ (color, size, font etc.), put such setting right in front of the ⟨*text*⟩: `\inoval{`⟨*text settings*⟩⟨*text*⟩`}`.

The `\incircle[\ratio=1.8]{`⟨*text*⟩`}` creates a box like this text. The `\ratio` parameter means width/height. The usage is analogical like for oval. The default parameters are

```
\circleparams={\ratio=1 \fcolor=\Yellow \lcolor=\Red \lwidth=0.5bp
               \shadow=N \ignoremargins=N \hhkern=2pt \vvkern=2pt}
```

The macros `\clipinoval` ⟨*x*⟩ ⟨*y*⟩ ⟨*width*⟩ ⟨*height*⟩ `{`⟨*text*⟩`}` and `\clipincircle` (with the same parameters) print the ⟨*text*⟩ when a clipping path (oval or cirle with given ⟨*with*⟩ and ⟨*height*⟩ shifted its center by ⟨*x*⟩ to right and by ⟨*y*⟩ to up) is used. The `\roundness=5mm` is default for `\clipinoval` and user can change it. Example:

```
\clipincircle 3cm 3.5cm 6cm 7cm {\picw=6cm \inspic{myphoto.jpg}}
```

1.6.5 Putting images and texts wherever

The `\puttext` ⟨*x*⟩ ⟨*y*⟩ `{`⟨*text*⟩`}` puts the ⟨*text*⟩ shifted by ⟨*x*⟩ right and by ⟨*y*⟩ up from current point of typesetting and does not change the position of the current point. Assume coordinate system with origin in the current point. Then `\puttext` ⟨*x*⟩ ⟨*y*⟩ `{`⟨*text*⟩`}` puts the text at the coordinates ⟨*x*⟩, ⟨*y*⟩. More exactly the left edge of its baseline is at that position.

The `\putpic` ⟨*x*⟩ ⟨*y*⟩ ⟨*width*⟩ ⟨*height*⟩ `{`⟨*image*⟩`}` puts the ⟨*image*⟩ of given ⟨*width*⟩ and ⟨*height*⟩ at given position (its left-bottom corner). You can write `\nospec` instead ⟨*width*⟩ or ⟨*height*⟩ if this parameter is not given.

1.7 Others

1.7.1 Using more languages

OpTEX prepares hyphenation patterns for all languages if such patterns are available in your TEX system. Only USenglish patterns (original from Plain TEX) are preloaded. Hyphenation patterns of all another languages are loaded on demand when you first use the `\`⟨*iso-code*⟩`lang` command in your document. For example `\delang` for German, `\cslang` for Czech, `\pllang`

for Polish. The ⟨*iso-code*⟩ is a shortcut of the language (mostly from ISO 639-1). You can list all available languages by `\langlist` macro. This macro prints now:

en(USenglish) enus(USenglishmax) engb(UKenglish) it(Italian) ia(Interlingua) id(Indonesian) cs(Czech) sk(Slovak) de(nGerman) fr(French) pl(Polish) cy(Welsh) da(Danish) es(Spanish) sl(Slovenian) fi(Finnish) hu(Hungarian) tr(Turkish) et(Estonian) eu(Basque) ga(Irish) nb(Bokmal) nn(Nynorsk) nl(Dutch) pt(Portuguese) ro(Romanian) hr(Croatian) zh(Pinyin) is(Icelandic) hsb(Uppersorbian) af(Afrikaans) gl(Galician) kmr(Kurmanji) tk(Turkmen) la(Latin) lac(classicLatin) lal(liturgicalLatin) elm(monoGreek) elp(Greek) grc(ancientGreek) ca(Catalan) cop(Coptic) mn(Mongolian) sa(Sanskrit) ru(Russian) uk(Ukrainian) hy(Armenian) as(Assamese) hi(Hindi) kn(Kannada) lv(Latvian) lt(Lithuanian) ml(Malayalam) mr(Marathi) or(Oriya) pa(Panjabi) ta(Tamil) te(Telugu) be(Belarusian) bg(Bulgarian) bn(Bengali) cu(churchslavonic) deo(oldGerman) gsw(swissGerman) eo(Esperanto) fur(Friulan) gu(Gujarati) ka(Georgian) mk(Macedonian) oc(Occitan) pi(Pali) pms(Piedmontese) rm(Romansh) sr(Serbian) sv(Swedish) th(Thai) ethi(Ethiopic)

For compatibility with e-plain macros, there is the command `\uselanguage{`⟨*language*⟩`}`. The parameter ⟨*language*⟩ is long form of language name, i.e. `\uselanguage{Czech}` works the same as `\cslang`. The `\uselanguage` parameter is case insensitive.

For compatibility with $\mathcal{CS}$plain, there are macros `\ehyph`, `\chyph`, `\shyph` which are equivalent to `\enlang`, `\cslang` and `\sklang`.

You can switch between language patterns by `\`⟨*iso-code*⟩`lang` commands mentioned above. Default is `\enlang`.

OpTEX generates three phrases used for captions and titles in technical articles or books: “Chapter”, “Table” and “Figure”. These phrases need to be known in used language and it depends on the previously used language selectors `\`⟨*iso-code*⟩`lang`. OpTEX declares these words only for few languages: Czech, German, Spanish, French, Greek, Italian, Polish, Russian, Slovak and English, If you need to use these words in another languages or you want to auto-generate more words in your macros, then you can declare it by `\sdef` or `\_langw` commands as shown in section 2.37.3.

The `\makeindex` command needs to know the sorting rules used in your language. OpTEX defines only few language rules for sorting: Czech, Slovak and English. How to declare sorting rules for more languages are described in the section 2.33.

If you declare `\`⟨*iso-code*⟩`quotes`, then the control sequences `\"` and `\'` should be used like this: `\"`⟨*quoted text*⟩`"` or `\'`⟨*quoted text*⟩`'` (note that the terminating character is the same but it isn't escaped). This prints language dependent normal or alternative quotes around ⟨*quoted text*⟩. The language is specified by ⟨*iso-code*⟩. OpTEX declares quotes only for Czech, German, Spanish, French, Greek, Italian, Polish, Russian, Slovak and English (`\csquotes`, `\dequotes`, ..., `\enquotes`). You can simply define your own quotes as shown in section 2.37.3. The `\"` is used for quotes visualy more similar to the `"` character which can be primary quotes or secondary quotes depending on the language rules. May be you want to alternate meaning of these two types of quotes. Use `\`⟨*isocode*⟩`quotes\altquotes` in such case.

1.7.2 Pre-defined styles

OpTEX defines three style-declaration macros `\report`, `\letter` and `\slides`. You can use them at the beginning of your document if you are preparing these types of document and you don't need to create your own macros.

The `\report` declaration is intended to create reports. It sets default font size to 11 pt and `\parindent` (paragraph indentation) to 1.2 em. The `\tit` macro uses smaller font because we assume that “chapter level” will be not used in reports. The first page has no page number, but next pages are numbered (from number 2). Footnotes are numbered from one in whole document. The macro `\author` ⟨*authors*⟩⟨*end-line*⟩ can be used when `\report` is declared. It prints ⟨*authors*⟩ in italics at center of the line. You can separate authors by `\nl` to more lines.

The `\letter` declaration is intended to create letters. See the files `op-letter-*.tex` for examples. The `\letter` style sets default font size to 11 pt and `\parindent` to 0 pt. It sets half-line space between paragraphs. The page numbers are not printed. The `\subject` macro can be used, it prints the word “Subject:” or “Věc” (or something else depending on current

language) in bold. Moreover, the \address macro can be used when \letter is declared. The usage of the \address macro looks like:

\address
⟨*first line of address*⟩
⟨*second line of address*⟩
⟨*etc.*⟩
⟨*empty line*⟩

It means that you need not to use any special mark at the end of lines: end of lines in the source file are the same as in printed output. The \address macro creates \vtop with address lines. The width of such \vtop is equal to the most wide line used in it. So, you can use \hfill\address... in order to put the address box to the right side of the document. Or you can use ⟨*prefixed text*⟩\address... to put ⟨*prefixed text*⟩ before first line of the address.

The \slides style creates a simple presentation slides. See an example in the file op-slides.tex. Run optex op-slides.tex and see the documentation of \slides style in the file op-slides.pdf.

Analogical declaration macro \book is not prepared. Each book needs an individual typographical care. You need to create specific macros for design.

1.7.3 Loading other macro packages

You can load more macro packages by \input{⟨*file-name*⟩} or by \load[⟨*file-names*⟩]. The first case (\input) is TEX primitive command, it can be used in the alternative old syntax \input ⟨*filename*⟩⟨*space*⟩ too. The second case (\load) allows to specify a comma separated list of included files. Moreover, it loads each macro file only once, it sets temporarily standard category codes during loading and it tries to load ⟨*filename*⟩.opm or ⟨*filename*⟩.tex or ⟨*filename*⟩, first occurence wins. Example:

```
\load [qrcode, tikz]
```

does \input qrcode.opm and \input tikz.tex and it saves local information about the fact that these file names qrcode and tikz were already used, i. e. next \load will skip them.

It is strongly recommended to use the \load macro for loading external macros, if you need them. On the other hand, if your source document is structured to more files (with individual chapters or sections), use simply the \input primitive.

1.7.4 Lorem ipsum dolor sit

A designer needs to concentrate to the design of the output and maybe he/she needs a material for testing macros. There is the possibility to generate a neutral text for such experiments. Use \lorem[⟨*number*⟩] or \lorem[⟨*from*⟩-⟨*to*⟩]. It prints a paragraph (or paragraphs) with neutral text. The numbers ⟨*number*⟩ or ⟨*from*⟩, ⟨*to*⟩ must be in the range 1 to 150 because there are 150 paragraphs with neutral text prepared for you. The \lipsum macro is equivalent to \lorem. Example: \lipsum[1-150] prints all prepared paragraphs.

1.7.5 Logos

The control sequences for typical logos can be terminated by optional / which is ignored when printing. This makes logos more legible in source file:

```
We are using \TeX/ because it is cool. \OpTeX/ is better than \LaTeX.
```

1.7.6 The last page

The number of the last page (it may be different from number of pages) is expanded by \lastpage macro. It expands to ? in first TEX run and to the last page in next TEX runs.

There is an example for footlines in the format “current page / last page”:

```
\footline={\hss \fixedrm \folio/\lastpage \hss}
```

The \lastpage expands to the last \folio which is a decimal number or Roman numeral (when \pageno is negative). If you need to know total pages used in the document, use \totalpages macro. It expands to zero (in first TEX run) or to the number of all pages in the document (in next TEX runs).

1.7.7 Use OpTEX

The command \useOpTeX (or \useoptex) does nothing in OpTEX but it causes an error (undefined control sequence) when another format is used. You can put it as the first command in your document:

```
\useOpTeX % we are using OpTeX format, no LaTeX :)
```

1.8 Summary

```
\tit Title (terminated by end of line)
\chap Chapter Title (terminated by end of line)
\sec Section Title (terminated by end of line)
\secc Subsection Title (terminated by end of line)

\maketoc         % table of contents generation
\ii item1,item2  % insertion the items to the index
\makeindex       % the index is generated

\label [labname]  % link target location
\ref [labname]    % link to the chapter, section, subsection, equation
\pgref [labname]  % link to the page of the chapter, section, ...

\caption/t  % a numbered table caption
\caption/f  % a numbered caption for the picture
\eqmark     % a numbered equation

\begitems       % start list of the items
\enditems       % end of list of the items
\begtt          % start verbatim text
\endtt          % end verbatim text
\activettchar X % initialization character X for in-text verbatim
\code           % another alternative for in-text verbatim
\verbinput      % verbatim extract from the external file
\begmulti num   % start multicolumn text (num columns)
\endmulti       % end multicolumn text

\cite [labnames]  % refers to the item in the lits of references
\rcite [labnames] % similar to \cite but [] are not printed.
\sortcitations \shortcitations \nonumcitations % cite format
\bib [labname]  % an item in the list of references
\usebib/? (style) bib-base % direct using of .bib file, ? in {s,c}

\load [<filenames>]   % loadaing macro files
\fontfam [FamilyName] % selection of font family
\typosize [font-size/baselineskip] % size setting of typesetting
\typoscale [factor-font/factor-baselineskip] % size scaling
\thefontsize [size] \thefontscale [factor]   % current font size

\inspic file.ext    % insert a picture, extensions: jpg, png, pdf
\table {rule}{data} % macro for the tables like in LaTeX
```

```
\fnote {text}   % footnote (local numbering on each page)
\mnote {text}   % note in the margin (left or right by page number)

\hyperlinks {color-in}{color-out} % PDF links activate as clickable
\outlines {level}   % PDF will have a table of contents in the left tab

\magscale[factor]  % resize typesetting, line/page breaking unchanged
\margins/pg format (left, right, top, bottom)unit % margins setting

\report \letter \slides  % style declaration macros
```

1.9 Compatibility with Plain TEX

All macros of Plain TEX are re-written in OpTEX. Common macros should work in the same sense as in original Plain TEX. Internal control sequences like `\p@` or `\f@@t` are removed and mostly replaced by control sequences prefixed by `_` (like `\_this`). If you need to use basic set of old Plain TEX control sequences like `\p@` (for example you are reading an old macro file), use `\load[plain-at]`.

All primitives and common macros have two control sequences with the same meaning: in prefixed and unprefixed form. For example `\hbox` is equal to `\_hbox`. Internal macros of OpTEX have and use only prefixed form. User should use unprefixed forms, but prefixed forms are accessible too, because the `_` is set as a letter category code globally (in macro files and in users document too). User should re-define unprefixed forms of control sequences without worries that something internal will be broken (only the sequence `\par` cannot be re-defined without change of internal TEX behavior because it is hard-coded in TEX, unfortunately).

The Latin Modern 8bit fonts instead Computer Modern 7bit fonts are preloaded in the format, but only few ones. The full family set is ready to use after the command `\fontfam[LMfonts]` which reads the fonts in OTF format.

Plain TEX defines `\newcount`, `\bye` etc. as `\outer` macros. OpTEX doesn't set any macro as `\outer`. Macros like `\TeX`, `\rm` are defined as `\protected`.

The text accents macros `\"`, `\'`, `\v`, `\u`, `\=`, `\^`, `\.`, `\H`, `\~`, `\``, `\t` are undefined[8] in OpTEX. Use real letters like á, ř, ž in your source document instead of these old accents macros. If you really want to use them, you can initialize them by the `\oldaccents` command. But we don't recommend it.

The default paper size is not set as letter with 1 in margins but as A4 with 2.5 cm margins. You can change it, for example by `\margins/1 letter (1,1,1,1)in`. This example sets the classical Plain TEX page layout.

The origin for typographical area is not at top left 1 in 1 in coordinates but at top left paper corner exactly. For example, `\hoffset` includes directly left margin.

The tabbing macros `\settabs` and `\+` (from Plain TEX) are not defined in OpTEX because they are obsolete. But you can use the OpTEX trick 0021 if you really need such feature.

The `\sec` macro is reserved to sections but original Plain TEX declares this control sequence for math secans.

[8] The math accents macros like `\acute`, `\bar`, `\dot`, `\hat` still work.

Chapter 2
Technical documentation

This documentation is written in the source files `*.opm` between the `\_doc` and `\_cod` pairs or after the `\_endcode` command. When the format is generated by

```
luatex -ini optex.ini
```

then the text of the documentation is ignored and the format `optex.fmt` is generated. On the other hand, if you run

```
optex optex-doc.tex
```

then the same `*.opm` files are read when the second chapter of this documentation is printed.

A knowledge about TEX is expected from the reader. You can see a short document TEX in a Nutshell or more detail TEX by topic.

Notices about hyperlinks. If a control sequence is printed in red color in this documentation then this denotes its "main documentation point". Typically, the listing where the control sequence is declared follows immediately. If a control sequence is printed in the blue color in the listing or in the text then it is active link which points (usually) to the main documentation point. The main documentation point can be active link which points to a previous text where the control sequence was mentioned. Such occurrences are active links to the main documentation point.

2.1 The main initialization file

The `optex.ini` file is read as main file when the format is generated.

optex.ini

```
%% This is part of OpTeX project, see http://petr.olsak.net/optex

%% OpTeX ini file
%% Petr Olsak <project started from: Jan. 2020>
```

Category codes are set first. Note that the `_` is set to category code "letter", it can be used as a part of control sequence names. Other category codes are set as in the plain TEX.

optex.ini

```
% Catcodes:

\catcode `\{=1 % left brace is begin-group character
\catcode `\}=2 % right brace is end-group character
\catcode `\$=3 % dollar sign is math shift
\catcode `\&=4 % ampersand is alignment tab
\catcode `\#=6 % hash mark is macro parameter character
\catcode `\^=7 %
\catcode `\^^K=7 % circumflex and uparrow are for superscripts
\catcode `\^^A=8 % downarrow is for subscripts
\catcode `\^^I=10 % ascii tab is a blank space
\catcode `\_=11 % underline can be used in control sequences
\catcode `\~=13 % tilde is active
\catcode `\^^a0=13 % non breaking space in Unicode
\catcode 127=12 % normal character
```

The `\optexversion` and `\fmtname` are defined.

optex.ini

```
% OpTeX version

\def\optexversion{Beta 0.18 Dec.2020}
\def\fmtname{OpTeX}
```

We check if LuaTEX engine is used at `-ini` state. And the `^^J` character is set as `\newlinechar`.

optex.ini

```
% Engine testing:

\newlinechar=`\^^J
\ifx\directlua\undefined
```

```
    \message{This format is based only on LuaTeX, use luatex -ini optex.ini^^J}
    \endinput \fi

\ifx\bgroup\undefined \else
    \message{This file can be used only for format initialisation, use luatex -ini^^J}
    \endinput \fi
```

The basic macros for macro file syntax is defined, i. e. `\_endcode`, `\_doc` and `\_cod`. The `\_codedecl` will be re-defined later.

optex.ini

```
% Basic .opm syntax:

\let\_endcode =\endinput
\def \_codedecl #1#2{\message{#2^^J}}%  information about .opm file
\long\def\_doc#1\_cod#2 {} % skip documentation
```

Individual `*.opm` macro files are read.

optex.ini

```
% Initialization:

\message{OpTeX (Olsak's Plain TeX) initialization <\optexversion>^^J}

\input prefixed.opm        % prefixed primitives and code syntax
\input luatex-ini.opm      % luaTeX initialization
\input basic-macros.opm    % basic macros
\input alloc.opm           % allocators for registers
\input if-macros.opm       % special \if-macros, \is-macros and loops
\input parameters.opm      % parameters setting
\input more-macros.opm     % OpTeX useful macros  (todo: doc)
\input keyval.opm          % key=value dictionaries
\input plain-macros.opm    % plainTeX macros
\input fonts-preload.opm   % preloaded Latin Modern fonts
\input fonts-resize.opm    % font resizing (low-level macros)
\input fonts-select.opm    % font selection system
\input math-preload.opm    % math fams CM + AMS preloaded
\input math-macros.opm     % basic macros for math plus mathchardefs
\input math-unicode.opm    % macros for loading UnicodeMath fonts
\input fonts-opmac.opm     % font managing macros from OPmac
\input output.opm          % output routine
\input margins.opm         % macros for margins setting
\input colors.opm          % colors
\input ref-file.opm        % ref file
\input references.opm      % references
\input hyperlinks.opm      % hyperlinks
\input maketoc.opm         % maketoc
\input outlines.opm        % PDF outlines
\input pdfuni-string.opm   % PDFunicode strings for outlines
\input sections.opm        % titles, chapters, sections
\input lists.opm           % lists, \begitems, \enditems
\input verbatim.opm        % verbatim
\input hi-syntax.opm       % syntax highlighting of verbatim listimgs
\input graphics.opm        % graphics
\input table.opm           % table macro
\input multicolumns.opm    % more columns by \begmulti ...\endmulti
\input cite-bib.opm        % Bibliography, \cite
\input makeindex.opm       % Make index and sorting
\input fnotes.opm          % \fnotes, \mnotes
\input styles.opm          % styles \report, \letter
\input logos.opm           % standard logos
\input uni-lcuc.opm        % Setting lccodes and uccodes for Unicode characters
\input hyphen-lan.opm      % initialization of hyphenation patterns
\input languages.opm       % languages
```

The file `optex.lua` is embedded into the format as byte-code. It is documented in section 2.39.

optex.ini

```

\_directlua{
    % preload OpTeX's lua code into format as bytecode
    lua.bytecode[1] = assert(loadfile(kpse.find_file("optex", "lua")))
```

The `\everyjob` register is initialized and the format is saved by the `\dump` command.

```
94
95 \_everyjob = {%
96    \_message{This is OpTeX (Olsak's Plain TeX), version <\optexversion>^^J}%
97    \_mathchardef\_fnotestack=\_pdfcolorstackinit page {0 g 0 G}%
98    \_directlua{lua.bytecode[1]()}% load OpTeX's Lua code
99    \_mathsbon % replaces \int _a^b to \int _a^b
100   \_inputref % inputs \jobname.ref if exists
101 }
102
```

2.2 Concept of name spaces of control sequences

2.2.1 Prefixing internal control sequences

All control sequences used in OpTEX are used and defined with _ prefix. The user can be sure that when he/she does `\def\foo` then internal macros of OpTEX nor TEX primitives will be not damaged. For example `\def\if{...}` will not damage macros because OpTEX's macros are using `\_if` instead of `\if`.

All TEX primitives are initialized with two representative control sequences: `\word` and `\_word`, for example `\hbox` and `\_hbox`. The first alternative is reserved for users or such control sequences can be re-defined by user.

OpTEX sets the character _ as letter, so it can be used in control sequences. When a control sequence begins with this character then it means that it is a primitive or it is used in OpTEX macros as internal. User can redefine such prefixed control sequence only if he/she explicitly know what happens.

We never change catcode of _, so internal macros can be redefined by user without problems if it is desired. We need not something like `\makealetter` from LATEX.

OpTEX defines all new macros as prefixed. For public usage of such macros we need to set non-prefixed version. This is done by

```
\public <list of control sequences> ;
```

For example `\public \foo \bar ;` does `\let\foo=\_foo`, `\let\bar=\_bar`.

At the end of each code segment in OpTEX, the `\_public` macro is used. You can see, what macros are defined for public usage in such code segment.

The macro `\private` does a reverse job to `\public` with the same syntax. For example `\private \foo \bar ;` does `\let\_foo=\foo`, `\let\_bar=\bar`. This should be used when unprefixed variant of control sequence is declared already but we need the prefixed variant too.

In this documentation: if both variants of a control sequence are declared (prefixed and unprefixed), then the accompanying text mentions only unprefixed variant. The code typically defines prefixed variant and then the `\public` (or `\_public`) macro is used.

2.2.2 Name space of control sequences for users

User can define or declare any control sequence with a name without any _. This does not make any problem. Only one exception is the reserved control sequence `\par`. It is generated by tokenizer (at empty lines) and used as internal in TEX.

User can define or declare control sequences with _ character, for example `\my_control_sequence`, but with the following exceptions:

- Control sequences which begin with _ are reserved for TEX primitives, OpTEX internal macros and packages internal macros.
- Control sequences (terminated by non-letter) in the form \⟨*word*⟩_ or \⟨*word*⟩_⟨*one-letter*⟩, where ⟨*word*⟩ is a sequence of letters, are inaccessible, because they are interpreted as \⟨*word*⟩ followed by _ or as \⟨*word*⟩ followed by _⟨*one-letter*⟩. This is important for writing math, for example:

  ```
  \int_a^b    ... is interpreted as \int _a^b
  \max_M      ... is interpreted as \max _M
  \alpha_{ij} ... is interpreted as \alpha _{ij}
  ```

  This feature is implemented using lua code at input processor level, see the section 2.15 for more details. You can deactivate this feature by `\mathsboff`. After this, you can still write `$∫_a^b$` (Unicode) or `$\int _a^b$` without problems but `\int_a^b` yields to undefined control sequence

`\int_a`. You can activate this feature again by `\mathsbon`. The effect will take shape from next line read from input file.
- Control sequences in the form `\_`⟨*pkg*⟩`_`⟨*word*⟩ is intended for package writers as internal macros for a package with ⟨*pkg*⟩ identifier, see section 2.2.4.

The single letter control sequences like `\%`, `\$`, `\^` etc. are not used in internal macros. User can redefine them, but (of course) some classical features can be lost (printing percent character by `\%` for example).

2.2.3 Macro files syntax

Each segment of OpTEX macros is stored in one file with `.opm` extension (means OPtex Macros). Your local macros should be in normal `*.tex` file.

The code in macro files starts by `\_codedecl` and ends by `\_endcode`. The `\_endcode` is equivalent for `\endinput`, so documentation can follow. The `\_codedecl` has syntax:

```
\_codedecl \sequence {Name <version>}
```

If the mentioned `\sequence` is defined, then `\_codedecl` does the same as `\endinput`: this protect from reading the file twice. We suppose, that `\sequence` is defined in the macro file.

It is possible to use the `\_doc` ... `\_cod` pair between the macro lines. The documentation text should be here. It is ignored when macros are read but it can be printed using `doc.opm` macros like in this documentation.

2.2.4 Name spaces for package writers

Package writer should use internal names in the form `\_`⟨*pgk*⟩`_`⟨*sequence*⟩, where ⟨*pkg*⟩ is a package label. For example: `\_qr_utfstring` from `qrcode.opm` package.

The package writer needs not write repeatedly `\_pkg_foo` `\_pkg_bar` etc. again and again in the macro file.[1] When the `\_namespace` `{`⟨*pkg*⟩`}` is declared at the beginning of the macro file then all occurrences of `\.foo` will be replaced by `\_`⟨*pkg*⟩`_foo` at the input processor level. The macro writer can write (and backward can read his/her code) simply with `\.foo`, `\.bar` control sequences and `\_`⟨*pkg*⟩`_foo`, `\_`⟨*pkg*⟩`_bar` control sequences are processed internally. The scope of the `\_namespace` command ends at the `\_endnamespace` command or when another `\_namespace` is used. This command checks if the same package label is not declared by the `\_namespace` twice.

The `\_nspublic` macro does `\let\foo = \_`⟨*pkg*⟩`_foo` when `\_namespace{`⟨*pkg*⟩`}` is declared. And the `\_nsprivate` macro does reverse operation to it. Example: you can define `\def\.macro{...}` and then set it to the user name space by `\_nspublic \macro;`.

Don't load another packages (which are using their own name space) inside your name space. Do load them before your `\_namespace` `{`⟨*pkg*⟩`}` is initialized. Or close your name space by `\_endnamespace` and open it again (after other packages are loaded) by `\_resetnamespace` `{`⟨*pkg*⟩`}`.

If the package writer needs to declare a control sequence by `\newif`, then there is an exception of the rule described above. Use `\_newifi\_if`⟨*pkg*⟩`_bar`, for example `\_newifi\_ifqr_incorner`. Then the control sequences `\_qr_incornertrue` and `\_qr_incornerfalse` can be used (or the sequences `\.incornertrue` and `\.incornerfalse` when `\_namespace{qr}` is used).

2.2.5 Summary about rules for external macro files published for OpTEX

If you are writting a macro file which is intended to be published for OpTEX, then you are greatly welcome. You should follow these rules:

- Don't use a control sequences from user name space in the macro bodies if there is not explicit and documented reason to do this.
- Don't declare control sequences in the user name space if there is not explicit and documented reason to do this.
- Use control sequences from OpTEX and primitive name space in read only mode if there is not explicit and documented reason to redefine them.
- Use `\_`⟨*pkg*⟩`_`⟨*name*⟩ for your internal macros or `\.`⟨*name*⟩ if the `\_namespace{`⟨*pkg*⟩`}` is declared. See section 2.2.4.

[1] We have not adatped the idea from expl3 language:)

- Use \load (or better: _load) for loading more external macros if you need them. Don't use _input explicitly in such cases. The reason is: the external macro file is not loaded twice if another macro or the user needs it explicitly too.
- Use _codedecl as your first command in the macro file and _endcode to close the text of macros.
- Use _doc ... _cod pairs for documenting the code pieces and/or write more documentation after the _endcode command.

If the macro file accepts these recommendations then it should be named by ⟨*filename*⟩.opm where ⟨*filename*⟩ differs from file names used directly in OpTEX and from other published macros. This extension opm has a precedence before .tex when the \load macro is used.

The qrcode.opm is first example how an external macro file for OpTEX can look like.

2.2.6 The implementation of the name spaces

prefixed.opm

```
\_codedecl \public {Prefixing and code syntax <2020-02-14>} % preloaded in format
```

All TEX primitives have alternative control sequence _hbox _string, ...

prefixed.opm

```
\let\_directlua = \directlua
\_directlua {
    % enable all TeX primitives with _ prefix
    tex.enableprimitives('_', tex.extraprimitives('tex'))
    % enable all primitives without prefixing
    tex.enableprimitives('', tex.extraprimitives())
    % enable all primitives with _ prefix
    tex.enableprimitives('_', tex.extraprimitives())
}
```

\ea is useful shortcut for \expandafter. We recommend to use always the private form of _ea because there is high probability that \ea will be redefined by the user.
\public ⟨*sequence*⟩ ⟨*sequence*⟩ ... ; does \let \⟨*sequence*⟩ = _⟨*sequence*⟩ for all sequences.
\private ⟨*sequence*⟩ ⟨*sequence*⟩ ...; does \let _⟨*sequence*⟩ = \⟨*sequence*⟩ for all sequences.
\xargs ⟨*what*⟩ ⟨*sequence*⟩ ⟨*sequence*⟩ ... ; does ⟨*what*⟩⟨*sequence*⟩ for each sequences.

prefixed.opm

```
\let\_ea =\_expandafter  % usefull shortcut

\_long\_def \_xargs #1#2{\_ifx #2;\_else \_ea#1\_ea#2\_ea\_xargs \_ea #1\_fi}

\_def \_pkglabel{}
\_def \_public {\_xargs \_publicA}
\_def \_publicA #1{\_ea\_let \_ea#1\_csname  _\_csstring #1\_endcsname}

\_def \_private {\_xargs \_privateA}
\_def \_privateA #1{\_ea\_let \_csname  _\_csstring #1\_endcsname =#1}

\_public \public \private \xargs \ea ;
```

Each macro file should begin with _codedecl \macro {⟨*info*⟩}. If the \macro is defined already then the \endpinput protects to read such file more than one times. Else the ⟨*info*⟩ is printed to the terminal and the file is read.
The _endcode is defined as \endinput in the optex.ini file. \wterm {⟨*text*⟩} prints ⟨*text*⟩ to the terminal and to the .log file (as in plain TEX).

prefixed.opm

```
\_def \_codedecl #1#2{%
   \_ifx #1\_undefined \_wterm{#2}%
   \_else \_expandafter \_endinput \_fi
}
\_def \_wterm {\_immediate \_write16 }

\_public \wterm ;
```

The \optexversion and \fmtname are defined in the optex.ini file. Maybe, somebody will need a private version of these macros.

prefixed.opm

```
\_private \optexversion \fmtname ;
```

The `\_mathsbon` and `\_mathsboff` are defined in `math-macros.opm` file. Now, we define the macros `\_namespace {⟨pkg label⟩}`, `\_resetnamespace {⟨pkg label⟩}`, `\_endnamespace`, `\_nspublic` and `\_nsprivate` for package writers, see section 2.2.4.

prefixed.opm

```
\_def \_pkglabel{}
\_def\_namespace #1{%
   \_ifcsname namesp:#1\_endcsname \_errmessage
      {The name space "#1" is used already, it cannot be used twice}%
      \_endinput
   \_else \_resetnamespace{#1}\_fi
}
\_def\_resetnamespace #1{%
   \_ea \_gdef \_csname namesp:#1\_endcsname {}%
   \_gdef \_pkglabel{_#1}%
   \_directlua{
      callback.add_to_callback("process_input_buffer",
        function (str)
           return string.gsub(str, "\_nbb[.]([a-zA-Z])", "\_nbb _#1_\_pcent 1")
        end, "_namespace")
   }%
}
\_def\_endnamespace {%
   \_directlua{ callback.remove_from_callback("process_input_buffer", "_namespace") }%
   \_gdef \_pkglabel{}%
}

\_def \_nspublic {\_xargs \_nspublicA}
\_def \_nspublicA #1{\_ea\_let \_ea#1\_csname \_pkglabel _\_csstring #1\_endcsname}

\_def \_nsprivate {\_xargs \_nsprivateA}
\_def \_nsprivateA #1{\_ea\_let \_csname \_pkglabel _\_csstring #1\_endcsname =#1}
```

2.3 pdfTEX initialization

Common pdfTEX primitives equivalents are declared here. Initial values are set.

luatex-ini.opm

```
\_codedecl \pdfprimitive {LuaTeX initialization code <2020-02-21>} % preloaded in format

\_let\_pdfpagewidth        \pagewidth
\_let\_pdfpageheight       \pageheight
\_let\_pdfadjustspacing    \adjustspacing
\_let\_pdfprotrudechars    \protrudechars
\_let\_pdfnoligatures      \ignoreligaturesinfont
\_let\_pdffontexpand       \expandglyphsinfont
\_let\_pdfcopyfont         \copyfont
\_let\_pdfxform            \saveboxresource
\_let\_pdflastxform        \lastsavedboxresourceindex
\_let\_pdfrefxform         \useboxresource
\_let\_pdfximage           \saveimageresource
\_let\_pdflastximage       \lastsavedimageresourceindex
\_let\_pdflastximagepages  \lastsavedimageresourcepages
\_let\_pdfrefximage        \useimageresource
\_let\_pdfsavepos          \savepos
\_let\_pdflastxpos         \lastxpos
\_let\_pdflastypos         \lastypos
\_let\_pdfoutput           \outputmode
\_let\_pdfdraftmode        \draftmode
\_let\_pdfpxdimen          \pxdimen
\_let\_pdfinsertht         \insertht
\_let\_pdfnormaldeviate    \normaldeviate
\_let\_pdfuniformdeviate   \uniformdeviate
\_let\_pdfsetrandomseed    \setrandomseed
\_let\_pdfrandomseed       \randomseed
\_let\_pdfprimitive        \primitive
\_let\_ifpdfprimitive      \ifprimitive
\_let\_ifpdfabsnum         \ifabsnum
\_let\_ifpdfabsdim         \ifabsdim

```

```
\_public
   \pdfpagewidth \pdfpageheight \pdfadjustspacing \pdfprotrudechars
   \pdfnoligatures \pdffontexpand \pdfcopyfont \pdfxform \pdflastxform
   \pdfrefxform \pdfximage \pdflastximage \pdflastximagepages \pdfrefximage
   \pdfsavepos \pdflastxpos \pdflastypos \pdfoutput \pdfdraftmode \pdfpxdimen
   \pdfinsertht \pdfnormaldeviate \pdfuniformdeviate \pdfsetrandomseed
   \pdfrandomseed \pdfprimitive \ifpdfprimitive \ifpdfabsnum \ifpdfabsdim ;

\_directlua {tex.enableprimitives('pdf',{'tracingfonts'})}

\_protected\_def \_pdftexversion     {\_numexpr 140\_relax}
           \_def \_pdftexrevision    {7}
\_protected\_def \_pdflastlink       {\_numexpr\_pdffeedback lastlink\_relax}
\_protected\_def \_pdfretval         {\_numexpr\_pdffeedback retval\_relax}
\_protected\_def \_pdflastobj        {\_numexpr\_pdffeedback lastobj\_relax}
\_protected\_def \_pdflastannot      {\_numexpr\_pdffeedback lastannot\_relax}
           \_def \_pdfxformname      {\_pdffeedback xformname}
{\_outputmode=1
           \_xdef\_pdfcreationdate   {\_pdffeedback creationdate}
}
           \_def \_pdffontname       {\_pdffeedback fontname}
           \_def \_pdffontobjnum     {\_pdffeedback fontobjnum}
           \_def \_pdffontsize       {\_pdffeedback fontsize}
           \_def \_pdfpageref        {\_pdffeedback pageref}
           \_def \_pdfcolorstackinit {\_pdffeedback colorstackinit}
\_protected\_def \_pdfliteral        {\_pdfextension literal}
\_protected\_def \_pdfcolorstack     {\_pdfextension colorstack}
\_protected\_def \_pdfsetmatrix      {\_pdfextension setmatrix}
\_protected\_def \_pdfsave           {\_pdfextension save\_relax}
\_protected\_def \_pdfrestore        {\_pdfextension restore\_relax}
\_protected\_def \_pdfobj            {\_pdfextension obj }
\_protected\_def \_pdfrefobj         {\_pdfextension refobj }
\_protected\_def \_pdfannot          {\_pdfextension annot }
\_protected\_def \_pdfstartlink      {\_pdfextension startlink }
\_protected\_def \_pdfendlink        {\_pdfextension endlink\_relax}
\_protected\_def \_pdfoutline        {\_pdfextension outline }
\_protected\_def \_pdfdest           {\_pdfextension dest }
\_protected\_def \_pdfthread         {\_pdfextension thread }
\_protected\_def \_pdfstartthread    {\_pdfextension startthread }
\_protected\_def \_pdfendthread      {\_pdfextension endthread\_relax}
\_protected\_def \_pdfinfo           {\_pdfextension info }
\_protected\_def \_pdfcatalog        {\_pdfextension catalog }
\_protected\_def \_pdfnames          {\_pdfextension names }
\_protected\_def \_pdfincludechars   {\_pdfextension includechars }
\_protected\_def \_pdffontattr       {\_pdfextension fontattr }
\_protected\_def \_pdfmapfile        {\_pdfextension mapfile }
\_protected\_def \_pdfmapline        {\_pdfextension mapline }
\_protected\_def \_pdftrailer        {\_pdfextension trailer }
\_protected\_def \_pdfglyphtounicode {\_pdfextension glyphtounicode }

\_protected\_edef\_pdfcompresslevel       {\_pdfvariable compresslevel}
\_protected\_edef\_pdfobjcompresslevel    {\_pdfvariable objcompresslevel}
\_protected\_edef\_pdfdecimaldigits       {\_pdfvariable decimaldigits}
\_protected\_edef\_pdfgamma               {\_pdfvariable gamma}
\_protected\_edef\_pdfimageresolution     {\_pdfvariable imageresolution}
\_protected\_edef\_pdfimageapplygamma     {\_pdfvariable imageapplygamma}
\_protected\_edef\_pdfimagegamma          {\_pdfvariable imagegamma}
\_protected\_edef\_pdfimagehicolor        {\_pdfvariable imagehicolor}
\_protected\_edef\_pdfimageaddfilename    {\_pdfvariable imageaddfilename}
\_protected\_edef\_pdfpkresolution        {\_pdfvariable pkresolution}
\_protected\_edef\_pdfinclusioncopyfonts  {\_pdfvariable inclusioncopyfonts}
\_protected\_edef\_pdfinclusionerrorlevel {\_pdfvariable inclusionerrorlevel}
\_protected\_edef\_pdfgentounicode        {\_pdfvariable gentounicode}
\_protected\_edef\_pdfpagebox             {\_pdfvariable pagebox}
\_protected\_edef\_pdfminorversion        {\_pdfvariable minorversion}
\_protected\_edef\_pdfuniqueresname       {\_pdfvariable uniqueresname}
\_protected\_edef\_pdfhorigin             {\_pdfvariable horigin}
\_protected\_edef\_pdfvorigin             {\_pdfvariable vorigin}
\_protected\_edef\_pdflinkmargin          {\_pdfvariable linkmargin}
```

```
\_protected\_edef\_pdfdestmargin          {\_pdfvariable destmargin}
\_protected\_edef\_pdfthreadmargin        {\_pdfvariable threadmargin}
\_protected\_edef\_pdfpagesattr           {\_pdfvariable pagesattr}
\_protected\_edef\_pdfpageattr            {\_pdfvariable pageattr}
\_protected\_edef\_pdfpageresources       {\_pdfvariable pageresources}
\_protected\_edef\_pdfxformattr           {\_pdfvariable xformattr}
\_protected\_edef\_pdfxformresources      {\_pdfvariable xformresources}
\_protected\_edef\_pdfpkmode              {\_pdfvariable pkmode}

\_public
   \pdftexversion \pdftexrevision \pdflastlink \pdfretval \pdflastobj
   \pdflastannot \pdfxformname \pdfcreationdate \pdffontname \pdffontobjnum
   \pdffontsize \pdfpageref \pdfcolorstackinit \pdfliteral \pdfcolorstack
   \pdfsetmatrix \pdfsave \pdfrestore \pdfobj \pdfrefobj \pdfannot
   \pdfstartlink \pdfendlink \pdfoutline \pdfdest \pdfthread \pdfstartthread
   \pdfendthread \pdfinfo \pdfcatalog \pdfnames \pdfincludechars \pdffontattr
   \pdfmapfile \pdfmapline \pdftrailer \pdfglyphtounicode \pdfcompresslevel
   \pdfobjcompresslevel \pdfdecimaldigits \pdfgamma \pdfimageresolution
   \pdfimageapplygamma \pdfimagegamma \pdfimagehicolor \pdfimageaddfilename
   \pdfpkresolution \pdfinclusioncopyfonts \pdfinclusionerrorlevel
   \pdfgentounicode \pdfpagebox \pdfminorversion \pdfuniqueresname \pdfhorigin
   \pdfvorigin \pdflinkmargin \pdfdestmargin \pdfthreadmargin \pdfpagesattr
   \pdfpageattr \pdfpageresources \pdfxformattr \pdfxformresources \pdfpkmode ;

\_pdfminorversion     = 5
\_pdfobjcompresslevel = 2
\_pdfcompresslevel    = 9
\_pdfdecimaldigits    = 3
\_pdfpkresolution     = 600
```

2.4 Basic macros

We define first bundle of basic macros.

basic-macros.opm

```
\_codedecl \sdef {Basic macros for OpTeX <2020-02-14>} % loaded in format
```

\bgroup, \egroup, \empty, \space, \null and \wlog are classical macros from plain TEX.

basic-macros.opm

```
\_let\_bgroup={  \_let\_egroup=}
\_def \_empty {}
\_def \_space { }
\_def \_null {\_hbox{}}
\_def \_wlog {\_immediate\_write-1 } % write on log file (only)

\_public \bgroup \egroup \empty \space \null \wlog ;
```

\bslash is "normal backslash" with category code 12. \nbb and \pcent are double backslash and normal %, they should be used in lua codes, for example.

basic-macros.opm

```
\_edef \_bslash {\_csstring\\}
\_edef \_nbb {\_bslash\_bslash}
\_edef \_pcent{\_csstring\%}

\_public \bslash \nbb \pcent ;
```

\sdef {⟨*text*⟩} is equivalent to \def\⟨*text*⟩, where \⟨*text*⟩ is a control sequence. You can use arbitrary parameter mask after \sdef{⟨*text*⟩}, don't put the (unwanted) space immediately after closing brace }.
\sxdef {⟨*text*⟩} is equivalent to \xdef\⟨*text*⟩.
\slet {⟨*textA*⟩}{⟨*textB*⟩} is equivalent to \let \⟨*textA*⟩ = \⟨*textB*⟩.

basic-macros.opm

```
\_def \_sdef #1{\_ea\_def \_csname#1\_endcsname}
\_def \_sxdef #1{\_ea\_xdef \_csname#1\_endcsname}
\_def \_slet #1#2{\_ea\_let \_csname#1\_ea\_endcsname \_csname#2\_endcsname}

\_public \sdef \sxdef \slet ;
```

\adef {⟨*char*⟩}{⟨*body*⟩} puts the ⟨*char*⟩ as active character and defines it as {⟨*body*⟩}. You can declare a macro with parameters too. For example \adef @#1{...$1...}.

basic-macros.opm

```
\_def \_adef #1{\_catcode`#1=13 \_begingroup \_lccode`\~=`#1\_lowercase{\_endgroup\_def~}}
\_public \adef ;
```

\cs {⟨*text*⟩} is only a shortcut to \csname ⟨*text*⟩\endcsname, but you need one more _ea if you need to get the real control sequence \⟨*text*⟩.
\trycs {⟨*csname*⟩}{⟨*text*⟩} expands to \⟨*csname*⟩ if it is defined else to the ⟨*text*⟩.

basic-macros.opm

```
\_def \_cs #1{\_csname#1\_endcsname}
\_def \_trycs#1#2{\_ifcsname #1\_endcsname \_csname #1\_endcsname \_else #2\_fi}
\_public \cs \trycs ;
```

\addto \macro{⟨*text*⟩} adds ⟨*text*⟩ to your \macro, which must be defined.

basic-macros.opm

```
\_long\_def \_addto #1#2{\_ea\_def\_ea#1\_ea{#1#2}}
\_public \addto ;
```

\opwarning {⟨*text*⟩} prints warning on the terminal and to the log file.

basic-macros.opm

```
\_def \_opwarning #1{\_wterm{l.\_the\_inputlineno> WARNING: #1.}}
\_public \opwarning ;
```

\loggingall and \tracingall are defined similarly as in plain TEX, but they print more logging information to the log file and to the terminal.

basic-macros.opm

```
\_def\_loggingall{\_tracingcommands=3 \_tracingstats=2 \_tracingpages=1
  \_tracingoutput=1 \_tracinglostchars=1 \_tracingmacros=2
  \_tracingparagraphs=1 \_tracingrestores=1 \_tracingscantokens=1
  \_tracingifs=1 \_tracinggroups=1 \_tracingassigns=1 }
\_def\_tracingall{\_tracingonline=1 \_loggingall}

\_public \loggingall \tracingall ;
```

Write a warning if the user did not to load a Unicode Font *or* if there were unresolved references. _byehook is used in the \bye macro.

basic-macros.opm

```
\_def\_byehook{%
   \_ifx\_initunifonts\_relax \_relax\_else \_opwarning{Unicode font was not loaded}\_fi
   \_ifnum\_unresolvedrefs>0 \_opwarning{Rerun to get references right}\_fi
}
```

2.5 Allocators for TEX registers

Like plainTEX, the allocators \newcount, \newwrite, etc. are defined. The registers are allocated from 256 to the _mai⟨*type*⟩ which is 65535 in LuaTEX.

Unlike in PlainTEX, the mentioned allocators are not \outer.

User can use \dimen0 to \dimen200 and similarly for \skip, \muskip, \box and \toks directly. User can use \count20 to \count200 directly too. This is the same philosophy like in old plainTEX, but the range of directly used registers is wider.

Inserts are allocated form 254 to 201 using \newinsert.

You can define your own allocation concept (for example for allocation of arrays) from top of registers array. The example shows a definition of the array-like declarator of counters.

```
\newcount \_maicount    % redefine maximal allocation index as variable
\_maicount = \maicount  % first value is top of the array

\def\newcountarray #1[#2]{% \newcountarray \foo[100]
    \global\advance\_maicount by -#2\relax
    \ifnum \_countalloc > \_maicount
        \errmessage{No room for a new array of \string\count}%
    \else
        \global\chardef#1=\_maicount
    \fi
}
\def\usecount #1[#2]{%  \usecount \foo[2]
    \count\numexpr#1+#2\relax
}
```

alloc.opm

```
\_codedecl \newdimen {Allocators for registers <2020-05-12>} % loaded in format
```

The limits are set first.

alloc.opm

```
\_chardef\_maicount = 65535    % Max Allocation Index for counts registers in LuaTeX
\_let\_maidimen  = \_maicount
\_let\_maiskip   = \_maicount
\_let\_maimuskip = \_maicount
\_let\_maibox    = \_maicount
\_let\_maitoks   = \_maicount
\_chardef\_mairead  = 15
\_chardef\_maiwrite = 15
\_chardef\_maifam   = 255
```

Each allocation macro needs its own counter.

alloc.opm

```
\_countdef\_countalloc=10  \_countalloc=255
\_countdef\_dimenalloc=11  \_dimenalloc=255
\_countdef\_skipalloc=12   \_skipalloc=255
\_countdef\_muskipalloc=13 \_muskipalloc=255
\_countdef\_boxalloc=14    \_boxalloc=255
\_countdef\_toksalloc=15   \_toksalloc=255
\_countdef\_readalloc=16   \_readalloc=-1
\_countdef\_writealloc=17  \_writealloc=-1
\_countdef\_famalloc=18    \_famalloc=3
```

The common allocation macro _allocator \⟨*sequence*⟩ {⟨*type*⟩} \⟨*primitive declarator*⟩ is defined. This idea was used in classical plain TEX by Donald Knuth too but the macro from plain TEX seems to be more complicated:).

alloc.opm

```
\_def\_allocator #1#2#3{%
   \_global\_advance\_cs{_#2alloc}by1
   \_ifnum\_cs{_#2alloc}>\_cs{_mai#2}%
      \_errmessage{No room for a new \_ea\_string\_csname #2\_endcsname}%
   \_else
      \_global#3#1=\_cs{_#2alloc}%
      \_wlog{\_string#1=\_ea\_string\_csname #2\_endcsname\_the\_cs{_#2alloc}}%
   \_fi
}
```

The allocation macros \newcount, \newdimen, \newskip, \newmuskip, \newbox, \newtoks, \newread, \newwrite and \newfam are defined here.

alloc.opm

```
\_def\_newcount #1{\_allocator #1{count}\_countdef}
\_def\_newdimen #1{\_allocator #1{dimen}\_dimendef}
\_def\_newskip #1{\_allocator #1{skip}\_skipdef}
\_def\_newmuskip #1{\_allocator #1{muskip}\_muskipdef}
\_def\_newbox #1{\_allocator #1{box}\_chardef}
\_def\_newtoks #1{\_allocator #1{toks}\_toksdef}
\_def\_newread #1{\_allocator #1{read}\_chardef}
\_def\_newwrite #1{\_allocator #1{write}\_chardef}
\_def\_newfam #1{\_allocator #1{fam}\_chardef}

\_public \newcount \newdimen \newskip \newmuskip \newbox \newtoks \newread \newwrite \newfam ;
```

The \newinsert macro is defined differently than others.

alloc.opm

```
\_newcount\_insertalloc   \_insertalloc=255
\_chardef\_insertmin = 201

\_def\_newinsert #1{%
   \_global\_advance\_insertalloc by-1
   \_ifnum\_insertalloc <\_insertmin
      \_errmessage {No room for a new \_string\insert}%
   \_else
      \_global\_chardef#1=\_insertalloc
      \_wlog {\_string#1=\_string\_insert\_the\_insertalloc}%
   \_fi
}
\_public \newinsert ;
```

Other allocation macros \newattribute and \newcatcodetable have their counter allocated by the \newcount macro.

alloc.opm

```
\_newcount \_attributealloc  \_attributealloc=0
\_chardef\_maiattribute=\_maicount
\_def\_newattribute #1{\_allocator #1{attribute}\_attributedef}

\_newcount \_catcodetablealloc  \_catcodetablealloc=10
\_chardef\_maicatcodetable=32767
\_def\_newcatcodetable #1{\_allocator #1{catcodetable}\_chardef}

\_public \newattribute \newcatcodetable ;
```

We declare public and private versions of \tmpnum and \tmpdim registers separately. They are independent registers.

alloc.opm

```
\_newcount \tmpnum  \_newcount \_tmpnum
\_newdimen \tmpdim  \_newdimen \_tmpdim
```

A few registers are initialized like in plainTEX. We absolutely don't support the @category dance, so \z@skip \z@, \p@ etc. are not defined in OpTEX. If you need such control sequences then you can initailaize them by \load[plain-at].

Only the _zo and _zoskip (equivalents to \z@ and \z@skip) are declared here and used in some internal macros of OpTEX for improving speed.

alloc.opm

```
\_newdimen\_maxdimen \_maxdimen=16383.99999pt % the largest legal <dimen>
\_newdimen\_zo \_zo=0pt
\_newskip\_hideskip \_hideskip=-1000pt plus 1fill % negative but can grow
\_newskip\_centering \_centering=0pt plus 1000pt minus 1000pt
\_newskip\_zoskip \_zoskip=0pt plus0pt minus0pt
\_newbox\_voidbox % permanently void box register

\_public \maxdimen \hideskip \centering \voidbox ;
```

2.6 If-macros, loops, is-macros

if-macros.opm

```
\_codedecl \newif {Special if-macros, is-macros and loops <2020-05-22>} % preloaded in format
```

2.6.1 Classical \newif

The \newif macro implements boolean value. It works as in plain TEX. It means that after \newif\ifxxx you can use \xxxtrue or \xxxfalse to set the boolean value and use \ifxxx true\else false\fi to test this value. The default value is false.

The macro _newifi enables to declare _ifxxx and to use _xxxtrue and _xxxfalse. This means that it is usable for internal name space (_prefixed macros).

if-macros.opm

```
\_def\_newif #1{\_ea\_newifA \_string #1\_relax#1}
\_ea\_def \_ea\_newifA \_string\if #1\_relax#2{%
   \_sdef{#1true}{\_let#2=\_iftrue}%
   \_sdef{#1false}{\_let#2=\_iffalse}%
   \_let#2=\_iffalse
}
\_def\_newifi #1{\_ea\_newifiA \string#1\_relax#1}
\_ea\_def \_ea\_newifiA \_string\_if #1\_relax#2{%
   \_sdef{_#1true}{\_let#2=\_iftrue}%
   \_sdef{_#1false}{\_let#2=\_iffalse}%
   \_let#2=\_iffalse
}
\_public \newif ;
```

\afterfi {⟨*what to do*⟩}⟨*ignored*⟩\fi closes condition by \fi and processes ⟨*what to do*⟩. Usage:

```
\if<something> \afterfi{<result is true>} \else \afterfi{<resut is false>} \fi
```

if-macros.opm

```
\_def\_afterfi#1#2\_fi{\_fi#1}
\_def\afterfi#1#2\fi{\_fi#1}
```

2.6.2 Loops

The \loop ⟨*codeA*⟩ \ifsomething ⟨*codeB*⟩ \repeat loops ⟨*codeA*⟩⟨*codeB*⟩ until \ifsomething is false. Then ⟨*codeB*⟩ is not executed and loop is finished. This works like in plain TEX, but implementation is somewhat better (you can use \else clause after the \ifsomething).

There are public version \loop...\repeat and private version _loop ..._repeat. You cannot mix both versions in one loop.

The \loop macro keeps its original plain TeX meaning. It is not expandable and nested \loops are possible only in a TEX group.

if-macros.opm

```
\_long\_def \_loop #1\_repeat{\_def\_body{#1}\_iterate}
\_def \loop #1\repeat{\_def\_body{#1}\_iterate}
\_let \_repeat=\_fi % this makes \loop...\if...\repeat skippable
\_let \repeat=\_fi
\_def \_iterate {\_body \_ea \_iterate \_fi}
```

\foreach ⟨*list*⟩\do {⟨*what*⟩} repeats ⟨*what*⟩ for each element of the ⟨*list*⟩. The ⟨*what*⟩ can include #1 which is substituted by each element of the ⟨*list*⟩. The macro is expandable.
\foreach ⟨*list*⟩\do ⟨*parameter-mask*⟩{⟨*what*⟩} reads parameters from ⟨*list*⟩ repeatedly and does ⟨*what*⟩ for each such reading. The parameters are declared by ⟨*parameter-mask*⟩. Examples:

```
\foreach (a,1)(b,2)(c,3)\do (#1,#2){#1=#2 }
\foreach word1,word2,word3,\do #1,{Word is #1.}
\foreach A=word1 B=word2 \do #1=#2 {"#1 is set as #2".}
```

Note that \foreach ⟨*list*⟩\do {⟨*what*⟩} is equivalent to \foreach ⟨*list*⟩\do #1{⟨*what*⟩}.

Recommendation: it is better to use private variants of _foreach. When the user writes \input tikz then \foreach macro is redefined! The private variants use _do separator instead \do separator.

if-macros.opm

```
\_newcount\_frnum        % the numeric variable used in \fornum
\_def\_do{\_doundefined} % we need to ask \_ifx#1\_do ...

\_long\_def\_foreach #1\_do #2#{\_isempty{#2}\_iftrue
   \_afterfi{\_foreachA{#1}{##1}}\_else\_afterfi{\_foreachA{#1}{#2}}\_fi}
\_long\_def\_foreachA #1#2#3{\_putforstack
   \_immediateassignment \_long\_gdef\_fbody#2{\_testparam##1..\_iftrue #3\_ea\_fbody\_fi}%
   \_fbody #1#2\_finbody\_getforstack
}
\_def\_testparam#1#2#3\_iftrue{\_ifx###1\_empty\_ea\_finbody\_else}
\_def\_finbody#1\_finbody{}

\_def\foreach #1\do#2#{\_isempty{#2}\_iftrue
   \_afterfi{\_foreachA{#1}{##1}}\_else\_afterfi{\_foreachA{#1}{#2}}\_fi}
```

\fornum ⟨*from*⟩..⟨*to*⟩ \do {⟨*what*⟩} or \fornumstep ⟨*num*⟩: ⟨*from*⟩..⟨*to*⟩ \do {⟨*what*⟩} repeats ⟨*what*⟩ for each number from ⟨*from*⟩ to ⟨*to*⟩ (with step ⟨*num*⟩ or with step one). The ⟨*what*⟩ can include #1 which is substituted by current number. The sequence ⟨*from*⟩..⟨*to*⟩ can be decreasing too. The macro is expandable.

if-macros.opm

```
\_def\_fornum#1..#2\_do{\_fornumstep 1:#1..#2\_do}
\_long\_def\_fornumstep#1:#2..#3\_do#4{\_putforstack
   \_immediateassigned{%
      \_gdef\_fbody##1{#4}%
      \_gdef\_fornumsgn{}%
      \_gdef\_fornumrel{<}%
      \_global\_frnum=\_numexpr#2\_relax
      \_ifnum\_numexpr#3<\_frnum \_gdef\_fornumrel{>}\_fi %decreasing sequence
      \_ifnum\_numexpr#1\_fornumrel0 \_gdef\_fornumsgn{-}\_fi % correction
   }%
   \_fornumB{#3}{#1}%
}
\_def\_fornumB #1#2{\_ifnum\_numexpr#1\_fornumrel\_frnum \_getforstack \_else
   \_ea\_fbody\_ea{\_the\_frnum}%
   \_immediateassignment\_global\_advance\_frnum by\_numexpr\_fornumsgn#2\_relax
   \_afterfi{\_fornumB{#1}{#2}}\_fi
}
```

```
\_def\fornum#1..#2\do{\_fornumstep 1:#1..#2\_do}
\_def\fornumstep#1:#2..#3\do{\_fornumstep #1:#2..#3\_do}
```

The `\foreach` and `\fornum` macros can be nested and arbitrary combined. When they are nested then use `##1` for the variable of nested level, `####1` for the variable of second nested level etc. Example:

```
\foreach ABC \do {\fornum 1..5 \do {letter:#1, number: ##1. }}
```

Implementation note: we cannot use TEX-groups for nesting levels because we want to do the macros expandable. We must implement a special for-stack which saves the data needed by `\foreach` and `\fornum`. The `\_putforstack` is used when `\for*` is initialized and `\_getforstack` is used when the `\for*` macro ends. The `\_forlevel` variable keeps the current nesting level. If it is zero, then we need not save nor restore any data.

if-macros.opm

```
\_newcount\_forlevel
\_def\_putforstack{\_immediateassigned{%
   \_ifnum\_forlevel>0
      \_sxdef{_frnum:\_the\_forlevel\_ea}{\_the\_frnum}%
      \_global\_slet{_fbody:\_the\_forlevel}{_fbody}%
   \_fi
   \_global\_advance\_forlevel by1
}}
\_def\_getforstack{\_immediateassigned{%
   \_global\_advance\_forlevel by-1
   \_ifnum\_forlevel>0
      \_global\_slet{_fbody}{_fbody:\_the\_forlevel}%
      \_global\_frnum=\_cs{_frnum:\_the\_forlevel}\_space
   \_fi
}}
```

User can define own expandable "foreach" macro by `\foreachdef \macro` ⟨*parameter-mask*⟩`{`⟨*what*⟩`}` which can be used by `\macro {`⟨*list*⟩`}`. The macro reads repeatedly parameters from ⟨*list*⟩ using ⟨*parameter-mask*⟩ and does ⟨*what*⟩ for each such reading. For example

```
\foreachdef\mymacro #1,{[#1]}
\mymacro{a,b,cd,efg,}
```

expands to [a][b][cd][efg]. Such user defined macros are more effecive during processing than `\foreach` itself because they need not to operate with the for-stack.

if-macros.opm

```
\_def\_foreachdef#1#2#{\_toks0{#2}%
   \_long\_edef#1##1{\_ea\_noexpand\_csname _body:\_csstring#1\_endcsname
                     ##1\_the\_toks0 \_noexpand\_finbody}%
   \_foreachdefA#1{#2}}
\_def\_foreachdefA#1#2#3{%
   \_long\_sdef{_body:\_csstring#1}#2{\_testparam##1..\_iftrue #3\_cs{_body:\_csstring#1\_ea}\_fi}}

\_public \foreachdef ;
```

2.6.3 Is-macros

There are a collection of macros `\isempty`, `\istoksempty`, `\isequal`, `\ismacro`, `\isdefined`, `\isinlist` and `\isfile` with common syntax:

`\issomething` ⟨*params*⟩ `\iftrue` ⟨*codeA*⟩ `\else` ⟨*codeB*⟩ `\fi`
or
`\issomething` ⟨*params*⟩ `\iffalse` ⟨*codeB*⟩ `\else` ⟨*codeA*⟩ `\fi`

The `\else` part is optional. The ⟨*codeA*⟩ is processed if `\issomething`⟨*params*⟩ generates true condition. The ⟨*codeB*⟩ is processed if `\issomething`⟨*params*⟩ generates false condition.

The `\iftrue` or `\iffalse` is an integral part of this syntax because we need to keep skippable nested `\if` conditions.

Implementation note: we read this `\iftrue` or `\iffalse` into unseparated parameter and repeat it because we need to remove an optional space before this command.

`\isempty {`⟨*text*⟩`}\iftrue` is true if the ⟨*text*⟩ is empty. This macro is expandable.
`\istoksempty` ⟨*tokens variable*⟩`\iftrue` is true if the ⟨*tokens variable*⟩ is empty. It is expandable.

if-macros.opm

```
\_long\_def \_isempty #1#2{\_if\_relax\_detokenize{#1}\_relax \_else \_ea\_unless \_fi#2}
\_def \_istoksempty #1#2{\_ea\_isempty\_ea{\_the#1}#2}
\_public \isempty \istoksempty ;
```

`\isequal {`⟨*textA*⟩`}{`⟨*textB*⟩`}\iftrue` is true if the ⟨*textA*⟩ and ⟨*textB*⟩ are equal, only from strings point of view, category codes are ignored. The macro is expandable.

if-macros.opm

```
\_def\_isequal#1#2#3{\_directlua{%
   if "\_luaescapestring{\_detokenize{#1}}"=="\_luaescapestring{\_detokenize{#2}}"
   then else tex.print("\_nbb unless") end}#3}
\_public \isequal ;
```

`\ismacro \macro{text}\iftrue` is true if macro is defined as ⟨*text*⟩. Category codes are ignored in this testing. The macro is expandable.

if-macros.opm

```
\_def\_ismacro#1{\_ea\_isequal\_ea{#1}}
\_public \ismacro ;
```

`\isdefined {`⟨*csname*⟩`}\iftrue` is true if `\`⟨*csname*⟩ is defined. The macro is expandable.

if-macros.opm

```
\_def\_isdefined #1#2{\_ifcsname #1\_endcsname \_else \_ea\_unless \_fi #2}
\_public \isdefined ;
```

`\isinlist \list{`⟨*text*⟩`}\iftrue` is true if the ⟨*text*⟩ is included the macro body of the `\list`. The category code are relevant here. The macro is not expandable.

if-macros.opm

```
\_long\_def\_isinlist#1#2{\_begingroup
   \_long\_def\_tmp##1#2##2\_end/_%
        {\_endgroup\_if\_relax\_detokenize{##2}\_relax \_ea\_unless\_fi}%
   \_ea\_tmp#1\_endlistsep#2\_end/_%
}
\_public \isinlist ;
```

`\isfile {`⟨*filename*⟩`}\iftrue` is true if the file ⟨*filename*⟩ exists and are readable by TEX.

if-macros.opm

```
\_newread \_testin
\_def\_isfile #1{%
   \_openin\_testin ={#1}\_relax
   \_ifeof\_testin \_ea\_unless
   \_else \_closein\_testin
   \_fi
}
\_public \isfile ;
```

`\isfont {`⟨*fontname or [fontfile]*⟩`}\iftrue` is true if given font exists. The result of this testing is saved to the `\_ifexistfam`.

if-macros.opm

```
\_newifi \_ifexistfam
\_def\_isfont#1#2{%
   \_begingroup
       \_suppressfontnotfounderror=1
       \_font\_testfont={#1}\_relax
       \_ifx\_testfont\_nullfont \_def\_tmp{\_existfamfalse \_unless}
       \_else \_def\_tmp{\_existfamtrue}\_fi
   \_ea \_endgroup \_tmp #2%
}
\_public \isfont ;
```

The last macro `\isnextchar` ⟨*char*⟩`{`⟨*codeA*⟩`}{`⟨*codeB*⟩`}` has different syntax than all others is-macros. It executes ⟨*codeA*⟩ if next character is equal to ⟨*char*⟩. Else the ⟨*codeB*⟩ is executed. The macro is not expandable.

if-macros.opm

```
\_long\_def\_isnextchar#1#2#3{\_begingroup\_toks0={\_endgroup#2}\_toks1={\_endgroup#3}%
   \_let\_tmp= #1\_futurelet\_next\_isnextcharA
}
\_def\_isnextcharA{\_the\_toks\_ifx\_tmp\_next0\_else1\_fi\_space}

\_public \isnextchar ;
```

2.7 Setting parameters

The behavior of document processing by OpTEX is controlled by *parameters*. The parameters are

- primitive registers used in build-in algorithms of TEX,
- registers declared and used by OpTEX macros.

Both groups of registers have their type: number, dimension, skip, token list.

The registers are represented by their names (control sequences). If the user re-defines such control sequence then the appropriate register exists steadily and build-in algorithms are using it without change. But user cannot access its value in such case. OpTEX declares two control sequences for each register: prefixed and unprefixed. OpTEX macros use only prefixed variants of control sequences. The user should use unprefixed variant with the same meaning and set or read values of registers using the unprefixed variant. If the user re-defines the unprefixed control sequence of a register then OpTEX macros still work without change.

parameters.opm

```
\_codedecl \normalbaselineskip {Parameter settings <2020-03-17>} % preloaded in format
```

2.7.1 Primitive registers

The primitive registers with the same default value as in plain TEX follow:

parameters.opm

```
\_parindent=20pt     % indentation of paragraphs
\_pretolerance=100   % parameters used in paragraph breaking algorithm
\_tolerance=200
\_hbadness=1000
\_vbadness=1000
\_doublehyphendemerits=10000
\_finalhyphendemerits=5000
\_adjdemerits=10000
\_uchyph=1
\_defaulthyphenchar=`\-
\_defaultskewchar=-1
\_hfuzz=0.1pt
\_vfuzz=0.1pt
\_overfullrule=5pt
\_linepenalty=10     % penalty between lines inside the paragraph
\_hyphenpenalty=50   % when a word is bro-ken
\_exhyphenpenalty=50 % when the hyphenmark is used explicitly
\_binoppenalty=700   % between binary operators in math
\_relpenalty=500     % between relations in math
\_brokenpenalty=100  % after lines if they end by a broken word.
\_displaywidowpenalty=50   % before last line of paragraph if display math follows
\_predisplaypenalty=10000  % above display math
\_postdisplaypenalty=0     % below display math
\_delimiterfactor=901 % parameter for scaling delimiters
\_delimitershortfall=5pt
\_nulldelimiterspace=1.2pt
\_scriptspace=0.5pt
\_maxdepth=4pt
\_splitmaxdepth=\_maxdimen
\_boxmaxdepth=\_maxdimen
\_parskip=0pt plus 1pt
\_abovedisplayskip=12pt plus 3pt minus 9pt
\_abovedisplayshortskip=0pt plus 3pt
\_belowdisplayskip=12pt plus 3pt minus 9pt
\_belowdisplayshortskip=7pt plus 3pt minus 4pt
\_parfillskip=0pt plus 1fil
\_thinmuskip=3mu
\_medmuskip=4mu plus 2mu minus 4mu
\_thickmuskip=5mu plus 5mu
```

Note that `\topskip` and `\splittopskip` are changed when first `\typosize` sets the main values (default font size and default `\baselineskip`).

parameters.opm

```
\_topskip=10pt       % top edge of page-box to first baseline distance
\_splittopskip=10pt
```

2.7.2 Plain TEX registers

Declared registers used in plain TEX

parameters.opm

```
% We also define special registers that function like parameters:
\_newskip\_smallskipamount \_smallskipamount=3pt plus 1pt minus 1pt
\_newskip\_medskipamount \_medskipamount=6pt plus 2pt minus 2pt
\_newskip\_bigskipamount \_bigskipamount=12pt plus 4pt minus 4pt
\_newskip\_normalbaselineskip \_normalbaselineskip=12pt
\_newskip\_normallineskip \_normallineskip=1pt
\_newdimen\_normallineskiplimit \_normallineskiplimit=0pt
\_newdimen\_jot \_jot=3pt
\_newcount\_interdisplaylinepenalty \_interdisplaylinepenalty=100
\_newcount\_interfootnotelinepenalty \_interfootnotelinepenalty=100

\_def\_normalbaselines{\_lineskip=\_normallineskip
  \_baselineskip=\_normalbaselineskip \_lineskiplimit=\_normallineskiplimit}

\_def\_frenchspacing{\_sfcode`\.=1000 \_sfcode`\?=1000 \_sfcode`\!=1000
  \_sfcode`\:=1000 \_sfcode`\;=1000 \_sfcode`\,=1000 }
\_def\_nonfrenchspacing{\_sfcode`\.=3000 \_sfcode`\?=3000 \_sfcode`\!=3000
  \_sfcode`\:=2000 \_sfcode`\;=1500 \_sfcode`\,=1250 }

\_public \normalbaselines \frenchspacing \nonfrenchspacing
   \smallskipamount \medskipamount \bigskipamount
   \normalbaselineskip \normallineskip \normallineskiplimit
   \jot \interdisplaylinepenalty \interfootnotelinepenalty ;
```

2.7.3 Different settings than in plain TEX

Default "baseline setting" is for 10 pt fonts (like in plain TEX). But `\typosize` and `\typoscale` macros re-declare it if another font size is used.

The `\nonfrenchspacing` is not set by default because the author of OpTEX is living in the Europe. If you set `\enlang` hyphenation patterns then `\nonfrenchspacing` is set.

parameters.opm

```
\_normalbaselines % baseline setting, 10 pt font size
```

Different values than in plain TEX have following primitive registers. We prohibit orphans, set more information for tracing boxes, set page origin to upper left corner of the paper (no at 1 in, 1 in coordinates) and set default page dimensions as A4, no letter.

parameters.opm

```
\_emergencystretch=20pt % we want to use third pass of aparagraph building algoritmh
                        % we need not to keep the compatibility with old documents

\_clubpenalty=10000    % after first line of paragraph
\_widowpenalty=10000   % before last line of paragraph

\_showboxbreadth=150   % for tracing boxes
\_showboxdepth=7
\_errorcontextlines=15
\_tracinglostchars=2   % missing chracter warnings on terminal too

\_outputmode=1   % PDF ouput
\_pdfvorigin=0pt % orgin is exatly at left upper corner
\_pdfhorigin=0pt
\_hoffset=25mm   % margins are 2.5cm, no 1in
\_voffset=25mm
\_hsize=160mm    % 210mm (from A4 size) - 2*25mm (default margins)
\_vsize=244mm    % 297mm (from A4 size) - 2*25mm (default margins) -3mm baseline correction
\_pagewidth=210 true mm
\_pageheight=297 true mm
```

If you insist on plain TEX values of these parameters then you can call the `\plaintexsetting` macro.

parameters.opm

```
\_def\_plaintexsetting{%
   \_emergencystretch=0pt
   \_clubpenalty=150
   \_widowpenalty=150
```

```
    \_pdfvorigin=1in
    \_pdfhorigin=1in
    \_hoffset=0pt
    \_voffset=0pt
    \_hsize=6.5in
    \_vsize=8.9in
    \_pagewidth=8.5 true in
    \_pageheight=11 true in
    \_nonfrenchspacing
}
\_public \plaintexsetting ;
```

2.7.4 OpTEX parameters

The main principle how to configure OpTEX is not to use only parameters. A designer can copy macros from OpTEX and re-define them as required. This is a reason why we don't implement dozens of parameters, but we keep OpTEX macros relatively simple. Example: do you want another design of section titles? Copy macros `\_printsec` and `\_printsecc` from `sections.opm` file to your macro file and re-define them.

Notice for OPmac users: there is important difference: all "string-like" parameters are token lists in OpTEX (OPmac uses macros for them). The reason of this difference: if user sets parameter by unprotected control sequence, an OpTEX macro can read *the same data* using protected control sequence. If user re-defines such unprotected control sequence (because he/she does know about it) then nothing bad happens.

The `\picdir` tokens list can include a directory where image files (loaded by `\inspic`) are saved. Empty `\picdir` (default value) means that image files are in the current directory (or somewhere in the TEX system where LuaTEX is able to find them). If you set non-empty value to the `\picdir`, then it must end by `/` character, for example `\picdir={img/}` means that there exists a directory `img` in your current directory and the image files are stored here.

parameters.opm

```
\_newtoks\_picdir
\_public \picdir ;
```

You can control the dimensions of included images by the parameters `\picwidth` (which is equivalent to `\picw`) and `\picheight`. By default these parameters are set to zero: the native dimension of the image is used. If only `\picwidth` has a nonzero value, then this is the width of the image (height is calculated automatically in order to respect the aspect of the image). If only `\picheight` has a nonzero value then height is given, width is calculated. If both parameters are non-zero, the height and width are given and the aspect ratio of the image is (probably) broken. We recommend to set these parameters locally in the group where `\inspic` is used in order to not influence the dimensions of another images. But there exist many situations you need to put the same dimensions to more images, so you can set this parameter only once before more `\inspic` macros.

parameters.opm

```
\_newdimen\_picwidth   \_picwidth=0pt   \_let\picw=\_picwidth
\_newdimen\_picheight  \_picheight=0pt
\_public \picwidth \picheight ;
```

The `\everytt` is token list used in `\begtt...\endtt` environment and in the verbatim group opened by `\verbinput` macro. You can include a code which is processed inside the group after basic settings were done On the other hand, it is processed before scanner of verbatim text is started. Your macros should influence scanner (catcode settings) or printing process of the verbatim code or both.

The code from the line immediately after `\begtt` is processed after the `\everytt`. This code should overwrite `\everytt` settings. Use `\everytt` for all verbatim environments in your document and use a code after `\begtt` locally only for this environment.

The `\everyintt` token list does similar work but acts in the in-line verbatim text processed by a pair of `\activettchar` characters or by `\code{`⟨*text*⟩`}`. You can set `\everyintt={\Red}` for example if you want in-line verbatim in red color.

parameters.opm

```
\_newtoks\_everytt
\_newtoks\_everyintt
\_public \everytt \everyintt ;
```

The `\ttline` is used in `\begtt...\endtt` environment or in the code printed by `\verbinput`. If `\ttline` is positive or zero, then the verbatim code have numbered lines from `\ttline+1`. The `\ttline` register

is re-set to new value after a code piece is printed, so next code pieces have numbered lines continuously. If `\ttline=-1`, then `\begtt...\endtt` lines are without numbers and `\verbinput` lines shows the line numbers of inputted file. If `\ttline<-1` then no line numbers are printed.

parameters.opm

```
\_newcount\_ttline    \_ttline=-1  % last line number in \begtt...\endtt
\_public \ttline ;
```

The `\ttindent` gives default indentation of verbatim lines printed by `\begtt...\endtt` pair or by `\verbinput`.
The `\ttshift` gives the amount of shift of all verbatim lines to right. Despite to the `\ttindent`, it does not shift the line numbers, only the text.
The `\iindent` gives default indentations used in table of contents, captions, lists, bib references,
It is strongly recommended to re-set this value if you set `\parindent` to another value than plain TEX default 20pt. A well typeset document should have the same dimension for all indentations, so you should say `\ttindent=\parindent` and `\iindent=\parindent`.

parameters.opm

```
\_newdimen\_ttindent \_ttindent=\_parindent % indentation in verbatim
\_newdimen\_ttshift
\_newdimen\_iindent  \_iindent=\_parindent
\_public \ttindent \ttshift \iindent ;
```

The tabelator `^^I` has its category code like space: it behaves as a space in normal text. This is normal plain TEX setting. But in the multiline verbatim environment it is active and expands to the `\hskip`⟨*dimen*⟩ where ⟨*dimen*⟩ is the width of `\tabspaces` spaces. Default `\tabspaces=3` means that tabelator behaves like three spaces in multiline verbatim.

parameters.opm

```
\_newcount \_tabspaces   \_tabspaces=3
\_public \tabspaces ;
```

If `\hicolors` is non-empty then its contents is used instead `\_hicolors`⟨*name*⟩ declared in the file `hisyntax-`⟨*name*⟩`.opm`. The user can give his/her preferences about colors for syntax highlighting by this tokens list. Full color set must be declared here.

parameters.opm

```
\_newtoks\_hicolors
\_public \hicolors ;
```

The default item mark used between `\begitems` and `\enditems` is bullet. The `\defaultitem` tokens list declare this default item mark.
The `\everyitem` tokens list is applied in vertical mode at the start of each item.
The `\everylist` tokens list is applied after group is opened by
The `\ilevel` keeps the value of current nesting level of the items list.
The `\listskipamount` gives vertical skip above and below the items list if `\ilevel=1`.

parameters.opm

```
\_newtoks\_defaultitem  \_defaultitem={$\_bullet$\_enspace}
\_newtoks\_everyitem
\_newtoks\_everylist
\_newskip \_listskipamount  \_listskipamount=\_medskipamount
\_newcount \_ilevel
\_public \defaultitem \everyitem \everylist \listskipamount \ilevel ;
```

The `\tit` macro includes `\vglue\titskip` above the title of the document.

parameters.opm

```
\_newskip\_titskip   \_titskip=40pt \_relax  % \vglue above title printed by \tit
\_public \titskip ;
```

The `\begmulti \endmulti` pair creates more columns. The parameter `\colsep` declares the space between columns. If n columns are specified then we have $n-1$ `\colseps` and n columns in total `\hsize`. This gives definite result of columns width.

parameters.opm

```
\_newdimen\_colsep \_colsep=20pt  % space between columns
\_public \colsep ;
```

Each line in the Table of contents is printed in a group. The `\everytocline` tokens list is processed here before the internal `\_tocl:`⟨*num*⟩ macro which starts printing the line.

parameters.opm

```
\_newtoks \_everytocline
\_public \everytocline ;
```

The \bibtexhook tokens list is used inside the group when \usebib command is processed after style file is loaded and before printing bib-entries. You can re-define a behavior of style file here or you can modify the more declaration for printing (fonts, baselineskip, etc.) or you can define a specific macros used in your .bib file.

parameters.opm

```
\_newtoks\_bibtexhook
\_public \bibtexhook ;

\_newtoks\_everycaptiont  \_newtoks\_everycaptionf
\_public \everycaptiont \everycaptionf ;
```

The \everyii tokens list is used before \noindent for each Index item when printing the Index.

parameters.opm

```
\_newtoks\_everyii
\_public \everyii ;
```

The \everymnote is used in the \mnote group before \noindent which immediately precedes marginal note text.
The \mnotesize is horizontal size of the marginal notes.
The \mnoteindent is horizontal space between body-text and marginal note.

parameters.opm

```
\_newtoks\_everymnote
\_newdimen\_mnotesize   \_mnotesize=20mm   % the width of the mnote paragraph
\_newdimen\_mnoteindent \_mnoteindent=10pt % ditance between mnote and text
\_public \everymnote \mnotesize \mnoteindent ;
```

The \table parameters follows. The \thistable tokens list register should be used for giving an exception for only one \table which follows. It should change locally other parameters of the \table. It is reset to empty list after the table is printed.
The \everytable tokens list register is applied in every table. There is another difference between these two registers. The \thistable is used first, then strut and baselineskip settings are done, then \everytable is applied and then the table is printed.
\tabstrut configures the height and depth of lines in the table. You can declare \tabstrut={}, then normal baselineskip is used in the table. This can be used when you don't use horizontal nor vertical lines in tables.
\tabiteml is applied before each item, \tabitemr is applied after each item of the table.
\tablinespace is additional vertical space between horizontal rules and the lines of the table.
\hhkern gives the space between horizontal lines if they are doubled and \vvkern gives the space between such vertical lines.
\tabskipl is \tabskip used before first column, \tabskipr is \tabskip used after the last column.
\tsize is virtual unit of the width of paragraph-like table items when \table pxto⟨*size*⟩ is used.

parameters.opm

```
\_newtoks\_everytable \_newtoks\_thistable
\_newtoks\_tabiteml \_newtoks\_tabitemr \_newtoks\_tabstrut
\_newdimen\_tablinespace \_newdimen\_vvkern \_newdimen\_hhkern \_newdimen\_tsize
\_newskip\_tabskipl  \_newskip\_tabskipr
\_everytable={}        % code used after settings in \vbox before table processing
\_thistable={}         % code used when \vbox starts, is is removed after using it
\_tabstrut={\_strut}
\_tabiteml={\_enspace} % left material in each column
\_tabitemr={\_enspace} % right material in each column
\_tablinespace=2pt     % additional vertical space before/after horizontal rules
\_vvkern=1pt           % space between double vertical line and used in \frame
\_hhkern=1pt           % space between double horizontal line and used in \frame
\_tabskipl=0pt\_relax  % \tabskip used before first column
\_tabskipr=0pt\_relax  % \tabskip used after the last column
\_public \everytable \thistable \tabiteml \tabitemr \tabstrut \tablinespace
         \vvkern \hhkern \tsize \tabskipl \tabskipr ;
```

The \eqalign macro can be configured by \eqlines and \eqstyle tokens lists. The default values are set in order this macro beahaves like in Plain TEX. The \eqspace is horizontal space put between equation systems if more columns in \eqalign is used.

parameters.opm

```
\_newtoks  \_eqlines  \_eqlines={\_openup\_jot}
\_newtoks  \_eqstyle  \_eqstyle={\_strut\_displaystyle}
\_newdimen \_eqspace  \_eqspace=20pt
```

```
\_public \eqlines \eqstyle \eqspace ;
```

\lmfil is "left matrix filler" (for \matrix columns). The default value does centering because right matrix filler is directly set to \hfil.

parameters.opm

```
\_newtoks \_lmfil   \_lmfil={\_hfil}
\_public \lmfil ;
```

The output routine uses token list \headline and \footline in the same sense as in plain TEX. If they are non-empty then \hfil or \hss must be here because they are used inside \hbox to\hsize.

