

# The L<sup>A</sup>T<sub>E</sub>X3 Interfaces

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## Abstract

This is the reference documentation for the `expl3` programming environment. The `expl3` modules set up an experimental naming scheme for L<sup>A</sup>T<sub>E</sub>X commands, which allow the L<sup>A</sup>T<sub>E</sub>X programmer to systematically name functions and variables, and specify the argument types of functions.

The T<sub>E</sub>X and  $\varepsilon$ -T<sub>E</sub>X primitives are all given a new name according to these conventions. However, in the main direct use of the primitives is not required or encouraged: the `expl3` modules define an independent low-level L<sup>A</sup>T<sub>E</sub>X3 programming language.

At present, the `expl3` modules are designed to be loaded on top of L<sup>A</sup>T<sub>E</sub>X 2 $\varepsilon$ . In time, a L<sup>A</sup>T<sub>E</sub>X3 format will be produced based on this code. This allows the code to be used in L<sup>A</sup>T<sub>E</sub>X 2 $\varepsilon$  packages *now* while a stand-alone L<sup>A</sup>T<sub>E</sub>X3 is developed.

**While `expl3` is still experimental, the bundle is now regarded as broadly stable. The syntax conventions and functions provided are now ready for wider use. There may still be changes to some functions, but these will be minor when compared to the scope of `expl3`.**

**New modules will be added to the distributed version of `expl3` as they reach maturity.**

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## Part I

# Introduction to expl3 and this document

This document is intended to act as a comprehensive reference manual for the `expl3` language. A general guide to the `LATEX3` programming language is found in [expl3.pdf](#).

## 1 Naming functions and variables

`LATEX3` does not use `@` as a “letter” for defining internal macros. Instead, the symbols `_` and `:` are used in internal macro names to provide structure. The name of each *function* is divided into logical units using `_`, while `:` separates the *name* of the function from the *argument specifier* (“arg-spec”). This describes the arguments expected by the function. In most cases, each argument is represented by a single letter. The complete list of arg-spec letters for a function is referred to as the *signature* of the function.

Each function name starts with the *module* to which it belongs. Thus apart from a small number of very basic functions, all `expl3` function names contain at least one underscore to divide the module name from the descriptive name of the function. For example, all functions concerned with comma lists are in module `clist` and begin `\clist_`.

Every function must include an argument specifier. For functions which take no arguments, this will be blank and the function name will end `:`. Most functions take one or more arguments, and use the following argument specifiers:

- D** The `D` specifier means *do not use*. All of the `TEX` primitives are initially `\let` to a `D` name, and some are then given a second name. Only the kernel team should use anything with a `D` specifier!
- N and n** These mean *no manipulation*, of a single token for `N` and of a set of tokens given in braces for `n`. Both pass the argument though exactly as given. Usually, if you use a single token for an `n` argument, all will be well.
- c** This means *cname*, and indicates that the argument will be turned into a *cname* before being used. So `\foo:c {ArgumentOne}` will act in the same way as `\foo:N \ArgumentOne`.
- V and v** These mean *value of variable*. The `V` and `v` specifiers are used to get the content of a variable without needing to worry about the underlying `TEX` structure containing the data. A `V` argument will be a single token (similar to `N`), for example `\foo:V \MyVariable`; on the other hand, using `v` a *cname* is constructed first, and then the value is recovered, for example `\foo:v {MyVariable}`.

- o** This means *expansion once*. In general, the **V** and **v** specifiers are favoured over **o** for recovering stored information. However, **o** is useful for correctly processing information with delimited arguments.
- x** The **x** specifier stands for *exhaustive expansion*: the plain  $\text{\TeX}\ \backslash\text{edef}$ .
- f** The **f** specifier stands for *full expansion*, and in contrast to **x** stops at the first non-expandable item without trying to execute it.
- T and F** For logic tests, there are the branch specifiers **T** (*true*) and **F** (*false*). Both specifiers treat the input in the same way as **n** (no change), but make the logic much easier to see.
- p** The letter **p** indicates  $\text{\TeX}\ \textit{parameters}$ . Normally this will be used for delimited functions as `expl3` provides better methods for creating simple sequential arguments.
- w** Finally, there is the **w** specifier for *weird* arguments. This covers everything else, but mainly applies to delimited values (where the argument must be terminated by some arbitrary string).

Notice that the argument specifier describes how the argument is processed prior to being passed to the underlying function. For example, `\foo:c` will take its argument, convert it to a control sequence and pass it to `\foo:N`.

Variables are named in a similar manner to functions, but begin with a single letter to define the type of variable:

- c** Constant: global parameters whose value should not be changed.
- g** Parameters whose value should only be set globally.
- l** Parameters whose value should only be set locally.

Each variable name is then build up in a similar way to that of a function, typically starting with the module<sup>1</sup> name and then a descriptive part. Variables end with a short identifier to show the variable type:

**bool** Either true or false.

**box** Box register.

**clist** Comma separated list.

**coffin** a “box with handles” — a higher-level data type for carrying out **box** alignment operations.

---

<sup>1</sup>The module names are not used in case of generic scratch registers defined in the data type modules, e.g., the **int** module contains some scratch variables called `\l_tmpa_int`, `\l_tmpb_int`, and so on. In such a case adding the module name up front to denote the module and in the back to indicate the type, as in `\l_int_tmpa_int` would be very unreadable.

**dim** “Rigid” lengths.

**fp** floating-point values;

**int** Integer-valued count register.

**prop** Property list.

**seq** “Sequence”: a data-type used to implement lists (with access at both ends) and stacks.

**skip** “Rubber” lengths.

**stream** An input or output stream (for reading from or writing to, respectively).

**tl** Token list variables: placeholder for a token list.

## 1.1 Terminological inexactitude

A word of warning. In this document, and others referring to the `expl3` programming modules, we often refer to “variables” and “functions” as if they were actual constructs from a real programming language. In truth, `TeX` is a macro processor, and functions are simply macros that may or may not take arguments and expand to their replacement text. Many of the common variables are *also* macros, and if placed into the input stream will simply expand to their definition as well — a “function” with no arguments and a “token list variable” are in truth one and the same. On the other hand, some “variables” are actually registers that must be initialised and their values set and retrieved with specific functions.

The conventions of the `expl3` code are designed to clearly separate the ideas of “macros that contain data” and “macros that contain code”, and a consistent wrapper is applied to all forms of “data” whether they be macros or actually registers. This means that sometimes we will use phrases like “the function returns a value”, when actually we just mean “the macro expands to something”. Similarly, the term “execute” might be used in place of “expand” or it might refer to the more specific case of “processing in `TeX`’s stomach” (if you are familiar with the `TeXbook` parlance).

If in doubt, please ask; chances are we’ve been hasty in writing certain definitions and need to be told to tighten up our terminology.

## 2 Documentation conventions

This document is typeset with the experimental `l3doc` class; several conventions are used to help describe the features of the code. A number of conventions are used here to make the documentation clearer.

Each group of related functions is given in a box. For a function with a “user” name, this might read:

<code>\ExplSyntaxOn</code>
<code>\ExplSyntaxOff</code>

`\ExplSyntaxOn ... \ExplSyntaxOff`

The textual description of how the function works would appear here. The syntax of the function is shown in mono-spaced text to the right of the box. In this example, the function takes no arguments and so the name of the function is simply reprinted.

For programming functions, which use `_` and `:` in their name there are a few additional conventions: If two related functions are given with identical names but different argument specifiers, these are termed *variants* of each other, and the latter functions are printed in grey to show this more clearly. They will carry out the same function but will take different types of argument:

<code>\seq_new:N</code>
<code>\seq_new:c</code>

`\seq_new:N <sequence>`

When a number of variants are described, the arguments are usually illustrated only for the base function. Here, `<sequence>` indicates that `\seq_new:N` expects the name of a sequence. From the argument specifier, `\seq_new:c` also expects a sequence name, but as a name rather than as a control sequence. Each argument given in the illustration should be described in the following text.

**Fully expandable functions** Some functions are fully expandable, which allows it to be used within an `x`-type argument (in plain  $\text{\TeX}$  terms, inside an `\edef`). These fully expandable functions are indicated in the documentation by a star:

<code>\cs_to_str:N</code>	★
---------------------------	---

`\cs_to_str:N <cs>`

As with other functions, some text should follow which explains how the function works. Usually, only the star will indicate that the function is expandable. In this case, the function expects a `<cs>`, shorthand for a `<control sequence>`.

**Restricted expandable functions** A few functions are fully expandable but cannot be fully expanded within an `f`-type argument. In this case a hollow star is used to indicate this:

<code>\seq_map_function:NN</code>	☆
-----------------------------------	---

`\tl_trim_spaces:n <seq> <function>`

**Conditional functions** Conditional (`if`) functions are normally defined in three variants, with `T`, `F` and `TF` argument specifiers. This allows them to be used for different “true”/“false” branches, depending on which outcome the conditional is being used to test. To indicate this without repetition, this information is given in a shortened form:



`\xetex_if_engine:TF *` `\xetex_if_engine:TF {\true code} {\false code}`

The underlining and italic of `TF` indicates that `\xetex_if_engine:T`, `\xetex_if_engine:F` and `\xetex_if_engine:TF` are all available. Usually, the illustration will use the `TF` variant, and so both `\true code` and `\false code` will be shown. The two variant forms `T` and `F` take only `\true code` and `\false code`, respectively. Here, the star also shows that this function is expandable. With some minor exceptions, *all* conditional functions in the `expl3` modules should be defined in this way.

Variables, constants and so on are described in a similar manner:

`\l_tmpa_tl` A short piece of text will describe the variable: there is no syntax illustration in this case.

In some cases, the function is similar to one in  $\text{\LaTeX} 2_{\epsilon}$  or plain  $\text{\TeX}$ . In these cases, the text will include an extra “ **$\text{\TeX}$ hackers note**” section:

`\token_to_str:N *` `\token_to_str:N \token`

The normal description text.

**$\text{\TeX}$ hackers note:** Detail for the experienced  $\text{\TeX}$  or  $\text{\LaTeX} 2_{\epsilon}$  programmer. In this case, it would point out that this function is the  $\text{\TeX}$  primitive `\string`.

### 3 Formal language conventions which apply generally

As this is a formal reference guide for  $\text{\LaTeX} 3$  programming, the descriptions of functions are intended to be reasonably “complete”. However, there is also a need to avoid repetition. Formal ideas which apply to general classes of function are therefore summarised here.

For tests which have a `TF` argument specification, the test is evaluated to give a logically `TRUE` or `FALSE` result. Depending on this result, either the `\true code` or the `\false code` will be left in the input stream. In the case where the test is expandable, and a predicate (`_p`) variant is available, the logical value determined by the test is left in the input stream: this will typically be part of a larger logical construct.

## Part II

# The `l3bootstrap` package

# Bootstrap code

## 4 Using the L<sup>A</sup>T<sub>E</sub>X3 modules

The modules documented in `source3` are designed to be used on top of L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub> and are loaded all as one with the usual `\usepackage{expl3}` or `\RequirePackage{expl3}` instructions. These modules will also form the basis of the L<sup>A</sup>T<sub>E</sub>X3 format, but work in this area is incomplete and not included in this documentation at present.

As the modules use a coding syntax different from standard L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub> it provides a few functions for setting it up.

<code>\ExplSyntaxOn</code>
<code>\ExplSyntaxOff</code>

`\ExplSyntaxOn <code> \ExplSyntaxOff`

The `\ExplSyntaxOn` function switches to a category code régime in which spaces are ignored and in which the colon (`:`) and underscore (`_`) are treated as “letters”, thus allowing access to the names of code functions and variables. Within this environment, `~` is used to input a space. The `\ExplSyntaxOff` reverts to the document category code régime.