Assume that page-body text can be typeset in different sizes and different fonts and we don't know in what font context the output routine is invoked. So, it is strongly recommended to declare fixed variants of fonts at the beginning of your document. For example \fontdef\rmfixed{\rm}, \fontdef\itfixed{\it}. Then use them in headline and footline:

```
\headline={\itfixed Text of headline, section: \fistmark \hss}
\footline={\rmfixed \ifodd\pageno \hfill\fi \folio \hfil}
```

parameters.opm

```
\_newtoks\_headline   \_headline={}
\_newtoks\_footline   \_footline={\_hss\_rmfixed \_folio \_hss}
\_public \headline \footline ;
```

The distance between the \headline and the top of the page-text is controlled by the \headlinedist register. The distance between bottom of page-text and \footline is \footlinedist. More precisely: baseline of headline and baseline of first line in page-text have distance \headlinedist+\topskip. The baseline of the last line in page-text and the baseline of the footline have distance \footlinedist. Default values are inspired from plain TEX.

parameters.opm

```
\_newdimen \_headlinedist  \_headlinedist=14pt
\_newdimen \_footlinedist  \_footlinedist=24pt
\_public \headlinedist \footlinedist ;
```

The \pgbottomskip is inserted to the page bottom in the output routine. You can set a less tolerance here than \raggedbotom does. By default, no tolerance is given.

parameters.opm

```
\_newskip \_pgbottomskip  \_pgbottomskip=0pt \_relax
\_public \pgbottomskip ;
```

The \nextpages tokens list can include settings which will be used at next pages. It is processed at the end of output routine with \globaldefs=1 prefix. The \nextpages is reset to empty after processing. Example of usage:

```
\headline={} \nexptages={\headline={\rmfixed \firstmark \hfil}}
```

This example sets current page with empty headline, but next pages have non-empty headlines.

parameters.opm

```
\_newtoks \_nextpages
\_public \nextpages ;
```

The \pgbackground token list can include macros which generate a vertical list. It is used as page background. The top-left corner of such \vbox is at the top-left corner of the paper. Example creates the background of all pages yellow:

```
\pgbackground={\Yellow \hrule height 0pt depth\pdfpageheight width\pdfpagewidth}
```

parameters.opm

```
\_newtoks \_pgbackground   \_pgbackground={} % for page background
\_public \pgbackground  ;
```

The parameters used in \inoval and \incircle macros can be re-set by \ovalparams, \circleparams tokens lists. The default values (documented in the user manual) are set in the macros.

parameters.opm

```
\_newtoks \_ovalparams
\_newtoks \_circleparams
%\_ovalparams={\_roundness=2pt \_fcolor=\Yellow \_lcolor=\Red \_lwidth=.5bp
%              \_shadow=N \_overlapmargins=N \_hhkern=0pt \_vvkern=0pt }
%\_circleparams={\_ratio=1 \_fcolor=\Yellow \_lcolor=\Red \_lwidth=.5bp
%                \_shadow=N \_overlapmargins=N \_hhkern=3pt \_vvkern=3pt}

\_newdimen \_roundness    \_roundness=5mm % used in \clippingoval macro

\_public \ovalparams \circleparams \roundness ;
```

2.8 More OpTEX macros

The second bundle of OpTEX macros is here.

more-macros.opm

```
\_codedecl \eoldef {OpTeX useful macos <2020-05-22>} % preloaded in format
```

We define \opinput {⟨*file name*⟩} macro which does \input {⟨*file name*⟩} but the catcodes are set to normal catcodes (like OpTEX initializes them) and the catcodes setting are returned back to the current values when the file is read. You can use \opinput in any situation inside the document and you will be sure that the file is read correctly with correct catcode settings.

In order to achieve this, we declare \optexcatcodes catcode table and \plaintexcatcodes. They save the commonly used catcode tables. Note that \catcodetable is a part of LuaTEX extension. The catcodetable stack is implemented by OpTEX macros. The \setctable ⟨*catcode table*⟩ pushes current catcode table to the stack and activates catcodes from the ⟨*catcode table*⟩. The \restorectable returns to the saved catcodes from the catcode table stack.

The \opinput works inside catcode table stack. It reads \optexcatcodes table and stores it to _tmpcatcodes table. This table is actually used during \input (maybe catcodes are changed here). Finally, _restoretable pops the stacks and returns to the catcodes used before \opinput is run.

more-macros.opm

```
\_def\_opinput #1{\_setctable\_optexcatcodes
   \_savecatcodetable\_tmpcatcodes \_catcodetable\_tmpcatcodes
   \_input {#1}\_relax\_restorectable}

\_newcatcodetable \_optexcatcodes
\_newcatcodetable \_plaintexcatcodes
\_newcatcodetable \_tmpcatcodes

\_public \optexcatcodes \plaintexcatcodes \opinput ;

\_savecatcodetable\_optexcatcodes
{\_catcode`_=8 \savecatcodetable\plaintexcatcodes}
```

The implementation of the catcodetable stack follows.

The current catcodes are managed in the \catcodetable0. If the \setctable is used first (or at the outer level of the stack), then the \catcodetable0 is pushed to the stack and the current table is re-set to the given ⟨*catcode table*⟩. The numbers of these tables are stacked to the _ctablelist macro. The \restorectable reads the last saved catcode table number from the _ctablelist and uses it.

more-macros.opm

```
\_newcount\_currctable \_currctable=0
\_catcodetable0

\_def\_setctable#1{\_edef\_ctablelist{{\_the\_currctable}\_ctablelist}%
   \_catcodetable#1\_relax \_currctable=#1\_relax
}
\_def\_restorectable{\_ea\_restorectableA\_ctablelist\_relax}
\_def\_restorectableA#1#2\_relax{%
   \_ifx^#2^\_opwarning
      {You can't use \_noindent\restorectable without previous \_string\setctable}%
   \_else \_def\_ctablelist{#2}\_catcodetable#1\_relax \_currctable=#1\_relax \_fi
}
\_def\_ctablelist{.}

\_public \setctable \restorectable ;
```

When a special macro is defined with different catcodes then \normalcatcodes can be used at the end of such definition. The normal catcodes are restored. The macro reads catcodes from \optecatodes table and sets it to the main catcode table 0.

more-macros.opm

```
\_def\_normalcatcodes {\_catcodetable\_optexcatcodes \_savecatcodetable0 \_catcodetable0 }
\_public \normalcatodes ;
```

The \load [⟨*filename-list*⟩] loads files specfied in comma separated ⟨*filename-list*⟩. The first space (after comma) is ignored using the trick #1#2,: first parameter is unseparated. The \load macro saves the information about loaded files by setting _load:⟨*filename*⟩ as a defined macro.

If the _afterload macro is defined then it is run after _opinput. The catcode setting should be here. Note that catcode setting done in the loaded file is forgotten after the \opinput.

more-macros.opm

```
\_def \_load [#1]{\_loadA #1,,,\_end}
\_def \_loadA #1#2,{\_ifx,#1 \_ea \_loadE \_else \_loadB{#1#2}\_ea\_loadA\_fi}
\_def \_loadB #1{%
   \_ifcsname _load:#1\_endcsname \_else
      \_isfile {#1.opm}\_iftrue \_opinput {#1.opm}\_else \_opinput {#1}\_fi
      \_sxdef{_load:#1}{}%
      \_trycs{_afterload}{}\_let\_afterload=\_undefined
   \_fi
}
\_def \_loadE #1\_end{}
\_public \load ;
```

The declarator \optdef\macro [⟨*opt default*⟩] ⟨*params*⟩{⟨*replacement text*⟩} defines the \macro with the optional parameter followed by normal parameters declared in ⟨*params*⟩. The optional parameter must be used as the first first parameter in brackets [...]. If it isn't used then ⟨*opt default*⟩ is taken into account. The ⟨*replacement text*⟩ can use \the\opt because optional parameter is saved to the \opt tokens register. Note the difference from LaTeX concept where the optional parameter is in #1. OpTeX uses #1 as the first normal parameter (if declared).

The _nospaceafter ignores the following optional space at expand processor level using the negative \romannumeral trick.

more-macros.opm

```
\_def\_optdef#1[#2]{%
   \_def#1{\_opt={#2}\_isnextchar[{\_cs{_oA:\_string#1}}{\_cs{_oB:\_string#1}}}%
   \_sdef{_oA:\_string#1}[##1]{\_opt={##1}\_cs{_oB:\_string#1\_nospaceafter}}%
   \_sdef{_oB:\_string#1\_nospaceafter}%
}
\_def\_nospaceafter#1{\_ea#1\_romannumeral-`\.}
\_newtoks\_opt

\_public \opt \optdef ;
```

The declarator \eoldef\macro #1{⟨*replacement text*⟩} defines a \macro which scans its parameter to the end of the current line. This is the parameter #1 which can be used in the ⟨*replacement text*⟩. The catcode of the \endlinechar is reset temporarily when the parameter is scanned.

The macro defined by \eoldef cannot be used with its parameter inside other macros because the catcode dancing is not possible here. But the \bracedparam\macro{⟨*parameter*⟩} can be used here. The \bracedparam is a prefix which re-sets temporarily the \macro to a \macro with normal one parameter.

The \skiptoeol macro reads the text to the end of the current line and ignores it.

more-macros.opm

```
\_def\_eoldef #1{\_def #1{\_begingroup \_catcode`\^^M=12 \_eoldefA #1}%
   \_ea\_def\_csname _\_csstring #1:M\_endcsname}
\_catcode`\^^M=12 %
\_def\_eoldefA #1#2^^M{\_endgroup\_csname _\_csstring #1:M\_endcsname{#2}}%
\_normalcatcodes %

\_eoldef\_skiptoeol#1{}
\_def\_bracedparam#1{\_ifcsname _\_csstring #1:M\_endcsname
    \_csname _\_csstring #1:M\_ea \_endcsname
    \_else \_csname __in\_csstring #1:M\_ea \_endcsname \_fi
}
\_public \eoldef \skiptoeol \bracedparam ;
```

\scantoeol\macro ⟨*text to end of line*⟩ scans the ⟨*text to end of line*⟩ in verbatim mode and runs the \macro{⟨*text to end of line*⟩}. The \macro can be defined \def\macro#1{...\scantextokens{#1}...}. The new tokenization of the parameter is processed when the parameter is used, no when the parameter is scanned. This principle is used in definition of \chap, \sec, \secc and _Xtoc macros. It means that user can write \sec text `&` text for example. Inline verbatim works in title sections.

The verbatim scanner of \scatoeol keeps category 7 for ^ in order to be able to use ^^J as comment chracter which means that the next line continues.

more-macros.opm

```
\_def\_scantoeol#1{\def\_tmp{#1}\_begingroup \_setscancatcodes \_scantoeolA}
\_def\_setscancatcodes{\_setverb \_catcode`\^^M=12\_catcode`\^=7\_catcode`\ =10\_catcode`\^^J=14 }
\_catcode`\^^M=12 %
\_def\_scantoeolA#1^^M{\_endgroup \_tmp{#1}}%
\_normalcatcodes %

```

```
\_public \scantoeol ;
```

The \replstring\macro{⟨textA⟩}{⟨textB⟩} replaces all occurrences of ⟨textA⟩ by ⟨textB⟩ in the \macro body. The \macro must be defined without parameters. The occurrences of ⟨textA⟩ are not replaced if they are "hidden" in braces, for example ...{...⟨textA⟩...}.... The category codes in the ⟨textA⟩ must exactly match.

more-macros.opm

```
\_catcode`!=3 \_catcode`?=3
\_def\_replstring #1#2#3{%  \replstring #1{stringA}{stringB}
   \_long\_def\_replacestringsA##1#2{\_def #1{##1}\_replacestringsB}%
   \_long\_def\_replacestringsB##1#2{\_ifx!##1\_relax \_else \_addto #1{#3##1}%
      \_ea\_replacestringsB\_fi}%
   \_ea\_replacestringsA #1?#2!#2%
   \_long\_def\_replacestringsA##1?{\_def #1{##1}}\_ea\_replacestringsA #1}
\_normalcatcodes

\_public \replstring ;
```

The \catcode primitive is redefined here. Why? There is very common cases like \catcode`⟨something⟩ or \catcode"⟨number⟩ but these characters ` or " can be set as active (typically by \activettchar macro). Nothing problematic happens if re-defined \catcode is used in this case.

If you really need primitive \catcode then you can use _catcode.

more-macros.opm

```
\_def\catcode#1{\_catcode \_if`\_noexpand#1\_ea`\_else\_if"\_noexpand#1"\_else
   \_if'\_noexpand#1'\_else \_ea\_ea\_ea\_ea\_ea\_ea\_ea#1\_fi\_fi\_fi}
```

The \removespaces ⟨text with spaces ⟩{} expands to ⟨textwithoutspaces⟩.
The _ea\ignorept\the⟨dimen⟩ expands to a decimal number \the⟨dimen⟩ but without pt unit.
The \ignoreit⟨token⟩ just ignores the ⟨token⟩.

more-macros.opm

```
\_def\_removespaces #1 {\_isempty{#1}\_iffalse #1\_ea\_removespaces\_fi}
\_ea\_def \_ea\_ignorept \_ea#\_ea1\_detokenize{pt}{#1}
\_def\_ignoreit#1{}

\public \removespaces \ignorept \ignoreit ;
```

You can use expandable \bp{⟨dimen⟩} convertor from TEX ⟨dimen⟩ (or from an expression accepted by \dimexpr primitive) to a decimal value in big points (used as natural unit in the PDF format). So, you can write, for example:

```
\pdfliteral{q \_bp{.3\hsize-2mm} \_bp{2mm} m 0 \_bp{-4mm} l S Q}
```

You can use expandable \expr{⟨expression⟩} for analogical purposes. It expands to the value of the ⟨expression⟩ at expand processor level with _decdigits digits after decimal point. The ⟨expression⟩ can include +-*/() and decimal numbers in common syntax.

The usage of prefixed versions _expr or _bp is more recommended because user can re-define the control sequences \expr or \bp.

more-macros.opm

```
\_def\_decdigits{3} % digits after decimal point in \_bp and \_expr outputs.
\_def\_pttopb{%
   \_directlua{tex.print(string.format('\_pcent.\_decdigits f',
               token.scan_dimen()/65781.76))}%  pt to bp conversion
}
\def\_bp#1{\_ea\_pttopb\_dimexpr#1\_relax}
\def\_expr#1{\_directlua{tex.print(string.format('\_pcent.\_decdigits f',#1))}}

\_public \expr \bp ;
```

The pair _doc ... _cod is used for documenting macros and to printing the technical documentation of the OpTEX. The syntax is:

```
\_doc <ignored text>
<documentation>
\_cod <ignored text>
```

The ⟨documentation⟩ (and ⟨ignored text⟩ too) must be ⟨balanced text⟩. It means that you cannot document only the { but you must document the } too.

more-macros.opm

```
\_long\_def\_doc #1\_cod {\_skiptoeol}
```

2.9 Using key=value format in parameters

User or macro programmer can define macros with options in key=value format. It means a comma separated list of equations key=value. First, we give an example.

Suppose that you want to define a macro `\myframe` with options: color of rules, color of text inside the frame, rule-width, space between text and rules. You want to use this macro as:

```
\myframe [margins=5pt,rule-width=2pt,frame-color=\Red,text-color=\Blue] {text1}
or
\myframe [frame-color=\Blue] {text2} % other parameters are default
```

You can define `\myframe` as follows:

```
\def\myframedefaults{%    defaults:
   frame-color=\Black, % color of frame rules
   text-color=\Black,  % color ot text nside the frame
   rule-width=0.4pt,   % width of rules used in the frame
   margins=2pt,        % space between text inside and rules.
}
\optdef\myframe [] #1{\bgroup
   \ea\addto\ea\myframedefaults\ea{\ea,\the\opt}%
   \readkv\myframedefaults
   \rulewidth=\kv{rule-width}
   \hhkern=\kv{margins}\vvkern=\kv{margins}\relax
   \kv{frame-color}\frame{\kv{text-color}\strut #1}%
   \egroup}
```

We recommend to use `\optdef` for defining macros with optional parameters written in `[]`. Then the optional parameters are saved in the `\opt` tokens register. First: we append the `\opt` (actual optional parameters) to `\myframedefault` by `\addto` macro. LuaTEX primitive. Second: we read the parameters by `\readkv{`⟨*pramaters list*⟩`}` macro. Third: the values can be used by expandable `\kv{`⟨*key*⟩`}` macro. The `\kv{`⟨*key*⟩`}` returns `???` if such key is not declared.

You can use keys without values in the parameters list too, but with additional care. For example, suppose `draft` option without parameter. If user write `\myframe [..., draft, ...]{text}` then `\myframe` should behave differently. We have to add `DRAFTv=0,` in `\myframedefault` macro,. Moreover, `\myframe` macro must include preprocessing of `\myframedefault` using `\replstring` which replaces the occurence of `draft` by `DRAFTv=1`.

```
\optdef\myframe [] #1{...
   \ea\addto\ea\myframedefaults\ea{\the\opt}%
   \replstring\myframedefaults{draft}{DRAFTv=1}%
   \readkv\myframedefaults
   ...
   \ifnum\kv{DRAFTv}=1 draft mode\else normal mode\fi
   ...}
```

keyval.opm

```
\_codedecl \readkv {Key-value dictionaries <2020-12-21>} % preloaded in format
```

Implementation. The `\readkv` expands its parameter and does replace-strings in order to remove spaces around equal signs and after comma. Double comma is removed. Then `\_kvscan` reads the parameters list finished by double comma and saves values to `\_kv:`⟨*key*⟩ macros.
The `\kv{`⟨*key*⟩`}` expands the `\_kv:`⟨*key*⟩ macro. If this macro is not defined then `\_kvunknown` is processed. You can re-define it if you want.

keyval.opm

```
\_def\_readkv#1{\_ea\_def\_ea\_tmpb\_ea{#1}%
   \_replstring\_tmpb{= }{=}\_replstring\_tmpb{ =}{=}%
   \_replstring\_tmpb{, }{,}\_replstring\_tmpb{,,}{,}%
   \_ea \_kvscan \_tmpb,,=,}
\_def\_kvscan #1#2=#3,{\_ifx#1,\_else \_sdef{_kv:#1#2}{#3}\_ea\_kvscan\_fi}
\_def\_kv#1{\_trycs{_kv:#1}{\_kvunknown}}
\_def\_kvunknown{???}

\public \readkv \kv ;
```

2.10 Plain TEX macros

All macros from plain TEX are rewritten here. Differences are mentioned in the documentation below.

plain-macros.opm

```
\_codedecl \magstep {Macros from plain TeX <2020-02-14>} % preloaded in format
```

The \dospecials works like in plain TeX but does nothing with _. If you need to do the same with this character, you can re-define:

```
\addto \dospecials{\do\_}
```

plain-macros.opm

```
\_def\_dospecials {\do\ \do\\\do\{\do\}\do\$\do\&%
  \do\#\do\^\do\^^K\do\^^A\do\%\do\~}
\_chardef\_active = 13

\_public \dospecials \active ;
```

The shortcuts \chardef\@one is not defined in OpTEX. Use normal numbers instead of such obscurities. The \magstep and \magstephalf are defined with \space, (no \relax), in order to be expandable.

plain-macros.opm

```
\_def \_magstephalf{1095 }
\_def \_magstep#1{\_ifcase#1 1000\_or 1200\_or 1440\_or 1728\_or 2074\_or 2488\_fi\_space}
\_public \magstephalf \magstep ;
```

Plain TEX basic macros and control sequences. \endgraf, \endline. The ^^L is not defined in OpTEX because it is obsolete.

plain-macros.opm

```
\_def\^^M{\ } % control <return> = control <space>
\_def\^^I{\ } % same for <tab>

\_def\lq{`} \def\rq{'}
\_def\lbrack{[} \_def\rbrack{]} % They are only public versions.
% \catcode`\^^L=\active \outer\def^^L{\par} % ascii form-feed is "\outer\par" % obsolete

\_let\_endgraf=\_par \_let\_endline=\_cr
\_public \endgraf \endline ;
```

Plain TEX classical \obeylines and \obeyspaces.

plain-macros.opm

```
% In \obeylines, we say `\let^^M=\par' instead of `\def^^M{\par}'
% since this allows, for example, `\let\par=\cr \obeylines \halign{...'
{\_catcode`\^^M=13 % these lines must end with %
  \_gdef\_obeylines{\_catcode`\^^M=13\_let^^M\_par}%
  \_global\_let^^M=\par} % this is in case ^^M appears in a \write
\_def\_obeyspaces{\_catcode`\ =13 }
{\_obeyspaces\_global\_let =\_space}
\_public \obeylines \obeyspaces ;
```

Spaces. \thinspace, \negthinspace, \enspace, \enskip, \quad, \qquad, \smallskip, \medskip, \bigskip, \nointerlineskip, \offinterlineskip, \topglue, \vglue, \hglue, \slash.

plain-macros.opm

```
\_protected\_def\_thinspace {\_kern .16667em }
\_protected\_def\_negthinspace {\_kern-.16667em }
\_protected\_def\_enspace {\_kern.5em }
\_protected\_def\_enskip {\_hskip.5em\_relax}
\_protected\_def\_quad {\_hskip1em\_relax}
\_protected\_def\_qquad {\_hskip2em\_relax}
\_protected\_def\_smallskip {\_vskip\_smallskipamount}
\_protected\_def\_medskip {\_vskip\_medskipamount}
\_protected\_def\_bigskip {\_vskip\_bigskipamount}
\_def\_nointerlineskip {\_prevdepth=-1000pt }
\_def\_offinterlineskip {\_baselineskip=-1000pt \_lineskip=0pt \_lineskiplimit=\_maxdimen}

\_public \thinspace \negthinspace \enspace \enskip \quad \qquad \smallskip
   \medskip \bigskip \nointerlineskip \offinterlineskip ;

\_def\_topglue {\_nointerlineskip\_vglue-\_topskip\_vglue} % for top of page
\_def\_vglue {\_afterassignment\_vglA \_skip0=}
\_def\_vglA {\_par \_dimen0=\_prevdepth \_hrule height0pt
  \_nobreak\_vskip\_skip0 \_prevdepth=\_dimen0 }
```

```
\_def\_hglue {\_afterassignment\_hglA \_skip0=}
\_def\_hglA {\_leavevmode \_count255=\_spacefactor \_vrule width0pt
  \_nobreak\_hskip\_skip0 \_spacefactor=\_count255 }
\_protected\_def~{\_penalty10000 \ } % tie
\_protected\_def\_slash {/\_penalty\_exhyphenpenalty} % a `/' that acts like a `-'

\_public \topglue \vglue \hglue \slash ;
```

Penalties macros: \break, \nobreak, \allowbreak, \filbreak, \goodbreak, \eject, \supereject, \dosupereject, \removelastskip, \smallbreak, \medbreak, \bigbreak.

plain-macros.opm

```
\_protected\_def \_break {\_penalty-10000 }
\_protected\_def \_nobreak {\_penalty10000 }
\_protected\_def \_allowbreak {\_penalty0 }
\_protected\_def \_filbreak {\_par\_vfil\_penalty-200\_vfilneg}
\_protected\_def \_goodbreak {\_par\_penalty-500 }
\_protected\_def \_eject {\_par\_break}
\_protected\_def \_supereject {\_par\_penalty-20000 }
\_protected\_def \_dosupereject {\_ifnum \_insertpenalties>0 % something is being held over
  \_line{}\_kern-\_topskip \_nobreak \_vfill \_supereject \_fi}
\_def \_removelastskip {\_ifdim\_lastskip=\_zo \_else \_vskip-\_lastskip \_fi}
\_def \_smallbreak {\_par\_ifdim\_lastskip<\_smallskipamount
  \_removelastskip \_penalty-50 \_smallskip \_fi}
\_def \_medbreak {\_par\_ifdim\_lastskip<\_medskipamount
  \_removelastskip \_penalty-100 \_medskip \_fi}
\_def \_bigbreak {\_par\_ifdim\_lastskip<\_bigskipamount
  \_removelastskip \_penalty-200 \_bigskip \_fi}

\_public \break \nobreak \allowbreak \filbreak \goodbreak \eject \supereject \dosupereject
   \removelastskip \smallbreak \medbreak \bigbreak ;
```

Boxes. \line, \leftline, \rightline, \centerline, \rlap, \llap, \underbar.

plain-macros.opm

```
\_def \_line {\_hbox to\_hsize}
\_def \_leftline #1{\_line{#1\_hss}}
\_def \_rightline #1{\_line{\_hss#1}}
\_def \_centerline #1{\_line{\_hss#1\_hss}}
\_def \_rlap #1{\_hbox to\_zo{#1\_hss}}
\_def \_llap #1{\_hbox to\_zo{\_hss#1}}
\_def\_underbar #1{$\_setbox0=\_hbox{#1}\_dp0=\_zo \_math \_underline{\_box0}$}

\_public \line \leftline \rightline \centerline \rlap \llap \underbar ;
```

The \strutbox is declared as 10pt size dependent (like in plain TEX), but the macro _setbaselineskip (from fonts-opmac.opm) redefines it.

plain-macros.opm

```
\_newbox\_strutbox
\_setbox\_strutbox=\_hbox{\_vrule height8.5pt depth3.5pt width0pt}
\_def \_strut {\_relax\_ifmmode\_copy\_strutbox\_else\_unhcopy\_strutbox\_fi}

\_public \strutbox \strut ;
```

Alignment. \hidewidth \ialign \multispan.

plain-macros.opm

```
\_def \_hidewidth {\_hskip\_hideskip} % for alignment entries that can stick out
\_def \_ialign{\_everycr={}\_tabskip=\_zoskip \_halign} % initialized \halign
\_newcount\_mscount
\_def \_multispan #1{\_omit \_mscount=#1\_relax
   \_loop \_ifnum\_mscount>1 \_spanA \_repeat}
\_def \_spanA {\_span\_omit \_advance\_mscount by-1 }

\_public \hidewidth \ialign \multispan ;
```

Tabbing macros are omitted because they are obsolete.
Indentation and others. \textindent, \item, \itemitem, \narrower, \raggedright, \ttraggedright, \leavevmode.

plain-macros.opm

```
\_def \_hang {\_hangindent\_parindent}
\_def \_textindent #1{\_indent\_llap{#1\_enspace}\_ignorespaces}
\_def \_item {\_par\_hang\_textindent}
```

```
\_def \_itemitem {\_par\_indent \_hangindent2\_parindent \_textindent}
\_def \_narrower {\_advance\_leftskip\_parindent
   \_advance\_rightskip\_parindent}
\_def \_raggedright {\_rightskip=0pt plus2em
   \_spaceskip=.3333em \_xspaceskip=.5em\_relax}
\_def \_ttraggedright {\_tt \_rightskip=0pt plus2em\_relax} % for use with \tt only
\_def \_leavevmode {\_unhbox\_voidbox} % begins a paragraph, if necessary

\_public \hang \textindent \item \itemitem \narrower \raggedright \ttraggedright \leavevmode ;
```

Few character codes are set for backward compatibility. But old obscurities (from plain TeX) based on \mathhexbox are not supported – an error message and recommendation to directly using of the desired character is implemented by the _usedirectly macro). The user can re-define these control sequences of course.

plain-macros.opm

```
%\chardef\%=`\%
\_let\% = \_pcent  % more natural, can be used in lua codes.
\_chardef\&=`\&
\_chardef\#=`\#
\_chardef\$=`\$
\_chardef\ss="FF
\_chardef\ae="E6
\_chardef\oe="F7
\_chardef\o="F8
\_chardef\AE="C6
\_chardef\OE="D7
\_chardef\O="D8
\_chardef\i="11 \chardef\j="12 % dotless letters
\_chardef\aa="E5
\_chardef\AA="C5
\_chardef\S="9F
\_def\l{\_errmessage{\_usedirectly ł}}
\_def\L{\_errmessage{\_usedirectly Ł}}
%\def\_{\_ifmmode \kern.06em \vbox{\hrule width.3em}\else _\fi} % obsolete
\_def\_{\_hbox{_}}
\_def\dag{\_errmessage{\_usedirectly †}}
\_def\ddag{\_errmessage{\_usedirectly ‡}}
%\_def\copyright{\_errmessage{\_usedirectly ©}}
\_def\copyright{©} % << example, what to do
%\_def\Orb{\_mathhexbox20D} % obsolete (part of Copyright)
%\_def\P{\_mathhexbox27B}   % obsolete

\_def \_usedirectly #1{Load Unicoded font by \string\fontfam\space and use directly #1}
\_def \_mathhexbox #1#2#3{\_leavevmode \_hbox{$\_math \_mathchar"#1#2#3$}}
\_public \mathhexbox ;
```

Accents. The macros \ooalign, \d, \b, \c, \dots, are defined for backward compatibility.

plain-macros.opm

```
\_def \_oalign #1{\_leavevmode\_vtop{\_baselineskip=\_zo \_lineskip=.25ex
   \_ialign{##\_crcr#1\_crcr}}}
\_def \_oalignA {\_lineskiplimit=\_zo \_oalign}
\_def \_ooalign {\_lineskiplimit=-\_maxdimen \_oalign} % chars over each other
\_def \_shiftx #1{\_dimen0=#1\_kern\_ea\_ignorept \_the\_fontdimen1\_font
   \_dimen0 } % kern by #1 times the current slant
\_def \_d #1{{\_oalignA{\_relax#1\_crcr\_hidewidth\_shiftx{-1ex}.\_hidewidth}}}
\_def \_b #1{{\_oalignA{\_relax#1\_crcr\_hidewidth\_shiftx{-3ex}%
   \_vbox to.2ex{\_hbox{\_char\_macron}\_vss}\_hidewidth}}}
\_def \_c #1{{\_setbox0=\_hbox{#1}\_ifdim\_ht0=1ex\_accent\_cedilla #1%
   \_else\_ooalign{\_unhbox0\_crcr\_hidewidth\_cedilla\_hidewidth}\_fi}}
\_def\_dots{\_relax\_ifmmode\_ldots\_else$\_math\_ldots\_thinsk$\_fi}
\_public \oalign \ooalign \d \b \c \dots ;
```

The accents commands like \v, \., \H, etc. are not defined. Use the accented characters directly – it is best solution. But you can use the macro \oldaccents which defines accented macros.
Much more usable is to define these control sequences to other purposes.

plain-macros.opm

```
\_def \_oldaccents {%
   \_def\`##1{{\_accent\_tgrave  ##1}}%
   \_def\'##1{{\_accent\_tacute  ##1}}%
```

```
  \_def\v##1{{\_accent\_caron  ##1}}%
  \_def\u##1{{\_accent\_tbreve  ##1}}%
  \_def\=##1{{\_accent\_macron ##1}}%
  \_def\^##1{{\_accent\_circumflex ##1}}%
  \_def\.##1{{\_accent\_dotaccent ##1}}%
  \_def\H##1{{\_accent\_hungarumlaut ##1}}%
  \_def\~##1{{\_accent\_ttilde  ##1}}%
  \_def\"##1{{\_accent\_dieresis ##1}}%
  \_def\r##1{{\_accent\_ring   ##1}}%
}
\_public \oldaccents ;

% ec-lmr encoding (will be changed after \fontfam macro):
\_chardef\_tgrave=0
\_chardef\_tacute=1
\_chardef\_circumflex=2
\_chardef\_ttilde=3
\_chardef\_dieresis=4
\_chardef\_hungarumlaut=5
\_chardef\_ring=6
\_chardef\_caron=7
\_chardef\_tbreve=8
\_chardef\_macron=9
\_chardef\_dotaccent=10
\_chardef\_cedilla=11

\_def \_uniaccents {% accents with Unicode
  \_chardef\_tgrave="0060
  \_chardef\_tacute="00B4
  \_chardef\_circumflex="005E
  \_chardef\_ttilde="02DC
  \_chardef\_dieresis="00A8
  \_chardef\_hungarumlaut="02DD
  \_chardef\_ring="02DA
  \_chardef\_caron="02C7
  \_chardef\_tbreve="02D8
  \_chardef\_macron="00AF
  \_chardef\_dotaccent="02D9
  \_chardef\_cedilla="00B8
  \_chardef\_ogonek="02DB
  \_let \_uniaccents=\_relax
}
```

The plain TEX macros \hrulefill, \dotfill, \rightarrowfill, \leftarrowfill, \downbracefill, \upbracefill. The last four are used in non-Unicode variants of \overrightarrow, \overleftarrow, \overbrace and \underbrace macros, see section 2.15.

plain-macros.opm

```
\_def \_hrulefill {\_leaders\_hrule\_hfill}
\_def \_dotfill {\_cleaders\_hbox{$\_math \_mkern1.5mu.\_mkern1.5mu$}\_hfill}
\_def \_rightarrowfill {$\_math\_smash-\_mkern-7mu%
  \_cleaders\_hbox{$\_mkern-2mu\_smash-\_mkern-2mu$}\_hfill
  \_mkern-7mu\_mathord\_rightarrow$}
\_def \_leftarrowfill {$\_math\_mathord\_leftarrow\_mkern-7mu%
  \_cleaders\_hbox{$\_mkern-2mu\_smash-\_mkern-2mu$}\_hfill
  \_mkern-7mu\_smash-$}

\_mathchardef \_braceld="37A \_mathchardef \_bracerd="37B
\_mathchardef \_braceru="37C \_mathchardef \_braceru="37D
\_def \_downbracefill {$\_math \_setbox0=\_hbox{$\_braceld$}%
  \_braceld \_leaders\_vrule height\_ht0 depth\_zo \_hfill \_braceru
  \_braceru \_leaders\_vrule height\_ht0 depth\_zo \_hfill \_bracerd$}
\_def \_upbracefill {$\_math \_setbox0=\_hbox{$\_braceld$}%
  \_braceru \_leaders\_vrule height\_ht0 depth\_zo \_hfill \_bracerd
  \_braceld \_leaders\_vrule height\_ht0 depth\_zo \_hfill \_braceru$}

\_public \hrulefill \dotfill
   \rightarrowfill \leftarrowfill \downbracefill \upbracefill ;
```

The last part of plain TEX macros: \magnification, \bye. Note that math macros are defined in the `math-macros.opm` file (section 2.15).

plain-macros.opm

```
\_def \_magnification {\_afterassignment \_magA \_count255 }
\_def \_magA {\_mag=\_count255 \_truedimen\_hsize \_truedimen\_vsize
  \_dimen\_footins=8truein
}
% only for backward compatibility, but \margins macro is preferred.
\_public \magnification ;

\_def \_showhyphens #1{\_setbox0=\_vbox{\_parfillskip=0pt \_hsize=\_maxdimen \_tenrm
  \_pretolerance=-1 \tolerance=-1 \hbadness=0 \showboxdepth=0 \ #1}}

\_def \_bye {\_par \_vfill \_supereject \_byehook \_end}
\_public \bye ;
```

2.11 Preloaded fonts for text mode

Format in luaTEX can download only non-Unicode fonts. Latin Modern EC is loaded here. These fonts are totally unusable in LuaTeX when languages with out of ASCII or ISO-8859-1 alphabets are used (for example Czech). We load only few 8bit fonts here especially for simple testing the format. But, if the user needs to do a more serious work, he/she can use `\fontfam` macro in order to load a selected font family of Unicode fonts.

We have a dilemma: when the Unicode fonts cannot be preloaded in format then basic font set can be loaded by `\everyjob`. But why to load a set of fonts ta the beginning of every job when there is highly likely that the user will load something completely different. Our decision is: there is a basic 8bit font set and user will load the font at beginning of the document.

The fonts selectors `\tenrm`, `\tenbf`, `\tenit`, `\tenbi`, `\tentt` are declared as `\public` here but only for backward compatibility. We don't use them in the Font Selection System. But the protected versions of these control sequences are used in the Font Selection System.

fonts-preload.opm

```
\_codedecl \tenrm {Latin Modern fonts (EC) preloaded <2020-01-23>} % loaded in format

% Only few text fonts are preloaded:

\_font\_tenrm=ec-lmr10   % roman text
\_font\_tenbf=ec-lmbx10  % boldface extended
\_font\_tenit=ec-lmri10  % text italic
\_font\_tenbi=ec-lmbxi10 % bold italic
\_font\_tentt=ec-lmtt10  % typewriter
\_tenrm

\_public \tenrm \tenbf \tenit \tenbi \tentt ;
```

2.12 Scaling fonts in text mode (low-level macros)

2.12.1 The `\setfontsize` macro

The `\setfontsize {`⟨*size spec*⟩`}` saves the information about ⟨*size spec*⟩. This information is taken into account when a variant selector (for example `\rm`, `\bf`, `\it`, `\bi`) or `\resizethefont` is used. The ⟨*size spec*⟩ can be:

- `at`⟨*dimen*⟩, for example `\setfontsize{at12pt}`. It gives the desired font size directly.
- `scaled`⟨*scale factor*⟩, for example `\setfontsize{scaled1200}`. The font is scaled in respect to its native size (which is typically 10 pt). It behaves like `\font\... scaled`⟨*number*⟩.
- `mag`⟨*decimal number*⟩, for example `\setfontsize{mag1.2}`. The font is scaled in respect to the current size of the fonts given by the previous `\setfontsize` command.

The initialization value in OpTEX is given by `\setfontsize{at10pt}`.

The `\resizethefont` resizes the currently selected font to the size given by previous `\setfontsize`. For example

```
                      Here is 10 pt text,
\setfontsize{at12pt} 10 pt text here unchanged...
\resizethefont       and 12 pt text is here.
```

The \setfontsize command acts like *font modifier*. It means that it saves information about fonts but does not change the font actually until variant selector or \resizethefont is used.

The following example demonstrates the mag format of \setfontsize parameter. It is only a curious example probably not used in practical typography.

```
\def\smaller{\setfontsize{mag.9}\resizethefont}
Text \smaller text \smaller text \smaller text.
```

2.12.2 The \font primitive

If you load a font directly by \font primitive and you want to create a size-dependent selector for such font then you can use \resizethefont:

```
\font\tencomfortaa=Comfortaa-Regular-T1 at10pt
\def\comfortaa{\tencomfortaa\resizethefont}

\comfortaa Here is 10 pt text
\setfontsize{at12pt}
\comfortaa Here is 12 pt text
```

The example above uses the 8 bit tfm font. You can use Unicode font too, of course. The \fontfam macro initializes the extended \font primitive features for LuaTEX (see section 2.13.14). If you didn't use this command, you must to initialize these features by the \initunifonts command explicitly, for example:

```
\initunifonts
\font\tencyklop=[cyklop-regular] at10pt % the font cyklop-regular.otf is loaded
\def\cyklop{\tencyklop\resizethefont}

\cyklop Here is 10 pt text
\setfontsize{at12pt}
\cyklop Here is 12 pt text
```

2.12.3 The \fontdef declarator

You can declare \⟨*newfont*⟩ by the \fontdef command.

```
\fontdef \⟨newfont⟩ {⟨font modifiers⟩ \⟨variant-selector⟩}
example:
\fontdef \bigfont {\setfontsize{at15pt}\bf}
```

This command runs ⟨*font modifiers*⟩ \⟨*variant-selector*⟩ in an internal group and sets the resulting selected font as \⟨*newfont*⟩.

The resulting \⟨*newfont*⟩ declared by \fontdef is "fixed font switch" independent of \setfontsize and other font modifiers. More exactly, it is fixed font switch when it is used but it can depend on the current font modifiers and font family and given font modifiers when it is declared.

The parameter of the \fontdef macro must be exactly finished by the variant selector. More information about font modifiers and variant selectors are in the section 2.13.

2.12.4 The \fontlet declarator

We have another command for scaling: \fontlet which is able to resize arbitrary font given by its font switch. This font switch was declared it by the \font primitive or the \fontdef macro.

```
\fontlet \⟨newfont⟩ = \⟨fontswitch⟩ ⟨sizespec⟩
example:
\fontlet \bigfont = \_tenbf at15pt
```

The resulted \bigfont is the same as in previous example where \fontdef was used. The advantage of \fontdef macro will be more clear when you load font families by \fontfam and you are using more font modifiers declared in such families.

Summary: you can declare font switches:

- by the \font primitive if you know the font file,
- by the \fontlet command if you know the font switch and the size, or
- by the \fontdef command if you know the variant and modifiers.

2.12.5 Optical sizes

There are font families with more font files where almost the same font is implemented in various design sizes: `cmr5`, `cmr6`, `cmr7`, `cmr8`, `cmr9`, `cmr10`, `cmr12`, `cmr17` for example. This feature is called "optical sizes". OpTEX chooses a font with an optical size closest to desired size specified by the `\setfontsize`, when `at`⟨*dimen*⟩ or `mag`⟨*coefficient*⟩ is used. When `scaled`⟨*scale factor*⟩ is used then optical size is chosen using the value of the `\defaultoptsize` register and such font is scaled by the specified ⟨*scale factor*⟩. There is `\defaultoptsize=10pt` by default.

Font collections with optical sizes must be registered by the `\_regtfm` for `tfm` files or `\_regoptsizes` for Unicode fonts. OpTEX registers 8bit Latin Moder fonts in the format (`fonts-resize.opm` file) and OTF Latin Modern fonts in the `f-lmfonts.opm` file.

2.12.6 Implementation notes

fonts-resize.opm

```
\_codedecl \setfontsize {Font resizing macros <2020-04-17>} % preloaded in format
```

The `\setfontsize` `{`⟨*sizespec*⟩`}` saves the ⟨*sizespec*⟩ to the `\_sizespec` macro. The `\_optsize` value is calculated from the ⟨*sizespec*⟩. If the ⟨*sizepec*⟩ is in the `mag`⟨*number*⟩ format then the contents of the `\_sizespec` macro is re-calculated to the `at`⟨*dimen*⟩ format using previous `\_optsize` value.

fonts-resize.opm

```
\_newdimen \_optsize         \_optsize=10pt
\_newdimen \_defaultoptsize  \_defaultoptsize=10pt
\_newdimen\_lastmagsize

\_def\_setfontsize #1{%
   \_edef\_sizespec{#1}%
   \_ea \_setoptsize \_sizespec\_relax
   \_reloading
}
\_def\_setoptsize {\_isnextchar a{\_setoptsizeA}
                                {\_isnextchar m{\_setoptsizeC}{\_setoptsizeB}}}
\_def\_setoptsizeA at#1\_relax{\_optsize=#1\_relax\_lastmagsize=\_optsize}   % at<dimen>
\_def\_setoptsizeB scaled#1\_relax{\_optsize=\_defaultoptsize\_relax} % scaled<scalenum>
\_def\_setoptsizeC mag#1\_relax{%
   \_ifdim\_lastmagsize>\_zo \_optsize=\_lastmagsize \_else \_optsize=\_pdffontsize\_font \_fi
   \_optsize=#1\_optsize
   \_lastmagsize=\_optsize
   \_edef\_sizespec{at\_the\_optsize}%
}
\_public \setfontsize \defaultoptsize ;
```

`\_resizefont` `{`⟨*variant-name*⟩`}`⟨*font switch*⟩, for example `\resizefont{bf}\_tenbf` resizes the font given by the variant. The variant `XX` have its font switch `\_tenXX`. The `\_doresizefont\fontswitch` is used. It works in TFM mode (`\_doresizetfmfont`) or OTF mode (`\_doresizeunifont`). In both modes, it does

`\_font \_tenXX =` ⟨*fontname*⟩ `\_sizespec`

The ⟨*fontname*⟩ is generated by the `\fontname` TEX primitive where `\_rfontskipat` removes the `at`⟨*dimen*⟩ part of the `\_fontname` output. The ⟨*fontname*⟩ is generated differently in OTF mode, see `\_doresizeunifont` macro.
The `\_whatresize` is defined as ⟨*variant-name*⟩.

fonts-resize.opm

```
\_def\_resizefont#1#2{%
    \_edef\_whatresize{#1}%
    \_ifx \_fontselector \_undefined \_doresizefont#2%
    \_else \_ea \_doresizefont \_fontselector \_fi
    \_lastmagsize=\_zo
    \_slet{_tryload#1}{_relax}%
}
\_def\_doresizetfmfont#1{\_logfont{#1}%
   \_ea\_font\_ea#1\_ea\_rfontskipat
      \_fontname \_cs{_ten\_whatresize} \_relax\_space \_sizespec \_relax
}
\_let\_doresizefont=\_doresizetfmfont
\_def\_logfont#1{} % default is no logging of used fonts
```

```
\def\_rfontskipat#1{\_ifx#1"\_ea\_rfskipatX \_else\_ea\_rfskipatN\_ea#1\_fi}
\def\_rfskipatX #1" #2\_relax{"\_whichtfm{#1}"}
\def\_rfskipatN #1 #2\_relax{\_whichtfm{#1}}
```

`\fontdef` ⟨*font switch*⟩`{`⟨*modifiers*⟩⟨*variant selector*⟩`}` opens group, runs ⟨*modifiers*⟩⟨*variant selector*⟩ (i.e. it runs `#2` parameter). The font switch `#1` saved in the `\_fontselector` macro is re-declared because the variant selector runs the `\_resizefont`. Now, we need to keep the current meaning of the font switch `#1` but we must leave the opened group. This is done by the `\_keepmeaning` macro.
`\fontlet` ⟨*font switch A*⟩ ⟨*font switch B*⟩ ⟨*size spec*⟩ does

`\font` ⟨*font switch A*⟩ `=` ⟨*fontname*⟩ ⟨*sizespec*⟩

The ⟨*fontname*⟩ is extracted using the primitive command `\_fontname` ⟨*font switch B*⟩.

fonts-resize.opm

```
\_def \_fontdef #1#2{\_begingroup
   \_ifx\_fontselector\_undefined \_def\_fontselector{#1}\_fi
   \_reloading #2%
   \_ea \_keepmeaning \_fontselector \_endgroup
}
\_def\_fontlet#1#2{\_ifx #2=\_ea\_fontlet \_ea#1\_else
  \_ea\_font\_ea#1\_ea\_rfontskipat\_fontname#2 \_relax\_space \_fi
}
\_def \_keepmeaning #1#2{\_global\_let\_keepmeaningdata=#1%
   #2\_let#1=\_keepmeaningdata \_global\_let\_keepmeaningdata=\_undefined
}
\_public \fontdef \fontlet ;
```

`\newcurrfontsize` ⟨*size spec*⟩ sets current font size to the ⟨*size spec*⟩ It is implemented by `\fontlet`. The font switch of the current font is extracted by `\_the\_font`. We must re-create the control sequence `\_the\_font` because its original meaning is set to "inaccessible" by TEX when `\font` primitive is started. `\resizethefont` is implemented by `\newcurrfontsize` using data from the `\_sizespec` macro.

fonts-resize.opm

```
\_def \_newcurrfontsize #1{% \newcurrfontsize{at25pt}
   \_edef\_tmp{\_ea\_csstring \_the\_font}%
   \_ea \_fontlet \_csname \_tmp\_ea\_endcsname \_the\_font \_space #1\_relax
   \_csname \_tmp\_endcsname
}
\_protected\_def \_resizethefont{\_newcurrfontsize\_sizespec}

 \_public \newcurrfontsize \resizethefont ;
```

The variant selector is defined by `\protected\def\XX{\_tryloadXX \_tenXX}` The `\_tryloadXX` can be in `\_relax` state if no font modifiers were declared. But normally it does `\_resizefont{XX}\tenXX`. This meaning is activated by the `\_reloading` macro.

fonts-resize.opm

```
\_def\_reloading{\_loadf{rm}\_tenrm \_loadf{bf}\_tenbf
   \_loadf{it}\_tenit \_loadf{bi}\_tenbi
}
\_def\_loadf#1#2{\_sdef{_tryload#1}{\_ifmmode \_else \_resizefont{#1}#2\_fi}}
\_def\_tryloadtt{\_resizefont{tt}\_tentt}

\_let\_tryloadrm=\_relax
\_let\_tryloadbf=\_relax
\_let\_tryloadit=\_relax
\_let\_tryloadbi=\_relax
```

The font selection system allows to use `\currvar` instead explicitly specified variant selector. The current variant is extracted from `\the\font` output which could be `\_tenXX` control sequence. Then `\currvar` expands to `\_rm` or `\_it` etc.

fonts-resize.opm

```
\_protected \_def \_currvar{\_cs{_currvar:\_ea \_csstring \_the\_font}}
\_sdef{_currvar:_tenrm}{\_rm}
\_sdef{_currvar:_tenbf}{\_bf}
\_sdef{_currvar:_tenit}{\_it}
\_sdef{_currvar:_tenbi}{\_bi}
\_sdef{_currvar:_tentt}{\_tt}
\_public \currvar ;
```

The _regtfm ⟨*font id*⟩ ⟨*optical size data*⟩ saves the ⟨*optical size data*⟩ concerned to ⟨*font id*⟩. The ⟨*optical size data*⟩ is in the form as shown below in the code where _regtfm is used.
The _wichtfm ⟨*fontname*⟩ expands to the ⟨*fontname*⟩ or to the corrected ⟨*fontname*⟩ read from the ⟨*optical size data*⟩. It is used in the _rfontskipat macro and it is used in \fontlet macro. It means that each ⟨*fontname*⟩ generated by the \fontname primitive in the \fontlet macro is processed by the _whichtfm. The real ⟨*fontname*⟩ or corrected ⟨*fontname*⟩ (depending on the optical data does not exist or exist) is the output of the expansion before \font primitive takes this output as its parameter.

The implementation detail: The _⟨*font id*⟩:reg is defined as the ⟨*optical size data*⟩ and all control sequences _⟨*fontname*⟩:reg from this data line has the same meaning because of the _reversetfm macro. The _whichtfm expands this data line and apply _dowhichtfm. This macro select the right result from the data line by testing with the current _optsize value.

fonts-resize.opm

```
\_def\_regtfm #1 0 #2 *{\_ea\_def \_csname _#1:reg\_endcsname{#2 16380 \_relax}%
  \_def\_tmpa{#1}\_reversetfm #2 * %
}
\_def\_reversetfm #1 #2 {% we need this data for \_setmathfamily
   \_ea\_let\_csname _#1:reg\_ea\_endcsname
   \_csname _\_tmpa:reg\_endcsname
   \_if*#2\_else \_ea\_reversetfm \_fi
}
\_def\_whichtfm #1{%
   \_ifcsname _#1:reg\_endcsname
      \_ea\_ea\_ea \_dowhichtfm
      \_csname _#1:reg\_ea\_endcsname
   \_else
      #1%
   \_fi
}
\_def\_dowhichtfm #1 #2 {%
   \_ifdim\_optsize<#2pt #1\_ea\_ignoretfm\_else \_ea\_dowhichtfm
\_fi
}
\_def\_ignoretfm #1\_relax{}
```

Optical sizes data for preloaded 8bit Latin Modern fonts:

fonts-resize.opm

```
\_regtfm lmr  0 ec-lmr5 5.5 ec-lmr6 6.5 ec-lmr7 7.5 ec-lmr8 8.5 ec-lmr9 9.5
                ec-lmr10 11.1 ec-lmr12 15 ec-lmr17 *
\_regtfm lmbx 0 ec-lmbx5 5.5 ec-lmbx6 6.5 ec-lmbx7 7.5 ec-lmbx8 8.5 ec-lmbx9 9.5
                ec-lmbx10 11.1 ec-lmbx12 *
\_regtfm lmri 0 ec-lmri7 7.5 ec-lmri8 8.5 ec-lmri9 9.5 ec-lmri10 11.1 ec-lmri12 *
\_regtfm lmtt 0 ec-lmtt8 8.5 ec-lmtt9 9.5 ec-lmtt10 11.1 ec-lmtt12 *

\_setfontsize {at10pt} % default font size
```

2.13 The Font Selection System

The basic principles of the Font Selection System used in OpTEX was documented in the section 1.3.1.

2.13.1 Terminology

We distinguish between

- *font switchers*, they are declared by the \font primitive or by \fontlet or \fontdef macros, they select given font.
- *variant selectors*, there are four basic variant selectors \rm, \bf, \it, \bi, there is a special selector \currvar. More variant selectors can be declared by the \famvardef macro. They select the font depending on given variant and on the *font context* (i.e. on current family and on more features given by font modifiers). In addition, OpTEX defines \tt as variant selector independent of chosen font family. It selects typewriter-like font.
- *font modifiers* are declared in a family (\cond, \caps) or are "build in" (\setfontsize{⟨*size spec*⟩}, \setff{⟨*features*⟩}). They do appropriate change in the *font context* but do not select the font.
- *family selectors* (for example \Termes, \LMfonts), they are declared typically in the *font family files*. They enable to swithch between font families, they do appropriate change in the *font context* but do not select the font.

These commands set their values locally. When the TEX group is leaved then selected font and the *font context* are returned back to the values used when the group was opened. They have the following features:

The *font context* is a set of macro values which will affect the selection of real font when variant selector is processed. It includes the value of *current family*, current font size and more values stored by font modifiers.

The *family context* is the current family value stored in the font context. The variant selectors declared by `\famvardef` and font modifiers declared by `\moddef` are dependent on the *family context*. They can have the same names but different behavior in different families.

The fonts registered in OpTEX have their macros in the *font family files*, each family is declared in one font family file with the name `f-famname.opm`. All families are collected in `fams-ini.opm` and user can give more declarations in the file `fams-local.opm`.

2.13.2 Font families, selecting fonts

The `\fontfam [`⟨*Font Family*⟩`]` opens the relevant font family file where the ⟨*Font Family*⟩ is declared. The family selector is defined here by rules described in the section 2.13.11. Font modifiers and variant selectors may be declared here. The loaded family is set as current and `\rm` variant selector is processed.

The available declared font modifiers and declared variant selectors are listed in the log file when font family is load. Or you can print `\fontfam[catalog]` to show available font modifiers and variant selectors.

The font modifiers can be independent, like `\cond` and `\light`. They can be arbitrary combined (in arbitrary order) and if the font family disposes with all such sub-variants then the desired font is selected (after variant selector is used). On the other hand there are font modifiers which negates the previous font modifier, for example `\cond`, `\extend`. You can reset all modifiers to their initial value by the `\resetmod` command.

You can open more font families by more `\fontfam` commands. Then the general method to selecting the individual font is:

⟨*family selector*⟩ ⟨*font modifiers*⟩ ⟨*variant selector*⟩

For example:

```
\fontfam [Heros]  % Heros family is active here, default \rm variant.
\fontfam [Termes] % Termes family is active here, default \rm variant.
{\Heros \caps \cond \it The caps+condensed italics in Heros family is here.}
The Termes roman is here.
```

There is one special command `\currvar` which acts as variant selector. It keeps the current variant and the font of such variant is reloaded with respect to the current font context by previously given family selector and font modifiers.

You can use the `\setfontsize {`⟨*sizespec*⟩`}` command in the same sense as other font modifiers. It saves information about font size to the font context. See section 2.12. Example:

```
\rm default size \setfontsize{at14pt}\rm here is 14pt size \it italic is
in 14pt size too \bf bold too.
```

Much more comfortable way to resize fonts is using OPmac-like commands `\typosize` and `\typoscale`. These commands prepare the right sizes for math fonts too and they re-calculate many internal parameters like `\baselineskip`. See section 2.17 for more information.

2.13.3 Math Fonts

Most font families are connected with a preferred Unicode-math font. This Unicode-math is activated when the font family is loaded. If you don't prefer this and you are satisfied with 8bit math CM+AMS fonts preloaded in the OpTEX format then you can use command `\noloadmath` before you load a first font family.

If you want to use your specially selected Unicode-math font then use `\loadmath {[`⟨*font_file*⟩`]}` or `\loadmath {`⟨*font_name*⟩`}` before first `\fontfam` is used.

2.13.4 Declaring font commands

Font commands can be font switches, variant selectors, font modifiers, family selectors and defined font macros doing something with fonts.

- Font switches can be decared by `\font` primitive (see section 2.12.2) or by `\fontlet` command (see section 2.12.4) or by `\fontdef` command (see sections 2.13.5 and 2.12.3). When the font switches are used then they select given font independently of current font context. They can be used in `\output` routine (for example) becuase we need to set fixed fonts in hedares and footers.
- Variant selectors are `\rm`, `\bf`, `\it`, `\bi`, `\tt` and `\currvar`. More variant selectors can be declared by `\famvardef` command. They select a font dependent on the current font context, see section 2.13.6. The `\tt` selector is documented in section 2.13.7.
- Font modifiers are "build in" or declared by `\moddef` command. They do modifications in the font context but don't select any font.
  - "build-in" font modifiers are `\setfontsize` (see section 2.12), `\setff` (see section 2.13.9), `\setfontcolor`, `\setletterspace` and `\setwordspace` (see section 2.13.10). They are independent of font family.
  - Font modifiers declared by `\moddef` depend on the font family and they are typicaly declared in font family files, see section 2.13.11.
- Family selectors set the given font family as current and re-set data used by family-dependent font modifiers to initial values and to the currently used modifiers. They are declared in font family files by `\_famdecl` macro, see section 2.13.11.
- Font macros can be defined arbitrary by `\def` primitive by user. See an example in section 2.13.8.

All declaration commands mentioned here: `\font`, `\fontlet`, `\fontdef`, `\famvardef`, `\moddef`, `\_famdecl` and `\def` make local assignment.

2.13.5 The `\fontdef` declarator in detail

The general format for `\fontdef` usage is

`\fontdef`\⟨*font switch*⟩ `{`\⟨*family selector*⟩ ⟨*font modifiers*⟩ \⟨*variant selector*⟩`}`

where \⟨*family selector*⟩ and ⟨*font modifiers*⟩ are optional and \⟨*variant selector*⟩ is mandatory.

The `\fontdef` does following steps. It pushes current font context to a stack, it do modifications of the font context by given \⟨*family selector*⟩ and/or ⟨*font modifiers*⟩ and it find the real font by \⟨*variant selector*⟩. This font is not selected but it is assigned to the declared \⟨*font switch*⟩ (like `\font` primitive does it). Finally, `\fontdef` pops the font context stack, so the current font context is the same as it was before `\fontdef` is used.

More about `\fontdef` command including examples is written in section 2.12.3.

2.13.6 The `\famvardef` declarator

You can declare a new variant selector by the `\famvardef` macro. This macro has similar syntax as `\fontdef`:

`\famvardef`\⟨*new variant selector*⟩ `{`\⟨*family selector*⟩ ⟨*font modifiers*⟩ \⟨*variant selector*⟩`}`

where \⟨*family selector*⟩ and ⟨*font modifiers*⟩ are optional and \⟨*variant selector*⟩ is mandatory. The \⟨*new variant selector*⟩ should be used in the same sense as `\rm`, `\bf` etc. It can be used as the final command in next `\fontdef` or `\famvardef` declarators too. When the \⟨*new variant selector*⟩ is used in normal text then it does following steps: pushes current font context to a stack, modifies font context by declared \⟨*family selector*⟩ and/or ⟨*font modifiers*⟩, runs following \⟨*variant selector*⟩. This last one selects a real font. Then pops the font context stack. The new font is selected but the font context has its original values. This is main difference between `\famvardef\foo{...}` and `\def\foo{...}`.

Moreover, the `\famvardef` creates the \⟨*new variant selector*⟩ family dependent. When the selector is used in another family context than it is defined then warning is printed on the terminal "⟨*var selector*⟩ is undeclared in current family" and nothing happens. But you can declare the same variant selector by `\famvardef` macro in the context of new family. Then the same command may do different work depending on the current font family.

Suppose that the selected font family provides the font modifier `\medium` for mediate weight of fonts. Then you can declare:

```
\famvardef \mf {\medium\rm}
\famvardef \mi {\medium\it}
```

Now, you can use six independent variant selectors `\rm`, `\bf`, `\it`, `\bi`, `\mf` and `\mi` in the selected font family.

A `\`⟨*family selector*⟩ can be written before ⟨*font modifiers*⟩ in the `\famvardef` parameter. Then the `\`⟨*new variant selector*⟩ is declared in the current family but it can use fonts from another family represented by the `\`⟨*family selector*⟩.

When you are mixing fonts from more families then you probably run into problem with incompatible ex-heights. This problem can be solved using `\setfontsize` and `\famvardef` macros:

```
\fontfam[Heros]  \fontfam[Termes]

\def\exhcorr{\setfontsize{mag.88}}
\famvardef\rmsans{\Heros\exhcorr\rm}
\famvardef\itsans{\Heros\exhcorr\it}

Compare ex-height of Termes \rmsans with Heros \rm and Termes.
```

The variant selectors (declared by `\famvardef`) or font modifiers (declared by `\moddef`) are (typically) control sequences in user name space (`\mf`, `\caps`). They are most often declared in font family files and they are loaded by `\fontfam`. A conflict with such names in user name space can be here. For example: if `\mf` is defined by user and then `\fontfam[Roboto]` is used then `\famvardef\mf` is performed for Roboto family and the original meaning of `\mf` is lost. But OpTEX prints warning about it. There are two cases:

```
\def\mf{Metafont}
\fontfam[Roboto]  % warning: "The \mf is redefined by \famvardef" is printed
  or
\fontfam[Roboto]
\def\mf{Metafont} % \mf variant selector redefined by user, we suppose that \mf
                  % is used only in the meaning of "Metafont" in the document.
```

2.13.7 The `\tt` variant selector

`\tt` is additional special variant selector which is defined as "select typewriter font independently of current font family". By default, the typewriter font-face from LatinModern font family is used.

The `\tt` variant selector is used in OpTEX internal macros `\_ttfont` (verbatim texts) and `\_urlfont` (printing URL's).

You can redefine the behavior of `\tt` by `\famvardef`. For example:

```
\fontfam[Cursor]
\fontfam[Heros]
\fontfam[Termes]
\famvardef\tt{\Cursor\setff{-liga;-tlig}\rm}

Test in Termes: {\tt text}. {\Heros\rm Test in Heros: {\tt text}}.
Test in URL \url{http://something.org}.
```

You can see that `\tt` stay family independent. This is special feature only for `\tt` selector. New definition is used in `\_ttfont` and `\_urlfont` too. It is recommended to use `\setff{-liga;-tlig}` in order to supress the liguatures in typewriter fonts.

If Unicode math font is loaded then the `\tt` macro selects typewriter font-face in math mode too. This face is selected from used Unicode math font and it is independent of `\famvardef\tt` declaration.

2.13.8 Font commands defined by `\def`

Such font commands can be used as fonts selectors for titles, footnotes, ctitations etc. User can define them.

The following example shows how to define a "title-font selector". Titles are not only bigger but they are typically in bold variant. When the user puts `{\it...}` into the title text then he/she expects bold italic here, no normal italic. You can remember the great song by John Lennon "Let It Be" and define:

```
\def\titlefont{\setfontsize{at14pt}\bf \let\it\bi}
...
{\titlefont Title in bold 14pt font and {\it bold 14pt italics} too}
```

OpTEX defines similar internal commands _titfont, _chapfont, _secfont and _seccfont, see section 2.26. The commands \typosize and \boldify are used in these macros. They set the math fonts to given size too and they are defined in section 2.17.

2.13.9 Modifying font features

Each OTF font provides "font features". You can list these font features by `otfinfo -f font.otf`. For example LinLibertine fonts provide `frac` font feature. If it is active then fractions like 1/2 are printed in a special form.

The font features are part of the font context data. The macro \setff {⟨*feature*⟩} acts like family independent font modifier and prepares a new ⟨*feature*⟩. You must use a variant selector in order to reinitialize the font with the new font feature. For example \setff{+frac}\rm or \setff{+frac}\currvar. You can declare a new variant selector too:

```
\fontfam[LinLibertine]
\famvardef \fraclig {\setff{+frac}\currvar}
Compare 1/2 or 1/10 \fraclig to 1/2 or 1/10.
```

If the used font does not supports given font feature then font is realoaded without warning nor error, silently. The font feature is not activated.

The `onum` font feature (old style digits) is connected to \caps macro for Caps+SmallCaps variant in OpTEX font family files. So you need not to create a new modifier, just use {\caps\currvar 012345}.

2.13.10 Special font modifiers

Despite the font modifiers declared in the font family file (and dependent on the font family), we have following font modifiers (independent of font family):

```
\setfontsize{⟨sizespec⟩}     % sets the font size
\setff{⟨font feature⟩}       % adds the font feature
\setfontcolor{⟨color⟩}      % sets font color
\setletterspace{⟨number⟩} % sets letter spacing
\setwordspace{⟨scaling⟩}     % modifies word spacing
```

The \setfontsize command is described in the section 2.12. The \setff command was described in previous subsection.

\setfontcolor {⟨*color*⟩} specifies the color and the opacity of the text. The ⟨*color*⟩ parameter should be in hexadecimal format of four bytes ⟨*red*⟩⟨*green*⟩⟨*blue*⟩⟨*opacity*⟩, for example `FF0080FF` means full red, zero green, half blue and full opacity. You can use names `red`, `green`, `blue`, `yellow`, `cyan`, `magenta`, `white`, `grey`, `lgrey` (without backslash) instead of the hexadecimal specification. The empty parameter ⟨*color*⟩ means default black color.

That colors of fonts are implemented using LuaTEX internal font feature. This is different approach than using colors in section 2.20.

\setletterspace {⟨*number*⟩} specifies letter spacing of the font. The ⟨*number*⟩ is decimal number without unit. The unit is supposed as 1/100 of the font size. I.e. `2.5` means 0.25 pt when the font is at 10 pt size. The empty parameter ⟨*number*⟩ means no letter spacing which is default.

\setwordspace {⟨*scaling*⟩} scales the default inter word space (defined in the font) and its stretching and shrinking parameters by given ⟨*scaling*⟩ factor. For example `\setwordspace{2.5}` multiplies inter word space by 2.5.

If you need another font transformations, you can use \setff with following font features provided by LuaTEX:

```
\setff{embolden=1.5}\rm % font is bolder because outline has nonzero width
\setff{slant=0.2}\rm    % font is slanted by a linear transformation
\setff{extend=1.2}\rm   % font is extended by a linear transformation.
\setff{colr=yes}\rm     % if the font includes colored characters, use colors
```

Use font transformations mentioned above and \setletterspace, \setwordspace with care. The best setting of these values is default setting in every font, of course. If you really needs to set a different

letter spacing then it is strongly recommended to add `\setff{-liga}` in order to disable ligatures. And setting a positive letter spacing probably needs to scale inter word spacing too.

All mentioned font modifiers (with the exception of `\setfontsize`) work only with Unicode fonts loaded by `\fontfam`.

2.13.11 How to create the font family file

The font family file declares the font family for selecting fonts from such family at arbitrary size and with various shapes. Unicode fonts (OTF) are preferred. The following example declares the Heros family:

f-heros.opm

```
\_famdecl [Heros] \Heros {TeX Gyre Heros fonts based on Helvetica}
     {\caps \cond} {\rm \bf \it \bi} {FiraMath}
     {[texgyreheros-regular]}
     {\_def\_fontnamegen{[texgyreheros\_condV-\_currV]:\_capsV\_fontfeatures}}

\_wlog{\_detokenize{%
Modifiers:^^J
 \caps ..... caps & small caps^^J
 \cond ..... condensed variants^^J
}}

\_moddef \resetmod {\_fsetV caps={},cond={} \_fvars regular bold italic bolditalic }
\_moddef \caps     {\_fsetV caps=+smcp;+onum; }
\_moddef \nocaps   {\_fsetV caps={} }
\_moddef \cond     {\_fsetV cond=cn }
\_moddef \nocond   {\_fsetV cond={} }

\_initfontfamily % new font family must be initialized

\_loadmath {[FiraMath-Regular]}
```

If you want to write such font file, you need to keep following rules.

- Use the `\_famdecl` command first. It has the following syntax:

  `\_famdecl` `[`⟨*Name of family*⟩`]` `\`⟨*Familyselector*⟩ `{`⟨*comments*⟩`}`
  `{`⟨*modifiers*⟩`}` `{`⟨*variant selectors*⟩`}` `{`⟨*comments about math fonts*⟩`}`
  `{`⟨*font-for-testing*⟩`}`
  `{\_def\_fontnamegen{`⟨*font name or font file name generated*⟩`}}`

  This writes information about font family at the terminal and prevents loading such file twice. Moreover, it probes existence of ⟨*font-for-testing*⟩ in your system. If it doesn't exist, the file loading is skipped with a warning on the terminal. The `\_ifexistfam` macro returns false in such case. The `\_fontnamegen` macro must be defined in the last parameter of the `\_famdecl`. More about it is documented below.
- You can use `\_wlog{\_detokenize{...` to write additional information into log file.
- You can declare optical sizes using `\_regoptsizes` if there are more font files with different optical sizes (like in Latin Modern). See `f-lmfonts.opm` file for more information about this special feature.
- Declare font modifiers using `\moddef` if they are present. The `\resetmod` must be declared in each font family.
- Check if all your declared modifiers does not produce any space in horizontal mode. For example check: `X\caps Y`, the letters `XY` must be printed without any space.
- Optionally, declare new variants by the `\famvardef` macro.
- Run `\_initfontfamily` in order to start the family (it is mandatory).
- If math font should be loaded, use `\_loadmath{`⟨*math font*⟩`}`.

The `\_fontnamegen` macro (declared in the last parameter of the `\_famdecl`) must expand (at expand processor level only) to a file name of loaded font (or to its font name) and to optional font features appended. The Font Selection System uses this macro at primitive level in the following sense:

```
\font \<selector> {\_fontnamegen} \_sizespec
```

Note that the extended `\font` syntax `\font\`⟨*selector*⟩ `{`⟨*font name*⟩`:`⟨*font features*⟩`}` ⟨*size spec.*⟩ or `\font\`⟨*selector*⟩ `{[`⟨*font file name*⟩`]:`⟨*font features*⟩`}` ⟨*size spec.*⟩ is expected here.

Example 1
Assume an abstract font family with fonts `xx-Regular.otf`, `xx-Bold.otf`, `xx-Italic.otf` and `xx-BoldItalic.otf`. Then you can declare the `\resetmod` (for initializing the family) by:

```
\_moddef\resetmod{\_fvars Regular Bold Italic BoldItalic }
```

and define the `\_fontnamegen` in the last parameter of the `\_famdecl` by:

```
\_famdecl ...
    {\def\_fontnamegen{[xx-\_currV]}}
```

The following auxiliary macros are used here:

- `\moddef` declares the family dependent modifier. The `\resetmod` saves initial values for the family.
- `\_fvars` saves four names to the memory, they are used by the `\_currV` macro.
- `\_currV` expands to one of the four names dependent on `\rm` or `\bf` or `\it` or `\bi` variant is required.

Assume that the user needs `\it` variant in this family. Then the `\_fontnamegen` macro expands to `[xx-\_currV]` and it expands to `[xx-Italic]`. The Font Selection System uses `\font {[xx-Italic]}`. This command loads the `xx-Italic.otf` font file.

See more advanced examples are in `f-`⟨*family*⟩`.opm` files.

Example 2
The `f-heros.opm` is listed here. Look at it. When Heros family is selected and `\bf` is asked then `\font {[texgyreheros-bold]:+tlig;} at10pt` is processed.

You can use any expandable macros or expandable primitives in the `\_fontnamegen` macro. The simple macros in our example with names `\_`⟨*word*⟩`V` are preferred. They expand typically to their content. The macro `\_fsetV` ⟨*word*⟩=⟨*content*⟩ (terminated by a space) is equivalent to `\def\_`⟨*word*⟩`V{`⟨*content*⟩`}` and you can use it in font modifiers. You can use the `\_fsetV` macro in more general form:

`\_fsetV` ⟨*word-a*⟩=⟨*value-a*⟩`,`⟨*word-b*⟩=⟨*value-b*⟩ `...etc. terminated by a space`

with obvious result `\def\_`⟨*word-a*⟩`V {`⟨*value-a*⟩`}\def\_`⟨*word-b*⟩`V {`⟨*value-b*⟩`}` etc.

Example 3
If both font modifiers `\caps`, `\cond` were applied in Heros family, then `\def\_capsV{+smcp;+onum}` and `\def\_condV{cn}` were processed by these font modifiers. If user needs the `\bf` variant at 11 pt now then the

```
\font {[texgyreheroscn-bold]:+smcp;+onum;+tlig;} at11pt
```

is processed. We assume that a font file `texgyreheroscn-bold.otf` is present in your TEX system.

The `\_onlyif` macro
has the syntax `\_onlyif` ⟨*word*⟩=⟨*value-a*⟩`,`⟨*value-b*⟩`,...`⟨*value-n*⟩`: {`⟨*what*⟩`}`. It can be used inside `\moddef` as simple IF statement: the ⟨*what*⟩ is processed only if ⟨*word*⟩ has ⟨*value-a*⟩ or ⟨*value-b*⟩ ... or ⟨*value-n*⟩. See `f-roboto.opm` for examples of usage of many `\_onlyif`'s.

Recommendation: use the `\_fontfeatures` macro at the end of the `\_fontnamegen` macro in order to the `\setff`, `\setfontcolor`, `\setletterspace` macros can work.

The `\moddef` macro
has the syntax `\moddef\<modifier>{`⟨*what to do*⟩`}`. It does more things than simple `\_def`:

- The modifier macros are defined as `\_protected`.
- The modifier macros are defined as family-dependent.
- If the declared control sequence is defined already (and it is not font modifier) then it is re-defined with warning.

The `\famvardef` macro has the same features.

The `\`⟨*Familyselector*⟩ is defined by the `\_famdecl` macro as:

```
\protected\def\⟨Familyselector⟩ {%
   \_def\_currfamily {⟨Familyselector⟩}%
   \_def\_fontnamegen {...}% this is copied from 7-th parameter of \_famdecl
   \resetmod
   ⟨run all family-dependent font modifiers used before Familyselector without warnings⟩
```

The _initfontfamily
must be run after modifers decaration. It runs the \⟨*Familyselector*⟩ and it runs _rm, so first font from new family is loaded and it is ready to use it.

Name conventions
Create font modifiers, new variants and the \⟨*Familyselector*⟩ only as public, i.e. in user name space without _ prefix. We assume that if user re-defines them then he/she needs not them, so we have no problems. If user's definition done before loading font family file is re-defined then OpTEX warns about it. See the end of section 2.13.4.

The name of \⟨*Familyselector*⟩ should begin with uppercase letter.

Please, look at OpTEX font catalogue before you will create your own font family file and use the same names for analogical font modifiers (like \cond, \caps, \sans, \mono etc.) and for extra variant selectors (like \lf, \li, \kf, \ki etc. used in Roboto font family).

If you are using the same font modifier names to analogical font shapes then such modifiers are kept when family is changend. For example:

```
\fontfam [Termes] \fontfam[Heros]
\caps\cond\it Caps+Cond italic in Heros \Termes\currvar Caps italic in Termes.
```

The family selector first resets all modifiers data by \resetmod and then it tries to run all currently used family-dependent modifiers before the family switching (without warnings if such modifier is unavailable in the new family). In this example, \Termes does \resetmod followed by \caps\cond. The \caps is applied and \cond is silently ignored in Termes family.

If you need to declare your private modifier (because it is used in another modifiers or macros, for example), use the name _wordM. You can be sure that such name does not influence the private name space used by OpTEX.

Additional notes
See the font family file f-libertine-s.opm which is another example where no font files but font names are used.

See the font family file f-lmfonts.opm or f-poltawski.opm where you can find the the example of the optical sizes declaration including a documentation about it.

If you need to create font family file with non-Unicode font, you can do it. The _fontnamegen must expand to the name of TFM file in such case. But we don't prefer such font family files, because they are usable only with languages with alphabet subset to ISO-8859-1 (Unicodes are equal to letter codes of such alphabets), but middle or east Europe use languages where such condition is not true.