<code>\ExplSyntaxNamesOn</code>
<code>\ExplSyntaxNamesOff</code>

`\ExplSyntaxNamesOn <code> \ExplSyntaxNamesOff`

The `\ExplSyntaxOn` function switches to a category code régime in which the colon (`:`) and underscore (`_`) are treated as “letters”, thus allowing access to the names of code functions and variables. In contrast to `\ExplSyntaxOn`, using `\ExplSyntaxNamesOn` does not cause spaces to be ignored. The `\ExplSyntaxNamesOff` reverts to the document category code régime.

<code>\ProvidesExplPackage</code>
<code>\ProvidesExplClass</code>
<code>\ProvidesExplFile</code>

`\RequirePackage{expl3}`  
`\ProvidesExplPackage {<package>} {<date>} {<version>}`  
`{<description>}`

These functions act broadly in the same way as the L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub> kernel functions `\ProvidesPackage`, `\ProvidesClass` and `\ProvidesFile`. However, they also implicitly switch `\ExplSyntaxOn` for the remainder of the code with the file. At the end of the file, `\ExplSyntaxOff` will be called to reverse this. (This is the same concept as L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub> provides in turning on `\makeatletter` within package and class code.)

<code>\GetIdInfo</code>
-------------------------

`\RequirePackage{l3names}`  
`\GetIdInfo $Id: <SVN info field> $ {<description>}`

Extracts all information from a SVN field. Spaces are not ignored in these fields. The information pieces are stored in separate control sequences with `\ExplFileName` for the part

of the file name leading up to the period, `\ExplFileName` for date, `\ExplFileVersion` for version and `\ExplFileDescription` for the description.

To summarize: Every single package using this syntax should identify itself using one of the above methods. Special care is taken so that every package or class file loaded with `\RequirePackage` or alike are loaded with usual  $\text{\LaTeX} 2_\epsilon$  category codes and the  $\text{\LaTeX} 3$  category code scheme is reloaded when needed afterwards. See implementation for details. If you use the `\GetIdInfo` command you can use the information when loading a package with

```
\ProvidesExplPackage{\ExplFileName}{\ExplFileName}{\ExplFileVersion}{\ExplFileDescription}
```

## Part III

# The `l3names` package Namespace for primitives

## 5 Setting up the $\text{\LaTeX} 3$ programming language

This module is at the core of the  $\text{\LaTeX} 3$  programming language. It performs the following tasks:

- defines new names for all  $\text{\TeX}$  primitives;
- switches to the category code regime for programming;
- provides support settings for building the code as a  $\text{\TeX}$  format.

This module is entirely dedicated to primitives, which should not be used directly within  $\text{\LaTeX} 3$  code (outside of “kernel-level” code). As such, the primitives are not documented here: *The  $\text{\TeX}$  book*,  *$\text{\TeX}$  by Topic* and the manuals for  $\text{pdf}\text{\TeX}$ ,  $\text{X}\text{\LaTeX}$  and  $\text{Lua}\text{\TeX}$  should be consulted for details of the primitives. These are named based on the engine which first introduced them:

`\tex_...` Introduced by  $\text{\TeX}$  itself;

`\etex_...` Introduced by the  $\epsilon$ - $\text{\TeX}$  extensions;

`\pdftex_...` Introduced by  $\text{pdf}\text{\TeX}$ ;

`\xetex_...` Introduced by  $\text{X}\text{\LaTeX}$ ;

`\luatex_...` Introduced by  $\text{Lua}\text{\TeX}$ .

## Part IV

# The l3basics package

## Basic definitions

As the name suggest this package holds some basic definitions which are needed by most or all other packages in this set.

Here we describe those functions that are used all over the place. With that we mean functions dealing with the construction and testing of control sequences. Furthermore the basic parts of conditional processing are covered; conditional processing dealing with specific data types is described in the modules specific for the respective data types.

## 6 No operation functions

<code>\prg_do_nothing:</code>
-------------------------------

`\prg_do_nothing:`

An expandable function which does nothing at all: leaves nothing in the input stream after a single expansion.

<code>\scan_stop:</code>
--------------------------

`\scan_stop:`

A non-expandable function which does nothing. Does not vanish on expansion but produces no typeset output.

## 7 Grouping material

<code>\group_begin:</code> <code>\group_end:</code>
--------------------------------------------------------

`\group_begin:`  
`\group_end:`

These functions begin and end a group for definition purposes. Assignments are local to groups unless carried out in a global manner. (A small number of exceptions to this rule will be noted as necessary elsewhere in this document.) Each `\group_begin:` must be matched by a `\group_end:`, although this does not have to occur within the same function. Indeed, it is often necessary to start a group within one function and finish it within another, for example when seeking to use non-standard category codes.

<code>\group_insert_after:N</code>
------------------------------------

`\group_insert_after:N` *<token>*

Adds *<token>* to the list of *<tokens>* to be inserted when the current group level ends.

The list of  $\langle tokens \rangle$  to be inserted will be empty at the beginning of a group: multiple applications of `\group_insert_after:N` may be used to build the inserted list one  $\langle token \rangle$  at a time. The current group level may be closed by a `\group_end:` function or by a token with category code 2 (close-group). The later will be a `}` if standard category codes apply.

## 8 Control sequences and functions

As  $\text{\TeX}$  is a macro language, creating new functions means creating macros. At point of use, a function is replaced by the replacement text (“code”) in which each parameter in the code (`#1`, `#2`, *etc.*) is replaced the appropriate arguments absorbed by the function. In the following,  $\langle code \rangle$  is therefore used as a shorthand for “replacement text”.

Functions which are not “protected” will be fully expanded inside an  $\mathbf{x}$  expansion. In contrast, “protected” functions are not expanded within  $\mathbf{x}$  expansions.

### 8.1 Defining functions

Functions can be created with no requirement that they are declared first (in contrast to variables, which must always be declared). Declaring a function before setting up the code means that the name chosen will be checked and an error raised if it is already in use. The name of a function can be checked at the point of definition using the `\cs_new...` functions: this is recommended for all functions which are defined for the first time.

### 8.2 Defining new functions using primitive parameter text

<code>\cs_new:Npn</code> <code>\cs_new:cpn</code> <code>\cs_new:Npx</code> <code>\cs_new:cpx</code>	<code>\cs_new:Npn</code> $\langle function \rangle$ $\langle parameters \rangle$ $\{ \langle code \rangle \}$
--------------------------------------------------------------------------------------------------------------	---------------------------------------------------------------------------------------------------------------

Creates  $\langle function \rangle$  to expand to  $\langle code \rangle$  as replacement text. Within the  $\langle code \rangle$ , the  $\langle parameters \rangle$  (`#1`, `#2`, *etc.*) will be replaced by those absorbed by the function. The definition is global and an error will result if the  $\langle function \rangle$  is already defined.

<code>\cs_new_nopar:Npn</code> <code>\cs_new_nopar:cpn</code> <code>\cs_new_nopar:Npx</code> <code>\cs_new_nopar:cpx</code>	<code>\cs_new_nopar:Npn</code> $\langle function \rangle$ $\langle parameters \rangle$ $\{ \langle code \rangle \}$
--------------------------------------------------------------------------------------------------------------------------------------	---------------------------------------------------------------------------------------------------------------------

Creates  $\langle function \rangle$  to expand to  $\langle code \rangle$  as replacement text. Within the  $\langle code \rangle$ , the  $\langle parameters \rangle$  (`#1`, `#2`, *etc.*) will be replaced by those absorbed by the function. When the

$\langle function \rangle$  is used the  $\langle parameters \rangle$  absorbed cannot contain  $\backslash par$  tokens. The definition is global and an error will result if the  $\langle function \rangle$  is already defined.

$\backslash cs\_new\_protected:Npn$ $\backslash cs\_new\_protected:cpn$ $\backslash cs\_new\_protected:Npx$ $\backslash cs\_new\_protected:cpx$	$\backslash cs\_new\_protected:Npn \langle function \rangle \langle parameters \rangle$ $\{ \langle code \rangle \}$
----------------------------------------------------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------

Creates  $\langle function \rangle$  to expand to  $\langle code \rangle$  as replacement text. Within the  $\langle code \rangle$ , the  $\langle parameters \rangle$  ( $\#1$ ,  $\#2$ , *etc.*) will be replaced by those absorbed by the function. The  $\langle function \rangle$  will not expand within an x-type argument. The definition is global and an error will result if the  $\langle function \rangle$  is already defined.

$\backslash cs\_new\_protected\_nopar:Npn$ $\backslash cs\_new\_protected\_nopar:cpn$ $\backslash cs\_new\_protected\_nopar:Npx$ $\backslash cs\_new\_protected\_nopar:cpx$	$\backslash cs\_new\_protected\_nopar:Npn \langle function \rangle \langle parameters \rangle$ $\{ \langle code \rangle \}$
--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------

Creates  $\langle function \rangle$  to expand to  $\langle code \rangle$  as replacement text. Within the  $\langle code \rangle$ , the  $\langle parameters \rangle$  ( $\#1$ ,  $\#2$ , *etc.*) will be replaced by those absorbed by the function. When the  $\langle function \rangle$  is used the  $\langle parameters \rangle$  absorbed cannot contain  $\backslash par$  tokens. The  $\langle function \rangle$  will not expand within an x-type argument. The definition is global and an error will result if the  $\langle function \rangle$  is already defined.

$\backslash cs\_set:Npn$ $\backslash cs\_set:cpn$ $\backslash cs\_set:Npx$ $\backslash cs\_set:cpx$	$\backslash cs\_set:Npn \langle function \rangle \langle parameters \rangle \{ \langle code \rangle \}$
--------------------------------------------------------------------------------------------------------------	---------------------------------------------------------------------------------------------------------

Sets  $\langle function \rangle$  to expand to  $\langle code \rangle$  as replacement text. Within the  $\langle code \rangle$ , the  $\langle parameters \rangle$  ( $\#1$ ,  $\#2$ , *etc.*) will be replaced by those absorbed by the function. The assignment of a meaning to  $\langle function \rangle$  is restricted to the current T<sub>E</sub>X group level.

$\backslash cs\_set\_nopar:Npn$ $\backslash cs\_set\_nopar:cpn$ $\backslash cs\_set\_nopar:Npx$ $\backslash cs\_set\_nopar:cpx$	$\backslash cs\_set\_nopar:Npn \langle function \rangle \langle parameters \rangle \{ \langle code \rangle \}$
------------------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------

Sets  $\langle function \rangle$  to expand to  $\langle code \rangle$  as replacement text. Within the  $\langle code \rangle$ , the  $\langle parameters \rangle$  ( $\#1$ ,  $\#2$ , *etc.*) will be replaced by those absorbed by the function. When the  $\langle function \rangle$  is used the  $\langle parameters \rangle$  absorbed cannot contain  $\backslash par$  tokens. The assignment

of a meaning to  $\langle function \rangle$  is restricted to the current T<sub>E</sub>X group level.

<code>\cs_set_protected:Npn</code>	<code>\cs_set_protected:Npn <math>\langle function \rangle</math> <math>\langle parameters \rangle</math> {<math>\langle code \rangle</math>}</code>
<code>\cs_set_protected:cpn</code>	
<code>\cs_set_protected:Npx</code>	
<code>\cs_set_protected:cpx</code>	

Sets  $\langle function \rangle$  to expand to  $\langle code \rangle$  as replacement text. Within the  $\langle code \rangle$ , the  $\langle parameters \rangle$  (**#1**, **#2**, *etc.*) will be replaced by those absorbed by the function. The assignment of a meaning to  $\langle function \rangle$  is restricted to the current T<sub>E</sub>X group level. The  $\langle function \rangle$  will not expand within an x-type argument.