2.13.12 How to write the font family file with optical sizes

You can use _optname macro when _fontnamegen in expanded. This macro is fully expandable and its input is ⟨*internal-template*⟩ and its output is a part of the font file name ⟨*size-dependent-template*⟩ with respect to given optical size.

You can declare a collection of ⟨*size-dependent-template*⟩s for one given ⟨*internal-template*⟩ by the _regoptsizes macro. The syntax is shown for one real case:

```
\_regoptsizes lmr.r lmroman?-regular
    5 <5.5 6 <6.5 7 <7.5 8 <8.5 9 <9.5 10 <11.1 12 <15 17 <*
```

In general:

_regoptsizes ⟨*internal-template*⟩ ⟨*general-ouput-template*⟩ ⟨*resizing-data*⟩

Suppose our example above. Then _optname{lmr.r} expands to lmroman?-regular where the question mark is substituted by a number depending on current _optsize. If the _optsize lies between two boundary values (they are prefixed by < character) then the number written between them is used. For example if $11.1 < \_optsize \leq 15$ then 12 is substituted instead question mark. The ⟨*resizing-data*⟩ virtually begins with zero <0, but it is not explicitly written. The right part of ⟨*resizing-data*⟩ must be terminated by <* which means "less than infinity".

If _optname gets an argument which is not registered ⟨*internal-template*⟩ then it expands to _failedoptname which typically ends to error message about missing font. You can redefine _failedoptname macro to some existing font if you find it useful.

We are using a special macro _LMregfont in f-lmfonts.opm. It sets the file names to lowercase and enables to use a shortcasts isntead real ⟨*resizing-data*⟩. There are shortcats _regoptFS, _regoptT,

etc. here. The collection of ⟨*internal-templates*⟩ are declared, each of them covers a collection of real file names.

The `\_optfontalias {`⟨*new-template*⟩`} {`⟨*internal-template*⟩`}` declares ⟨*new-template*⟩ with the same meaning as previously declared ⟨*internal-template*⟩.

The `\_optname` macro can be used even if no otical sizes are provided by a font family. Suppose that font file names are much more chaotic (because artists are very creative people), so you need to declare more systematic ⟨*internal-templates*⟩ and do an alias from each ⟨*internal-template*⟩ to ⟨*real-font-name*⟩. For example, you can do it as follows:

```
\def\fontalias #1 #2 {\_regoptsizes #1 ?#2 {} <*}
%          alias name           real font name
\fontalias crea-a-regular       {Creative Font}
\fontalias crea-a-bold          {Creative FontBold}
\fontalias crea-a-italic        {Creative olique}
\fontalias crea-a-bolditalic    {Creative Bold plus italic}
\fontalias crea-b-regular       {Creative Regular subfam}
\fontalias crea-b-bold          {Creative subfam bold}
\fontalias crea-b-italic        {Creative-subfam Oblique}
\fontalias crea-b-bolditalic    {Creative Bold subfam Oblique}
```

Another example of font family with optical sizes is Antykwa Półtawskiego. The optical sizes feature is deactivated by default and it is switched on by `\osize` font modifier:

f-poltawski.opm

```
\_famdecl [Poltawski] \Poltawski {Antykwa Poltawskiego, Polish traditional font family}
      {\light \noexpd \expd \eexpd \cond \ccond \osize \caps} {\rm \bf \it \bi} {}
      {[antpolt-regular]}
      {\_def\_fontnamegen {[antpolt\_liV\_condV-\_currV]\_capsV\_fontfeatures}}

\_wlog{\_detokenize{%
Modifiers:^^J
 \light ..... light weight, \bf,\bi=semibold^^J
 \noexpd .... no expanded, no condensed, designed for 10pt size (default)^^J
 \eexpd ..... expanded, designed for 6pt size^^J
 \expd ...... semi expanded, designed for 8pt size^^J
 \cond ...... semi condensed, designed for 12pt size^^J
 \ccond ..... condensed, designed for 17pt size^^J
 \osize ..... auto-sitches between \ccond \cond \noexpd \expd \eexpd by size^^J
 \caps ...... caps & small caps^^J
}}

\_moddef \resetmod {\_fsetV li={},cond={},caps={} \_fvars regular bold italic bolditalic }
\_moddef \light    {\_fsetV li=lt }
\_moddef \noexpd   {\_fsetV cond={} }
\_moddef \eexpd    {\_fsetV cond=expd }
\_moddef \expd     {\_fsetV cond=semiexpd }
\_moddef \cond     {\_fsetV cond=semicond }
\_moddef \ccond    {\_fsetV cond=cond }
\_moddef \caps     {\_fsetV caps=+smcp;+onum; }
\_moddef \nocaps   {\_fsetV caps={} }
\_moddef \osize    {\_def\_fontnamegen{[antpolt\_liV\_optname{x}-\_currV]:\_capsV\_fontfeatures}%
                    \_regoptsizes x ? expd <7 semiexpd <9 {} <11.1 semicond <15 cond <*}

\_initfontfamily % new font family must be initialized
```

2.13.13 How to register the font family in the Font Selection System

Once you have prepared a font family file with the name `f-`⟨*famname*⟩`.opm` and TEX is able to see it in your filesystem then you can type `\fontfam[`⟨*famname*⟩`]` and the file is read, so the information about the font family is loaded. The name ⟨*famname*⟩ must be lowercase and without spaces in the file name `f-`⟨*famname*⟩`.opm`. On the other hand the `\fontfam` command is more tolerant: you can write uppercase letters and spaces here. The spaces are ignored and uppercase letters are converted to lowercase. For example `\fontfam [LM Fonts]` is equivalent to `\fontfam [LMfonts]` and both commands load the file `f-lmfonts.opm`.

You can use your font file in sense of previous paragraph without registering it. But problem is that such families are not listed when `\fontfam[?]` is used and it is not included in font catalogue when

`\fontfam[catalog]` is printed. The list of families taken in the catalogue and listed on the terminal is declared in two files: `fams-ini.opm` and `fams-local.opm`. The second file is optional. User can create it and write to it the information about user-defined families using the same syntax as in existed file `fams-ini.opm`.

The information from the user's `fams-local.opm` file has precedence. For example `fams-ini.opm` declares aliases Times→Termes etc. If you have the original Times purchased from Adobe then you can register your declaration of Adobe's Times family in `fams-local.opm`. When a user writes `\fontfam[Times]` then the original Times (not Termes) is used.

The `fams-ini.opm` and `fams-local.opm` files use the macros `\_famifo`, `\_famalias` and `\_famtext`. See the example from `fams-ini.tex`:

fams-ini.opm

```
% Version <2020-02-28>. Loaded in format and secondly on demand by \fontfam[catalog]

\_famtext {Special name for printing a catalogue:}

\_faminfo [Catalogue] {Catalogue of all registered font families} {fonts-catalog} {}
\_famalias [Catalog]

\_famtext {Computer Modern like family:}

\_famfrom {GUST}
\_faminfo [Latin Modern] {TeX Gyre fonts based on Coputer Modern} {f-lmfonts}
   { -,\nbold,\sans,\sans\nbold,\slant,\ttset,\ttset\slant,\ttset\caps,%
       \ttprop,\ttprop\bolder,\quotset: {\rm\bf\it\bi}
       \caps: {\rm\it}
       \ttlight,\ttcond,\dunhill: {\rm\it} \upital: {\rm} }
\_famalias [LMfonts] \_famalias [Latin Modern Fonts] \_famalias [lm]

\_famtext {TeX Gyre fonts based on Adobe 35:}

\_faminfo [Termes] {TeX Gyre Termes fonts based on Times} {f-termes}
   { -,\caps: {\rm\bf\it\bi} }
\_famalias [Times]

\_faminfo [Heros] {TeX Gyre Heros fonts based on Helvetica} {f-heros}
   { -,\caps,\cond,\caps\cond: {\rm\bf\it\bi} }
\_famalias [Helvetica]
```

... etc.

The `\_faminfo` commad has the syntax:

`\_faminfo [`⟨*Family Name*⟩`] {`⟨*comments*⟩`} {`⟨*file-name*⟩`}`
`{ `⟨*mod-plus-vars*⟩` }`

The ⟨*mod-plus-vars*⟩ data is used only when printing catalogue. It consists with one or more pairs ⟨*mods*⟩`: {`⟨*vars*⟩`}`. For each pair: each modifiers (separated by comma) is applied to each variant selector in ⟨*vars*⟩ and prepared samples are printed. The `-` character means no modifiers should be applied.

The `\_famalias` declares an alias to the last declared family.

The `\_famtext` writes a line to the terminal and to the log file when all families are listed.

The `\_famfrom` saves the information about font type foundry or manufacturer or designer or license owner. You can use it before `\_faminfo` in order to print `\_famfrom` info into the catalogue. The `\_famfrom` data is applied to each following declared families until new `\_famfrom` is given. Use `\_famfrom {}` if the information is not known.

2.13.14 Notices about extension of `\font` primitive

Unicode fonts are dealed by extended `\font` primitive. This extension is not activated in OpTEX by default, `\initunifonts` macro activates it. You need not to use `\initunifonts` explicitly if `\fontfam` macro is used because `\fontfam` runs it internally.

The `\initunifonts` loads the lua code from Luaotfload package which actually implements the `\font` primitive extension. See its documentation `luaotfload-latex.pdf` for information about all possibilities of extended `\font` primitive.

The OpTEX format is initialized by `luatex` engine by default but you can initialize it by `luahbtex` engine too. Then the harfbuzz library is ready to use for font rendering as an alternative of build-in

font renderer from Luaotfload. The harfbuzz library gives more features for rendering indic and arabic scripts. But it is not used as default, you need to specify `mode=harf` in fontfeatures field when `\font` is used. Moreover, when `mode=harf` is used, then you must specify `script` too. For example

```
\font\devafont=[NotoSansDevanagari-Regular]:mode=harf;script=dev2
```

If `luahbtex` engine is not used then `mode=harf` is ignored. See Luaotfload documentation for more information.

2.13.15 Implementation of the Font Selection System

fonts-select.opm

```
\_codedecl \fontfam {Fonts selection system <2020-12-12>} % preloaded in format
```

\initunifonts macro extends LuaTEX's font capabalities, in order to be able to load Unicode fonts. Unfortunately, this part of OpTEX depends on `luaotfload` package, which adapts ConTEXt's generic font loader for plain TEX and LATEX. `luaotfload` uses Lua functions from LATEX's `luatexbase` namespace, we provide our own replacements. Moreover, `\initunifont` switches with the _doresizefont macro to OTF mode which is represented by the macro _doresizeunifont. This mode includes a fallback to TFM mode if _fontnamegen is not defined. Finally, `\initunifonts` sets itself to relax because we don't want to do this work twice.

fonts-select.opm

```
\_def\_initunifonts {%
   \directlua{%
      require('luaotfload-main')
      print_bak = print
      print = function () end
      luaotfload.main()
      print = print_bak % "print hack" until luaotfload will be corrected
   }%
   \_gdef\_rfskipatX ##1" ##2\_relax{"##1"}%
   \_global\_let \_doresizefont=\_doresizeunifont
   \_gdef\_tryloadtt {\_fontdef\_tentt{\_def\_fontnamegen{[lmmono10-regular]}\_rm}}%
   \_global\_let \_initunifonts=\_relax % we need not to do this work twice
   \_global\_let \initunifonts=\_relax
}
\_gdef\_doresizeunifont #1{\_logfont{#1}%
   \_ifx\_fontnamegen\_undefined \_doresizetfmfont#1\_else
       \_font#1={\_fontnamegen} \_sizespec \_relax \_setwsp#1\_relax
   \_fi
}
\_public \initunifonts ;
```

The _famdecl `[`⟨*Family Name*⟩`]` \⟨*Famselector*⟩ `{`⟨*comment*⟩`}` `{`⟨*modifiers*⟩`}` `{`⟨*variants*⟩`}` `{`⟨*math*⟩`}` `{`⟨*font for testing*⟩`}` `{\def\_fontnamegen{`⟨*data*⟩`}}` runs `\initunifonts`, then checks if \⟨*Famselector*⟩ is defined. If it is true, then closes the file by `\endinput`. Else it defines \⟨*Famselector*⟩ and saves it to the internal `\_f:`⟨*currfamily*⟩`:main.fam` command. The macro _initfontfamily needs it. The _currfamily is set to the ⟨*Famselector*⟩ because the following `\moddef` commands need to be in the right font family context. The `\_currfamily` is set to the ⟨*Famselector*⟩ by the \⟨*Famselector*⟩ too, because \⟨*Famselector*⟩ must set the right font family context. The font family context is given by the current `\_currfamily` value and by the actual meaning of the _fontnamegen macro. The _mathfaminfo is saved for usage in the catalogue.

fonts-select.opm

```
\_def\_famdecl [#1]#2#3#4#5#6#7#8{%
   \_initunifonts \_uniaccents
   \_unless\_ifcsname _f:\_csstring#2:main.fam\_endcsname
      \_isfont{#7}\_iffalse
         \_opwarning{Family [#1] skipped, font "#7" not found}\_ea\_ea\_ea\_endinput \_else
         \_edef\_currfamily {\_csstring #2}\_def\_mathfaminfo{#6}%
         \_wterm {FONT: [#1] -- \_string#2 \_detokenize{(#3)^^J mods:{#4} vars:{#5} math:{#6}}}%
         \_unless \_ifx #2\_undefined
            \_opwarning{\_string#2 is redefined by \_string\_famdecl\_space[#1]}\_fi
         \_protected\_edef#2{\_def\_noexpand\_currfamily{\_csstring #2}\_unexpanded{#8\_resetfam}}%
         \_ea \_let \_csname _f:\_currfamily:main.fam\_endcsname =#2%
      \_fi
   \_else \_csname _f:\_csstring#2:main.fam\_endcsname \_reloading \_rm \_ea \_endinput \_fi
}
```

```
\_def\_initfontfamily{%
   \_csname _f:\_currfamily:main.fam\_endcsname \_reloading \_rm
}
```

`\_regoptsizes` ⟨*internal-template*⟩ ⟨*left-output*⟩`?`⟨*right-output*⟩ ⟨*resizing-data*⟩ prepares data for using by the `\_optname` ⟨*internal-template*⟩ macro. The data are saved to the `\_oz:`⟨*internal-template*⟩ macro. When the `\_optname` is expanded then the data are scanned by the macro `\_optnameA` ⟨*left-output*⟩`?`⟨*right-output*⟩ ⟨*mid-output*⟩ `<`⟨*size*⟩ in the loop.
`\_optfontalias {`⟨*template A*⟩`}{`⟨*template B*⟩`}` is defined as `\let\_oz:`⟨*templateA*⟩`=\_oz:`⟨*templateB*⟩.

fonts-select.opm

```
\_def\_regoptsizes #1 #2?#3 #4*{\_sdef{_oz:#1}{#2?#3 #4* }}
\_def\_optname #1{\_ifcsname _oz:#1\_endcsname
   \_ea\_ea\_ea \_optnameA \_csname _oz:#1\_ea\_endcsname
   \_else \_failedoptname{#1}\_fi
}
\_def\_failedoptname #1{optname-fails:(#1)}
\_def\_optnameA #1?#2 #3 <#4 {\_ifx*#4#1#3#2\_else
   \_ifdim\_optsize<#4pt #1#3#2\_optnameC
   \_else \_afterfifi \_optnameA #1?#2 \_fi\_fi
}
\_def\_optnameC #1* {\_fi\_fi}
\_def\_afterfifi #1\_fi\_fi{\_fi\_fi #1}
\_def\_optfontalias #1#2{\_slet{_oz:#1}{_oz:#2}}
```

`\_fvars` ⟨*rm-template*⟩ ⟨*bf-template*⟩ ⟨*it-template*⟩ ⟨*bi-template*⟩ saves data for usage by the `\_currV` macro. If a template is only dot then previous template is used (it can be used if the font family doesn't dispose with all standard variants).
`\_currV` expands to a template declared by `\_fvars` depending on the ⟨*variant name*⟩. Usable only of standard four variants. Next variants can be declared by the `\famvardef` macro.
`\_fsetV` ⟨*key*⟩`=`⟨*value*⟩`,...,`⟨*key*⟩`=`⟨*value*⟩ expands to `\def\_`⟨*key*⟩`V{`⟨*value*⟩`}` in the loop.
`\_onlyif` ⟨*key*⟩`=`⟨*value-a*⟩`,`⟨*value-b*⟩`...,`⟨*value-z*⟩`: {`⟨*what*⟩`}` runs ⟨*what*⟩ only if the `\_`⟨*key*⟩`V` is defined as ⟨*value-a*⟩ or ⟨*value-b*⟩ or ... or ⟨*value-z*⟩.
`\_prepcommalist ab,{},cd,\_end,` expands to `ab,,cd,` (auxiliary macro used in `\_onlyif`).

fonts-select.opm

```
\_def\_fvars #1 #2 #3 #4 {%
   \_sdef{_fvar:rm}{#1}%
   \_sdef{_fvar:bf}{#2}%
   \_ifx.#2\_slet{_fvar:bf}{_fvar:rm}\_fi
   \_sdef{_fvar:it}{#3}%
   \_ifx.#3\_slet{_fvar:it}{_fvar:rm}\_fi
   \_sdef{_fvar:bi}{#4}%
   \_ifx.#4\_slet{_fvar:bi}{_fvar:it}\_fi
}
\_def\_currV{\_cs{_fvar:\_whatresize}}
\_def\_V{ }
\_def \_fsetV #1 {\_fsetVa #1,=,}
\_def \_fsetVa #1=#2,{\_isempty{#1}\_iffalse
   \_ifx,#1\_else\_sdef{_#1V}{#2}\_ea\_ea\_ea\_fsetVa\_fi\_fi
}
\_def \_onlyif #1=#2:#3{%
    \_edef\_act{\_noexpand\_isinlist{,\_prepcommalist #2,\_end,}{,\_cs{_#1V},}}\_act
    \_iftrue #3\_fi
}
\_def\_prepcommalist#1,{\_ifx\_end#1\_empty\_else #1,\_ea\_prepcommalist\_fi}
```

The `\moddef` `\`⟨*modifier*⟩ `{`⟨*data*⟩`}` simply speaking does `\def\`⟨*modifier*⟩`{`⟨*data*⟩`}`, but we need to respect the family context. In fact, `\protected\def\_f:`⟨*current family*⟩`:`⟨*modifier*⟩`{`⟨*data*⟩`}` is performed and the `\`⟨*modifier*⟩ is defined as `\_famdepend\`⟨*modifier*⟩`{_f:\_currfamily:`⟨*modifier*⟩`}`. It expands to `\_f:\_currfamily:`⟨*modifier*⟩ value if it is defined or it prints warning. When the `\_currfamily` value is changed then we can declare the same `\`⟨*modifier*⟩ with different meaning.

When user declare a prefixed variant of the `\`⟨*modifier*⟩ then unprefixed modifier name is used in internal macros, this is reason why we are using the `\_remifirstunderscore\_tmp` (where `\_tmp` expands to `_`⟨*something*⟩ or to ⟨*something*⟩. The `\_remifirstunderscore` redefines `\_tmp` in the way that it expands only to ⟨*something*⟩ without the first `_`.

`\_setnewmeaning` ⟨*cs-name*⟩`=\_tmpa` ⟨*by-what*⟩ does exactly `\_let` ⟨*csname*⟩`=\_tmpa` but warning is printed if ⟨*cs-name*⟩ is defined already and it is not a variant selector or font modifier.

`\_addtomodlist` ⟨*font modifier*⟩ adds given modifier to `\_modlist` macro. This list is used after `\resetmod` when new family is selected by a family selector, see `\_resetfam` macro. This allows to reinitialize the same current modifiers in the font context after family is changed.

fonts-select.opm

```
\_def \_moddef #1#2{\_edef\_tmp{\_csstring#1}%
   \_sdef{_f:\_currfamily:\_tmp}{\_addtomodlist#1#2\_reloading}%
   \_protected \_edef \_tmpa{\_noexpand\_famdepend\_noexpand#1{_f:\_noexpand\_currfamily:\_tmp}}%
   \_setnewmeaning #1=\_tmpa \moddef
}
\_protected \_def\_resetmod {\_cs{_f:\_currfamily:resetmod}} % private variant of \resetmod
\_def \_resetfam{\_def\_addtomodlist##1{}\_resetmod
   \_edef \_modlist{\_ea}\_modlist
   \_let\_addtomodlist=\_addtomodlistb
}
\_def \_currfamily{} % default current family is empty
\_def \_modlist{}    % list of currently used modifiers

\_def \_addtomodlist#1{\_addto\_modlist#1}
\_let \_addtomodlistb=\_addtomodlist

\_def\_famdepend#1#2{\_ifcsname#2\_endcsname \_csname#2\_ea\_endcsname \_else
   \_ifx\_addtomodlist\_addtomodlistb
      \_opwarning{\_string#1 is undeclared in family "\_currfamily", ignored}\_fi\_fi
}
\_def\_setnewmeaning #1=\_tmpa#2{%
   \_ifx #1\_undefined \_else \_ifx #1\_tmpa \_else
      \_opwarning{\_string#1 is redefined by \_string#2}%
   \_fi\_fi
   \_let#1=\_tmpa
}
\_public \moddef ;
```

The `\famvardef` `\`⟨*XX*⟩ `{`⟨*data*⟩`}` uses analogical trick like `\moddef` with the `\_famdepend` macro. The auxiliary `\_famvardefA` `\`⟨*XX*⟩ `\_ten`⟨*XX*⟩ `\_tryload`⟨*XX*⟩ `{`⟨*data*⟩`}` is used. It does:

- `\def \_tryload:`⟨*currfam*⟩`:`⟨*XX*⟩ `{\fontdef \_ten`⟨*XX*⟩ `{`⟨*data*⟩`}}` loads font `\_ten`⟨*XX*⟩,
- `\protected\def \`⟨*XX*⟩ `{\_famdepend \`⟨*XX*⟩ `{_f:`⟨*currfam*⟩`:`⟨*XX*⟩`}}`,
- `\def \_f:`⟨*currfam*⟩`:`⟨*XX*⟩ `{\_tryload:`⟨*currfam*⟩`:`⟨*XX*⟩`\_ten`⟨*XX*⟩`}` keeps family dependent definition,
- `\def \_currvar:_ten`⟨*XX*⟩ `{\`⟨*XX*⟩`}` in order to the `\currvar` macro work correctly.

`\famvardef\tt` behaves somewhat differently: it doesn't re-define the `\tt` macro which is defined as `\_tryloadtt \_tentt` in sections 2.14 and 2.16.2. It only re-defines the internal `\_tryloadtt` macro.

fonts-select.opm

```
\_def\_famvardef#1{\_edef\_tmp{\_csstring#1}%
   \_ea\_famvardefA \_ea#1\_csname _ten\_tmp\_ea\_endcsname
      \_csname _tryload:\_currfamily:\_tmp\_endcsname
}
\_def\_famvardefA #1#2#3#4{% #1=\XX #2=\_tenXX #3=\_tryload:currfam:XX #4=data
   \_isinlist{.\_rm\_bf\_it\_bi\currvar\_currvar}#1\_iftrue
      \_opwarning{\_string\famvardef:
         You cannot re-declare standard variant selector \_string#1}%
   \_else
      \_def#3{\_fontdef#2{#4}}%
      \_protected\_edef\_tmpa{\_noexpand\_famdepend\_noexpand#1{_f:\_noexpand\_currfamily:\_tmp}}%
      \_ifx #1\_tt \_let\_tryloadtt=#3\_else \_setnewmeaning #1=\_tmpa \famvardef \_fi
      \_sdef{_f:\_currfamily:\_tmp}{#3#2}%
      \_sdef{_currvar:\_csstring#2}{#1}%
   \_fi
}
\_public \famvardef ;
```

The `\fontfam` `[`⟨*Font Family*⟩`]` does:

- Convert its parameter to lower case and without spaces, e.g. ⟨*fontfamily*⟩.
- If the file `f-`⟨*fontfamily*⟩`.opm` exists read it and finish.
- Try to load user defined `fams-local.opm`.
- If the ⟨*fontfamily*⟩ is declared in `fams-local.opm` or `fams-ini.opm` read relevant file and finish.
- Print the list of declared families.

The `fams-local.opm` is read by the `\_tryloadfamslocal` macro. It sets itself to `\_relax` because we need not to load this file twice. The `\_listfamnames` macro prints registered font families to the terminal and to the log file.

fonts-select.opm

```
\_def\_fontfam[#1]{%
   \_lowercase{\_edef\_famname{\_ea\_removespaces #1 {} }}%
   \_isfile {f-\_famname.opm}\_iftrue \_opinput {f-\_famname.opm}%
   \_else
      \_tryloadfamslocal
      \_edef\_famfile{\_trycs{_famf:\_famname}{}}%
      \_ifx\_famfile\_empty \_listfamnames
      \_else \_opinput {\_famfile.opm}%
   \_fi\_fi
}
\_def\_tryloadfamslocal{%
   \_isfile {fams-local.opm}\_iftrue
      \_opinput {fams-local.opm}\_famfrom={}%
   \_fi
   \_let \_tryloadfamslocal=\_relax  % need not to load fams-local.opm twice
}
\_def\_listfamnames {%
   \_wterm{===== List of font families ======}
   \_begingroup
      \_let\_famtext=\_wterm
      \_def\_faminfo [##1]##2##3##4{%
         \_wterm{ \_space\_noexpand\fontfam [##1] -- ##2}%
      \_let\_famalias=\_famaliasA}%
      \_opinput {fams-ini.opm}%
      \_isfile {fams-local.opm}\_iftrue \_opinput {fams-local.opm}\_fi
      \_message{^^J}%
   \_endgroup
}
\_def\_famaliasA{\_message{ \_space\_space\_space\_space -- alias:}
   \_def\_famalias[##1]{\_message{[##1]}}\_famalias
}
\_public \fontfam ;
```

When the `fams-ini.opm` or `fams-local.opm` files are read then we need to save only a mapping from family names or alias names to the font family file names. All other information is ignored in this case. But if these files are read by the `\_listfamnames` macro or when printing a catalog then more infrormation is used and printed.

`\_famtext` does nothing or prints the text on the terminal.

`\_faminfo` [⟨*Family Name*⟩] {⟨*comments*⟩} {⟨*file-name*⟩} {⟨*mod-plus-vars*⟩} does `\_def \_famf:`⟨*familyname*⟩ {⟨*file-name*⟩} or prints information on the terminal.

`\_famalias` [⟨*Family Alias*⟩] does `\def \_famf:`⟨*familyalias*⟩ {⟨*file-name*⟩} where ⟨*file-name*⟩ is stored from the previous `\_faminfo` command. Or prints information on the terminal.

`\_famfrom` declares type foundry or owner or designer of the font family. It can be used in `fams-ini.opm` or `fams-local.opm` and it is printed in the font catalog.

fonts-select.opm

```
\_def\_famtext #1{}
\_def\_faminfo [#1]#2#3#4{%
   \_lowercase{\_edef\_tmp{\_ea\_removespaces #1 {} }}%
   \_sdef{_famf:\_tmp}{#3}%
   \_def\_famfile{#3}%
}
\_def\_famalias [#1]{%
   \_lowercase{\_edef\_famname{\_ea\_removespaces #1 {} }}%
   \_sdef{_famf:\_famname\_ea}\_ea{\_famfile}%
}
\_newtoks\_famfrom
\_input fams-ini.opm
\_let\_famfile=\_undefined
\_famfrom={}
```

When the `\fontfam[catalog]` is used then the file `fonts-tatalog.opm` is read. The macro `\_faminfo` is redefined here in order to print catalog samples of all declared modifiers/variant pairs. The user can declare different samples and different behavior of the catalog, see the end of catalog listing for

more information. The default parameters \catalogsample, \catalogmathsample, \catalogonly and \catalogexclude of the catalog are declared here.

fonts-select.opm

```
\_newtoks \_catalogsample
\_newtoks \_catalogmathsample
\_newtoks \_catalogonly
\_newtoks \_catalogexclude
\_catalogsample={ABCDabcd Qsty fi fl áéíóúüů řžč ÁÉÍÓŰ ŘŽČ 0123456789}

\_public \catalogonly \catalogexclude \catalogsample \catalogmathsample ;
```

The font features are managed in the _fontfeatures macro. They have their implicit values saved in the _defaultfontfeatures and the \setff {⟨*features*⟩} can add next font features. If there is the same font feature as the newly added one then the old value is removed from the _fontfeatures list.

fonts-select.opm

```
\_def \_defaultfontfeatures {+tlig;}
\_def \_setff #1{%
   \_ifx^#1^\_let \_fontfeatures=\_defaultfontfeatures
   \_else \_edef\_fontfeatures{\_fontfeatures #1;}\_fi
   \_reloading
}
\_setff {} % default font features: +tlig;
\_def\_removefeature #1{%
    \_isinlist\_fontfeatures{#1}\_iftrue
        \_def\_tmp ##1#1##2;##3\_relax{\_def\_fontfeatures{##1##3}}%
        \_ea \_tmp \_fontfeatures \_relax
    \_fi
}
\_public \setff ;
```

The \setfontcolor and \setletterspace are macros based on the special font features provided by LuaTEX (and by XETEX too but it is not our business). The \setwordspace recalulates the \fontdimen2,3,4 of the font using the \setwsp macro which is used by the _doresizeunifont macro. It activates a dummy font feature +Ws too in order the font is reloded by the \font primitive (with independent \fontdimen registers).

fonts-select.opm

```
\_def\_savedfontcolor{}
\_def\_savedletterspace{}
\_def\_savedwsp{}

\_def \_setfontcolor #1{\_removefeature{color=}%
    \_edef\_tmp{\_calculatefontcolor{#1}}%
    \_ifx\_tmp\_empty \_else \_edef\_fontfeatures{\_fontfeatures color=\_tmp;}\_fi
    \_reloading
}
\_def \_setletterspace #1{\_removefeature{letterspace=}%
    \_if^#1^\_else \_edef\_fontfeatures{\_fontfeatures letterspace=#1;}\_fi
    \_reloading
}
\_def \_setwordspace #1{%
   \_if^#1^\_def\_setwsp##1{}\_removefeature{+Ws}%
   \_else \_def\_setwsp{\_setwspA{#1}}\_setff{+Ws}\_fi
   \_reloading
}
\_def\_setwsp #1{}
\_def\_setwspA #1#2{\_fontdimen2#2=#1\_fontdimen2#2%
   \_fontdimen3#2=#1\_fontdimen3#2\_fontdimen4#2=#1\_fontdimen4#2}

\_def\_calculatefontcolor#1{\_trycs{_fc:#1}{#1}} % you can define more smart macro ...
\_sdef{_fc:red}{FF0000FF}    \_sdef{_fc:green}{00FF00FF} \_sdef{_fc:blue}{0000FFFF}
\_sdef{_fc:yellow}{FFFF00FF} \_sdef{_fc:cyan}{00FFFFFF}  \_sdef{_fc:magenta}{FF00FFFF}
\_sdef{_fc:white}{FFFFFFFF}  \_sdef{_fc:grey}{00000080}  \_sdef{_fc:lgrey}{00000025}
\_sdef{_fc:black}{} % ... you can declare more colors...

\_public \setfontcolor \setletterspace \setwordspace ;
```

2.14 Preloaded fonts for math mode

The Computer Modern and AMS fonts are preloaded here in classical math-fam concept, where each math family includes three fonts with max 256 characters (typically 128 characters).

On the other hand, when \fontfam macro is used in the document then text font family and appropriate math family is loaded with Unicoded fonts, i.e. Unicoded-math is used. It re-defines all settings given here.

The general rule of usage the math fonts in different sizes in OpTEX says: set three sizes by the macro \setmathsizes [⟨*text-size*⟩/⟨*script-size*⟩/⟨*scriptscript-size*⟩] and then load all math fonts in given sizes by \normalmath or \boldmath macros. For example

```
\setmathsizes[12/8.4/6]\normalmath ... math typesetting at 12 pt is ready.
```

math-preload.opm

```
\_codedecl \normalmath {Math fonts CM + AMS preloaded <2020-05-06>} % preloaded in format
```

We have two math macros \normalmath for normal shape of all math symbols and \boldmath for bold shape of all math symbols. The second one can be used in bold titles, for example. These macros load all fonts from all given math font families.

math-preload.opm

```
\_def\_normalmath{%
  \_loadmathfamily 0 cmr  % CM Roman
  \_loadmathfamily 1 cmmi % CM Math Italic
  \_loadmathfamily 2 cmsy % CM Standard symbols
  \_loadmathfamily 3 cmex % CM extra symbols
  \_loadmathfamily 4 msam % AMS symbols A
  \_loadmathfamily 5 msbm % AMS symbols B
  \_loadmathfamily 6 rsfs % script
  \_loadmathfamily 7 eufm % fractur
  \_loadmathfamily 8 bfsans % sans serif bold
  \_loadmathfamily 9 bisans % sans serif bold slanted (for vectors)
%  \_setmathfamily 10 \_tentt
%  \_setmathfamily 11 \_tenit
  \_setmathdimens
}
\_def\_boldmath{%
  \_loadmathfamily 0 cmbx  % CM Roman Bold Extended
  \_loadmathfamily 1 cmmib % CM Math Italic Bold
  \_loadmathfamily 2 cmbsy % CM Standard symbols Bold
  \_loadmathfamily 3 cmexb % CM extra symbols Bold
  \_loadmathfamily 4 msam  % AMS symbols A (bold not available?)
  \_loadmathfamily 5 msbm  % AMS symbols B (bold not available?)
  \_loadmathfamily 6 rsfs  % script (bold not available?)
  \_loadmathfamily 7 eufb  % fractur bold
  \_loadmathfamily 8 bbfsans % sans serif extra bold
  \_loadmathfamily 9 bbisans % sans serif extra bold slanted (for vectors)
%  \_setmathfamily 10 \_tentt
%  \_setmathfamily 11 \_tenbi
  \_setmathdimens
}
\_count18=9   % families declared by \newfam are 12, 13, ...

\_def \normalmath {\_normalmath}  \_def\boldmath {\_boldmath}
```

The classical math family selectors \mit, \cal, \bbchar, \frak and \script are defined here. The \rm, \bf, \it, \bi and \tt does two things: they are variant selectors for text fonts and math family selectors for math fonts. The idea was adapted from plain TEX.
These macros are redefined when `unimat-codes.opm` is loaded, see the section 2.16.2.

math-preload.opm

```
\_chardef\_bffam = 8
\_chardef\_bifam = 9
%\_chardef\_ttfam = 10
%\_chardef\_itfam = 11

\_protected\_def \_rm {\_tryloadrm \_tenrm \_fam0 }
\_protected\_def \_bf {\_tryloadbf \_tenbf \_fam\_bffam}
\_protected\_def \_it {\_tryloadit \_tenit \_fam1 }
\_protected\_def \_bi {\_tryloadbi \_tenbi \_fam\_bifam}
```

```
\_protected\_def \_tt {\_tryloadtt \_tentt}

\_protected\_def \_mit    {\_fam1 }
\_protected\_def \_cal    {\_fam2 }
\_protected\_def \_bbchar {\_fam5 }  % double stroked letters
\_protected\_def \_frak   {\_fam7 }  % fraktur
\_protected\_def \_script {\_fam6 }  % more extensive script than \cal

\_public \rm \bf \it \bi \tt \mit \cal \bbchar \frak \script ;
```

The optical sizes of Computer Modern fonts, AMS and other fonts are declared here.

math-preload.opm

```
%% CM math fonts, optical sizes:

\_regtfm cmmi 0 cmmi5 5.5 cmmi6 6.5 cmmi7 7.5 cmmi8 8.5 cmmi9 9.5
                cmmi10 11.1 cmmi12 *
\_regtfm cmmib 0 cmmib5 5.5 cmmib6 6.5 cmmib7 7.5 cmmib8 8.5 cmmib9 9.5 cmmib10 *
\_regtfm cmtex 0 cstex8 8.5 cstex9 9.5 cstex10 *
\_regtfm cmsy 0 cmsy5 5.5 cmsy6 6.5 cmsy7 7.5 cmsy8 8.5 cmsy9 9.5 cmsy10 *
\_regtfm cmbsy 0 cmbsy5 5.5 cmbsy6 6.5 cmbsy7 7.5 cmbsy8 8.5 cmbsy9 9.5 cmbsy10 *
\_regtfm cmex 0 cmex7 7.5 cmex8 8.5 cmex9 9.5 cmex10 *
\_regtfm cmexb 0 cmexb10 *

\_regtfm cmr  0 cmr5 5.5 cmr6 6.5 cmr7 7.5 cmr8 8.5 cmr9 9.5
                cmr10 11.1 cmr12 15 cmr17 *
\_regtfm cmbx 0 cmbx5 5.5 cmbx6 6.5 cmbx7 7.5 cmbx8 8.5 cmbx9 9.5
                cmbx10 11.1 cmbx12 *
\_regtfm cmti 0 cmti7 7.5 cmti8 8.5 cmti9 9.5 cmti10 11.1 cmti12 *
\_regtfm cmtt 0 cmtt8 8.5 cmtt9 9.5 cmtt10 11.1 cmtt12 *

%% AMS math fonts, optical sizes:

\_regtfm msam 0 msam5 5.5 msam6 6.5 msam7 7.5 msam8 8.5 msam9 9.5 msam10 *
\_regtfm msbm 0 msbm5 5.5 msbm6 6.5 msbm7 7.5 msbm8 8.5 msbm9 9.5 msbm10 *

%% fraktur, rsfs, optical sizes:

\_regtfm eufm 0 eufm5 6 eufm7 8.5 eufm10 *
\_regtfm eufb 0 eufb5 6 eufb7 8.5 eufb10 *
\_regtfm rsfs 0 rsfs5 6 rsfs7 8.5 rsfs10 *

%% bf and bi sansserif math alternatives:

\_regtfm bfsans 0 ecsx0500 5.5 ecsx0600 6.5 ecsx0700 7.5 ecsx0800
             8.5 ecsx0900 9.5 ecsx1000 11.1 ecsx1200 *
\_regtfm bisans 0 ecso0500 5.5 ecso0600 6.5 ecso0700 7.5 ecso0800
             8.5 ecso0900 9.5 ecso1000 11.1 ecso1200 *
\_regtfm bbfsans 0 ecsx0500 5.5 ecsx0600 6.5 ecsx0700 7.5 ecsx0800
             8.5 ecsx0900 9.5 ecsx1000 11.1 ecsx1200 *
\_regtfm bbisans 0 ecso0500 5.5 ecso0600 6.5 ecso0700 7.5 ecso0800
             8.5 ecso0900 9.5 ecso1000 11.1 ecso1200 *
```

_loadmathfamily ⟨*number*⟩ ⟨*font*⟩ loads one math family, i. e. the triple of fonts in the text size, script size and script-script size. The ⟨*font*⟩ is ⟨*font-id*⟩ used in the _regtfm parameter or the real TFM name. The family is saved as \fam⟨*number*⟩.
_setmathfamily ⟨*number*⟩ \⟨*font-switch*⟩ loads one math family like _loadmathfamily does it. But the second parameter is a \⟨*font-switch*⟩ declared previously by the \font primitive.
The font family is loaded at _sizemtext, _sizemscript and _sizemsscript sizes. These sizes are set by the \setmathsizes [⟨*text-size*⟩/⟨*script-size*⟩/⟨*scriptscript-size*⟩] macro. These parameters are given in the \ptmunit unit, it is set to 1\ptunit and it is set to 1 pt by default.
_corrmsizes should be used in the \normalmath and \boldmath macros if you need a size correction when a selected math family is loaded. It is similar as ex-height correction but for math fonts.

math-preload.opm

```
\_def\_corrmsizes{\_ptmunit=1\_ptunit\_relax} % for corrections of sizes in diferent fomts

\_def\_loadmathfamily #1 #2 {\_chardef\_tmp#1\_corrmsizes
  \_edef\_optsizesave{\_the\_optsize}%
  \_optsize=\_sizemtext    \_font\_mF=\_whichtfm{#2} at\_optsize \_textfont#1=\_mF
```

```
  \_optsize=\_sizemscript  \_font\_mF=\_whichtfm{#2} at\_optsize \_scriptfont#1=\_mF
  \_optsize=\_sizemsscript \_font\_mF=\_whichtfm{#2} at\_optsize \_scriptscriptfont#1=\_mF
  \_optsize=\_optsizesave \_relax
}
\_def\_setmathfamily #1 #2{\_let\_mF=#2\_chardef\_tmp#1\_corrmsizes
  \_edef\_optsizesave{\_the\_optsize}%
  \_optsize=\_sizemtext    \_fontlet#2=#2 at\_optsize \_textfont#1=#2%
  \_optsize=\_sizemscript  \_fontlet#2=#2 at\_optsize \_scriptfont#1=#2%
  \_optsize=\_sizemsscript \_fontlet#2=#2 at\_optsize \_scriptscriptfont#1=#2%
  \_optsize=\_optsizesave \_let#2=\_mF
}
\_def\_setmathsizes[#1/#2/#3]{%
   \_def\_sizemtext{#1\_ptmunit}\_def\_sizemscript{#2\_ptmunit}%
   \_def\_sizemsscript{#3\_ptmunit}%
}
\_newdimen\_ptunit   \_ptunit=1pt
\_newdimen\_ptmunit  \_ptmunit=1\_ptunit

\_public \setmathsizes \ptunit \ptmunit ;
```

The _setmathdimens macro is used in \normalmath or \boldmath macros. It makes math dimensions dependent on the font size (plain TEX sets them only for 10 pt typesetting). The \skewchar of some math families are set here too.

math-preload.opm

```
\_def\_setmathdimens{% PlainTeX sets these dimens for 10pt size only:
  \_delimitershortfall=0.5\_fontdimen6\_textfont3
  \_nulldelimiterspace=0.12\_fontdimen6\_textfont3
  \_scriptspace=0.05\_fontdimen6\_textfont3
  \_skewchar\_textfont1=127 \_skewchar\_scriptfont1=127
  \_skewchar\_scriptscriptfont1=127
  \_skewchar\_textfont2=48  \_skewchar\_scriptfont2=48
  \_skewchar\_scriptscriptfont2=48
  \_skewchar\_textfont6=127 \_skewchar\_scriptfont6=127
  \_skewchar\_scriptscriptfont6=127
}
```

Finaly, we preload a math fonts colleciton in [10/7/5] sizes when the format is generated. This is done when _suppressfontnotfounderror=1 because we need not errors when format is generated. Maybe there are not all fonts in the TEX distribution installed.

math-preload.opm

```
\_suppressfontnotfounderror=1
\_setmathsizes[10/7/5]\_normalmath
\_suppressfontnotfounderror=0
```

2.15 Math macros

math-macros.opm

```
\_codedecl \sin {Math macros plus mathchardefs <2020-06-13>} % preloaded in format
```

The category code of the character _ remains as letter (11) and the mathocode of it is "8000. It means that it is active character in math mode. It is defined as subscript prefix.

There is a problem: The x_n is tokenized as x, _, n and it works without problem. But \int_a^b is tokenized as \int_a, ^, b. The control sequence \int_a isn't defined. We must write \int _a^b.

The Lua code presented here solves this problem. But you cannot set our own control sequence in the form \⟨*word*⟩_ or \⟨*word*⟩_⟨*one-letter*⟩ (where ⟨*word*⟩ is sequence of letters) because such control sequences are inaccessible: preprocessor rewrites it.

The \mathsbon macro activates the rewriting rule \⟨*word*⟩_⟨*nonleter*⟩ to \⟨*word*⟩ _⟨*nonletter*⟩ and \⟨*word*⟩_⟨*letter*⟩⟨*nonletter*⟩ to \⟨*word*⟩ _⟨*letter*⟩⟨*nonletter*⟩ at input processor level. The \mathsboff deactivates it. You can ask by _ifmathsb if this feature is activated or deactivated. By default, it is activated in the \everyjob, see section 2.1. Note, that the \everyjob is processed after the first line of the document is read, so the \mathsbon is activated from second line of the document.

math-macros.opm

```
\catcode`\_ = 8   \let\sb = _
\catcode`\_ = 13  \let _ = \sb
\catcode`\_ = 11
\_private \sb ;
```

```
33
34 \_newifi\_ifmathsb   \_mathsbfalse
35 \_def \_mathsbon {%
36    \_directlua{
37    callback.add_to_callback("process_input_buffer",
38      function (str)
39        return string.gsub(str.." ", "(\_nbb[a-zA-Z]+)_([a-zA-Z]?[^_a-zA-Z])", "\_pcent 1 _\_pcent 2")
40      end, "_mathsb") }%
41    \_global\_mathsbtrue
42 }
43 \_def \_mathsboff {%
44    \_directlua{ callback.remove_from_callback("process_input_buffer", "_mathsb") }%
45    \_global \_mathsbfalse
46 }
47 \_public \mathsboff \mathsbon ;
```

All mathcodes are set to equal values as in plainTEX. But all encoding-dependend declarations (like these) will be set to different values when Unicode-math font is used.

math-macros.opm

```
55 \_mathcode`\^^@="2201 % \cdot
56 \_mathcode`\^^A="3223 % \downarrow
57 \_mathcode`\^^B="010B % \alpha
58 \_mathcode`\^^C="010C % \beta
59 \_mathcode`\^^D="225E % \land
60 \_mathcode`\^^E="023A % \lnot
61 \_mathcode`\^^F="3232 % \in
62 \_mathcode`\^^G="0119 % \pi
63 \_mathcode`\^^H="0115 % \lambda
64 \_mathcode`\^^I="010D % \gamma
65 \_mathcode`\^^J="010E % \delta
66 \_mathcode`\^^K="3222 % \uparrow
67 \_mathcode`\^^L="2206 % \pm
68 \_mathcode`\^^M="2208 % \oplus
69 \_mathcode`\^^N="0231 % \infty
70 \_mathcode`\^^O="0140 % \partial
71 \_mathcode`\^^P="321A % \subset
72 \_mathcode`\^^Q="321B % \supset
73 \_mathcode`\^^R="225C % \cap
74 \_mathcode`\^^S="225B % \cup
75 \_mathcode`\^^T="0238 % \forall
76 \_mathcode`\^^U="0239 % \exists
77 \_mathcode`\^^V="220A % \otimes
78 \_mathcode`\^^W="3224 % \leftrightarrow
79 \_mathcode`\^^X="3220 % \leftarrow
80 \_mathcode`\^^Y="3221 % \rightarrow
81 \_mathcode`\^^Z="8000 % \ne
82 \_mathcode`\^^[="2205 % \diamond
83 \_mathcode`\^^\="3214 % \le
84 \_mathcode`\^^]="3215 % \ge
85 \_mathcode`\^^^="3211 % \equiv
86 \_mathcode`\^^_="225F % \lor
87 \_mathcode`\ ="8000 % \space
88 \_mathcode`\!="5021
89 \_mathcode`\'="8000 % ^\prime
90 \_mathcode`\(="4028
91 \_mathcode`\)="5029
92 \_mathcode`\*="2203 % \ast
93 \_mathcode`\+="202B
94 \_mathcode`\,="613B
95 \_mathcode`\-="2200
96 \_mathcode`\.="013A
97 \_mathcode`\/="013D
98 \_mathcode`\:="303A
99 \_mathcode`\;="603B
100 \_mathcode`\<="313C
101 \_mathcode`\=="303D
102 \_mathcode`\>="313E
103 \_mathcode`\?="503F
104 \_mathcode`\[="405B
```

```
\_mathcode`\\="026E % \backslash
\_mathcode`\]="505D
\_mathcode`\_="8000 % math-active subscript
\_mathcode`\{="4266
\_mathcode`\|="026A
\_mathcode`\}="5267
\_mathcode`\^^?="1273 % \smallint

\_delcode`\(="028300
\_delcode`\)="029301
\_delcode`\[="05B302
\_delcode`\]="05D303
\_delcode`\<="26830A
\_delcode`\>="26930B
\_delcode`\/="02F30E
\_delcode`\|="26A30C
\_delcode`\\="26E30F
```

All control sequences declared by `\mathchardef` are supposed (by default) only for public usage. It means that they are declared without `_` prefix. If such sequences are used in internal OpTEX macro then their internal prefixed form is declared using `\_private` macro.
These encoding dependent declarations will be set to different values when Unicode-math font is loaded. The declared sequences for math symbols are not hyperlinked in this documentation.

math-macros.opm

```
\_mathchardef\alpha="010B
\_mathchardef\beta="010C
\_mathchardef\gamma="010D
\_mathchardef\delta="010E
\_mathchardef\epsilon="010F
\_mathchardef\zeta="0110
\_mathchardef\eta="0111
\_mathchardef\theta="0112
\_mathchardef\iota="0113
\_mathchardef\kappa="0114
\_mathchardef\lambda="0115
\_mathchardef\mu="0116
\_mathchardef\nu="0117
\_mathchardef\xi="0118
\_mathchardef\pi="0119
```

...etc. (see math-macros.opm)

The math functions like log, sin, cos are declared in tha same way as in plainTEX, but they are `\protected` in OpTEX.

math-macros.opm

```
\_protected\_def\log {\_mathop{\_rm log}\_nolimits}
\_protected\_def\lg {\_mathop{\_rm lg}\_nolimits}
\_protected\_def\ln {\_mathop{\_rm ln}\_nolimits}
\_protected\_def\lim {\_mathop{\_rm lim}}
\_protected\_def\limsup {\_mathop{\_rm lim\_thinsk sup}}
\_protected\_def\liminf {\_mathop{\_rm lim\_thinsk inf}}
\_protected\_def\sin {\_mathop{\_rm sin}\_nolimits}
\_protected\_def\arcsin {\_mathop{\_rm arcsin}\_nolimits}
\_protected\_def\sinh {\_mathop{\_rm sinh}\_nolimits}
\_protected\_def\cos {\_mathop{\_rm cos}\_nolimits}
\_protected\_def\arccos {\_mathop{\_rm arccos}\_nolimits}
\_protected\_def\cosh {\_mathop{\_rm cosh}\_nolimits}
\_protected\_def\tan {\_mathop{\_rm tan}\_nolimits}
\_protected\_def\arctan {\_mathop{\_rm arctan}\_nolimits}
\_protected\_def\tanh {\_mathop{\_rm tanh}\_nolimits}
\_protected\_def\cot {\_mathop{\_rm cot}\_nolimits}
\_protected\_def\coth {\_mathop{\_rm coth}\_nolimits}
%\_protected\_def\sec {\_mathop{\_rm sec}\_nolimits} % \sec is section
\_protected\_def\csc {\_mathop{\_rm csc}\_nolimits}
\_protected\_def\max {\_mathop{\_rm max}}
\_protected\_def\min {\_mathop{\_rm min}}
\_protected\_def\sup {\_mathop{\_rm sup}}
\_protected\_def\inf {\_mathop{\_rm inf}}
\_protected\_def\arg {\_mathop{\_rm arg}\_nolimits}
```

```
\_protected\_def\ker {\_mathop{\_rm ker}\_nolimits}
\_protected\_def\dim {\_mathop{\_rm dim}\_nolimits}
\_protected\_def\hom {\_mathop{\_rm hom}\_nolimits}
\_protected\_def\det {\_mathop{\_rm det}}
\_protected\_def\exp {\_mathop{\_rm exp}\_nolimits}
\_protected\_def\Pr {\_mathop{\_rm Pr}}
\_protected\_def\gcd {\_mathop{\_rm gcd}}
\_protected\_def\deg {\_mathop{\_rm deg}\_nolimits}
```

These macros are defined similarly as in plainTEX. Only internal macro names from plainTEX with `@` character are re-written in more readable form.
\sp is alternative for ^. The \sb alternative for _ was defined at the line 27 of the file `math-macros.opm`.

math-macros.opm

```
\_let\_sp=^ \public \sp ;
% \sb=_ , defined at beginning of this file

\_def\_thinsk {\_mskip\_thinmuskip}
\_protected\_def\,{\_relax\_ifmmode \_thinsk \_else \_thinspace \_fi}
\_protected\_def\>{\_mskip\_medmuskip}    \let\_medsk   = \>
\_protected\_def\;{\_mskip\_thickmuskip}  \let\_thicksk = \;
\_protected\_def\!{\_mskip-\_thinmuskip}  \let\_thinneg = \!
%\_def\*{\discretionary{\thinspace\the\textfont2\char2}{}{}} % obsolete
```

Active \prime character is defined here.

math-macros.opm

```
{\_catcode`\'=\active \_gdef'{^\_bgroup\_primes}} % primes dance
\_def\_primes{\_prime\_isnextchar'{\_primesA}%
                                  {\_isnextchar^{\_primesB}{\_egroup}}}
\_def\_primesA #1{\_primes}
\_def\_primesB #1#2{#2\egroup}
\_private \prime ;
```

\big, \Big, \bigg, \Bigg, \bigl, \bigm, \bigr, \Bigl, \Bigm, \Bigr, \biggl, \biggm, \biggr, \Biggl, \Biggm, \Bigg, \Biggr are based on the _scalebig macro because we need the dependency on the various sizes of the fonts.

math-macros.opm

```
%{\catcode`\^^Z=\active \gdef^^Z{\not=}} % ^^Z is like \ne in math %obsolete

\_def\_scalebig#1#2{{\_left#1\_vbox to#2\_fontdimen6\_textfont1{}%
                     \_kern-\_nulldelimiterspace\_right.}}
\_protected\_def\_big#1{\_scalebig{#1}{.85}}
\_protected\_def\_Big#1{\_scalebig{#1}{1.15}}
\_protected\_def\_bigg#1{\_scalebig{#1}{1.45}}
\_protected\_def\_Bigg#1{\_scalebig{#1}{1.75}}
\_public \big \Big \bigg \Bigg ;

\_protected\_def\_bigl{\_mathopen\_big}
\_protected\_def\_bigm{\_mathrel\_big}
\_protected\_def\_bigr{\_mathclose\_big}
\_protected\_def\_Bigl{\_mathopen\_Big}
\_protected\_def\_Bigm{\_mathrel\_Big}
\_protected\_def\_Bigr{\_mathclose\_Big}
\_protected\_def\_biggl{\_mathopen\_bigg}
\_protected\_def\_biggm{\_mathrel\_bigg}
\_protected\_def\_biggr{\_mathclose\_bigg}
\_protected\_def\_Biggl{\_mathopen\_Bigg}
\_protected\_def\_Biggm{\_mathrel\_Bigg}
\_protected\_def\_Biggr{\_mathclose\_Bigg}
\_public \bigl \bigm \bigr \Bigl \Bigm \Bigr \biggl \biggm \biggr \Biggl \Biggm \Biggr ;
```

Math relations defined by the \jointrel plain TEX macro:

math-macros.opm

```
\_protected\_def\_joinrel{\_mathrel{\_mkern-2.5mu}}  % -3mu in plainTeX
\_protected\_def\relbar{\_mathrel{\_smash-}} % \_smash, because - has the same height as +
\_protected\_def\Relbar{\_mathrel=}
\_mathchardef\lhook="312C
\_protected\_def\hookrightarrow{\_lhook\_joinrel\_rightarrow}
\_mathchardef\rhook="312D
\_protected\_def\hookleftarrow{\_leftarrow\_joinrel\_rhook}
```

```
\_protected\_def\bowtie{\_mathrel\_triangleright\_joinrel\_mathrel\_triangleleft}
\_protected\_def\models{\_mathrel|\_joinrel=}
\_protected\_def\Longrightarrow{\_Relbar\_joinrel\_Rightarrow}
\_protected\_def\longrightarrow{\_relbar\_joinrel\_rightarrow}
\_protected\_def\longleftarrow{\_leftarrow\_joinrel\_relbar}
\_protected\_def\Longleftarrow{\_Leftarrow\_joinrel\_Relbar}
\_protected\_def\longmapsto{\_mapstochar\_longrightarrow}
\_protected\_def\longleftrightarrow{\_leftarrow\_joinrel\_rightarrow}
\_protected\_def\Longleftrightarrow{\_Leftarrow\_joinrel\_Rightarrow}
\_protected\_def\iff{\_thicksk\_Longleftrightarrow\_thicksk}
\_private \lhook \rightarrow \leftarrow \rhook \triangleright \triangleleft
   \Relbar \Rightarrow \relbar \rightarrow \Leftarrow \mapstochar
   \longrightarrow \Longleftrightarrow ;
\_public \joinrel ;
```

`\ldots`, `\cdots`, `\vdots`, `\ddots` from plain TEX

math-macros.opm

```
\_mathchardef\_ldotp="613A % ldot as a punctuation mark
\_mathchardef\_cdotp="6201 % cdot as a punctuation mark
\_mathchardef\_colon="603A % colon as a punctuation mark
\_public \ldotp \cdotp \colon ;

\_protected\_def\_ldots{\_mathinner{\_ldotp\_ldotp\_ldotp}}
\_protected\_def\_cdots{\_mathinner{\_cdotp\_cdotp\_cdotp}}
\_protected\_def\_vdots{\_vbox{\_baselineskip=.4em \_lineskiplimit=\_zo
    \_kern.6em \_hbox{.}\_hbox{.}\_hbox{.}}}
\_protected\_def\_ddots{\_mathinner{%
    \_mkern1mu\_raise.7em\_vbox{\_kern.7em\_hbox{.}}\_mkern2mu
    \_raise.4em\_hbox{.}\_mkern2mu\_raise.1em\_hbox{.}\_mkern1mu}}

\_public \ldots \cdots \vdots \ddots ;
```

`\adots` ispired by plain TEX

math-macros.opm

```
\_protected\_def\_adots{\_mathinner{%
    \_mkern1mu\_raise.1em\_hbox{.}\_mkern2mu
    \_raise.4em\_hbox{.}\_mkern2mu\_raise.7em\_vbox{\_kern.7em\_hbox{.}}\_mkern1mu}}

\_public \adots ;
```

Math accents (encoding dependent declarations).

math-macros.opm

```
\_protected\_def\acute{\_mathaccent"7013 }
\_protected\_def\grave{\_mathaccent"7012 }
\_protected\_def\ddot{\_mathaccent"707F }
\_protected\_def\tilde{\_mathaccent"707E }
\_protected\_def\bar{\_mathaccent"7016 }
\_protected\_def\breve{\_mathaccent"7015 }
\_protected\_def\check{\_mathaccent"7014 }
\_protected\_def\hat{\_mathaccent"705E }
\_protected\_def\vec{\_mathaccent"017E }
\_protected\_def\dot{\_mathaccent"705F }
\_protected\_def\widetilde{\_mathaccent"0365 }
\_protected\_def\widehat{\_mathaccent"0362 }
```

`\_math`, `\skew`, `\overrightarrow`, `\overleftarrow`, `\overbrace`, `\underbrace` macros. The last four are redefined when Unicode math is loaded.

math-macros.opm

```
\_def\_math{\_mathsurround\_zo}
\_protected\_def\_skew #1#2#3{{\_muskip0=#1mu\_divide\_muskip0=by2 \_mkern\_muskip0
    #2{\_mkern-\_muskip0{#3}\_mkern\_muskip0}\_mkern-\_muskip0}{}}
\_protected\_def\_overrightarrow #1{\_vbox{\_math\_ialign{##\_crcr
      \_rightarrowfill\_crcr\_noalign{\_kern-.1em \_nointerlineskip}
      $\_hfil\_displaystyle{#1}\_hfil$\_crcr}}}
\_protected\_def\_overleftarrow #1{\_vbox{\_math\_ialign{##\_crcr
      \_leftarrowfill\_crcr\_noalign{\_kern-.1em \_nointerlineskip}
      $\_hfil\_displaystyle{#1}\_hfil$\_crcr}}}
\_protected\_def\_overbrace #1{\_mathop{%
      \_vbox{\_math\_ialign{##\_crcr\_noalign{\_kern.3em}
      \_downbracefill\_crcr\_noalign{\_kern.3em \_nointerlineskip}
```

```
      $\_hfil\_displaystyle{#1}\_hfil$\_crcr}}}\_limits}
\_protected\_def\_underbrace #1{\_mathop{\_vtop{\_math\_ialign{##\_crcr
      $\_hfil\_displaystyle{#1}\_hfil$\_crcr\_noalign{\_kern.3em \_nointerlineskip}
      \_upbracefill\_crcr\_noalign{\_kern.3em}}}}\_limits}

\_public \overrightarrow \overleftarrow \overbrace \underbrace \skew ;
```

Macros based on `\delimiter`, `\*witdelims` and `\radical` primitives.

math-macros.opm

```
\_protected\_def\lmoustache{\_delimiter"437A340 } % top from (, bottom from )
\_protected\_def\rmoustache{\_delimiter"537B341 } % top from ), bottom from (
\_protected\_def\lgroup{\_delimiter"462833A } % extensible ( with sharper tips
\_protected\_def\rgroup{\_delimiter"562933B } % extensible ) with sharper tips
\_protected\_def\arrowvert{\_delimiter"26A33C } % arrow without arrowheads
\_protected\_def\Arrowvert{\_delimiter"26B33D } % double arrow without arrowheads
\_protected\_def\bracevert{\_delimiter"77C33E } % the vertical bar that extends braces
\_protected\_def\Vert{\_delimiter"26B30D } \_let\|=\Vert
\_protected\_def\vert{\_delimiter"26A30C }
\_protected\_def\uparrow{\_delimiter"3222378 }
\_protected\_def\downarrow{\_delimiter"3223379 }
\_protected\_def\updownarrow{\_delimiter"326C33F }
\_protected\_def\Uparrow{\_delimiter"322A37E }
\_protected\_def\Downarrow{\_delimiter"322B37F }
\_protected\_def\Updownarrow{\_delimiter"326D377 }
\_protected\_def\backslash{\_delimiter"26E30F } % for double coset G\_backslash H
\_protected\_def\rangle{\_delimiter"526930B }
\_protected\_def\langle{\_delimiter"426830A }
\_protected\_def\rbrace{\_delimiter"5267309 } \_let\}=\rbrace \_let\_rbrace=\rbrace
\_protected\_def\lbrace{\_delimiter"4266308 } \_let\{=\lbrace \_let\_lbrace=\lbrace
\_protected\_def\rceil{\_delimiter"5265307 }
\_protected\_def\lceil{\_delimiter"4264306 }
\_protected\_def\rfloor{\_delimiter"5263305 }
\_protected\_def\lfloor{\_delimiter"4262304 }

\_protected\_def\choose{\_atopwithdelims()}
\_protected\_def\brack{\_atopwithdelims[]}
\_protected\_def\brace{\_atopwithdelims\_lbrace\_rbrace}

\_protected\_def\_sqrt{\_radical"270370 }  \_public \sqrt ;
```

`\mathpalette`, `\vphantom`, `\hphantom`, `\phantom`, `\mathstrut`, and `\smash` macros from plain TEX.

math-macros.opm

```
\_def\_mathpalette#1#2{\_mathchoice{#1\_displaystyle{#2}}%
  {#1\_textstyle{#2}}{#1\_scriptstyle{#2}}{#1\_scriptscriptstyle{#2}}}
\_newbox\_rootbox
\_protected\_def\root#1\of{\_setbox\_rootbox
  \_hbox{$\_math\_scriptscriptstyle{#1}$}\_mathpalette\_rootA}
\_def\_rootA#1#2{\_setbox0=\_hbox{$\_math#1\_sqrt{#2}$}\_dimen0=\_ht0
  \_advance\_dimen0by-\_dp0
  \_mkern5mu\_raise.6\_dimen0\_copy\_rootbox \_mkern-10mu\_box0 }
\_newifi\_ifvp \_newifi\_ifhp
\_protected\_def\_vphantom{\_vptrue\_hpfalse\_phant}
\_protected\_def\_hphantom{\_vpfalse\_hptrue\_phant}
\_protected\_def\_phantom{\_vptrue\_hptrue\_phant}
\_def\_phant{\_ifmmode\_def\_next{\_mathpalette\_mathphant}%
  \_else\_let\_next=\_makephant\_fi\_next}
\_def\_makephant#1{\_setbox0\_hbox{#1}\_finphant}
\_def\_mathphant#1#2{\_setbox0=\_hbox{$\_math#1{#2}$}\_finphant}
\_def\_finphant{\_setbox2=\_null
  \_ifvp \_ht2=\_ht0 \_dp2=\_dp0 \_fi
  \_ifhp \_wd2=\_wd0 \_fi \_hbox{\_box2}}
\_def\_mathstrut{\_vphantom()}
\_protected\_def\_smash{\_relax % \_relax, in case this comes first in \halign
  \_ifmmode\_def\_next{\_mathpalette\_mathsmash}\_else\_let\_next\_makesmash
  \_fi\_next}
\_def\_makesmash#1{\_setbox0=\_hbox{#1}\_finsmash}
\_def\_mathsmash#1#2{\_setbox0=\_hbox{$\_math#1{#2}$}\_finsmash}
\_def\_finsmash{\_ht0=\_zo \_dp0=\_zo \_hbox{\_box0}}
\_public \mathpalette \vphantom \hphantom \phantom \mathstrut \smash ;
```

\cong, \notin, \rightleftharpoons, \buildrel, \doteq, \bmod and \pmod macros from plain TEX.

math-macros.opm

```
\_protected\_def\_cong{\_mathrel{\_mathpalette\_overeq\_sim}} % congruence sign
\_def\_overeq#1#2{\_lower.05em\_vbox{\_lineskiplimit\_maxdimen\_lineskip=-.05em
    \_ialign{$\_math#1\_hfil##\_hfil$\_crcr#2\_crcr=\_crcr}}}
\_protected\_def\_notin{\_mathrel{\_mathpalette\_cancel\_in}}
\_def\_cancel#1#2{\_math\_ooalign{$\_hfil#1\_mkern1mu/\_hfil$\_crcr$#1#2$}}
\_protected\_def\_rightleftharpoons{\_mathrel{\_mathpalette\_rlhp{}}}
\_def\_rlhp#1{\_vcenter{\_math\_hbox{\_ooalign{\_raise.2em
          \_hbox{$#1\_rightharpoonup$}\_crcr
        $#1\_leftharpoondown$}}}}
\_protected\_def\_buildrel#1\over#2{\_mathrel{\_mathop{\_kern\_zo #2}\_limits^{#1}}}
\_protected\_def\_doteq{\_buildrel\_textstyle.\over=}
\_private \in \sim ;
\_public \cong \notin \rightleftharpoons \buildrel \doteq ;

\_protected\_def\_bmod{\_nonscript\_mskip-\_medmuskip\_mkern5mu
  \_mathbin{\_rm mod}\_penalty900\_mkern5mu\_nonscript\_mskip-\_medmuskip}
\_protected\_def\_pmod#1{\_allowbreak\_mkern18mu({\_rm mod}\_thinsk\_thinsk#1)}
\_public \bmod \pmod ;
```

\matrix and \pmatrix behave as in Plain TEX, if it is used in the \displaystyle. On the other hand, it is printed in smaller size (by appropriate amount) in \textstyle = \scriptstyle and \scriptscriptstyle. This feature is new in OpTEX.

math-macros.opm

```
\_protected\_def\_matrix#1{\_null\_thinsk
    \_edef\_stylenum{\_the\_numexpr\_mathstyle/2\_relax}%
    \_vcenter{\_matrixbaselines\_math
    \_ialign{\_the\_lmfil$\_matrixstyle##$\_hfil&&\_quad\_the\_lmfil$\_matrixstyle##$\_hfil\_crcr
      \_mathstrut\_crcr\_noalign{\_kern-\_baselineskip}
      #1\_crcr\_mathstrut\_crcr\_noalign{\_kern-\_baselineskip}}}\_thinsk}

\_def\_matrixbaselines{\_normalbaselines \_def\_matrixstyle{}%
   \_let\_matrixbaselines=\_relax % \matrix inside matrix does not change size again
   \_ifcase\_stylenum \_or \_matrixscriptbaselines \_or \_matrixscriptbaselines
   \_or
       \_baselineskip=.5\_baselineskip
       \_def\_quad {\_hskip.5em\_relax}%
       \_let\_matrixstyle=\_scriptscriptstyle
   \_fi
}
\_def\_matrixscriptbaselines{\_baselineskip=.7\_baselineskip
   \_def\_quad {\_hskip.7em\_relax}\_let\_matrixstyle=\_scriptstyle
}
\_protected\_def\_pmatrix#1{\_left(\_matrix{#1}\_right)}

\_public \matrix \pmatrix ;
```

The \cases and \bordermatrix macros are identical from plain TEX.

math-macros.opm

```
\_protected\_long\_def\_cases#1{\_left\{\_thinsk\_vcenter{\_normalbaselines\_math
    \_ialign{$##\_hfil$&\_quad{##\_unsskip}\_hfil\_crcr#1\_crcr}}\_right.}

\_newdimen\_ptrenwd
\_ptrenwd=8.75pt % width of the big left (
\_protected\_def\_bordermatrix#1{\_begingroup \_math
  \_setbox0=\_vbox{\_bordermatrixA #1\_stopbmatrix}%
  \_setbox2=\_vbox{\_unvcopy0 \_global\_setbox1=\_lastbox}%
  \_setbox2=\_hbox{\_unhbox1 \_unskip\_global\_setbox1=\_lastbox}%
  \_setbox2=\_hbox{$\_kern\_wd1 \_kern-\_ptrenwd\_left(\_kern-\_wd1
    \_global\_setbox1=\_vbox{\_box1 \_kern.2em}%
    \_vcenter{\_kern-\_ht1 \_unvbox0 \_kern-\_baselineskip}\_thinsk\_right)$}%
  \_null\_thicksk\_vbox{\_kern\_ht1 \_box2}\_endgroup}
\_def\_bordermatrixA #1\cr#2\_stopbmatrix{%
    \_ialign{$##$\_hfil\_kern.2em\_kern\_ptrenwd&\_thinspace\_hfil$##$\_hfil
      &&\_quad\_hfil$##$\_hfil\_crcr
      \_omit\_strut\_hfil\_crcr\_noalign{\_kern-\_baselineskip}%
      #1\_crcr\_noalign{\_kern.2em}#2\_crcr\_omit\_strut\_cr}}

```

```
\_public \cases \bordermatrix ;
```

The \eqalign macro behaves like in Plain TEX by default. It creates the \vcenter in the math mode. The contents is two column \halign with right aligned left column and left aligned right column. The table items are in \displaystyle and the \baselineskip is advanced by \jot (3pt in plain TEX). It follows from the default settings of \eqlines and \eqstyle parameters.

In OpTEX, this macro is more flexible. See section 4.4 in the Typesetting Math with OpTEX. The \baselineskip value is set by the \eqlines parameter and math style by the \eqstyle parameter.

There are more possible columns than two (used in classical Plain TeX): rlcrlcrlc etc. where r and l columns are without spaces and c column (if used) has the space \eqspace/2 at its both sides.

math-macros.opm

```
\_long\_def\_eqalign#1{\_null\_thinsk\_vcenter{\_the\_eqlines\_math
   \_ialign{&\_hfil$\_the\_eqstyle{##}$&$\_the\_eqstyle{{}##}$\_hfil
            &\_hskip.5\_eqspace\_hfil$\_the\_eqstyle{##}$\_hskip.5\_eqspace\_hfil
            \_crcr#1\_crcr}}\_thinsk}

\_public \eqalign ;
```

The \displaylines{⟨formula⟩\cr⟨formula⟩\cr...⟨formula⟩} creates horizontally centered formulae. It behaves exactly as in Plain TEX. The \halign is applied directly in the outer display environment with lines of type \hbox to\displaywidth. This enables to break lines inside such display to more pages but it is impossible to use \eqno or \leqno or \eqmark.

OpTEX offers \dislaylines to⟨dimen⟩{⟨formula⟩\cr⟨formula⟩\cr...⟨formula⟩} as an alternative case of usage \displaylines. See section 4.3 in the Typesetting Math with OpTEX. The centered formulas are in \vcenter in this case, so lines cannot be broken to more pages, but this case enables to use \eqno or \leqno or \eqmark.

math-macros.opm

```
\_def\_displaylines #1#{\_ifx&#1&\_ea\_displaylinesD
   \_else \_def\_tmp to##1\_end{\_def\_tmp{\_dimexpr ##1}}\_tmp #1\_end
       \_ea\_displaylinesto \_fi}
\_long\_def\_displaylinesD #1{\_display \_tabskip=\_zoskip
   \_halign{\_hbox to\_displaywidth{$\_elign\_hfil\_displaystyle##\_hfil$}\_crcr
      #1\_crcr}}
\_long\_def\_displaylinesto #1{\_vcenter{\_openup\_jot \_math \_tabskip=\_zoskip
   \_halign{\_strut\_hbox to\_span\_tmp{$\_hss\_displaystyle##\_hss$}\_crcr
      #1\_crcr}}}

\_public\displaylines ;
```

\openup, \eqalignno and \leqalignno macros are copied from Plain TEX unchanged.

math-macros.opm

```
\_def\_openup{\_afterassignment\_openupA\_dimen0=}
\_def\_openupA{\_advance\_lineskip by\_dimen0
  \_advance\_baselineskip by\_dimen0
  \_advance\_lineskiplimit by\_dimen0 }
\_newifi\_ifdtop
\_def\_display{\_global\_dtoptrue\_openup\_jot\_math
  \_everycr{\_noalign{\_ifdtop \_global\_dtopfalse \_ifdim\_prevdepth>-1000pt
      \_vskip-\_lineskiplimit \_vskip\_normallineskiplimit \_fi
      \_else \_penalty\_interdisplaylinepenalty \_fi}}}
\_def\_elign{\_tabskip=\_zoskip\_everycr{}} % restore inside \_display
\_long\_def\_eqalignno#1{\_display \_tabskip=\_centering
  \_halign to\_displaywidth{\_hfil$\_elign\_displaystyle{##}$\_tabskip=\_zoskip
    &$\_elign\_displaystyle{{}##}$\_hfil\_tabskip\_centering
    &\_llap{$\_elign##$}\_tabskip\_zoskip\_crcr
    #1\_crcr}}
\_long\_def\_leqalignno#1{\_display \_tabskip=\_centering
  \_halign to\_displaywidth{\_hfil$\_elign\_displaystyle{##}$\_tabskip=\_zoskip
    &$\_elign\_displaystyle{{}##}$\_hfil\_tabskip=\_centering
    &\_kern-\_displaywidth\_rlap{$\_elign##$}\_tabskip\_displaywidth\_crcr
    #1\_crcr}}
\_public \openup \eqalignno \leqalignno ;
```

These macros are inspired from ams-math.tex file.

math-macros.opm

```
\_def\_amsafam{4} \_def\_amsbfam{5}

```

```
\_mathchardef \boxdot   "2\_amsafam 00
\_mathchardef \boxplus   "2\_amsafam 01
\_mathchardef \boxtimes   "2\_amsafam 02
\_mathchardef \square   "0\_amsafam 03
\_mathchardef \blacksquare   "0\_amsafam 04
\_mathchardef \centerdot   "2\_amsafam 05
\_mathchardef \lozenge   "0\_amsafam 06
\_mathchardef \blacklozenge   "0\_amsafam 07
\_mathchardef \circlearrowright   "3\_amsafam 08
\_mathchardef \circlearrowleft   "3\_amsafam 09
\_mathchardef \rightleftharpoons   "3\_amsafam 0A
\_mathchardef \leftrightharpoons   "3\_amsafam 0B
\_mathchardef \boxminus   "2\_amsafam 0C
```

...etc. (see math-macros.opm)

The \not macro is re-defined to be smarter than in plain TEX. The macro follows this rule:

```
\not< becomes \_nless
\not> becomes \_ngtr
if \_notXXX is defined, \not\XXX becomes \_notXXX;
if \_nXXX is defined, \not\XXX becomes \_nXXX;
otherwise, \not\XXX is done in the usual way.
```

math-macros.opm

```
\_mathchardef \_notchar  "3236

\_protected\_def \_not#1{%
  \_ifx #1<\_nless \_else
  \_ifx #1>\_ngtr \_else
  \_edef\_tmpn{\_csstring#1}%
  \_ifcsname _not\_tmpn\_endcsname \_csname _not\_tmpn\_endcsname
  \_else \_ifcsname _n\_tmpn\_endcsname \_csname _n\_tmpn\_endcsname
  \_else \_mathrel{\_mathord{\_notchar}\_mathord{#1}}%
  \_fi \_fi \_fi \_fi}
\_private
  \nleq \ngeq \nless \ngtr \nprec \nsucc \nleqslant \ngeqslant \npreceq
  \nsucceq \nleqq \ngeqq \nsim \ncong \nsubseteqq \nsupseteqq \nsubseteq
  \nsupseteq \nparallel \nmid \nshortmid \nshortparallel \nvdash \nVdash
  \nvDash \nVDash \ntrianglerighteq \ntrianglelefteq \ntriangleleft
  \ntriangleright \nleftarrow \nrightarrow \nLeftarrow \nRightarrow
  \nLeftrightarrow \nleftrightarrow \nexists ;
\_public \not ;
```

\mathstyles{⟨*math list*⟩} behaves like {⟨*math list*⟩}, but you can use following commands in the ⟨*math list*⟩:

- \currstyle which expands to \displaystyle, \textstyle, \scriptstyle or \scriptscriptstyle depending on the current math style when \mathstyles was opened.
- \dobystyle{⟨*D*⟩}{⟨*T*⟩}{⟨*S*⟩}{⟨*SS*⟩} is expandable macro. It expands to ⟨*D*⟩, ⟨*T*⟩, ⟨*S*⟩ or ⟨*SS*⟩ depending on the current math style when \mathstyles was opened.
- The value of the \stylenum is 0, 1, 2 or 3 depending on the current math style when \mathstyles was opened.

Example of usage of \mathstyles: \def\mathframe#1{\mathstyles{\frame{$\currstyle#1$}}}.

math-macros.opm

```
\_newcount\_stylenum
\_def\_mathstyles#1{{\_mathchoice{\_stylenum0 #1}{\_stylenum1 #1}%
                                 {\_stylenum2 #1}{\_stylenum1 #1}}}
\_def\_dobystyle#1#2#3#4{\_ifcase\_stylenum#1\_or#2\_or#3\_or#4\_fi}
\_def\_currstyle{\dobystyle\_displaystyle\_textstyle\_scriptstyle\_scriptscriptstyle}
\_public \mathstyles \dobystyle \currstyle \stylenum ;
```

The \mathbox{⟨*text*⟩} macro is copied from OPmac trick 078. It behaves like \hbox{⟨*text*⟩} but the ⟨*text*⟩ is scaled to smaller size if it is used in scriptstyle or scriptscript style.

math-macros.opm

```
\_def\_mathbox#1{{\_mathstyles{\_hbox{%
   \_ifnum\_stylenum<2 \_everymath{\_currstyle}%
   \_else \_typoscale[\_dobystyle{}{}{700}{500}/]\_fi #1}}}%
}
\_public \mathbox ;
```

2.16 Unicode-math fonts

The \loadmath {⟨*Unicode-math font*⟩} macro loads math fonts and redefines all default math-codes using \input unimath-codes.opm. If Unicode-math font is loaded then _mathloadingfalse is set, so new UnicodeMath font isn't loaded until \doloadmath is used.