<code>\cs_set_protected_nopar:Npn</code>	<code>\cs_set_protected_nopar:Npn <math>\langle function \rangle</math> <math>\langle parameters \rangle</math> {<math>\langle code \rangle</math>}</code>
<code>\cs_set_protected_nopar:cpn</code>	
<code>\cs_set_protected_nopar:Npx</code>	
<code>\cs_set_protected_nopar:cpx</code>	

Sets  $\langle function \rangle$  to expand to  $\langle code \rangle$  as replacement text. Within the  $\langle code \rangle$ , the  $\langle parameters \rangle$  (**#1**, **#2**, *etc.*) will be replaced by those absorbed by the function. When the  $\langle function \rangle$  is used the  $\langle parameters \rangle$  absorbed cannot contain `\par` tokens. The assignment of a meaning to  $\langle function \rangle$  is restricted to the current T<sub>E</sub>X group level. The  $\langle function \rangle$  will not expand within an x-type argument.

<code>\cs_gset:Npn</code>	<code>\cs_gset:Npn <math>\langle function \rangle</math> <math>\langle parameters \rangle</math> {<math>\langle code \rangle</math>}</code>
<code>\cs_gset:cpn</code>	
<code>\cs_gset:Npx</code>	
<code>\cs_gset:cpx</code>	

Globally sets  $\langle function \rangle$  to expand to  $\langle code \rangle$  as replacement text. Within the  $\langle code \rangle$ , the  $\langle parameters \rangle$  (**#1**, **#2**, *etc.*) will be replaced by those absorbed by the function. The assignment of a meaning to  $\langle function \rangle$  is *not* restricted to the current T<sub>E</sub>X group level: the assignment is global.

<code>\cs_gset_nopar:Npn</code>	<code>\cs_gset_nopar:Npn <math>\langle function \rangle</math> <math>\langle parameters \rangle</math> {<math>\langle code \rangle</math>}</code>
<code>\cs_gset_nopar:cpn</code>	
<code>\cs_gset_nopar:Npx</code>	
<code>\cs_gset_nopar:cpx</code>	

Globally sets  $\langle function \rangle$  to expand to  $\langle code \rangle$  as replacement text. Within the  $\langle code \rangle$ , the  $\langle parameters \rangle$  (**#1**, **#2**, *etc.*) will be replaced by those absorbed by the function. When the  $\langle function \rangle$  is used the  $\langle parameters \rangle$  absorbed cannot contain `\par` tokens. The assignment of a meaning to  $\langle function \rangle$  is *not* restricted to the current T<sub>E</sub>X group level:

the assignment is global.

<code>\cs_gset_protected:Npn</code> <code>\cs_gset_protected:cpn</code> <code>\cs_gset_protected:Npx</code> <code>\cs_gset_protected:cpx</code>	<code>\cs_gset_protected:Npn &lt;function&gt; &lt;parameters&gt;</code> <code>{&lt;code&gt;}</code>
----------------------------------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------

Globally sets  $\langle function \rangle$  to expand to  $\langle code \rangle$  as replacement text. Within the  $\langle code \rangle$ , the  $\langle parameters \rangle$  ( $\#1$ ,  $\#2$ , *etc.*) will be replaced by those absorbed by the function. The assignment of a meaning to  $\langle function \rangle$  is *not* restricted to the current  $\text{\TeX}$  group level: the assignment is global. The  $\langle function \rangle$  will not expand within an  $\text{x}$ -type argument.

<code>\cs_gset_protected_nopar:Npn</code> <code>\cs_gset_protected_nopar:cpn</code> <code>\cs_gset_protected_nopar:Npx</code> <code>\cs_gset_protected_nopar:cpx</code>	<code>\cs_gset_protected_nopar:Npn &lt;function&gt;</code> <code>&lt;parameters&gt; {&lt;code&gt;}</code>
----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------

Globally sets  $\langle function \rangle$  to expand to  $\langle code \rangle$  as replacement text. Within the  $\langle code \rangle$ , the  $\langle parameters \rangle$  ( $\#1$ ,  $\#2$ , *etc.*) will be replaced by those absorbed by the function. When the  $\langle function \rangle$  is used the  $\langle parameters \rangle$  absorbed cannot contain  $\backslash\text{par}$  tokens. The assignment of a meaning to  $\langle function \rangle$  is *not* restricted to the current  $\text{\TeX}$  group level: the assignment is global. The  $\langle function \rangle$  will not expand within an  $\text{x}$ -type argument.

### 8.3 Defining new functions using the signature

<code>\cs_new:Nn</code> <code>\cs_new:cn</code> <code>\cs_new:Nx</code> <code>\cs_new:cx</code>	<code>\cs_new:Nn &lt;function&gt; {&lt;code&gt;}</code>
----------------------------------------------------------------------------------------------------------	---------------------------------------------------------

Creates  $\langle function \rangle$  to expand to  $\langle code \rangle$  as replacement text. Within the  $\langle code \rangle$ , the number of  $\langle parameters \rangle$  is detected automatically from the function signature. These  $\langle parameters \rangle$  ( $\#1$ ,  $\#2$ , *etc.*) will be replaced by those absorbed by the function. The definition is global and an error will result if the  $\langle function \rangle$  is already defined.

<code>\cs_new_nopar:Nn</code> <code>\cs_new_nopar:cn</code> <code>\cs_new_nopar:Nx</code> <code>\cs_new_nopar:cx</code>	<code>\cs_new_nopar:Nn &lt;function&gt; {&lt;code&gt;}</code>
----------------------------------------------------------------------------------------------------------------------------------	---------------------------------------------------------------

Creates  $\langle function \rangle$  to expand to  $\langle code \rangle$  as replacement text. Within the  $\langle code \rangle$ , the number of  $\langle parameters \rangle$  is detected automatically from the function signature. These  $\langle parameters \rangle$  ( $\#1$ ,  $\#2$ , *etc.*) will be replaced by those absorbed by the function. When the



$\langle function \rangle$  is used the  $\langle parameters \rangle$  absorbed cannot contain  $\backslash par$  tokens. The definition is global and an error will result if the  $\langle function \rangle$  is already defined.

$\backslash cs\_new\_protected:Nn$ $\backslash cs\_new\_protected:cn$ $\backslash cs\_new\_protected:Nx$ $\backslash cs\_new\_protected:cx$	$\backslash cs\_new\_protected:Nn \langle function \rangle \{ \langle code \rangle \}$
------------------------------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------

Creates  $\langle function \rangle$  to expand to  $\langle code \rangle$  as replacement text. Within the  $\langle code \rangle$ , the number of  $\langle parameters \rangle$  is detected automatically from the function signature. These  $\langle parameters \rangle$  ( $\#1$ ,  $\#2$ , *etc.*) will be replaced by those absorbed by the function. The  $\langle function \rangle$  will not expand within an  $x$ -type argument. The definition is global and an error will result if the  $\langle function \rangle$  is already defined.

$\backslash cs\_new\_protected\_nopar:Nn$ $\backslash cs\_new\_protected\_nopar:cn$ $\backslash cs\_new\_protected\_nopar:Nx$ $\backslash cs\_new\_protected\_nopar:cx$	$\backslash cs\_new\_protected\_nopar:Nn \langle function \rangle \{ \langle code \rangle \}$
----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------

Creates  $\langle function \rangle$  to expand to  $\langle code \rangle$  as replacement text. Within the  $\langle code \rangle$ , the number of  $\langle parameters \rangle$  is detected automatically from the function signature. These  $\langle parameters \rangle$  ( $\#1$ ,  $\#2$ , *etc.*) will be replaced by those absorbed by the function. When the  $\langle function \rangle$  is used the  $\langle parameters \rangle$  absorbed cannot contain  $\backslash par$  tokens. The  $\langle function \rangle$  will not expand within an  $x$ -type argument. The definition is global and an error will result if the  $\langle function \rangle$  is already defined.

$\backslash cs\_set:Nn$ $\backslash cs\_set:cn$ $\backslash cs\_set:Nx$ $\backslash cs\_set:cx$	$\backslash cs\_set:Nn \langle function \rangle \{ \langle code \rangle \}$
----------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------

Sets  $\langle function \rangle$  to expand to  $\langle code \rangle$  as replacement text. Within the  $\langle code \rangle$ , the number of  $\langle parameters \rangle$  is detected automatically from the function signature. These  $\langle parameters \rangle$  ( $\#1$ ,  $\#2$ , *etc.*) will be replaced by those absorbed by the function. The assignment of a meaning to  $\langle function \rangle$  is restricted to the current  $\text{\TeX}$  group level.

$\backslash cs\_set\_nopar:Nn$ $\backslash cs\_set\_nopar:cn$ $\backslash cs\_set\_nopar:Nx$ $\backslash cs\_set\_nopar:cx$	$\backslash cs\_set\_nopar:Nn \langle function \rangle \{ \langle code \rangle \}$
--------------------------------------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------

Sets  $\langle function \rangle$  to expand to  $\langle code \rangle$  as replacement text. Within the  $\langle code \rangle$ , the number of  $\langle parameters \rangle$  is detected automatically from the function signature. These  $\langle parameters \rangle$  ( $\#1$ ,  $\#2$ , *etc.*) will be replaced by those absorbed by the function. When the  $\langle function \rangle$

is used the  $\langle parameters \rangle$  absorbed cannot contain  $\backslash par$  tokens. The assignment of a meaning to  $\langle function \rangle$  is restricted to the current  $\TeX$  group level.

$\backslash cs\_set\_protected:Nn$ $\backslash cs\_set\_protected:cn$ $\backslash cs\_set\_protected:Nx$ $\backslash cs\_set\_protected:cx$	$\backslash cs\_set\_protected:Nn \langle function \rangle \{ \langle code \rangle \}$
------------------------------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------

Sets  $\langle function \rangle$  to expand to  $\langle code \rangle$  as replacement text. Within the  $\langle code \rangle$ , the number of  $\langle parameters \rangle$  is detected automatically from the function signature. These  $\langle parameters \rangle$  ( $\#1$ ,  $\#2$ , *etc.*) will be replaced by those absorbed by the function. The  $\langle function \rangle$  will not expand within an x-type argument. The assignment of a meaning to  $\langle function \rangle$  is restricted to the current  $\TeX$  group level.

$\backslash cs\_set\_protected\_nopar:Nn$ $\backslash cs\_set\_protected\_nopar:cn$ $\backslash cs\_set\_protected\_nopar:Nx$ $\backslash cs\_set\_protected\_nopar:cx$	$\backslash cs\_set\_protected\_nopar:Nn \langle function \rangle \{ \langle code \rangle \}$
----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------

Sets  $\langle function \rangle$  to expand to  $\langle code \rangle$  as replacement text. Within the  $\langle code \rangle$ , the number of  $\langle parameters \rangle$  is detected automatically from the function signature. These  $\langle parameters \rangle$  ( $\#1$ ,  $\#2$ , *etc.*) will be replaced by those absorbed by the function. When the  $\langle function \rangle$  is used the  $\langle parameters \rangle$  absorbed cannot contain  $\backslash par$  tokens. The  $\langle function \rangle$  will not expand within an x-type argument. The assignment of a meaning to  $\langle function \rangle$  is restricted to the current  $\TeX$  group level.

$\backslash cs\_gset:Nn$ $\backslash cs\_gset:cn$ $\backslash cs\_gset:Nx$ $\backslash cs\_gset:cx$	$\backslash cs\_gset:Nn \langle function \rangle \{ \langle code \rangle \}$
--------------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------

Sets  $\langle function \rangle$  to expand to  $\langle code \rangle$  as replacement text. Within the  $\langle code \rangle$ , the number of  $\langle parameters \rangle$  is detected automatically from the function signature. These  $\langle parameters \rangle$  ( $\#1$ ,  $\#2$ , *etc.*) will be replaced by those absorbed by the function. The assignment of a meaning to  $\langle function \rangle$  is global.

$\backslash cs\_gset\_nopar:Nn$ $\backslash cs\_gset\_nopar:cn$ $\backslash cs\_gset\_nopar:Nx$ $\backslash cs\_gset\_nopar:cx$	$\backslash cs\_gset\_nopar:Nn \langle function \rangle \{ \langle code \rangle \}$
------------------------------------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------

Sets  $\langle function \rangle$  to expand to  $\langle code \rangle$  as replacement text. Within the  $\langle code \rangle$ , the number of  $\langle parameters \rangle$  is detected automatically from the function signature. These  $\langle parameters \rangle$  ( $\#1$ ,  $\#2$ , *etc.*) will be replaced by those absorbed by the function. When the  $\langle function \rangle$

is used the  $\langle parameters \rangle$  absorbed cannot contain  $\backslash par$  tokens. The assignment of a meaning to  $\langle function \rangle$  is global.

$\backslash cs\_gset\_protected:Nn$ $\backslash cs\_gset\_protected:cn$ $\backslash cs\_gset\_protected:Nx$ $\backslash cs\_gset\_protected:cx$	$\backslash cs\_gset\_protected:Nn \langle function \rangle \{ \langle code \rangle \}$
----------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------

Sets  $\langle function \rangle$  to expand to  $\langle code \rangle$  as replacement text. Within the  $\langle code \rangle$ , the number of  $\langle parameters \rangle$  is detected automatically from the function signature. These  $\langle parameters \rangle$  ( $\#1$ ,  $\#2$ , *etc.*) will be replaced by those absorbed by the function. The  $\langle function \rangle$  will not expand within an x-type argument. The assignment of a meaning to  $\langle function \rangle$  is global.

$\backslash cs\_gset\_protected\_nopar:Nn$ $\backslash cs\_gset\_protected\_nopar:cn$ $\backslash cs\_gset\_protected\_nopar:Nx$ $\backslash cs\_gset\_protected\_nopar:cx$	$\backslash cs\_gset\_protected\_nopar:Nn \langle function \rangle \{ \langle code \rangle \}$
--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------

Sets  $\langle function \rangle$  to expand to  $\langle code \rangle$  as replacement text. Within the  $\langle code \rangle$ , the number of  $\langle parameters \rangle$  is detected automatically from the function signature. These  $\langle parameters \rangle$  ( $\#1$ ,  $\#2$ , *etc.*) will be replaced by those absorbed by the function. When the  $\langle function \rangle$  is used the  $\langle parameters \rangle$  absorbed cannot contain  $\backslash par$  tokens. The  $\langle function \rangle$  will not expand within an x-type argument. The assignment of a meaning to  $\langle function \rangle$  is global.

$\backslash cs\_generate\_from\_arg\_count:NNnn$ $\backslash cs\_generate\_from\_arg\_count:cNnn$	$\backslash cs\_generate\_from\_arg\_count:NNnn \langle function \rangle$ $\langle creator \rangle \langle number \rangle \langle code \rangle$
------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------

Uses the  $\langle creator \rangle$  function (which should have signature  $Npn$ , for example  $\backslash cs\_new:Npn$ ) to define a  $\langle function \rangle$  which takes  $\langle number \rangle$  arguments and has  $\langle code \rangle$  as replacement text. The  $\langle number \rangle$  of arguments is an integer expression, evaluated as detailed for  $\backslash int\_eval:n$ .

## 8.4 Copying control sequences

Control sequences (not just functions as defined above) can be set to have the same meaning using the functions described here. Making two control sequences equivalent means that the second control sequence is a *copy* of the first (rather than a pointer to it). Thus the old and new control sequence are not tied together: changes to one are not reflected in the other.

In the following text “cs” is used as an abbreviation for “control sequence”.

<code>\cs_new_eq:NN</code>
<code>\cs_new_eq:Nc</code>
<code>\cs_new_eq:cN</code>
<code>\cs_new_eq:cc</code>

`\cs_new_eq:NN <cs 1> <cs 2>`

Creates  $\langle \textit{control sequence 1} \rangle$  and sets it to have the same meaning as  $\langle \textit{control sequence 2} \rangle$  at the point where `\cs_new_eq:NN` is executed. The two control sequences may subsequently be altered without affecting the copy. The assignment of a meaning to  $\langle \textit{control sequence 1} \rangle$  is global.

<code>\cs_set_eq:NN</code>
<code>\cs_set_eq:Nc</code>
<code>\cs_set_eq:cN</code>
<code>\cs_set_eq:cc</code>

`\cs_set_eq:NN <cs 1> <cs 2>`

Sets  $\langle \textit{control sequence 1} \rangle$  to have the same meaning as  $\langle \textit{control sequence 2} \rangle$  at the point where `\cs_set_eq:NN` is executed. The two control sequences may subsequently be altered without affecting the copy. The assignment of a meaning to  $\langle \textit{control sequence 1} \rangle$  is restricted to the current  $\text{\TeX}$  group level.

<code>\cs_gset_eq:NN</code>
<code>\cs_gset_eq:Nc</code>
<code>\cs_gset_eq:cN</code>
<code>\cs_gset_eq:cc</code>

`\cs_gset_eq:NN <cs 1> <cs 2>`

Globally sets  $\langle \textit{control sequence 1} \rangle$  to have the same meaning as  $\langle \textit{control sequence 2} \rangle$  at the point where `\cs_gset_eq:NN` is executed. The two control sequences may subsequently be altered without affecting the copy. The assignment of a meaning to  $\langle \textit{control sequence 1} \rangle$  is *not* restricted to the current  $\text{\TeX}$  group level: the assignment is global.

## 8.5 Deleting control sequences

There are occasions where control sequences need to be deleted. This is handled in a very simple manner.

<code>\cs_undefine:N</code>
<code>\cs_undefine:c</code>

`\cs_undefine:N <control sequence>`

Sets  $\langle \textit{control sequence} \rangle$  to be globally undefined.

## 8.6 Showing control sequences

<code>\cs_meaning:N</code>	★
<code>\cs_meaning:c</code>	★

`\cs_meaning:N <control sequence>`

This function expands to the *meaning* of the `<control sequence>` control sequence. This will show the *<replacement text>* for a macro.

**T<sub>E</sub>Xhackers note:** This is T<sub>E</sub>X's `\meaning` primitive.

<code>\cs_show:N</code>
<code>\cs_show:c</code>

`\cs_show:N <control sequence>`

Displays the definition of the `<control sequence>` on the terminal.

**T<sub>E</sub>Xhackers note:** This is the T<sub>E</sub>X primitive `\show`.

## 8.7 Converting to and from control sequences

<code>\use:c</code>	★
---------------------	---

`\use:c {<control sequence name>}`

Converts the given `<control sequence name>` into a single control sequence token. This process requires two expansions. The content for `<control sequence name>` may be literal material or from other expandable functions. The `<control sequence name>` must, when fully expanded, consist of character tokens which are not active: typically, they will be of category code 10 (space), 11 (letter) or 12 (other), or a mixture of these. As an example, both

```
\use:c { a b c }
```

and

```
\tl_new:N \l_my_tl  
\tl_set:Nn \l_my_tl { a b c }  
\use:c { \tl_use:N \l_my_tl }
```

would be equivalent to

```
\abc
```

after two expansions of `\use:c`.

<code>\cs:w</code>	★
<code>\cs_end:</code>	★

`\cs:w <control sequence name> \cs_end:`

Converts the given *<control sequence name>* into a single control sequence token. This process requires one expansion. The content for *<control sequence name>* may be literal material or from other expandable functions. The *<control sequence name>* must, when fully expanded, consist of character tokens which are not active: typically, they will be of category code 10 (space), 11 (letter) or 12 (other), or a mixture of these. As an example, both

```
\cs:w a b c \cs_end:
```

and

```
\tl_new:N \l_my_tl
\tl_set:Nn \l_my_tl { a b c }
\cs:w \tl_use:N \l_my_tl \cs_end:
```

would be equivalent to

```
\abc
```

after one expansion of `\cs:w`.

**T<sub>E</sub>Xhackers note:** These are the T<sub>E</sub>X primitives `\csname` and `\endcsname`.

<code>\cs_to_str:N</code>	★
---------------------------	---

`\cs_to_str:N {<control sequence>}`

Converts the given *<control sequence>* into a series of characters with category code 12 (other), except spaces, of category code 10. The sequence will *not* include the current escape token, *cf.* `\token_to_str:N`. Full expansion of this function requires a variable number of expansion steps (either 3 or 4), and so an **f**- or **x**-type expansion will be required to convert the *<control sequence>* to a sequence of characters in the input stream.

## 9 Using or removing tokens and arguments

Tokens in the input can be read and used or read and discarded. If one or more tokens are wrapped in braces then in absorbing them the outer set will be removed. At the same time, the category code of each token is set when the token is read by a function (if it is

read more than once, the category code is determined by the the situation in force when first function absorbs the token).

<code>\use:n</code>	★	<code>\use:n</code>	<code>{\group_1}</code>
<code>\use:nn</code>	★	<code>\use:nn</code>	<code>{\group_1}</code> <code>{\group_2}</code>
<code>\use:nnn</code>	★	<code>\use:nnn</code>	<code>{\group_1}</code> <code>{\group_2}</code> <code>{\group_3}</code>
<code>\use:nnnn</code>	★	<code>\use:nnnn</code>	<code>{\group_1}</code> <code>{\group_2}</code> <code>{\group_3}</code> <code>{\group_4}</code>

As illustrated, these functions will absorb between one and four arguments, as indicated by the argument specifier. The braces surrounding each argument will be removed leaving the remaining tokens in the input stream. The category code of these tokens will also be fixed by this process (if it has not already been by some other absorption). All of these functions require only a single expansion to operate, so that one expansion of

```
\use:nn { abc } { { def } }
```

will result in the input stream containing

```
abc { def }
```

*i.e.* only the outer braces will be removed.

<code>\use_i:nn</code>	★	<code>\use_i:nn</code>	<code>{\group_1}</code> <code>{\group_2}</code>
<code>\use_ii:nn</code>	★		

These functions will absorb two groups and leave only the first or the second in the input stream. The braces surrounding the arguments will be removed as part of this process. The category code of these tokens will also be fixed (if it has not already been by some other absorption). A single expansion is needed for the functions to take effect.

<code>\use_i:nnn</code>	★	<code>\use_i:nnn</code>	<code>{\group_1}</code> <code>{\group_2}</code> <code>{\group_3}</code>
<code>\use_ii:nnn</code>	★		
<code>\use_iii:nnn</code>	★		

These functions will absorb three groups and leave only of these in the input stream. The braces surrounding the arguments will be removed as part of this process. The category code of these tokens will also be fixed (if it has not already been by some other absorption). A single expansion is needed for the functions to take effect.

<code>\use_i:nnnn</code>	★	<code>\use_i:nnnn</code>	<code>{\group_1}</code> <code>{\group_2}</code> <code>{\group_3}</code> <code>{\group_4}</code>
<code>\use_ii:nnnn</code>	★		
<code>\use_iii:nnnn</code>	★		
<code>\use_iv:nnnn</code>	★		

These functions will absorb four groups and leave only of these in the input stream.

The braces surrounding the arguments will be removed as part of this process. The category code of these tokens will also be fixed (if it has not already been by some other absorption). A single expansion is needed for the functions to take effect.