\loadboldmath {⟨*bold-font*⟩} \to {⟨*normal-font*⟩} loads bold variant only if ⟨*normal-font*⟩ was sucessully loaded by the \loadmath. For example:

```
\loadmath     {[xitsmath-regular]}
\loadboldmath {[xitsmath-bold]} \to {[xitsmath-regular]}
```

You can combine more fonts, if you register them to another math families (5, 6, 7, etc.) in the \normalmath macro.

The default value of \normalmath shows a combination of base Unicode Math font with 8bit Math font at family 4. See definition of \script macro where \fam4 is used. Of course, we need to set \rmvariables too, because 8bit font accepts only codes less than 255.

See http://tex.stackexchange.com/questions/308749/ for more technical details.

The \loadmath macro was succesfully tested on:

```
\loadmath{[XITSMath-Regular]}       ... XITS MATH
\loadmath{[latinmodern-math]}       ... Latin Modern Math
\loadmath{[texgyretermes-math]}     ... TeXGyre Termes Math
\loadmath{[texgyrebonum-math]}      ... TeXGyre Bonum Math
\loadmath{[texgyrepagella-math]}    ... TeXGyre Pagella Math
\loadmath{[texgyreschola-math]}     ... TeXGyre Schola Math
\loadmath{[texgyredejavu-math]}     ... TeXGyre DeJaVu Math
\loadmath{[LibertinusMath-Regular]} ... Libertinus Math
\loadmath{[FiraMath-Regular]}       ... Fira Math
\loadmath{[Asana-Math]}             ... Asana Math
```

2.16.1 Unicode-math macros preloaded in the format

math-unicode.opm

```
\_codedecl \loadmath {Unicode Math fonts <2020-06-06>} % preloaded in format
```

\loadmath {⟨*Unicode-math font*⟩} loads given font. It does:

- define _unimathfont as ⟨*Unicode-math font*⟩,
- redefine \normalmath and \boldmath macros to their Unicode counterparts,
- load the _unimathfont by \normalmath,
- print information about loaded font on the terminal,
- redefine all encoding dependent setting by \input unimath-codes.opm,
- protect new loading by setting _ifmathloading to false.

\noloadmath disallows Unicode-math loading by _mathloadingfalse.
\doloadmath allows Unicode-math loading by _mathloadingtrue.

math-unicode.opm

```
\_newifi \_ifmathloading   \_mathloadingtrue

\_def\_noloadmath{\_mathloadingfalse}
\_def\_doloadmath{\_mathloadingtrue}

\_def\_loadmath#1{%
   \_ifmathloading
   \_initunifonts
   \_isfont{#1}\_iffalse
      \_opwarning{Math font "#1" not found, skipped...}%
   \_else
      \_def\_unimathfont{#1}%
      \_let\_normalmath = \_normalunimath  \_let\_boldmath = \_boldunimath
      \_normalmath
      \_wterm {MATH-FONT: "#1" -- unicode math prepared.}%
      \_ifx\_ncharrmA\_undefined \_opinput {unimath-codes.opm}\_fi
      \_mathloadingfalse
   \_fi\_fi}

```

```
\_public \loadmath \noloadmath \doloadmath ;
```

`\loadboldmath` {⟨*bold-font*⟩} `\to` {⟨*normal-font*⟩} defines `\_unimathboldfont` as ⟨*bold-font*⟩ only if `\_unimathfont` is defined as ⟨*normal-font*⟩. It is used when `\boldmath` macro is run. When no `\_unimathboldfont` is defined then the `\boldmath` macro use "fake bold" generated by `embolden` LuaTEX font feature.

math-unicode.opm

```
\_def\_loadboldmath#1#2\to #3{%
   \_def\_tmp{#3}\_ifx\_unimathfont\_tmp % do work only if #3 is loaded as normal Math
   \_isfont{#1}\_iffalse
      \_opwarning{Bold-Math font "#1" not found, skipped...}
   \_else
      \_def\_unimathboldfont{#1}%
      \_wterm {MATH-FONT: "#1" -- unicode math bold prepared.}%
   \_fi\_fi}

\_public \loadboldmath ;
```

The Unicode version of the `\normalmath` and `\boldmath` macros are defined here as `\_normalunimath` and `\_boldunimath` macros. They are using `\_setunimathdimens` in similar sense as `\_setmathdimens`.

math-unicode.opm

```
\_def\_normalunimath{%
    \_loadumathfamily 1 {\_unimathfont}{} % Base font
    \_loadmathfamily  4 rsfs              % script
    \_setunimathdimens
}%
\_def\_boldunimath{%
    \_ifx\_unimathboldfont \_undefined
       \_loadumathfamily 1 {\_unimathfont}{embolden=1.7;} % Base faked bold
    \_else
       \_loadumathfamily 1 {\_unimathboldfont}{} % Base real bold font
    \_fi
    \_loadmathfamily  4 rsfs              % script
    \_setunimathdimens
}%
\_def\_setunimathdimens{% PlainTeX sets these dimens for 10pt size only:
  \_delimitershortfall=0.5\_fontdimen6\_textfont3
  \_nulldelimiterspace=0.12\_fontdimen6\_textfont3
  \_scriptspace=0.05\_fontdimen6\_textfont3
  {\_everymath{}\_global\_setbox0=\_hbox{$\_fam1\_displaystyle{0\_atop0}$}}% correction for \choose
  \_Umathfractiondelsize\_displaystyle = \_dimexpr(\_ht0-\_Umathaxis\_displaystyle)*2\_relax
}
```

`\_loadumathfamily` ⟨*number*⟩ {⟨*font*⟩}{⟨*font features*⟩} loads the given Unicode-math fonts in three sizes given by the `\setmathsizes` macro and sets it as the math family ⟨*number*⟩. The ⟨*font features*⟩ are added to the default `\_mfontfeatures` and to the size dependent features `+ssty=0` if script size is asked or `+ssty=1` if scriptscriptsize is asked. If the fath family 1 is loaded then the family 2 and 3 is set by the same font because TEX needs to read dimension information about generating math formulae from these three math families. All information needed by TEX is collected in single Unicode-math font.

math-unicode.opm

```
\_def\_umathname#1#2{"#1:\_mfontfeatures#2"}
\_def\_mfontfeatures{mode=base;script=math;}

\_def\_loadumathfamily #1 #2#3 {%
  \_edef\_optsizesave{\_the\_optsize}%
  \_optsize=\_sizemtext  \_font\_mF=\_umathname{#2}{#3} at\_optsize \_textfont#1=\_mF
  \_ifnum#1=1 \_textfont2=\_mF \_textfont3=\_mF \_fi
  \_optsize=\_sizemscript \_font\_mF=\_umathname{#2}{+ssty=0;#3} at\_optsize \_scriptfont#1=\_mF
  \_ifnum#1=1 \_scriptfont2=\_mF \_scriptfont3=\_mF \_fi
  \_optsize=\_sizemsscript \_font\_mF=\_umathname{#2}{+ssty=1;#3} at\_optsize\_scriptscriptfont#1=\_mF
  \_ifnum#1=1 \_scriptscriptfont2=\_mF \_scriptscriptfont3=\_mF \_fi
  \_optsize=\_optsizesave \_relax
}
```

Unicode math font includes all typical math alphabets together, user needs not to load more TEX math families. These math aphabets are encoded by different parts of Unicode table. We need auxiliary macros for setting mathcodes by selected math alphabet.

`\_umathrange` {⟨*from*⟩-⟨*to*⟩}⟨*class*⟩⟨*family*⟩\⟨*first*⟩ sets `\Umathcodes` of the characters in the interval

⟨*from*⟩-⟨*to*⟩ to \⟨*first*⟩, \⟨*first*⟩+1, \⟨*first*⟩+2 etc., but _umathcharholes are skipped (_umathcharholes are parts of the Unicode table not designed for math alphabets but they causes that the math alphabets are not continuously spread out in the table; I mean that the designers were under the influence of drugs when they created this part of the Unicode table). The ⟨*from*⟩-⟨*to*⟩ clause includes normal letters like A-Z.
_umahrangegreek \⟨*first*⟩ is the same as _umathrange {⟨*alpha*⟩-⟨*omega*⟩}\⟨*first*⟩.
_umahrangeGREEK \⟨*first*⟩ is the same as _umathrange {⟨*Alpha*⟩-⟨*Omega*⟩}\⟨*first*⟩.
_greekdef ⟨*control sequences*⟩ _relax defines each control sequence as a normal character with codes _umathnumB, _umathnumB+1, _umathnumB+2 etc. It is used for redefinig the contol sequences for math Greek \alpha, \beta, \gamma etc.

math-unicode.opm

```
\_newcount\_umathnumA  \_newcount\_umathnumB

\_def\_umathcorr#1#2{\_ea#1\_ea{\_the#2}}
\_def\_umathprepare#1{\_def\_umathscanholes##1[#1]##2##3\_relax{##2}}
\_def\_umathvalue#1{\_ea\_umathscanholes\_umathcharholes[#1]{#1}\_relax}

\_def\_umathcharholes{% holes in math alphabets:
   [119893]{"210E}[119965]{"212C}[119968]{"2130}[119969]{"2131}%
   [119971]{"210B}[119972]{"2110}[119975]{"2112}[119976]{"2133}[119981]{"211B}%
   [119994]{"212F}[119996]{"210A}[120004]{"2134}%
   [120070]{"212D}[120075]{"210C}[120076]{"2111}[120085]{"211C}[120093]{"2128}%
   [120122]{"2102}[120127]{"210D}[120133]{"2115}[120135]{"2119}
   [120136]{"211A}[120137]{"211D}[120145]{"2124}%
}
\_def\_umathrange#1#2#3#4{\_umathnumB=#4\_def\_tmp{#2 #3 }\_umathrangeA#1}
\_def\_umathrangeA#1-#2{\_umathnumA=`#1\_relax
   \_loop
      \_umathcorr\_umathprepare\_umathnumB
      \_Umathcode \_umathnumA = \_tmp \_umathcorr\_umathvalue{\_umathnumB}
      \_ifnum\_umathnumA<`#2\_relax
         \_advance\_umathnumA by1 \_advance\_umathnumB by1
   \_repeat
}
\_def\_umathrangeGREEK{\_umathrange{^^^^0391-^^^^03a9}}
\_def\_umathrangegreek{\_umathrange{^^^^03b1-^^^^03d6}}
\_def\_greekdef#1{\_ifx#1\_relax \_else
   \_begingroup \_lccode`X=\_umathnumB \_lowercase{\_endgroup \_def#1{X}}%
   \_advance\_umathnumB by 1
   \_expandafter\_greekdef \_fi
}
```

2.16.2 Macros and codes set when \loadmatfont is processed

The file unimath-codes.opm is loaded when the \loadmath is used. The macros here redefines globally all encoding dependent settings declared in the section 2.15.

unimath-codes.opm

```
\_codedecl \_ncharrmA {Uni math codes <2020-11-13>} % preloaded on demand by \loadmath
```

The control sequences for \alpha, \beta etc are redefined here. The \alpha expands to the character with unicode "03B1, this is normal character α. You can type it directly in your editor, if you know how to do this.

unimath-codes.opm

```
\_umathnumB="0391
\_greekdef \Alpha \Beta \Gamma \Delta \Epsilon \Zeta \Eta \Theta \Iota \Kappa
   \Lambda \Mu \Nu \Xi \Omicron \Pi \Rho \varTheta \Sigma \Tau \Upsilon \Phi
   \Chi \Psi \Omega \_relax

\_umathnumB="03B1
\_greekdef \alpha \beta \gamma \delta \varepsilon \zeta \eta \theta \iota \kappa
   \lambda \mu \nu \xi \omicron \pi \rho \varsigma \sigma \tau \upsilon
   \varphi \chi \psi \omega \vardelta \epsilon \vartheta \varkappa \phi
   \varrho \varpi \_relax
```

The math alphabets are declared here using the _umathrange{⟨*range*⟩}⟨*class*⟩⟨*family*⟩⟨*starting-code*⟩ macro.

```
\_chardef\_ncharrmA="A       \_chardef\_ncharrma="a
\_chardef\_ncharbfA="1D400   \_chardef\_ncharbfa="1D41A
\_chardef\_ncharitA="1D434   \_chardef\_ncharita="1D44E
\_chardef\_ncharbiA="1D468   \_chardef\_ncharbia="1D482
\_chardef\_ncharclA="1D49C   \_chardef\_ncharcla="1D4B6
\_chardef\_ncharbcA="1D4D0   \_chardef\_ncharbca="1D4EA
\_chardef\_ncharfrA="1D504   \_chardef\_ncharfra="1D51E
\_chardef\_ncharbrA="1D56C   \_chardef\_ncharbra="1D586
\_chardef\_ncharbbA="1D538   \_chardef\_ncharbba="1D552
\_chardef\_ncharsnA="1D5A0   \_chardef\_ncharsna="1D5BA
\_chardef\_ncharbsA="1D5D4   \_chardef\_ncharbsa="1D5EE
\_chardef\_ncharsiA="1D608   \_chardef\_ncharsia="1D622
\_chardef\_ncharsxA="1D63C   \_chardef\_ncharsxa="1D656
\_chardef\_nchartta="1D670   \_chardef\_nchartta="1D68A

\_protected\_def\_rmvariables     {\_umathrange{A-Z}71\_ncharrmA \_umathrange{a-z}71\_ncharrma}
\_protected\_def\_bfvariables     {\_umathrange{A-Z}71\_ncharbfA \_umathrange{a-z}71\_ncharbfa}
\_protected\_def\_itvariables     {\_umathrange{A-Z}71\_ncharitA \_umathrange{a-z}71\_ncharita}
\_protected\_def\_bivariables     {\_umathrange{A-Z}71\_ncharbiA \_umathrange{a-z}71\_ncharbia}
\_protected\_def\_calvariables    {\_umathrange{A-Z}71\_ncharclA \_umathrange{a-z}71\_ncharcla}
\_protected\_def\_bcalvariables   {\_umathrange{A-Z}71\_ncharbcA \_umathrange{a-z}71\_ncharbca}
\_protected\_def\_frakvariables   {\_umathrange{A-Z}71\_ncharfrA \_umathrange{a-z}71\_ncharfra}
\_protected\_def\_bfrakvariables  {\_umathrange{A-Z}71\_ncharbrA \_umathrange{a-z}71\_ncharbra}
\_protected\_def\_bbvariables     {\_umathrange{A-Z}71\_ncharbbA \_umathrange{a-z}71\_ncharbba}
\_protected\_def\_sansvariables   {\_umathrange{A-Z}71\_ncharsnA \_umathrange{a-z}71\_ncharsna}
\_protected\_def\_bsansvariables  {\_umathrange{A-Z}71\_ncharbsA \_umathrange{a-z}71\_ncharbsa}
\_protected\_def\_isansvariables  {\_umathrange{A-Z}71\_ncharsiA \_umathrange{a-z}71\_ncharsia}
\_protected\_def\_bisansvariables {\_umathrange{A-Z}71\_ncharsxA \_umathrange{a-z}71\_ncharsxa}
\_protected\_def\_ttvariables     {\_umathrange{A-Z}71\_nchartta \_umathrange{a-z}71\_nchartta}

\_chardef\_greekrmA="0391   \_chardef\_greekrma="03B1
\_chardef\_greekbfA="1D6A8  \_chardef\_greekbfa="1D6C2
\_chardef\_greekitA="1D6E2  \_chardef\_greekita="1D6FC
\_chardef\_greekbiA="1D71C  \_chardef\_greekbia="1D736
\_chardef\_greeksnA="1D756  \_chardef\_greeksna="1D770
\_chardef\_greeksiA="1D790  \_chardef\_greeksia="1D7AA

\_protected\_def\_itgreek    {\_umathrangegreek71\_greekita}
\_protected\_def\_rmgreek    {\_umathrangegreek71\_greekrma}
\_protected\_def\_bfgreek    {\_umathrangegreek71\_greekbfa}
\_protected\_def\_bigreek    {\_umathrangegreek71\_greekbia}
\_protected\_def\_bsansgreek {\_umathrangegreek71\_greeksna}
\_protected\_def\_bisansgreek{\_umathrangegreek71\_greeksia}
\_protected\_def\_itGreek    {\_umathrangeGREEK71\_greekitA}
\_protected\_def\_rmGreek    {\_umathrangeGREEK71\_greekrmA}
\_protected\_def\_bfGreek    {\_umathrangeGREEK71\_greekbfA}
\_protected\_def\_biGreek    {\_umathrangeGREEK71\_greekbiA}
\_protected\_def\_bsansGreek {\_umathrangeGREEK71\_greeksnA}
\_protected\_def\_bisansGreek{\_umathrangeGREEK71\_greeksiA}

\_chardef\_digitrmO="0
\_chardef\_digitbfO="1D7CE
\_chardef\_digitbbO="1D7D8
\_chardef\_digitsnO="1D7E2
\_chardef\_digitbsO="1D7EC
\_chardef\_digitttO="1D7F6

\_protected\_def\_rmdigits    {\_umathrange{0-9}71\_digitrmO}
\_protected\_def\_bfdigits    {\_umathrange{0-9}71\_digitbfO}
\_protected\_def\_bbdigits    {\_umathrange{0-9}71\_digitbbO}
\_protected\_def\_sansdigits  {\_umathrange{0-9}71\_digitsnO}
\_protected\_def\_bsansdigits {\_umathrange{0-9}71\_digitbsO}
\_protected\_def\_ttdigits    {\_umathrange{0-9}71\_digitttO}
```

The \cal, \bbchar, \frak, \script and the \rm, \bf, \it, \bi, \tt are defined here. Their "8bit definitions" from the file `math-preload.opm` (section 2.14) are removed.
You can redefine them again if you need different behavior (for example you don't want to use sans serif bold in math). What to do:

```
\_protected\_def\_bf
   {\_tryloadbf\_tenbf \_inmath{\_bfvariables\_bfgreek\_bfGreek\_bfdigits}}
\_protected\_def\_bi
   {\_tryloadbi\_tenbi \_inmath{\_bivariables\_bigreek\_bfGreek\_bfdigits}}
\_public \bf \bi ;
```

`\_inmath` {⟨*cmds*⟩} applies ⟨*cmds*⟩ only in math mode.

unimath-codes.opm

```
\_protected\_def\_inmath#1{\_relax \_ifmmode#1\_fi} % to keep off \loop processing in text mode

% You can redefine these macros to follow your wishes.
% For example you need upgright lowercase greek letters, you don't need
% \bf and \bi behaves as sans serif in math, ...

\_protected\_def\_rm {\_tryloadrm \_tenrm \_inmath{\_rmvariables \_rmdigits}}
\_protected\_def\_it {\_tryloadit \_tenit \_inmath{\_itvariables}}
\_protected\_def\_bf
   {\_tryloadbf \_tenbf \_inmath{\_bsansvariables \_bsansgreek \_bsansGreek \_bsansdigits}}
\_protected\_def\_bi
   {\_tryloadbi \_tenbi \_inmath{\_bisansvariables \_bisansgreek \_bsansGreek \_bsansdigits}}
\_protected\_def\_tt {\_tryloadtt \_tentt \_inmath{\_ttvariables \_ttdigits}}
\_protected\_def\_bbchar  {\_bbvariables \_bbdigits}
\_protected\_def\_cal     {\_calvariables}
\_protected\_def\_frak    {\_frakvariables}
\_protected\_def\_misans  {\_isansvariables \_sansdigits}
\_protected\_def\_mbisans {\_bisansvariables \_bisansgreek \_bsansGreek \_bsansdigits}
\_protected\_def\_script  {\_rmvariables \_fam4 }
\_protected\_def\_mit     {\_itvariables \_rmdigits \_itgreek \_rmGreek }

\_public \rm \it \bf \bi \tt \bbchar \cal \frak \misans \mbisans \script \mit ;
```

Each Unicode slot carries information about math type. This is saved in the file `mathclass.txt` which is copied to `mathclass.opm` The file has the following format:

mathclass.opm

```
002E;P
002F;B
0030..0039;N
003A;P
003B;P
003C;R
003D;R
003E;R
003F;P
0040;N
0041..005A;A
005B;O
005C;B
005D;C
005E;N
005F;N
```

We have to read this information and convert it to the `\Umathcodes`.

unimath-codes.opm

```
\_begingroup  % \input mathclass.opm  (which is a copy of MathClass.txt):
   \_def\_p#1;#2{\_edef\_tmp{\_pB#2}\_ifx\_tmp\_empty \_else\_pA#1....\_end#2\_fi}
   \_def\_pA#1..#2..#3\_end#4{%
      \_ifx\_relax#2\_relax \_pset{"#1}{#4}\_else
         \_umathnumA="#1
         \_loop
            \_pset{\_umathnumA}{#4}%
            \_ifnum\_umathnumA<"#2 \_advance\_umathnumA by1
         \_repeat
      \_fi
   }
   \_def\_pB#1{\_if#1L1\_fi \_if#1B2\_fi \_if#1V2\_fi \_if#1R3\_fi \_if#1N0\_fi \_if#1U0\_fi
            \_if#1F0\_fi \_if#1O4\_fi \_if#1C5\_fi \_if#1P6\_fi \_if#1A7\_fi}
   \_def\_pset#1#2{\_global\_Umathcode#1=\_tmp\_space 1 #1\_relax
      \_if#2O\_global\_Udelcode#1=1 #1\_relax\_fi
      \_if#2C\_global\_Udelcode#1=1 #1\_relax\_fi
```

```
      \_if#2F\_global\_Udelcode#1=1 #1\_relax\_fi
   }
   \_catcode`#=14
   \_everypar={\_setbox0=\_lastbox \_par \_p}
   \_input mathclass.opm
\_endgroup
```

Each math symbol has its declaration in the file `unicode-math-table.tex` which is copied to `unimath-table.opm`. The file has following format:

unimath-table.opm

```
\UnicodeMathSymbol{"00394}{\mupDelta              }{\mathalpha}{capital delta, greek}%
\UnicodeMathSymbol{"00395}{\mupEpsilon            }{\mathalpha}{capital epsilon, greek}%
\UnicodeMathSymbol{"00396}{\mupZeta               }{\mathalpha}{capital zeta, greek}%
\UnicodeMathSymbol{"00397}{\mupEta                }{\mathalpha}{capital eta, greek}%
\UnicodeMathSymbol{"00398}{\mupTheta              }{\mathalpha}{capital theta, greek}%
\UnicodeMathSymbol{"00399}{\mupIota               }{\mathalpha}{capital iota, greek}%
\UnicodeMathSymbol{"0039A}{\mupKappa              }{\mathalpha}{capital kappa, greek}%
\UnicodeMathSymbol{"0039B}{\mupLambda             }{\mathalpha}{capital lambda, greek}%
\UnicodeMathSymbol{"0039C}{\mupMu                 }{\mathalpha}{capital mu, greek}%
\UnicodeMathSymbol{"0039D}{\mupNu                 }{\mathalpha}{capital nu, greek}%
\UnicodeMathSymbol{"0039E}{\mupXi                 }{\mathalpha}{capital xi, greek}%
\UnicodeMathSymbol{"0039F}{\mupOmicron            }{\mathalpha}{capital omicron, greek}%
\UnicodeMathSymbol{"003A0}{\mupPi                 }{\mathalpha}{capital pi, greek}%
\UnicodeMathSymbol{"003A1}{\mupRho                }{\mathalpha}{capital rho, greek}%
\UnicodeMathSymbol{"003A3}{\mupSigma              }{\mathalpha}{capital sigma, greek}%
\UnicodeMathSymbol{"003A4}{\mupTau                }{\mathalpha}{capital tau, greek}%
```

We have to read this information and convert it to the Unicode math codes.

unimath-codes.opm

```
\_begingroup  % \input unimath-table.opm (it is a copy of unicode-math-table.tex):
   \_def\UnicodeMathSymbol #1#2#3#4{%
      \_global\_Umathcharnumdef#2=\_Umathcodenum#1\_relax
      \_ifx#3\_mathopen   \_gdef#2{\_Udelimiter 4 1 #1 }\_fi
      \_ifx#3\_mathclose  \_gdef#2{\_Udelimiter 5 1 #1 }\_fi
      \_ifx#3\_mathaccent \_gdef#2{\_Umathaccent fixed 7 1 #1 }\_fi
   }
   \_input unimath-table.opm
\_endgroup
```

Many special characters must be declared with care...

unimath-codes.opm

```
\_global\_Udelcode`<=1 "027E8 % these characters have different meaning
\_global\_Udelcode`>=1 "027E9 % as normal and as delimeter

\_mit % default math alphapbets setting

\_Umathcode `- = 2 1 "2212
%\_Umathcode`: = 3 1 "3A  % mathclass defines it as 6 1 "3A (punctuation)
\_let\{=\lbrace \_let\}=\rbrace

\_protected\_def \_sqrt       {\_Uradical 1 "0221A }
\_protected\_def \_cuberoot   {\_Uradical 1 "0221B }
\_protected\_def \_fourthroot {\_Uradical 1 "0221C }

\_public \sqrt \cuberoot \fourthroot ;

\_def\_intwithnolimits#1#2 {\_ifx#1\_relax \_else
   \_ea\_let\_csname\_csstring#1op\_endcsname=#1%
   \_ea\_def\_ea #1\_ea{\_csname\_csstring#1op\_endcsname \_nolimits}%
   \_bgroup \_lccode`\~=#2 \_lowercase{\_egroup \_mathcode`~="8000 \_let ~=#1}%
   \_ea \_intwithnolimits \_fi
}
\_intwithnolimits \int "0222B \iint "0222C \iiint "0222D
   \oint "0222E \oiint "0222F \oiiint "02230
   \intclockwise "02231 \varointclockwise "02232 \ointctrclockwise "02233
   \sumint "02A0B \iiiint "02A0C \intbar "02A0D \intBar "02A0E \fint "02A0F
   \pointint "02A15 \sqint "02A16 \intlarhk "02A17 \intx "02A18
   \intcap "02A19 \intcup "02A1A \upint "02A1B \lowint "02A1C \_relax "0

\_protected\_def \vert  {\_Udelimiter 0 1 "07C }
```

```
\_protected\_def \Vert  {\_Udelimiter 0 1 "02016 }
\_protected\_def \Vvert {\_Udelimiter 0 1 "02980 }

\_protected\_def \_overbrace    #1{\mathop {\Umathaccent  7 1 "023DE{#1}}\limits}
\_protected\_def \_underbrace   #1{\mathop {\Umathaccent bottom 7 1 "023DF{#1}}\limits}
\_protected\_def \_overparen    #1{\mathop {\Umathaccent  7 1 "023DC{#1}}\limits}
\_protected\_def \_underparen   #1{\mathop {\Umathaccent bottom 7 1 "023DD{#1}}\limits}
\_protected\_def \_overbracket  #1{\mathop {\Umathaccent  7 1 "023B4{#1}}\limits}
\_protected\_def \_underbracket #1{\mathop {\Umathaccent bottom 7 1 "023B5{#1}}\limits}

\_public \overbrace \underbrace \overparen \underparen \overbracket \underbracket ;

\_protected\def \widehat            {\Umathaccent 7 1 "00302 }
\_protected\def \widetilde          {\Umathaccent 7 1 "00303 }
\_protected\def \overleftharpoon    {\Umathaccent 7 1 "020D0 }
\_protected\def \overrightharpoon   {\Umathaccent 7 1 "020D1 }
\_protected\def \overleftarrow      {\Umathaccent 7 1 "020D6 }
\_protected\def \overrightarrow     {\Umathaccent 7 1 "020D7 }
\_protected\def \overleftrightarrow {\Umathaccent 7 1 "020E1 }

\_mathchardef\ldotp="612E
\_let\|=\Vert
\_mathcode`\_="8000

\_global\_Umathcode    "22EF         = 0 1 "22EF % mathclass.txt says that it is Rel
\_global\_Umathchardef \unicodecdots = 0 1 "22EF

\_global\_Umathcode `/ = 0 1 `/  % mathclass says that / is Bin, Plain TeX says that it is Ord.
```

Aliases are declared here. They are names not menitioned in the `unimath-table.opm` file but commonly used in TEX.

unimath-codes.opm

```
\_let \setminus=\smallsetminus
\_let \diamond=\smwhtdiamond
\_let \colon=\mathcolon
\_let \bullet=\smblkcircle
\_let \circ=\vysmwhtcircle
\_let \bigcirc=\mdlgwhtcircle
\_let \to=\rightarrow
\_let \le=\leq
\_let \ge=\geq
\_let \neq=\ne
\_protected\_def \triangle {\mathord{\bigtriangleup}}
\_let \emptyset=\varnothing
\_let \hbar=\hslash
\_let \land=\wedge
\_let \lor=\vee
\_let \owns=\ni
\_let \gets=\leftarrow
\_let \mathring=\ocirc
\_let \lnot=\neg
\_let \longdivisionsign=\longdivision
\_let \backepsilon=\upbackepsilon
\_let \eth=\matheth
\_let \dbkarow=\dbkarrow
\_let \drbkarow=\drbkarrow
\_let \hksearow=\hksearrow
\_let \hkswarow=\hkswarrow

\_let \upalpha=\mupalpha
\_let \upbeta=\mupbeta
\_let \upgamma=\mupgamma
\_let \updelta=\mupdelta
\_let \upepsilon=\mupvarepsilon
\_let \upvarepsilon=\mupvarepsilon
\_let \upzeta=\mupzeta
\_let \upeta=\mupeta
\_let \uptheta=\muptheta
\_let \upiota=\mupiota
```

```
\_let \upkappa=\mupkappa
\_let \uplambda=\muplambda
\_let \upmu=\mupmu
\_let \upnu=\mupnu
\_let \upxi=\mupxi
\_let \upomicron=\mupomicron
\_let \uppi=\muppi
\_let \uprho=\muprho
\_let \upvarrho=\mupvarrho
\_let \upvarsigma=\mupvarsigma
\_let \upsigma=\mupsigma
\_let \uptau=\muptau
\_let \upupsilon=\mupupsilon
\_let \upvarphi=\mupvarphi
\_let \upchi=\mupchi
\_let \uppsi=\muppsi
\_let \upomega=\mupomega
\_let \upvartheta=\mupvartheta
\_let \upphi=\mupphi
\_let \upvarpi=\mupvarpi
```

The \not macro is redefined here. If the _not!⟨*char*⟩ is defined (by _negationof) then this macro is used. Else centered / is printed over the ⟨*char*⟩.

unimath-codes.opm

```
\_protected\_def\_not#1{%
  \_trycs{_not!\_csstring#1}{\_mathrel\_mathstyles{%
     \_setbox0=\_hbox{\_math$\_currstyle#1$}%
     \_hbox to\_wd0{\_hss$\_currstyle/$\_hss}\_kern-\_wd0 \_box0
}}}
\_def\_negationof #1#2{\_ea\_let \_csname _not!\_csstring#1\_endcsname =#2}

\_negationof =         \neq
\_negationof <         \nless
\_negationof >         \ngtr
\_negationof \gets     \nleftarrow
\_negationof \simeq    \nsime
\_negationof \equal    \ne
\_negationof \le       \nleq
\_negationof \ge       \ngeq
\_negationof \greater  \ngtr
\_negationof \forksnot \forks
\_negationof \in       \notin
\_negationof \mid      \nmid
\_negationof \cong     \ncong
\_negationof \leftarrow \nleftarrow
\_negationof \rightarrow \nrightarrow
\_negationof \leftrightarrow \nleftrightarrow
\_negationof \Leftarrow \nLeftarrow
\_negationof \Leftrightarrow \nLeftrightarrow
\_negationof \Rightarrow \nRightarrow
\_negationof \exists  \nexists
\_negationof \ni      \nni
\_negationof \paralel \nparalel
\_negationof \sim     \nsim
\_negationof \approx  \napprox
\_negationof \equiv   \nequiv
\_negationof \asymp   \nasymp
\_negationof \lesssim \nlesssim
\_negationof \ngtrsim \ngtrsim
\_negationof \lessgtr \nlessgtr
\_negationof \gtrless \ngtrless
\_negationof \prec    \nprec
\_negationof \succ    \nsucc
\_negationof \subset  \nsubset
\_negationof \supset  \nsupset
\_negationof \subseteq \nsubseteq
\_negationof \supseteq \nsupseteq
\_negationof \vdash   \nvdash
\_negationof \vDash   \nvDash
```

```
\_negationof \Vdash  \nVdash
\_negationof \VDash  \nVDash
\_negationof \preccurlyeq \npreccurlyeq
\_negationof \succcurlyeq \nsucccurlyeq
\_negationof \sqsubseteq \nsqsubseteq
\_negationof \sqsupseteq \nsqsupseteq
\_negationof \vartriangleleft \nvartriangleleft
\_negationof \vartriangleright \nvartriangleright
\_negationof \trianglelefteq \ntrianglelefteq
\_negationof \trianglerighteq \ntrianglerighteq
\_negationof \vinfty \nvinfty

\_public \not ;
```

Newly declared public control sequences are used in internal macros by OpTEX. We need to get new meanings of these control sequences in private name space.

unimath-codes.opm

```
\_private
   \ldotp \cdotp \bullet \triangleleft \trianglerigt \mapstochar \rightarrow
   \prime \lhook \rightarrow \leftarrow \rhook \triangleright \triangleleft
   \Relbar \Rightarrow \relbar \rightarrow \Leftarrow \mapstochar
   \longrightarrow \Longleftrightarrow \vdots \ddots ;
```

2.16.3 A few observations

1. You can combine more fonts in math, if you register them to another math families (5, 6, 7, etc.) in the `\normalmath` macro.

The default value of `\normalmath` shows a combination of base Unicode Math font with 8bit Math font at family 4. See definition of the `\script` macro where `\fam4` is used. Of course, we need to set `\rmvariables` too, because 8bit font accepts only codes less than 255.

2. XITSmath-bold needs correction: the norm symbol $\|x\|$ is missing here. So, you can define:

```
\def\_boldmath{%
   \loadumathfamily 1 {[xitsmath-bold]}{} % Base font
   \loadmathfamily  4 rsfs                % script
   \loadumathfamily 5 {[xitsmath-regular]}{}
   \def\|{\Udelimiter 0 5 "02016 }%       % norm delimiter from family 5
   \setmathdimens
}
```

3. You can combine more Unicode math fonts in single formula using OpTEX trick 0030.

2.16.4 Printing all Unicode math slots in used math font

This file can be used for testing your Unicode Math font and/or for printing TEX sequences which can be used in math.

Load Unicode math font first (for example by `\fontfam[termes]` or by `\loadmath{`⟨*math-font*⟩`}`) and then you can do `\input print-unimath.opm`. The big table with all math symbols is printed.

print-unimath.opm

```
\_codedecl \_undefined {Printing Unicode-math table \string<2020-06-08>}

\_begingroup
   \_def\UnicodeMathSymbol#1#2#3#4{%
      \_ifnum#1>"10000 \_endinput \_else \_printmathsymbol{#1}{#2}{#3}{#4}\_fi
   }
   \_def\UnicodeMathSymbolA#1#2#3#4{%
      \_ifnum#1>"10000 \_printmathsymbol{#1}{#2}{#3}{#4}\_fi
   }
   \_def\_printmathsymbol#1#2#3#4{%
      \_hbox{\_hbox to2em{$#2{}$\_hss}\_hbox to3em
          {\small\_printop#3\_hss}{\_tt\_string#2\_trycs{_eq:\_string#2}{}}}
   }
   \_def\_eq#1#2{\_sdef{_eq:\_string#2}{=\_string#1}}
   \_eq \diamond\smwhtdiamond \_eq \bullet\smblkcircle \_eq \circ\vysmwhtcircle
   \_eq \bigcirc\mdlgwhtcircle \_eq \to\rightarrow \_eq \le\leq
```

```
   \_eq \ge\geq \_eq \neq\ne \_eq \emptyset\varnothing \_eq \hbar\hslash
   \_eq \land\wedge \_eq \lor\vee \_eq \owns\ni \_eq \gets\leftarrow
   \_eq \mathring\ocirc \_eq \lnot\neg \_eq \backepsilon\upbackepsilon
   \_eq \eth\matheth \_eq \dbkarow\dbkarrow \_eq \drbkarow\drbkarrow
   \_eq \hksearow\hksearrow  \_eq \hkswarow\hkswarrow

   \_tracinglostchars=0
   \_fontdef\small{\_setfontsize{at5pt}\_rm}
   \_def\_printop{\_def\mathop{Op}}
   \_def\mathalpha{Alph}\_def\mathord{Ord}\_def\mathbin{Bin}\_def\mathrel{Rel}
   \_def\mathopen{Open}\_def\mathclose{Close}\_def\mathpunct{Punct}\_def\mathfence{Fence}
   \_def\mathaccent{Acc}\_def\mathaccentwide{Accw}\_def\mathbotaccentwide{AccBw}
   \_def\mathbotaccent{AccB}\_def\mathaccentoverlay{AccO}
   \_def\mathover{Over}\_def\mathunder{Under}
   \_typosize[7.5/9]\_normalmath \_everymath={}

   Codes U+00000 \_dots\ U+10000
   \_begmulti 3
      \_input unimath-table.opm
   \_endmulti

   \_medskip\_goodbreak
   Codes U+10001 \_dots\ U+1EEF1  \_let\UnicodeMathSymbol=\UnicodeMathSymbolA
   \_begmulti 4
      \_input unimath-table.opm
   \_endmulti
\_endgroup
```

2.17 Scaling fonts in document (high-level macros)

These macros are documented in section 1.3.2 from user point of view.

fonts-opmac.opm

```
\_codedecl \typosize {Font managing macros from OPmac <2020-12-12>} % loaded in format
```

`\typosize` [⟨*font-size*⟩/⟨*baselineskip*⟩] sets given parameters. It sets text font size by the `\setfontsize` macro and math font sizes by setting internal macros `\_sizemtext`, `\_sizemscript` and `\_sizemsscript`. It uses common concept font thes sizes: 100 %, 70 % and 50 %. The `\_setmainvalues` sets the parameters as main values when the `\_typosize` is called first.

fonts-opmac.opm

```
\_protected\_def \_typosize [#1/#2]{%
   \_textfontsize{#1}\_mathfontsize{#1}\_setbaselineskip{#2}%
   \_setmainvalues \_ignorespaces
}
\_protected\_def \_textfontsize #1{\_if$#1$\_else \_setfontsize{at#1\_ptunit}\_fi}

\_def \_mathfontsize #1{\_if$#1$\_else
    \_tmpdim=#1\_ptunit
    \_edef\_sizemtext{\_ea\_ignorept \_the\_tmpdim \_ptmunit}%
    \_tmpdim=0.7\_tmpdim
    \_edef\_sizemscript{\_ea\_ignorept \_the\_tmpdim \_ptmunit}%
   \_tmpdim=#1\_ptunit \_tmpdim=0.5\_tmpdim
    \_edef\_sizemsscript{\_ea\_ignorept \_the\_tmpdim \_ptmunit}%
    \_fi
}
\_public \typosize ;
```

`\typoscale` [⟨*font-factor*⟩/⟨*baseline-factor*⟩] scales font size and baselineskip by given factors in respect to current values. It calculates the `\typosize` parameters and runs the `\typosize`.

fonts-opmac.opm

```
\_protected\_def \_typoscale [#1/#2]{%
   \_ifx$#1$\_def\_tmp{[/}\_else
      \_settmpdim{#1}\_optsize
      \_edef\_tmp{[\_ea\_ignorept\_the\_tmpdim/}\_fi
   \_ifx$#2$\_edef\_tmp{\_tmp]}\_else
      \_settmpdim{#2}\_baselineskip
      \_edef\_tmp{\_tmp \_ea\_ignorept\_the\_tmpdim]}\_fi
   \_ea\_typosize\_tmp
}
```

```
\_def\_settmpdim#1#2{%
   \_tmpdim=#1pt \_divide\_tmpdim by1000
   \_tmpdim=\_ea\_ignorept \_the#2\_tmpdim
}
\_public \typoscale ;
```

_setbaselineskip {⟨*baselineskip*⟩} sets new \baselineskip and more values of registers which are dependent on the ⟨*baselineskip*⟩ including the \strutbox.

fonts-opmac.opm

```
\_def \_setbaselineskip #1{\_if$#1$\_else
   \_tmpdim=#1\_ptunit
   \_baselineskip=\_tmpdim \_relax
   \_bigskipamount=\_tmpdim plus.33333\_tmpdim minus.33333\_tmpdim
   \_medskipamount=.5\_tmpdim plus.16666\_tmpdim minus.16666\_tmpdim
   \_smallskipamount=.25\_tmpdim plus.08333\_tmpdim minus.08333\_tmpdim
   \_normalbaselineskip=\_tmpdim
   \_jot=.25\_tmpdim
   \_maxdepth=.33333\_tmpdim
   \_setbox\_strutbox=\_hbox{\_vrule height.709\_tmpdim depth.291\_tmpdim width0pt}%
   \_fi
}
```

_setmainvalues sets the current font size and \baselineskip values to the \mainfosize and \mainbaselineskip registers. It redefines itself in order to set the main values only first.
\scalemain returns to these values if they were set. Else they are set to 10/12 pt.

fonts-opmac.opm

```
\_newskip   \_mainbaselineskip   \_mainbaselineskip=0pt \_relax
\_newdimen  \_mainfosize         \_mainfosize=0pt

\_def\_setmainvalues {%
   \_mainbaselineskip=\_baselineskip
   \_mainfosize=\_optsize
   \_topskip=\_mainfosize \_splittopskip=\_topskip
   \_ifmmode \_else \_bf \_it \_bi \_rm \_fi % load all basic variants of the family
   \_normalmath  % load fonts if \typosize is running first
   \_let \_setmainvalues =\_setmainvaluesL
}
\_def\_setmainvaluesL {\_ifmmode \_normalmath \_else
   \_rm \_everymath={\_normalmath}\_everydisplay={\_normalmath}\_fi}
\_def\_scalemain {%
   \_ifdim \_mainfosize=\_zo
       \_mainfosize=10pt  \_mainbaselineskip=12pt
       \_let \_setmainvalues=\_setmainvaluesL
    \_fi
   \_optsize=\_mainfosize  \_baselineskip=\_mainbaselineskip
}
\_public \scalemain \mainfosize \mainbaselineskip ;
```

\thefontsize [⟨*size*⟩] and \thefontscale [⟨*factor*⟩] do modification of the size of the current font. They are implemented by the \newcurrfontsize macro.

fonts-opmac.opm

```
\_protected\_def\_thefontsize[#1]{\_if$#1$\_else
     \_tmpdim=#1\_ptunit
     \_newcurrfontsize{at\_tmpdim}%
  \_fi
  \_ignorespaces
}
\_protected\_def\_thefontscale[#1]{\_ifx$#1$\_else
     \_tmpdim=#1pt \_divide\_tmpdim by1000
     \_tmpdim=\_ea\_ea\_ea\_ignorept \_pdffontsize\_font \_tmpdim
     \_newcurrfontsize{at\_tmpdim}%
  \_fi
  \_ignorespaces
}
\_public \thefontsize \thefontscale ;
```

\em keeps the weight of the current vaiant and switches roman ↔ italic. It adds the italic correction by the _additcorr and _afteritcorr macros. The second does not add italic correction if the next character is dot or comma.

fonts-opmac.opm

```
\_protected\_def\_em {%
   \_ea\_ifx \_the\_font \_tenit \_additcorr \_rm  \_else
   \_ea\_ifx \_the\_font \_tenbf \_bi\_aftergroup\_afteritcorr\_else
   \_ea\_ifx \_the\_font \_tenbi \_additcorr \_bf  \_else
   \_it \_aftergroup\_afteritcorr\_fi\_fi\_fi
}
\_def\_additcorr{\_ifdim\_lastskip>\_zo
   \_skip0=\_lastskip \_unskip\_italcorr \_hskip\_skip0 \_else\_italcorr \_fi}
\_def\_afteritcorr{\_futurelet\_next\_afteritcorrA}
\_def\_afteritcorrA{\_ifx\_next.\_else\_ifx\_next,\_else \_italcorr \_fi\_fi}
\_let\_italcorr=\/
```

The \boldify macro does \let\it\bi and \let\normalmath=\boldmath.

fonts-opmac.opm

```
\_protected\_def \_boldify {%
   \_let \_setmainvalues=\_setmainvaluesL
   \_let\it =\_bi \_let\rm =\_bf \_let\_normalmath=\_boldmath \_bf
}
\_public \em \boldify ;
```

We need to use a font selector for default pagination. Because we don't know what default font size will be selected by the user, we use this _rmfixed macro. It sets the \rm font from default font size (declared by first \typosize command and redefines itself be only the font switch for next pages.

fonts-opmac.opm

```
\_def \_rmfixed {% used in default \footline
   {\_ifdim\_mainfosize=0pt \_mainfosize=10pt \_fi
    \_fontdef\_tenrm{\_setfontsize{at\mainfosize}\_resetmod\_rm}%
    \_global\_let\_rmfixed=\_tenrm}% next use will be font switch only
   \_rmfixed
}
\_let \rmfixed = \_tenrm % user can redefine it
```

2.18 Output routine

The output routine _optexoutput is similar as in plain TEX. It does:

- _begoutput which does:
  - increments \gpageno,
  - prints _Xpage{⟨*gpageno*⟩}{⟨*pageno*⟩} to the .ref file (if \openref is active),
  - calculates \hoffset,
  - sets local meaning of macros used in headlines/footlines (see \regmacro).
- \shipout_completepage, which is \vbox of –
  - backrground box, if \pgbackground is non-empty,
  - headline box by _makeheadline, if the \headline is nonempty,
  - \vbox to\vsize of _pagecontents which cosnists of –
    - _pagedest, the page destination pg:⟨*gpageno*⟩ for hyperlinks is created here,
    - \topins box if non-empty (from \topinserts),
    - \box255 with completed vertical material from main vertical mode,
    - _footnoterule and \footins box if nonempty (from \fnote, \footnote),
    - \pgbottomskip (default is 0 pt).
  - footline box by _makefootline, if the \footline is nonempty
- _endoutput which does:
  - increments \pageno using \advancepageno
  - runs output routine repeatedly if \dosupereject is activated.

output.opm

```
\_codedecl \nopagenumbers {Output routine <2020-03-28>} % preloaded in format
```

_optexoutput is default output routine. You can create another...

output.opm

```
\_output={\_optexoutput}
\_def \_optexoutput{\_begoutput \_shipout\_completepage \_endoutput}
```

Default _begoutput and _endoutput is defined. If you need another functionality implemented in the output routine, you can \addto_begoutput{...} or \addto_endoutput{...}. The settings here is local in the \output group.

The _prepoffsets can set \hoffset differently for left or right page. It is re-defined by the \margins macro..

The _regmark tokens list includes accumulated #2 from the \regmacro. Logos and another macros are re-defined here (locally) for their usage in headlines or footlines.

output.opm

```
\_def \_begoutput{\_incr\_gpageno
   \_immediate\_wref\_Xpage{{\_the\_gpageno}{\_folio}}%
   \_setxhsize \_prepoffsets \_the\_regmark}
\_def \_endoutput{\_advancepageno
   {\_globaldefs=1 \_the\_nextpages \_nextpages={}}%
   \_ifnum\_outputpenalty>-20000 \_else\_dosupereject\_fi
}
\_def \_prepoffsets {}
```

The \hsize value can be changed at various places in the document but we need to have constant value _xhsize in output routine (for headlines and footlines, for instance). This value is set from current value of \hsize when _setxhsize macro is called. This macro destroys itself, so the value is set only once. Typicaly it is done when first _optexoutput routine is called (see _begoutput). Or it is called at begining of the \begtt...\endtt environment before \hsize value is eventually changed by user in this environment.

output.opm

```
\_newdimen \_xhsize
\_def\_setxhsize {\_global\_xhsize=\_hsize \_global\_let\_setxhsize=\_relax}
```

\gpageno counts pages from one in whole document

output.opm

```
\_newcount\_gpageno
\_public \gpageno ;
```

The _completepage is similar what plain TEX does in its output routine. New is only _backgroundbox. It is \vbox with zero height with its contents (from \pgbackground) llaped down. It is shifted directly to the left-upper corner of the paper.

The _ensureblack sets the typesetting of its parameter locally to \Black color. We needn't do this if colors are never used in the document. So, default value of the _ensureblack macro is empty. But first usage of color macros in the document re-defines _ensureblack. See the section 2.20 for more details.

output.opm

```
\_def\_completepage{\_vbox{%
     \_istoksempty \_pgbackground
        \_iffalse \_ensureblack{\_backgroundbox{\_the\_pgbackground}}\_nointerlineskip \_fi
     \_ensureblack{\_makeheadline}%
     \_vbox to\_vsize {\_boxmaxdepth=\_maxdepth \_pagecontents}% \pagebody in plainTeX
     \_ensureblack{\_makefootline}}%
}
\_def \_ensureblack #1{#1} % will be re-defined by color macros
\_let \_openfnotestack = \_relax % will be re-defined by color macros
\_def \_backgroundbox #1{\_moveleft\_hoffset\_vbox to\_zo{\_kern-\_voffset #1\_vss}}
```

_makeheadline creates \vbox to0pt with its contents (the \headline) shifted by \headlinedist up.

output.opm

```
\_def\_makeheadline {\_istoksempty \_headline \_iffalse
   \_vbox to\_zo{\_vss
                \_baselineskip=\_headlinedist \_lineskiplimit=-\_maxdimen
                \_hbox to\_xhsize{\_the\_headline}\_hbox{}}\_nointerlineskip
   \_fi
}
```

The _makefootline appends the \footline to the page-body box.

output.opm

```
\_def\_makefootline{\_istoksempty \_footline \_iffalse
      \_baselineskip=\_footlinedist
      \_lineskiplimit=-\_maxdimen \_hbox to\_xhsize{\_the\_footline}
   \_fi
}
```

The _pagecontents is similar as in plain TEX. The only differnece is that the _pagedest is inserted at the top of _pagecontents and _ensureblack is applied to the \topins and \footins material. The _footnoterule is defined here.

output.opm

```
\_def\_pagecontents{\_pagedest % destination of the page
  \_ifvoid\_topins \_else \_ensureblack{\_unvbox\_topins}\_fi
  \_dimen0=\_dp255 \_unvbox255 % open up \box255
  \_ifvoid\_footins \_else % footnote info is present
    \_vskip\_skip\_footins
    \_ensureblack{\_footnoterule \_openfnotestack \_unvbox\_footins}\_fi
  \_kern-\_dimen0 \_vskip \_pgbottomskip
}
\_def \_pagedest {{\_def\_destheight{25pt}\_dest[pg:\_the\_gpageno]}}
\_def \_footnoterule {\_kern-3pt \_hrule width 2truein \_kern 2.6pt }
```

\pageno, \folio, \nopagenumbers, \advancepageno and \normalbottom used in the context of the output routine from plain TEX is defined here. Only the \raggedbottom macro is defined differently. We use the \pgbottomskip register here which is set to 0 pt by default.

output.opm

```
\_countdef\_pageno=0 \_pageno=1 % first page is number 1
\_def \_folio {\_ifnum\_pageno<0 \_romannumeral-\_pageno \_else \_number\_pageno \_fi}
\_def \_nopagenumbers {\_footline={}}
\_def \_advancepageno {%
   \_ifnum\_pageno<0 \_global\_advance\_pageno by-1 \_else \_incr\_pageno \_fi
} % increase |pageno|
\_def \_raggedbottom {\_topskip=\_dimexpr\_topskip plus60pt \_pgbottomskip=0pt plus1fil\_relax}
\_def \_normalbottom {\_topskip=\_dimexpr\_topskip \_pgbottomskip=0pt\_relax}

\_public \pageno \folio \nopagenumbers \advancepageno \raggedbottom \normalbottom ;
```

Macros for footnotes are the same as in plain TEX. There is only one difference: \vfootnote is implemented as _opfootnote with empty parameter #1. This parameter should do a local settings inside the \footins group and it does it when \fnote macro is used.
The _opfootnote nor \vfootnote don't take the footnote text as a parameter. This is due to user can do catcode settings (like inline verbatim) in the footnote text. This idea is adapted from plain TEX.
The \footnote and \footstrut is defined as in plain TEX.

output.opm

```
\_newinsert\_footins
\_def \_footnote #1{\_let\_osf=\_empty % parameter #2 (the text) is read later
   \_ifhmode \_edef\_osf{\_spacefactor\_the\_spacefactor}\/\_fi
  #1\_osf\_vfootnote{#1}}
\_def\_vfootnote{\_opfootnote{}}
\_def \_opfootnote #1#2{\_insert\_footins\_bgroup
  \_interlinepenalty=\_interfootnotelinepenalty
  \_leftskip=\_zo \_rightskip=\_zo \_spaceskip=\_zo \_xspaceskip=\_zo \_relax
  \_let\_colorstackcnt=\_fnotestack % special color stack for footnotes
  #1\_relax % local settings used by \fnote macro
  \_splittopskip=\_ht\_strutbox % top baseline for broken footnotes
  \_splitmaxdepth=\_dp\_strutbox \_floatingpenalty=20000
  \_textindent{#2}\_footstrut
  \_isnextchar \_bgroup
     {\_bgroup \_aftergroup\_vfootA \_afterassignment\_ignorespaces \_let\_next=}{\_vfootB}%
}
\_def\_vfootA{\_unskip\_strut\_isnextchar\_colorstackpop\_closefncolor\_vfootF}
\_def\_vfootB #1{#1\_unskip\_strut\_vfootF}
\_def\_vfootF{\_egroup} % close \_insert\_footins\_bgroup
\_def\_closefncolor#1{#1\_isnextchar\_colorstackpop\_closefncolor\_vfootF}
\_def \_footstrut {\_vbox to\_splittopskip{}}
\_skip\_footins=\_bigskipamount % space added when footnote is present
\_count\_footins=1000 % footnote magnification factor (1 to 1)
\_dimen\_footins=8in % maximum footnotes per page
\_public
   \footins \footnote \vfootnote \footstrut ;
```

The \topins macros \topinsert, \midinsert, \pageinsert, \endinsert are the same as in plain TEX.

output.opm

```
\_newinsert\_topins
\_newifi\_ifupage \_newifi\_ifumid
\_def \_topinsert {\_umidfalse \_upagefalse \_oins}
\_def \_midinsert {\_umidtrue \_oins}
\_def \_pageinsert {\_umidfalse \_upagetrue \_oins}
\_skip\_topins=\_zoskip % no space added when a topinsert is present
```

```
\_count\_topins=1000 % magnification factor (1 to 1)
\_dimen\_topins=\_maxdimen % no limit per page
\_def \_oins {\_par \_begingroup\_setbox0=\_vbox\_bgroup} % start a \_vbox
\_def \_endinsert {\_par\_egroup % finish the \_vbox
  \_ifumid \_dimen0=\_ht0 \_advance\_dimen0 by\_dp0 \_advance\_dimen0 by\_baselineskip
    \_advance\_dimen0 by\_pagetotal \_advance\_dimen0 by-\_pageshrink
    \_ifdim\_dimen0>\_pagegoal \_umidfalse \_upagefalse \_fi \_fi
  \_ifumid \_bigskip \_box0 \_bigbreak
  \_else \_insert \_topins {\_penalty100 % floating insertion
    \_splittopskip=0pt
    \_splitmaxdepth=\_maxdimen \_floatingpenalty=0
    \_ifupage \_dimen0=\_dp0
    \_vbox to\_vsize {\_unvbox0 \_kern-\_dimen0}% depth is zero
    \_else \_box0 \_nobreak \_bigskip \_fi}\_fi\_endgroup}

\_public \topins \topinsert \midinsert \pageinsert \endinsert ;
```

The \draft macro is an example of usage _pgbackground to create water color marks.

output.opm

```
\_def \_draft {\_pgbackground={\_draftbox{\_draftfont DRAFT}}%
   \_fontdef\_draftfont{\_setfontsize{at10pt}\_bf}%
   \_global\_let\_draftfont=\_draftfont
}
\_def \_draftbox #1{\_setbox0=\_hbox{#1}%
   \_kern.5\_vsize \_kern4.5\_wd0
   \_hbox to0pt{\_kern.5\_xhsize \_kern-1\_wd0
   \_pdfsave \_pdfrotate{55}\_pdfscale{10}{10}%
   \_hbox to0pt{\_localcolor\LightGrey \_box0\_hss}%
   \_pdfrestore
   \_hss}%
}
\_public \draft ;
```

2.19 Margins

The \margins macro is documented in the section 1.2.1.

margins.opm

```
\_codedecl \margins {Macros for margins setting <2020-03-14>} % preloaded in format
```

\margins/⟨*pg*⟩ ⟨*fmt*⟩ (⟨*left*⟩,⟨*right*⟩,⟨*top*⟩,⟨*bot*⟩)⟨*unit*⟩ takes its parameters, does calculation and sets \hoffset, \voffset, \hsize and \vsize registers. Note that OpTEX sets the page origin at the top left corner of the paper, no at the obscure position 1 in, 1 in. It is much more comfortable for macro writers.

margins.opm

```
\_newdimen\_pgwidth  \_newdimen\_pgheight  \_pgwidth=0pt
\_newdimen\_shiftoffset

\_def\_margins/#1 #2 (#3,#4,#5,#6)#7 {\_def\_tmp{#7}%
   \_ifx\_tmp\_empty
      \_opwarning{\_string\_margins: missing unit, mm inserted}\_def\_tmp{mm}\_fi
   \_setpagedimens #2 % setting \_pgwidth, \_pgheight
   \_ifdim\_pgwidth=0pt \_else
      \_hoffset=0pt \_voffset=0pt
      \_if$#3$\_if$#4$\_hoffset =\_dimexpr (\_pgwidth -\_hsize)/2 \_relax
              \_else  \_hoffset =\_dimexpr \_pgwidth -\_hsize - #4\_tmp \_relax % only right margin
              \_fi
      \_else  \_if$#4$\_hoffset = #3\_tmp \_relax  % only left margin
              \_else  \_hsize =\_dimexpr \_pgwidth - #3\_tmp - #4\_tmp \_relax % left+right margin
                      \_hoffset = #3\_tmp \_relax
      \_fi\_fi
      \_if$#5$\_if$#6$\_voffset =\_dimexpr (\_pgheight -\_vsize)/2 \_relax
              \_else  \_voffset =\_dimexpr \_pgheight -\_vsize - #6\_tmp \_relax % only bottom margin
              \_fi
      \_else  \_if$#6$\_voffset = #5\_tmp \_relax  % only top margin
              \_else  \_vsize=\_dimexpr \_pgheight - #5\_tmp - #6\_tmp \_relax % top+bottom margin
                      \_voffset = #5\_tmp \_relax
      \_fi\_fi
      \_if 1#1\_shiftoffset=0pt \_def\_prepoffsets{}\_else \_if 2#1% double-page layout
         \_shiftoffset = \_dimexpr \_pgwidth -\_hsize -2\_hoffset \_relax
```

```
        \_def\_prepoffsets{\_ifodd\_pageno \_else \_advance\_hoffset \_shiftoffset \_fi}%
      \_else \_opwarning{use \_string\_margins/1 or \_string\_margins/2}%
   \_fi\_fi\_fi
}
\_def\_setpagedimens{\_isnextchar({\_setpagedimensB}{\_setpagedimensA}}
\_def\_setpagedimensA#1 {\_ifcsname _pgs:#1\_endcsname
   \_ea\_ea\_ea\_setpagedimensB \_csname _pgs:#1\_ea\_endcsname\_space
   \_else \_opwarning{page specification "#1" is undefined}\_fi}
\_def\_setpagedimensB (#1,#2)#3 {\_setpagedimensC\_pgwidth=#1:#3
                                 \_setpagedimensC\_pgheight=#2:#3
        \_pdfpagewidth=\_pgwidth \_pdfpageheight=\_pgheight
}
\_def\_setpagedimensC #1=#2:#3 {#1=#2\_ifx^#3^\_tmp\_else#3\_fi\_relax\_truedimen#1}

\_public \margins ;
```

The common page dimensions are defined here.

margins.opm

```
\_sdef{_pgs:a3}{(297,420)mm}  \_sdef{_pgs:a4}{(210,297)mm}  \_sdef{_pgs:a5}{(148,210)mm}
\_sdef{_pgs:a3l}{(420,297)mm} \_sdef{_pgs:a4l}{(297,210)mm} \_sdef{_pgs:a5l}{(210,148)mm}
\_sdef{_pgs:b5}{(176,250)mm}  \_sdef{_pgs:letter}{(8.5,11)in}
```

\magscale [⟨*factor*⟩] does \mag=⟨*factor*⟩ and recalculates page dimensions to their true values.

margins.opm

```
\_def\_trueunit{}
\_def\_magscale[#1]{\_mag=#1\_def\_trueunit{true}%
   \_ifdim\_pgwidth=0pt \_else \_truedimen\_pgwidth \_truedimen\_pgheight \_fi
   \_truedimen\_pdfpagewidth \_truedimen\_pdfpageheight
}
\_def\_truedimen#1{\_ifx\_trueunit\_empty \_else#1=\_ea\_ignorept\_the#1truept \_fi}

\_public \magscale ;
```

2.20 Colors

The colors have different behavior than fonts. A marks (whatsits) with color information are stored into PDF output and TEX doesn't interpret them. The PDF viewer (or PDF interpreter in a printer) reads these marks and switches colors according to them. This is totally independent on TEX group mechanism. You can declare \nolocalcolor at the beginning of the document, if you want this behavior. In this case, if you set a color then you must to return back to black color using \Black manually.

By default, OpTEX sets \localcolor. It means that the typesetting returns back to a previous color at the end of current group, so you cannot write \Black explicitly. This is implemented using \aftergroup feature. There is a limitation of this feature: when a color selector is used in a group of a box, which is saved by \setbox, then the activity or reconstruction of previous color are processed at \setbox time, no in the box itself. You must correct it by double group:

```
\setbox0=\hbox{\Red text}   % bad:  \Black is done after \setbox
\setbox0=\hbox{{\Red text}} % good: \Black is done after group inside the box
```

The implementation of colors is based on colorstack, so the current color can follow across more pages. It is not so obvious because PDF viewer (or PDF interpreter) manipulates with colors locally at each PDF page and it initializes each PDF page with black on white color.

Macros \setcmykcolor{⟨*C*⟩ ⟨*M*⟩ ⟨*Y*⟩ ⟨*K*⟩} or \setrgbcolor{⟨*R*⟩ ⟨*G*⟩ ⟨*B*⟩} or \setgreycolor{⟨*Grey*⟩} should be used in color selectors or user can specify these macros explicitly.

The color mixing processed by the \colordef is done in the substractive color model CMYK. If the result has a component greater than 1 then all components are multiplied by a coefficient in order to maximal component is equal to 1.

You can move a shared amount of CMY components (i.e. their minimum) to the K component. This saves the color tonners and the result is more true. This should be done by \useK command at the end of a linear combination used in \colordef. For example

```
\colordef \myColor {.3\Green + .4\Blue \useK}
```

The \useK command exactly does:

$$k' = \min(C, M, Y),$$
$$C = (C - k')/(1 - k'),\ M = (M - k')/(1 - k'),\ Y = (Y - k')/(1 - k'),$$
$$K = \min(1, K + k').$$

You can use minus instead plus in the linear combination in \colordef. The given color is substracted in such case and the negative components are rounded to zero immediately. For example

```
\colordef \Color {\Brown-\Black}
```

can be used for removing black component from the color. You can use the -\Black trick after \useK command in order to remove grey components occured during color mixing.

Finally, you can use ^ immediately preceeded before macro name of the color. Then the complementary color is used here.

```
\colordef\mycolor{\Grey+.6^\Blue} % the same as \colordef\mycolor{\Grey+.6\Yellow}
```

The \rgbcolordef can be used to mix colors in additive color model RGB. If \onlyrgb is declared, then \colordef works as \rgbcolordef.

If a CMYK to RGB or RGB to CMYK conversion is needed then the following simple formulae are used (ICC profiles are not supported):

CMYK to RGB:
$$R = (1 - C)(1 - K),\ G = (1 - M)(1 - K),\ B = (1 - Y)(1 - K).$$
RGB to CMYK:
$$K' = \max(R, G, B),\ C = (K' - R)/K',\ M = (K' - G)/K',\ Y = (K' - B)/K',\ K = 1 - K'.$$

The RGB to CMYK conversion is invoked when a color is declared using \setrgbcolor and it is used in \colordef or if it is printed when \onlycmyk is declared. The CMYK to RGB conversion is invoked when a color is declared using \setcmykcolor and it is used in \rgbcolordef or if it is printed when \onlyrgb is declared.

colors.opm
```
\_codedecl \colordef {Colors <2020-03-18>} % loaded in format
```

We declare internal boolean value _iflocalcolor ad do \localcolor as default.

colors.opm
```
\_newifi \_iflocalcolor \_localcolortrue
\_protected\_def \_localcolor   {\_localcolortrue}
\_protected\_def \_nolocalcolor {\_localcolorfalse}
\_public \localcolor \nolocalcolor ;
```

The basic colors in CMYK \Blue \Red \Brown \Green \Yellow \Cyan \Magenta \Grey \LightGrey \White and \Black are declared here.

colors.opm
```
\_def\Blue      {\_setcmykcolor{1 1 0 0}}
\_def\Red       {\_setcmykcolor{0 1 1 0}}
\_def\Brown     {\_setcmykcolor{0 0.67 0.67 0.5}}
\_def\Green     {\_setcmykcolor{1 0 1 0}}
\_def\Yellow    {\_setcmykcolor{0 0 1 0}}
\_def\Cyan      {\_setcmykcolor{1 0 0 0}}
\_def\Magenta   {\_setcmykcolor{0 1 0 0}}
\_def\Grey      {\_setcmykcolor{0 0 0 0.5}}
\_def\LightGrey {\_setcmykcolor{0 0 0 0.2}}
\_def\White     {\_setgreycolor{1}}
\_def\Black     {\_setgreycolor{0}}
```

By default, the \setcmykcolor \setrgbcolor and \setgreycolor macros with {⟨*componetns*⟩} parameter expand to _setcolor{⟨*pdf-primitive*⟩} using _formatcmyk or _formatrgb or _formatgrey expandable macros. For example \setrgbcolor{1 0 0} expands to _setcolor{1 0 0 rg 1 0 0 RG}. We set both types of colors (for lines (K or RG or G) and for fills (r or rg or g) together in the ⟨*pdf-primitive*⟩ command. This is the reason why the _fillstroke uses both its parameters. If only fills are needed you can do \def_fillstroke#1#2{#1}. If only strokes are needed you can do \def_fillstroke#1#2{#2}.

colors.opm

```
\_def\_setcmykcolor#1{\_setcolor{\_formatcmyk{#1}}}
\_def\_setrgbcolor#1{\_setcolor{\_formatrgb{#1}}}
\_def\_setgreycolor#1{\_setcolor{\_formatgrey{#1}}}
\_def\_formatcmyk#1{\_fillstroke{#1 k}{#1 K}}
\_def\_formatrgb#1{\_fillstroke{#1 rg}{#1 RG}}
\_def\_formatgrey#1{\_fillstroke{#1 g}{#1 G}}
\_def\_fillstroke#1#2{#1 #2}
\_public \setcmykcolor \setrgbcolor \setgreycolor ;
```

The \onlyrgb declaration redefines _formatcmyk in order it expands to its conversion to RGB ⟨*pdf-primitive*⟩. This conversion is done by the _cmyktorgb macro. Moreover, \onlyrgb re-defines three basic RGB colors for RGB color space and re-declares \colordef as \rgbcolordef. The \onlycmyk macro does a similar work, it re-defines _formatrgb macro. The Grey color space is unchanged and works in both main settings (RGB or CMYK) without collisions.

colors.opm

```
\_def\_onlyrgb{\_def\Red{\_setrgbcolor{1 0 0}}%
   \_def\Green{\_setrgbcolor{0 1 0}}\_def\Blue{\_setrgbcolor{0 0 1}}%
   \_let\_colordef=\_rgbcolordef
   \_def\_formatrgb##1{\_fillstroke{##1 rg}{##1 RG}}%
   \_def\_formatcmyk##1{\_fillstroke{\_cmyktorgb ##1 ; rg}{\_cmyktorgb ##1 ; RG}}}
\_def\_onlycmyk{\_def\_formatcmyk##1{\_fillstroke{##1 k}{##1 K}}%
   \_def\_formatrgb##1{\_fillstroke{\_rgbtocmyk ##1 ; k}{\_rgbtocmyk ##1 ; K}}}
\_public \onlyrgb \onlycmyk ;
```

The _setcolor macro redefines empty _ensureblack macro (used in output routine for headers and footers) to _ensureblackA which sets Black at the start of its parameter and returns to the current color at the end of its parameter.

The current color is saved into _currentcolor macro and colorstack is pushed. Finally, the _colorstackpop is initialized by \aftergroup if \localcolor is declared.

You can save current color to your macro by \let\yourmacro=_currentcolor and you can return to this color by the command _setcolor\yourmacro.

colors.opm

```
\_protected\_def \_setcolor #1{\_global\_let\_ensureblack=\_ensureblackA
   \_iflocalcolor \_edef\_currentcolor{#1}\_colorstackpush\_currentcolor
                  \_aftergroup\_colorstackpop
   \_else         \_xdef\_currentcolor{#1}\_colorstackset\_currentcolor \_fi
}
\_def\_pdfblackcolor{0 g 0 G}
\_edef\_currentcolor{\_pdfblackcolor}
\_def\_ensureblackA#1{\_global\_let\_openfnotestack=\_openfnotestackA
   \_colorstackpush\_pdfblackcolor #1\_colorstackpop}
```

The colorstack is initialized here and the basic macros _colorstackpush, _colorstackpop and _colorstackset are defined here.

colors.opm

```
\_mathchardef\_colorstackcnt=0 % Implicit stack usage
\_def\_colorstackpush#1{\_pdfcolorstack\_colorstackcnt push{#1}}
\_def\_colorstackpop{\_pdfcolorstack\_colorstackcnt pop}
\_def\_colorstackset#1{\_pdfcolorstack\_colorstackcnt set{#1}}
```

We need to open a special color stack for footnotes, because footnotes can follow on next pages and their colors are independent on colors used in the main page-body. The _openfnotestack is defined as _openfnotestackA when the _setcolor is used first. The _fnotestack is initialized in in \everyjob because the initialization is not saved to the format.

colors.opm

```
%\_mathchardef\_fnotestack=\_pdfcolorstackinit page {0 g 0 G} % must be in \everyjob
\_def \_openfnotestackA {\_pdfcolorstack\_fnotestack current}
```

We use lua codes for RGB to CMYK or CMYK to RGB conversions and for addition color components in the \colordef macro. The _rgbtocmyk ⟨*R*⟩ ⟨*G*⟩ ⟨*B*⟩ ; expands to ⟨*C*⟩ ⟨*M*⟩ ⟨*Y*⟩ ⟨*K*⟩ and the _cmyktorgb ⟨*C*⟩ ⟨*M*⟩ ⟨*Y*⟩ ⟨*K*⟩ ; expands to ⟨*R*⟩ ⟨*G*⟩ ⟨*B*⟩. The _colorcrop, _colordefFin and _douseK are auxiliary macros used in the \colordef. The _colorcrop rescales color components in order to they are in $[0,1]$ interval. The \colordefFin expands to the values accumulated in Lua code color_C, color_M, color_Y and color_K. The _douseK applies \useK to CMYK components.

colors.opm

```
\_def\_rgbtocmyk #1 #2 #3 ;{%
   \_ea \_stripzeros \_detokenize \_ea{\_directlua{
```

```
      local kr = math.max(#1,#2,#3)
      if (kr==0) then
         tex.print('0. 0. 0. 1 ;')
      else
         tex.print(string.format('\_pcent.3f \_pcent.3f \_pcent.3f \_pcent.3f ;',
            (kr-#1)/kr, (kr-#2)/kr, (kr-#3)/kr, 1-kr))
      end
}}}
\_def\_cmyktorgb #1 #2 #3 #4 ;{%
   \_ea \_stripzeros \_detokenize \_ea{\_directlua{
      local kr = 1-#4
      tex.print(string.format('\_pcent.3f \_pcent.3f \_pcent.3f ;',
         (1-#1)*kr, (1-#2)*kr, (1-#3)*kr))
}}}
\_def\_colorcrop{\_directlua{
   local m=math.max(color_C, color_M, color_Y, color_K)
   if (m>1) then
      color_C=color_C/m  color_M=color_M/m  color_Y=color_Y/m color_K=color_K/m
   end
}}
\_def\_colordefFin{\_colorcrop \_ea \_stripzeros \_detokenize \_ea{\_directlua{
   tex.print(string.format('\_pcent.3f \_pcent.3f \_pcent.3f \_pcent.3f ;',
      color_C, color_M, color_Y, color_K))
}}}
\_def\_douseK{\_colorcrop \_directlua{
   kr=math.min(color_C, color_M, color_Y)
   if (kr>=1) then
      color_C=0  color_M=0  color_Y=0  color_K=1
   else
      color_C=(color_C-kr)/(1-kr)  color_M=(color_M-kr)/(1-kr)
      color_Y=(color_Y-kr)/(1-kr)  color_K=math.min(color_K+kr,1)
   end
}}
```

We have a problem with the `%.3f` directive in Lua code. It prints trailed zeros: (0.300 instead desired 0.3) but we want to save PDF file space. The macro _stripzeros removes these trailing zeros at expand processor level. So `\_stripzeros 0.300 0.400 0.560 ;` expands to `.3 .4 .56`.

colors.opm

```
\_def\_stripzeros #1.#2 #3{\_ifx0#1\_else#1\_fi.\_stripzeroA #2 0 :%
    \_ifx;#3\_else \_space \_ea\_stripzeros\_ea#3\_fi}
\_def\_stripzeroA #10 #2:{\_ifx^#2^\_stripzeroC#1:\_else \_stripzeroB#1 0 :\_fi}
\_def\_stripzeroB #10 #2:{\_ifx^#2^\_stripzeroC#1:\_else #1\_fi}
\_def\_stripzeroC #1 #2:{#1}
```

The \rgbcolordef and \cmykcolordef use common macro _commoncolordef with different first four parameters. The `\_commoncolordef` ⟨*selector*⟩⟨*K*⟩⟨*R*⟩⟨*G*⟩⟨*what-define*⟩`{`⟨*data*⟩`}` does the real work. It initializes the Lua variables for summation. It expands ⟨*data*⟩ in the group where color selectors have special meaning, then it adjusts the resulting string by \replstring and runs it. Example shows how the ⟨*data*⟩ are processed:

```
input <data>: ".3\Blue + .6^\KhakiC \useK -\Black"
expanded to:  ".3 !=K 1 1 0 0 +.6^!=R .804 .776 .45 \_useK -!=G 0"
adjusted to:  "\_addcolor .3!=K 1 1 0 0 \_addcolor .6!^R .804 .776 .45
               \_useK \_addcolor -1!=G 0"
and this is processed.
```

_addcolor ⟨*coef.*⟩`!`⟨*mod*⟩⟨*type*⟩ expands to `\_addcolor:`⟨*mod*⟩⟨*type*⟩ ⟨*coef*⟩ for example it expands to `\_addcolor:=K` ⟨*coef*⟩ followed by one or three or four numbers (depending on ⟨*type*⟩). ⟨*mod*⟩ is `=` (use as is) or `^` (use complementary color). ⟨*type*⟩ is `K` for CMYK, `R` for RGB and `G` for GREY color space. Uppercase ⟨*type*⟩ informs that `\cmykcolordef` is processed and lowercase ⟨*type*⟩ informs that `\rgbcolordef` is processed. All variants of commands `\_addcolor:`⟨*mod*⟩⟨*type*⟩ are defined. All of them expand to `\_addcolorA` ⟨*v1*⟩ ⟨*v2*⟩ ⟨*v3*⟩ ⟨*v4*⟩ which adds the values of Lua variables. The `\rgbcolordef` uses `\_addcolorA` ⟨*R*⟩ ⟨*G*⟩ ⟨*B*⟩ `0` and `\cmkykcolordef` uses `\_addcolorA` ⟨*C*⟩ ⟨*M*⟩ ⟨*Y*⟩ ⟨*K*⟩. So the Lua variable names are a little confusing when `\rgbcolordef` is processed.