<code>\use_i_ii:nnn</code>	★	<code>\use_i_ii:nnn {&lt;group<sub>1</sub>&gt;} {&lt;group<sub>2</sub>&gt;} {&lt;group<sub>3</sub>&gt;}</code>
----------------------------	---	----------------------------------------------------------------------------------------------------------------

This functions will absorb three groups and leave the first and second in the input stream. The braces surrounding the arguments will be removed as part of this process. The category code of these tokens will also be fixed (if it has not already been by some other absorption). A single expansion is needed for the functions to take effect. An example:

```
\use_i_ii:nnn { abc } { { def } } { ghi }
```

will result in the input stream containing

```
abc { def }
```

*i.e.* the outer braces will be removed and the third group will be removed.

<code>\use_none:n</code>	★	<code>\use_none:n {&lt;group<sub>1</sub>&gt;}</code>
<code>\use_none:nn</code>	★	
<code>\use_none:nnn</code>	★	
<code>\use_none:nnnn</code>	★	
<code>\use_none:nnnnn</code>	★	
<code>\use_none:nnnnnn</code>	★	
<code>\use_none:nnnnnnn</code>	★	
<code>\use_none:nnnnnnnn</code>	★	
<code>\use_none:nnnnnnnnn</code>	★	

These functions absorb between one and nine groups from the input stream, leaving nothing on the resulting input stream. These functions work after a single expansion. One or more of the `n` arguments may be an unbraced single token (*i.e.* an `N` argument).

<code>\use:x</code>	<code>\use:x {&lt;expandable tokens&gt;}</code>
---------------------	-------------------------------------------------

Fully expands the `<expandable tokens>` and inserts the result into the input stream at the current location. Any hash characters (`#`) in the argument must be doubled.



## 9.1 Selecting tokens from delimited arguments

A different kind of function for selecting tokens from the token stream are those that use delimited arguments.

<code>\use_none_delimit_by_q_nil:w</code>	★	<code>\use_none_delimit_by_q_nil:w &lt;balanced text&gt; \q_nil</code>
<code>\use_none_delimit_by_q_stop:w</code>	★	
<code>\use_none_delimit_by_q_recursion_stop:w</code>	★	

Absorb the *<balanced>* text from the input stream delimited by the marker given in the function name, leaving nothing in the input stream.

<code>\use_i_delimit_by_q_nil:nw</code>	★	<code>\use_i_delimit_by_q_nil:nw {&lt;inserted tokens&gt;} &lt;balanced text&gt; \q_nil</code>
<code>\use_i_delimit_by_q_stop:nw</code>	★	
<code>\use_i_delimit_by_q_recursion_stop:nw</code>	★	

Absorb the *<balanced>* text from the input stream delimited by the marker given in the function name, leaving *<inserted tokens>* in the input stream for further processing.

<code>\use_i_after_or:nw</code>	★	<code>\use_i_after_or:nw {&lt;inserted tokens&gt;} \or: &lt;balanced text&gt; \fi: {&lt;inserted tokens&gt;} \or: &lt;balanced text&gt; \fi: {&lt;inserted tokens&gt;} \or: or &lt;balanced text&gt; \fi:</code>
<code>\use_i_after_or:nw</code>	★	
<code>\use_i_after_or:nw</code>	★	
<code>\use_i_after_or:nw</code>	★	
<code>\use_i_after_or:nw</code>	★	

Absorb the *<balanced text>*, if appropriate, delimited by the function name given. The *<inserted tokens>* are then placed in the input stream after the delimiter. Thus for example

```
\use_i_after_or:nw { some tokens } \or:
```

will leave

```
\or: some tokens
```

in the input stream for further processing. See the discussion of the primitive TeX conditionals for more detail on `\else:`, `\fi:` and `\or:`.

## 9.2 Decomposing control sequences

`\cs_get_arg_count_from_signature:N *` `\cs_get_arg_count_from_signature:N <function>`

Splits the  $\langle function \rangle$  into the name (*i.e.* the part before the colon) and the signature (*i.e.* after the colon). The  $\langle number \rangle$  of tokens in the  $\langle signature \rangle$  is then left in the input stream. If there was no  $\langle signature \rangle$  then the result is the marker value  $-1$ .

`\cs_get_function_name:N *` `\cs_get_function_name:NN <function>`

Splits the  $\langle function \rangle$  into the name (*i.e.* the part before the colon) and the signature (*i.e.* after the colon). The  $\langle name \rangle$  is then left in the input stream without the escape character present made up of tokens with category code 12 (other).

`\cs_get_function_signature:N *` `\cs_get_function_signature:NN <function>`

Splits the  $\langle function \rangle$  into the name (*i.e.* the part before the colon) and the signature (*i.e.* after the colon). The  $\langle signature \rangle$  is then left in the input stream made up of tokens with category code 12 (other).

`\cs_split_function:NN *` `\cs_split_function:NN <function> <processor>`

Splits the  $\langle function \rangle$  into the name (*i.e.* the part before the colon) and the signature (*i.e.* after the colon). This information is then placed in the input stream after the  $\langle processor \rangle$  function in three parts: the  $\langle name \rangle$ , the  $\langle signature \rangle$  and a logic token indicating if a colon was found (to differentiate variables from function names). The  $\langle name \rangle$  will not include the escape character, and both the  $\langle name \rangle$  and  $\langle signature \rangle$  are made up of tokens with category code 12 (other). The  $\langle processor \rangle$  should be a function with argument specification `:nnN` (plus any trailing arguments needed).

`\cs_to_str:N *` `\cs_to_str:N {<control sequence>}`

Converts the given  $\langle control sequence \rangle$  into a series of characters with category code 12 (other), except spaces, of category code 10. The sequence will *not* include the current escape token, *cf.* `\token_to_str:N`. Full expansion of this function requires a variable number of expansion steps (either 3 or 4), and so an **f**- or **x**-type expansion will be required to convert the  $\langle control sequence \rangle$  to a sequence of characters in the input stream.

## 10 Predicates and conditionals

L<sup>A</sup>T<sub>E</sub>X3 has three concepts for conditional flow processing:

**Branching conditionals** Functions that carry out a test and then execute, depending on its result, either the code supplied in the  $\langle true\ arg \rangle$  or the  $\langle false\ arg \rangle$ . These arguments are denoted with T and F, respectively. An example would be

```
\cs_if_free:cTF{abc} {\langle true code \rangle} {\langle false code \rangle}
```

a function that will turn the first argument into a control sequence (since it's marked as c) then checks whether this control sequence is still free and then depending on the result carry out the code in the second argument (true case) or in the third argument (false case).

These type of functions are known as “conditionals”; whenever a TF function is defined it will usually be accompanied by T and F functions as well. These are provided for convenience when the branch only needs to go a single way. Package writers are free to choose which types to define but the kernel definitions will always provide all three versions.

Important to note is that these branching conditionals with  $\langle true\ code \rangle$  and/or  $\langle false\ code \rangle$  are always defined in a way that the code of the chosen alternative can operate on following tokens in the input stream.

These conditional functions may or may not be fully expandable, but if they are expandable they will be accompanied by a “predicate” for the same test as described below.

**Predicates** “Predicates” are functions that return a special type of boolean value which can be tested by the function `\if_predicate:w` or in the boolean expression parser. All functions of this type are expandable and have names that end with `_p` in the description part. For example,

```
\cs_if_free_p:N
```

would be a predicate function for the same type of test as the conditional described above. It would return “true” if its argument (a single token denoted by N) is still free for definition. It would be used in constructions like

```
\if_predicate:w \cs_if_free_p:N \l_tmpz_tl
  \langle true code \rangle
else:
  \langle false code \rangle
\fi:
```

or in expressions utilizing the boolean logic parser:

```
\bool_if:nTF {
  \cs_if_free_p:N \l_tmpz_tl || \cs_if_free_p:N \g_tmpz_tl
} {\langle true code \rangle} {\langle false code \rangle}
```

Like their branching cousins, predicate functions ensure that all underlying primitive `\else:` or `\fi:` have been removed before returning the boolean true or false values.<sup>2</sup>

For each predicate defined, a “predicate conditional” will also exist that behaves like a conditional described above.

**Primitive conditionals** There is a third variety of conditional, which is the original concept used in plain  $\text{\TeX}$  and  $\text{\LaTeX 2}_{\epsilon}$ . Their use is discouraged in `expl3` (although still used in low-level definitions) because they are more fragile and in many cases require more expansion control (hence more code) than the two types of conditionals described above.

<code>\c_true_bool</code> <code>\c_false_bool</code>	Constants that represent <code>true</code> and <code>false</code> , respectively. Used to implement predicates.
---------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------

## 10.1 Tests on control sequences

<code>\cs_if_eq_p:NN</code> ★ <code>\cs_if_eq:NNTF</code> ★	<code>\cs_if_eq_p:NN</code> $\{\langle cs_1 \rangle\}$ $\{\langle cs_2 \rangle\}$ <code>\cs_if_eq:NNTF</code> $\{\langle cs_1 \rangle\}$ $\{\langle cs_2 \rangle\}$ $\{\langle true\ code \rangle\}$ $\{\langle false\ code \rangle\}$
----------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Compares the definition of two  $\langle control\ sequence \rangle$  and is logically `true` if the two are the same.

<code>\cs_if_exist_p:N</code> ★ <code>\cs_if_exist:NTF</code> ★ <code>\cs_if_exist_p:c</code> ★ <code>\cs_if_exist:cTF</code> ★	<code>\cs_if_exist_p:N</code> $\langle control\ sequence \rangle$ <code>\cs_if_exist:NNTF</code> $\langle control\ sequence \rangle$ $\langle true\ code \rangle$ $\langle false\ code \rangle$
------------------------------------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Tests whether the  $\langle control\ sequence \rangle$  is currently defined (whether as a function or another control sequence type). Any valid definition of  $\langle control\ sequence \rangle$  will evaluate as `true`.

<code>\cs_if_free_p:N</code> ★ <code>\cs_if_free:NNTF</code> ★ <code>\cs_if_free_p:c</code> ★ <code>\cs_if_free:cTF</code> ★	<code>\cs_if_free_p:N</code> $\langle control\ sequence \rangle$ <code>\cs_if_free:NNTF</code> $\langle control\ sequence \rangle$ $\langle true\ code \rangle$ $\langle false\ code \rangle$
---------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Tests whether the  $\langle control\ sequence \rangle$  is currently free to be defined. This test will be `false` if the  $\langle control\ sequence \rangle$  currently exists (as defined by `\cs_if_exist:N`).

---

<sup>2</sup>If defined using the interface provided.

## 10.2 Testing string equality

<code>\str_if_eq_p:nn</code>	★	
<code>\str_if_eq:nn</code>	<u>TF</u>	★
<code>\str_if_eq_p:Vn</code>	★	
<code>\str_if_eq:Vn</code>	<u>TF</u>	★
<code>\str_if_eq_p:on</code>	★	
<code>\str_if_eq:on</code>	<u>TF</u>	★
<code>\str_if_eq_p:no</code>	★	
<code>\str_if_eq:no</code>	<u>TF</u>	★
<code>\str_if_eq_p:nV</code>	★	
<code>\str_if_eq:nV</code>	<u>TF</u>	★
<code>\str_if_eq_p:VV</code>	★	
<code>\str_if_eq:VV</code>	<u>TF</u>	★
<code>\str_if_eq_p:xx</code>	★	<code>\str_if_eq_p:nn {&lt;tl<sub>1</sub>&gt;} {&lt;tl<sub>2</sub>&gt;}</code>
<code>\str_if_eq:xx</code>	<u>TF</u>	★ <code>\str_if_eq:nnTF {&lt;tl<sub>1</sub>&gt;} {&lt;tl<sub>2</sub>&gt;} {&lt;true code&gt;} {&lt;false code&gt;}</code>

Compares the two *<token lists>* on a character by character basis, and is `true` if the two lists contain the same characters in the same order. Thus for example

```
\str_if_eq_p:xx { abc } { \tl_to_str:n { abc } }
```

is logically `true`. All versions of these functions are fully expandable (including those involving an `x`-type expansion).

## 10.3 Engine-specific conditionals

<code>\luatex_if_engine:</code>	<u>TF</u>	★	<code>\luatex_if_engine:TF {&lt;true code&gt;} {&lt;false code&gt;}</code>
---------------------------------	-----------	---	----------------------------------------------------------------------------

Detects if the document is being compiled using LuaTeX.

<code>\pdftex_if_engine:</code>	<u>TF</u>	★	<code>\pdftex_if_engine:TF {&lt;true code&gt;} {&lt;false code&gt;}</code>
---------------------------------	-----------	---	----------------------------------------------------------------------------

Detects if the document is being compiled using pdfTeX.

<code>\xetex_if_engine:</code>	<u>TF</u>	★	<code>\xetex_if_engine:TF {&lt;true code&gt;} {&lt;false code&gt;}</code>
--------------------------------	-----------	---	---------------------------------------------------------------------------

Detects if the document is being compiled using XeTeX.

<code>\c_luatex_is_engine_bool</code>	
<code>\c_pdftex_is_engine_bool</code>	
<code>\c_xetex_is_engine_bool</code>	

Boolean versions of the engine conditionals, for use in predicate tests.

## 10.4 Primitive conditionals

The  $\varepsilon$ -TeX engine itself provides many different conditionals. Some expand whatever comes after them and others don't. Hence the names for these underlying functions will often contain a :w part but higher level functions are often available. See for instance `\int_compare_p:nNn` which is a wrapper for `\if_num:w`.

Certain conditionals deal with specific data types like boxes and fonts and are described there. The ones described below are either the universal conditionals or deal with control sequences. We will prefix primitive conditionals with `\if_`.

<code>\if_true:</code>	★	
<code>\if_false:</code>	★	
<code>\or:</code>	★	
<code>\else:</code>	★	
<code>\fi:</code>	★	<code>\if_true: &lt;true code&gt; \else: &lt;false code&gt; \fi:</code>
<code>\reverse_if:N</code>	★	<code>\if_false: &lt;true code&gt; \else: &lt;false code&gt; \fi:</code>
		<code>\reverse_if:N &lt;primitive conditional&gt;</code>

`\if_true:` always executes *<true code>*, while `\if_false:` always executes *<false code>*. `\reverse_if:N` reverses any two-way primitive conditional. `\else:` and `\fi:` delimit the branches of the conditional. `\or:` is used in case switches, see `l3intexpr` for more.

**TeXhackers note:** These are equivalent to their corresponding TeX primitive conditionals; `\reverse_if:N` is  $\varepsilon$ -TeX's `\unless`.

<code>\if_meaning:w</code>	★	<code>\if_meaning:w &lt;arg<sub>1</sub>&gt; &lt;arg<sub>2</sub>&gt; &lt;true code&gt; \else: &lt;false code&gt; \fi:</code>
----------------------------	---	-----------------------------------------------------------------------------------------------------------------------------

`\if_meaning:w` executes *<true code>* when *<arg<sub>1</sub>>* and *<arg<sub>2</sub>>* are the same, otherwise it executes *<false code>*. *<arg<sub>1</sub>>* and *<arg<sub>2</sub>>* could be functions, variables, tokens; in all cases the *unexpanded* definitions are compared.

**TeXhackers note:** This is TeX's `\ifx`.

<code>\if:w</code>	★	<code>\if:w &lt;token<sub>1</sub>&gt; &lt;token<sub>2</sub>&gt; &lt;true code&gt; \else: &lt;false code&gt;</code>
<code>\if_charcode:w</code>	★	<code>\fi:</code>
<code>\if_catcode:w</code>	★	<code>\if_catcode:w &lt;token<sub>1</sub>&gt; &lt;token<sub>2</sub>&gt; &lt;true code&gt; \else: &lt;false code&gt; \fi:</code>

These conditionals will expand any following tokens until two unexpandable tokens are left. If you wish to prevent this expansion, prefix the token in question with `\exp_not:N`. `\if_catcode:w` tests if the category codes of the two tokens are the same whereas `\if:w` tests if the character codes are identical. `\if_charcode:w` is an alternative name for `\if:w`.

<code>\if_predicate:w</code>	★	<code>\if_predicate:w &lt;predicate&gt; &lt;true code&gt; \else: &lt;false code&gt; \fi:</code>
------------------------------	---	-------------------------------------------------------------------------------------------------

This function takes a predicate function and branches according to the result. (In practice

this function would also accept a single boolean variable in place of the  $\langle predicate \rangle$  but to make the coding clearer this should be done through  $\backslash\text{if\_bool:N}$ .)

$\backslash\text{if\_bool:N}$ ★
---------------------------------

 $\backslash\text{if\_bool:N} \langle boolean \rangle \langle true\ code \rangle \backslash\text{else:} \langle false\ code \rangle \backslash\text{fi:}$   
This function takes a boolean variable and branches according to the result.

$\backslash\text{if\_cs\_exist:N}$ ★
$\backslash\text{if\_cs\_exist:w}$ ★

 $\backslash\text{if\_cs\_exist:N} \langle cs \rangle \langle true\ code \rangle \backslash\text{else:} \langle false\ code \rangle \backslash\text{fi:}$   
 $\backslash\text{if\_cs\_exist:w} \langle tokens \rangle \backslash\text{cs\_end:} \langle true\ code \rangle \backslash\text{else:}$   
 $\langle false\ code \rangle \backslash\text{fi:}$ 

Check if  $\langle cs \rangle$  appears in the hash table or if the control sequence that can be formed from  $\langle tokens \rangle$  appears in the hash table. The latter function does not turn the control sequence in question into  $\backslash\text{scan\_stop:}$ ! This can be useful when dealing with control sequences which cannot be entered as a single token.

$\backslash\text{if\_mode\_horizontal:}$ ★
$\backslash\text{if\_mode\_vertical:}$ ★
$\backslash\text{if\_mode\_math:}$ ★
$\backslash\text{if\_mode\_inner:}$ ★

 $\backslash\text{if\_mode\_horizontal:} \langle true\ code \rangle \backslash\text{else:} \langle false\ code \rangle \backslash\text{fi:}$ 

Execute  $\langle true\ code \rangle$  if currently in horizontal mode, otherwise execute  $\langle false\ code \rangle$ . Similar for the other functions.

## 11 Internal kernel functions

$\backslash\text{chk\_if\_exist\_cs:N}$
$\backslash\text{chk\_if\_exist\_cs:c}$

 $\backslash\text{chk\_if\_exist\_cs:N} \langle cs \rangle$ 

This function checks that  $\langle cs \rangle$  exists according to the criteria for  $\backslash\text{cs\_if\_exist\_p:N}$ , and if not raises a kernel-level error.

$\backslash\text{chk\_if\_free\_cs:N}$
$\backslash\text{chk\_if\_free\_cs:c}$

 $\backslash\text{chk\_if\_free\_cs:N} \langle cs \rangle$ 

This function checks that  $\langle cs \rangle$  is free according to the criteria for  $\backslash\text{cs\_if\_free\_p:N}$ , and if not raises a kernel-level error.

$\backslash\text{pref\_global:D}$
$\backslash\text{pref\_long:D}$
$\backslash\text{pref\_protected:D}$

 $\backslash\text{pref\_global:D} \backslash\text{cs\_set\_npar:Npn}$ 

Prefix functions that can be used in front of some definition functions (namely ...). The result of prefixing a function definition with  $\backslash\text{pref\_global:D}$  makes the definition global,

`\pref_long:D` change the argument scanning mechanism so that it allows `\par` tokens in the argument of the prefixed function, and `\pref_protected:D` makes the definition robust inside `x`-type expansions.

None of these internal functions should be used by a programmer since the necessary combinations are all available as separate function, *e.g.* `\cs_set:Npn` is internally implemented as `\pref_long:D` ç.

**T<sub>E</sub>Xhackers note:** These prefixes are the primitives `\global`, `\long`, and `\protected`.

## Part V

# The l3expan package

## Argument expansion

This module provides generic methods for expanding T<sub>E</sub>X arguments in a systematic manner. The functions in this module all have prefix `exp`.

Not all possible variations are implemented for every base function. Instead only those that are used within the L<sup>A</sup>T<sub>E</sub>X3 kernel or otherwise seem to be of general interest are implemented. Consult the module description to find out which functions are actually defined. The next section explains how to define missing variants.

## 12 Defining new variants

The definition of variant forms for base functions may be necessary when writing new functions or when applying a kernel function in a situation that we haven't thought of before.

Internally preprocessing of arguments is done with functions from the `\exp_` module. They all look alike, an example would be `\exp_args:NNo`. This function has three arguments, the first and the second are a single tokens the third argument gets expanded once. If `\seq_gpush:No` was not defined the example above could be coded in the following way:

```
\exp_args:NNo \seq_gpush:Nn
  \g_file_name_stack
  \l_tmpa_tl
```

In other words, the first argument to `\exp_args:NNo` is the base function and the other arguments are preprocessed and then passed to this base function. In the example the



first argument to the base function should be a single token which is left unchanged while the second argument is expanded once. From this example we can also see how the variants are defined. They just expand into the appropriate `\exp_` function followed by the desired base function, *e.g.*

```
\cs_new_nopar:Npn\seq_gpush:No{\exp_args:NNo\seq_gpush:Nn}
```

Providing variants in this way in style files is uncritical as the `\cs_new_nopar:Npn` function will silently accept definitions whenever the new definition is identical to an already given one. Therefore adding such definition to later releases of the kernel will not make such style files obsolete.

The steps above may be automated by using the function `\cs_generate_variant:Nn`, described next.

## 13 Methods for defining variants

<code>\cs_generate_variant:Nn</code>	<code>\cs_generate_variant:Nn &lt;parent control sequence&gt; {&lt;variant argument specifiers&gt;}</code>
--------------------------------------	----------------------------------------------------------------------------------------------------------------

This function is used to define argument-specifier variants of the *<parent control sequence>* for L<sup>A</sup>T<sub>E</sub>X3 code-level macros. The *<parent control sequence>* is first separated into the *<base name>* and *<original argument specifier>*. The comma-separated list of *<variant argument specifiers>* is then used to define variants of the *<original argument specifier>* where these are not already defined. For each *<variant>* given, a function is created which will expand its arguments as detailed and pass them to the *<parent control sequence>*. So for example

```
\cs_set:Npn \foo:Nn #1#2 { code here }
\cs_generate_variant:Nn \foo:Nn { c }
```

will create a new function `\foo:cn` which will expand its first argument into a control sequence name and pass the result to `\foo:Nn`. Similarly

```
\cs_generate_variant:Nn \foo:Nn { NV , cV }
```

would generate the functions `\foo:NV` and `\foo:cV` in the same way. The `\cs_generate_variant:Nn` function can only be applied if the *<parent control sequence>* is already defined. If the *<parent control sequence>* is protected then the new sequence will also be protected. The *<variant>* is created globally, as is any `\exp_args:N<variant>` function needed to carry out the expansion.

## 14 Introducing the variants

The available internal functions for argument expansion come in two flavours, some of them are faster than others. Therefore it is usually best to follow the following guidelines when defining new functions that are supposed to come with variant forms:

- Arguments that might need expansion should come first in the list of arguments to make processing faster.
- Arguments that should consist of single tokens should come first.
- Arguments that need full expansion (*i.e.*, are denoted with `x`) should be avoided if possible as they can not be processed expandably, *i.e.*, functions of this type will not work correctly in arguments that are itself subject to `x` expansion.
- In general, unless in the last position, multi-token arguments `n`, `f`, and `o` will need special processing which is not fast. Therefore it is best to use the optimized functions, namely those that contain only `N`, `c`, `V`, and `v`, and, in the last position, `o`, `f`, with possible trailing `N` or `n`, which are not expanded.