Next, `\_commoncolordef` saves resulting values from Lua to `\_tmpb` using `\_colordefFin`. If `\rgbcolordef` is processed, then we must to remove the last ⟨*K*⟩ component which is in the

format `.0` in such case. The `\_stripK` macro does it. Finally, the ⟨*what-define*⟩ is defined as ⟨*selector*⟩`{`⟨*expanded _tmpb*⟩`}`, for example `\_setcmykclor{1 0 .5 .3}`.

colors.opm

```
\_def\_rgbcolordef  {\_commoncolordef \_setrgbcolor  krg}
\_def\_cmykcolordef {\_commoncolordef \_setcmykcolor KRG}
\_def\_commoncolordef#1#2#3#4#5#6{%
  \_begingroup
     \_directlua{color_C=0 color_M=0 color_Y=0 color_K=0}%
     \_def\_setcmykcolor##1{!=#2 ##1 }%
     \_def\_setrgbcolor ##1{!=#3 ##1 }%
     \_def\_setgreycolor##1{!=#4 ##1 }%
     \_let\_useK=\_relax
     \_edef\_tmpb{+#6}%
     \_replstring\_tmpb{+ }{+}\_replstring\_tmpb{- }{-}%
     \_replstring\_tmpb{+}{\_addcolor}\_replstring\_tmpb{-}{\_addcolor-}%
     \_replstring\_tmpb{^!=}{!^}\_replstring\_tmpb{-!}{-1!}%
     \_ifx K#2\_let\_useK=\_douseK \_fi
     \_tmpb
     \_edef\_tmpb{\_colordefFin}%
     \_ifx k#2\_edef\_tmpb{\_ea\_stripK \_tmpb;}\_fi
  \_ea\_endgroup
  \_ea\_def\_ea#5\_ea{\_ea#1\_ea{\_tmpb}}%
}
\_def\_addcolor#1!#2#3{\_cs{addcolor:#2#3}#1}
\_def\_addcolorA #1 #2 #3 #4 #5 {%
   \_def\_tmpa{#1}\_ifx\_tmpa\_empty \_else \_edef\_tmpa{\_tmpa*}\_fi
   \_directlua{color_C=math.max(color_C+\_tmpa#2,0)
               color_M=math.max(color_M+\_tmpa#3,0)
               color_Y=math.max(color_Y+\_tmpa#4,0)
               color_K=math.max(color_K+\_tmpa#5,0)
}}
\_sdef{addcolor:=K}#1 #2 #3 #4 #5 {\_addcolorA #1 #2 #3 #4 #5 }
\_sdef{addcolor:^K}#1 #2 #3 #4 #5 {\_addcolorA #1 (1-#2) (1-#3) (1-#4) #5 }
\_sdef{addcolor:^G}#1 #2 {\_addcolorA #1 0 0 0 #2 }
\_sdef{addcolor:=G}#1 #2 {\_addcolorA #1 0 0 0 (1-#2) }
\_sdef{addcolor:=R}#1 #2 #3 #4 {%
   \_edef\_tmpa{\_noexpand\_addcolorA #1 \_rgbtocmyk #2 #3 #4 ; }\_tmpa
}
\_sdef{addcolor:^R}#1 #2 #3 #4 {\_cs{addcolor:=R}#1 (1-#2) (1-#3) (1-#4) }

\_sdef{addcolor:=k}#1 #2 #3 #4 #5 {%
   \_edef\_tmpa{\_noexpand\_addcolorA #1 \_cmyktorgb #2 #3 #4 #5 ; 0 }\_tmpa
}
\_sdef{addcolor:^k}#1 #2 #3 #4 #5 {\_cs{addcolor:=k}#1 (1-#2) (1-#3) (1-#4) #5 }
\_sdef{addcolor:^g}#1 #2 {\_addcolorA #1 (1-#2) (1-#2) (1-#2) 0 }
\_sdef{addcolor:=g}#1 #2 {\_addcolorA #1 #2 #2 #2 0 }
\_sdef{addcolor:=r}#1 #2 #3 #4 {\_addcolorA #1 #2 #3 #4 0 }
\_sdef{addcolor:^r}#1 #2 #3 #4 {\_addcolorA #1 (1-#2) (1-#3) (1-#4) 0 }
\_def\_stripK#1 .0;{#1}
\_let\_colordef=\_cmykcolordef  % default \_colordef is \_cmykcolordef
```

Public versions of `\colordef` and `\useK` macros are declared using `\_def`, because the internal versions `\_colordef` and `\_useK` are changed during processing.

colors.opm

```
\_def \useK{\_useK}
\_def \colordef {\_colordef}
\_public \cmykcolordef \rgbcolordef ;
```

The LaTeX file `x11nam.def` is read by `\morecolors`. The numbers 0,1,2,3,4 are transformed to letters O, ⟨*none*⟩, B, C, D in the name of the color. Colors defined already are not re-defined. The empty `\_showcolor` macro should be re-defined for color catalog printing. For example:

```
\def\vr{\vrule height10pt depth2pt width20pt}
\def\_showcolor{\hbox{\tt\_bslash\_tmpb: \csname\_tmpb\endcsname \vr}\space\space}
\begmulti 4 \typosize[11/14]
\morecolors
\endmulti
```

```
\_def\_morecolors{%
   \_long\_def\_tmp##1\preparecolorset##2##3##4##5{\_tmpa ##5;,,,;}
   \_def\_tmpa##1,##2,##3,##4;{\_ifx,##1,\_else
      \_def\_tmpb{##1}\_replstring\_tmpb{1}{}\_replstring\_tmpb{2}{B}%
      \_replstring\_tmpb{3}{C}\_replstring\_tmpb{4}{D}\_replstring\_tmpb{0}{0}%
      \_ifcsname \_tmpb\_endcsname \_else
          \_sdef{\_tmpb}{\_setrgbcolor{##2 ##3 ##4}}\_showcolor\_fi
      \_ea\_tmpa\_fi
   }
   \_ea\_tmp\_input x11nam.def
}
\_let\_showcolor=\_relax % re-define it if you want to print a color catalog
\_public \morecolors ;
```

2.21 The .ref file

The `.ref` file has the name `\jobname.ref` and it saves information about references, TOC lines, etc. All data needed in next TEX run are saved here. OpTEX reads this file at the beginning of the document (using `\everyjob`) if such file exists. The `.ref` file looks like:

```
\Xrefversion{⟨ref-version⟩}
\_Xpage{⟨gpageno⟩}{⟨pageno⟩}
\_Xtoc{⟨level⟩}{⟨type⟩}{⟨text⟩}⟨title⟩
\_Xlabel{⟨label⟩}{⟨text⟩}
\_Xlabel{⟨label⟩}{⟨text⟩}
...
\_Xpage{⟨gpageno⟩}{⟨pageno⟩}
\_Xlabel{⟨label⟩}{⟨text⟩}
...
```

where ⟨*gpageno*⟩ is internal page number globally numbered from one and ⟨*pageno*⟩ is a page number (`\the\pageno`) used in pagination (they may be differ). Each page begins with `\_Xpage`. The ⟨*label*⟩ is a label used by user in `\label[`⟨*label*⟩`]` and ⟨*text*⟩ is a text which should be referenced (the number of section or table, for example `2.3.14`). The ⟨*title*⟩ is a title of the chapter (⟨*level*⟩=1, ⟨*type*⟩=`chap`), section (⟨*level*⟩=2, ⟨*type*⟩=`sec`), subsection (⟨*level*⟩=3, ⟨*type*⟩=`secc`). The `\_Xpage` is written at begining of each page, the `\_Xtoc` is written when chapter or section or subsection title exists on the page and `\_Xlabel` when labeled object prefixed by `\label[`⟨*label*⟩`]` exists on the page.

The `.ref` file is read when the processing of the document starts using `\everyjob`. It is read, removed and opened to writing immediately. But the `.ref` file should be missing. If none forward references are needed in the document then `.ref` file is not created. For example, you only want to test a simple plain TEX macro, you create `test.tex` file, you do `optex test` and you don't need to see empty `test.ref` file in your directory.


```
\_codedecl \openref {File for references <2020-02-14>} % preloaded in format
```

The `\_inputref` macro is used in `\everyjob`. It reads `\jobname.ref` file if it exists. After the file is read then it is removed and opened to write a new contents to this file.


```
\_newwrite\_reffile

\_def\_inputref {%
  \_isfile{\_jobname.ref}\_iftrue
     \_input {\_jobname.ref}
     \_gfnotenum=0 \_lfnotenum=0 \_mnotenum=0
     \_openrefA{\_string\_inputref}%
  \_fi
}
```

If the file does not exists then it is not created by default. It means that if you process a document without any forward references then no `\jobname.ref` file is created because it is unusable. The `\_wref` macro is dummy in such case.


```
\_def\_wrefrelax#1#2{}
\_let\_wref=\_wrefrelax
```

If a macro needs to create and to use `.ref` file then such macro must use `\openref`. When the file is created (using internal `\_openrefA`) then the `\_wref` `\⟨macro⟩{⟨data⟩}` is redefined in order to save the line `\⟨macro⟩⟨data⟩` to the `.ref` file using asynchronous `\write` primitive. Finally, the `\_openref` destroys itself, because we need not to open the file again.

ref-file.opm

```
\_def\_openref {%
  \_ifx \_wref\_wrefrelax \_openrefA{\_string\openref}\_fi
  \_gdef\_openref{}%
}
\_def\_openrefA #1{%
   \_immediate\_openout\_reffile="\_jobname.ref"\_relax
   \_gdef\_wref ##1##2{\_write\_reffile{\_string##1##2}}%
   \_immediate\_write\_reffile {\_pcent\_pcent\_space OPTeX <\_optexversion> - REF file (#1)}%
   \_immediate\_wref \Xrefversion{{\_REFversion}}%
}
\def\openref{\_openref}
```

We are using convention that the macros used in `.ref` file are named `\_X⟨foo⟩`. If there is a new version of OpTEX with different collection of such macros then we don't want to read the `.ref` files produced by an old version of OpTEX or by OPmac. So first line of `.ref` file is in the form

`\Xrefversion{⟨version⟩}`

We can check the version compatibility by this macro. Because OPmac does not understand `\_Xrefversion` we use `\Xrefversion` (with different number of ⟨*version*⟩ form OPmac) here. The result: OPmac skips the `.ref` files produced by OpTEX and vice versa.

ref-file.opm

```
\_def\_REFversion{4} % actual version of .ref files in OpTeX
\_def\_Xrefversion#1{\_ifnum #1=\_REFversion\_relax \_else \_endinput \_fi}
\_public \Xrefversion ; % we want to ignore .ref files generated by OPmac
```

You cannot define your special `.ref` macros before `.ref` file is read because it is read in `\everyjob`. But you can define such macros using `\refdecl{⟨definitions of your ref macros⟩}`. This command sends to `.ref` file your ⟨*definitions of your ref macros*⟩ immediately. Next lines in `.ref` file should include our macros. Example from CTUstyle2:

```
\refdecl{%
   \def\totlist{} \def\toflist{}^^J
   \def\Xtab#1#2#3{\addto\totlist{\totline{#1}{#2}{#3}}}^^J
   \def\Xfig#1#2#3{\addto\toflist{\tofline{#1}{#2}{#3}}}
}
```

We must read ⟨*definition of your ref macros*⟩ when catcode of `#` is 12 because we needn't to duplicate each `#` in the `.ref` file.

ref-file.opm

```
\_def\_refdecl{\_bgroup \_catcode`\#=12 \_refdeclA}
\_def\_refdeclA #1{\egroup\_openref
   \_immediate\_write\_reffile {\_pcent\_space \_string \refdecl:}%
   \_immediate\_write\_reffile {\_detokenize{#1}}%
}
\_public \refdecl ;
```

2.22 References

If the references are "forward" (i. e. the `\ref` is used first, the destination is created later) or if the reference text is page number then we must read `.ref` file first in order to get appropriate information. See section 2.21 for more information about `.ref` file concept.

references.opm

```
\_codedecl \ref {References <2020-03-03>} % preloaded in format
```

`\_Xpage {⟨gpageno⟩}{⟨pageno⟩}` saves the parameter pair into `\_currpage`. Resets `\_lfnotenum`; it is used if footnotes are numbered from one at each page.

references.opm

```
\_def\_Xpage#1#2{\_def\_currpage{{#1}{#2}}\_lfnotenum=0 }
```

Counter for number of unresolved references `\_unresolvedrefs`.

references.opm

```
\_newcount\_unresolvedrefs
\_unresolvedrefs=0
```

`\_Xlabel {`⟨*label*⟩`}{`⟨*text*⟩`}` saves the ⟨*text*⟩ to `\_lab:`⟨*label*⟩ and saves `[pg:`⟨*gpageno*⟩`]{`⟨*pageno*⟩`}` to `\_pgref:`⟨*label*⟩.

references.opm

```
\_def\_Xlabel#1#2{\_sdef{_lab:#1}{#2}\_sxdef{_pgref:#1}{\_ea\_bracketspg\_currpage}}
\_def\_bracketspg#1#2{[pg:#1]{#2}}
```

`\label[`⟨*label*⟩`]` saves the decalred label to `\_lastlabel` and `\wlabel{`⟨*text*⟩`}` uses the `\_lastlabel` and activates `\wref\_Xlabel{`⟨*label*⟩`}{`⟨*text*⟩`}`.

references.opm

```
\_def\_label[#1]{\_isempty{#1}\_iftrue \_global\_let \_lastlabel=\_undefined
  \_else \_isdefined{l0:#1}%
     \_iftrue \_opwarning{duplicated label [#1], ignored}\_else \_xdef\_lastlabel{#1}\_fi
  \_fi \_ignorespaces
}
\_def\_wlabel#1{%
  \_ifx\_lastlabel\_undefined \_else
     \_dest[ref:\_lastlabel]%
     \_printlabel\_lastlabel
     \_edef\_tmp{{\_lastlabel}{#1}}%
     \_ea\_wref \_ea\_Xlabel \_ea{\_tmp}%
     \_sxdef{_lab:\_lastlabel}{#1}\_sxdef{l0:\_lastlabel}{}%
     \_global\_let\_lastlabel=\_undefined
  \_fi
}
\_public \label \wlabel ;
```

`\ref[`⟨*label*⟩`]` uses saved `\_lab:`⟨*label*⟩ and prints (linked) ⟨*text*⟩. If the reference is backwarded then we know `\lab:`⟨*label*⟩ without any need to read REF file. On the other hand, if the reference is forwarded, then we doesn't know `\_lab:`⟨*label*⟩ in first run of TEX and we print warning and do `\_openref`.
`\pgref[`⟨*label*⟩`]` uses `{`⟨*gpageno*⟩`}{`⟨*pageno*⟩`}` from `\_pgref:`⟨*label*⟩ and prints (linked) ⟨*pageno*⟩ using `\_ilink` macro.

references.opm

```
\_def\_ref[#1]{\_isdefined{_lab:#1}%
  \_iftrue \_ilink[ref:#1]{\_csname _lab:#1\_endcsname}%
  \_else ??\_opwarning{label [#1] unknown. Try to TeX me again}%
  \_incr\_unresolvedrefs \_openref
  \_fi
}
\_def\_pgref[#1]{\_isdefined{_pgref:#1}%
  \_iftrue \_ea\_ea\_ea\_ilink \_csname _pgref:#1\_endcsname
  \_else ??\_opwarning{pg-label [#1] unknown. Try to TeX me again}%
  \_incr\_unresolvedrefs \_openref
  \_fi
}
\_public \ref \pgref ;
```

Default `\_printlabel` is empty macro (labels are not printed). The `\showlabels` redefines it as box with zero dimensions and with left lapped `[`⟨*label*⟩`]` in blue 10pt `\tt` font shifted up by 1.7ex.

references.opm

```
\_def\_printlabel#1{}
\_def\_showlabels {%
   \_def\_printlabel##1{\_vbox to\_zo{\_vss\_llap{\_labelfont[##1]}\_kern1.7ex}}%
   \_fontdef\_labelfont{\_setfontsize{at10pt}\setfontcolor{blue}\_tt}
}
\_public \showlabels ;
```

2.23 Hyperlinks

There are four types of the internal links and one type of external link:

- `ref:`⟨*label*⟩ – the destination is created when `\label[`⟨*label*⟩`]` is used, see also the section 2.22.
- `toc:`⟨*tocrefnum*⟩ – the destination is created at chap/sec/secc titles, see also the section 2.24.
- `pg:`⟨*gpageno*⟩ – the destination is created at beginning of each page, see also the section 2.18.
- `cite:`⟨*bibnum*⟩ – the destination is created in bibliography reference, see also the section 2.32.1.
- `url:`⟨*url*⟩ – used by `\url` or `\ulink`, see also the end of this section.

The ⟨*tocrefnum*⟩, ⟨*gpageno*⟩ and ⟨*bibnum*⟩ are numbers starting from one and globally incremented by one in whole document. The registers \tocrefnum, \gpageno and \bibnum are used for these numbers.

When a chap/sec/secc title is prefixed by \label[⟨*label*⟩], then both types of internal links are created at the same destination place: toc:⟨*tocrefnum*⟩ and ref:⟨*label*⟩.

hyperlinks.opm

```
\_codedecl \ulink {Hyperlinks <2020-04-22>} % preloaded in format
```

\dest[⟨*type*⟩:⟨*spec*⟩] creates a destination of internal links. The destination is declared in the format ⟨*type*⟩:⟨*spec*⟩. If the \hyperlinks command in not used, then \dest does nothing else it is set to _destactive. The _destactive is implemented by _pdfdest primitive. It creates a box in which the destination is shifted by _destheight. The reason is that the destination is exactly at top border of the PDF viewer but we want to see the line where destination is. The destination box is positioned by different way dependent on current vertical or horizontal mode.

hyperlinks.opm

```
\_def\_destheight{1.4em}
\_def\_destactive[#1:#2]{\_if$#2$\_else\_ifvmode
      \_tmpdim=\_prevdepth \_prevdepth=-1000pt
      \_destbox[#1:#2]\_prevdepth=\_tmpdim
   \_else \_destbox[#1:#2]%
   \_fi\_fi
}
\_def\_destbox[#1]{\_vbox to\_zo{\_kern-\_destheight \_pdfdest name{#1} xyz\_vss}}
\_def\_dest[#1]{}
\_public \dest ;
```

\link[⟨*type*⟩:⟨*spec*⟩]{⟨*color*⟩}{⟨*text*⟩} creates an internal link to \dest with the same ⟨*type*⟩:⟨*spec*⟩. You can have more links with the same ⟨*type*⟩:⟨*spec*⟩ but only one \dest in the document. If \hyperlinks command is not used, then \link only prints ⟨*text*⟩ else it is set to _linkactive. The _linkactive is implemented by _pdfstartlink..._pdfendlink primitives.
\ilink[⟨*type*⟩:⟨*spec*⟩]{⟨*text*⟩} is equivalent to _link but the ⟨*color*⟩ is used from \hyperlinks declaration.

hyperlinks.opm

```
\_protected\_def\_linkactive[#1:#2]#3#4{\_leavevmode\_pdfstartlink height.9em depth.3em
      \_pdfborder{#1} goto name{#1:#2}\_relax {#3#4}\_pdfendlink
}
\_protected\_def\_link[#1]#2#3{\_leavevmode{#3}}
\_protected\_def\_ilink[#1]#2{\_leavevmode{#2}}
\_public \ilink \link ;
```

\ulink[⟨*url*⟩]{⟨*text*⟩} creates external link. It prints only the ⟨*text*⟩ by default but the \hyperlinks declaration defines it as _urlactive[url:⟨*url*⟩]{⟨*text*⟩}. The external link is created by the _pdfstartlink...\pdfendlink primitives. The ⟨*url*⟩ is detokenized with \escapechar=-1 before it is used, so \%, \# etc. can be used in the ⟨*url*⟩.

hyperlinks.opm

```
\_protected\_def\_urlactive[#1:#2]#3#4{\_leavevmode{\_escapechar=-1
   \_pdfstartlink height.9em depth.3em \_pdfborder{#1}%
      user{/Subtype/Link/A <</Type/Action/S/URI/URI(\_detokenize{#2})>>}\_relax
      {#3#4}\_pdfendlink}%
}
\_def\_ulink[#1]#2{\_leavevmode{#2}}
\_def\_urlcolor{}
\_public \ulink ;
```

The _pdfstartlink primitive uses _pdfborder{⟨*type*⟩} in its parameter (see _linkactive or _urlactive macros). The _pdfborder{⟨*type*⟩} expands to attr{/C[? ? ?] /Border[0 0 .6]} if the _⟨*type*⟩border (i.e. _refborder, _citeborder, _tocborder, _pgborder, _urlborder, _fntborder or _fnfborder) is defined. User can define it in order to create colored frames around active links. For example \def_tocborder{1 0 0} causes red frames in TOC (not printed, only visible in PDF viewers).

hyperlinks.opm

```
\_def\_pdfborder#1{\_ifcsname _#1border\_endcsname
       attr{/C[\_csname _#1border\_endcsname] /Border[0 0 .6]}%
   \_else attr{/Border[0 0 0]}\_fi
}
```

\hyperlinks{⟨*ilink_color*⟩}{⟨*ulink_color*⟩} activates \dest, \link, \ilink, \ulink in order they create links. These macros are redefined here to their "active" version.

hyperlinks.opm

```
\_def\_hyperlinks#1#2{%
   \_let\_dest=\_destactive \_let\_link=\_linkactive
   \_def\_ilink[##1]##2{\_link[##1]{\_localcolor#1}{##2}}%
   \_def\_ulink[##1]##2{\_urlactive[url:##1]{\_localcolor#2}{##2}}%
   \_public \dest \ilink \ulink ;%
}
\_public \hyperlinks ;
```

`\url{`⟨*url*⟩`}` does approximately the same as `\ulink[`⟨*url*⟩`]{`⟨*url*⟩`}`, but more work is done before the `\ulink` is processed. The link-version of ⟨*url*⟩ is saved to `\_tmpa` and the printed version in `\_tmpb`. The printed version is modified in order to set a breakpoints to special places of the ⟨*url*⟩. For example `//` is replaced by `\_urlskip/\_urlskip/\_urlbskip` where `\urlskip` adds a small nobreakable glue between these two slashes and before them and `\_urlbskip` adds a breakable glue after them.
The text version of the ⟨*url*⟩ is printed in `\_urlfont`.

hyperlinks.opm

```
\_def\_url#1{{%
   \_def\_tmpa{#1}\_replstring\_tmpa {\|}{}%
   {\_escapechar=-1 \_ea}\_ea\_edef\_ea\_tmpa\_ea{\_detokenize\_ea{\_tmpa}}%
   \_def\_tmpb{#1}\_replstring\_tmpb {\|}{\_urlbskip}%
   \_replstring\_tmpb {//} {{\_urlskip\_urlslashslash\_urlbskip}}%
   \_replstring\_tmpb {/}  {{\_urlskip/\_urlbskip}}%
   \_replstring\_tmpb {.}  {{\_urlskip.\_urlbskip}}%
   \_replstring\_tmpb {?}  {{\_urlskip?\_urlbskip}}%
   \_replstring\_tmpb {=}  {{\_urlskip=\_urlbskip}}%
   \_ea\_replstring\_ea\_tmpb \_ea{\_string &} {{\_urlbskip\_char`\& \_urlskip}}%
   \_ea\_replstring\_ea\_tmpb \_ea{\_bslash|}  {{\_penalty0}}%
   \_ea\_ulink \_ea[\_tmpa] {\_urlfont\_tmpb\_null}%
}}
\_def\_urlfont{\_tt}
\_def\_urlskip{\_null\_nobreak\_hskip0pt plus0.05em\_relax}
\_def\_urlbskip{\_penalty100 \_hskip0pt plus0.05em\_relax}
\_def\_urlslashslash{/\_urlskip/}

\_public \url ;
```

2.24 Making table of contents

maketoc.opm

```
\_codedecl \maketoc {Macros for maketoc <2020-03-12>} % preloaded in format
```

`\_Xtoc {`⟨*level*⟩`}{`⟨*type*⟩`}{`⟨*number*⟩`}`⟨*title*⟩ (in `.ref` file) reads the specified data and appends them to the `\_toclist` as `\_tocline{`⟨*level*⟩`}{`⟨*type*⟩`}{`⟨*number*⟩`}{`⟨*title*⟩`}{`⟨*gpageno*⟩`}{`⟨*pageno*⟩`}` where:

- ⟨*level*⟩: 0 reserved, 1: chapter, 2: section, 3: subsection
- ⟨*type*⟩: the type of the level, i.e. chap, sec, secc
- ⟨*number*⟩: the number of the chapter/section/subsection in the format 1.2.3
- ⟨*title*⟩: the title text
- ⟨*gpageno*⟩: the page number numbered from 1 independently of pagination
- ⟨*pageno*⟩: the page number used in the pagination

The last two parameters are restored from previous `\_Xpage{`⟨*pageno*⟩`}{`⟨*gpageno*⟩`}`, data were saved in the `\_currpage` macro.

We read the ⟨*title*⟩ parameter by `\scantoeol` from `.ref` file because the ⟨*title*⟩ can include something like `` `{` ``.

maketoc.opm

```
\_def\_toclist{}
\_newifi \_ifischap \_ischapfalse

\_def\_Xtoc#1#2#3{\_ifnum#1=0 \_ischaptrue\_fi
   \_addto\_toclist{\_tocline{#1}{#2}{#3}}\_scantoeol\_XtocA}
\_def\_XtocA#1{\_addto\_toclist{{#1}}\_ea\_addto\_ea\_toclist\_ea{\_currpage}}
```

`\_tocline{`⟨*level*⟩`}{`⟨*type*⟩`}{`⟨*number*⟩`}{`⟨*title*⟩`}{`⟨*gpageno*⟩`}{`⟨*pageno*⟩`}` prints the record to the table of contents. It opens group, reduces `\_leftskip`, `\_rightskip`, runs the `\everytocline` (user can customise the design of TOC here) and runs `\_tocl:`⟨*level*⟩ `{`⟨*number*⟩`}{`⟨*title*⟩`}{`⟨*pageno*⟩`}` macro. This macro starts with vertical mode, inserts one record with given ⟨*level*⟩ and it should end by `\_tocpar` which

returns to hrizontal mode. The `\_tocpar` appends `\_nobreak \_hskip-2\_iindent\_null \_par`. This causes that the last line of the record is shifted outside the margin given by `\_rightskip`. A typical record (with long ⟨*title*⟩) looks like:

```
                  |                          |
\llap{<number>} text text text text text
                  text text text text text
                  text text ..................... <pageno>
```

Margins given by `\leftskip` and `\rightskip` are denoted by `|` in the examle above.
`\tocrefnum` is global counter of all TOC records (used by hyperlinks).

maketoc.opm

```
\_newcount \_tocrefnum
\_def\_tocline#1#2#3#4#5#6{%
   \_advance\_tocrefnum by1
   \_bgroup
      \_leftskip=\_iindent \_rightskip=2\_iindent
      \_ifischap \_advance\_leftskip by \_iindent \_fi
      \_def\_pgn{\_ilink[pg:#5]}%
      \_the\_everytocline
      \_ifcsname _tocl:#1\_endcsname
         \_cs{_tocl:#1}{#3}{\_scantextokens{#4}}{#6}\_par
      \_fi
   \_egroup
}
\_public \tocrefnum ;
```

You can re-define default macros for each level of tocline if you want.
Parameters are `{`⟨*number*⟩`}{`⟨*title*⟩`}{`⟨*pageno*⟩`}`.

maketoc.opm

```
\_sdef{_tocl:1}#1#2#3{\_nofirst\_bigskip \_bf\_llaptoclink{#1}{#2}\_hfill \_pgn{#3}\_tocpar}
\_sdef{_tocl:2}#1#2#3{\_llaptoclink{#1}{#2}\_tocdotfill \_pgn{#3}\_tocpar}
\_sdef{_tocl:3}#1#2#3{\_advance\_leftskip by\_iindent \_cs{_tocl:2}{#1}{#2}{#3}}
```

The auxiliary macros are:

- `\_llaptoclink`⟨*text*⟩ does `\_noindent\_llap{`⟨*linked text*⟩`}`.
- `\_tocdotfill` creates dots in the TOC.
- `\_nofirst\macro` applies the `\macro` only if we don't print the first record of the TOC.
- `\_tocpar` finalizes one TOC recors whith rlapped ⟨*pageno*⟩.
- `\_pgn{`⟨*pageno*⟩`}` creates ⟨*pageno*⟩ as link to real ⟨*gpage*⟩ saved in `#6` of `\_tocline`. This is temporarily defined in the `\_tocline`.

maketoc.opm

```
\_def\_llaptoclink#1{\_noindent
   \_llap{\_ilink[toc:\_the\_tocrefnum]{\_enspace#1\_kern.4em}\_kern.1em}}
\_def\_tocdotfill{\_nobreak\_leaders\_hbox to.8em{\_hss.\_hss}\_hskip 1em plus1fill\_relax}
\_def\_nofirst #1{\_ifnum \_lastpenalty=11333 \_else #1\_fi}
\_def\_tocpar{\_nobreak \_hskip-2\_iindent\_null \_par}
```

`\maketoc` prints warning if TOC data is empty, else it creates TOC by running `\_toclist`

maketoc.opm

```
\_def\_maketoc{\_par \_ifx\_toclist\_empty
      \_opwarning{\_noexpand\maketoc -- data unavailable, TeX me again}\_openref
      \_incr\_unresolvedrefs
   \_else \_begingroup
      \_tocrefnum=0 \_penalty11333
      \_the\_regtoc \_toclist
   \_endgroup \_fi
}
```

`\regmacro` appends its parameters to `\_regtoc`, `\_regmark` and `\_regoul`. These token lists are used in `\maketoc`, `\_begoutput` and `\pdfunidef`.

maketoc.opm

```
\_newtoks \_regtoc  \_newtoks \_regmark  \_newtoks \_regoul

\_def\_regmacro #1#2#3{%
   \_toksapp\_regtoc{#1}\_toksapp\_regmark{#2}\_toksapp\_regoul{#3}%
}
\_public \maketoc \regmacro ;
```

2.25 PDF outlines

2.25.1 Nesting PDF outlines

The problem is that PDF format needs to know the number of direct descendants of each outline if we need to create the tree of structured outlines. But we know only the level of each outline. The required data should be calculated from TOC data. We use two steps over TOC data saved in the `\_toclist` where each record is represented by one `\_tocline`.

First step, the `\outlines` macro sets `\_tocline` to `\_outlinesA` and calculates the number of direct descendants of each record. Second step, the `\outlines` macro sets `\_tocline` to `\_outlinesB` and it uses prepared data and create outlines.

Each ouline is mapped to the control sequence of the type `\_ol:`⟨*num*⟩ or `\_ol:`⟨*num*⟩`:`⟨*num*⟩ or `\_ol:`⟨*num*⟩`:`⟨*num*⟩`:`⟨*num*⟩ or etc. The first one is reserved for level 0, the second one for level 1 (chapters), third one for level 2 (sections) etc. The number of direct descentants will be stored in these macros after first step is finished. Each new outline of given level increases the ⟨*num*⟩ at given level. When the first step is processed then (above that) the `\_ol:..` sequence of the parent inceases its value too. The `_ol:...` sequences are implemented by `\_ol:\_count0:\_count1:\count2` etc. For example, when section (level 2) is processed in the first step then we do:

```
\advance \count2 by 1
                % increases the mapping pointer of the type
                % \_ol:<\_count0:\_count1:\_count2> of this section
\advance \<_ol:\_count0:\_count1> by 1
                % increases the number of descendants connected
                % to the parent of this section.
```

When second step is processed, then we only read the stored data about the number of descentants. Ad we use it in `count` parameter of `\_pdfoutline` primitive.

For linking, we use the same links as in TOC, i.e. the `toc:\_the\_tocrefnum` labels are used.

`\insertoutline {`⟨*text*⟩`}` inserts one outline with zero direct descendants. It creates link destination of the type `oul:`⟨*num*⟩ into the document (where `\insertoutline` is used) and the link itself is created too in the outline.

outlines.opm

```
\_codedecl \outlines {PDF outlines <2020-03-12>} % preloaded in format

\_def\_outlines#1{\_pdfcatalog{/PageMode/UseOutlines}\_openref
   \_ifx\_toclist\_empty
     \_opwarning{\_noexpand\outlines -- data unavailable. TeX me again}%
     \_incr\_unresolvedrefs
   \_else
     \_ifx\_dest\_destactive \_else
        \_opwarning{\_noexpand\outlines doesn't work when \_noexpand\hyperlinks isn't declared}\_fi
     {\_let\_tocline=\_outlinesA
      \_count0=0 \_count1=0 \_count2=0 \_count3=0 \_toclist % calculate numbers o childs
      \_def\_outlinelevel{#1}\_let\_tocline=\_outlinesB
      \_tocrefnum=0 \_count0=0 \_count1=0 \_count2=0 \_count3=0
      \_toclist}% create outlines
   \_fi
}
\_def\_outlinesA#1#2#3#4#5#6{%
   \_advance\_count#1 by1
   \_ifcase#1\_or
      \_addoneol{_ol:\_the\_count0}\_or
      \_addoneol{_ol:\_the\_count0:\_the\_count1}\_or
      \_addoneol{_ol:\_the\_count0:\_the\_count1:\_the\_count2}\_or
      \_addoneol{_ol:\_the\_count0:\_the\_count1:\_the\_count2:\_the\_count3}\_fi
}
\_def\_addoneol#1{%
   \_ifcsname #1\_endcsname
           \_tmpnum=\_csname#1\_endcsname\_relax
           \_advance\_tmpnum by1 \_sxdef{#1}{\_the\_tmpnum}%
   \_else \_sxdef{#1}{1}%
   \_fi
}
\_def\_outlinesB#1#2#3#4#5#6{%
```

```
   \_advance\_count#1 by1
   \_ifcase#1%
      \_tmpnum=\_trycs{_ol:\_the\_count0}{0}\_or
      \_tmpnum=\_trycs{_ol:\_the\_count0:\_the\_count1}{0}\_relax\_or
      \_tmpnum=\_trycs{_ol:\_the\_count0:\_the\_count1:\_the\_count2}{0}\_relax\_or
      \_tmpnum=\_trycs{_ol:\_the\_count0:\_the\_count1:\_the\_count2:\_the\_count3}{0}\_relax\_or
      \_tmpnum = 0\_relax\_fi
   \_pdfunidef\_tmp{#4}%
   \_advance\_tocrefnum by1
   \_outlinesC{#1}{toc:\_the\_tocrefnum}{\_ifnum#1<\_outlinelevel\_space\_else-\_fi}{\_tmpnum}{\_tmp}%
}
\_def\_outlinesC#1#2#3#4#5{\_pdfoutline goto name{#2} count #3#4{#5}\_relax}

\_newcount\_oulnum
\_def\_insertoutline#1{\_global\_advance\_oulnum by1
   \_pdfdest name{oul:\_the\_oulnum} xyz\_relax
   \_pdfunidef\_tmp{#1}%
   \_pdfoutline goto name{oul:\_the\_oulnum} count0 {\_tmp}\_relax
}
\_public \outlines \insertoutline ;
```

2.25.2 Strings in PDF outlines

There are only two encodings for PDF strings (used in PDFoutlines, PDFinfo etc.). First one is PDFDocEncoding which is one-byte encoding, but most Czech or Slovak characters are missing here.

The second encoding is PDFunicode encoding wich is implemented in this file. This encoding is TEX-discomfortable, because it looks like

```
\376\377\000C\000v\000i\001\015\000e\000n\000\355\000\040\000j\000e\000\040
\000z\000\341\000t\001\033\001\176
```

This example is real encoding of the string "Cvičení je zátěž". You can see that this is UTF-16 encoding (two bytes per character) with two starting bytes FEFF. Moreover, each byte is encoded by three octal digits preceded by backslash. The only exception is the visible ASCII character encoding: such a character is encoded by its real byte preceded by `\000`.

pdfuni-string.opm

```
\_codedecl \pdfunidef {PDFunicode strings for outlines <2020-03-12>} % preloaded in format
```

The `\_octalprint` is lua script which prints the character code in the octal notation.

pdfuni-string.opm

```
\_edef\_octalprint#1#2{\_noexpand\_directlua{% #1=character-code #2=character
    if ('#2'>='A' and '#2'<='Z') or ('#2'>='a' and '#2'<='z') then
      tex.print(string.format('000\_pcent s',"#2"))
    else
      local num=#1\_pcent256
      tex.print(string.format('\_pcent 03o\_nbb\_pcent03o',(#1-num)/256,num))
    end
}}
```

`\pdfunidef\macro{`⟨*text*⟩`}` does more things than only converting to octal notation. The ⟨*text*⟩ can be scanned in verbatim mode (it is true becuase `\_Xtoc` reads the ⟨*text*⟩ in verbatim mode). First `\edef` do `\_scantextokens\unexpanded` and second `\edef` expands the parameter according to current values on selected macros from `\_regoul`. Then `\_removeoutmath` converts `..$x^2$..` to `..x^2..`, i.e removes dollars. Then `\_removeoutbraces` converts `..{x}..` to `..x...` Finaly, the ⟨*text*⟩ is detokenized, spaces are preprocessed using `\replstring` and then the `\_pdfunidefB` is repeated on each character. It calls the `\directlua` chunk to print octal numbers in the macro `\_octalprint`.

pdfuni-string.opm

```
\_def\_pdfunidef#1#2{%
   \_begingroup
      \_the\_regoul \_relax % \_regmacro alternatives of logos etc.
      \_ifx\_savedttchar\_undefined \_def#1{\_scantextokens{\_unexpanded{#2}}}%
      \_else \_lccode`\;=\_savedttchar \_lowercase{\_prepinverb#1;}{#2}\fi
      \_edef#1{#1}%
      \_escapechar=-1
      \_edef#1{#1\_empty}%
      \_escapechar=`\\
      \_ea\_edef \_ea#1\_ea{\_ea\_removeoutmath   #1$\_end$}%  $x$ -> x
```

```
      \_ea\_edef \_ea#1\_ea{\_ea\_removeoutbraces #1{\_end}}%  {x} -> x
      \_edef#1{\_detokenize\_ea{#1}}%
      \_replstring#1{ }{{ }}%  text text -> text{ }text
      \_catcode`\\=12 \_let\\=\_bslash
      \_edef\_out{\\376\\377}%
      \_ea\_pdfunidefB#1~%  text -> \_out in octal
      \_ea
   \_endgroup
   \_ea\_def\_ea#1\_ea{\_out}
}
\_def\_pdfunidefB#1{%
   \_ifx^#1\_else
      \_tmpnum=`#1
      \_pdfunidefC{\_luaescapestring{#1}}%
   \_ea\_pdfunidefB \_fi
}
\_def\_pdfunidefC #1{\_edef\_out{\_out \\\_ea\_octalprint\_ea{\_the\_tmpnum}{#1}}}

\_def\_removeoutbraces #1#{#1\_removeoutbracesA}
\_def\_removeoutbracesA #1{\_ifx\_end#1\_else #1\_ea\_removeoutbraces\_fi}
\_def\_removeoutmath #1$#2${#1\_ifx\_end#2\_else #2\_ea\_removeoutmath\_fi}
```

The _prepinverb⟨*macro*⟩⟨*separator*⟩{⟨*text*⟩}, e.g. _prepinverb\tmpb|{aaa |bbb| cccc |dd| ee} does \def\tmpb{⟨*su*⟩{aaa }bbb⟨*su*⟩{ cccc }dd⟨*su*⟩{ ee}} where ⟨*su*⟩ is \scantextokens\unexpanded. It means that in-line verbatim are not argument of \scantextoken. First \edef\tmpb tokenizes again the ⟨*text*⟩ but not the parts which were in the the in-line verbatim.

pdfuni-string.opm

```
\_def\_prepinverb#1#2#3{\_def#1{}%
   \_def\_dotmpb ##1#2##2{\_addto#1{\_scantextokens{\_unexpanded{##1}}}%
      \_ifx\_end##2\_else\_ea\_dotmpbA\_ea##2\_fi}%
   \_def\_dotmpbA ##1#2{\_addto#1{##1}\_dotmpb}%
   \_dotmpb#3#2\_end
}
```

The \regmacro is used in order to sed the values of macros \em, \rm, \bf, \it, \bi, \tt, \/ and ~ to values usable in PDF outlines.

pdfuni-string.opm

```
\_regmacro {}{}{\_let\em=\_empty \_let\rm=\_empty \_let\bf=\_empty
    \_let\it=\_empty \_let\bi=\_empty \_let\tt=\_empty \_let\/=\_empty
    \_let~=\_space
}
\public \pdfunidef ;
```

2.26 Chapters, sections, subsections

sections.opm

```
\_codedecl \chap {Titles, chapters, sections, subsections <2020-03-28>} % preloaded in format
```

We are using scaled fonts for titles _titfont, _chapfont, _secfont and _seccfont. They are scaled from main fonts size of the document, which is declared by first \typosize[⟨*fo-size*⟩/⟨*b-size*⟩] command.

sections.opm

```
\_def \_titfont  {\_scalemain\_typoscale[\_magstep4/\_magstep5]\_boldify}
\_def \_chapfont {\_scalemain\_typoscale[\_magstep3/\_magstep3]\_boldify}
\_def \_secfont  {\_scalemain\_typoscale[\_magstep2/\_magstep2]\_boldify}
\_def \_seccfont {\_scalemain\_typoscale[\_magstep1/\_magstep1]\_boldify}
```

The \tit macro is defined using \scantoeol and _printtit. It means that the parameter is separated by end of line and inline verbatim is allowed. The same principle is used in the \chap, \sec and \secc macros.

sections.opm

```
\_def\_printtit #1{\_vglue\_titskip
  {\_leftskip=0pt plus1fill \_rightskip=\_leftskip % centering
   \_titfont \_noindent \_scantextokens{#1}\_par}%
   \_nobreak\_bigskip
}
\_def\_tit{\_scantoeol\_printtit}

\_public \tit ;
```

You can re-define _printchap, _printsec or _printsecc macros if another design of section titles is needed. These macros gets the ⟨*title*⟩ text in its parameter. The common recommendations for these macros are:

- Use _abovetitle{⟨*penaltyA*⟩}{⟨*skipA*⟩} and _belowtitle{⟨*skipB*⟩} for inserting vertical material above and below the section title. The arguments of these macros are normally used, i. e. _abovetitle inserts ⟨*penaltyA*⟩⟨*skipA*⟩ and _belowtitle inserts ⟨*skipB*⟩. But there is an exception: if _belowtitle{⟨*skipB*⟩} is immediately followed by _abovetitle{⟨*penaltyA*⟩}{⟨*skipA*⟩} (for example section title is immediately followed by subsection title), then only ⟨*skipA*⟩ is generated, i. e. ⟨*skipB*⟩⟨*penaltyA*⟩⟨*skipA*⟩ is reduced only to ⟨*skipA*⟩. The reason of such behavior: we don't want to duplicate vertical skip and we don't want to use negative penalty in such cases. Moreover, _abovetitle{⟨*penaltyA*⟩}{⟨*skipA*⟩} takes previous whatever vertical skip (other than from _belowtitle) and generates only greater from this pair of skips. It means that ⟨*whatever-skip*⟩⟨*penaltyA*⟩⟨*skipA*⟩ is transformed to ⟨*penaltyA*⟩max(⟨*whatever-skip*⟩⟨*skipA*⟩). The reason of such behavior: we don't want to duplicate vertical skips (from _belowlistskip, for example) above the title.
- Use _printrefnum[⟨*pre*⟩@⟨*post*⟩] in horizontal mode. It prints ⟨*pre*⟩⟨*ref-num*⟩⟨*post*⟩. The ⟨*ref-num*⟩ is _thechapnum or _thesecnum or _theseccnum depending on what type o title is processed. If \nonum prefix is used then _printrefnum prints nothing. The macro _printrefnum does more work: it creates destination of hyperlinks (if \hyperlinks{}{} is used) and saves references from label (if \label[⟨*label*⟩] precedes) and saves references for table of contents (if \maketoc is used).
- Use \nbpar for closing the paragraph for printing title. This command inserts _nobreak between each line of such paragraph, so the title cannot be broken to more pages.
- You can use _firstnoindent in order to the first paragraph after the title is not indented.

sections.opm

```
\_def\_printchap #1{\_vfill\_supereject
   \_vglue\_medskipamount % shifted by topkip+\medskipamount
   {\_chapfont \_noindent \_mtext{chap} \_printrefnum[@]\_par
    \_nobreak\_smallskip
    \_noindent \_raggedright #1\_nbpar}\_mark{}%
   \_nobreak \_belowtitle{\_bigskip}%
   \_firstnoindent
}
\_def\_printsec#1{\_par
   \_abovetitle{\_penalty-400}\_bigskip
   {\_secfont \_noindent \_raggedright \_printrefnum[@\_quad]#1\_nbpar}\_insertmark{#1}%
   \_nobreak \_belowtitle{\_medskip}%
   \_firstnoindent
}
\_def\_printsecc#1{\_par
   \_abovetitle{\_penalty-200}{\_medskip\_smallskip}
   {\_seccfont \_noindent \_raggedright \_printrefnum[@\_quad]#1\_nbpar}%
   \_nobreak \_belowtitle{\_medskip}%
   \_firstnoindent
}
```

The _sectionlevel is the level of the printed section:

- _sectionlevel=0 – reserved for parts of the book (unused by default)
- _sectionlevel=1 – chapters (used in \chap)
- _sectionlevel=2 – sections (used in \sec)
- _sectionlevel=3 – subsections (used in \secc)
- _sectionlevel=4 – subsubsections (unused by default)

sections.opm

```
\_newcount\_sectionlevel
\_def \_secinfo {\_ifcase \_sectionlevel
   part\_or chap\_or sec\_or secc\_or seccc\_fi
}
```

The _chapx initializes counters used in chapters, the _secx initializes counters in sections and _seccx initializes counters in subsections. If you have more types of numbered objects in your document then you can declare appropriate counters and do \addto_chapx{\yourcounter=0 } for example. If you have another concept of numbering objects used in your document, you can re-define these macros. All settings here are global because it is used by {_globaldefs=1 _chapx}.

Default concept: Tables, figuers and display maths are numbered from one in each section – subsetions doesn't reset these counters. Footnotes declared by \fnotenumchapters are numbered in each chapter from one.

The _the* macros _thechapnum, _thesecnum, _theseccnum, _thetnum, _thefnum and _thednum include the format of numbers used when the object is printing. If chapter is never used in the document then _chapnum=0 and _othe_chapnum. expands to empty. Sections have numbers ⟨*num*⟩ and subsections ⟨*num*⟩.⟨*num*⟩. On the other hand, if chapter is used in the document then _chapnum>0 and sections have numbers ⟨*num*⟩.⟨*num*⟩ and subsections have numbers ⟨*num*⟩.⟨*num*⟩.⟨*num*⟩.

sections.opm

```
\_newcount \_chapnum  % chapters
\_newcount \_secnum   % sections
\_newcount \_seccnum  % subsections
\_newcount \_tnum     % table numbers
\_newcount \_fnum     % figure numbers
\_newcount \_dnum     % numbered display maths

\_def \_chapx {\_secx  \_secnum=0  \_lfnotenum=0 }
\_def \_secx  {\_seccx \_seccnum=0 \_tnum=0 \_fnum=0 \_dnum=0 \_resetABCDE }
\_def \_seccx {}

\_def \_thechapnum {\_the\_chapnum}
\_def \_thesecnum  {\_othe\_chapnum.\_the\_secnum}
\_def \_theseccnum {\_othe\_chapnum.\_the\_secnum.\_the\_seccnum}
\_def \_thetnum    {\_othe\_chapnum.\_the\_secnum.\_the\_tnum}
\_def \_thefnum    {\_othe\_chapnum.\_the\_secnum.\_the\_fnum}
\_def \_thednum    {(\_the\_dnum)}

\_def\_othe #1.{\_ifnum#1>0 \_the#1.\_fi}
\_def\_incr #1{\_global\_advance#1by1 }
```

The \notoc and \nonum prefixes are implemented by internal _ifnotoc and _ifnonum. They are reset after each chapter/section/subsection by the _resetnonumnotoc macro.

sections.opm

```
\_newifi \_ifnotoc  \_notocfalse  \_def\_notoc {\_global\_notoctrue}
\_newifi \_ifnonum  \_nonumfalse  \_def\_nonum {\_global\_nonumtrue}
\_def \_resetnonumnotoc{\_global\_notocfalse \_global\_nonumfalse}
\_public \notoc \nonum ;
```

The \chap, \sec and \secc macros are implemented here. The _inchap, _insec and _insecc macros does the real work, First, we read the optional parameter [⟨*label*⟩], if it exists. The \chap, \sec and \secc macro reads its parameter using \scantoeol. This causes that they cannot be used inside other macros. Use _inchap, _insec and _insecc macros directly in such case.

sections.opm

```
\_optdef\_chap[]{\_trylabel \_scantoeol\_inchap}
\_optdef\_sec []{\_trylabel \_scantoeol\_insec}
\_optdef\_secc[]{\_trylabel \_scantoeol\_insecc}
\_def\_trylabel{\_istoksempty\_opt\_iffalse \_label[\_the\_opt]\_fi}

\_def\_inchap #1{\_par \_sectionlevel=1
   \_def \_savedtitle {#1}% saved to .ref file
   \_ifnonum \_else {\_globaldefs=1 \_incr\_chapnum \_chapx}\_fi
   \_edef \_therefnum {\_ifnonum \_space \_else \_thechapnum \_fi}%
   \_printchap{\_scantextokens{#1}}%
   \_resetnonumnotoc
}
\_def\_insec #1{\_par \_sectionlevel=2
   \_def \_savedtitle {#1}% saved to .ref file
   \_ifnonum \_else {\_globaldefs=1 \_incr\_secnum \_secx}\_fi
   \_edef \_therefnum {\_ifnonum \_space \_else \_thesecnum \_fi}%
   \_printsec{\_scantextokens{#1}}%
   \_resetnonumnotoc
}
\_def\_insecc #1{\_par \_sectionlevel=3
   \_def \_savedtitle {#1}% saved to .ref file
   \_ifnonum \_else {\_globaldefs=1 \_incr\_seccnum \_seccx}\_fi
   \_edef \_therefnum {\_ifnonum \_space \_else \_theseccnum \_fi}%
   \_printsecc{\_scantextokens{#1}}%
   \_resetnonumnotoc
```

```
}
\_public \chap \sec \secc ;
```

The `\_printrefnum[`⟨*pre*⟩`@`⟨*post*⟩`]` macro is used in `\_print*` macros.
The `\_wtotoc {`⟨*level*⟩`}{`⟨*info*⟩`}{`⟨*ref-num*⟩`}{`⟨*title-text*⟩`}` macro expands its parameters and does `\_wref`.

Note that the ⟨*tite-text*⟩ is `\detokenized` before `\_wref`, so the problem of "fragile macros" from old LaTeX never occurs.

sections.opm

```
\_def \_printrefnum [#1@#2]{\_leavevmode % we must be in horizontal mode
   \_ifnonum \_else #1\_therefnum #2\_fi
   \_wlabel \_therefnum  % references, if `\label[<label>]` is declared
   \_ifnotoc \_else \_incr \_tocrefnum
      \_dest[toc:\_the\_tocrefnum]%
      \_wtotoc{\_the\_sectionlevel}{\_secinfo}%
            {\_therefnum}{\_detokenize\_ea{\_savedtitle}}%
   \_fi
}
\_def \_wtotoc #1#2#3#4{\_edef\_tmp{{#1}{#2}{#3}{#4}}\_ea\_wtotocA\_tmp}
\_def \_wtotocA #1#2#3#4{\_wref\_Xtoc{{#1}{#2}{#3}#4}}
```

The `\_abovetitle{`⟨*penaltyA*⟩`}{`⟨*skipA*⟩`}` and `\_belowtitle{`⟨*skipB*⟩`}` pair communicates using a special penalty 11333 in vertical mode. The `\_belowtitle` puts the vertical skip (its value is saved in `\_savedtitleskip`) followed by this special penalty. The `\_abovetitle` reads `\lastpenalty` and if it has this special value then it removes the skip used before and don't use the parameter. The `\abovetitle` creates ⟨*skipA*⟩ only if whatever previous skip is less or equal than ⟨*skipA*⟩. We must save ⟨*whatever-skip*⟩, remove it, create ⟨*penaltyA*⟩ (if `\_belowtitle` does not preceded) and create ⟨*whatever-skip*⟩ or ⟨*skipA*⟩ depending on what is greater. The amount of ⟨*skipA*⟩ is measured using `\setbox0=\vbox`.

sections.opm

```
\_newskip \_savedtitleskip
\_newskip \_savedlastskip
\_def\_abovetitle #1#2{\_savedlastskip=\_lastskip % <whatever-skip>
   \_ifdim\_lastskip>\_zo \_vskip-\_lastskip \_fi
   \_ifnum\_lastpenalty=11333 \_vskip-\_savedtitleskip \_else #1\_fi
   \_ifdim\_savedlastskip>\_zo \_setbox0=\_vbox{#2\_global\_tmpdim=\_lastskip}%
   \_else \_tmpdim=\_maxdimen \_fi
   \_ifdim\_savedlastskip>\_tmpdim \vskip\_savedlastskip \_else #2\_fi
}
\_def\_belowtitle #1{#1\_global\_savedtitleskip=\_lastskip \_penalty11333 }
```

`\nbpar` sets `\interlinepenaty` value. `\nl` is "new line" in text (or titles), but space in toc or headlines or outlines.

sections.opm

```
\_def\_nbpar{{\_interlinepenalty=10000\_endgraf}}

\_protected\_def\_nl{\_hfil\_break}
\_regmacro {\_def\_nl{\_unskip\_space}} {\_def\_nl{\_unskip\_space}} {\_def\_nl{ }}
\_regmacro {\_def\nl{\_unskip\_space}}  {\_def\nl{\_unskip\_space}}  {\_def\nl{ }}

\_public \nbpar \nl ;
```

`\_firstnoindent` puts a material to `\everypar` in order to next paragraph will be without indentation. It is useful after titles. If you dislike this feature then you can say `\let\_firtnoindent=\relax`. The `\_wipeepar` removes the material from `\everypar`.

sections.opm

```
\_def \_firstnoindent {\_global\_everypar={\_wipeepar \_setbox7=\_lastbox}}
\_def \_wipeepar {\_global\_everypar={}}
```

The `\mark` (for running heads) is used in `\_printsection` only. We suppose that chapters will be printed after `\vfil\break`, so user can implement chapter titles for running headers directly by macros, no `\mark` mechanism is needed. But sections need `\mark`s. And they can be mixed with chapter's running heads, of course.

The `\_insertmark{`⟨*title text*⟩`}` saves `\mark` in the format `{`⟨*title-num*⟩`} {`⟨*title-text*⟩`}`, so it can be printed "as is" in `\headline` (see the space between them), or you can define a formating macro with two parameters for processing these data, if you need it.

sections.opm

```
\_def\_insertmark#1{\_mark{{\_ifnonum\_else\_therefnum\_fi} {\_unexpanded{#1}}}}
```

OpTEX sets `\headline={}` by default, so no running headings are printed. You can activate the running headings by following code, for example:

```
\addto\_chapx {\_edef\_runningchap {\_thechapnum: \_unexpanded\_ea{\_savedtitle}}}
\def \formathead #1#2{\isempty{#1}\iffalse #1: #2\fi}
\headline = {%
   \ifodd \pageno
       \hfil \ea\formathead\firstmark{}{}%
   \else
       Chapter: \runningchap \hfil
   \fi
}
```

The `\caption`/⟨*letter*⟩ uses `\_`⟨*letter*⟩`num` counter. The group opened by `\caption` is finalized by first `\par` from empty line or from `\vskip` or from `\endinsert`. The `\_printcaption`⟨*letter*⟩ is called, it starts with printing of the caption.
The `\cskip` macro inserts nobreakable vertical space between caption and the object.

sections.opm

```
\_def\_caption/#1{\_def\_tmpa{#1}\_nospaceafter \_capA}
\_optdef\_capA []{\_trylabel \_incaption}
\_def\_incaption {\_bgroup
   \_ifcsname _\_tmpa num\_endcsname \_ea\_incr \_csname _\_tmpa num\_endcsname
   \_else \_opwarning{Unknown caption /\_tmpa}\_fi
   \_edef\_thecapnum {\_csname _the\_tmpa num\_endcsname}%
   \_edef\_thecaptitle{\_mtext{\_tmpa}}%
   \_ifcsname _everycaption\_tmpa\_endcsname
       \_ea\_the \_csname _everycaption\_tmpa\_endcsname \_fi
   \_def\_par{\_nbpar\_egroup}\_let\par=\_par
   \_cs{_printcaption\_tmpa}%
}
\_def \_cskip {\_par\_nobreak\_medskip} % space between caption and the object

\_public \caption \cskip ;
```

The `\_printcaptiont` and `\_printcaptionf` macros start in vertical mode. They switch to horizontal mode and use `\_wlabel\_thecapnum` (in order to make reference and hyperlink destination) a they can use:

- `\_thecaptitle` ... expands to the word Table or Figure (depending on the current language).
- `\_thecapnum` ... expands to `\the`⟨*letter*⟩`num` (caption number).

sections.opm

```
\_def \_printcaptiont {%
   \_noindent \_wlabel\_thecapnum {\_bf\_thecaptitle~\_thecapnum}\_enspace
   \_narrowlastlinecentered\_iindent
}
\_let \_printcaptionf = \_printcaptiont % caption of figures = caption of tables
```

The default format of `\caption` text is paragraph in block narrower by `\_iindent` and with the last line is centered. This setting is done by the `\_narrowlastlinecentered` macro.

sections.opm

```
\_def\_narrowlastlinecentered#1{%
   \_leftskip=#1plus1fil
   \_rightskip=#1plus-1fil
   \_parfillskip=0pt plus2fil
}
```

`\eqmark` is processed in display mode (we add `\eqno` primitive) or in internal mode when `\eqaligno` is used (we don't add `\eqno`).

sections.opm

```
\_optdef\_eqmark []{\_trylabel \_ineqmark}
\_def\_ineqmark{\_incr\_dnum
  \_ifinner\_else\_eqno \_fi
  \_wlabel\_thednum \_thednum
}
\_public \eqmark ;
```

The `\numberedpar` ⟨*letter*⟩`{`⟨*name*⟩`}` is implemented here.

sections.opm

```
\_newcount\_counterA \_newcount\_counterB \_newcount\_counterC
\_newcount\_counterD \_newcount\_counterE

\_def\_resetABCDE {\_counterA=0 \_counterB=0 \_counterC=0 \_counterD=0 \_counterE=0 }

\_def \_theAnum {\_othe\_chapnum.\_othe\_secnum.\_the\_counterA}
\_def \_theBnum {\_othe\_chapnum.\_othe\_secnum.\_the\_counterB}
\_def \_theCnum {\_othe\_chapnum.\_othe\_secnum.\_the\_counterC}
\_def \_theDnum {\_othe\_chapnum.\_othe\_secnum.\_the\_counterD}
\_def \_theEnum {\_othe\_chapnum.\_othe\_secnum.\_the\_counterE}

\_def\_numberedpar#1#2{\_ea \_incr \_csname _counter#1\_endcsname
   \_def\_tmpa{#1}\_def\_tmpb{#2}\_numberedparparam}
\_optdef\_numberedparparam[]{%
   \_ea \_printnumberedpar \_csname _the\_tmpa num\_ea\_endcsname\_ea{\_tmpb}}

\_public \numberedpar ;
```

The _printnumberedpar \theXnum {⟨*name*⟩} opens numbered paragraph and prints it. The optional parameter is in _the_opt. You can re-define it if you need another design.

_printnumberedpar needs not to be re-defined if you only want to print Theorems in italic and to insert vertical skips (for example). You can do this by the following code:

```
\def\theorem    {\medskip\bgroup\it \numberedpar A{Theorem}}
\def\endtheorem {\par\egroup\medskip}

\theorem Let $M$ be... \endtheorem
```

sections.opm

```
\_def \_printnumberedpar #1#2{\_par
   \_noindent\_wlabel #1%
   {\_bf #2 #1\_istoksempty\_opt\_iffalse \_space \_the\_opt \_fi.}\_space
   \_ignorespaces
}
```

2.27 Lists, items

lists.opm

```
\_codedecl \begitems {Lists: begitems, enditems <2020-04-21>} % preloaded in format
```

_aboveliskip is used above the list of items,
_belowliskip is used below the list of items and
_interliskip is used between items.
_listskipA is used as \listskipamount at level 1 of items.
_listskipB is used as \listskipamount at other levels.
_setlistskip sets the skip dependent on the current level of items

lists.opm

```
\_def\_aboveliskip {\_removelastskip \_penalty-100 \_vskip\_listskipamount}
\_def\_belowliskip {\_penalty-200 \_vskip\_listskipamount}
\_def\_interliskip {}
\_def\_listskipA {\_medskipamount}
\_def\_listskipB {0pt plus.5\_smallskipamount}

\_def\_setlistskip {%
   \_ifnum \_ilevel = 1 \_listskipamount = \_listskipA \_relax
   \_else  \_listskipamount = \_listskipB \_relax
   \_fi}
```

The \itemnum is locally reset to zero in each group declared by \begitems. So nested lists are numbered independently. User can set initial value of \itemnum to another value after \beitems if he/she want. Each level of nested lists is indented by new \iindent from left. Default item mark is _printitem.
The \begitems runs _aboveliskip only if we are not near below a title, where a vertical skip is placed already and where the \penalty 11333 is. It activates * and defines it as _startitem.
The \enditems runs _isnextchar_par{}{_noindent} thus the next paragraph is without indentation if there is no empty line between the list and this paragraph (it is similar behavior as after display math).

lists.opm

```
\_newcount\_itemnum  \_itemnum=0
\_newtoks\_printitem

\_def\_begitems{\_par
  \_bgroup
  \_advance \_ilevel by1
  \_setlistskip
  \_ifnum\_lastpenalty<10000 \_aboveliskip \_fi
  \_itemnum=0 \_adef*{\_startitem}
  \_advance\_leftskip by\_iindent
  \_printitem=\_defaultitem
  \_the\_everylist \_relax
}
\_def\_enditems{\_par\_belowliskip\_egroup \_isnextchar\_par{}{\_noindent}}

\_def\_startitem{\_par \_ifnum\_itemnum>0 \_interliskip \_fi
   \_advance\_itemnum by1
   \_the\_everyitem \_noindent\_llap{\_the\_printitem}\_ignorespaces
}
\_public \begitems \enditems \itemnum ;
```

\novspaces sets \listskipamount to 0pt.

lists.opm

```
\_def\_novspaces {\_removelastskip \_listskipamount=0pt \_relax}
\_public \novspaces ;
```

Various item marks are saved in _item:⟨*letter*⟩ macros. You can re-define then or define more such macros. The \style ⟨*letter*⟩ does _printitem={_item:⟨*letter*⟩}. More exactly: \begitems does _printitem=\defaultitem first, then \style ⟨*letter*⟩ does _printitem={_item:⟨*letter*⟩} when it is used and finally, _startitem alias * uses _printitem.

lists.opm

```
\_def\_style#1{%
   \_ifcsname _item:#1\_endcsname \_printitem=\ea{\_csname _item:#1\_endcsname}%
   \_else \_printitem=\_defaultitem \_fi
}
\_sdef{_item:o}{\_raise.4ex\_hbox{$\_scriptscriptstyle\_bullet$} }
\_sdef{_item:-}{- }
\_sdef{_item:n}{\_the\_itemnum. }
\_sdef{_item:N}{\_the\_itemnum) }
\_sdef{_item:i}{(\_romannumeral\_itemnum) }
\_sdef{_item:I}{\_uppercase\_ea{\_romannumeral\_itemnum}\_kern.5em}
\_sdef{_item:a}{\_athe\_itemnum) }
\_sdef{_item:A}{\_uppercase\_ea{\_athe\_itemnum}) }
\_sdef{_item:x}{\_raise.3ex\_fullrectangle{.6ex}\_kern.4em}
\_sdef{_item:X}{\_raise.2ex\_fullrectangle{1ex}\_kern.5em}
```

_athe{⟨*num*⟩} returns the ⟨*num*⟩s lowercase letter from the alphabet.
_fullrectangle{⟨*dimen*⟩} prints full rectangle with given ⟨*dimen*⟩.

lists.opm

```
\_def\_fullrectangle#1{\_hbox{\_vrule height#1 width#1}}

\_def\_athe#1{\_ifcase#1?\_or a\_or b\_or c\_or d\_or e\_or f\_or g\_or h\_or
   i\_or j\_or k\_or l\_or m\_or n\_or o\_or p\_or q\_or r\_or s\_or t\_or
   u\_or v\_or w\_or x\_or y\_or z\_else ?\_fi
}
\_public \style ;
```

2.28 Verbatim, listings

2.28.1 Inline and “display” verbatim

verbatim.opm

```
\_codedecl \begtt {Verbatim <2020-11-13>} % preloaded in format
```

The internal parameters _ttskip, _ttpenalty, _viline, _vifile and _ttfont for verbatim macros are set.

verbatim.opm

```
\_def\_ttskip{\_medskip}          % space above and below \begtt, \verbinput
```

```
\_mathchardef\_ttpenalty=100       % penalty between lines in \begtt, \verbinput
\_newcount\_viline                 % last line number in \verbinput
\_newread\_vifile                  % file given by \verinput
\_def\_ttfont{\_tt}                % default tt font
```

`\code{`⟨*text*⟩`}` expands to `\detokenize{`⟨*text*⟩`}` when `\escapechar=-1`. In order to do it more robust when it is used in `\write` then it expands as noexpanded `\code`⟨*space*⟩ (followed by space in its csname). This macro does the real work.

The `\_printinverbatim{`⟨*text*⟩`}` macro is used for `\code{`⟨*text*⟩`}` printing and for `` `⟨*text*⟩` `` printing. It is defined as `\hbox`, so the in-verbatim ⟨*text*⟩ will be never broken. But you can re-define this macro.

When `\code` occurs in PDF outlines then it does the same as `\detokenize`. The macro for preparing outlines sets `\escapechar` to −1 and uses `\_regoul` token list before `\edef`.

The `\code` is not `\proteced` because we want it expands to `\unexpanded{\code`⟨*space*⟩`{`⟨*text*⟩`}}` in `\write` parameters. This protect the expansions of the `\code` parameter (like `\\`, `\^` etc.).

verbatim.opm

```
\_def\_code#1{\_unexpanded\_ea{\_csname _code \_endcsname{#1}}}
\_protected\_sdef{_code }#1{{\_escapechar=-1 \_ttfont \_the\_everyintt \_relax
   \_ea\_printinverbatim\_ea{\_detokenize{#1}}}}
\_def\_printinverbatim#1{\_leavevmode\_hbox{#1}}

\_regmacro {}{}{\_let\code=\_detokenize \_let\_code=\_detokenize}
\_public \code ;
```

The `\_setverb` macro sets all catcodes to “verbatim mode”. It should be used only in a group, so we prepare a new catcode table with “verbatim” catcodes and we define it as `\_catcodetable\_verbatimcatcodes`. After the group is finished then original catcode table is restored.

verbatim.opm

```
\_newcatcodetable \_verbatimcatcodes
\_def\_setverb{\_begingroup
   \_def\do##1{\_catcode`##1=12 }
   \_dospecials
   \_savecatcodetable\_verbatimcatcodes % all characters are normal
   \_endgroup
}
\_setverb
\_def\_setverb{\_catcodetable\_verbatimcatcodes }%
```

`\activettchar`⟨*char*⟩ saves original catcode of previously declared ⟨*char*⟩ (if such character was declared) using `\_savedttchar` and `\_savedttcharc` values. Then new such values are stored. The declared character is activated by `\_adef` as a macro (active character) which opens a group, does `\_setverb` and other settings and reads its parameter until second the same character. This is done by the `\_readverb` macro. Finally it prints scanned ⟨*text*⟩ by `\_printinverbatim` and closes group. Suppose that `\activettchar"` is used. Then the following work is schematically done:

```
\_def "{\_begingroup \_setverb ... \_readverb}
\_def \_readverb #1"{\_printinverbatim{#1}\_endgroup}
```

Note that the second occurrence of `"` is not active because `\_setverb` deactivates it.

verbatim.opm

```
\_def\_activettchar#1{%
   \_ifx\_savedttchar\_undefined\_else \_catcode\_savedttchar=\_savedttcharc \_fi
   \_chardef\_savedttchar=`#1
   \_chardef\_savedttcharc=\_catcode`#1
   \_adef{#1}{\_begingroup \_setverb \_adef{ }{\_dsp}\_ttfont \_the\_everyintt\_relax \_readverb}%
   \_def\_readverb ##1#1{\_printinverbatim{##1}\_endgroup}%
}
\_public \activettchar ;
```

`\begtt` is defined only as public. We don't need private `\_begtt` variant. This macro is defined by `\eoldef`, so user can put a parameter at the same line where `\begtt` is. This `#1` parameter is used after `\_everytt` parameters settings, so user can change them locally.

The `\begtt` macro opens group, does `\_setverb` and another preprocessing, sets `\endlinechar` to `^^J` and reads the following text in verbatim mode until `\endtt` occurs. This scanning is done by `\_startverb` macro which is defined as:

```
\_def\_startverb #1\endtt #2^^J{...}
```

We must to ensure that the backslash in `\endtt` has category 12 (this is a reason of the `\ea` chain in real code). The `#2` is something between `\endtt` and end of the same line and it is simply ignored.

The `\_startverb` puts the scanned data to `\_prepareverbdata`. It sets the data to `\_tmpb` without changes by default, but you should re-define it in order to do special changes, if you want. (For example, `\hisyntax` redefines this macro.) The scanned data have `^^J` at each end of line and all spaces are active characters (defined as `\␣`). Other characters have normal category 11 or 12.

When `\_prepareverbdata` finishes then `\_startverb` runs `\_printverb` loop over each line of the data and does a final work: last skip plus `\noindent` in the next paragraph.

verbatim.opm

```
\_eoldef \begtt#1{\_par \_wipeepar \_setxhsize
   \_vskip\_parskip \_ttskip
   \_begingroup
   \_setverb
   \_ifnum\_ttline<0 \_let\_printverblinenum=\_relax \_else \_initverblinenum \_fi
   \_adef{ }{\_dsp}\_adef\^^I{\t}\_parindent=\_ttindent \_parskip=0pt
   \_def\t{\_hskip \_dimexpr\_tabspaces em/2\_relax}%
   \_the\_everytt \_relax #1\_relax \_ttfont
   \_def\_testcommentchars##1\_iftrue{\_iffalse}\_let\_hicomments=\_relax
   \_endlinechar=`\^^J
   \_startverb
}
\_ea\_def\_ea\_startverb \_ea#\_ea1\_csstring\\endtt#2^^J{%
   \_prepareverbdata\_tmpb{#1^^J}%
   \_ea\_printverb \_tmpb\_end
   \_par
   \_endgroup \_ttskip
   \_isnextchar\_par{}{\_noindent}%
}
\_def\_prepareverbdata#1#2{\_def#1{#2}}
```

The `\_printverb` macro calls `\_printverbline{`⟨*line*⟩`}` repeatedly to each scanned line of verbatim text. The `\_printverb` is used from `\begtt...\endtt` and from `\verbinput` too.

The `\_testcommentchars` replaces the following `\_iftrue` to `\_iffalse` by default unless the `\commentchars` are set. So, main body of the loop is written in `\_else` part of the `\_iftrue` condition. The `\_printverbline{`⟨*line*⟩`}` is called here.

The `\_printverbline{`⟨*line*⟩`}` expects that it starts in vertical mode and it must do `\par` in order to return the vertical mode. The `\_printverblinenum` is used here: it does nothing when `\_ttline<0` else it prints the line number using `\_llap`.

verbatim.opm

```
\_def\_printverb #1^^J#2{%
   \_ifx\_printverblinenum\_relax \_else \_global\_advance\_ttline by1 \_fi
   \_testcommentchars #1\_relax\_relax\_relax
   \_iftrue
      \_ifx\_end#2 \_printcomments\_fi
   \_else
      \_ifx\_vcomments\_empty\_else  \_printcomments \_def\_vcomments{}\_fi
      \_ifx\_end#2
         \_bgroup \_adef{ }{}\_def\t{}% if the last line is emtpy, we don't print it
         \_ifcat&#1&\_egroup \_else\_egroup \_printverbline{#1}\_fi
      \_else
         \_printverbline{#1}%
      \_fi
   \_fi
   \_ifx\_end#2 \_let\_next=\_relax \_else \_def\_next{\_printverb#2}\_fi
   \_next
}
\_def\_printverbline#1{\_penalty \_ttpenalty
   \_indent \_printverblinenum \_kern\_ttshift #1\par}
\_def\_initverblinenum{\_tenrm \_thefontscale[700]\_ea\_let\_ea\_sevenrm\_the\_font}
\_def\_printverblinenum{\_llap{\_sevenrm \_the\_ttline\_kern.9em}}
```

Macro `\verbinput` uses a file read previously or opens the given file. Then it runs the parameter scanning by `\_viscanparameter` and `\_viscanminus`. Finally the `\_doverbinput` is run. At beginning of `\_doverbinput`, we have `\_viline`= number of lines already read using previous `\verbinput`, `\_vinolines`= the number of lines we need to skip and `\_vidolnes`= the number of lines we need to print. Similar preparation is done as in `\begtt` after the group is opened. Then we skip `\_vinolines`

lines in a loop a and we read _vidolines lines. The read data is accumulated into _tmpb macro. The next steps are equal to the steps done in _startverb macro: data are processed via _prepareverbdata and printed via _printverb loop.

verbatim.opm

```
\_def\_verbinput #1(#2) #3 {\_par \_def\_tmpa{#3}%
   \_def\_tmpb{#1}%  cmds used in local group
   \_ifx\_vifilename\_tmpa \_else
      \_openin\_vifile={#3}%
      \_global\_viline=0 \_global\_let\_vifilename=\_tmpa
      \_ifeof\_vifile
         \_opwarning{\_string\verbinput: file "#3" unable to read}
         \_ea\_ea\_ea\_skiptorelax
      \_fi
   \_fi
   \_viscanparameter #2+\_relax
}
\_def\_skiptorelax#1\_relax{}

\_def \_viscanparameter #1+#2\_relax{%
   \_if$#2$\_viscanminus(#1)\_else \_viscanplus(#1+#2)\_fi
}
\_def\_viscanplus(#1+#2+){%
   \_if$#1$\_tmpnum=\_viline
   \_else \_ifnum#1<0 \_tmpnum=\_viline \_advance\_tmpnum by-#1
       \_else \_tmpnum=#1
            \_advance\_tmpnum by-1
            \_ifnum\_tmpnum<0 \_tmpnum=0 \_fi % (0+13) = (1+13)
   \_fi \_fi
   \_edef\_vinolines{\_the\_tmpnum}%
   \_if$#2$\_def\_vidolines{0}\_else\_edef\_vidolines{#2}\_fi
   \_doverbinput
}
\_def\_viscanminus(#1-#2){%
   \_if$#1$\_tmpnum=0
      \_else \_tmpnum=#1 \_advance\_tmpnum by-1 \_fi
   \_ifnum\_tmpnum<0 \_tmpnum=0 \_fi  % (0-13) = (1-13)
   \_edef\_vinolines{\_the\_tmpnum}%
   \_if$#2$\_tmpnum=0
      \_else \_tmpnum=#2 \_advance\_tmpnum by-\_vinolines \_fi
   \_edef\_vidolines{\_the\_tmpnum}%
   \_doverbinput
}
\_def\_doverbinput{%
   \_tmpnum=\_vinolines
   \_advance\_tmpnum by-\_viline
   \_ifnum\_tmpnum<0
      \_openin\_vifile={\_vifilename}%
      \_global\_viline=0
   \_else
      \_edef\_vinolines{\_the\_tmpnum}%
   \_fi
   \_vskip\_parskip \_ttskip \_wipeepar \_setxhsize
   \_begingroup
   \_ifnum\_ttline<-1 \_let\_printverblinenum=\_relax \_else \_initverblinenum \_fi
   \_setverb \_adef{ }{\_dsp}\_adef\^^I{\t}\_parindent=\_ttindent \_parskip=0pt
   \_def\t{\_hskip \_dimexpr\_tabspaces em/2\_relax}%
   \_the\_everytt\_relax \_tmpb\_relax \_ttfont
   \_endlinechar=`\^^J \_tmpnum=0
   \_loop \_ifeof\_vifile \_tmpnum=\_vinolines\_space \_fi
         \_ifnum\_tmpnum<\_vinolines\_space
         \_vireadline \_advance\_tmpnum by1 \_repeat      %% skip lines
   \_edef\_ttlinesave{\_ttline=\_the\_ttline}%
   \_ifnum\_ttline=-1 \_ttline=\_viline \_fi
   \_tmpnum=0 \_def\_tmpb{}%
   \_ifnum\_vidolines=0 \_tmpnum=-1 \_fi
   \_ifeof\_vifile \_tmpnum=\_vidolines\_space \_fi
   \_loop \_ifnum\_tmpnum<\_vidolines\_space
            \_vireadline
            \_ifnum\_vidolines=0 \_else\_advance\_tmpnum by1 \_fi
```

```
            \_ifeof\_vifile \_tmpnum=\_vidolines\_space \_else \_visaveline \_fi %% save line
            \_repeat
   \_ea\_prepareverbdata \_ea \_tmpb\_ea{\_tmpb^^J}%
   \_catcode`\ =10 \_catcode`\%=9 % used in \commentchars comments
   \_ea\_printverb \_tmpb\_end
   \_global\_ttlinesave
   \_par
   \_endgroup
   \_ttskip
   \_isnextchar\_par{}{\_noindent}%
}
\_def\_vireadline{\_read\_vifile to \_tmp \_global\_advance\_viline by1 }
\_def\_visaveline{\_ea\_addto\_ea\_tmpb\_ea{\_tmp}}

\_public \verbinput ;
```

If the language of your code printed by \verbinput supports the format of comments started by two characters from beginning of the line then you can set these characters by \commentchars⟨*first*⟩⟨*second*⟩. Such comments are printed in non-verbatim mode without these two characters and they look like the verbatim printing is interrupred at the places where such comments are. See the section 2.39 for good illustration. The file optex.lua is read by single command \verbinput (4-) optex.lua here and the \commentchars -- was set before it.

If you need to set a special character by \commentchars then you must to set the catcode to 12 (and space to 13). Examples:

```
\commentchars //         % C++ comments
\commentchars --         % Lua comments
{\catcode`\%=12 \_ea}\commentchars %%                  % TeX comments
{\catcode`\#=12 \catcode`\ =13 \_ea}\commentchars#{ }  % bash comments
```

There is one limitation when TEX interprets the comments declared by \commentchars. Each block of comments are accummulated to one line and then it is re-interpreted by TEX. So, the ends of lines in the comments block are lost. You cannot use macros which need to scan end of lines, for example \begtt...\endtt inside comments block does not work. The character % is ignored in comments but you can use \% for printing or % alone for de-activating _endpar from empty comment lines.

Implementation: The \commentchars⟨*first*⟩⟨*second*⟩ redefines the _testcommentchars used in _printverb in order to it removes the following _iftrue and returns _iftrue or _iffalse depending on the fact that the comment characters are or aren't present at the beginning ot tested line. If it is true (\ifnum expands to \ifnum 10>0) then the rest of the line is added to the _vcomments macro.

The _hicomments is \relax by default but it is redefined by \commentchars in order to keep no-colorized comments if we need to use feature from \commentchars.

The accumulated comments are printed whenever the non-comment line occurs. This is done by _printcomments macro. You can re-define it, but main idea must be kept: it is printed in the group, _reloding _rm initializes normal font, \catcodetable0 returns to normal catcode table used before \verbinput is started, and the text accumulated in _vcomments must be printed by _scantextokens primitive.

verbatim.opm

```
\_def\_vcomments{}
\_let\_hicomments=\_relax

\_def\_commentchars#1#2{%
   \_def\_testcommentchars ##1##2##3\_relax ##4\_iftrue{\_ifnum % not closed in this macro
      \_ifx #1##1\_ifx#2##21\_fi\_fi 0>0
      \_ifx\_relax##3\_relax \_addto\_vcomments{\_endgraf}% empty comment=\enfgraf
      \_else \_addto\_vcomments{##3 }\_fi}%
   \_def\_hicomments{\_replfromto{\b\n#1#2}{^^J}{\w{#1#2####1}^^J}}% used in \hisyntax
}
\_def\_testcommentchars #1\_iftrue{\_iffalse} % default value of \_testcommentchar
\_def\_printcomments{\_ttskip
   {\_catcodetable0 \_reloading \_rm \_everypar={}%
    \_noindent \_ignorespaces \_scantextokens\_ea{\_vcomments}\_par}%
   \_ttskip
}
\_public \commentchars ;
```

The \visiblesp sets spaces as visible characters ␣. It redefines the _dsp, so it is useful for verbatim modes only.

The _dsp is equivalent to \␣ primitive. It is used in all verbatim environments: spaces are active and defined as _dsp here.

verbatim.opm

```
\_def \_visiblesp{\_ifx\_initunifonts\_relax \_def\_dsp{\_char9251 }%
                  \_else \_def\_dsp{\_char32 }\_fi}
\_let\_dsp=\  % primitive "direct space"

\_public \visiblesp ;
```

2.28.2 Listings with syntax highlighting

The user can write

```
\begtt \hisytnax{C}
...
\endtt
```

and the code is colorized by C syntax. The user can write \everytt={\hisyntax{C}} and all verbatim listings are colorized.