The `V` type returns the value of a register, which can be one of `tl`, `num`, `int`, `skip`, `dim`, `toks`, or built-in TeX registers. The `v` type is the same except it first creates a control sequence out of its argument before returning the value. This recent addition to the argument specifiers may shake things up a bit as most places where `o` is used will be replaced by `V`. The documentation you are currently reading will therefore require a fair bit of re-writing.

In general, the programmer should not need to be concerned with expansion control. When simply using the content of a variable, functions with a `V` specifier should be used. For those referred to by `(cs)name`, the `v` specifier is available for the same purpose. Only when specific expansion steps are needed, such as when using delimited arguments, should the lower-level functions with `o` specifiers be employed.

The `f` type is so special that it deserves an example. Let's pretend we want to set `\aaa` equal to the control sequence stemming from turning `b \l_tmpa_tl b` into a control sequence. Furthermore we want to store the execution of it in a *tl var*. In this example we assume `\l_tmpa_tl` contains the text string `lur`. The straightforward approach is

```
\tl_set:Nc \l_tmpb_tl {\cs_set_eq:Nc \aaa { b \l_tmpa_tl b } }
```

Unfortunately this only puts `\exp_args:Nnc \cs_set_eq:NN \aaa {b \l_tmpa_tl b}` into `\l_tmpb_tl` and not `\cs_set_eq:NwN \aaa = \blurb` as we probably wanted. Using `\tl_set:Nx` is not an option as that will die horribly. Instead we can do a

```
\tl_set:Nf \l_tmpb_tl {\cs_set_eq:Nc \aaa { b \l_tmpa_tl b } }
```

which puts the desired result in `\l_tmpb_tl`. It requires `\toks_set:Nf` to be defined as

`\cs_set_nopar:Npn \tl_set:Nf { \exp_args:NNf \tl_set:Nn }`

If you use this type of expansion in conditional processing then you should stick to using TF type functions only as it does not try to finish any `\if... \fi`: itself!

## 15 Manipulating the first argument

These functions are described in detail: expansion of multiple tokens follows the same rules but is described in a shorter fashion.

`\exp_args:No` ★ `\exp_args:No <function> {<tokens>} {<tokens2>} ...`

This function absorbs two arguments (the `<function>` name and the `<tokens>`). The `<tokens>` are expanded once, and the result is inserted in braces into the input stream *after* reinsertion of the `<function>`. Thus the `<function>` may take more than one argument: all others will be left unchanged.

`\exp_args:Nc` ★  
`\exp_args:cc` ★ `\exp_args:Nc <function> {<tokens>} {<tokens2>} ...`

This function absorbs two arguments (the `<function>` name and the `<tokens>`). The `<tokens>` are expanded until only characters remain, and are then turned into a control sequence. (An internal error will occur if such a conversion is not possible). The result is inserted into the input stream *after* reinsertion of the `<function>`. Thus the `<function>` may take more than one argument: all others will be left unchanged.

The `:cc` variant constructs the `<function>` name in the same manner as described for the `<tokens>`.

`\exp_args:Nv` ★ `\exp_args:Nv <function> <variable> {<tokens2>} ...`

This function absorbs two arguments (the names of the `<function>` and the `<variable>`). The content of the `<variable>` are recovered and placed inside braces into the input stream *after* reinsertion of the `<function>`. Thus the `<function>` may take more than one argument: all others will be left unchanged.

`\exp_args:Nv` ★ `\exp_args:Nv <function> {<tokens>} {<tokens2>} ...`

This function absorbs two arguments (the `<function>` name and the `<tokens>`). The `<tokens>` are expanded until only characters remain, and are then turned into a control sequence. (An internal error will occur if such a conversion is not possible). This control sequence should be the name of a `<variable>`. The content of the `<variable>` are recovered and placed inside braces into the input stream *after* reinsertion of the `<function>`. Thus the `<function>` may take more than one argument: all others will be left unchanged.

`\exp_args:Nf` ★ `\exp_args:Nf <function> {<tokens>} {<tokens2>} ...`

This function absorbs two arguments (the `<function>` name and the `<tokens>`). The

$\langle tokens \rangle$  are fully expanded until the first non-expandable token or space is found, and the result is inserted in braces into the input stream *after* reinsertion of the  $\langle function \rangle$ . Thus the  $\langle function \rangle$  may take more than one argument: all others will be left unchanged.

<code>\exp_args:Nx</code>
---------------------------

`\exp_args:Nx  $\langle function \rangle$   $\{\langle tokens \rangle\}$   $\{\langle tokens_2 \rangle\}$  ...`

This function absorbs two arguments (the  $\langle function \rangle$  name and the  $\langle tokens \rangle$ ) and exhaustively expands the  $\langle tokens \rangle$  second. The result is inserted in braces into the input stream *after* reinsertion of the  $\langle function \rangle$ . Thus the  $\langle function \rangle$  may take more than one argument: all others will be left unchanged.

## 16 Manipulating two arguments

<code>\exp_args:NNo</code>	★
<code>\exp_args:NNc</code>	★
<code>\exp_args:NNv</code>	★
<code>\exp_args:NNV</code>	★
<code>\exp_args:NNf</code>	★
<code>\exp_args:Nco</code>	★
<code>\exp_args:Ncf</code>	★
<code>\exp_args:Ncc</code>	★
<code>\exp_args:NVV</code>	★

`\exp_args:NNc  $\langle token1 \rangle$   $\langle token2 \rangle$   $\{\langle tokens \rangle\}$` 

These optimized functions absorb three arguments and expand the second and third as detailed by their argument specifier. The first argument of the function is then the next item on the input stream, followed by the expansion of the second and third arguments.

<code>\exp_args:Nno</code>	★
<code>\exp_args:NnV</code>	★
<code>\exp_args:Nnf</code>	★
<code>\exp_args:Noo</code>	★
<code>\exp_args:Noc</code>	★
<code>\exp_args:Nff</code>	★
<code>\exp_args:Nfo</code>	★
<code>\exp_args:Nnc</code>	★

`\exp_args:Noo  $\langle token \rangle$   $\{\langle tokens_1 \rangle\}$   $\{\langle tokens_2 \rangle\}$` 

These functions absorb three arguments and expand the second and third as detailed by their argument specifier. The first argument of the function is then the next item on the input stream, followed by the expansion of the second and third arguments. These

functions need special (slower) processing.

<code>\exp_args:NNx</code>	<code>\exp_args:NNx &lt;token1&gt; &lt;token2&gt; {(tokens)}</code>
<code>\exp_args:Nnx</code>	
<code>\exp_args:Ncx</code>	
<code>\exp_args:Nox</code>	
<code>\exp_args:Nxo</code>	
<code>\exp_args:Nxx</code>	

These functions absorb three arguments and expand the second and third as detailed by their argument specifier. The first argument of the function is then the next item on the input stream, followed by the expansion of the second and third arguments. These functions are not expandable.

## 17 Manipulating three arguments

<code>\exp_args:NNNo</code>	★	<code>\exp_args:NNNo &lt;token1&gt; &lt;token2&gt; &lt;token3&gt; {(tokens)}</code>
<code>\exp_args:NNNV</code>	★	
<code>\exp_args:Nccc</code>	★	
<code>\exp_args:NcNc</code>	★	
<code>\exp_args:NcNo</code>	★	
<code>\exp_args:Ncco</code>	★	

These optimized functions absorb four arguments and expand the second, third and fourth as detailed by their argument specifier. The first argument of the function is then the next item on the input stream, followed by the expansion of the second argument, *etc.*

<code>\exp_args:NNoo</code>	★	<code>\exp_args:NNNo &lt;token1&gt; &lt;token2&gt; &lt;token3&gt; {(tokens)}</code>
<code>\exp_args:NNno</code>	★	
<code>\exp_args:Nnno</code>	★	
<code>\exp_args:Nnnc</code>	★	
<code>\exp_args:Nooo</code>	★	
<code>\exp_args:Nooo</code>	★	

These functions absorb four arguments and expand the second, third and fourth as detailed by their argument specifier. The first argument of the function is then the next item on the input stream, followed by the expansion of the second argument, *etc.* These

functions need special (slower) processing.

<code>\exp_args:NNnx</code>	<code>\exp_args:NNnx &lt;token1&gt; &lt;token2&gt; &lt;tokens1&gt; {&lt;tokens2&gt;}</code>
<code>\exp_args:NNox</code>	
<code>\exp_args:Nnnx</code>	
<code>\exp_args:Nnox</code>	
<code>\exp_args:Noox</code>	
<code>\exp_args:Ncnx</code>	
<code>\exp_args:Nccx</code>	

These functions absorb four arguments and expand the second, third and fourth as detailed by their argument specifier. The first argument of the function is then the next item on the input stream, followed by the expansion of the second argument, *etc.*

## 18 Unbraced expansion

<code>\exp_last_unbraced:Nf</code>	<code>\exp_last_unbraced:Nno &lt;token&gt; &lt;tokens1&gt; &lt;tokens2&gt;</code>
<code>\exp_last_unbraced:NV</code>	
<code>\exp_last_unbraced:No</code>	
<code>\exp_last_unbraced:Nv</code>	
<code>\exp_last_unbraced:NcV</code>	
<code>\exp_last_unbraced:NNV</code>	
<code>\exp_last_unbraced:NNno</code>	
<code>\exp_last_unbraced:Nfo</code>	
<code>\exp_last_unbraced:NNNV</code>	
<code>\exp_last_unbraced:NNNo</code>	

These functions absorb the number of arguments given by their specification, carry out the expansion indicated and leave the the results in the input stream, with the last argument not surrounded by the usual braces. Of these, `\exp_last_unbraced:Nfo` needs special (slower) processing.

<code>\exp_last_two_unbraced:Noo</code> ★	<code>\exp_last_two_unbraced:Noo &lt;token&gt; &lt;tokens1&gt; {&lt;tokens2&gt;}</code>
-------------------------------------------	-----------------------------------------------------------------------------------------

This function absorbs three arguments and expand the second and third once. The first argument of the function is then the next item on the input stream, followed by the expansion of the second and third arguments, which are not wrapped in braces. This function needs special (slower) processing.

<code>\exp_after:wN</code> ★	<code>\exp_after:wN &lt;token1&gt; &lt;token2&gt;</code>
------------------------------	----------------------------------------------------------

Carries out a single expansion of `<token2>` prior to expansion of `<token1>`. If `<token2>` is a `TeX` primitive, it will be executed rather than expanded, while if `<token2>` has not

expansion (for example, if it is a character) then it will be left unchanged. It is important to notice that  $\langle token1 \rangle$  may be *any* single token, including group-opening and -closing tokens ( $\{$  or  $\}$ " assuming normal  $\text{\TeX}$  category codes). Unless specifically required, expansion should be carried out using an appropriate argument specifier variant or the appropriate  $\text{\exp\_arg:N}$  function.

**$\text{\TeX}$ hackers note:** This is the  $\text{\TeX}$  primitive  $\text{\expandafter}$  renamed.

## 19 Preventing expansion

$\text{\exp\_not:N}$   $\text{\exp\_not:N} \langle token \rangle$

Prevents expansion of the  $\langle token \rangle$  in a context where it would otherwise be expanded, for example an  $\mathbf{x}$ -type argument.

**$\text{\TeX}$ hackers note:** This is the  $\text{\TeX}$   $\text{\noexpand}$  primitive.

$\text{\exp\_not:c}$   $\text{\exp\_not:c} \{ \langle tokens \rangle \}$

Expands the  $\langle tokens \rangle$  until only unexpandable content remains, and then converts this into a control sequence. Further expansion of this control sequence is then inhibited.