The \hisyntax{⟨*name*⟩} reads the file hisyntax-⟨*name*⟩.opm where the colorization is declared. The parameter ⟨*name*⟩ is case insensitive and the file name must include it in lowercase letters. For example the file hisyntax-c.opm looks like:

hisyntax-c.opm

```
\_codedecl \_hisyntaxc {Syntax highlighting for C sources <2020-04-03>}

\_newtoks \_hisyntaxc  \_newtoks \_hicolorsc

\_global\_hicolorsc={%     colors for C language
   \_hicolor K \Red      % Keywords
   \_hicolor S \Magenta  % Strings
   \_hicolor C \Green    % Comments
   \_hicolor N \Cyan     % Numbers
   \_hicolor P \Blue     % Preprocessor
   \_hicolor O \Blue     % Non-letters
}
\_global\_hisyntaxc={%
   \_the\_hicolorsc
   \_let\c=\_relax \_let\e=\_relax \_let\o=\_relax
   \_replfromto {/*}{*/}         {\x C{/*#1*/}}%   /*...*/
   \_replfromto {//}{^^J}        {\z C{//#1}^^J}%  //...
   \_replfromto {\_string#}{^^J} {\z P{\##1}^^J}%  #include ...
   \_replthis   {\_string\"}     {{\_string\"}}%   \" protected inside strings
   \_replfromto {"}{"}           {\x S{"#1"}}%     "..."
   %
   \_edef\_tmpa {()\_string{\_string}+-*/=[]<>,:;\_pcent\_string&\_string^|!?}% non-letters
   \_ea \_foreach \_tmpa
      \_do {\_replthis{#1}{\n\o#1\n}}
   \_foreach                                                          % keywords
      {auto}{break}{case}{char}{continue}{default}{do}{double}%
      {else}{entry}{enum}{extern}{float}{for}{goto}{if}{int}{long}{register}%
      {return}{short}{sizeof}{static}{struct}{switch}{typedef}{union}%
      {unsigned}{void}{while}
      \_do {\_replthis{\n#1\n}{\z K{#1}}}
   \_replthis{.}{\n.\n}                                               % numbers
   \_foreach 0123456789
      \_do {\_replfromto{\n#1}{\n}{\c#1##1\e}}
   \_replthis{\e.\c}{.}
   \_replthis{\e.\n}{.\e}
   \_replthis{\n.\c}{\c.}
   \_replthis{e\e\o+\c}{e+}\_replthis{e\e\o-\c}{e-}
   \_replthis{E\e\o+\c}{E+}\_replthis{E\e\o-\c}{E-}
   \_def\o#1{\z O{#1}}
   \_def\c#1\e{\z N{#1}}
}
```

OpTEX provides `hisyntax-{c,python,tex,html}.opm` files. You can take inspiration from these files and declare more languages.

User can re-declare colors by `\hicolors={...}` This value has precedence before `\_hicolors`⟨*name*⟩ values declared in the `hicolors-`⟨*name*⟩`.opm` file. What exactly to do: copy `\_hicolors`⟨*name*⟩`={...}` from `hicolors-`⟨*name*⟩`.opm` to your document, rename it as `\hicolors={...}` and do you own colors modifications.

Another way to set non-default colors is to declare `\newtoks\hicolors`⟨*name*⟩ (without the `_` prefix) and set the colors palette here. It has precedence before `\_hicolors`⟨*name*⟩ (with the `_` prefix) declared in the `hicolors-`⟨*name*⟩`.opm` file. This is useful when there are more hi-syntax languages used in one document.

Notes for hi-syntax macro writers

The file `hisyntax-`⟨*name*⟩`.opm` is read only once in the TEX group. If there are definitions then they must be declared as global.

The `hisyntax-`⟨*name*⟩`.opm` file must (globally) declare `\_hisyntax`⟨*name*⟩ tokens string where the action over verbatim text is declared typically by `\replfromto` or `\replthis` macros.

The verbatim text is prepared by *pre-processing phase*, then the `\_hisyntax`⟨*name*⟩ is applied and then *post-processing phase* does final corrections. Finally, the verbatim text is printed line by line.

The pre-processing phase does:

- Each space is replaced by `\n␣\n`, so `\n`⟨*word*⟩`\n` should be a pattern to finding whole words (no subwords). The `\n` control sequence is removed in the post-processing phase.
- Each end of line is represented by `\n^^J\n`.
- The `\_start` control sequence is added before the verbatim text and `\_end` control sequence is appended to the end of the verbatim text. These control sequences are removed in post-processing phase.

There are special macros working only in a group when processing the verbatim text.

- `\n` means noting but it should be used as a boundary of words as mentioned above.
- `\t` means a tabulator. It is prepared as `\n\t\n` because it can be at the boundary of a word.
- `\x` ⟨*letter*⟩`{`⟨*text*⟩`}` can be used as replacing text. Suppose the example

  ```
  \replfromto{/*}{*/}{\x C{/*#1*/}}
  ```

  This replaces all C comments `/*...*/` by `\x C{/*...*/}`. But the C comments may span more lines, i.e. the `^^J` should be inside it.

  The macro `\x` ⟨*letter*⟩`{`⟨*text*⟩`}` is replaced by one or more `\z` ⟨*letter*⟩`{`⟨*text*⟩`}` in post-processing phase where each parameter ⟨*text*⟩ of `\z` keeps inside one line. Inside-line parameters are represented by `\x C{`⟨*text*⟩`}` and they are replaced to `\z C{`⟨*text*⟩`}` without any change. But:

  ```
  \x C{⟨text1⟩^^J⟨text3⟩^^J⟨text3⟩}
  is replaced by
  \z C{⟨text1⟩}^^J\z C{⟨text2⟩}^^J\z C{⟨text3⟩}
  ```

  The `\z` ⟨*letter*⟩`{`⟨*text*⟩`}` is expanded to `\_z:`⟨*letter*⟩`{`⟨*text*⟩`}` and if `\hicolor` ⟨*letter*⟩ ⟨*color*⟩ is declared then `\_z:`⟨*letter*⟩`{`⟨*text*⟩`}` expands to `{`⟨*color*⟩⟨*text*⟩`}`. So, required color is activated at all lines (separately) where C comment spans.
- `\y {`⟨*text*⟩`}` is replaced by `\`⟨*text*⟩ in the post processing phase. It should be used for macros without a parameter. You cannot use unprotected macros as replacement text before the post-processing phase, because the post-processing phase is based on expansion whole verbatim text.

hi-syntax.opm

```
\_codedecl \hisyntax {Syntax highlithing of verbatim listings <2020-04-04>} % preloaded in format
```

The following macros `\replfromto` and `\replthis` manipulate with the verbatim text which has been read already and stored in the `\_tmpb` macro.

The `\replfromto {`⟨*from*⟩`}{`⟨*to*⟩`}{`⟨*what*⟩`}` finds first ⟨*from*⟩ then the first ⟨*to*⟩ following by ⟨*from*⟩ pattern and the ⟨*text*⟩ between them is packed to `#1`. Then ⟨*from*⟩⟨*text*⟩⟨*to*⟩ is replaced by ⟨*what*⟩. The ⟨*what*⟩ parameter can use `#1` which is replaced by the ⟨*text*⟩.

The `\replfromto` continues by finding next ⟨*from*⟩, then, next ⟨*to*⟩ repeatedly over the whole verbatim text. If the verbatim text is ended by opened ⟨*from*⟩ but not closing by ⟨*to*⟩ then ⟨*to*⟩ is appended to the verbatim text automatically and the last part of verbatim text is replaced too.

First two parameters are expanded before usage of `\replfromto`. You can use `\csstring\%` or something else here.

hi-syntax.opm

```
\_def\_replfromto #1#2{\_edef\_tmpa{{#1}{#2}}\_ea\_replfromtoE\_tmpa}
\_def\_replfromtoE#1#2#3{% #1=from #2=to #3=what to replace
   \_def\_replfrom##1#1##2{\_addto\_tmpb{##1}%
      \_ifx\_end##2\_ea\_replstop \_else \_afterfi{\_replto##2}\_fi}%
   \_def\_replto##1#2##2{%
      \_ifx\_end##2\_afterfi{\_replfin##1}\_else
        \_addto\_tmpb{#3}%
        \_afterfi{\_replfrom##2}\_fi}%
   \_def\_replfin##1#1\_end{\_addto\_tmpb{#3}\_replstop}%
   \_edef\_tmpb{\_ea}\_ea\_replfrom\_tmpb#1\_end#2\_end\_end\_relax
}
\_def\_replstop#1\_end\_relax{}
\_def\_finrepl{}
```

The `\replthis` {⟨*pattern*⟩}{⟨*what*⟩} replaces each ⟨*pattern*⟩ by ⟨*what*⟩. Both parameters of `\replthis` are expanded first.

hi-syntax.opm

```
\_def\_replthis#1#2{\_edef\_tmpa{{#1}{#2}}\_ea\_replstring\_ea\_tmpb \_tmpa}

\_public \replfromto \replthis ;
```

The patterns ⟨*from*⟩, ⟨*to*⟩ and ⟨*pattern*⟩ are not found when they are hidden in braces `{...}`. Example:

```
\replfromto{/*}{*/}{\x C{/*#1/*}}
```

replaces all C comments by `\x C{...}`. The patterns inside `{...}` are not used by next usage of `\replfromto` or `\replthis` macros.

The `\_xscan` macro does replacing `\x` by `\z` in the post-processing phase. The `\x` ⟨*letter*⟩{⟨*text*⟩} expands to `\_xscan` {⟨*letter*⟩}⟨*text*⟩`^^J^`. If `#3` is `\_end` then it signals that something wrong happens, the ⟨*from*⟩ was not terminated by legal ⟨*to*⟩ when `\replfromto` did work. We must to fix it by the `\_xscanR` macro.

hi-syntax.opm

```
\_def\_xscan#1#2^^J#3{\_ifx\_end#3 \_ea\_xscanR\_fi
   \z{#1}{#2}%
   \_ifx^#3\_else ^^J\_afterfi{\_xscan{#1}#3}\_fi}
\_def\_xscanR#1\_fi#2^{^^J}
```

The `\hicolor` ⟨*letter*⟩ ⟨*color*⟩ defines `\_z`⟨*letter*⟩{⟨*text*⟩} as {⟨*color*⟩⟨*text*⟩}. It should be used in the context of `\x` ⟨*letter*⟩{⟨*text*⟩} macros.

hi-syntax.opm

```
\_def\_hicolor #1#2{\_sdef{_z:#1}##1{{#2##1}}}
```

The `\hisyntax`{⟨*name*⟩} re-defines default `\_prepareverbdata`⟨*macro*⟩⟨*verbtext*⟩ in order to it does more things: It saves ⟨*verbtext*⟩ to `\_tmpb`, appends `\n` around spaces and `^^J` characters in pre-processing phase, it opens `hisyntax-`⟨*name*⟩`.opm` file if `\_hisyntax`⟨*name*⟩ is not defined. Then `\_the\_isyntax`⟨*name*⟩ is processed. Finally, the post-processing phase is realized by setting appropriate values to `\x` and `\y` macros and doing `\_edef\_tmpb{\_tmpb}`.

hi-syntax.opm

```
\_def\_hisyntax#1{\_def\_prepareverbdata##1##2{%
   \_let\n=\_relax \_let\b=\_relax \_def\t{\n\_noexpand\t\n}\_let\_start=\_relax
   \_adef{ }{\n\_noexpand\ \n}\_edef\_tmpb{\_start^^J##2\_end}%
   \_replthis{^^J}{\n^^J\b\n}\_replthis{\b\n\_end}{\_end}%
   \_let\x=\_relax  \_let\y=\_relax \_let\z=\_relax \_let\t=\_relax
   \_hicomments % keeps comments declared by \commentchars
   \_endlinechar=`\^^M
   \_lowercase{\_def\_tmpa{#1}}%
   \_ifcsname _hialias:\_tmpa\_endcsname \_edef\_tmpa{\_cs{_hialias:\_tmpa}}\_fi
   \_ifx\_tmpa\_empty \_else
      \_unless \_ifcsname _hisyntax\_tmpa\_endcsname
          \_isfile{hisyntax-\_tmpa.opm}\_iftrue \_opinput {hisyntax-\_tmpa.opm} \_fi\_fi
      \_ifcsname _hisyntax\_tmpa\_endcsname
          \_ifcsname hicolors\_tmpa\_endcsname
              \_cs{_hicolors\_tmpa}=\_cs{hicolors\_tmpa}%
          \_else
              \_if^\_the\_hicolors^\_else
```

```
                \_ifcsname _hicolors\_tmpa\_endcsname
                    \_global\_cs{_hicolors\_tmpa}=\_hicolors \_global\_hicolors={}%
          \_fi\_fi\_fi
          \_ea\_the \_csname _hisyntax\_tmpa\_endcsname % \_the\_hisyntax<name>
      \_else\_opwarning{Syntax "\_tmpa" undeclared (no file hisyntax-\_tmpa.opm)}
   \_fi\_fi
   \_replthis{\_start\n^^J}{}\_replthis{^^J\_end}{^^J}%
   \_def\n{}\_def\b{}\_adef{ }{\_dsp}%
   \_bgroup \_lccode`\~=`\ \_lowercase{\_egroup\_def\ {\_noexpand~}}%
   \_def\w####1{####1}\_def\x####1####2{\_xscan{####1}####2^^J^}%
   \_def\y####1{\_ea \_noexpand \_csname ####1\_endcsname}%
   \_edef\_tmpb{\_tmpb}%
   \_def\z####1{\_cs{_z:####1}}%
   \_def\t{\_hskip \_dimexpr\_tabspaces em/2\_relax}%
   \_localcolor
}}
\_public \hisyntax \hicolor ;
```

Aliases for languages can be declared like this. When `\hisyntax{xml}` is used then this is the same as `\hisyntax{html}`.

hi-syntax.opm

```
\_sdef{_hialias:xml}{html}
\_sdef{_hialias:json}{c}
```

2.29 Graphics

The `\inspic` is defined by `\pdfximage` and `\pdfrefximage` primitives. If you want to use one picture more than once in your document, then the following code is recommended:

```
\newbox\mypic
\setbox\mypic = \hbox{\picw=3cm \inspic{⟨picture⟩}}

My picture: \copy\mypic, again my picture: \copy\mypic, etc.
```

This code downloads the picture data to the PFD oputput only once (when `\setbox` is processed). Each usage of `\copy\mypic` puts only a pointer to the picture data in the PDF.

If you want to copy the same picture in different sizes, then choose a "basic size" used in `\setbox` and all different sizes can be realized by the `\transformbox{`⟨*transformation*⟩`}{\copy\mypic}`.

graphics.opm

```
\_codedecl \inspic {Graphics <2020-04-12>} % preloaded in format
```

`\inspic` accepts old syntax `\inspic` ⟨*filename*⟩⟨*space*⟩ or new syntax `\inspic{`⟨*filename*⟩`}`. So, we need to define two auxiliary macros `\_inspicA` and `\_inspicB`.

You can include more `\pdfximage` parameters (like `page`⟨*number*⟩) in the `\_picparams` macro.

All `\inspic` macros are surrounded in `\hbox` in order user can write `\moveright\inspic ...` or something similar.

graphics.opm

```
\_def\_inspic{\_hbox\_bgroup\_isnextchar\_bgroup\_inspicB\_inspicA}
\_def\_inspicA #1 {\_inspicB {#1}}
\_def\_inspicB #1{%
   \_pdfximage \_ifdim\_picwidth=\_zo  \_else width\_picwidth\_fi
               \_ifdim\_picheight=\_zo \_else height\_picheight\_fi
               \_picparams {\_the\_picdir#1}%
   \_pdfrefximage\_pdflastximage\_egroup}

\_def\_picparams{}

\_public \inspic ;
```

Inkscape is able to save a picture to `*.pdf` file and labels for the picture to `*.pdf_tex` file. The second file is in LaTeX format (unfortunately) and it is intended to read immediately it after `*.pdf` in included in order to place labels of this picture in the same font as document is printed. We need to read this LaTeX file by plain TeX macros when `\inkinspic` is used. These macros are stored in the `\_inkdefs` tokens list and it is used locally in the group. The solution is borrowed from OPmac trick 0032.

graphics.opm

```
\_def\_inkinspic{\_hbox\_bgroup\_isnextchar\_bgroup\_inkinspicB\_inkinspicA}
```

```
\_def\_inkinspicA #1 {\_inkinspicB {#1}}
\_def\_inkinspicB #1{%
  \_ifdim\_picwidth=0pt \_setbox0=\_hbox{\_inspic{#1}}\_picwidth=\_wd0 \_fi
  \_the\_inkdefs
  \_opinput {\_the\_picdir #1_tex}% file with labels
  \_egroup}

\_newtoks\_inkdefs  \_inkdefs={%
  \_def\makeatletter#1\makeatother{}%
  \_def\includegraphics[#1]#2{\_inkscanpage#1,page=,\_end \_inspic{#2}\_hss}%
  \_def\_inkscanpage#1page=#2,#3\_end{\_ifx,#2,\_else\_def\_picparams{page#2}\_fi}%
  \_def\put(#1,#2)#3{\_nointerlineskip\_vbox to\_zo{\_vss\_hbox to\_zo{\_kern#1\_picwidth
      \_pdfsave\_hbox to\_zo{#3}\_pdfrestore\_hss}\_kern#2\_picwidth}}%
  \_def\begin#1{\_csname _begin#1\_endcsname}%
  \_def\_beginpicture(#1,#2){\_vbox\_bgroup
      \_hbox to\_picwidth{}\_kern#2\_picwidth \_def\end##1{\_egroup}}%
  \_def\_begintabular[#1]#2#3\end#4{%
      \_vtop{\_def\\{\_cr}\_tabiteml{}\_tabitemr{}\_table{#2}{#3}}}%
  \_def\color[#1]#2{\_scancolor #2,}%
  \_def\_scancolor#1,#2,#3,{\_pdfliteral{#1 #2 #3 rg}}%
  \_def\makebox(#1)[#2]#3{\_hbox to\_zo{\_csname _mbx:#2\_endcsname{#3}}}%
  \_sdef{_mbx:lb}#1{#1\_hss}\_sdef{_mbx:rb}#1{\_hss#1}\_sdef{_mbx:b}#1{\_hss#1\_hss}%
  \_sdef{_mbx:lt}#1{#1\_hss}\_sdef{_mbx:rt}#1{\_hss#1}\_sdef{_mbx:t}#1{\_hss#1\_hss}%
  \_def\rotatebox#1#2{\_pdfrotate{#1}#2}%
  \_def\lineheight#1{}%
  \_def\setlength#1#2{}%
}
\_public \inkinspic ;
```

\pdfscale{⟨*x-scale*⟩}{⟨*y-scale*⟩} and \pdfrotate{⟨*degrees*⟩} macros are implemented by \pdfsetmatrix primitive. We need to know values of sin, cos function in the \pdfrotate. We use Lua code for this.

graphics.opm

```
\_def\_pdfscale#1#2{\_pdfsetmatrix{#1 0 0 #2}}

\_def\_gonfunc#1#2{%
   \_directlua{tex.print(string.format('\_pcent.4f',math.#1(3.14159265*(#2)/180)))}%
}
\_def\_sin{\_gonfunc{sin}}
\_def\_cos{\_gonfunc{cos}}

\_def\_pdfrotate#1{\_pdfsetmatrix{\_cos{#1} \_sin{#1} \_sin{(#1)-180} \_cos{#1}}}

\_public \pdfscale \pdfrotate ;
```

The \transformbox{⟨*transformation*⟩}{⟨*text*⟩} is copied from OPmac trick 0046.
The \rotbox{⟨*degrees*⟩}{⟨*text*⟩} is a combination of \rotsimple from OPmac trick 0101 and the \transformbox. Note, that \rotbox{-90} puts the rotated text to the height of the outer box (depth is zero) because code from \rotsimple is processed. But \rotbox{-90.0} puts the rotated text to the depth of the outer box (height is zero) because \transformbox is processed.

graphics.opm

```
\_def\_multiplyMxV #1 #2 #3 #4 {% matrix * (vvalX, vvalY)
   \_tmpdim = #1\_vvalX \_advance\_tmpdim by #3\_vvalY
   \_vvalY  = #4\_vvalY \_advance\_vvalY  by #2\_vvalX
   \_vvalX = \_tmpdim
}
\_def\_multiplyMxM #1 #2 #3 #4 {% currmatrix := currmatrix * matrix
   \_vvalX=#1pt \_vvalY=#2pt \_ea\_multiplyMxV \_currmatrix
   \_edef\_tmpb{\_ea\_ignorept\_the\_vvalX\_space \_ea\_ignorept\_the\_vvalY}%
   \_vvalX=#3pt \_vvalY=#4pt \_ea\_multiplyMxV \_currmatrix
   \_edef\_currmatrix{\_tmpb\_space
      \_ea\_ignorept\_the\_vvalX\_space \_ea\_ignorept\_the\_vvalY\_space}%
}
\_def\_transformbox#1#2{\_hbox{\_setbox0=\_hbox{{#2}}%
   \_dimendef\_vvalX 11 \_dimendef\_vvalY 12 % we use these variables
   \_dimendef\_newHt 13 \_dimendef\_newDp 14 % only in this group
   \_dimendef\_newLt 15 \_dimendef\_newRt 16
   \_preptransform{#1}%
   \_kern-\_newLt \_vrule height\_newHt depth\_newDp width\_zo
```

```
   \_setbox0=\_hbox{\_box0}\_ht0=\_zo \_dp0=\_zo
   \_pdfsave#1\_rlap{\_box0}\_pdfrestore \_kern\_newRt}%
}
\_def\_preptransform #1{\_def\_currmatrix{1 0 0 1 }%
   \_def\_pdfsetmatrix##1{\_edef\_tmpb{##1 }\_ea\_multiplyMxM \_tmpb\_unskip}%
   \_let\pdfsetmatrix=\_pdfsetmatrix #1%
   \_setnewHtDp 0pt  \_ht0  \_setnewHtDp 0pt  -\_dp0
   \_setnewHtDp \_wd0 \_ht0  \_setnewHtDp \_wd0 -\_dp0
   \_protected\_def \_pdfsetmatrix {\_pdfextension setmatrix}%
   \_let\pdfsetmatrix=\_pdfsetmatrix
}
\_def\_setnewHtDp #1 #2 {%
   \_vvalX=#1\_relax \_vvalY=#2\_relax \_ea\_multiplyMxV \_currmatrix
   \_ifdim\_vvalX<\_newLt \_newLt=\_vvalX \_fi \_ifdim\_vvalX>\_newRt \_newRt=\_vvalX \_fi
   \_ifdim\_vvalY>\_newHt \_newHt=\_vvalY \_fi \_ifdim-\_vvalY>\_newDp \_newDp=-\_vvalY \_fi
}

\_def\_rotbox#1#2{%
   \_isequal{90}{#1}\_iftrue \_rotboxA{#1}{\_kern\_ht0 \_tmpdim=\_dp0}{\_vfill}{#2}%
   \_else \_isequal{-90}{#1}\_iftrue \_rotboxA{#1}{\_kern\_dp0 \_tmpdim=\_ht0}{}{#2}%
   \_else \_transformbox{\_pdfrotate{#1}}{#2}%
   \_fi \_fi
}
\_def\_rotboxA #1#2#3#4{\_hbox{\_setbox0=\_hbox{{#4}}#2%
   \_vbox to\_wd0{#3\_wd0=\_zo \_dp0=\_zo \_ht0=\_zo
                 \_pdfsave\_pdfrotate{#1}\_box0\_pdfrestore\vfil}%
   \_kern\_tmpdim
}}
\_public \transformbox \rotbox ;
```

_scantwodimens scans two objects with the syntactic rule ⟨*dimen*⟩ and returns {⟨*number*⟩}{⟨*number*⟩} in sp unit.
\puttext ⟨*right*⟩ ⟨*up*⟩{⟨*text*⟩} puts the ⟨*text*⟩ to desired place: From current point moves ⟨*down*⟩ and ⟨*right*⟩, puts the ⟨*text*⟩ and returns back. The current point is unchanged after this macro ends.
\putpic ⟨*right*⟩ ⟨*up*⟩ ⟨*width*⟩ ⟨*height*⟩ {⟨*image-file*⟩} does \puttext with the image scaled to desired ⟨*width*⟩ and ⟨*height*⟩. If ⟨*with*⟩ or ⟨*height*⟩ is zero, natural dimension is used. The \nospec is a shortcut to such natural dimension.
\backgroundpic{⟨*image-file*⟩} puts the image to the background of each page. It it used in the slides style, for example.

graphics.opm

```
\_def\_scantwodimens{%
   \_directlua{tex.print(string.format('{\_pcent d}{\_pcent d}',
               token.scan_dimen(),token.scan_dimen()))}%
}

\_def\_puttext{\_ea\_ea\_ea\_puttextA\_scantwodimens}
\_def\_puttextA#1#2#3{{\_setbox0=\_hbox{{#3}}\_dimen1=#1sp \_dimen2=#2sp \_puttextB}}
\_def\_puttextB{%
   \_ifvmode
      \_ifdim\_prevdepth>\_zo \_vskip-\_prevdepth \_relax \_fi
      \_nointerlineskip
   \_fi
   \_wd0=\_zo \_ht0=\_zo \_dp0=\_zo
   \_vbox to\_zo{\_kern-\_dimen2 \_hbox to\_zo{\_kern\_dimen1 \_box0\_hss}\_vss}}

\_def\_putpic{\_ea\_ea\_ea\_putpicA\_scantwodimens}
\_def\_putpicA#1#2{\_dimen1=#1sp \_dimen2=#2sp \_ea\_ea\_ea\_putpicB\_scantwodimens}
\_def\_putpicB#1#2#3{{\_setbox0=\_hbox{\_picwidth=#1sp \_picheight=#2sp \_inspic{#3}}\_puttextB}}

\_newbox\_bgbox
\_def\_backgroundpic#1{%
   \_setbox\_bgbox=\_hbox{\_picwidth=\_pdfpagewidth \_picheight=\_pdfpageheight \_inspic{#1}}%
   \_pgbackground={\_copy\_bgbox}
}
\_def\nospec{0pt}
\_public \puttext \putpic \backgroundpic ;
```

`\_circle{⟨x⟩}{⟨y⟩}` creates an ellipse with ⟨x⟩ axis and ⟨y⟩ axix. The origin is in the center.
`\_oval{⟨x⟩}{⟨y⟩}{⟨roundness⟩}` creates an oval with ⟨x⟩, ⟨y⟩ size and with given ⟨roundness⟩. The real size is bigger by 2⟨roundness⟩. The origin is at the left bottom corner.
`\_mv{⟨x⟩}{⟨y⟩}{⟨curve⟩}` moves current point to ⟨x⟩, ⟨y⟩, creates the ⟨curve⟩ and returns back the current point. All these macros are fully expandable and they can be used in the `\pdfliteral` argument.

graphics.opm

```
\def\_circle#1#2{\_expr{.5*(#1)} 0 m
   \_expr{.5*(#1)} \_expr{.276*(#2)} \_expr{.276*(#1)} \_expr{.5*(#2)} 0 \_expr{.5*(#2)} c
   \_expr{-.276*(#1)} \_expr{.5*(#2)} \_expr{-.5*(#1)} \_expr{.276*(#2)} \_expr{-.5*(#1)} 0 c
   \_expr{-.5*(#1)} \_expr{-.276*(#2)} \_expr{-.276*(#1)} \_expr{-.5*(#2)} 0 \_expr{-.5*(#2)} c
   \_expr{.276*(#1)} \_expr{-.5*(#2)} \_expr{.5*(#1)} \_expr{-.276*(#2)} \_expr{.5*(#1)} 0 c h}

\def\_oval#1#2#3{0 \_expr{-(#3)} m \_expr{#1} \_expr{-(#3)} l
    \_expr{(#1)+.552*(#3)} \_expr{-(#3)} \_expr{(#1)+(#3)} \_expr{-.552*(#3)}
                                                          \_expr{(#1)+(#3)} 0 c
    \_expr{(#1)+(#3)} \_expr{#2} l
    \_expr{(#1)+(#3)} \_expr{(#2)+.552*(#3)} \_expr{(#1)+.552*(#3)} \_expr{(#2)+(#3)}
                                             \_expr{#1} \_expr{(#2)+(#3)} c
    0 \_expr{(#2)+(#3)} l
    \_expr{-.552*(#3)} \_expr{(#2)+(#3)} \_expr{-(#3)} \_expr{(#2)+.552*(#3)}
                                        \_expr{-(#3)} \_expr{#2} c
    \_expr{-(#3)} 0 l
    \_expr{-(#3)} \_expr{-.552*(#3)} \_expr{-.552*(#3)} \_expr{-(#3)}  0 \_expr{-(#3)} c h}

\def\_mv#1#2#3{1 0 0 1 \_expr{#1} \_expr{#2} cm #3 1 0 0 1 \_expr{-(#1)} \_expr{-(#2)} cm}
```

The `\inoval{⟨text⟩}` is an example of `\_oval` usage.
The `\incircle{⟨text⟩}` is an example of `\_circle` usage.
The `\ratio`, `\lwidth`, `\fcolor`, `\lcolor`, `\shadow` and `\overlapmargins` are parameters, they can be set by user in optional brackets `[...]`. For example `\fcolor=\Red` does `\_let\_fcolorvalue=\Red` and it means filling color.
The `\_setflcolor` uses the `\_fillstroke` macro to separate filling color and drawing color.

graphics.opm

```
\_newdimen \_lwidth
\_def\_fcolor{\_let\_fcolorvalue}
\_def\_lcolor{\_let\_lcolorvalue}
\_def\_shadow{\_let\_shadowvalue}
\_def\_overlapmargins{\_let\_overlapmarginsvalue}
\_def\_ratio{\_isnextchar ={\_ratioA}{\_ratioA=}}
\_def\_ratioA =#1 {\_def\_ratiovalue{#1}}
\_def\_touppervalue#1{\_ifx#1n\_let#1=N\_fi}

\_def\_setflcolors#1{% use only in a group
   \_def\_setcolor##1{##1}%
   \_def\_fillstroke##1##2{##1}%
   \_edef#1{\_fcolorvalue}%
   \_def\_fillstroke##1##2{##2}%
   \_edef#1{#1\_space\_lcolorvalue\_space}%
}
\_optdef\_inoval[]{\_vbox\_bgroup
   \_roundness=2pt \_fcolor=\Yellow \_lcolor=\Red \_lwidth=.5bp
   \_shadow=N \_overlapmargins=N \_hhkern=0pt \_vvkern=0pt
   \_the\_ovalparams \_relax \_the\_opt \_relax
   \_touppervalue\_overlapmarginsvalue \_touppervalue\_shadowvalue
   \_ifx\_overlapmarginsvalue N%
      \_advance\_hsize by-2\_hhkern \_advance\_hsize by-2\_roundness \_fi
   \_setbox0=\_hbox\_bgroup\_bgroup \_aftergroup\_inovalA \_kern\_hhkern \_let\_next=%
}
\_def\_inovalA{\_isnextchar\_colorstackpop\_inovalB\_inovalC}
\_def\_inovalB#1{#1\_isnextchar\_colorstackpop\_inovalB\_inovalC}
\_def\_inovalC{\_egroup % of \setbox0=\hbox\bgroup
   \_ifdim\_vvkern=\_zo \_else \_ht0=\_dimexpr\_ht0+\_vvkern \_relax
                               \_dp0=\_dimexpr\_dp0+\_vvkern \_relax \_fi
   \_ifdim\_hhkern=\_zo \_else \_wd0=\_dimexpr\_wd0+\_hhkern \_relax \_fi
   \_ifx\_overlapmarginsvalue N\_dimen0=\_roundness \_dimen1=\_roundness
   \_else                      \_dimen0=-\_hhkern   \_dimen1=-\_vvkern \_fi
   \_setflcolors\_tmp
   \_hbox{\_kern\_dimen0
```

```
      \_vbox to\_zo{\_kern\_dp0
         \_ifx\_shadowvalue N\_else
            \_edef\_tmpb{{\_bp{\_wd0+\_lwidth}}{\_bp{\_ht0+\_dp0+\_lwidth}}{\_bp{\_roundness}}}%
            \_doshadow\_oval
         \_fi
         \_pdfliteral{q \_bp{\_lwidth} w \_tmp
            \_oval{\_bp{\_wd0}}{\_bp{\_ht0+\_dp0}}{\_bp{\_roundness}} B Q}\_vss}%
      \_ht0=\_dimexpr\_ht0+\_dimen1 \_relax \_dp0=\_dimexpr\_dp0+\_dimen1 \_relax
      \_box0
      \_kern\_dimen0}%
   \_egroup % of \vbox\bgroup
}
\_optdef\_incircle[]{\_vbox\_bgroup
   \_ratio=1 \_fcolor=\Yellow \_lcolor=\Red \_lwidth=.5bp
   \_shadow=N \_overlapmargins=N \_hhkern=3pt \_vvkern=3pt
   \_ea\_the \_ea\_circleparams \_space \_relax
   \_ea\_the \_ea\_opt \_space \_relax
   \_touppervalue\_overlapmarginsvalue \_touppervalue\_shadowvalue
   \_setbox0=\_hbox\_bgroup\_bgroup \_aftergroup\_incircleA \_kern\_hhkern \_let\_next=%
}
\_def\_incircleA {\_isnextchar\_colorstackpop\_incircleB\_incircleC}
\_def\_incircleB #1{#1\_isnextchar\_colorstackpop\_incircleB\_incircleC}
\_def\_incircleC {\_egroup % of \setbox0=\hbox\bgroup
   \_wd0=\_dimexpr \_wd0+\_hhkern \_relax
   \_ht0=\_dimexpr \_ht0+\_vvkern \_relax \_dp0=\_dimexpr \_dp0+\_vvkern \_relax
   \_ifdim \_ratiovalue\_dimexpr \_ht0+\_dp0 > \_wd0
          \_dimen3=\_dimexpr \_ht0+\_dp0 \_relax  \_dimen2=\_ratiovalue\_dimen3
   \_else \_dimen2=\_wd0 \_dimen3=\_expr{1/\_ratiovalue}\_dimen2 \_fi
   \_setflcolors\_tmp
   \_ifx\_overlapmarginsvalue N\_dimen0=\_zo \_dimen1=\_zo
   \_else \_dimen0=-\_hhkern \_dimen1=-\_vvkern \_fi
   \_hbox{\_kern\_dimen0
      \_ifx\_shadowvalue N\_else
         \_edef\_tmpb{{\_bp{\_dimen2+\_lwidth}}{\_bp{\_dimen3+\_lwidth}}{}}%
         \_doshadow\_circlet
      \_fi
      \_pdfliteral{q \_bp{\_lwidth} w \_tmp \_mv{\_bp{.5\_wd0}}{\_bp{(\_ht0-\_dp0)/2}}
                                    {\_circle{\_bp{\_dimen2}}{\_bp{\_dimen3}} B} Q}%
      \_ifdim\_dimen1=\_zo \_else
           \_ht0=\_dimexpr \_ht0+\_dimen1 \_relax \_dp0=\_dimexpr \_dp0+\_dimen1 \_relax \_fi
      \_box0
      \_kern\_dimen0}
   \_egroup % of \vbox\bgroup
}
\_def\_circlet#1#2#3{\_circle{#1}{#2}}

\_public \inoval \incircle \ratio \lwidth \fcolor \lcolor \shadow \overlapmargins ;
```

A shadow effect is implemented here. The shadow is equal to the silhouette of the given path in gray-transparent color shifted by _shadowmoveto vector and with blurred boundary. A waistline with the width 2*_shadowb around the boundary is blurred. The \shadowlevels levels of transparent shapes is used for creating this effect. The \shadowlevels+1/2 level is equal to the shifted given path.

graphics.opm

```
\_def\_shadowlevels{9}          % number of layers for blurr effect
\_def\_shadowdarknessA{0.025}  % transparency of first shadowlevels/2 layers
\_def\_shadowdarknessB{0.07}   % transparency of second half of layers
\_def\_shadowmoveto{1.8 -2.5}  % vector defines shifting layer (in bp)
\_def\_shadowb{1}              % 2*shadowb = blurring area thickness
```

The _pdfpageresources primitive is used to define transparency. It does not work when used in a box. So, we use it at the begining of the output routine. The modification of the output routine is done using _insertshadowresources only once when the shadow effect is used first.

graphics.opm

```
\_def\_insertshadowresources{%
   \_global\_addto\_begoutput{\_setshadowresources}%
   \_xdef\_setshadowresources{%
      \_pdfpageresources{/ExtGState
      <<
      /op1  <</Type /ExtGState /ca \_shadowdarknessA>>
```

```
      /op2  <</Type /ExtGState /ca \_shadowdarknessB>>
      \_morepgresources
      >>
      }%
  }%
  \_global\_let\_insertshadowresources=\_relax
}
\_def\_morepgresources{}
```

The _doshadow{⟨*curve*⟩} does the shadow effect.

graphics.opm

```
\_def\_doshadow#1{\_vbox{%
    \_insertshadowresources
    \_tmpnum=\_numexpr (\_shadowlevels-1)/2 \_relax
    \_edef\_tmpfin{\_the\_tmpnum}%
    \_ifnum\_tmpfin=0 \_def\_shadowb{0}\_def\_shadowstep{0}%
    \_else \_edef\_shadowstep{\_expr{\_shadowb/\_tmpfin}}\_fi
    \_def\_tmpa##1##2##3{\_def\_tmpb
        {#1{##1+2*\_the\_tmpnum*\_shadowstep}{##2+2*\_the\_tmpnum*\_shadowstep}{##3}}}%
    \_ea \_tmpa \_tmpb
    \_def\_shadowlayer{%
        \_ifnum\_tmpnum=0 /op2 gs \_fi
        \_tmpb\_space f
        \_immediateassignment\_advance\_tmpnum by-1
        \_ifnum-\_tmpfin<\_tmpnum
           \_ifx#1\_oval 1 0 0 1 \_shadowstep\_space \_shadowstep\_space cm \_fi
           \_ea \_shadowlayer \_fi
    }%
    \_pdfliteral{q /op1 gs 0 g 1 0 0 1 \_shadowmoveto\_space cm
       \_ifx#1\_circlet 1 0 0 1 \_expr{\_bp{.5\_wd0}} \_expr{\_bp{(\_ht0-\_dp0)/2}} cm
       \_else  1 0 0 1 -\_shadowb\_space -\_shadowb\_space cm \_fi
       \_shadowlayer Q}
}}
```

A generic macro _clipinpath⟨*x*⟩ ⟨*y*⟩ ⟨*curve*⟩ ⟨*text*⟩ declares a clipping path by the ⟨*curve*⟩ shifted by the ⟨*x*⟩, ⟨*y*⟩. The ⟨*text*⟩ is typeset when such clipping path is active. Dimensions are given by bp without the unit here. The macros \clipinoval ⟨*x*⟩ ⟨*y*⟩ ⟨*width*⟩ ⟨*height*⟩ {⟨*text*⟩} and \clipincircle ⟨*x*⟩ ⟨*y*⟩ ⟨*width*⟩ ⟨*height*⟩ {⟨*text*⟩} are defined here. These macros read normal TEX dimensions in their parameters.

graphics.opm

```
\_def\_clipinpath#1#2#3#4{% #1=x-pos[bp], #2=y-pos[bp], #3=curve, #4=text
   \_hbox{\_setbox0=\_hbox{{#4}}%
          \_tmpdim=\_wd0 \_wd0=\_zo
          \_pdfliteral{q \_mv{#1}{#2}{#3 W n}}%
          \_box0\_pdfliteral{Q}\_kern\_tmpdim
   }%
}

\_def\_clipinoval {\_ea\_ea\_ea\_clipinovalA\_scantwodimens}
\_def\_clipinovalA #1#2{%
   \_def\_tmp{{#1/65781.76}{#2/65781.76}}%
   \_ea\_ea\_ea\_clipinovalB\_scantwodimens
}
\_def\_clipinovalB{\_ea\_clipinovalC\_tmp}
\_def\_clipinovalC#1#2#3#4{%
   \_ea\_clipinpath{#1-(#3/131563.52)+(\_bp{\_roundness})}{#2-(#4/131563.52)+(\_bp{\_roundness})}%
   {\_oval{#3/65781.76-(\_bp{2\_roundness})}{#4/65781.76-(\_bp{2\_roundness})}{\_bp{\_roundness}}}%
}
\_def\_clipincircle {\_ea\_ea\_ea\_clipincircleA\_scantwodimens}
\_def\_clipincircleA #1#2{%
   \_def\_tmp{{#1/65781.76}{#2/65781.76}}%
   \_ea\_ea\_ea\_clipincircleB\_scantwodimens
}
\_def\_clipincircleB#1#2{%
   \_ea\_clipinpath\_tmp{\_circle{#1/65781.76}{#2/65781.76}}%
}
\_public \clipinoval \clipincircle ;
```

2.30 The \table macro, tables and rules

2.30.1 The boundary declarator :

The ⟨*declaration*⟩ part of `\table{`⟨*declaration*⟩`}{`⟨*data*⟩`}` includes column declarators (letters) and other material: the `|` or `(`⟨*cmd*⟩`)`. If the boundary declarator `:` is not used then the boundaries of columns are just before each column declarator with exception of the first one. For example, the declaration `{|c||c(xx)(yy)c}` should be written more exactly using the boundary declarator `:` by `{|c||:c(xx)(yy):c}`. But you can set these boundaries to another places using the boundary declarator `:` explicitly, for example `{|c:||c(xx):(yy)c}`. The boundary declarator `:` can be used only once between each two column declarators.

Each table item has its own group. The `(`⟨*cmd*⟩`)` are parts of the given table item (depending on the boundary declarator position). If you want to apply a special setting for given column, you can do this by `(`⟨*setting*⟩`)` followed by column declarator. But if such column is not first, you must use `:(`⟨*setting*⟩`)`. Example. We have three centered columns, the second one have to be in bold font and the third one have to be in red: `\table{c:(\bf)c:(\Red)c}{`⟨*data*⟩`}`

2.30.2 Usage of the \tabskip primitive

The value of `\tabskip` primitive is used between all columns of the table. It is glue-type, so it can be stretchable or shrinkable, see next section 2.30.3.

By default, `\tabskip` is 0 pt. It means that only `\tabiteml`, `\tabitemr` and `(`⟨*cmds*⟩`)` can generate visual spaces between columns. But they are not real spaces between columns because they are in fact the part of the total column width.

The `\tabskip` value declared before the `\table` macro (or in `\everytable` or in `\thistable`) is used between all columns in the table. This value is equal for all spaces between columns. But you can set each such space individualy if you use `(\tabskip=`⟨*value*⟩`)` in the ⟨*declaration*⟩ immediately before boundary character. The boundary character represents the column pair for which the `\tabskip` have individual value. For example `c(\tabskip=5pt):r` gives `\tabskip` value betwen `c` and `r` columns. You need not to use boundary character explicitly, so `c(\tabskip=5pt)r` gives the same result.

The space before first column is given by the `\tabskipl` and the space after last column is equal to `\tabskipr`. Default values are 0 pt.

Use nonzero `\tabskip` only in special applications. If `\tabskip` is nonzero then horizontal lines generated by `\crli`, `\crlli` and `\crlp` have another behavior than you probably expected: they are interrupted in each `\tabskip` space.

2.30.3 Tables to given width

There are two possibilities how to create tables to given width:

- `\table to`⟨*size*⟩`{`⟨*declaration*⟩`}{`⟨*data*⟩`}` uses stretchability or shrinkability of all spaces between columns generated by `\tabskip` value and eventually by `\tabskipl`, `\tabskipr` values. See example below.
- `\table pxto`⟨*size*⟩`{`⟨*declaration*⟩`}{`⟨*data*⟩`}` expands the columns declared by `p{`⟨*size*⟩`}`, if the ⟨*size*⟩ is given by a virtual `\tsize` unit. See example below.

Example of `\table to`⟨*size*⟩:

```
\thistable{\tabskip=0pt plus1fil minus1fil}
\table to\hsize {lr}{⟨data⟩}
```

This table has its width `\hsize`. First column starts at the left boundary of this table and it is justified left (to the boundary). Second column ends at the right boundary of the table and it is justified right (to the boundary). The space between them are stretchable and shrinkable in order to reach given width `\hsize`.

Example of `\table pxto`⟨*size*⟩ (means "**p**aragraphs e**x**panded **to**"):

```
\table pxto\hsize {|c|p{\tsize}|}{\crl
 aaa         & Ddkas jd dsjds ds cgha sfgs dd fddzf dfhz xxz
               dras ffg hksd kds d sdjds h sd jd dsjds ds cgha
               sfgs dd fddzf dfhz xxz. \crl
 bb ddd ggg  & Dsjds ds cgha sfgs dd fddzf dfhz xxz
               ddkas jd dsjds ds cgha sfgs dd fddzf. \crl }
```

aaa	Ddkas jd dsjds ds cgha sfgs dd fddzf dfhz xxz dras ffg hksd kds d sdjds h sd jd dsjds ds cgha sfgs dd fddzf dfhz xxz.
bb ddd ggg	Dsjds ds cgha sfgs dd fddzf dfhz xxz ddkas jd dsjds ds cgha sfgs dd fddzf.

The first `c` colum is variable width (it gets the width of most wide item) and the resting space to given `\hsize` is filled by the `p` column.

You can declare more than one `p{`⟨*coefficient*⟩`\tsize}` columns in the table when `pxto` keyword is used. The total sum of ⟨*coefficinets*⟩ must be exactly one. For example,

```
\table pxto13cm {r p{.3\tsize} p{.5\tsize} p{.2\tsize} l}{⟨data⟩}
```

This gives the ratio of widths of individual paragraphs in the table.

2.30.4 \eqbox: boxes with equal width acros the whole document

The `\eqbox [`⟨*label*⟩`]{`⟨*text*⟩`}` behaves like `\hbox{`⟨*text*⟩`}` in the first run of TEX. But the widths of all boxes with the same label are saved to `.ref` file and the maximum box width for each label is calculated at the beginning of the next TEX run. Then `\eqbox [`⟨*label*⟩`]{`⟨*text*⟩`}` behaves like `\hbox to` ⟨*dim:label*⟩ `{\hss` ⟨*text*⟩`\hss}`, where ⟨*dim:label*⟩ is the maximum width of all boxes labeled by the same `[`⟨*label*⟩`]`. The documentation of the LATEX package `eqparbox` includes more information and tips.

The `\eqboxsize [`⟨*label*⟩`]{`⟨*dimen*⟩`}` expands to ⟨*dim:label*⟩ if this value is known, else it expands to the given ⟨*dimen*⟩.

The optional parameter `r` or `l` can be writen before `[`⟨*label*⟩`]` (for example `\eqbox r[label]{text}`) if you want to put the text to the right or to the left side of the box width.

Try the following example and watch what happens after first TEX run and after second one.

```
\def\leftitem#1{\par
   \noindent \hangindent=\eqboxsize[items]{2em}\hangafter=1
   \eqbox r[items]{#1 }\ignorespaces}

\leftitem {\bf first}      \lorem[1]
\leftitem {\bf second one} \lorem[2]
\leftitem {\bf final}      \lorem[3]
```

2.30.5 Implemetation of the \table macro and friends

table.opm

```
\_codedecl \table {Basic macros for OpTeX <2020-05-26>} % preloaded in format
```

The result of the `\table{`⟨*declaration*⟩`}{`⟨*data*⟩`}` macro is inserted into `\_tablebox`. You can change default value if you want by `\let\_tablebox=\vtop` or `\let\_tablebox=\relax`.

table.opm

```
\_let\_tablebox=\_vbox
```

We save the `to`⟨*size*⟩ or `pxto`⟨*size*⟩ to `#1` and `\_tableW` sets the `to`⟨*size*⟩ to the `\_tablew` macro. If `pxto`⟨*size*⟩ is used then `\_tablew` is empty and `\_tmpdim` includes given ⟨*size*⟩. The `\_ifpxto` returns true in this case.

The `\table` continues by reading `{`⟨*declaration*⟩`}` in the `\_tableA` macro. Catcodes (for example the `|` character) have to be normal when reading `\table` parameters. This is the reason why we use `\catcodetable` here.

table.opm

```
\_newifi \_ifpxto
\_def\_table#1#{\_tablebox\_bgroup \_tableW#1\_empty\_end
   \_bgroup \_catcodetable\_optexcatcodes \_tableA}
\_def\_tableW#1#2\_end{\_pxtofalse
   \_ifx#1\_empty \_def\_tablew{}\_else
   \_ifx#1p \_def\_tablew{}\_tableWx#2\_end \_else \_def\_tablew{#1#2}\_fi\_fi}
\_def\_tableWx xto#1\_end{\_tmpdim=#1\_relax \_pxtotrue}
\_public \table ;
```

The `\tablinespace` is implemented by enlarging given `\tabstrut` by desired dimension (height and depth too) and by setting `\_lineskip=-2\_tablinespace`. Normal table rows (where no `\hrule` is between them) have normal baseline distance.

The _tableA{⟨*declaration*⟩} macro scans the ⟨*declaration*⟩ by _scantabdata#1_relax and continues by reading {⟨*data*⟩} by the _tableB macro.

table.opm

```
\_def\_tableA#1{\_egroup
   \_the\_thistable \_global\_thistable={}%
   \_ea\_ifx\_ea^\_the\_tabstrut^\_setbox\_tstrutbox=\_null
   \_else \_setbox\_tstrutbox=\_hbox{\_the\_tabstrut}%
          \_setbox\_tstrutbox=\_hbox{\_vrule width\_zo
              height\_dimexpr\_ht\_tstrutbox+\_tablinespace
              depth\_dimexpr\_dp\_tstrutbox+\_tablinespace}%
          \_offinterlineskip
          \_lineskip=-2\_tablinespace
   \_fi
   \_colnum=0 \_let\_addtabitem=\_addtabitemx
   \_def\_tmpa{}\_tabdata={\_colnum1\_relax}\_scantabdata#1\_relax
   \_the\_everytable \_tableB
}
```

The _tableB{⟨*data*⟩} saves ⟨*data*⟩ to _tmpb and does four \replstrings to prefix each macro \crl (etc.) by _crcr. The reason is: we want to use macros which scan its parameter to the delimeiter written in right part of table item declaration. See \fS for example. The \crcr cannot be hidden in other macro in such case.

The \tabskip value is saved for places between columns into the _tabskipmid macro. Then it runs

\tabskip=\tabskipl \halign{⟨*converted declaration*⟩\tabskip=\tabskipr \cr ⟨*data*⟩\crcr}

This sets the desired boundary values of \tabskip. The "between-columns" values are set as \tabskip=_tabskipmid in the ⟨*converted declaration*⟩ immediately after each column declarator.

If pxto keyword was used, then we set the virtual unit \tsize to \hsize first. Then the first attempt of the table is created in box 0. Then the \tsize is re-calculated using \wd0 and the real table is printed by \halign in the second pass.

If no pxto keyword was used, then we print the table using \halign directly. The _tablew macro is nonempty if the to keyword was used.

Because the color selector with \aftergroup can be used inside the table item, we must to create second real group for each table item. This is reason why we start ⟨*converted declaration*⟩ by \bgroup and we end it by \egroup in the _tableC macro. Each & character is stored as \egroup&\bgroup in ⟨*converted declaration*⟩. The \halign_tablew_tableC really does:

\halign_tablew{\bgroup⟨*converted declaration*⟩\egroup\tabskip=\tabskipr \cr⟨*data*⟩\crcr}

table.opm

```
\_def\_tableB#1{\_def\_tmpb{#1}%
   \_replstring\_tmpb{\crl}{\_crcr\crl}\_replstring\_tmpb{\crll}{\_crcr\crll}%
   \_replstring\_tmpb{\crli}{\_crcr\crli}\_replstring\_tmpb{\crlli}{\_crcr\crlli}%
   \_replstring\_tmpb{\crlp}{\_crcr\crlp}%
   \_edef\_tabskipmid{\_the\_tabskip}\_tabskip=\_tabskipl
   \_ifpxto
      \_tsize=\_hsize \_setbox0 = \_vbox{\_halign \_tableC}%
      \_tsize=\_dimexpr\_hsize-(\_wd0-\_tmpdim)\_relax
      \_setbox0=\_null \_halign \_tableC
   \_else
      \_halign\_tablew \_tableC
   \_fi \_egroup
}
\_def\_tableC{\_ea{\_ea\_bgroup\_the\_tabdata\_egroup\_tabskip=\_tabskipr\_cr\_tmpb\_crcr}}

\_newbox\_tstrutbox  % strut used in table rows
\_newtoks\_tabdata   % the \halign declaration line
```

The _scantabdata macro converts \table's ⟨*declaration*⟩ to \halign ⟨*converted declaration*⟩. The result is stored into _tabdata tokens list. For example, the following result is generated when ⟨*declaration*⟩=|cr||cl|.

```
tabdata: \_vrule\_the\_tabiteml\_hfil#\_unsskip\_hfil\_the\_tabitemr\_tabstrutA
   &\_the\_tabiteml\_hfil#\_unsskip\_the\_tabitemr
                                        \_vrule\_kern\_vvkern\_vrule\_tabstrutA
```

```
    &\_the\_tabiteml\_hfil#\_unsskip\_hfil\_the\_tabitemr\_tabstrutA
    &\_the\_tabiteml#\_unsskip\_hfil\_the\_tabitemr\_vrule\_tabstrutA
ddlinedata: &\_dditem &\_dditem\_vvitem &\_dditem &\_dditem
```

The second result in the _ddlinedata macro is a template of one row of the table used by \crli macro.

table.opm

```
\_def\_scantabdata#1{\_let\_next=\_scantabdata
  \_ifx\_relax#1\_let\_next=\_relax
  \_else\_ifx|#1\_addtabvrule
    \_else\_ifx(#1\_def\_next{\_scantabdataE}%
      \_else\_ifx:#1\_def\_next{\_scantabdataF}%
        \_else\_isinlist{123456789}#1\_iftrue \_def\_next{\_scantabdataC#1}%
          \_else \_ea\_ifx\_csname _tabdeclare#1\_endcsname \_relax
            \_ea\_ifx\_csname _paramtabdeclare#1\_endcsname \_relax
              \_opwarning{tab-declarator "#1" unknown, ignored}%
            \_else
              \_def\_next{\_ea\_scantabdataB\_csname _paramtabdeclare#1\_endcsname}\_fi
            \_else \_def\_next{\_ea\_scantabdataA\_csname _tabdeclare#1\_endcsname}%
  \_fi\_fi\_fi\_fi\_fi\_fi \_next
}
\_def\_scantabdataA#1{\_addtabitem
  \_ea\_addtabdata\_ea{#1\_tabstrutA \_tabskip\_tabskipmid}\_scantabdata}
\_def\_scantabdataB#1#2{\_addtabitem
  \_ea\_addtabdata\_ea{#1{#2}\_tabstrutA \_tabskip\_tabskipmid}\_scantabdata}
\_def\_scantabdataC {\_def\_tmpb{}\_afterassignment\_scantabdataD \_tmpnum=}
\_def\_scantabdataD#1{\_loop \_ifnum\_tmpnum>0 \_advance\_tmpnum by-1 \_addto\_tmpb{#1}\_repeat
  \_ea\_scantabdata\_tmpb}
\_def\_scantabdataE#1){\_addtabdata{#1}\_scantabdata}
\_def\_scantabdataF {\_addtabitem\_def\_addtabitem{\_let\_addtabitem=\_addtabitemx}\_scantabdata}
```

The _addtabitemx adds the boundary code (used between columns) to the ⟨*converted declaration*⟩. This code is \egroup &\bgroup \colnum=⟨*value*⟩\relax. You can get the current number of column from the \colnum register, but you cannot write \the\colnum as the first object in a ⟨*data*⟩ item because \halign first expands the front of the item and the left part of the declaration is processed after this. Use \relax\the\colnum instead. Or you can write:

```
\def\showcolnum{\ea\def\ea\totcolnum\ea{\the\colnum}\the\colnum/\totcolnum}
\table{ccc}{\showcolnum & \showcolnum & \showcolnum}
```

This example prints 1/3 2/3 3/3, because the value of the \colnum is equal to the total number of columns before left part of the column declaration is processed.

table.opm

```
\_newcount\_colnum     % number of current column in the table
\_public \colnum ;

\_def\_addtabitemx{\_ifnum\_colnum>0
  \_addtabdata{\_egroup &\_bgroup}\_addto\_ddlinedata{&\_dditem}\_fi
  \_advance\_colnum by1 \_let\_tmpa=\_relax
  \_ifnum\_colnum>1 \_ea\_addtabdata\_ea{\_ea\_colnum\_the\_colnum\_relax}\_fi}
\_def\_addtabdata#1{\_tabdata\_ea{\_the\_tabdata#1}}
```

This code converts || or | from \table ⟨*declaration*⟩ to the ⟨*converted declaration*⟩.

table.opm

```
\_def\_addtabvrule{%
   \_ifx\_tmpa\_vrule \_addtabdata{\_kern\_vvkern}%
     \_ifnum\_colnum=0 \_addto\_vvleft{\_vvitem}\_else\_addto\_ddlinedata{\_vvitem}\_fi
   \_else \_ifnum\_colnum=0 \_addto\_vvleft{\_vvitemA}\_else\_addto\_ddlinedata{\_vvitemA}\_fi\_fi
   \_let\_tmpa=\_vrule \_addtabdata{\_vrule}%
}
\_def\_tabstrutA{\_copy\_tstrutbox}
\_def\_vvleft{}
\_def\_ddlinedata{}
```

The default "declaration letters" c, l, r and p are declared by setting \tabdeclarec, \tabdeclarel, \tabdeclarer and \paramtabdeclarep macros. In general, define \def_tabdeclare⟨*letter*⟩{...} for a non-parametric letter and \def_paramtabdeclare⟨*letter*⟩{...} for a letter with a parameter. The double hash ## must be in the definition, it is replaced by a real table item data. You can declare more such "declaration letters" if you want.

table.opm

```
\_def\_tabdeclarec{\_the\_tabiteml\_hfil##\_unsskip\_hfil\_the\_tabitemr}
\_def\_tabdeclarel{\_the\_tabiteml\_relax##\_unsskip\_hfil\_the\_tabitemr}
\_def\_tabdeclarer{\_the\_tabiteml\_hfil##\_unsskip\_the\_tabitemr}
\_def\_paramtabdeclarep#1{\_the\_tabiteml
   \_vtop{\_hsize=#1\_relax \_baselineskip=\_normalbaselineskip
   \_lineskiplimit=\_zo \_noindent##\_unsskip
   \_ifvmode\_vskip\_dp\_tstrutbox \_else\_lower\_dp\_tstrutbox\_hbox{}\_fi}\_the\_tabitemr}
```

User puts optional spaces around the table item typically, i.e. he/she writes `& text &` instead `&text&`. The left space is ignored by internal TEX algorithm but the right space must be removed by macros. This is a reason why we recommend to use `\_unsskip` after each `##` in your definition of "declaration letters". This macro isn't only the primitive `\unskip` because we allow usage of plain TEX `\hideskip` macro: `&\hideskip text\hideskip&`.

table.opm

```
\_def\_unsskip{\_ifmmode\_else\_ifdim\_lastskip>\_zo \_unskip\_fi\_fi}
```

The `\fL`, `\fR`, `\fC` and `\fX` macros only does a special parameters settings for paragraph building algorithm. The `\fS` prints the paragraph into box 0 first, measures the number of lines by the `\prevgraf` primitive and use (or don't use) `\hfil` (for centering) before the first line.

table.opm

```
\_let\_fL=\_raggedright
\_def\_fR{\_leftskip=0pt plus 1fill \_relax}
\_def\_fC{\_leftskip=0pt plus1fill \_rightskip=0pt plus 1fill \_relax}
\_def\_fX{\_leftskip=0pt plus1fil  \_rightskip=0pt plus-1fil \_parfillskip=0pt plus2fil \_relax}
\_long\_def\_fS #1\_unsskip{\_noindent \_setbox0 =\_vbox{\_noindent #1\_endgraf \_ea}%
   \_ifnum\_prevgraf=1 \_hfil \_fi #1\_unsskip
}
\_public \fL \fR \fC \fX \fS ;
```

The family of `\_cr*` macros `\crl`, `\crll`, `\crli`, `\crlli`, `\crlp` and `\tskip` ⟨*dimen*⟩ is implemented here. The `\_zerotabrule` is used in order to suppress the negative `\lineskip` declared by `\tablinespace`.

table.opm

```
\_def\_crl{\_crcr\_noalign{\_hrule}}
\_def\_crll{\_crcr\_noalign{\_hrule\_kern\_hhkern\_hrule}}
\_def\_zerotabrule {\_noalign{\_hrule height\_zo width\_zo depth\_zo}}

\_def\_crli{\_crcr \_zerotabrule \_omit
   \_gdef\_dditem{\_omit\_tablinefil}\_gdef\_vvitem{\_kern\_vvkern\_vrule}\_gdef\_vvitemA{\_vrule}%
   \_vvleft\_tablinefil\_ddlinedata\_crcr \_zerotabrule}
\_def\_crlli{\_crli\_noalign{\_kern\_hhkern}\_crli}
\_def\_tablinefil{\_leaders\_hrule\_hfil}

\_def\_crlp#1{\_crcr \_zerotabrule \_noalign{\_kern-\_drulewidth}%
   \_omit \_xdef\_crlplist{#1}\_xdef\_crlplist{,\_expandafter}\_expandafter\_crlpA\_crlplist,\_end,%
   \_global\_tmpnum=0 \_gdef\_dditem{\_omit\_crlpD}%
   \_gdef\_vvitem{\_kern\_vvkern\_kern\_drulewidth}\_gdef\_vvitemA{\_kern\_drulewidth}%
   \_vvleft\_crlpD\_ddlinedata \_global\_tmpnum=0 \_crcr \_zerotabrule}
\_def\_crlpA#1,{\_ifx\_end#1\_else \_crlpB#1-\_end,\_expandafter\_crlpA\_fi}
\_def\_crlpB#1#2-#3,{\_ifx\_end#3\_xdef\_crlplist{\_crlplist#1#2,}\_else\_crlpC#1#2-#3,\_fi}
\_def\_crlpC#1-#2-#3,{\_tmpnum=#1\_relax
   \_loop \_xdef\_crlplist{\_crlplist\_the\_tmpnum,}\_ifnum\_tmpnum<#2\_advance\_tmpnum by1 \_repeat}
\_def\_crlpD{\_global\_advance\_tmpnum by1
   \_edef\_tmpa{\_noexpand\_isinlist\_noexpand\_crlplist{,\_the\_tmpnum,}}%
   \_tmpa\_iftrue \_kern-\_drulewidth \_tablinefil \_kern-\_drulewidth\_else\_hfil \_fi}

\_def\_tskip{\_afterassignment\_tskipA \_tmpdim}
\_def\_tskipA{\_gdef\_dditem{}\_gdef\_vvitem{}\_gdef\_vvitemA{}\_gdef\_tabstrutA{}%
    \_vbox to\_tmpdim{}\_ddlinedata \_crcr
    \_zerotabrule \_noalign{\_gdef\_tabstrutA{\_copy\_tstrutbox}}}

\_public \crl \crll \crli \crlli \crlp \tskip ;
```

The `\mspan{`⟨*number*⟩`}[`⟨*declaration*⟩`]{`⟨*text*⟩`}` macro generates similar `\omit\span\omit\span` sequence as plain TEX macro `\multispan`. Moreover, it uses `\_scantabdata` to convert ⟨*declaration*⟩ from `\table` syntax to `\halign` syntax.

table.opm

```
\_def\_mspan{\_omit \_tabdata={\_tabstrutA}\_let\_tmpa=\_relax \_afterassignment\_mspanA \_mscount=}
\_def\_mspanA[#1]#2{\_loop \_ifnum\_mscount>1 \_cs{_span}\_omit \_advance\_mscount-1 \_repeat
```

```
    \_count1=\_colnum \_colnum=0 \_def\_tmpa{}\_tabdata={}\_scantabdata#1\_relax
    \_colnum=\_count1 \_setbox0=\_vbox{\_halign\_ea{\_ea\_bgroup\_the\_tabdata\_egroup\_cr#2\_cr}%
    \_global\_setbox8=\_lastbox}%
    \_setbox0=\_hbox{\_unhbox8 \_unskip \_global\_setbox8=\_lastbox}%
    \_unhbox8 \_ignorespaces}
\_public \mspan ;
```

The `\vspan{`⟨*number*⟩`}{`⟨*text*⟩`}` implementaiton is here. We need to lower the box by

`(`⟨*number*⟩`-1)*(\ht+\dp of \tabstrut) / 2.`

The `#1` parameter must be one-digit number. If you want to set more digits then use braces.

table.opm

```
\_def\_vspan#1#2{\_vtop to\_zo{\_hbox{\_lower \_dimexpr
   #1\_dimexpr(\_ht\_tstrutbox+\_dp\_tstrutbox)/2\_relax
    -\_dimexpr(\_ht\_tstrutbox+\_dp\_tstrutbox)/2\_relax \_hbox{#2}}\_vss}}
\_public \vspan ;
```

The parameters of primitive `\vrule` and `\hrule` keeps the rule "last wins". If we re-define `\hrule` to `\_orihrule height1pt` then each usage of redefined `\hrule` uses `1pt` height if this parameter isn't overwritten by another following `height` parameter. This principle is used for settings another default rule thickness than 0.4 pt by the macro `\rulewidth`.

table.opm

```
\_newdimen\_drulewidth  \_drulewidth=0.4pt
\_let\_orihrule=\_hrule  \_let\_orivrule=\_vrule
\_def\_rulewidth{\_afterassignment\_rulewidthA \_drulewidth}
\_def\_rulewidthA{\_edef\_hrule{\_orihrule height\_drulewidth}%
                  \_edef\_vrule{\_orivrule width\_drulewidth}%
                  \_let\_rulewidth=\_drulewidth
                  \_public \vrule \hrule \rulewidth;}
\_public \rulewidth ;
```

The `\frame{`⟨*text*⟩`}` uses "`\vbox` in `\vtop`" trick in order to keep the baseline of the internal text at the same level as outer baseline. User can write `\frame{abcxyz}` in normal paragraph line, for example and gets the expected result: abcxyz. The internal margins are set by `\vvkern` and `\hhkern` parameters.

table.opm

```
\_long\_def\_frame#1{%
   \_hbox{\_vrule\_vtop{\_vbox{\_hrule\_kern\_vvkern
      \_hbox{\_kern\_hhkern\_relax#1\_kern\_hhkern}%
   }\_kern\_vvkern\_hrule}\_vrule}}
\_public \frame ;
```

`\eqbox` and `\eqboxsize` are implemented here. The widths of all `\eqbox`es are saved to the `.ref` file in the format `\_Xeqbox{`⟨*label*⟩`}{`⟨*size*⟩`}`. The `.ref` file is read again and maximum box width for each ⟨*label*⟩ is saved to `\_eqb:`⟨*label*⟩.

table.opm

```
\_def\_Xeqbox#1#2{%
   \_ifcsname _eqb:#1\_endcsname
      \_ifdim #2>\_cs{_eqb:#1}\_relax \_sdef{_eqb:#1}{#2}\_fi
   \_else \_sdef{_eqb:#1}{#2}\_fi
}
\_def\_eqbox #1[#2]#3{\_setbox0=\_hbox{{#3}}%
   \_openref \_immediate\_wref \_Xeqbox{{#2}{\_the\_wd0}}%
   \_ifcsname _eqb:#2\_endcsname
      \_hbox to\_cs{_eqb:#2}{\_ifx r#1\_hfill\_fi\_hss\_unhbox0\_hss\_ifx l#1\_hfill\_fi}%
   \_else \_box0 \_fi
}
\_def\_eqboxsize [#1]#2{\_trycs{_eqb:#1}{#2}}

\public \eqbox \eqboxsize ;
```

2.31 Balanced multi-columns

multicolumns.opm

```
\_codedecl \begmulti {Balanced columns <2020-03-26>} % preloaded in format
```

This code is documented in detail in the "TEXbook naruby", pages 244–246, free available, http://petr.olsak.net/tbn.html, but in Czech. Roughly speaking, macros complete all material between

\begmulti⟨*num-columns*⟩ and \endmulti into one \vbox 6. Then the macro measures the amount of free space at the current page using \pagegoal and \pagtotal and does \vsplit of \vbox 6 to columns with height of such free space. This is done only if we have enought amount of material in \vbox 6 to fill full page by columns. This is repeated in loop until we have less amount of material in \vbox 6. Then we run _balancecolumns which balances the last part of columns. Each part of printed material is distributed to main vertical list as \hbox{⟨*columns*⟩} and we need not do any change in the output routine.

If you have paragraphs in \begmulti... \endmulti environment then you may say \raggedright inside this environment and you can re-assign \widowpenalty and \clubppenalty (they are set to 10000 in OpTEX).

multicolumns.opm

```
\_def\_multiskip{\_medskip}      % space above and below \begmulti...\endmulti

\_newcount\_mullines

\_def\_begmulti #1 {\_par\_bgroup\_wipeepar\_multiskip\_penalty0 \_def\_Ncols{#1}
   \_setbox6=\_vbox\_bgroup \_let\_setxhsize=\_relax \_penalty0
   %% \hsize := column width = (\hsize+\colsep) / n - \colsep
   \_advance\_hsize by\_colsep
   \_divide\_hsize by\_Ncols  \_advance\_hsize by-\_colsep
   \_mullines=0
   \_def\par{\_ifhmode\_endgraf\_global\_advance\_mullines by\_prevgraf\_fi}%
}
\_def\_endmulti{\_vskip-\_prevdepth\_vfil
   \_ea\_egroup\_ea\_baselineskip\_the\_baselineskip\_relax
   \_dimen0=.8\_maxdimen \_tmpnum=\_dimen0 \_divide\_tmpnum by\_baselineskip
   \_splittopskip=\_baselineskip
   \_setbox1=\_vsplit6 to0pt
   %% \dimen1 := the free space on the page
   \_ifdim\_pagegoal=\_maxdimen \_dimen1=\_vsize \_corrsize{\_dimen1}
   \_else \_dimen1=\_pagegoal \_advance\_dimen1 by-\_pagetotal \_fi
   \_ifdim \_dimen1<2\_baselineskip
     \_vfil\_break \_dimen1=\_vsize \_corrsize{\_dimen1} \_fi
   \_ifnum\_mullines<\_tmpnum \_dimen0=\_ht6 \_else \_dimen0=.8\_maxdimen \_fi
   \_divide\_dimen0 by\_Ncols \_relax
   %% split the material to more pages?
   \_ifdim \_dimen0>\_dimen1 \_splitpart
   \_else \_balancecolumns \_fi  % only balancing
   \_multiskip\_egroup
}
```

Splitting columns...

multicolumns.opm

```
\_def\_makecolumns{\_bgroup % full page, destination height: \dimen1
   \_vbadness=20000 \_setbox1=\_hbox{}\_tmpnum=0
   \_loop \_ifnum\_Ncols>\_tmpnum
      \_advance\_tmpnum by1
      \_setbox1=\_hbox{\_unhbox1 \_vsplit6 to\_dimen1 \_hss}
   \_repeat
   \_hbox{}\_nobreak\_vskip-\_splittopskip \_nointerlineskip
   \_line{\_unhbox1\_unskip}
   \_dimen0=\_dimen1 \_divide\_dimen0 by\_baselineskip \_multiply\_dimen0 by\_Ncols
   \_global\_advance\_mullines by-\_dimen0
   \_egroup
}
\_def\_splitpart{%
   \_makecolumns % full page
   \_vskip 0pt plus 1fil minus\_baselineskip \_break
   \_ifnum\_mullines<\_tmpnum \_dimen0=\_ht6 \_else \_dimen0=.8\_maxdimen \_fi
   \_divide\_dimen0 by\_Ncols \_relax
   \_ifx\_balancecolumns\_flushcolumns \_advance\_dimen0 by-.5\_vsize \_fi
   \_dimen1=\_vsize \_corrsize{\_dimen1}\_dimen2=\_dimen1
   \_advance\_dimen2 by-\_baselineskip
   %% split the material to more pages?
   \_ifvoid6 \_else
      \_ifdim \_dimen0>\_dimen2 \_ea\_ea\_ea \_splitpart
      \_else \_balancecolumns % last balancing
   \_fi \_fi
```

```
}
```

Final balancing of the columns.

multicolumns.opm

```
\_def\_balancecolumns{\_bgroup \_setbox7=\_copy6 % destination height: \dimen0
   \_ifdim\_dimen0>\_baselineskip \_else \_dimen0=\_baselineskip \_fi
   \_vbadness=20000
   \_def\_tmp{%
      \_setbox1=\_hbox{}\_tmpnum=0
      \_loop \_ifnum\_Ncols>\_tmpnum
         \_advance\_tmpnum by1
         \_setbox1=\_hbox{\_unhbox1
              \_ifvoid6 \_hbox to\_wd6{\_hss}\_else \_vsplit6 to\_dimen0 \_fi\_hss}
      \_repeat
   \_ifvoid6 \_else
      \_advance \_dimen0 by.2\_baselineskip
      \_setbox6=\_copy7
      \_ea \_tmp \_fi}\_tmp
   \_hbox{}\_nobreak\_vskip-\_splittopskip \_nointerlineskip
   \_hbox to\_hsize{\_unhbox1\_unskip}%
   \_egroup
}
\_def\_corrsize #1{%% #1 := #1 + \splittopskip - \topskip
   \_advance #1 by \_splittopskip \_advance #1 by-\_topskip
}
\_public \begmulti \endmulti ;
```

2.32 Citations, bibliography

2.32.1 Macros for citations and bibliography preloaded in the format

cite-bib.opm

```
\_codedecl \cite {Cite, Bibliography <2020-03-09>} % loaded in format
```

Registers used by `\cite`, `\bib` macros are declared here. The `\bibnum` counts the bibliography items from one. The `\bibmark` is used when `\nonumcitations` is set.

cite-bib.opm

```
\_newcount\_bibnum                      % the bibitem counter
\_newtoks\_bibmark                      % the bibmark used if \nonumcitations
\_newcount\_lastcitenum \_lastcitenum=0  % for \shortcitations
\_public \bibnum \bibmark ;
```

`\cite` `[`⟨*label*⟩`,`⟨*label*⟩`,...,`⟨*label*⟩`]` manages ⟨*labes*⟩ using `\_citeA` and prints `[`⟨*bib-marks*⟩`]` using `\_printsavedcites`.
`\nocite` `[`⟨*label*⟩`,`⟨*label*⟩`,...,`⟨*label*⟩`]` only manages ⟨*labels*⟩ but prints nothing.
`\rcite` `[`⟨*label*⟩`,`⟨*label*⟩`,...,`⟨*label*⟩`]` behaves like `\cite` but prints ⟨*bib-marks*⟩ without brackets.
`\ecite` `[`⟨*label*⟩`]{`⟨*text*⟩`}` behaves like `\rcite` `[`⟨*label*⟩`]` but prints ⟨*text*⟩ instead ⟨*bib-mark*⟩. The ⟨*text*⟩ is hyperlinked like ⟨*bib-marks*⟩ when `\cite` or `\rcite` is used. The empty internal macro `\_savedcites` will include the ⟨*bib-marks*⟩ list to be printed. This list is set by `\_citeA` inside group and it is used by `\_printsavedcites` in the same group. Each `\cite`/`\rcite`/`\ecite` macro starts from empty list of ⟨*bib-marks*⟩ because new group is opened.

cite-bib.opm

```
\_def\_cite[#1]{{\_citeA#1,,,[\_printsavedcites]}}
\_def\_nocite[#1]{{\_citeA#1,,,}}
\_def\_rcite[#1]{{\_citeA#1,,,\_printsavedcites}}
\_def\_ecite[#1]{\_bgroup\_citeA#1,,,\_ea\_eciteB\_savedcites;}
\_def\_eciteB#1,#2;#3{\_if?#1\_relax #3\_else \_ilink[cite:#1]{#3}\_fi\_egroup}
\_def\_savedcites{}

\_public \cite \nocite \rcite \ecite ;
```

⟨*bib-marks*⟩ may be numbers or a special text related to cited bib-entry. It depends on `\nonumcitations` and on used bib-style. The mapping from ⟨*label*⟩ to ⟨*bib-mark*⟩ is done when `\bib` or `\usebib` is processed. These macros store the information to `\_Xbib{`⟨*label*⟩`}{`⟨*number*⟩`}{`⟨*nonumber*⟩`}` where ⟨*number*⟩ and ⟨*nonumber*⟩ are two variants of ⟨*bib-mark*⟩ (numbered or text-like). This information is read from `.ref` file and it is saved to macros `\_bib:`⟨*label*⟩ and `\_bibm:`⟨*number*⟩. First one includes number and

second one includes ⟨*nonumber*⟩. The `\_lastbibnum` macro includes last number of bib-entry used in the document. A designer can use it to set appropriate indentation when printing the list of all bib-entries.

cite-bib.opm

```
\_def\_Xbib#1#2#3{\_sdef{_bib:#1}{\_bibnn{#2}&}%
   \_if^#3^\_else\_sdef{_bim:#2}{#3}\_fi\_def\_lastbibnum{#2}}
```

`\_citeA` ⟨*label*⟩, processes one label from list of labels given in the parameter of `\cite`, `\nocite`, `\rcite` or `\ecite` macros. It adds the ⟨*label*⟩ to global list `\_citelist` which will be used by `\usebib` (it must to know what ⟨*labels*⟩ are used in the document in order to pick-up only relevant bib-entries from the database. Because we want to save space and not to save the same ⟨*label*⟩ to `\_citelist` twice, we distinguish four cases:

- ⟨*label*⟩ was not declared by `\_Xbib` and it is first such ⟨*label*⟩ in the document: Then `\_bib:`⟨*label*⟩ is undefined and we save label using `\_addcitlist`, write warning on the terminal and define `\_bib:`⟨*label*⟩ as empty.
- ⟨*label*⟩ was not declared by `\_Xbib` but it was used previously in the document: Then `\_bib:`⟨*label*⟩ is empty and we do nothing (only data to `\_savedcites` are saved).
- ⟨*label*⟩ was declared by `\_Xbib` and it is first such ⟨*label*⟩ in the document: Then `\_bin:`⟨*label*⟩ includes `\_bibnn{`⟨*number*⟩`}&` and we test this case by `\if &\_bibnn{`⟨*number*⟩`}&`. This is true when `\_bibnn{`⟨*number*⟩`}` expands to empty. The ⟨*label*⟩ is saved by `\_addcitelist` and `\_bib:`⟨*label*⟩ is re-defined directly as ⟨*number*⟩.
- ⟨*label*⟩ was declared by `\_Xbib` and it was used previously in the document. Then we do nothing (only data to `\_savedcites` are saved.

The `\_citeA` macro runs repeatedly over whole list of ⟨*labels*⟩.

cite-bib.opm

```
\_def\_citeA #1#2,{\_if#1,\_else
   \_if *#1\_addcitelist{*}\_ea\_skiptorelax \_fi
   \_ifcsname _bib:#1#2\_endcsname \_else
      \_addcitelist{#1#2}%
      \_opwarning{\_noexpand\cite [#1#2] unknown. Try to TeX me again}\_openref
      \_incr\_unresolvedrefs
      \_addto\_savedcites{?,}\_def\_sortcitesA{}\_lastcitenum=0
      \_ea\_gdef \_csname _bib:#1#2\_endcsname {}%
      \_ea\_skiptorelax \_fi
   \_ea\_ifx \_csname _bib:#1#2\_endcsname \_empty
      \_addto\_savedcites{?,}\_def\_sortcitesA{}\_lastcitenum=0
      \_ea\_skiptorelax \_fi
   \_def\_bibnn##1{}%
   \_if &\_csname _bib:#1#2\_endcsname
      \_def\_bibnn##1##2{##1}%
      \_addcitelist{#1#2}%
      \_sxdef{_bib:#1#2}{\_csname _bib:#1#2\_endcsname}%
   \_fi
   \_edef\_savedcites{\_savedcites \_csname _bib:#1#2\_endcsname,}%
   \_relax
   \_ea\_citeA\_fi
}
\_def\_addcitelist#1{\_global\_addto\_citelist{\_citeI[#1]}}
\_def\_citelist{}
```

The ⟨*bib-marks*⟩ (in numeric or text form) are saved in `\_savedcites` macro separated by commas. The `\_printsavedcites` prints them by normal order or sorted if `\sortcitations` is specified or condensed if `\shordcitations` is specified.

The `\sortcitations` appends the dummy number 300000 and we suppose that normal numbers of bib-entries are less than this constant. This constant is removed after sorting algorithm. The `\shortcitations` sets simply `\_lastcitenum=1`. The macros for ⟨*bib-marks*⟩ printing follows (sorry, without detail documentation). They are documented in `opmac-d.pdf` (but only in Czech).

cite-bib.opm

```
\_def\_printsavedcites{\_sortcitesA
   \_chardef\_tmpb=0 \_ea\_citeB\_savedcites,%
   \_ifnum\_tmpb>0 \_printdashcite{\_the\_tmpb}\_fi
}
\_def\_sortcitesA{}
\_def\_sortcitations{%
  \_def\_sortcitesA{\_edef\_savedcites{300000,\_ea}\_ea\_sortcitesB\_savedcites,%
```

```
                    \_def\_tmpa####1300000,{\_def\_savedcites{####1}}\_ea\_tmpa\_savedcites}%
}
\_def\_sortcitesB #1,{\_if $#1$%
  \_else
     \_mathchardef\_tmpa=#1
     \_edef\_savedcites{\_ea}\_ea\_sortcitesC \_savedcites\_end
     \_ea\_sortcitesB
  \_fi
}
\_def\_sortcitesC#1,{\_ifnum\_tmpa<#1\_edef\_tmpa{\_the\_tmpa,#1}\_ea\_sortcitesD
                    \_else\_edef\_savedcites{\_savedcites#1,}\_ea\_sortcitesC\_fi}
\_def\_sortcitesD#1\_end{\_edef\_savedcites{\_savedcites\_tmpa,#1}}

\_def\_citeB#1,{\_if$#1$\_else
   \_if?#1\_relax??%
      \_else
      \_ifnum\_lastcitenum=0   % only comma separated list
         \_printcite{#1}%
      \_else
         \_ifx\_citesep\_empty  % first cite item
            \_lastcitenum=#1\_relax
            \_printcite{#1}%
         \_else               % next cite item
            \_advance\_lastcitenum by1
            \_ifnum\_lastcitenum=#1\_relax % cosecutive cite item
               \_mathchardef\_tmpb=\_lastcitenum
            \_else  % there is a gap between cite items
               \_lastcitenum=#1\_relax
               \_ifnum\_tmpb=0 % previous items were printed
                  \_printcite{#1}%
               \_else
                  \_printdashcite{\_the\_tmpb}\_printcite{#1}\_chardef\_tmpb=0
   \_fi\_fi\_fi\_fi\_fi
   \_ea\_citeB\_fi
}
\_def\_shortcitations{\_lastcitenum=1 }

\_def\_printcite#1{\_citesep\_ilink[cite:#1]{\_citelinkA{#1}}\_def\_citesep{,\_hskip.2em\_relax}}
\_def\_printdashcite#1{\_ifmmode-\_else\_hbox{--}\_fi\_ilink[cite:#1]{\_citelinkA{#1}}}
\_def\_citesep{}

\_def\_nonumcitations{\_lastcitenum=0\_def\_sortcitesA{}\_def\_etalchar##1{$^{##1}$}%
   \_def\_citelinkA##1{\_isdefined{_bim:##1}\_iftrue \_csname _bim:##1\_endcsname
      \_else ##1\_opwarning{\_noexpand\nonumcitations + empty bibmark. Maybe bad bib style}\_fi}
}
\_def\_citelinkA{}

\_public \nonumcitations \sortcitations \shortcitations ;
```

The \bib [⟨*label*⟩] {⟨*optional bib-mark*⟩} prints one bib-entry without reading any database. The bib-enty follows after this command. This command counts the used \bib**s** from one by \bib**num** counter and saves _Xbib{⟨*label*⟩}{_the_bibnum}{_the_bibmark} into .ref file immediately using _wbib. This is the core of creation of mapping from ⟨*labels*⟩ to ⟨*bib-marks*⟩.

cite-bib.opm

```
\_def\_bib[#1]{\_def\_tmp{\_isnextchar={\_bibA[#1]}{\_bibmark={}\_bibB[#1]}}%
   \_ea\_tmp\_romannumeral-`\.} % ignore optional space
\_def\_bibA[#1]=#2{\_bibmark={#2}\_bibB[#1]}
\_def\_bibB[#1]{\_par \_bibskip
   \_advance\_bibnum by1
   \_noindent \_def\_tmpb{#1}\_wbib{#1}{\_the\_bibnum}{\_the\_bibmark}%
   \_printlabel{#1}%
   \_printbib \_ignorespaces
}
\_def\_wbib#1#2#3{\_dest[cite:\_the\_bibnum]%
   \_ifx\_wref\_wrefrelax\_else \_immediate\_wref\_Xbib{{#1}{#2}{#3}}\_fi}

\_public \bib ;
```

The _printbib prints the bib-entry itself. You can re-define it if you want different design. The _pritbib starts in horizontal mode after \noindent and after the eventual hyperlink destination is inserted. By default, the _printbib sets the indentation by \hangindent and prints numeric ⟨*bib-marks*⟩ by \llap{[\the\bibnum]} If \nonumcitations then the _citelinkA is not empty and ⟨*bib-marks*⟩ (\the\bibnum nor \the\bibmark) are not printed. The text of bib-entry follows. User can create this text manually using \bib command or it is generated automatically from a .bib database by \usebib command.

The vertical space between bib-entries is controlled by _bibskip macro.

cite-bib.opm

```
\_def \_printbib {\_hangindent=\_iindent
   \_ifx\_citelinkA\_empty \_hskip\_iindent \_llap{[\_the\_bibnum] }\_fi
}
\_def \_bibskip {\_ifnum\_bibnum>0 \_smallskip \_fi}
```

The \usebib command is implemented in usebib.opm file which is loaded when the \usebib command is firstly used. The usebib.opm file loads the librarian.tex for scanning the .bib files. See the section 2.32.2, where the file usebib.opm is documented.

cite-bib.opm

```
\_def\_usebib{\_par \_opinput {usebib.opm} \_usebib}
\_def\usebib{\_usebib}
```

\nobibwarning [⟨*list of bib-labels*⟩] declares a list of bib labels which are not fully declared in .bib file but we want to suppress the warning about it. List of bib labels are comma separated case sensitive list without spaces.

cite-bib.opm

```
\_def\_nobibwarnlist{,}
\_def\_nobibwarning[#1]{\_global\_addto\_nobibwarnlist{#1,}}
\_public \nobibwarning ;
```

The macros above works if all \cite (or similar) commands are used before the \usebib command is used because \usebib prints only such bib-entries their ⟨*labels*⟩ are saved in the _citelist. But if some \cite is used after \usebib, then \usebib sets _addcitelist to _writeXcite, so such \cite saves the information to the .reffile in the format _Xcite{⟨*label*⟩}. Such information are copied to _citelistB during reading .ref file and \usebib concats two lists of ⟨*labels*⟩ from _citelist and _citelistB and uses this concatenated list.

cite-bib.opm

```
\_def\_Xcite#1{\_addto\_citelistB{\_citeI[#1]}}
\_def\_writeXcite#1{\_openref\_immediate\_wref\_Xcite{{#1}}}
\_def\_citelistB{}
```

2.32.2 The \usebib command

The file usebib.opm implements the command \usebib/⟨*sorttype*⟩ (⟨*style*⟩) ⟨*bibfiles*⟩ where ⟨*sorttype*⟩ is one letter c (references ordered by citation order in the text) or s (references ordered by key in the style file), ⟨*style*⟩ is the part of the name bib-⟨*style*⟩.opm of the style file and ⟨*bibfiles*⟩ are one or more .bib file names without suffix separated by comma without space. Example:

```
\usebib/s (simple) mybase,yourbase
```

This command reads the ⟨*bibfiles*⟩ directly and creates the list of bibliographics references (only those declared by by \cite[] or \nocite[] in the text). The formatting of such references is defined in the style file.

The principle "first entry wins" is used. Suppose \usebib/s (simple) local,global. If an entry with the same label is declared in local.bib and in global.bib too then the first wins. So, you can set an exceptions in your local.bib file for your document.

The bib-⟨*style*⟩.opm declares entry types (like @BOOK, @ARTICLE) and declares their mandatory and optionals fields (like author, title). When mandatory field is missing in an entry in the .bib file then warning is printed on the terminal about it. You can suppress such warnings by command \nobibwarning [⟨*bib-labels*⟩], where ⟨*bib-labels*⟩ is comma separated list of labels (without spaces) where missing mandatory fields will be no warned.

Old .bib files may use obscure notation for accents like {\"o}. Recommendation: convert such old files to Unicode encoding. If you are unable to do this then you can set \bibtexhook={\oldaccents}.

2.32.3 Notes for bib style writers

The `.bib` files include records in the format:

```
@<entry-type>{<label>,
   <field-name> = "<field-data>",
   <field-name> = "<field-data>",
   ...etc
}
```

see the file `demo/op-biblist.bib` for a real example. The ⟨*entry-types*⟩ and ⟨*field-names*⟩ are case insensitive.

Ancient BibTEX has read such files and has generated files appropriate for reading by LATEX. It has worked with a set of ⟨*entry-types*⟩, see the www page http://en.wikipedia.org/wiki/BibTeX. The set of entry types listed on this www page is de facto the BibTEX standard. The OpTEX bib style writer must "declare" all such entry types and more non-standard entry types can be declared too, if there is a good reason for doing it. The word "declare" used in previous sentence means that bib style writer must define the printing rules for each ⟨*entry-type*⟩. The printing rules for ⟨*entry-type*⟩ include: which fields will be printed, in what oder, by what format they will printed on (italic, caps, etc.), which fields are mandatory, which are optional and which are ingnored in `.bib` records.

The style writer can be inspired by two styles alredy done: `bib-simple.opm` and `bib-iso690.opm`. The second one is documented in detail in section 2.32.5.

The printing rules for each ⟨*entry-type*⟩ must be declared by `\_sdef{_print:`⟨*entry-type*⟩`}` in `bib-`⟨*style*⟩`.opm` file. The ⟨*entry-type*⟩ have to be lowercase here. OpTEX supports following macros for more comfortable setting of printing rules:

- `\_bprinta [`⟨*field-name*⟩`]  {`⟨*if defined*⟩`} {`⟨*if not defined*⟩`}`. The part ⟨*if defined*⟩ is executed if ⟨*field-name*⟩ is declared in .bib file for the entry which is currently processed. Else the part ⟨*if not defined*⟩ is processed. The part ⟨*if defined*⟩ can include the `*` parameter which is replaced by the value of the ⟨*field-name*⟩.
- The part ⟨*if not defined*⟩ can include the `\_bibwarning` command if the ⟨*field-name*⟩ is mandatory.
- `\_bprintb [`⟨*field-name*⟩`]  {`⟨*if defined*⟩`} {`⟨*if not defined*⟩`}`. The same as `\_bprinta`, but the `##1` parameter is used instead `*`. Differences: `##1` parameter can be used more than once and can be enclosed in nested braces. The `*` parameter can be used at most once and cannot be enclosed in braces. Warning: if the `\_bprintb` commands are nested (`\_bprintb` in `\_bprintb`), then you need to write `####1` parameter for internal `\_bprintb`. But if `\_bprinta` commands are nested then the parameter is not duplicated.
- `\_bprintc \macro {`⟨*if non-empty*⟩`}`. The ⟨*if non-empty*⟩ part is executed if `\macro` is non-empty. The `*` parameter can be used, it is replaced by the `\macro`.
- `\_bprintv [`⟨*field1*⟩`,`⟨*field2*⟩`,...] {`⟨*if defined*⟩`} {`⟨*if not defined*⟩`}`. The part ⟨*if defined*⟩ is executed if ⟨*field1*⟩ or ⟨*filed2*⟩ or ... is defined, else the second part ⟨*if not defined*⟩ is executed. There is one filed name or the list field names separated by commas. The parts cannot include any parameter.

There are two special field-names: `!author` and `!editor`. The processed list of authors or editors are printed here instead of raw data, see the commands `\_authorname` and `\_editorname` below.

The bib style writer can define `_print:BEGIN` and/or `_print:END`. They are executed at the begin or end of each ⟨*entry-type*⟩. The formatting does not solve the numbering and paragraph indentation of the entry. This is processed by `\_printbib` macro used in OpTEX (and may be redefined by the author or document designer).

The `\bibmark={something}` can be declared, for instance in the `_print:END` macro. Such bibmark is saved to the `.ref` file and used in next TEX run as `\cite` marks when `\nonumcitations` is set.

Moreover, the bib style writer must declare the format of printing of special fields `author` and `editor`. These fields include a list of names, each name is precessed individually in a loop. The `\_authorname` or `\_editorname` is called for each name in the list. The bib style writer must define the `\_authorname` and `\_editorname` commands in order to declare the format of printing each individual name. The following control sequences can be used in these macros:

- `\_NameCount`: the number of currently processed author in the list
- `\_namecont`: the total number of the authors in the list
- `\_Lastname`, `\_Firstname`, `\_Von`, `\_Junior`: the parts of the name.

The whole style file is read in the group during `\usebib` command is executed before typesetting the reference list. Each definition or setting is local here.

The auto-generated phrases (dependent on current language) can be used in bib style files by `\_mtext{bib.`⟨*identifier*⟩`}`, where ⟨*ident*⟩ is an identifier of the phrase and the phrase itself is defined by `\_sdef{_mt:bib.`⟨*identifier*⟩`:`⟨*language*⟩`}{`⟨*phrase*⟩`}`. See section 2.37.3 for more detail. Phrases for ⟨*identifiers*⟩: and, etal, edition, citedate, volume, number, prepages, postpages, editor, editors, available, availablealso, bachthesis, masthesis, phdthesis are defined already, see the end of section 2.37.3.

If you are using non-standard field-names in .bib database and bib style, you have to declare them by `\_CreateField {`⟨*fieldname*⟩`}`.

You can declare `\_SortingOrder` in the manner documented by librarian package.

User or author of the bib style can create the hidden field which has a precedence while sorting names. Example:

```
\CreateField {sortedby}
\SpecialSort {sortedby}
```

Suppose that the .bib file includes:

```
...
author   = "Jan Chadima",
sortedby = "Hzzadima Jan",
...
```

Now, this author is sorted between H and I, because the Ch digraph in this name has to be sorted by this rule.

If you need (for example) to place the autocitations before other citations, then you can mark your entries in `.bib` file by `sortedby = "@"`, because this character is sorted before `A`.

2.32.4 The `usebib.opm` macro file loaded when `\usebib` is used

usebib.opm

```
\_codedecl \MakeReference {Reading bib databases <2020-03-13>} % loaded on demand by \usebib
```

Loading the `librarian.tex` macro package. See `texdoc librarian` for more information about it.

We want to ignore `\errmessage` and we want not to create `\jobname.lbr` file.

usebib.opm

```
\_def\errmessage#1{}
\_def\newwrite#1{\_csname lb@restoreat\_endcsname \_endinput}
\_def\_tmpb{\_catcode`\_=12 \_input librarian \_catcode`\_=11 }\_tmpb
\_let\errmessage=\_errmessage
\_let\newwrite=\_newwrite

\_private \BibFile \ReadList \SortList \SortingOrder \NameCount \AbbreviateFirstname
   \CreateField \RetrieveFieldInFor \RetrieveFieldIn ;
```

The `\usebib` command.

usebib.opm

```
\_def\_usebib/#1 (#2) #3 {%
  \_ifx\_citelist\_empty
     \_opwarning{No cited items. \_noexpand\usebib ignored}%
  \_else
     \_bgroup \_par
        \_emergencystretch=.3\_hsize
        \_ifx\_bibpart\_undefined \_def\_bibpart{none}\_fi
        \_def\_optexbibstyle{#2}%
        \_setctable\_optexcatcodes
        \_ea \_skiptoendinput \_input languages.opm
        \_input bib-#2.opm
        \_the \_bibtexhook
        \_ifcsname _mt:bib.and:\_cs{_lan:\_the\_language}\_endcsname \_else
           \_opwarning{\_string\usebib: No phrases for language
                       "\_cs{_lan:\_the\_language}" (using "en")}%
           \_language=0 \_chardef\_documentlanguage=0
        \_fi
        \_let\_citeI=\_relax \_xdef\_citelist{\_citelist\_citelistB}%
        \_global\_let\_addcitelist=\_writeXcite
        \_def\_tmp##1[*]##2\_relax{\_def\_tmp{##2}}\_expandafter\_tmp\_citelist[*]\_relax
```

```
        \_ifx\_tmp\_empty\_else % there was \nocite[*] used.
           \_setboxO=\_vbox{\_hsize=\_maxdimen \_def\_citelist{}\_adef@{\_readbibentry}%
           \_input #3.bib
           \_expandafter}\_expandafter\_def\_expandafter\_citelist\_expandafter{\_citelist}%
        \_fi
        \_def\_citeI[##1]{\_csname lb@cite\_endcsname{##1}{\_bibpart}{}{}}\_citelist
        \_BibFile{#3}%
        \_if s#1\_SortList{\_bibpart}\_fi
        \_ReadList{\_bibpart}%
        \_restorectable
     \_egroup
  \_fi
}
\_long\_def\_skiptoendinput#1\_endinput{}
\_def\_readbibentry#1#{\_readbibentryA}
\_def\_readbibentryA#1{\_readbibentryB#1,,\_relax!.}
\_def\_readbibentryB#1#2,#3\_relax!.{\_addto\_citelist{\_citeI[#1#2]}}
```

Corrections in librarian macros.

usebib.opm

```
\_tmpnum=\_catcode`\@  \_catcode`\@=11
\_def\lb@checkmissingentries#1,{% we needn't \errmessage here, only \opmacwarning
  \_def\lb@temp{#1}%
  \_unless\_ifx\lb@temp\lb@eoe
    \lb@ifcs{#1}{fields}%
            {}%
            {\_opwarning{\_string\usebib: entry [#1] isn't found in .bib}}%
    \_ea\lb@checkmissingentries
  \_fi
}
\_def\lb@readentry#1#2#3,{% space before key have to be ingnored
  \_def\lb@temp{#2#3}%      we need case sensitive keys
  \_def\lb@next{\_ea\lb@gotoat\lb@gobbletoeoe}%
  \lb@ifcs\lb@temp{requested}%
          {\_let\lb@entrykey\lb@temp
           \lb@ifcs\lb@entrykey{fields}{}%
                {\lb@defcs\lb@entrykey{fields}{}%
                 \_lowercase{\lb@addfield{entrytype}{#1}}%
                 \_let\lb@next\lb@analyzeentry}}{}%
  \lb@next
}
\_let\lb@compareA=\lb@compare
\_let\lb@preparesortA=\lb@preparesort
\_def\lb@compare#1\lb@eoe#2\lb@eoe{% SpecialSort:
  \_ifx\lb@sorttype\lb@namestring
     \_ifx\_sortfield\_undefined \lb@compareA#1\lb@eoe#2\lb@eoe
     \_else
        \_ea\_RetrieveFieldInFor\_ea{\_sortfield}\lb@entrykey\lb@temp
        \_ifx\lb@temp\_empty \_toks1={#1\lb@eoe}\_else \_toks1=\_ea{\lb@temp\lb@eoe}\_fi
        \_ea\_RetrieveFieldInFor\_ea{\_sortfield}\lb@currententry\lb@temp
        \_ifx\lb@temp\_empty \_toks2={#2\lb@eoe}\_else \_toks2=\_ea{\lb@temp\lb@eoe}\_fi
        \_edef\lb@temp{\_noexpand\lb@compareA\_space\_the\_toks1 \_space\_the\_toks2}\lb@temp
     \_fi
  \_else \lb@compareA#1\lb@eoe#2\lb@eoe \_fi
}
\_def\lb@preparesort#1#2\lb@eoe{%
  \_if#1-%
    \_def\lb@sorttype{#2}%
  \_else
    \_def\lb@sorttype{#1#2}%
  \_fi
  \lb@preparesortA#1#2\lb@eoe
}
\_def\_SpecialSort#1{\_def\_sortfield{#1}}
\_def\WriteImmediateInfo#1{}  % the existence of .lbr file bocks new reading of .bib
\_catcode`\@=\_tmpnum
```

Main action per every entry.

usebib.opm

```
\_def\MakeReference{\_par \_bibskip
```

```
  \_advance\_bibnum by1
  \_isdefined{_bim:\_the\_bibnum}\_iftrue
     \_edef\_tmpb{\_csname _bim:\_the\_bibnum\_endcsname}%
     \_bibmark=\_ea{\_tmpb}%
  \_else \_bibmark={}\_fi
  \_edef\_tmpb{\EntryKey}%
  \_noindent \_dest[cite:\_the\_bibnum]\_printlabel\EntryKey
  \_printbib
  {%
     \_RetrieveFieldIn{entrytype}\_entrytype
     \_csname _print:BEGIN\_endcsname
     \_isdefined{_print:\_entrytype}\_iftrue
        \_csname _print:\_entrytype\_endcsname
     \_else
        \_ifx\_entrytype\_empty \_else
           \_opwarning{Entrytype @\_entrytype\_space from [\EntryKey] undefined}%
           \_csname _print:misc\_endcsname
     \_fi\_fi
     \_csname _print:END\_endcsname
     \_ifx\_wref\_wrefrelax\_else
         \_immediate\_wref\_Xbib{{\EntryKey}{\_the\_bibnum}{\_the\_bibmark}}\_fi
  }\_par
}
```

The _bprinta, _bprintb, _bprintc, _bprintv commands used in the style files:

usebib.opm

```
\_def\_bprinta {\_bprintb*}
\_def\_bprintb #1[#2#3]{%
   \_def\_bibfieldname{#2#3}%
   \_if!#2\_relax
      \_def\_bibfieldname{#3}%
      \_RetrieveFieldIn{#3}\_bibfield
      \_ifx\_bibfield\_empty\_else
         \_RetrieveFieldIn{#3number}\_namecount
         \_def\_bibfield{\_csname _Read#3\_ea\_endcsname \_csname _pp:#3\_endcsname}%
      \_fi
   \_else
      \_RetrieveFieldIn{#2#3}\_bibfield
   \_fi
   \_if^#1^%
      \_ifx\_bibfield\_empty \_ea\_ea\_ea \_doemptyfield
      \_else \_ea\_ea\_ea \_dofullfield \_fi
   \_else \_ea \_bprintaA
   \_fi
}
\_def\_dofullfield#1#2{\_def\_dofield##1{#1}\_ea\_dofield\_ea{\_bibfield}}
\_def\_doemptyfield#1#2{\_def\_dofield##1{#2}\_ea\_dofield\_ea{\_bibfield}}
\_let\_Readauthor=\ReadAuthor  \_let\_Readeditor=\ReadEditor
\_def\_bprintaA #1#2{\_ifx\_bibfield\_empty #2\_else\_bprintaB #1**\_eee\_fi}
\_def\_bprintaB #1*#2*#3\_eee{\_if^#3^#1\_else\_ea\_bprintaC\_ea{\_bibfield}{#1}{#2}\_fi}
\_def\_bprintaC #1#2#3{#2#1#3}
\_def\_bprintc#1#2{\_bprintcA#1#2**\_relax}
\_def\_bprintcA#1#2*#3*#4\_relax{\_ifx#1\_empty \_else \_if^#4^#2\_else#2#1#3\_fi\_fi}
\_def\_bprintv [#1]#2#3{\_def\_tmpa{#2}\_def\_tmpb{#3}\_bprintvA #1,,}
\_def\_bprintvA #1,{%
   \_if^#1^\_tmpb\_else
      \_RetrieveFieldIn{#1}\_tmp
      \_ifx \_tmp\_empty
      \_else \_tmpa \_def\_tmpb{}\_def\_tmpa{}%
      \_fi
   \_ea \_bprintvA
   \_fi
}
\_sdef{_pp:author}{\_letNames\_authorname}
\_sdef{_pp:editor}{\_letNames\_editorname}
\_def\_letNames{\_let\_Firstname=\Firstname \_let\_Lastname=\Lastname
   \_let\_Von=\Von \_let\_Junior=\Junior
}
```

Various macros + multilinguas. Note that _nobibwarnlist is used in _bibwarning and it is set by \nobibwarning macro.

usebib.opm

```
\_def\_bibwarning{%
  \_ea\_isinlist \_ea\_nobibwarnlist\_ea{\_ea,\EntryKey,}\_iffalse
      \_opwarning{Missing field "\_bibfieldname" in [\EntryKey]}\_fi}
```

2.32.5 Usage of the bib-iso690 style

This is the iso690 bibliographic style used by OpTEX.

See op-biblist.bib for an example of the .bib input. You can try it by:

```
\fontfam[LMfonts]
\nocite[*]
\usebib/s (iso690) op-biblist
\end
```

Common rules in .bib files

There are entries of type @FOO{...} in the .bib file. Each entry consists of fields in the form name␣=␣"value", or name␣=␣{value}. No matter which form is used. If the value is pure numeric then you can say simply name␣=␣value. Warning: the comma after each field value is mandatory! If it is missing then the next field is ignored or bad interpreted.

The entry names and field names are case insensitive. If there exist a data field no mentioned here then it is simply ignored. You can use it to store more information (abstract, for example).

There are "standard fields" used in ancient bibTEX (author, title, editor, edition, etc., see http://en.wikipedia.org/wiki/BibTeX). The iso690 style introduces several "non-standard" fields: ednote, numbering, isbn, issn, doi, url, citedate, key, bibmark. They are documented here.

Moreover, there are two optional special fields:

- lang = language of the entry. The hyphenation plus autogenerated phrases and abbreviations will be typeset by this language.
- option = options by which you can control special printing of various fields.

There can be only one option field per each entry with (may be) more options separated by spaces. You can declare the global option(s) in your document applied for each entry by \biboptions={...}.

The author field

All names in the author list have to be separated by " and ". Each author can be written by various formats (the von part is typically missing):

```
Firstname(s) von Lastname
or
von Lastname, Firstname(s)
or
von Lastname, After, Firstname(s)
```

Only the Lastname part is mandatory. Examples:

```
Petr Olšák
or
Olšák, Petr

Leonardo Piero da Vinci
or
da Vinci, Leonardo Piero
or
da Vinci, painter, Leonardo Piero
```

The separator " and " between authors will be converted to comma during printing, but between semi-final and final author the word "and" (or something different depending on current language) is printed.

The first author is printed in reverse order: "LASTNAME, Firstname(s) von, After" and the others author are printed in normal order: "Firstname(s) von LASTNAME, After". This feature follows the

ISO 690 norm. The Lastname is capitalized using uppercase letters. But if the `\caps` font modifier is defined, then it is used and printed `{\caps\_rm␣Lastname}`.

You can specify the option `aumax:`⟨*number*⟩. The ⟨*number*⟩ denotes the maximum authors to be printed. The rest of authors are ignored and the `et~al.` is appended to the list of printed authors. This text is printed only if the `aumax` value is less than the real number of authors. If you have the same number of authors in the .bib file as you need to print but you want to append `et~al.` then you can use `auetal` option.

There is an `aumin:`⟨*number*⟩ option which denotes the definitive number of printed authors if the author list is not fully printed due to `aumax`. If `aumin` is unused then `aumax` authors is printed in such case.

All authors are printed if `aumax:`⟨*number*⟩ option isn't given. There is no internal limit. But you can set the global options in your document by setting the `\biboptions` tokens list. For example:

```
\biboptions={aumax:7 aumin:1}
% if there is 8 or more authors then only first author is printed.
\entdd

Examples:
\begtt
author = "John Green and Bob Brown and Alice Black",
```

output: GREEN, John, Bob BROWN, and Alice BLACK.

```
author = "John Green and Bob Brown and Alice Black",
option = "aumax:1",
```

output: GREEN, John et al.

```
author = "John Green and Bob Brown and Alice Black",
option = "aumax:2",
```

output: GREEN, John, Bob BROWN et al.

```
author = "John Green and Bob Brown and Alice Black",
option = "aumax:3",
```

output: GREEN, John, Bob BROWN, and Alice BLACK.

```
author = "John Green and Bob Brown and Alice Black",
option = "auetal",
```

output: GREEN, John, Bob BROWN, Alice BLACK et al.

If you need to add a text before or after authors list, you can use the `auprint:{`⟨*value*⟩`}` option. The ⟨*value*⟩ will be printed instead of the authors list. The ⟨*value*⟩ can include `\AU` macro which expands to the authors list. Example:

```
author = "Robert Calbraith",
option = "auprint:{\AU\space [pseudonym of J. K. Rowling]}",
```

output: CALBRAITH Robert [pseudonym of J. K. Rowling].

You can use the `autrim:`⟨*number*⟩ option. All Firstnames of all authors are trimmed (i. e. reduced to initials) iff the number of authors in the author field is greater than or equal to ⟨*number*⟩. There is an exception: `autrim:0` means that no Firstnames are trimmed. This is default behavior. Another example: `autrim:1` means that all Firstnames are trimmed.

```
author = "John Green and Bob Brown and Alice Black",
option = "auetal autrim:1",
```

output: GREEN, J., B. BROWN, A. BLACK et al.

If you need to write a team name or institution instead authors, replace all spaces by `\␣` in this name. Such text is interpreted as Lastname. You can add the secondary name (interpreted as Firstname) after comma. Example:

```
author = "Czech\ Technical\ University\ in\ Prague,
          Faculty\ of\ Electrical\ Engeneering",
```

output: CZECH TECHNICAL UNIVERSITY IN PRAGUE, Faculty of Electrical Engeneering.

The editor field
The editor field is used for list of the authors of the collection. The analogous rules as in author field are used here. It means that the authors are separated by " `and` ", the Firstnames, Lastnames etc. are interpreted and you can use the options `edmax:`⟨*number*⟩, `edmin:`⟨*number*⟩, `edetal`, `edtrim:`⟨*number*⟩ and `edprint:{`⟨*value*⟩`}` (with `\ED` macro). Example:

```
editor = "Jan Tomek and Petr Karas",
option = "edprint:{\ED, editors.} edtrim:1",
```

Output: J. TOMEK and P. KARAS, editors.

If `edprint` option is not set then `{\ED,␣eds.}` or `{\ED,␣ed.}` is used depending on the entry language and on the singular or plural of the editor(s).

The ednote field
The ednote field is used as the secondary authors and more editional info. The value is read as raw data without any interpretation of Lastname, Firstname etc.

```
ednote = "Illustrations by Robert \upper{Agarwal}, edited by Tom \upper{Nowak}",
```

output: Illustrations by Robert AGARWAL, edited by Tom NOWAK.

The `\upper` command have to be used for Lastnames in ednote field.

The title field
This is the title of the work. It will be printed (in common entry types) by italics. The ISO 690 norm declares, that the title plus optional subtitle are in italics and they are separated by colon. Next, the optional secondary title have to be printed in upright font. This can be added by `titlepost:{`⟨*value*⟩`}`. Example:

```
title = "The Simple Title of The Work",
or
title = "Main Title: Subtitle",
or
title  = "Main Title: Subtitle",
option = "titlepost:{Secondary title}",
```

The output of the last example: *Main Title: Subtitle*. Secondary title.

The edition field
This field is used only for second or more edition of cited work. Write only the number without the word "edition". The shortcut "ed." (or something else depending on current language) is added automatically. Examples:

```
edition = "Second",
edition = "2nd",
edition = "2$^{\rm nd}$",
edition = "2.",
```

Output of the last example: 2. ed.

```
edition = "2."
lang    = "cs",
```

Output: 2. vyd.

Note, that the example `edition␣=␣"Second"` may cause problems. If you are using language "cs" then the output is bad: Second vyd. But you can use `editionprint:{`⟨*value*⟩`}` option. The the ⟨*value*⟩ is printed instead of edition field and shortcut. The edition field must be set. Example:

```
edition = "whatever",
option  = "editionprint:{Second full revised edition}",
```

Output: Second full revised edition.

You can use `\EDN` macro in `editionprint` value. This macro is expanded to the edition value. Example:

```
edition = "Second",
option  = "editionprint:{\EDN\space full revised edition}",
or
edition = "Second full revised edition",
option  = "editionprint:{\EDN}",
```

The address, publisher, year fields
This is an anachronism from ancient BibTEX (unfortunately no exclusive) that the address field includes only the city of the publisher residence. No more data are here. The publisher field includes the name of the publisher.

```
address = "Berlin",
publisher = "Springer Verlag",
year = 2012,
```

Output: Berlin: Springer Verlag, 2012.

Note, that the year needn't to be inserted into quotes because it is pure numeric.

The letter a, b etc. are appended to the year automatically, if two or more subsequent entries in the bibliography list are not distinct by the first author and year fields. If you needn't this feature, you can use the `noautoletters` option.

You can use "yearprint:⟨*value*⟩" option. If it is set then the ⟨*value*⟩ is used for printing year instead the real field value. The reason: year is sort sensitive, may be you need to print something else than only sorting key. Example:

```
year   = 2000,
option = "yearpint:{© 2000}",
```

Output: © 2000, sorted by: 2000.

```
year   = "2012a",
option = "yearprint:{2012}",
```

Output: 2012, sorted by: 2012a.

The address, publisher and year are typically mandatory fields. If they are missing then the warning occurs. But you can set `unpublished` option. Then this warning is suppressed. There is no difference in the printed output.

The url field
Use it without `\url` macro, but with `http://` prefix. Example:

```
url = "http://petr.olsak.net/opmac.html",
```

The ISO 690 norm recommends to add the text "Available from" (or something else if different current language is used) before URL. It means, that the output of previous example is:

Available from http://petr.olsak.net/opmac.html.

If the `cs` language is the current one than the output is:

Dostupné z: http://petr.olsak.net/opmac.html.

If the `urlalso` option is used, then the added text has the form "Available also from" or "Dostupné také z:" (if `cs` language is current).

The citedate field
This is the citation date. The field must be in the form year/month/day. It means, that the two slashes must be written here. The output depends on the current language. Example:

```
citedate = "2004/05/21",
```

Output when `en` is current: [cit. 2004-05-21].
Output when `cs` is current: [vid. 21. 5. 2004].

The howpublished field
This declares the available medium for cited document if it is not in printed form. Alternatives: online, CD, DVD, etc. Example:

```
howpublished = "online",
```

Output: [online].

The volume, number, pages and numbering fields
The volume is the "big mark" of the journal issue and the number is the "small mark" of the journal issue and pages includes the page range of the cited article in the journal. The volume is prefixed by Vol. , the number by No. and the pages by pp. . But these prefixes depends on the language of the entry.

Example:

```
volume = 31,
number = 3,
pages  = "37--42",
```

Output: Vol. 31, No. 3, pp. 37–42.

```
volume = 31,
number = 3,
pages  = "37--42",
lang   = "cs",
```

Output: ročník 31, č. 3, s. 37–42.

If you disagree with the default prefixes, you can use the numbering field. When it is set then it is used instead of volume, number, pages fields and instead of any mentioned prefixes. The numbering can include macros `\VOL`, `\NO`, `\PP`, which are expanded to the respective values of fields. Example:

```
volume    = 31,
number    = 3,
pages     = "37--42"
numbering = "Issue~\VOL/\NO, pages~\PP",
```

Output: Issue 31/3, pages 37–42

Note: The volume, numbers and pages fields are printed without numbering filed only in the `@ARTICLE` entry. It means, that if you need to visible them in the `@INBOOK`, `@INPROCEEDINGS` etc. entries, then you must to use numbering field.

Common notes about entries
The order of the fields in the entry is irrelevant. We use the printed order in this manual. The exclamation mark (!) denotes the mandatory field. If such field is missing then the warning occurs during processing.

If the `unpublished` option is set then the fields address, publisher, year, isbn and pages are not mandatory. If the `nowarn` option is set then no warnings about missing mandatory fields occurs.

If the field is used but not mentioned in the entry documentation below then it is silently ignored.

• The `@BOOK` entry

This is used for book-like entries.

Fields: author(!), title(!), howpublished, edition, ednote, address(!), publisher(!), year(!), citedate, series, isbn(!), doi, url, note.

The ednote field here means the secondary authors (illustrator, cover design etc.).

• The `@ARTICLE` entry

This is used for articles published in a journal.

Fields: author(!), title(!), journal(!), howpublished, address, publisher, month, year, [numbering or volume, number, pages(!)], citedate, issn, doi, url, note.

If the numbering is used then it is used instead volume, number, pages.

• The `@INBOOK` entry

This is used for the part of a book.

Fields: author(!), title(!), booktitle(!), howpublished, edition, ednote, address(!), publisher(!), year(!), numbering, citedate, series, isbn or issn, doi, url, note.

The author field is used for author(s) of the part, the editor field includes author(s) or editor(s) of whole document. The pages field specifies the page range of the part. The series field can include more information about the part (chapter numbers etc.).

The `@INPROCEEDINGS` and `@CONFERENCE` entries are equivalent to `@INBOOK` entry.

• The `@THESIS` entry

This is used for student's thesis.

Fields: author(!), title(!), howpublished, address(!), school(!), month, year(!), citedate, type(!), ednote, doi, url, note.

The type field must include the text “Master’s Thesis” or something similar (depending on the language of the outer document).

There are nearly equivalent entries: `@BACHELORSTHESIS`, `@MASTERSTHESIS` and `@PHDTHESIS`. These entries set the type field to an appropriate value automatically. The type field is optional in such case. If it is used then it has a precedence before default setting.

- The @MISC entry

  It is intended for various usage.

  Fields: author, title, howpublished, ednote, citedate, doi, url, note.

  You can use `\AU`, `\ED`, `\EDN`, `\VOL`, `\NO`, `\PP`, `\ADDR`, `\PUBL`, `\YEAR` macros in ednote field. These macros print authors list, editors list, edition, volume, number, pages, address, publisher and year field values respectively.

  The reason of this entry is to give to you the possibility to set the format of entry by your own decision. The most of data are concentrated in ednote field.

- The `@BOOKLET`, `@INCOLLECION`, `@MANUAL`, `@PROCEEDINGS`, `@TECHREPORT`, `@UNPUBLISHED` entries

  These entries are equivalent to `@MICS` entry because we need to save the simplicity. They are implemented only for (almost) backward compatibility with the ancient BibTEX. But the ednote is mandatory field here, so you cannot use these entries from the old databases without warnings and without some additional work with the `.bib` file.

The cite-marks (bibmark) used when `\nonumcitations` is set

When `\nonumcitations` is set then `\cite` prints text orientes bib-marks instead numbers. This style file autogenerates these marks in the form “Lastname of the first author, comma, space, the year” if bibmark field isn’t declared. If you need to set an exception from this common format, then you can use bibmark field.

The OPmac trick http://petr.olsak.net/opmac-tricks-e.html#bibmark describes how to redefine the algorithm for bibmark auto-generating when you need the short form of the type [Au13].

Sorting

If `\usebib/c` is used then entries are sorted by citation order in the text. If `\usebib/s` is used then entries are sorted by “Lastname, Firstname(s)” of the first author and if more entries have this value equal, then the year is used (from older to newer). This feature follows the recommendation of the ISO 690 norm.

If you have the same authors and the same year, you can control the sorting by setting years as 2013, 2013a, 2013b, etc. You can print something different to the list using `yearprint{`⟨*value*⟩`}` option, see the section about address, publisher and year above. The real value of year field (ie. not yearprint value) is also used in the text oriented bib-marks when `\nonumcitations` is set.

If you have some problems with name sorting, you can use the hidden field `key`, which is used for sorting instead of the “Lastname Firstname(s)” of authors. If the `key` field is unset then the “Lastname Firstname(s)” is used for sorting normally. Example:

```
author    = "Světla Čmejrková",
key       = "Czzmejrkova Svetla",
```

This entry is now sorted between C and D.

The norm recommends to place the autocitations to the top of the list of references. You can do this by setting `key␣=␣"@"`, to each entry with your name because the `@` character is sorted before `A`.

Languages

There is the language of the outer document and the languages of each entry. The ISO 690 norm recommends that the technical notes (the prefix before URL, the media type, the “and” conjunction between semifinal and final author) may be printed in the language of the outer document. The data of the entry have to be printed in the entry language (edition ed./vyd., Vol./ročník, No./č. etc.). Finally there are the phrases independent on the language (for example In:). Unfortunately, the bibTEX supposes that the entry data are not fully included in the fields so the automaton have to add some text during processing (“ed.”, “Vol.”, “see also”, etc.). But what language have to be chosen?

The current value of the `\language` register at the start of the `.bib` processing is descided as the language of the outer document. This language is used for technical notes regardless of the entry language. Moreover, each entry can have the `lang` field (short name of the language). This language is used for ed./vyd., vol./ročník etc. and it is used for hyphenation too. If the `lang` is not set then the outer document language is used.

You can use `\_Mtext{bib.⟨identifier⟩}` if you want to use a phrase dependent on outer document language (no on entry language). Example:

```
howpublished = "\_Mtext{bib.blue-ray}"
```

Now, you can set the variants of `bib.blue-ray` phrase for various languages:

```
\_sdef{_mt:bib.blue-ray:en} {Blue-ray disc}
\_sdef{_mt:bib.blue-ray:cs} {Blue-ray disk}
```

Summary of non-standard fields
This style uses the following fields unkown by bibTEX:

```
option    ... options separated by spaces
lang      ... the language two-letter code of one entry
ednote    ... editional info (secondary authors etc.) or
              global data in @MISC-like entries
citedate  ... the date of the citation in year/month/day format
numbering ... format for volume, number, pages
isbn      ... ISBN
issn      ... ISSN
doi       ... DOI
url       ... URL
```

Summary of options

```
aumax:<number>       ... maximum number of printed authors
aumin:<number>       ... number of printed authors if aumax exceedes
autrim:<number>      ... full Firstnames iff number of authors are less than this
auprint:{<value>}    ... text instead authors list (\AU macro may be used)
edmax, edmin, edtrim ... similar as above for editors list
edprint:{<value>}    ... text instead editors list (\ED macro may be used)
titlepost:{<value>}  ... text after title
yearprint:{<value>}  ... text instead real year (\YEAR macro may be used)
editionprint:{<value>} . text instead real edition (\EDN macro may be used)
urlalso      ... the ``available also from'' is used instead ``available from''
unpublished  ... the publisher etc. fields are not mandatory
nowarn       ... no mandatory fields
```

Another options in the option field are silently ignored.

2.32.6 Implementation of the `bib-iso690` style

bib-iso690.opm

```
% bibliography style (iso690), version <2020-03-10>, loaded on demand by \usebib

\_ifx\_optexbibstyle\_undefined \_errmessage
   {This file can be read by: \_string\usebib/? (iso690) bibfiles command only}
   \_endinput \_fi
```

`\_maybetod` (alias `\.` in the style file group) does not put second dot.

bib-iso690.opm

```
\_def\_maybedot{\_ifnum\_spacefactor=\_sfcode`\.\_relax\_else.\_fi}
\_tmpnum=\_sfcode`\. \_advance\_tmpnum by-2 \_sfcode`\.=\_tmpnum
\_sfcode`\?=\_tmpnum \_sfcode`\!=\_tmpnum
\_let\.=\_maybedot  % prevents from double periods
```

Option field.

bib-iso690.opm

```
\_CreateField {option}
\_def\_isbiboption#1#2{\_edef\_tmp{\_noexpand\_isbiboptionA{#1}}\_tmp}
\_def\_isbiboptionA#1{\_def\_tmp##1 #1 ##2\_relax{%
      \_if^##2^\_csname iffalse\_ea\_endcsname \_else\_csname iftrue\_ea\_endcsname \_fi}%
   \_ea\_tmp\_biboptionsi #1 \_relax}
\_def\_bibopt[#1]#2#3{\_isbiboption{#1}\_iftrue\_def\_tmp{#2}\_else\_def\_tmp{#3}\_fi\_tmp}
\_def\_biboptionvalue#1#2{\_def\_tmp##1 #1:##2 ##3\_relax{\_def#2{##2}}%
```

```
   \_ea\_tmp\_biboptionsi #1: \_relax}

\_def\_readbiboptions{%
   \_RetrieveFieldIn{option}\_biboptionsi
   \_toks1=\_ea{\_biboptionsi}%
   \_edef\_biboptionsi{\_space \_the\_toks1 \_space \_the\_biboptions \_space}%
}
\_newtoks\_biboptions
\_public \biboptions ;
```

Formating of Author/Editor lists.

bib-iso690.opm

```
\_def\_firstauthorformat{%
   \_upper{\_Lastname}\_bprintc\_Firstname{, *}\_bprintc\_Von{ *}\_bprintc\_Junior{, *}%
}
\_def\_otherauthorformat{%
   \_bprintc\_Firstname{* }\_bprintc\_Von{* }\_upper{\_Lastname}\_bprintc\_Junior{, *}%
}
\_def\_commonname{%
  \_ifnum\_NameCount=1
     \_firstauthorformat
     \_ifx\_dobibmark\_undefined \_edef\_dobibmark{\_Lastname}\_fi
  \_else
     \_ifnum0\_namecount=\_NameCount
        \_ifx\_maybeetal\_empty \_bibconjunctionand\_else , \_fi
     \_else , \_fi
     \_otherauthorformat
  \_fi
}
\_def\_authorname{%
   \_ifnum\_NameCount>0\_namecount\_relax\_else \_commonname \_fi
   \_ifnum\_NameCount=0\_namecount\_relax \_maybeetal \_fi
}
\_let\_editorname=\_authorname

\_def\_prepareauedoptions#1{%
   \_def\_mabyetal{}\_csname lb@abbreviatefalse\_endcsname
   \_biboptionvalue{#1max}\_authormax
   \_biboptionvalue{#1min}\_authormin
   \_biboptionvalue{#1pre}\_authorpre
   \_biboptionvalue{#1print}\_authorprint
   \_isbiboption{#1etal}\_iftrue \_def\_maybeetal{\_Mtext{bib.etal}}\_fi
   \_biboptionvalue{#1trim}\_autrim
   \_let\_namecountraw=\_namecount
   \_ifx\_authormax\_empty \_else
      \_ifnum 0\_authormax<0\_namecount
         \_edef\_namecount{\_ifx\_authormin\_empty\_authormax\_else\_authormin\_fi}%
         \_def\_maybeetal{\_Mtext{bib.etal}}%
   \_fi\_fi
   \_ifx\_autrim\_empty \_def\_autrim{10000}\_fi
   \_ifnum\_autrim=0 \_def\_autrim{10000}\_fi
   \_ifnum 0\_namecount<\_autrim\_relax \_else \_AbbreviateFirstname \_fi
}
\_def\_maybeetal{}

\_ifx\upper\_undefined
   \_ifx\caps \_undefined \_def\upper{\_uppercase\_ea}\_else
                          \_def\upper#1{{\caps\_rm #1}}\_fi
\_fi
\_let\_upper=\upper
```

Preparing bib-mark (used when `\nonumcitations` is set).

bib-iso690.opm

```
\_def\_setbibmark{%
   \_ifx\_dobibmark\_undefined \_def\_dobibmark{}\_fi
   \_RetrieveFieldIn{bibmark}\_tmp
   \_ifx\_tmp\_empty \_RetrieveFieldIn{year}\_tmp \_edef\_tmp{\_dobibmark, \_tmp}\_fi
   \_bibmark=\_ea{\_tmp}%
}
```

Setting phrases.

bib-iso690.opm

```
\_def\_bibconjunctionand{\_Mtext{bib.and}}
\_def\_preurl{\_Mtext{bib.available}}
\_let\_predoi=\_preurl
\_def\_postedition{\_mtext{bib.edition}}
\_def\_Inclause{In:~}
\_def\_prevolume{\_mtext{bib.volume}}
\_def\_prenumber{\_mtext{bib.number}}
\_def\_prepages{\_mtext{bib.prepages}}
\_def\_posteditor{\_ifnum0\_namecountraw>1 \_Mtext{bib.editors}\_else\_Mtext{bib.editor}\_fi}
```

`\_Mtext{`⟨*identifier*⟩`}` expands to a phrase by outer document language (no entry language).

bib-iso690.opm

```
\_chardef\_documentlanguage=\_language
\_def\_Mtext#1{\_csname _mt:#1:\_csname _lan:\_the\_documentlanguage\_endcsname\_endcsname}

\_CreateField {lang}
\_def\_setlang#1{\_ifx#1\_empty \_else
     \_ifcsname _mt:bib.and:#1\_endcsname \_language=\_csname _#1Patt\_endcsname \_relax
     \_else \_opwarning{No phrases for "#1" used by [\EntryKey] in .bib}%
   \_fi\_fi
}
```

Non-standard fieldnames.

bib-iso690.opm

```
\_CreateField {ednote}
\_CreateField {citedate}
\_CreateField {numbering}
\_CreateField {isbn}
\_CreateField {issn}
\_CreateField {doi}
\_CreateField {url}
\_CreateField {bibmark}
```

Sorting.

bib-iso690.opm

```
\_SortingOrder{name,year}{lfvj}
\_SpecialSort {key}
```

Supporting macros.

bib-iso690.opm

```
\_def\_bibwarninga{\_bibwarning}
\_def\_bibwarningb{\_bibwarning}

\_def\_docitedate #1/#2/#3/#4\_relax{[\_Mtext{bib.citedate}%
   \_if^#2^#1\_else
      \_if^#3^#1/#2\_else
         \_cs{_\_cs{_lan:\_the\_documentlanguage}dateformat}#1/#2/#3\relax
   \_fi\_fi ]%
}
\_def\_doyear#1{
   \_biboptionvalue{yearprint}\_yearprint
   \_ifx\_yearprint\_empty#1\_else\_def\YEAR{#1}\_yearprint\_fi
}
\_def\_preparenumbering{%
   \_def\VOL{\_RetrieveField{volume}}%
   \_def\NO{\_RetrieveField{number}}%
   \_def\PP{\_RetrieveField{pages}}%
}
\_def\_prepareednote{%
   \_def\EDN{\_RetrieveField{edition}}%
   \_def\ADDR{\_RetrieveField{address}}%
   \_def\PUBL{\_RetrieveField{publisher}}%
   \_def\YEAR{\_RetrieveField{year}}%
   \_def\AU{\_bprintb[!author]{\_doauthor0{####1}}{}}%
   \_def\ED{\_bprintb[!editor]{\_doeditor0{####1}}{}}%
   \_preparenumbering
}
\_def\_doedition#1{%
```

```
   \_biboptionvalue{editionprint}\_editionprint
   \_ifx\_editionprint\_empty#1\_postedition\_else\_def\ED{#1}\_editionprint\_fi
}
\_def\_doauthor#1#2{\_prepareauedoptions{au}\_let\_iseditorlist=\_undefined
   \_if1#1\_def\AU{#2}\_else\_let\_authorprint=\_empty\_fi
   \_ifx\_authorprint\_empty #2\_else \_authorprint\_fi
}
\_def\_doeditor#1#2{\_prepareauedoptions{ed}\_let\_firstauthorformat=\_otherauthorformat
   \_if1#1\_def\ED{#2}\_else\_let\_authorprint=\_empty\_fi
   \_ifx\_authorprint\_empty #2\_posteditor\_else \_authorprint\_fi
}
```

Entry types.

bib-iso690.opm

```
\_sdef{_print:BEGIN}{%
   \_readbiboptions
   \_biboptionvalue{titlepost}\_titlepost
   \_isbiboption{unpublished}\_iftrue \_let\_bibwarninga=\_relax \_let\_bibwarningb=\_relax \_fi
   \_isbiboption{nowarn}\_iftrue \_let\_bibwarning=\_relax \_fi
   \_isbiboption{urlalso}\_iftrue \_def\_preurl{\_Mtext{bib.availablealso}}\_fi
   \_RetrieveFieldIn{lang}\_langentry \_setlang\_langentry
}
\_sdef{_print:END}{%
   \_bprinta [note]       {*.}{}%
   \_setbibmark
}
\_def\_bookgeneric#1{%
   \_bprinta [howpublished]  {[*].\ }{}%
   \_bprintb [edition]    {\_doedition{##1}\.\ }{}%
   \_bprinta [ednote]     {*.\ }{}%
   \_bprinta [address]    {*\_bprintv[publisher]{:}{\_bprintv[year]{,}{.}}\ }{\_bibwarninga}%
   \_bprinta [publisher]  {*\_bprintv[year]{,}{.}\ }{\_bibwarninga}%
   \_bprintb [year]       {\_doyear{##1}\_bprintv[citedate]{\_bprintv[numbering]{.}{}}{.}\ }%
                                                                                {\_bibwarning}%
   \_bprinta [numbering]  {\_preparenumbering*\_bprintv[citedate]{}{\.}\ }{}%
   \_bprinta [citedate]   {\_docitedate*///\_relax.\ }{}%
   #1%
   \_bprinta [series]     {*.\ }{}%
   \_bprinta [isbn]       {ISBN~*.\ }{\_bibwarningb}%
   \_bprinta [issn]       {ISSN~*.\ }{}%
   \_bprintb [doi]        {\_predoi DOI \_ulink[http://dx.doi.org/##1]{##1}.\ }{}%
   \_bprintb [url]        {\_preurl\_url{##1}. }{}%
}
\_sdef{_print:book}{%
   \_bprintb [!author]    {\_doauthor1{##1}\.\ }{\_bibwarning}%
   \_bprintb [title]      {{\_em##1}\_bprintc\_titlepost{\.\ *}\_bprintv[howpublished]{}{\.}\ }%
                                                                                {\_bibwarning}%
   \_bookgeneric{}%
}
\_sdef{_print:article}{%
   \_biboptionvalue{journalpost}\_journalpost
   \_bprintb [!author]   {\_doauthor1{##1}\.\ }{\_bibwarning}%
   \_bprinta [title]     {*.\ \_bprintc\_titlepost{*.\ }}{\_bibwarning}%
   \_bprintb [journal]   {{\_em##1}\_bprintc\_journalpost{\.\ *}\_bprintv[howpublished]{}{\.}\ }%
                                                                                {\_bibwarninga}%
   \_bprinta [howpublished]  {[*].\ }{}%
   \_bprinta [address]   {*\_bprintb[publisher]{:}{,}\ }{}%
   \_bprinta [publisher] {*, }{}%
   \_bprinta [month]     {*, }{}%
   \_bprintb [year]      {\_doyear{##1}\_bprintv[volume,number,pages]{,}{\.}\ }{}%
   \_bprinta [numbering] {\_preparenumbering*\_bprintv[citedate]{}{\.}\ }
                        {\_bprinta [volume] {\_prevolume*\_bprintv[number,pages]{,}{\.}\ }{}%
                         \_bprinta [number] {\_prenumber*\_bprintv[pages]{,}{\.}\ }{}%
                         \_bprintb [pages]  {\_prepages\_hbox{##1}\_bprintv[citedate]{}{\.}\ }%
                                                                                {\_bibwarninga}}%
   \_bprinta [citedate]  {\_docitedate*///\_relax.\ }{}%
   \_bprinta [issn]      {ISSN~*.\ }{}%
   \_bprintb [doi]       {\_predoi DOI \_ulink[http://dx.doi.org/##1]{##1}.\ }{}%
   \_bprintb [url]       {\_preurl\_url{##1}. }{}%
```

```
}
\_sdef{_print:inbook}{%
   \_let\_bibwarningb=\_relax
   \_bprintb [!author]   {\_doauthor1{##1}\.\ }{\_bibwarning}%
   \_bprinta [title]     {*.\ }{\_bibwarning}%
                        \_Inclause
   \_bprintb [!editor]   {\_doeditor1{##1}\.\ }{}%
   \_bprintb [booktitle] {{\_em##1}\_bprintc\_titlepost{\.\ *}\_bprintv[howpublished]{}{\.}\ }%
                                                                              {\_bibwarning}%
   \_bookgeneric{\_bprintb [pages]  {\_prepages\_hbox{##1}. }{}}%
}
\_slet{_print:inproceedings}{_print:inbook}
\_slet{_print:conference}{_print:inbook}

\_sdef{_print:thesis}{%
   \_bprintb [!author]    {\_doauthor1{##1}\.\ }{\_bibwarning}%
   \_bprintb [title]      {{\_em##1}\_bprintc\_titlepost{\.\ *}\_bprintv[howpublished]{}{\.}\ }%
                                                                              {\_bibwarning}%
   \_bprinta [howpublished]  {[*].\ }{}%
   \_bprinta [address]    {*\_bprintv[school]{:}{\_bprintv[year]{,}{.}}\ }{\_bibwarning}%
   \_bprinta [school]     {*\_bprintv[year]{,}{.}\ }{\_bibwarning}%
   \_bprinta [month]      {*, }{}%
   \_bprintb [year]       {\_doyear{##1}\_bprintv[citedate]{}{.}\ }{\_bibwarninga}%
   \_bprinta [citedate]   {\_docitedate*///\_relax.\ }{}%
   \_bprinta [type]       {*\_bprintv[ednote]{,}{.}\ }%
                         {\_ifx\_thesistype\_undefined\_bibwarning
                          \_else\_thesistype\_bprintv[ednote]{,}{.}\ \_fi}%
   \_bprinta [ednote]     {*.\ }{}%
   \_bprintb [doi]        {\_predoi DOI \_ulink[http://dx.doi.org/##1]{##1}.\ }{}%
   \_bprintb [url]        {\_preurl\_url{##1}. }{}%
}
\_sdef{_print:phdthesis}{\_def\_thesistype{\_Mtext{bib.phdthesis}}\_cs{_print:thesis}}
\_sdef{_print:mastershesis}{\_def\_thesistype{\_Mtext{bib.masthesis}}\_cs{_print:thesis}}
\_sdef{_print:bachelorsthesis}{\_def\_thesistype{\_Mtext{bib.bachthesis}}\_cs{_print:thesis}}

\_sdef{_print:generic}{%
   \_bprintb [!author]    {\_doauthor1{##1}\.\ }{\_bibwarning}%
   \_bprintb [title]      {{\_em##1}\_bprintc\_titlepost{\.\ *}\_bprintv[howpublished]{}{\.}\ }%
                                                                              {\_bibwarning}%
   \_bprinta [howpublished]  {[*].\ }{}%
   \_bprinta [ednote]     {\_prepareednote*\_bprintv[citedate]{}{.}\ }{\_bibwarning}%
   \_bprinta [year]       {}{\_bibwarning}%
   \_bprinta [citedate]   {\_docitedate*///\_relax.\ }{}%
   \_bprintb [doi]        {\_predoi DOI \_ulink[http://dx.doi.org/##1]{##1}.\ }{}%
   \_bprintb [url]        {\_preurl\_url{##1}. }{}%
}
\_slet{_print:booklet}{_print:generic}
\_slet{_print:incolleciton}{_print:generic}
\_slet{_print:manual}{_print:generic}
\_slet{_print:proceedings}{_print:generic}
\_slet{_print:techreport}{_print:generic}
\_slet{_print:unpublished}{_print:generic}

\_sdef{_print:misc}{\_let\_bibwarning=\_relax \_cs{_print:generic}}
```

2.33 Sorting and making Index

makeindex.opm

```
\_codedecl \makeindex {Makeindex and sorting <2020-04-26>} % loaded in format
```

\makeindex implements sorting algorithm at TEX macro-language level. You need not any external program.

There are two passes in sorting algorithm. Primary pass does not distinguish between a group o letters (typically non-accented and accented). If the result of comparing two string is equal in primary pass then secondary pass is started. It distinguish between variously accented letters. Czech rules, for example says: not accented before dieresis before acute before circumflex before ring. At less priority: lowercase letters must be before uppercase letters.

The _sortingdata⟨*iso-code*⟩ implements these rules for the language ⟨*iso-code*⟩. The groups between commas are not distinguished in the first pass. The second pass distinguishes all characters mentioned in the _sortingdata⟨*iso-code*⟩ (commas are ignored). The order of letters in the _sortingdata⟨*iso-code*⟩ macro is significant for sorting algorithm. The Czech rules (cs) are implemented here:

makeindex.opm

```
\_def \_sortingdatacs {%
  /,{ },-,&,@,%
  aAäÄáÁ,%
  bB,%
  cC,%
  čČ,%
  dDdĎ,%
  eEéÉěĚ,%
  fF,%
  gG,%
  hH,%
  ^^T^^U^^V,% ch Ch CH
  iIíÍ,%
  jJ,%
  kK,%
  lLÍĹŀĽ,%
  mM,%
  nNňŇ,%
  oOöÖóÓôÔ,%
  pP,%
  qQ,%
  rRŕŔ,%
  řŘ,%
  sS,%
  šŠ,%
  tTťŤ,%
  uUüÜúÚůŮ,%
  vV,%
  wW,%
  xX,%
  yYýÝ,%
  zZ,%
  žŽ,%
  0,1,2,3,4,5,6,7,8,9,'%
}
```

Characters ignored by sorting algorithm are declared in _ignoredchars⟨*iso-code*⟩. The compound characters (two or more characters interpreted as one character in sorting algorithm) is mapped to single invisible characters in _compoundchars⟨*iso-code*⟩. Czech rules declares ch or Ch or CH as a single letter sorted between H and I. See _sortingdatacs above where these declared characters are used.

The characters declared in _ignoredchars are ignored in first pass without additional condition. All characters are taken into account in second pass: ASCII characters with code ‘65 are sorted first if they are not mentioned in the _sortingdata⟨*iso-code*⟩ macro. Others not mentioned characters have undefined behavior during sorting.

makeindex.opm

```
\_def \_ignoredcharscs  {.,;?!:'"|()[]<>=+}
\_def \_compoundcharscs {ch:^^T Ch:^^U CH:^^V} % DZ etc. are sorted normally
```

Slovak sorting rules are the same as Czech. The macro _sortingdatacs includes Slovak letters too. Compound characters are the same. English sorting rules can be defined by _sortingdatacs too because English alphabet is subset of Czech and Slovak alphabets. Only difference: _compoundcharsen is empty in English rules.

You can declare these macros for more languages, if you wish to use \makeindex with sorting rules in respect to your language. Note: if you need to map compound characters to a character, don’t use ^^I or ^^M because these characters have very specific category code. And use space to separate more mappings, like in _compoundcharscs above.

makeindex.opm

```
\_let \_sortingdatask = \_sortingdatacs
\_let \_compoundcharssk = \_compoundcharscs
\_let \_ignoredcharssk = \_ignoredcharscs
```

```
\_let \_sortingdataen = \_sortingdatacs
\_def \_compoundcharsen {}
\_let \_ignoredcharsen = \_ignoredcharscs
```

Preparing to primary pass is implemented by the _setprimarysorting macro. It is called from \makeindex macro and all processing of sorting is in a group.

makeindex.opm

```
\_def\_setprimarysorting {%
   \_ea\_let \_ea\_sortingdata \_csname _sortingdata\_sortinglang\_endcsname
   \_ea\_let \_ea\_compoundchars \_csname _compoundchars\_sortinglang\_endcsname
   \_ea\_let \_ea\_ignoredchars \_csname _ignoredchars\_sortinglang\_endcsname
   \_ifx \_sortingdata\_relax \_addto\_nold{ sortingdata}%
       \_let \_sortingdata = \_sortingdataen \_fi
   \_ifx \_compoundchars\_relax \_addto\_nold{ compoundchars}%
       \_let \_compoundchars = \_compoundcharsen \_fi
   \_ifx \_ignoredchars\_relax \_addto\_nold{ ignoredchars}%
       \_let \_ignoredchars = \_ignoredcharsen \_fi
   \_ifx \_compoundchars\_empty \_else
      \_edef \_compoundchars {\_detokenize\_ea{\_compoundchars} }\_fi % all must be catcode 12
   \_def \_act ##1{\_ifx##1\_relax \_else
      \_ifx##1,\_advance\_tmpnum by1
      \_else \_lccode`##1=\_tmpnum \_fi
      \_ea\_act \_fi}%
   \_tmpnum=65 \_ea\_act \_sortingdata \_relax
   \_def \_act ##1{\_ifx##1\_relax \_else
      \_lccode`##1=`\^^I
      \_ea\_act \_fi}%
   \_ea\_act \_ignoredchars \_relax
}
```

Preparing to secondary pass is implemented by the _setsecondarysorting macro.

makeindex.opm

```
\_def\_setsecondarysorting {%
   \_def \_act ##1{\_ifx##1\_relax \_else
      \_ifx##1,\_else \_advance\_tmpnum by1 \_lccode`##1=\_tmpnum \_fi
      \_ea\_act \_fi}%
  \_tmpnum=65 \_ea\_act \_sortingdata \_relax
}
```

Strings to be sorted are prepared in \,⟨*string*⟩ control sequences (in order to save \TeX memory). The _preparesorting \,⟨*string*⟩ converts ⟨*string*⟩ to _tmpb with respect to the data initialized in _setprimarysorting or _setsecondarysorting.
The compoud characters are converted to single characters by the _docompound macro.

makeindex.opm

```
\_def \_preparesorting #1{%
   \_edef \_tmpb {\_ea\_ignorefirst\_csstring #1}% \,<string> -> <string>
   \_ea \_docompound \_compoundchars \_relax:{}       % replace compound characters
   \_lowercase \_ea{\_ea\_def \_ea\_tmpb \_ea{\_tmpb}}% convert in respect to \_sortingdata
   \_ea\_replstring \_ea\_tmpb \_ea{\_csstring\^^I}{}% remove ignored characters
}
\_def \_docompound #1:#2 {%
   \_ifx\_relax#1\_else \_replstring\_tmpb {#1}{#2}\_ea\_docompound \_fi
}
\_def \_ignorefirst#1{}
```

Macro _isAleB \,⟨*string1*⟩ \,⟨*string2*⟩ returns the result of comparison of given two strings to _ifAleB control sequence. Usage: \isAleB \,⟨*string1*⟩ \,⟨*string2*⟩ _ifAleB ... _else ... _fi The converted strings (in respect of the data prepared for first pass) must be saved as values of \,⟨*string1*⟩ and \,⟨*string2*⟩ macros. The reason is speed: we don't want to convert them repeatedly in each comparison. The macro _testAleB ⟨*converted string1*⟩&_relax⟨*converted-string2*⟩_relax \,⟨*string1*⟩\,⟨*string2*⟩ does the real work. It reads first character from both converted strings, compares them and if it is equal then calls itself recursively else gives result.

makeindex.opm

```
\_newifi \_ifAleB

\_def\_isAleB #1#2{%
   \_edef\_tmpb {#1&\_relax#2&\_relax}%
   \_ea \_testAleB \_tmpb #1#2%
```

```
}
\_def\_testAleB #1#2\_relax #3#4\_relax #5#6{%
  \_if #1#3\_if #1&\_testAleBsecondary #5#6%   goto to the second pass::
          \_else \_testAleB #2\_relax #4\_relax #5#6%
          \_fi
  \_else \_ifnum `#1<`#3 \_AleBtrue \_else \_AleBfalse \_fi
  \_fi
}
\_def\_testAleBsecondary#1#2{%
  \_bgroup
     \_setsecondarysorting
     \_preparesorting#1\_let\_tmpa=\_tmpb \_preparesorting#2%
     \_edef\_tmpb{\_tmpa0\_relax\_tmpb1\_relax}%
     \_ea\_testAleBsecondaryX \_tmpb
  \_egroup
}
\_def\_testAleBsecondaryX #1#2\_relax #3#4\_relax {%
   \_if #1#3\_testAleBsecondaryX #2\_relax #4\_relax
   \_else \_ifnum `#1<`#3 \_global\_AleBtrue \_else \_global \_AleBfalse \_fi
   \_fi
}
```

Merge sort is very effectively implemented by TEX macros. The following code is created by my son Miroslav. The `\_mergesort` macro expects that all items in `\_iilist` are separated by comma when it starts. It ends with sorted items in `\_iilist` without commas. So `\_dosorting` macro must prepare commas between items.

makeindex.opm

```
\_def\_mergesort #1#2,#3{% by Miroslav Olsak
   \_ifx,#1%                      % prazdna-skupina,neco,  (#2=neco #3=pokracovani)
      \_addto\_iilist{#2,}%        % dvojice skupin vyresena
      \_sortreturn{\_fif\_mergesort#3}%   % \mergesort pokracovani
   \_fi
   \_ifx,#3%                      % neco,prazna-skupina,  (#1#2=neco #3=,)
      \_addto\_iilist{#1#2,}%      % dvojice skupin vyresena
      \_sortreturn{\_fif\_mergesort}%      % \mergesort dalsi
   \_fi
   \_ifx\_end#3%                   % neco,konec (#1#2=neco)
      \_ifx\_empty\_iilist                % neco=kompletni setrideny seznam
         \_def\_iilist{#1#2}%
         \_sortreturn{\_fif\_fif\_gobbletoend}%   % koncim
      \_else                       % neco=posledni skupina nebo \end
         \_sortreturn{\_fif\_fif       % spojim \indexbuffer+necoa cele znova
                      \_edef\_iilist{\_ea}\_ea\_mergesort\_iilist#1#2,#3}%
   \_fi\_fi                       % zatriduji: p1+neco1,p2+neco2, (#1#2=p1+neco1 #3=p2)
   \_isAleB #1#3\_ifAleB          % p1<p2
      \_addto\_iilist{#1}%        % p1 do bufferu
      \_sortreturn{\_fif\_mergesort#2,#3}%         % \mergesort neco1,p2+neco2,
   \_else                        % p1>p2
      \_addto\_iilist{#3}%        % p2 do bufferu
      \_sortreturn{\_fif\_mergesort#1#2,}%         % \mergesort p1+neco1,neco2,
   \_fi
   \_relax % zarazka, na ktere se zastavi \sortreturn
}
\_def\_sortreturn#1#2\_fi\_relax{#1} \_def\_fif{\_fi}
\_def\_gobbletoend #1\_end{}
```

The `\_dosorting` `\list` macro redefines `\list` as sorted `\list`. The `\list` have to include control sequences in the form $\backslash\langle c\rangle\langle string\rangle$. These control sequences will be sorted in respect to $\langle strings\rangle$ without change of meanings of these control sequences. Their meanings are irrelevant when sorting. The first character $\langle c\rangle$ in $\backslash\langle c\rangle\langle string\rangle$ should be whatever. It does not influence the sorting. OPTEX uses comma at this place for sorting indexes: $\backslash,\langle word1\rangle$ $\backslash,\langle word2\rangle$ $\backslash,\langle word3\rangle$ ....

The actual language (chosen for hyphenation patterns) is used for sorting data. If the `\_sortinglang` macro is defined as $\langle iso\text{-}code\rangle$(for example `\def\sortinglang{de}`) then this has precedence and actual language is not used. Moreover, if you specify `\_asciisortingtrue` then ASCII sorting will be processed and all language sorting data will be ignored.

makeindex.opm

```
\_newifi \_ifasciisorting  \_asciisortingfalse
```

```
\_def\_dosorting #1{%
   \_begingroup
     \_def\_nold{}%
     \_ifx\_sotringlang\_undefined \_edef\_sortinglang{\_cs{_lan:\_the\_language}}\_fi
      \_ifasciisorting
          \_edef\_sortinglang{ASCII}%
          \_def \_preparesorting##1{\_edef\_tmpb{\_ea\_ignorefirst\_csstring##1}}%
          \_let \_setsecondarysorting=\_relax
     \_else
        \_setprimarysorting
     \_fi
     \_message{OpTeX: Sorting \_string#1 (\_sortinglang) ...^^J}%
     \_ifx\_nold\_empty\_else \_opwarning{Missing\_nold\_space for language (\_sortinglang)}\_fi
     \_def \_act##1{\_preparesorting ##1\_edef##1{\_tmpb}}%
     \_ea\_xargs \_ea\_act #1;%
     \_def \_act##1{\_addto #1{##1,}}%
     \_edef #1{\_ea}\_ea\_xargs \_ea\_act #1;%
     \_edef \_iilist{\_ea}\_ea\_mergesort #1\_end,\_end
   \_ea\_endgroup
   \_ea\_def\_ea#1\_ea{\_iilist}%
}
```

The \makeindex prints the index. First, it sorts the _iilist second, it prints the sorted _iilist, each item is printed using _printindexitem.

makeindex.opm

```
\_def\_makeindex{\_par
  \_ifx\_iilist\_empty \_opwarning{index data-buffer is empty. TeX me again}%
  \_incr\_unresolvedrefs
  \_else
    \_dosorting \_iilist % sorting \_iilist
    \_bgroup
       \_rightskip=0pt plus1fil \_exhyphenpenalty=10000 \_leftskip=\_iindent
       \_ea\_xargs \_ea\_printindexitem \_iilist ;\_par
    \_egroup
  \_fi
}
\_public \makeindex ;
```

The _printindexitem \,⟨*word*⟩ prints one item to the index. If _,⟨*word*⟩ is defined then this is used instead real ⟨*word*⟩ (this exception is declared by \iis macro). Else ⟨*word*⟩ is printed by _printii. Finally, _printiipages prints the value of \,⟨*word*⟩, i.e. the list of pages.

makeindex.opm

```
\_def\_printindexitem #1{%
   \_ifcsname _\_csstring #1\_endcsname
      \_ea\_ea\_ea \_printii \_csname _\_csstring #1\_endcsname &%
   \_else
      \_ea\_ea\_ea\_printii \_ea\_ignorefirst \_csstring #1&%
   \_fi
   \_ea\_printiipages #1&
}
```

_printii ⟨*word*⟩& does more intelligent work because we are working with words in the form ⟨*main-word*⟩/⟨*sub-word*⟩/⟨*sub-sub-word*⟩. The \everyii tokens register is applied before \noindent. User can declare something special here.

The _newiiletter{⟨*letter*⟩} macro is empty by default. It is invoked if first letter of index entries is changed. You can declare a design between index entries here. You can try, for example:

```
\def\_newiiletter#1#2{%
    \bigskip \hbox{\setfontsize{at15pt}\bf\uppercase{#1}}\medskip}
```

makeindex.opm

```
\_def\_printii #1#2&{%
   \_ismacro\_lastii{#1}\_iffalse \_newiiletter{#1}{#2}\_def\_lastii{#1}\_fi
   \_gdef\_currii{#1#2}\_the\_everyii\_noindent
   \_hskip-\_iindent \_ignorespaces\_printiiA#1#2//}
\_def\_printiiA #1/{\_if^#1^\_let\_previi=\_currii \_else
   \_ea\_scanprevii\_previi/&\_edef\_tmpb{\_detokenize{#1}}%
   \_ifx\_tmpa\_tmpb \_iiemdash \_else#1 \_gdef\_previi{}\_fi
   \_expandafter\_printiiA\_fi
```

```
}
\_def\_iiemdash{\_kern.1em---\_space}
\_def\_lastii{}
\_def\_newiiletter#1#2{}

\_def\_scanprevii#1/#2&{\_def\_previi{#2}\_edef\_tmpa{\_detokenize{#1}}}
\_def\_previi{} % previous index item
```

`\_printiipages` ⟨*pglist*⟩`&` gets ⟨*pglist*⟩ in the form ⟨*pg*⟩`:`⟨*type*⟩`,`⟨*pg*⟩`:`⟨*type*⟩`,...`⟨*pg*⟩`:`⟨*type*⟩ and it converts them to ⟨*pg*⟩`,` ⟨*pg*⟩`,` ⟨*from*⟩`--`⟨*to*⟩`,` ⟨*pg*⟩ etc. The same pages must be printed only once and continuous consequences of pages must be compressed to the form ⟨*from*⟩`-`⟨*to*⟩. Moreover, the consequence is continuous only if all pages have the same ⟨*type*⟩. Empty ⟨*type*⟩ is most common, pages with `b` ⟨*type*⟩ must be printed as bold and with `i` ⟨*type*⟩ as italics. Moreover, the ⟨*pg*⟩ mentioned here are ⟨*gpageno*⟩, but we have to print ⟨*pageno*⟩. The following macros solves these tasks.

makeindex.opm

```
\_def\_printiipages#1&{\_let\_pgtype=\_undefined \_tmpnum=0 \_printpages #1,:,\_par}
\_def\_printpages#1:#2,{%  state automaton for compriming pages
   \_ifx,#1,\_uselastpgnum
   \_else \_def\_tmpa{#2}%
      \_ifx\_pgtype\_tmpa \_else
         \_let\_pgtype=\_tmpa
         \_uselastpgnum \_usepgcomma \_pgprint#1:{#2}%
         \_tmpnum=#1 \_returnfi \_fi
      \_ifnum\_tmpnum=#1 \_returnfi \_fi
      \_advance\_tmpnum by1
      \_ifnum\_tmpnum=#1 \_ifx\_lastpgnum\_undefined \_usepgdash\_fi
                         \_edef\_lastpgnum{\_the\_tmpnum:{\_pgtype}}%
                         \_returnfi \_fi
      \_uselastpgnum \_usepgcomma \_pgprint#1:{#2}%
      \_tmpnum=#1
      \_relax
   \_ea\_printpages \_fi
}
\_def\_returnfi #1\_relax{\_fi}
\_def\_uselastpgnum{\_ifx\_lastpgnum\_undefined
   \_else \_ea\_pgprint\_lastpgnum \_let\_lastpgnum=\_undefined \_fi
}
\_def\_usepgcomma{\_ifnum\_tmpnum>0, \_fi} % comma+space between page numbers
\_def\_usepgdash{\_hbox{--}}               % dash in the <from>--<to> form
```

You can re-define `\_pgprint` ⟨*gpageno*⟩`:{`⟨*iitype*⟩`}` if you need to implement more ⟨*iitypes*⟩.

makeindex.opm

```
\_def\_pgprint #1:#2{%
   \_ifx ,#2,\_pgprintA{#1}\_returnfi \_fi
   \_ifx b#2{\_bf \_pgprintA{#1}}\_returnfi \_fi
   \_ifx i#2{\_it \_pgprintA{#1}}\_returnfi \_fi
   \_ifx u#2\_pgu{\_pgprintA{#1}}\_returnfi \_fi
  \_pgprintA{#1}\_relax
}
\_def\_pgprintA #1{\_ilink[pg:#1]{\_cs{_pgi:#1}}} % \ilink[pg:<gpageno>]{<pageno>}
\_def\_pgu#1{\_leavevmode\_vtop{\_hbox{#1}\kern.3ex\_hrule}}
```

The `\iindex{`⟨*word*⟩`}` puts one ⟨*word*⟩ to the index. It writes `\_Xindex{`⟨*word*⟩`}{`⟨*iitype*⟩`}` to the `.ref` file. All othes variants of indexing macros expands internally to `\iindex`.

makeindex.opm

```
\_def\_iindex#1{\_isempty{#1}\_iffalse\_openref{\def~{ }%
   \edef\_act{\_noexpand\_wref\_noexpand\_Xindex{{#1}{\_iitypesaved}}}\_act}\_fi}
\_public \iindex ;
```

The `\_Xindex{`⟨*word*⟩`}{`⟨*iitype*⟩`}` stores `\,`⟨*word*⟩ to the `\_iilist` if there is first occurrence of the ⟨*word*⟩. The list of pages where ⟨*word*⟩ occurs, is the value of the macro `\,`⟨*word*⟩, so the ⟨*gpageno*⟩`:`⟨*iitype*⟩ is appended to this list. Moreover, we need a mapping from ⟨*gpageno*⟩ to ⟨*pageno*⟩, because we print ⟨*pageno*⟩ in the index, but hyperlinks are implemented by ⟨*gpageno*⟩. So, the macro `\_pgi:`⟨*gpageno*⟩ is defined as ⟨*pageno*⟩.

makeindex.opm

```
\_def \_iilist {}
\_def \_Xindex #1#2{\_ea\_XindexA \_csname ,#1\_ea\_endcsname \_currpage {#2}}
\_def \_XindexA #1#2#3#4{% #1=\,<word> #2=<gpageno> #3=<pageno> #4=<iitype>
```

```
    \_ifx#1\_relax \_global\_addto \_iilist {#1}%
                   \_gdef #1{#2:#4}%
    \_else \_global\_addto #1{,#2:#4}%
    \_fi
    \_sxdef{_pgi:#2}{#3}%
}
```

The implementation of macros \ii, \iid, \iis follows. Note that \ii works in horizontal mode on order to the \write whatsit is not broken from the following word. If you need to keep vertical mode, use \iindex{⟨*word*⟩} directly.
The \iitype {⟨*type*⟩} saves the ⟨*type*⟩ to the _iitypesaved macro. It is used in the \iindex macro.

makeindex.opm

```
\_def\_ii #1 {\_leavevmode\_def\_tmp{#1}\_iiA #1,,\_def\_iitypesaved{}}

\_def\_iiA #1,{\_if$#1$\_else\_def\_tmpa{#1}%
   \_ifx\_tmpa\_iiatsign \_ea\_iiB\_tmp,,\_else\_iindex{#1}\_fi
   \_ea\_iiA\_fi}
\_def\_iiatsign{@}

\_def\_iiB #1,{\_if$#1$\_else \_iiC#1/\_relax \_ea\_iiB\_fi}
\_def\_iiC #1/#2\_relax{\_if$#2$\_else\_iindex{#2#1}\_fi}

\_def\_iid #1 {\_leavevmode\_iindex{#1}#1\_futurelet\_tmp\_iiD\_def\_iitypesaved{}}
\_def\_iiD{\_ifx\_tmp,\_else\_ifx\_tmp.\_else\_space\_fi\_fi}

\_def\_iis #1 #2{{\_def~{ }\_global\_sdef{_,#1}{#2}}\_ignorespaces}

\_def\_iitypesaved{}
\_def\_iitype #1{\_def\_iitypesaved{#1}\_ignorespaces}

\_public \ii \iid \iis \iitype ;
```

2.34 Footnotes and marginal notes

fnotes.opm

```
\_codedecl \fnote {Footnotes, marginal notes OpTeX <2020-05-26>} % loaded in format
```

_gfnotenum is conter which counts footnotes globally in the document. whole document, chapters, pages.
_lfnotenum is counter which counts footnotes at each chapter from one. It is used for local page footnote counters too.
_ifpgfnote says that footnote numbers are counted on each page from one. We need to run \openref in such case.
\fnotenum is a macro which expands to footnote number counted in declared part.
\fnotenumchapters declares footnotes numbered in each chapter from one (default), \fnotenumglobal declares footnotes numbered in whole document from one and \fnotenumpages declares footnotes numbered at each page from one.

fnotes.opm

```
\_newcount\_gfnotenum \_gfnotenum=0
\_newcount\_lfnotenum

\_newifi \_ifpgfnote
\_def \_fnotenumglobal   {\_def\_fnotenum{\_the\_gfnotenum}\_pgfnotefalse}
\_def \_fnotenumchapters {\_def\_fnotenum{\_the\_lfnotenum}\_pgfnotefalse}
\_def \_fnotenumpages    {\_def\_fnotenum{\_trycs{_fn:\_the\_gfnotenum}{?}}\_pgfnotetrue}
\_fnotenumchapters  % default are footnotes counted from one in each chapter
\_def \fnotenum{\_fnotenum}
\_public \fnotenumglobal \fnotenumchapters \fnotenumpages ;
\_let \runningfnotes = \fnotenumglobal % for backward compatibility
```

The _printfnotemark prints the footnote mark. You can re-define this macro if you want another design of footnotes. For example

```
\fnotenumpages
\def \_printfnotemark {\ifcase 0\fnotenum\or
   *\or**\or***\or$^\mathbox{†}$\or$^\mathbox{‡}$\or$^\mathbox{††}$\fi}
```

This code gives footnotes* and ** and*** and† etc. and it supposes that there are no more than 6 footnotes at one page.

If you want to distinguish between footnote marks in the text and in the front of footnote itself, then you can define `\_printfnotemarkA` and `\_printfnotemarkB`.

The `\fnotelinks`⟨*colorA*⟩⟨*colorB*⟩ implements the hyperlinked footnotes (from text to footnote and backward).

fnotes.opm

```
\_def \_printfnotemark  {$^{\_fnotenum}$}   % default footnote mark
\_def \_printfnotemarkA {\_printfnotemark}  % footnote marks used in text
\_def \_printfnotemarkB {\_printfnotemark}  % footnote marks used in front of footnotes

\_def \_fnotelinks#1#2{% <inText color> <inFootnote color>
   \_def\_printfnotemarkA{\_link[fnt:\_the\_gfnotenum]{\_localcolor#1}{\_printfnotemark}%
                         \_dest[fnf:\_the\_gfnotenum]}%
   \_def\_printfnotemarkB{\_link[fnf:\_the\_gfnotenum]{\_localcolor#2}{\_printfnotemark}%
                         \_dest[fnt:\_the\_gfnotenum]}%
}
\public \fnotelinks ;
```

Each footnote saves the `\_Xfnote` (without parameter) to the `.ref` file (if `\openref`). We can create the mapping from ⟨*gfnotenum*⟩ to⟨*pgfnotenum*⟩ in the macro `\_fn:`⟨*fnotenum*⟩. Each `\_Xpage` macro sets the `\_lfnotenum` to zero.

fnotes.opm

```
\_def \_Xfnote {\_incr\_lfnotenum \_incr\_gfnotenum
   \_sxdef{_fn:\_the\_gfnotenum}{\_the\_lfnotenum}}
```

The `\fnote` {⟨*text*⟩} macro is simple, `\fnotemark` and `\fnotetext` does the real work.

fnotes.opm

```
\_def\_fnote{\_fnotemark1\_fnotetext}
\_def\_fnotemark#1{{\_advance\_gfnotenum by#1\_advance\_lfnotenum by#1\_relax \_printfnotemarkA}}
```

The `\fnotetext` calls `\_opfootnote` which is equivalent to plain TEX `\vfootnote`. It creates new data to Insert `\footins`. The only difference is that we are able to propagate a macro parameter into Insert group before the text is printed (see section 2.18). This propagated macro is `\_fnset` which sets smaller fonts.

Note that `\vfootnote` and `\_opfootnote` does't read the text as a parameter but during normal horizontal mode. This is reason why catcode changes (for example in-line verbatim) can be used here.

fnotes.opm

```
\_def\_fnotetext{\_incr\_gfnotenum \_incr\_lfnotenum % global increment
   \_ifpgfnote \_openref \_fi
   \_wref \_Xfnote{}%
   \_ifpgfnote \_ifcsname _fn:\_the\_gfnotenum \_endcsname \_else
      \_opwarning{unknown \_noexpand\fnote mark. TeX me again}%
      \_incr\_unresolvedrefs
   \_fi\_fi
   \_opfootnote\_fnset\_printfnotemarkB
}
\_def\_fnset{\_everypar={}\_scalemain \_typoscale[800/800]}

\_public \fnote \fnotemark \fnotetext ;
```

By default `\mnote`{⟨*text*⟩} are in right margin at odd pages and they are in left margin at even pages. The `\mnote` macro saves its position to `.ref` file as `\_Xmnote` without parameter. We define `\_mn:`⟨*mnotenum*⟩ as `\right` or `\left` when the `.ref` file is read. The `\ifnum 0`≤`0#2` trick returns true if ⟨*pageno*⟩ has numeric type and false if it is non-numeric type (Roman numeral, for example). We prefer to use ⟨*pageno*⟩, but only if it has numeric type. We use ⟨*gpageno*⟩ in other cases.

fnotes.opm

```
\_newcount\_mnotenum    \_mnotenum=0       % global counter of mnotes
\_def \_Xmnote {\_incr\_mnotenum \_ea \_XmnoteA \_currpage}
\_def \_XmnoteA #1#2{% #1=<gpageno> #2=<pageno>
   \_sxdef{_mn:\_the\_mnotenum}{\_ifodd\_numtype{#2}{#1} \_right \_else \_left \_fi}}
\_def \_numtype #1#2{\_ifnum 0<0#1 #1\_else #2\_fi}
```

User can declare `\fixmnotes\left` or `\fixmnotes\right`. It defines `\_mnotesfixed` as `\_left` or `\_right` which declares the placement of all marginal notes and such declaration has a precedence.

fnotes.opm

```
\_def \_fixmnotes #1{\_edef\_mnotesfixed{\_cs{_\_csstring #1}}}
```

```
\_public \fixmnotes ;
```

The _mnoteD{⟨*text*⟩} macro sets the position the marginal note. The outer box of marginal note has zero width and zero depth and it is appended after current line using \vadjust primitive or it is inverted to vertical mode as a box with \vskip-\baselineskip followed.

fnotes.opm

```
\_def\_mnote #1#{\_ifx^#1^\_else \_mnoteC#1\_end \_fi \_mnoteD}
\_def\_mnoteC up#1\_end{\_mnoteskip=#1\_relax} % \mnote up<dimen> {<text>} syntax
\_long\_def\_mnoteD#1{\_ifvmode {\_mnoteA{#1}}\_nobreak\_vskip-\_baselineskip \_else
   \_lower\_dp\_strutbox\_hbox{}\_vadjust{\_kern-\_dp\_strutbox \_mnoteA{#1}\_kern\_dp\_strutbox}%
   \_fi
}
\_public \mnote ;
```

The \mnoteskip is a dimen which denotes the vertical shift of marginal note from its normal position. Positive value means shift up, negative down. The \mnoteskip register is set to zero after the marginal note is printed. The new sytax \mnote up⟨*dimen*⟩{⟨*text*⟩} is possible too, but public \mnoteskip is kept for backward compatibility.

fnotes.opm

```
\_newdimen\_mnoteskip
\_public \mnoteskip ;
```

The _mnoteA macro does the real work. The _lrmnote{⟨*left*⟩}{⟨*right*⟩} uses only first or only second parameter depending on the left or right marginal note.

fnotes.opm

```
\_long\_def\_mnoteA #1{\_incr\_mnotenum
   \_ifx\_mnotesfixed\_undefined
      \_ifcsname _mn:\_the\_mnotenum \_endcsname
          \_edef\_mnotesfixed{\_cs{_mn:\_the\_mnotenum}}%
      \_else
          \_opwarning{unknown \_noexpand\mnote side. TeX me again}\_openref
          \_incr\_unresolvedrefs
          \_def\_mnotesfixed{\_right}%
   \_fi\_fi
   \_hbox to0pt{\_wref\_Xmnote{}\_everypar={}%
      \_lrmnote{\_kern-\_mnotesize \_kern-\_mnoteindent}{\_kern\_hsize \_kern\_mnoteindent}%
      \_vbox to0pt{\_vss \_setbox0=\_vtop{\_hsize=\_mnotesize
            \_lrmnote{\_leftskip=0pt plus 1fill \_rightskip=0pt}
                     {\_rightskip=0pt plus 1fil \_leftskip=0pt}%
            {\_the\_everymnote\_noindent#1\_endgraf}}%
         \_dp0=0pt \_box0 \_kern\_mnoteskip \_global\_mnoteskip=0pt}\_hss}%
}
\_def \_lrmnote#1#2{\_ea\_ifx\_mnotesfixed\_left #1\_else #2\_fi}
```

We don't want to process \fnote, \fnotemark, \mnote in TOC, headlines nor outlines.

fnotes.opm

```
\_regmacro {\_def\fnote#1{}} {\_def\fnote#1{}} {\_def\fnote#1{}}
\_regmacro {\_def\fnotemark#1{}} {\_def\fnotemark#1{}} {\_def\fnotemark#1{}}
\_regmacro {\_def\mnote#1{}} {\_def\mnote#1{}} {\_def\mnote#1{}}
```

2.35 Styles

OpTEX provides three styles: \report, \letter and \slides. Their behavior is documented in user part of the manual in the section 1.7.2 and \slides style (for presentations) is documented in op-slides.pdf which is an example of the presentation.

2.35.1 \report and \letter styles

styles.opm

```
\_codedecl \report {Basic styles of OpTeX <2020-03-28>} % preloaded in format
```

We define auxiliary macro first (used by the \address macro)
The {\boxlines ⟨*line-1*⟩⟨*eol*⟩⟨*line-2*⟩⟨*eol*⟩...⟨*line-n*⟩⟨*eol*⟩} returns to the outer vertical mode a box with ⟨*line-1*⟩, next box with ⟨*line-2*⟩ etc. Each box has its natural width. This is reason why we cannot use paragraph mode where each resulting box has the width \hsize. The ⟨*eol*⟩ is set active and \everypar starts \hbox{ and acive ⟨*eol*⟩ closes this \hbox by }.

styles.opm

```
\_def\_boxlines{%
   \_def\_boxlinesE{\_ifhmode\_egroup\_empty\_fi}%
   \_def\_nl{\_boxlinesE}%
   \_bgroup \_lccode`\~=`\^^M\_lowercase{\_egroup\_let~}\_boxlinesE
   \_everypar{\_setbox0=\_lastbox\_endgraf
      \_hbox\_bgroup \_catcode`\^^M=13 \_let\par=\_nl \_aftergroup\_boxlinesC}%
}
\_def\_boxlinesC{\_futurelet\_next\_boxlinesD}
\_def\_boxlinesD{\_ifx\_next\_empty\_else\_ea\_egroup\_fi}

\_public \boxlines ;
```

The \report and \letter style initialization macros are defined here.
The \letter defines \address and \subject macros.

styles.opm

```
\_def\_report{
   \_typosize[11/13.2]
   \_vsize=\_dimexpr \_topskip + 52\_baselineskip \_relax % added 2020-03-28
   \_let\_titfont=\_chapfont
   \_titskip=3ex
   \_eoldef\_author##1{\_removelastskip\_bigskip
      {\_leftskip=0pt plus1fill \_rightskip=\_leftskip \_it \_noindent ##1\_par}\_nobreak\_bigskip
   }
   \_public \author ;
   \_parindent=1.2em \_iindent=\_parindent \_ttindent=\_parindent
   \_footline={\_global\_footline={\_hss\_rmfixed\_folio\_hss}}
}
\_def\_letter{
   \_def\_address{\_vtop\_bgroup\_boxlines \_parskip=0pt \_let\par=\_egroup}
   \_def\_subject{{\_bf \_mtext{subj}: }}
   \_public \address \subject ;
   \_typosize[11/14]
   \_vsize=\_dimexpr \_topskip + 49\_baselineskip \_relax % added 2020-03-28
   \_parindent=0pt
   \_parskip=\_medskipamount
   \_nopagenumbers
}
\_public \letter \report ;
```

The \slides macro reads macro file slides.opm, see the section 2.35.2.

styles.opm

```
\_def\_slides{\_par
  \_opinput{slides.opm}
  \_adef*{\_startitem}
}
\_public \slides ;
```

2.35.2 \slides style for presentations

slides.opm

```
\_codedecl \slideshow {Slides style for OpTeX <2020-03-19>} % loaded on demand by \slides
```

Default margins and design is declared here. The _ttfont is scaled by mag1.15 in order to balance the ex height of Helvetica (Heros) and LM fonts Typewriter. The \begtt...\endtt verbatim is printed by smaller text.

slides.opm

```
\_margins/1 a5l (14,14,10,3)mm  % landscape A5 format
\_def\_wideformat{\_margins/1 (263,148) (16,16,10,3)mm } % 16:9 format

\_ifx\_fontnamegen\_undefined \_fontfam[Heros]
   \_let\_ttfont=\_undefined \_famvardef\_ttfont{\_setfontsize{mag1.15}\_tt}
\_fi
\_typosize[16/19]
\_def\_urlfont{}
\_everytt={\_typosize[13/16] \_advance\_hsize by10mm}
\_fontdef\_fixbf{\_bf}

\_nopagenumbers
\_parindent=0pt
```

```
\_ttindent=5mm
\_parskip=5pt plus 4pt minus2pt
\_rightskip=0pt plus 1fil
\_ttindent=10pt
\_def\_ttskip{\_smallskip}

\_onlyrgb   % RGB color space is better for presentations
```

The bottom margin is set to 3 mm. If we use 1 mm, then baseline of `\footline` is 2 mm from the bottom page. This is depth of the `\Grey` rectangle used for page numbers. It is r-lapped to `\hoffset` width because left margin = `\hoffset` = right margin. It is 14 mm for narrow pages or 16 mm for wide pages.

slides.opm

```
\_footlinedist=1mm
\_footline={\_hss \_rlap{%
   \_rlap{\Grey\_kern.2\_hoffset\_vrule height6mm depth2mm width.8\_hoffset}%
                       \_hbox to\_hoffset{\White\_hss\_folio\_kern3mm}}}
```

The `\subtit` is defined analogically like `\tit`.

slides.opm

```
\_eoldef\_subtit#1{\_vskip20pt {\_leftskip=0pt plus1fill \_rightskip=\_leftskip
   \_subtitfont #1\_nbpar}}
```

The `\pshow`⟨*num*⟩ prints the text in invisible (transparent) font when `\layernum`<⟨*num*⟩. The trasparency is set by by `\pdfpageresoyrces` primitive.

slides.opm

```
\pdfpageresources{/ExtGState << /Invisible << /Type /ExtGState /ca 0 /CA 0 >>
                                /Visible   << /Type /ExtGState /ca 1 /CA 1 >> >>}
\addto\_morepgresources{/Invisible << /Type /ExtGState /ca 0 /CA 0 >>
                         /Visible   << /Type /ExtGState /ca 1 /CA 1 >>}
\def\Invisible {\_pdfliteral{/Invisible gs}}
\def\Visible   {\_pdfliteral{/Visible gs}}
\def\Transparent {\Invisible \_aftergroup \Visible}

\_def\_use#1#2{\_ifnum\_layernum#1\_relax#2\_fi}
\_def\_pshow#1{\_use{=#1}\Red \_use{<#1}\Transparent \_ignorespaces}
```

The main level list of items is activated here. The `\_item:X` and `\_item:x` are used and are re-defined here. If we are in nested level of items and `\pg+` is used then `\egroups` macro expands to the right number of `\egroups` in order to close page correctly. The level of nested item lists is saved to the `\_ilevel` register and used when we start again the next text after `\pg+`.

slides.opm

```
\_newcount\_gilevel
\_def\*{*}
\_adef*{\_startitem}
\_sdef{_item:X}{\Blue\_raise.2ex\_fullrectangle{.8ex}\_kern.5em}
\_sdef{_item:x}{\Blue\_raise.3ex\_fullrectangle{.6ex}\_kern.4em}
\_style X
\_def\_egroups{\_par\_global\_gilevel=\_ilevel \_egroup}
\_everylist={\_novspaces \_ifcase\_ilevel \_or \_style x \_else \_style - \_fi
   \_addto\_egroups{\_egroup}}
```

The default values of `\pg`, i. e. `\pg;`, `\pg+` and `\pg.` are very simple. They are used when `\showslides` is not specified.

slides.opm

```
\_def\_pg#1{\_cs{_spg:#1}}
\_sdef{_spg:;}{\_vfil\_break \_lfnotenumreset}
\_sdef{_spg:.}{\_endslides}
\_sdef{_spg:+}{\_par}
```

The `\_endslides` is defined as `\_end` primitive, but slide-designer can redefine it. For example, OpTeX trick 0029 shows how to define a clickable navigation to the pages and how to check the data integrity at the end of document using `\_endslides`.

The `\bye` macro is re-defined here as an alternative to `\pg.`.

slides.opm

```
\_def\_endslides{\_end}
\_def\bye{\_pg.}
```

We need no numbers and no table of contents when using slides. The `\_printsec` macro is redefined in order the title is centered and typeset in `\Blue`.

slides.opm

```
\_def\_titfont{\_typosize[42/60]\_bf \Blue}
\_def\_subtitfont{\_typosize[20/30]\_bf}
\_def\_secfont{\_typosize[25/30]\_bf \Blue}

\_nonum \_notoc \_let\_resetnonumnotoc=\_relax
\_def\_printsec#1{\_par
   \_abovetitle{\_penalty-400}\_bigskip
   {\_secfont \_noindent \_leftskip=0pt plus1fill \_rightskip=\_leftskip
     \_printrefnum[@\_quad]#1\_nbpar}\_insertmark{#1}%
   \_nobreak \_belowtitle{\_medskip}%
}
```

When \slideshow is active then each page is opened by \setbox_slidepage=\vbox\bgroup (roughly speaking) and closed by \egroup. The material is \unvboxed and saved for the usage in the next usage if \pg+ is in process. The _slidelayer is incremented instead \pageno if \pg+. This counter is equal to \count1, so it is printed to the terminal and log file next to \pageno.

The code is somewhat more complicated when \layers is used. Then ⟨*layered-text*⟩ is saved to the _layertext macro, the material before it is in _slidepage box and the material after it is in _slidepageB box. The pages are completed in the \loop which increments the \layernum register.

slides.opm

```
\_newbox\_slidepage  \_newbox\_slidepageB
\_countdef\_slidelayer=1
\_def\_decr#1{\_global\_advance#1 by-1 }

\_def\_slideshow{\_slidelayer=1 \_slideshowactive \_setbox\_slidepage=\_vbox\_bgroup}

\_def\_slideshowactive{%
   \_sdef{_spg:;}{\_closepage \_global\_slidelayer=1 \_resetpage \_openslide}
   \_sdef{_spg:.}{\_closepage \_endslides}
   \_sdef{_spg:+}{\_closepage \_incr\_slidelayer \_decr\_pageno \_openslide}
   \_let\_layers=\_layersactive
   \_destboxslide % to prevent hyperlink-dests duplication
}
\_def\_destboxslide{\_def\_destbox[##1:##2]{\_isequal{##1}{ref}\_iffalse \_destboxori[##1:##2]\_fi}}

\_def\_openslide{\_setbox\_slidepage=\_vbox\_bgroup \_setilevel
   \_ifvoid\_slidepage \_else \_unvbox\_slidepage \_nointerlineskip\_lastbox \_fi}
\_def\_setilevel{\_loop \_decr\_gilevel \_ifnum\_gilevel<0 \_else \_begitems \_repeat}

\_def\_closepage{\_egroups
   \_ifnum \_maxlayers=0 \_unvcopy\_slidepage \_vfil\_break
   \_else \_begingroup \_setwarnslides \_layernum=0
      \_loop
         \_ifnum\_layernum<\_maxlayers \_advance\_layernum by1
            \_printlayers \_vfil\_break
            \_ifnum\_layernum<\_maxlayers \_incr\_slidelayer \_decr\_pageno \_fi
      \_repeat
      \_global\_maxlayers=0
      \_incr\_layernum \_global\_setbox\_slidepage=\_vbox{\_printlayers}%
      \_endgroup
   \_fi}
\_def\_resetpage{%
   \_global\_setbox\_slidepage=\_box\_voidbox \_global\_setbox\_slidepageB=\_box\_voidbox
   \_lfnotenumreset
}
\_def\_setwarnslides{%
   \_def\pg##1{\_opwarning{\_string\pg##1 \_layersenv}\_def\pg####1{}}%
   \_def\layers##1 {\_opwarning{\_string\layers\_space \_layersenv}\_def\layers####1{}}%
}
\_def\_layersenv{cannot be inside \_string\layers...\_string\endlayers, ignored}

\_def\_printlayers{\_unvcopy\_slidepage \_nointerlineskip\_lastbox
   \_layertext \_endgraf
   \_ifdim\_prevdepth>-1000pt \_kern-\_prevdepth \_kern\_dp\_strutbox \_fi
   \_vskip\_parskip
   \_unvcopy\_slidepageB
}
\_let\_destboxori=\_destbox
```

```
\_newcount\_layernum \_newcount\_maxlayers
\_maxlayers=0

\_long\_def\_layersactive #1 #2\endlayers{%
   \_par\_egroup
   \_gdef\_layertext{#2}%
   \_global\_maxlayers=#1
   \_setbox\_slidepageB=\_vbox\_bgroup
}
\_public \subtit \slideshow \pg \wideformat \use \pshow \layernum ;
```

Default \layers ⟨*num*⟩ macro (when \slideshow is not activated) is simple. It prints the ⟨*layered-text*⟩ with \layernum=⟨*num*⟩+1 because we need the result after last layer is processed.

slides.opm

```
\_def\_layers #1 {\_par\_layernum=\_numexpr#1+1\_relax}
\_let\endlayers=\_relax

\_def\layers{\_layers}
```

We must to redefine \fnotenumpages because the data from .ref file are less usable for implementing such feature: the footnote should be in more layers repeatedly. But we can suppose that each page starts by \pg; macro, so we can reset the footnote counter by this macro.

slides.opm

```
\_def \_fnotenumpages {\_def\_fnotenum{\_the\_lfnotenum}\_pgfnotefalse
   \_def\_lfnotenumreset{\_global\_lfnotenum=0 }}
\_let \_lfnotenumreset=\_relax
\_public \fnotenumpages ;
```

2.36 Logos

logos.opm

```
\_codedecl \TeX {Logos TeX, LuaTeX, etc. <2020-02-28>} % preloaded in format
```

Despite plain TEX each macro for logos ends by \ignoreslash. This macro ignores next slash if it is present. You can `use \TeX/ like this` for protecting the space following the logo. This is visually more comfortable. The macros \TeX, \OpTeX, \LuaTeX, \XeTeX are defined.

logos.opm

```
\_protected\_def \_TeX {T\_kern-.1667em\_lower.5ex\_hbox{E}\_kern-.125emX\_ignoreslash}
\_protected\_def \_OpTeX {Op\_kern-.1em\_TeX}
\_protected\_def \_LuaTeX {Lua\_TeX}
\_protected\_def \_XeTeX {X\_kern-.125em\_phantom E%
   \_pdfsave\_rlap{\_pdfscale{-1}{1}\_lower.5ex\_hbox{E}}\_pdfrestore \_kern-.1667em \_TeX}

\_def\_ignoreslash {\_futurelet\_next \_ignoreslashA}
\_def\_ignoreslashA {\_ifx\_next/\_ea\_ignoreit\_fi}

\_public \TeX \OpTeX \LuaTeX \XeTeX \ignoreslash ;
```

The _slantcorr macro expands to slant-correction of current font. It is used to shifting A if the \LaTeX logo is in italic.

logos.opm

```
\_protected\_def \_LaTeX{\_tmpdim=.42ex L\_kern-.36em \_kern \_slantcorr % slant correction
  \_raise \_tmpdim \_hbox{\_thefontscale[710]A}%
  \_kern-.15em \_kern-\_slantcorr \_TeX}
\_def\_slantcorr{\_ea\_ignorept \_the\_fontdimen1\_font\_tmpdim}

\_public \LaTeX ;
```

\OPmac, \CS and \csplain logos.

logos.opm

```
\_def\_OPmac{\_leavevmode
   \_lower.2ex\_hbox{\_thefontscale[1400]O}\_kern-.86em P{\_em mac}\_ignoreslash}
\_def\_CS{$\_cal C$\_kern-.1667em\_lower.5ex\_hbox{$\_cal S$}\_ignoreslash}
\_def\_csplain{\_CS plain\_ignoreslash}

\_public \OPmac \CS \csplain ;
```

The expandable versions of logos used in Outlines needs the expandable \ingnslash (instead of the \ignoreslash).

logos.opm

```
\_def\_ignslash#1{\_ifx/#1\_else #1\_fi}
\_regmacro {}{}{% conversion for PDF outlines
   \_def\TeX{TeX\_ignslash}\_def\OpTeX{OpTeX\_ignslash}%
   \_def\LuaTeX{LuaTeX\_ignslash}\_def\XeTeX{XeTeX\_ignslash}%
   \_def\LaTeX{LaTeX\_ignslash}\_def\OPmac{OPmac\_ignslash}%
   \_def\CS{CS}\_def\csplain{csplain\_ignslash}%
}
\_public \ignslash ;
```

2.37 Multilingual support

2.37.1 Lowercase, uppercase codes

All codes in unicode table keep information about pairs lowecase-uppercase letters or single letter. We need to read such information and set appropriate \lccode and \uccode. The \catcode above the code 127 is not set, i. e. the \catcode=12 for all codes above 127.

The file uni-lcuc.opm does this work. It is not much interesting file, only first few lines from 15928 lines in total is shown here.

uni-lcuc.opm

```
% Preloaded in format. A copy o uni-lcuc.tex fom csplain is here:

% uni-lcuc.tex -- sets \lccodes and \uccodes for Unicode chars, nothing more
%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%%
% Petr Olsak,  Jul. 2014

\_wterm{Setting lccodes and uccodes for Unicode characters}

\_def\_tmp #1 #2 {\_ifx^#1^\_else
   \_lccode"#1="#1
   \_ifx.#2%
      \_uccode"#1="#1
   \_else
      \_uccode"#2="#2
      \_lccode"#2="#1
      \_uccode"#1="#2
   \_fi
   \_ea \_tmp \_fi
}
\_tmp
00AA .
00B5 039C
00BA .
00E0 00C0
00E1 00C1
00E2 00C2
00E3 00C3
00E4 00C4
```

...etc. (see uni-lcuc.opm)

2.37.2 Hyphenations

hyphen-lan.opm

```
\_codedecl \langlist {Initialization of hypenation patterns <2020-03-10>} % preloaded in format
```

The ⟨*iso-code*⟩ means a shortcut of language name (mostly by ISO 639-1). The following control sequences are used for language switching:

- _lan:⟨*number*⟩ expands to ⟨*iso-code*⟩ of the language. The number is internal number of languages used as a value of \language register.
- _ulan:⟨*long-lang*⟩ expands to ⟨*iso-code*⟩ too. This is transformation from long name of language (lowercase letters) to ⟨*iso-code*⟩.
- _⟨*iso-code*⟩Patt (for example _csPatt) is the language ⟨*number*⟩ declared by \chardef.
- \⟨*iso-code*⟩lang (for example \enlang, \cslang, \sklang, \delang, \pllang) is language selector. It exists in two states

  - Initialization state: when \⟨*iso-code*⟩lang is used first then it must load the patterns into memory using Lua code. If it is done then the \⟨*iso-code*⟩lang re-defines itself to processing state.
  - Processing state: it only sets \language=_⟨*iso-code*⟩Patt, i.e it selects the hyphenation patterns. It does a little more language-dependent work, as mentioned below.
- _langspecific:⟨*isocode*⟩ is processed by \⟨*iso-code*⟩lang and it should include language-specific macros declared by user or macro designer.

The USenglish patters are preloaded first:

hyphen-lan.opm

```
\_chardef\_enPatt=0
\_def\_pattlist{\_enPatt=0}
\_def\_langlist{en(USenglish)}
\_sdef{_lan:0}{en}
\_sdef{_ulan:usenglish}{en}
\_def\_enlang{\_uselang{en}\_enPatt23} % \lefthyph=2 \righthyph=3
\_def\enlang{\_enlang}
\_sdef{_langspecific:en}{\_nonfrenchspacing}

\_lefthyphenmin=2 \_righthyphenmin=3 % disallow x- or -xx breaks
\_input hyphen  % en(USenglish) patterns from TeX82
```

_preplang ⟨*iso-code*⟩ ⟨*long-lang*⟩ ⟨*hyph-file-spec*⟩ ⟨*number*⟩ ⟨*pre-hyph*⟩⟨*post-hyph*⟩ prepares the \⟨*iso-code*⟩lang to its initialization state. Roughly speaking, it does:

```
\chardef\_⟨iso-code⟩Patt = ⟨number⟩
\def\_lan:⟨number⟩ {⟨iso-code⟩}
\def\_ulan:⟨long-lang⟩ {⟨iso-code⟩}
\def\_⟨iso-code⟩lang {%
   \_loadpattrs ⟨hyph-file-spec⟩ ⟨number⟩ ⟨long-lang⟩ % loads patterns using Lua code
   \gdef\_⟨iso-code⟩lang {\_uselang{⟨iso-code⟩}\_⟨iso-code⟩Patt ⟨pre-hyph⟩⟨post-hyph⟩}
   \_⟨iso-code⟩lang                  % runs itself in processing state
}
\def\⟨iso-code⟩lang {\_⟨iso-code⟩lang} % public version \⟨iso-code⟩lang
```

You can see that \⟨*iso-code*⟩lang runs _loadpattrs and _uselang first (in initialization state) and it runs only _uselang when it is called again (in processing state).

hyphen-lan.opm

```
\_def\_preplang #1 #2 #3 #4 #5 {%
   \_ea\_chardef \_csname _#1Patt\_endcsname=#4
   \_sdef{_lan:#4}{#1}\_lowercase{\_sdef{_ulan:#2}}{#1}%
   \_def\_next{\_ea\_noexpand\_csname _#1lang\_endcsname}%
   \_ea\_edef \_csname _#1lang\_endcsname {%
      \_noexpand\_loadpattrs #3 #4 #2 % loads patterns
      \_gdef\_next{\_noexpand\_uselang{#1}\_csname _#1Patt\_endcsname #5}% re-defines itself
      \_next                                %  runs itself in processing state
   }
   \_addto\_langlist{ #1(#2)}%
   \_sdef{#1lang\_ea}\_ea{\_csname _#1lang\_endcsname}% unprefixed \<isocode>lang
}
```

_loadpattrs ⟨*hyph-file-spec*⟩ ⟨*number*⟩ ⟨*long-lang*⟩ loads hyphenation patterns and hyphenation exceptions for given language and registers them as \language=⟨*number*⟩.

The ⟨*hyph-file-spec*⟩ is a part of full file name wich is read: hyph-⟨*hyph-file-spec*⟩.tex. The patterns and hyphenation exceptions are saved here in UTF-8 encoding. The ⟨*hyph-file-spec*⟩ should be a list of individual ⟨*hyph-file-spec*⟩'s separated by comma, see the language Serbian below for example.

hyphen-lan.opm

```
\_def\_loadpattrs#1 #2 #3 {%
   \_wlog{Loading hyphenation #3: (#1) \_string\language=#2}%
   \_begingroup\_setbox0=\_vbox{% we don't want spaces in horizontal mode
      \_language=#2\_def\\{#3}%
      \_let\patterns=\_patterns \_let\hyphenation=\_hyphenation \_def\message##1{}%
      \_loadpattrsA #1,,%
   }\_endgroup
}
\_def\_loadpattrsA #1,{\_ifx,#1,\_else
```

```
    \_isfile {hyph-#1}\_iftrue \_opinput{hyph-#1}%
    \_else \_opwarning{No hyph. patterns #1 for \\, missing package?}%
           \_def\_opwarning##1{}\_fi
    \_ea \_loadpattrsA \_fi
}
```

`\_uselang{`⟨*iso-code*⟩`}\_`⟨*iso-code*⟩`Patt` ⟨*pre-hyph*⟩⟨*post-hyph*⟩
sets `\language`, `\lefthyphenmin`, `\righthyphenmin` and runs `\frenchspacing`. This default language-dependent settings should be re-declared by `\_langspecific:`⟨*iso-code*⟩ which is run finally (it is `\relax` by default, only `\_langspecific:en` runs `\nonfrenchspacing`).

hyphen-lan.opm

```
\_def\_uselang#1#2#3#4{\_language=#2\_lefthyphenmin=#3\_righthyphenmin=#4\_relax
    \_frenchspacing  % \nonfrenchspacing can be set in \cs{_langspecific:lan}
    \_cs{_langspecific:#1}%
}
```

The `\uselanguage {`⟨*long-lang*⟩`}` is defined here (for compatibility with e-plain users).

hyphen-lan.opm

```
\_def\_uselanguage#1{\_lowercase{\_cs{_\_cs{_ulan:#1}lang}}}
\_public \uselanguage ;
```

The numbers for languages are declared as fixed constants (no auto-generated). This concept is inspired from CSplain. There are typical numbers of languages in CSplain: 5=Czech in IL2, 15=Czech in T1 and 115=Czech in Unicode. We keep these constants but we load only Unicode patterns (greater than 100), of course.

hyphen-lan.opm

```
\_preplang enus  USenglishmax    en-us             100 23
\_preplang engb  UKenglish       en-gb             101 23
\_preplang it    Italian         it                102 22
\_preplang ia    Interlingua     ia                103 22
\_preplang id    Indonesian      id                104 22

\_preplang cs    Czech           cs                115 23
\_preplang sk    Slovak          sk                116 23
\_preplang de    nGerman         de-1996           121 22
\_preplang fr    French          fr                122 22
\_preplang pl    Polish          pl                123 22
\_preplang cy    Welsh           cy                124 23
\_preplang da    Danish          da                125 22
\_preplang es    Spanish         es                126 22
\_preplang sl    Slovenian       sl                128 22
\_preplang fi    Finnish         fi                129 22
\_preplang hu    Hungarian       hu                130 22
\_preplang tr    Turkish         tr                131 22
\_preplang et    Estonian        et                132 23
\_preplang eu    Basque          eu                133 22
\_preplang ga    Irish           ga                134 23
\_preplang nb    Bokmal          nb                135 22
\_preplang nn    Nynorsk         nn                136 22
\_preplang nl    Dutch           nl                137 22
\_preplang pt    Portuguese      pt                138 23
\_preplang ro    Romanian        ro                139 22
\_preplang hr    Croatian        hr                140 22
\_preplang zh    Pinyin          zh-latn-pinyin    141 11
\_preplang is    Icelandic       is                142 22
\_preplang hsb   Uppersorbian    hsb               143 22
\_preplang af    Afrikaans       af                144 12
\_preplang gl    Galician        gl                145 22
\_preplang kmr   Kurmanji        kmr               146 22
\_preplang tk    Turkmen         tk                147 22
\_preplang la    Latin           la                148 22
\_preplang lac   classicLatin    la-x-classic      149 22
\_preplang lal   liturgicalLatin la-x-liturgic     150 22
\_preplang elm   monoGreek       el-monoton        201 11
\_preplang elp   Greek           el-polyton        202 11
\_preplang grc   ancientGreek    grc               203 11
\_preplang ca    Catalan         ca                204 22
\_preplang cop   Coptic          cop               205 11
```

```
\_preplang mn    Mongolian       mn-cyrl           206 22
\_preplang sa    Sanskrit        sa                207 13
\_preplang ru    Russian         ru                208 22
\_preplang uk    Ukrainian       uk                209 22
\_preplang hy    Armenian        hy                210 12
\_preplang as    Assamese        as                211 11
\_preplang hi    Hindi           hi                212 11
\_preplang kn    Kannada         kn                213 11
\_preplang lv    Latvian         lv                215 22
\_preplang lt    Lithuanian      lt                216 22
\_preplang ml    Malayalam       ml                217 11
\_preplang mr    Marathi         mr                218 11
\_preplang or    Oriya           or                219 11
\_preplang pa    Panjabi         pa                220 11
\_preplang ta    Tamil           ta                221 11
\_preplang te    Telugu          te                222 11

\_preplang be    Belarusian      be                223 22
\_preplang bg    Bulgarian       bg                224 22
\_preplang bn    Bengali         bn                225 11
\_preplang cu    churchslavonic  cu                226 12
\_preplang deo   oldGerman       de-1901           227 22
\_preplang gsw   swissGerman     de-ch-1901        228 22
\_preplang eo    Esperanto       eo                229 22
\_preplang fur   Friulan         fur               230 22
\_preplang gu    Gujarati        gu                231 11
\_preplang ka    Georgian        ka                232 12
\_preplang mk    Macedonian      mk                233 22
\_preplang oc    Occitan         oc                234 22
\_preplang pi    Pali            pi                235 12
\_preplang pms   Piedmontese     pms               236 22
\_preplang rm    Romansh         rm                237 22
\_preplang sr    Serbian         sh-cyrl,sh-latn   238 22
\_preplang sv    Swedish         sv                239 22
\_preplang th    Thai            th                240 23
\_preplang ethi  Ethiopic        mul-ethi          241 11
```

The \langlist includes names of all languages which are ready to load and use their hyphenation patterns. This list is printed to terminal and to log at iniTEX state here. It can be used when processing document too.

hyphen-lan.opm

```
\_message{Language hyph.patterns ready to load: \_langlist.
   Use \_string\<shortname>lang to initialize language,
   \_string\cslang\_space for example}

\_public \langlist ;
```

Maybe, you need to do more language specific actions than just switching hyphenation patterns. For example you need to load a specific font with a specific script used in selected language, you can define a macros for quotation marks depending on the language etc.

The example shows how to declare such language specific things.

```
\def\langset #1 #2{\sdef{_langspecific:#1}{#2}}

\langset fr {... declare French quotation marks}
\langset de {... declare German quotation marks}
\langset gr {... switch to Greek fonts family}
... etc.
```

Note that you need not to set language specific phrases (like \today) by this code. Another concept is used for such tasks. See the section 2.37.3 for more details.

2.37.3 Multilingual phrases and quotation marks

languages.opm

```
\_codedecl \_mtext {Languages <2020-12-05>} % preloaded in format
```

Only four words are generated by OpTEX macros: “Chapter”, “Table”, “Figure” and “Subject”. These phrases can be generated depending on the current value of \language register, if you use

`\_mtext{`⟨*phrase-id*⟩`}`, specially `\_mtext{chap}`, `\_mtext{t}`, `\_mtext{f}` or `\_mtext{subj}`. If your macros generate more words then you can define such words by `\sdef{_mt:`⟨*phrase-id*⟩`:`⟨*lang*⟩`}` where ⟨*phrase-id*⟩ is a label for declared word and ⟨*lang*⟩ is language shortcut (iso code).

languages.opm

```
\_def\_mtext#1{\_trycs{_mt:#1:\_trycs{_lan:\_the\_language}{en}}
   {\_csname _mt:#1:en\_endcsname}}

\_sdef{_mt:chap:en}{Chapter} \_sdef{_mt:chap:cs}{Kapitola} \_sdef{_mt:chap:sk}{Kapitola}
\_sdef{_mt:t:en}{Table}      \_sdef{_mt:t:cs}{Tabulka}     \_sdef{_mt:t:sk}{Tabuľka}
\_sdef{_mt:f:en}{Figure}     \_sdef{_mt:f:cs}{Obrázek}     \_sdef{_mt:f:sk}{Obrázok}
\_sdef{_mt:subj:en}{Subject} \_sdef{_mt:subj:cs}{Věc}      \_sdef{_mt:subj:sk}{Vec}
```

Using `\_langw` ⟨*lang*⟩ ⟨*chapter*⟩ ⟨*table*⟩ ⟨*figure*⟩ ⟨*subject*⟩ you can declare these words more effectively:

languages.opm

```
\_def \_langw #1 #2 #3 #4 #5 {%
   \_sdef{_mt:chap:#1}{#2}\_sdef{_mt:t:#1}{#3}\_sdef{_mt:f:#1}{#4}%
   \_sdef{_mt:subj:#1}{#5}%
}

\_langw en  Chapter      Table       Figure       Subject
%-------------------------------------------------------------
\_langw cs  Kapitola     Tabulka     Obrázek      Věc
\_langw de  Kapitel      Tabelle     Abbildung    Betreff
\_langw es  Capítulo     Tabla       Figura       Sujeto
\_langw fr  Chaptire     Tableau     Figure       Matière
\_langw it  Capitolo     Tabella     Fig.         Oggetto
\_langw pl  Rozdział     Tabela      Ilustracja   Temat
```

...etc. (see languages.opm)

You can add more words as you wish. For example `\today` macro:

languages.opm

```
\_def \_monthw #1 #2 #3 #4 #5 #6 #7 {%
   \_sdef{_mt:m1:#1}{#2}\_sdef{_mt:m2:#1}{#3}\_sdef{_mt:m3:#1}{#4}%
   \_sdef{_mt:m4:#1}{#5}\_sdef{_mt:m5:#1}{#5}\_sdef{_mt:m6:#1}{#5}%
   \_monthwB #1
}
\_def \_monthwB #1 #2 #3 #4 #5 #6 #7 {%
   \_sdef{_mt:m7:#1}{#2}\_sdef{_mt:m8:#1}{#3}\_sdef{_mt:m9:#1}{#4}%
   \_sdef{_mt:m10:#1}{#5}\_sdef{_mt:m11:#1}{#5}\_sdef{_mt:m12:#1}{#5}%
}

\_monthw en  January February March April May June
             July August September October November December
\_monthw cs  ledna února března dubna května června
             července srpna září října listopadu prosince
\_monthw sk  januára februára marca apríla mája júna
             júla augusta septembra októbra novembra decembra
\_monthw it  gennaio febbraio marzo aprile maggio giugno
             luglio agosto settembre ottobre novembre dicembre


\_sdef{_mt:today:en}{\_mtext{m\_the\_month} \_the\_day, \_the\_year}
\_sdef{_mt:today:cs}{\_the\_day.~\_mtext{m\_the\_month} \_the\_year}
\_slet{_mt:today:sk}{_mt:today:cs}

\_def\_today{\_mtext{today}}
\_public \today ;
```

Quotes should be tagged by `\"`⟨*text*⟩`"` and `\'`⟨*text*⟩`'` if `\`⟨*iso-code*⟩`quotes` is declared at beginning of the document (for example `\enquotes`). If not, then the control sequences `\"` and `\'` are undefined. Remember, that they are used in another meaning when `\oldaccents` command is used. The macros `\"` and `\'` are not defined as `\protected` because we need their expansion when `\outlines` are created. User can declare quotes by `\quoteschars`⟨*clqq*⟩⟨*crqq*⟩⟨*clq*⟩⟨*crq*⟩, where ⟨*clqq*⟩...⟨*crqq*⟩ are normal quotes and ⟨*clq*⟩...⟨*crq*⟩ are alternative quotes. or use `\altquotes` to swap between meaning of these two types of quotes.

`\enquotes`, `\csquotes`, `\dequotes`, `\frquotes` etc. are defined here.

languages.opm

```
\_def \_enquotes {\_quoteschars ""‘’}
```

```
\_def \_csquotes {\_quoteschars „",‘}
\_def \_frquotes {\_quoteschars ""«»}
\_let \_plquotes = \_frquotes
\_let \_esquotes = \_frquotes
\_let \_grquotes = \_frquotes
\_let \_ruquotes = \_frquotes
\_let \_itquotes = \_frquotes
\_let \_skquotes = \_csquotes
\_let \_dequotes = \_csquotes
```

The \quoteschars⟨*lqq*⟩⟨*rqq*⟩⟨*lq*⟩⟨*rq*⟩ defines \" and \' as _qqA in in normal mode and as expadable macros in outline mode. We want to well process the common cases: \"`&`" or \"`{`". This is reason why the quotes parameter is read in verbatim mode and retokenized again by \scantextokens. We want to allow to quote the quoutes mark itself by \"{`"`}". This is reason why the sub-verbatim mode is used when first character is { in the parameter.
The \" is defined as _qqA_qqB⟨*lqq*⟩⟨*rqq*⟩ and \' as _qqA_qqC⟨*lq*⟩⟨*rq*⟩. The _qqA_qqB⟨*clqq*⟩⟨*crqq*⟩ runs _qqB⟨*lqq*⟩⟨*rqq*⟩⟨*text*⟩".

languages.opm

```
\_def \_quoteschars #1#2#3#4{\_def\_altquotes{\_quoteschars#3#4#1#2}\_public\altquotes;%
   \_protected\_def \"{\_qqA\_qqB#1#2}\_protected\_def \'{\_qqA\_qqC#3#4}%
   \_regmacro{}{}{\_def \"##1"{#1##1#2}\_def \'##1'{#3##1#4}}}

\_def\_qqA#1#2#3{\_bgroup\_setverb \_catcode`\ =10
   \_isnextchar\_bgroup{\_catcode`\{=1 \_catcode`\}=2 #1#2#3}{#1#2#3}}
\_long\_def\_qqB#1#2#3"{\_egroup#1\_scantextokens{#3}#2}
\_long\_def\_qqC#1#2#3'{\_egroup#1\_scantextokens{#3}#2}
```

Sometimes should be usable to leave the markup "such" or 'such' i.e. without the first backslash. Then you can make the characters " and ' active by the \activequotes macro and leave quotes without first backslash. First, declare \⟨*iso-code*⟩quotes, then \altquotes (if needed) and finally \activequotes.

_resetaquotes redefines expandable version of \"⟨*text*⟩" and \'⟨*text*⟩' used in outlines in order to the delimiter is *active* character. We are testing if \quoteschars were used now because the error in outlines can be more confusing.

languages.opm

```
\_def\_activequotes{\_adef"{\"}\_adef'{\'}\_resetaquotes}

\_bgroup \_catcode`,=13 \_lccode`\~=`\" \_lccode`\,=`\' \_lowercase{\_egroup
   \_def\_resetaquotes{%
      \_bgroup \_the\_regoul \_edef\_tmp{\"?"}\_egroup % test if \quoteschar were used
      \_regmacro{}{}{\_edef\"##1~{\"##1"}\_edef\'##1,{\'##1'}}}
}

\_public \quoteschars \activequotes \enquotes \csquotes \skquotes \frquotes \plquotes
   \esquotes \grquotes \ruquotes \itquotes \dequotes ;
```

Bibliography references generated by \usebib uses more language-dependent phrases. They are declared here. We don't want to save all these phrases into format, so the trick with _endinput is used here. When \usebib is processed then following part of the file languages.opm is read again.

Only phrases of few languages are declared here now. If you want to declare phrases of your language, please create an "issue" or a "request" at https://github.com/olsak/OpTeX or send me email with new phrarses for your language (or language you know:). I am ready to put them here. Temporarily, you can put your definitions into \bibtexhook token list.

languages.opm

```
\_endinput  % don't save these \def's to the format

\_def\_langb#1 #2#3#4#5#6#7#8#9{\_def\_mbib##1##2{\_sdef{_mt:bib.##2:#1}{##1}}%
   \_mbib{#2}{and}\_mbib{#3}{etal}\_mbib{#4}{edition}\_mbib{#5}{citedate}\_mbib{#6}{volume}%
   \_mbib{#7}{number}\_mbib{#8}{prepages}\_mbib{#9}{postpages}\_langbA}
\_def\_langbA#1#2#3#4#5#6#7{\_mbib{#1}{editor}\_mbib{#2}{editors}\_mbib{#3}{available}%
   \_mbib{#4}{availablealso}\_mbib{#5}{bachthesis}\_mbib{#6}{masthesis}\_mbib{#7}{phdthesis}}

\_langb en {, and }  { et al.} { ed.} {cit.~} {Vol.~} {No.~} {pp.~} {~p.} {,~ed.} {,~eds.}
          {Available from } {Available also from }
          {Bachelor's Thesis} {Master's Thesis} {Ph.D. Thesis}
%-------------------------------------------------------------------------------------
\_langb cs { a } { a~kol.} { vyd.} {vid.~} {ročník~} {č.~} {s.~} {~s.} {,~editor} {,~editoři}
```

```
            {Dostupné na } {Dostupné též na }
            {Bakalářská práce} {Diplomová práce} {Disertační práce}
\_langb sk { a } { a~kol.} { vyd.} {vid.~} {ročník~} {č.~} {s.~} {~s.} {,~editor} {,~editoři}
            {Dostupné na } {Dostupné tiež na }
            {Bakalárska práca} {Diplomová práca} {Dizertačná práca}

% \_<lang>dateformat year/month/day\relax, for example: \_csdateformat 2020/05/21\relax
% This is used in iso690 bib style when the the field "citedate" is used.

\_def\_endateformat #1/#2/#3\relax{#1-#2-#3}
% \_csdateformat 2020/05/21\relax -> \hbox{21. 5. 2020}
\_def\_csdateformat #1/#2/#3\relax{\hbox{\_tmpnum=#3 \_the\_tmpnum. \_tmpnum=#2 \_the\_tmpnum. #1}}
\_let\_skdateformat =\_csdateformat
```

2.38 Other macros

Miscellaneous macros are here.

others.opm

```
\_codedecl \uv {Miscenaleous <2020-05-22>} % preloaded in format
```

\useOpTeX and \useoptex are declared as \relax.

others.opm

```
\_let \useOpTeX = \_relax   \_let \useoptex = \_relax
```

The \lastpage and \totalpages get the information from the _currpage. The _Xpage from .ref file sets the _currpage.

others.opm

```
\_def\_totalpages {\_openref\_ea\_lastpageA\_currpage}
\_def\_lastpage   {\_openref\_ea\_lastpageB\_currpage}
\_def\_lastpageA #1#2{#1}
\_def\_lastpageB #1#2{#2}
\_def\_currpage {{0}{?}}
\_public \lastpage \totalpages ;
```

We need \uv, \clqq, \crqq, \flqq, \frqq, \uslang, \ehyph \chyph, \shyph, for backward compatibility with $\mathcal{CS}$plain. Codes are set according to Unicode, because we are using Czech only in Unicode when LuaTEX is used.

others.opm

```

% for compatibility with csplain:

\_chardef\clqq=8222  \_chardef\crqq=8220
\_chardef\flqq=171   \_chardef\frqq=187
\_chardef\promile=8240

\_def\uv#1{\clqq#1\crqq}

\_let\uslang=\enlang  \_let\ehyph=\enlang
\_let\chyph=\cslang   \_let\shyph=\sklang
\_let\csUnicode=\csPatt \_let\czUnicode=\csPatt \_let\skUnicode=\skPatt
```

The \letfont was used in $\mathcal{CS}$plain instead of \fontlet.

others.opm

```
\_let \letfont = \_fontlet
```

Non breaking space in Unicode.

others.opm

```
\let ^^a0=~
```

TikZ needs these funny control sequences.

others.opm

```
\_ea\_toksdef \_csname toks@\_endcsname=0
\_ea\_let     \_csname voidb@x\_endcsname=\_voidbox
```

We don't want to read opmac.tex unless \input opmac is specified.

others.opm

```
\_def\OPmacversion{OpTeX}
```

We allow empty lines in math formulae. It is more comfortable.

others.opm

```
\_suppressmathparerror = 1
```

Lorem ipsum can be printed by `\lipsum[`⟨*range*⟩`]` or `\lorem[`⟨*range*⟩`]`, for example `\lipsum[3]` or `\lipsum[112-121]`, max=150.

First usage of `\lipsum` reads the LaTeX file `lipsum.ltd.tex` and prints the selected paragraph(s). Next usages of `\lipsum` prints the selected paragraph(s) from memory. This second and more usages of `\lipsum` are fully expandable. If you want to have all printings of `\lipsum` expandable, use dummy `\lipsum[0]` first.

others.opm

```
\_def \_lipsum {%
   {\_long\_def\ProvidesFile##1[##2]##3{\_ifx\_par##3\_relax\_else \_ea##3\_fi}\_tmpnum=0
    \_def\NewLipsumPar{\_advance\_tmpnum by1
       \_afterassignment\_negativermnm \_sxdef{lips:\_the\_tmpnum}}%
    \_opinput {lipsum.ltd.tex}%
    \_global\_let \_lipsum=\_reallipsum
   }\_lipsum
}
\_def\_negativermnm{\_romannumeral-`\.}
\_def\_reallipsum[#1]{\_lipsumA #1\_empty-\_empty\_end}
\_def\_lipsumA #1-#2\_empty#3\_end{%
    \_fornum #1..\_ifx^#2^#1\_else#2\_fi \_do {\_csname lips:##1\_endcsname \par}}

\def\lipsum {\_lipsum}
\def\lorem  {\_lipsum}
```

2.39 Lua code embedded to the format

The file `optex.lua` is loaded into the format in `optex.ini` as byte-code and initialized by `\everyjob`, see section 2.1.

The file implements part of the functionality from `luatexbase` namespace, nowadays defined by LaTeX kernel. `luatexbase` deals with modules, allocators and callback management. Callback management is a nice extension and is actually used in OpTeX. Other functions are defined more or less just to suit luaotfload's use.

optex.lua

```

```

GENERAL

```

```

Error function used by following functions for critical errors.

```
local function err(message)
    error("\nerror: "..message.."\n")
end
```

For a `\chardef`'d, `\countdef`'d, etc., csname return corresponding register number. The responsibility of providing a `\XXdef`'d name is on the caller.

```
function registernumber(name)
    return token.create(name).index
end
```

ALLOCATORS

```
alloc = alloc or {}
```

An attribute allocator in Lua that cooperates with normal OpTeX allocator.

```
local attributes = {}
local attribute_max = registernumber("_maiattribute")
function alloc.new_attribute(name)
    local cnt = tex.count["_attributealloc"] + 1
    if cnt > attribute_max then
        tex.error("No room for a new attribute")
    else
        tex.setcount("global", "_attributealloc", cnt)
        texio.write_nl("log", '"'..name..'"=\\attribute'..tostring(cnt))
        attributes[name] = cnt
```

```
        return cnt
    end
end
```

CALLBACKS

```
callback = callback or {}
```

Save `callback.register` function for internal use.

```
local callback_register = callback.register
function callback.register(name, fn)
    err("direct registering of callbacks is forbidden, use 'callback.add_to_callback'")
end
```

Table with lists of functions for different callbacks.

```
local callback_functions = {}
```

Table that maps callback name to a list of descriptions of its added functions. The order corresponds with `callback_functions`.

```
local callback_description = {}
```

Table used to differentiate user callbacks from standard callbacks. Contains user callbacks as keys.

```
local user_callbacks = {}
```

Table containing default functions for callbacks, which are called if either a user created callback is defined, but doesn't have added functions or for standard callbacks that are "extended" (see `mlist_to_hlist` and its pre/post filters below).

```
local default_functions = {}
```

Table that maps standard (and later user) callback names to their types.

```
local callback_types = {
    -- file discovery
    find_read_file     = "exclusive",
    find_write_file    = "exclusive",
    find_font_file     = "data",
    find_output_file   = "data",
    find_format_file   = "data",
    find_vf_file       = "data",
    find_map_file      = "data",
    find_enc_file      = "data",
    find_pk_file       = "data",
    find_data_file     = "data",
    find_opentype_file = "data",
    find_truetype_file = "data",
    find_type1_file    = "data",
    find_image_file    = "data",

    open_read_file     = "exclusive",
    read_font_file     = "exclusive",
    read_vf_file       = "exclusive",
    read_map_file      = "exclusive",
    read_enc_file      = "exclusive",
    read_pk_file       = "exclusive",
    read_data_file     = "exclusive",
    read_truetype_file = "exclusive",
    read_type1_file    = "exclusive",
    read_opentype_file = "exclusive",

    -- data processing
    process_input_buffer  = "data",
    process_output_buffer = "data",
    process_jobname       = "data",

    -- node list processing
    contribute_filter      = "simple",
    buildpage_filter       = "simple",
```

```
    build_page_insert      = "exclusive",
    pre_linebreak_filter   = "list",
    linebreak_filter       = "exclusive",
    append_to_vlist_filter = "exclusive",
    post_linebreak_filter  = "reverselist",
    hpack_filter           = "list",
    vpack_filter           = "list",
    hpack_quality          = "list",
    vpack_quality          = "list",
    process_rule           = "exclusive",
    pre_output_filter      = "list",
    hyphenate              = "simple",
    ligaturing             = "simple",
    kerning                = "simple",
    insert_local_par       = "simple",
    mlist_to_hlist         = "exclusive",

    -- information reporting
    pre_dump             = "simple",
    start_run            = "simple",
    stop_run             = "simple",
    start_page_number    = "simple",
    stop_page_number     = "simple",
    show_error_hook      = "simple",
    show_error_message   = "simple",
    show_lua_error_hook  = "simple",
    start_file           = "simple",
    stop_file            = "simple",
    call_edit            = "simple",
    finish_synctex       = "simple",
    wrapup_run           = "simple",

    -- pdf related
    finish_pdffile            = "data",
    finish_pdfpage            = "data",
    page_order_index          = "data",
    process_pdf_image_content = "data",

    -- font related
    define_font     = "exclusive",
    glyph_not_found = "exclusive",
    glyph_info      = "exclusive",

    -- undocumented
    glyph_stream_provider = "exclusive",
}
```

Return a list containing descriptions of added callback functions for specific callback.

```
function callback.callback_descriptions(name)
    return callback_description[name] or {}
end

local valid_callback_types = {
    exclusive = true,
    simple = true,
    data = true,
    list = true,
    reverselist = true,
}
```

Create a user callback that can only be called manually using `call_callback`. A default function is only needed by ”exclusive” callbacks.

```
function callback.create_callback(name, cbtype, default)
    if callback_types[name] then
        err("cannot create callback '"..name.."' - it already exists")
    elseif not valid_callback_types[cbtype] then
        err("cannot create callback '"..name.. "' with invalid callback type '"..cbtype.."'")
    elseif ctype == "exclusive" and not default then
```

```
        err("unable to create exclusive callback '"..name.."', default function is required")
    end

    callback_types[name] = cbtype
    default_functions[name] = default or nil
    user_callbacks[name] = true
end
```

Add a function to the list of functions executed when callback is called. For standard luatex callback a proxy function that calls our machinery is registered as the real callback function. This doesn't happen for user callbacks, that are called manually by user using `call_callback` or for standard callbacks that have default functions – like `mlist_to_hlist` (see below).

```
function callback.add_to_callback(name, fn, description)
    if user_callbacks[name] or callback_functions[name] or default_functions[name] then
        -- either:
        --  a) user callback - no need to register anything
        --  b) standard callback that has already been registered
        --  c) standard callback with default function registered separately
        --     (mlist_to_hlist)
    elseif callback_types[name] then
        -- This is a standard luatex callback with first function being added,
        -- register a proxy function as a real callback. Assert, so we know
        -- when things break, like when callbacks get redefined by future
        -- luatex.
        assert(callback_register(name, function(...)
            return callback.call_callback(name, ...)
        end))
    else
        err("cannot add to callback '"..name.."' - no such callback exists")
    end

    -- add function to callback list for this callback
    callback_functions[name] = callback_functions[name] or {}
    table.insert(callback_functions[name], fn)

    -- add description to description list
    callback_description[name] = callback_description[name] or {}
    table.insert(callback_description[name], description)
end
```

Remove a function from the list of functions executed when callback is called. If last function in the list is removed delete the list entirely.

```
function callback.remove_from_callback(name, description)
    local descriptions = callback_description[name]
    local index
    for i, desc in ipairs(descriptions) do
        if desc == description then
            index = i
            break
        end
    end

    table.remove(descriptions, index)
    local fn = table.remove(callback_functions[name], index)

    if #descriptions == 0 then
        -- Delete the list entirely to allow easy checking of "truthiness".
        callback_functions[name] = nil

        if not user_callbacks[name] and not default_functions[name] then
            -- this is a standard callback with no added functions and no
            -- default function (i.e. not mlist_to_hlist), restore standard
            -- behaviour by unregistering.
            callback_register(name, nil)
        end
    end

```

```
    return fn, description
end
```

helper iterator generator for iterating over reverselist callback functions

```
local function reverse_ipairs(t)
    local i, n = #t + 1, 1
    return function()
        i = i - 1
        if i >= n then
            return i, t[i]
        end
    end
end
```

Call all functions added to callback. This function handles standard callbacks as well as user created callbacks. It can happen that this function is called when no functions were added to callback – like for user created callbacks or `mlist_to_hlist` (see below), these are handled either by a default function (like for `mlist_to_hlist` and those user created callbacks that set a default function) or by doing nothing for empty function list.

```
function callback.call_callback(name, ...)
    local cbtype = callback_types[name]
    -- either take added functions or the default function if there is one
    local functions = callback_functions[name] or {default_functions[name]}

    if cbtype == nil then
        err("cannot call callback '"..name.."' - no such callback exists")
    elseif cbtype == "exclusive" then
        -- only one function, atleast default function is guaranteed by
        -- create_callback
        return functions[1](...)
    elseif cbtype == "simple" then
        -- call all functions one after another, no passing of data
        for _, fn in ipairs(functions) do
            fn(...)
        end
        return
    elseif cbtype == "data" then
        -- pass data (first argument) from one function to other, while keeping
        -- other arguments
        local data = (...)
        for _, fn in ipairs(functions) do
            data = fn(data, select(2, ...))
        end
        return data
    end

    -- list and reverselist are like data, but "true" keeps data (head node)
    -- unchanged and "false" ends the chain immediately
    local iter
    if cbtype == "list" then
        iter = ipairs
    elseif cbtype == "reverselist" then
        iter = reverse_ipairs
    end

    local head = (...)
    local new_head
    local changed = false
    for _, fn in iter(functions) do
        new_head = fn(head, select(2, ...))
        if new_head == false then
            return false
        elseif new_head ~= true then
            head = new_head
            changed = true
        end
    end
    return not changed or head
```

```
end
```

Create "virtual" callbacks `pre/post_mlist_to_hlist_filter` by setting `mlist_to_hlist` callback. The default behaviour of `mlist_to_hlist` is kept by using a default function, but it can still be overriden by using `add_to_callback`.

```
default_functions["mlist_to_hlist"] = node.mlist_to_hlist
callback.create_callback("pre_mlist_to_hlist_filter", "list")
callback.create_callback("post_mlist_to_hlist_filter", "reverselist")
callback_register("mlist_to_hlist", function(head, ...)
    -- pre_mlist_to_hlist_filter
    local new_head = callback.call_callback("pre_mlist_to_hlist_filter", head, ...)
    if new_head == false then
        node.flush_list(head)
        return nil
    elseif new_head ~= true then
        head = new_head
    end

    -- mlist_to_hlist means either added functions or standard luatex behavior
    -- of node.mlist_to_hlist (handled by default function)
    head = callback.call_callback("mlist_to_hlist", head, ...)

    -- post_mlist_to_hlist_filter
    new_head = callback.call_callback("post_mlist_to_hlist_filter", head, ...)
    if new_head == false then
        node.flush_list(head)
        return nil
    elseif new_head ~= true then
        head = new_head
    end
    return head
end)
```

Compatibility with LaTeX through luatexbase namespace. Needed for luaotfload.

```
luatexbase = {
    registernumber = registernumber,
    attributes = attributes,
    new_attribute = alloc.new_attribute,
    callback_descriptions = callback.callback_descriptions,
    create_callback = callback.create_callback,
    add_to_callback = callback.add_to_callback,
    remove_from_callback = callback.remove_from_callback,
    call_callback = callback.call_callback,
    callbacktypes = {}
}
```

2.40 Printing documentation

The `\printdoc` ⟨*filename*⟩⟨*space*⟩ and `\printdoctail` ⟨*filename*⟩⟨*space*⟩ commands are defined after the file `doc.opm` is load by `\load [doc]`.

The `\printcoc` starts reading of given ⟨*filename*⟩ from the second line. The file is read in *the listing mode*. The `\prindoctail` starts reading given ⟨*filename*⟩ from the first occurrence of the `\_encode`. The file is read in normal mode (like `\input` ⟨*filename*⟩).

The *listing mode* prints the lines as listing of a code. This mode is finished when first ␣␣`\_doc` occurs or first `\_endcode` occurs. At least two spaces must precede before such `\_doc`. On the other hand, the `\_encode` must be at the left edge of the line without spaces. If this rule is not met then the listing mode continues.

If the first line or the last line of the listing mode is empty then such lines are not printed. The maximal number of printed lines in the listing mode is `\maxlines`. Is is set to almost infinity (100000). You can set it to a more sensible value. Such setting is valid only for the first following listing mode.

When the listing mode is finished by `\_doc` then next lines are read in the normal way, but the material between `\begtt` ... `\endtt` pair is shifted by three letters left. The reason is that the three

spaces of indentation is recommended in the `\_doc ... \_cod` pair and this shifting is a compensation of this indentation.

The `\_cod` macro ignores the rest of current line and starts the listing mode again.

When the listing mode is finished by the `\_endcode` then the `\endinput` is applied, the reading of the file opened by `\printdoc` is finished.

You cannot reach the end of the file (without `\_endcode`) in the listing mode.

The listing mode creates all control sequences which are listed in the index as active link to the main documentation point of such control sequence and prints them in blue. Other text is printed in black.

The main documentation point is denoted by `\`\⟨sequence⟩`` in red, for example `\`\foo``. The user documentation point is the first occurrence of `\^`\⟨sequence⟩``, for example `\^`\foo``. There can be more such markups, all of them are hyperlinks to the main documentation point. And main documentation point is hyperlink to the user documentation point, if such point exists. Finally, the `\~`\⟨sequence⟩`` (for example `\~`\foo``) are hyperlinks to the user documentation point.

doc.opm

```
\_codedecl \printdoc {Macros for documentation printing <2020-04-28>}
```

General decalarations.

doc.opm

```
\_fontfam[lmfonts]
\_hyperlinks \Green \Green
\_enlang
\_enquotes
```

Maybe, somebody needs `\seccc` or `\secccc`?

doc.opm

```
\_eoldef\seccc#1{\_medskip \_noindent{\_bf#1}\_par\_nobreak\_firstnoindent}
\_def\secccc{\_medskip\_noindent $\_bullet$ }
```

`\enddocument` can be redefined.

doc.opm

```
\_let\enddocument=\_bye
```

Full page of listing causes underfill `\vbox` in output routine. We need to add a small tolerance.

doc.opm

```
\_pgbottomskip=0pt plus10pt minus2pt
```

The listing mode is implemented here. The `\maxlines` is maximal lines of code printed in the listing mode.

doc.opm

```
\_newcount \_maxlines   \_maxlines=100000
\_public \maxlines ;

\_eoldef\_cod#1{\_par \_wipeepar
   \_vskip\_parskip \_medskip \_ttskip
   \_begingroup
   \_typosize[8/10]
   \_let\_printverbline=\_printcodeline
   \_ttline=\_inputlineno
   \_setverb
   \_ifnum\_ttline<0 \_let\_printverblinenum=\_relax \_else \_initverblinenum \_fi
   \_adef{ }{\ }\_adef\^^I{\t}\_parindent=\_ttindent \_parskip=0pt
   \_relax \_ttfont
   \_endlinechar=`^^J
   \_def\_tmpb{\_start}%
   \_readverbline
}
\_def\_readverbline #1^^J{%
   \_def\_tmpa{\_empty#1}%
   \_let\_next=\_readverbline
   \_ea\_isinlist\_ea\_tmpa\_ea{\_Doc}\_iftrue \_let\_next=\_processinput \_fi
   \_ea\_isinlist\_ea\_tmpa\_ea{\_Endcode}\_iftrue \_endinput \_let\_next=\_processinput \_fi
   \_ifx\_next\_readverbline \_addto\_tmpb{#1^^J}\_fi
   \_next
}
{\_catcode`\ =13 \_gdef\_aspace{ }}\_def\_asp{\_ea\_noexpand\_aspace}
\_edef\_Doc{\_asp\_asp\_bslash _doc}
\_edef\_Endcode{\_noexpand\_empty\_bslash _endcode}
```

The scanner of the control sequences in the listing mode.

doc.opm

```
\_def\_makecs{\_def\_tmp{}\_futurelet\_next\_makecsA}
\_def\_makecsA{\_ifcat a\_noexpand\_next \_ea\_makecsB \_else \_ea\_makecsF \_fi}
\_def\_makecsB#1{\_addto\_tmp{#1}\_futurelet\_next\_makecsA}
\_def\_makecsF{\_ifx\_tmp\_empty \_csstring\\%
       \_else \_ifcsname ,\_tmp\_endcsname \_link[cs:\_tmp]{\Blue}{\_csstring\\\_tmp}%
       \_else \_let\_next=\_tmp \_remfirstunderscore\_next
              \_ifx\_next\_empty \_let\_next=\_tmp \_fi
              \_ifcsname ,\_next\_endcsname \_link[cs:\_next]{\Blue}{\_csstring\\\_tmp}%
       \_else \_csstring\\\_tmp \_fi\_fi\_fi
}
\_def\_processinput{%
   \_let\_start=\_relax
   \_ea\_replstring\_ea\_tmpb\_ea{\_aspace^^J}{^^J}
   \_addto\_tmpb{\_end}%
   \_isinlist\_tmpb{\_start^^J}\_iftrue \_advance\_ttline by1\_fi
   \_replstring\_tmpb{\_start^^J}{\_start}%
   \_replstring\_tmpb{\_start}{}%
   \_replstring\_tmpb{^^J\_end}{\_end}%
   \_replstring\_tmpb{^^J\_end}{}%
   \_replstring\_tmpb{\_end}{}%
   \_ea\_prepareverbdata\_ea\_tmpb\_ea{\_tmpb^^J}%
   \_replthis{\_csstring\\}{\_noexpand\_makecs}%
   \_ea\_printverb \_tmpb\_end
   \_par
   \_endgroup \_ttskip
   \_isnextchar\_par{}{\_noindent}%
}
\_def\_remfirstunderscore#1{\_ea\_remfirstunderscoreA#1\_relax#1}
\_def\_remfirstunderscoreA#1#2\_relax#3{\_if _#1\_def#3{#2}\_fi}
```

The lines in the listing mode have Yellow background.

doc.opm

```
\_def\Yellow{\_setcmykcolor{0.0 0.0 0.3 0.03}}

\_def\_printcodeline#1{\_advance \_maxlines by-1
   \_ifnum \_maxlines<0 \_ea \_endverbprinting \_fi
   \_penalty \_ttpenalty \_kern-4pt
   \_noindent\_rlap{\Yellow \_vrule height8pt depth5pt width\_hsize}%
   \_printfilename
   \_indent \_printverblinenum #1\par}

\_def\_printfilename{\_hbox to0pt{%
   \_hskip\_hsize\vbox to0pt{\_vss\_llap{\Brown\docfile}\_kern7.5pt}\_hss}%
   \_let\_printfilename=\_relax
}
\_everytt={\_let\_printverblinenum=\_relax}

\_long\_def\_endverbprinting#1\_end#2\_end{\_fi\_fi \_global\_maxlines=100000
   \_noindent\_typosize[8/]\_dots etc. (see {\_tt\Brown\docfile})}
```

`\docfile` is currently documented file.
\printdoc and \printdoctail macros are defined here.

doc.opm

```
\_def\docfile{}
\_def\_printdoc #1 {\_par \_def\docfile{#1}%
   \_everytt={\_ttshift=-15pt \_let\_printverblinenum=\_relax}%
   \_ea\_cod \input #1
   \_everytt={\_let\_printverblinenum=\_relax}%
   \_def\docfile{}%
}
\_def\_printdoctail #1 {\_bgroup
   \_everytt={}\_ttline=-1 \_ea\_printdoctailA \_input #1 \_egroup}
{\_long\_gdef\_printdoctailA#1\_endcode{}}

\_public \printdoc \printdoctail ;
```

You can do `\verbinuput \vitt{`⟨*filename*⟩`}` `(`⟨*from*⟩`-`⟨*to*⟩`)` ⟨*filename*⟩ if you need analogical design like in listing mode.

doc.opm

```
\_def\_vitt#1{\_def\docfile{#1}\_ttline=-1
   \_everytt={\_typosize[8/10]\_let\_printverbline=\_printcodeline \_medskip}}

\_public \vitt ;
```

The Index entries are without the trailing backslash. We must to add it when printing Index.

doc.opm

```
\_addto \_ignoredcharsen {_}  % \foo, \_foo is the same in the fist pass of sorting
\_def\_printii #1#2&{%
   \_ismacro\_lastii{#1}\_iffalse \_newiiletter{#1}{#2}\_def\_lastii{#1}\_fi
   \_gdef\_currii{#1#2}\_the\_everyii\_noindent
   \_hskip-\_iindent \_ignorespaces\_printiiA\bslash#1#2//}

\_def\_printiipages#1&{\_let\_pgtype=\_undefined \_tmpnum=0
   {\_rm\_printpages #1,:,\_par}}

\_sdef{_tocl:1}#1#2#3{\_nofirst\_bigskip
   \_bf\_llaptoclink{#1}{#2}\_hfill \_pgn{#3}\_tocpar\_medskip}
```

The `<something>` will be print as ⟨*something*⟩.

doc.opm

```
\_let\lt=<
\_catcode`\<=13

\_def<#1>{$\langle\hbox{\it#1\/}\rangle$}
\_everyintt{\_catcode`\<=13 }
```

If this macro is loaded by `\load` then we need to initialize catcodes using the `\_afteroad` macro.

doc.opm

```
\_def\_afterload{\_catcode`\<=13 \_catcode`\`=13 }
```

Main documentation point and hyperlinks to/from it. Main documentation point: `\`\foo``. User-level documentation point: `\^`\foo`, first occurence only. Next occurences are only links to main documentation point. Link to user-level documentation point: `\~`\foo`. If user-level documentation point follows the main documentation point then use `\_forwardlink\`\foo``.

doc.opm

```
\_activettchar`

\_def\`#1`{\_leavevmode\_edef\_tmp{\_csstring#1}\_iindex{\_tmp}%
   \_ifcsname cs:\_tmp\_endcsname\_else \_dest[cs:\_tmp]\_fi
   \_sxdef{cs:\_tmp}{}%
   \_hbox{\_ifcsname cs:^\_tmp\_endcsname
            \_link[cs:^\_tmp]{\Red}{\_tt\_csstring\\\_tmp}\_else
            {\_tt\Red\_csstring\\\_tmp}\_fi}%
}
\_def\_forwardlink\`#1`{{\_slet{cs:^\_csstring#1}{relax}\`#1`}}

\_def\^`#1{\_leavevmode\_edef\_tmp{\_csstring#1}\_iindex{\_tmp}%
   \_hbox{\_ifcsname cs:^\_tmp\_endcsname \_else \_dest[cs:^\_tmp]\_sxdef{cs:^\_tmp}{}\_fi
         \_link[cs:\_tmp]{\Blue}{\_tt\_string#1}}%
   \_futurelet\_next\_cslinkA
}
\_def\_cslinkA{\_ifx\_next`\_ea\_ignoreit \_else \_ea\_ea\_ea`\_ea\_string\_fi}

\_def\~`#1{\_leavevmode\_edef\_tmp{\_csstring#1}\_iindex{\_tmp}%
   \_hbox{\_link[cs:^\_tmp]{\Blue}{\_tt\_string#1}}%
   \_futurelet\_next\_cslinkA
}
```

Index