$\text{\exp\_not:n}$   $\text{\exp\_not:n} \{ \langle tokens \rangle \}$

Prevents expansion of the  $\langle tokens \rangle$  in a context where they would otherwise be expanded, for example an  $\mathbf{x}$ -type argument.

**$\text{\TeX}$ hackers note:** This is the  $\varepsilon$ - $\text{\TeX}$   $\text{\unexpanded}$  primitive.

$\text{\exp\_not:V}$   $\text{\exp\_not:V} \langle variable \rangle$

Recovers the content of the  $\langle variable \rangle$ , then prevents expansion of the this material in a context where it would otherwise be expanded, for example an  $\mathbf{x}$ -type argument.

$\text{\exp\_not:v}$   $\text{\exp\_not:v} \{ \langle tokens \rangle \}$

Expands the  $\langle tokens \rangle$  until only unexpandable content remains, and then converts this into a control sequence (which should be a  $\langle variable \rangle$  name). The content of the  $\langle variable \rangle$

is recovered, and further expansion is prevented in a context where it would otherwise be expanded, for example an `x`-type argument.

`\exp_not:o` `\exp_not:o {⟨tokens⟩}`

Expands the `⟨tokens⟩` once, then prevents any further expansion in a context where they would otherwise be expanded, for example an `x`-type argument.

`\exp_not:f` `\exp_not:f ⟨tokens⟩`

Expands `⟨tokens⟩` fully until the first unexpandable token is found. Expansion then stops, and the result of the expansion (including any tokens which were not expanded) is protected from further expansion.

`\exp_stop_f:` `\function:f ⟨tokens⟩ \exp_stop_f: ⟨more tokens⟩`

This function terminates an `f`-type expansion. Thus if a function `\function:f` starts an `f`-type expansion and all of `⟨tokens⟩` are expandable `\exp_stop_f` will terminate the expansion of tokens even if `⟨more tokens⟩` are also expandable. The function itself is an implicit space token. Inside an `x`-type expansion, it will retain its form, but when typeset it produces the underlying space (`\_`).

## 20 Internal functions and variables

`\l_exp_tl` The `\exp_` module has its private variables to temporarily store results of the argument expansion. This is done to avoid interference with other functions using temporary variables.

`\exp_eval_register:N` `\exp_eval_register:c` `\exp_eval_register:N ⟨variable⟩`

These functions evaluates a `⟨variable⟩` as part of a `V` or `v` expansion (respectively), preceded by `\c_zero` which stops the expansion of a previous `\tex_romannumeral:D`. A `⟨variable⟩` might exist as one of two things: a parameter-less non-long, non-protected



macro or a built-in T<sub>E</sub>X register such as `\count`.

<code>\::n</code>	<code>\cs_set_nopar:Npn \exp_args:Ncof { \::c \::o \::f \::: }</code>
<code>\::N</code>	
<code>\::c</code>	
<code>\::o</code>	
<code>\::f</code>	
<code>\::x</code>	
<code>\::v</code>	
<code>\::V</code>	
<code>\:::</code>	

Internal forms for the base expansion types. These names do *not* conform to the general L<sup>A</sup>T<sub>E</sub>X3 approach as this makes them more readily visible in the log and so forth.

<code>\cs_generate_internal_variant:n</code>	<code>\cs_generate_internal_variant:n &lt;arg spec&gt;</code>
----------------------------------------------	---------------------------------------------------------------

Tests if the function `\exp_args:N<arg spec>` exists, and defines it if it does not. The `<arg spec>` should be a series of one or more of the letters N, c, n, o, V, v, f and x.

## Part VI

# The l3prg package

## Control structures

Conditional processing in L<sup>A</sup>T<sub>E</sub>X3 is defined as something that performs a series of tests, possibly involving assignments and calling other functions that do not read further ahead in the input stream. After processing the input, a *state* is returned. The typical states returned are `<true>` and `<false>` but other states are possible, say an `<error>` state for erroneous input, *e.g.*, text as input in a function comparing integers.

L<sup>A</sup>T<sub>E</sub>X3 has two primary forms of conditional flow processing based on these states. One type is predicate functions that turn the returned state into a boolean `<true>` or `<false>`. For example, the function `\cs_if_free_p:N` checks whether the control sequence given as its argument is free and then returns the boolean `<true>` or `<false>` values to be used in testing with `\if_predicate:w` or in functions to be described below. The other type is the kind of functions choosing a particular argument from the input stream based on the result of the testing as in `\cs_if_free:NTF` which also takes one argument (the N) and then executes either `<true>` or `<false>` depending on the result. Important to note here is that the arguments are executed after exiting the underlying `\if... \fi:` structure.

## 21 Defining a set of conditional functions

<pre> \prg_new_conditional:Npnn \prg_set_conditional:Npnn \prg_new_conditional:Nnn \prg_set_conditional:Nnn </pre>	<pre> \prg_set_conditional:Npnn \&lt;name&gt;:\&lt;arg spec&gt;   \&lt;parameters&gt; {\&lt;conditions&gt;} {\&lt;code&gt;} \prg_set_conditional:Nnn \&lt;name&gt;:\&lt;arg spec&gt;   {\&lt;conditions&gt;} {\&lt;code&gt;} </pre>
--------------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

These functions creates a family of conditionals using the same  $\{\langle code \rangle\}$  to perform the test created. The **new** version will check for existing definitions (*cf.*  $\backslash cs\_new:Npn$ ) whereas the **set** version will not (*cf.*  $\backslash cs\_set:Npn$ ). The conditionals created are depended on the comma-separated list of  $\langle conditions \rangle$ , which should be one or more of **p**, **T**, **F** and **TF**. The conditionals are then defined in the obvious way as:

- $\backslash \langle name \rangle\_p:\langle arg\ spec \rangle$ , a predicate function which will supply either a logical **true** or logical **false**. This function is intended for use in cases where one or more logical tests are combined to lead to a final outcome.
- $\backslash \langle name \rangle:\langle arg\ spec \rangle T$ , a function with one more argument than the original  $\langle arg\ spec \rangle$  demands. The  $\langle true\ branch \rangle$  code in this additional argument will be left on the input stream only if the test is **true**.
- $\backslash \langle name \rangle:\langle arg\ spec \rangle F$ , a function with one more argument than the original  $\langle arg\ spec \rangle$  demands. The  $\langle false\ branch \rangle$  code in this additional argument will be left on the input stream only if the test is **false**.
- $\backslash \langle name \rangle:\langle arg\ spec \rangle TF$ , a function with two more argument than the original  $\langle arg\ spec \rangle$  demands. The  $\langle true\ branch \rangle$  code in the first additional argument will be left on the input stream if the test is **true**, while the  $\langle false\ branch \rangle$  code in the second argument will be left on the input stream if the test is **false**.

The  $\langle code \rangle$  of the test may use  $\langle parameters \rangle$  as specified by the second argument to  $\backslash prg\_set\_conditional:Npnn$ : this should match the  $\langle argument\ specification \rangle$  but this is not enforced. The **Nnn** versions infer the number of arguments from the argument specification given (*cf.*  $\backslash cs\_new:Nn$ , *etc.*). Within the  $\langle code \rangle$ , the functions  $\backslash prg\_return\_true:$  and  $\backslash prg\_return\_false:$  are used to indicate the logical outcomes of the test. If  $\langle code \rangle$  is expandable then  $\backslash prg\_set\_conditional:Npnn$  will generate a family of conditionals which are also expandable. All of the functions are created globally.

An example can easily clarify matters here:

```

\prg_set_conditional:Nnn \foo_if_bar:NN { p , T , TF }
{
  \if_meaning:w \l_tmpa_tl #1
  \prg_return_true:
\else:
  \if_meaning:w \l_tmpa_tl #2

```

```

        \prg_return_true:
    \else:
        \prg_return_false:
    \fi:
\fi:
}

```

This defines the function `\foo_if_bar_p:NN`, `\foo_if_bar:NNTF`, `\foo_if_bar:NNT` but not `\foo_if_bar:NNF` (because `F` is missing from the `<conds>` list). The return statements take care of resolving the remaining `\else:` and `\fi:` before returning the state. There must be a return statement for each branch, failing to do so will result in an error if that branch is executed.

<pre> \prg_new_protected_conditional:Npnn \prg_set_protected_conditional:Npnn \prg_new_protected_conditional:Nnn \prg_set_protected_conditional:Nnn </pre>	<pre> \prg_set_protected_conditional:Npnn   \&lt;name&gt;:\&lt;arg spec&gt; \&lt;parameters&gt;   \&lt;conditions&gt; {\&lt;code&gt;} \prg_set_protected_conditional:Nnn   \&lt;name&gt;:\&lt;arg spec&gt; \&lt;conditions&gt; {\&lt;code&gt;} </pre>
------------------------------------------------------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

These functions creates a family of conditionals using the same `{\<code>}` to perform the test created. The **new** version will check for existing definitions (*cf.* `\cs_new:Npn`) whereas the **set** version will not (*cf.* `\cs_set:Npn`). The conditionals created are depended on the comma-separated list of `<conditions>`, which should be one or more of `T`, `F` and `TF`. The conditionals are then defined in the obvious way as:

- `\<name>:\<arg spec>T`, a function with one more argument than the original `<arg spec>` demands. The `<true branch>` code in this additional argument will be left on the input stream only if the test is **true**.
- `\<name>:\<arg spec>F`, a function with one more argument than the original `<arg spec>` demands. The `<false branch>` code in this additional argument will be left on the input stream only if the test is **false**.
- `\<name>:\<arg spec>TF`, a function with two more argument than the original `<arg spec>` demands. The `<true branch>` code in the first additional argument will be left on the input stream if the test is **true**, while the `<false branch>` code in the second argument will be left on the input stream if the test is **false**.

The `<code>` of the test may use `<parameters>` as specified by the second argument to `\prg_set_conditional:Npn`: this should match the `<argument specification>` but this is not enforced. The `Nnn` versions infer the number of arguments from the argument specification given (*cf.* `\cs_new:Nn`, *etc.*). Within the `<code>`, the functions `\prg_return_true:` and `\prg_return_false:` are used to indicate the logical outcomes of the test. `\prg_set_protected_conditional:Npn` will generate a family of protected conditional functions,

and so  $\langle code \rangle$  does not need to be expandable. All of the functions are created globally.

$\backslash prg\_new\_eq\_conditional:NN$ $\backslash prg\_set\_eq\_conditional:NN$	$\backslash prg\_new\_eq\_conditional:NN$ $\backslash \langle name1 \rangle: \langle arg\ spec1 \rangle \backslash \langle name2 \rangle: \langle arg\ spec2 \rangle$
----------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------

These will set the definitions of the functions

- $\backslash \langle name1 \rangle\_p: \langle arg\ spec1 \rangle$
- $\backslash \langle name1 \rangle: \langle arg\ spec1 \rangle T$
- $\backslash \langle name1 \rangle: \langle arg\ spec1 \rangle F$
- $\backslash \langle name1 \rangle: \langle arg\ spec1 \rangle TF$

equal to those for

- $\backslash \langle name2 \rangle\_p: \langle arg\ spec2 \rangle$
- $\backslash \langle name2 \rangle: \langle arg\ spec2 \rangle T$
- $\backslash \langle name2 \rangle: \langle arg\ spec2 \rangle F$
- $\backslash \langle name2 \rangle: \langle arg\ spec2 \rangle TF$

In most cases, the two  $\langle arg\ specs \rangle$  will be identical, although this is not enforced. In the case of the `new` function, a check is made for any existing definitions for  $\langle name1 \rangle$ . The functions are set globally.

$\backslash prg\_return\_true: \star$ $\backslash prg\_return\_false: \star$	$\backslash prg\_return\_true:$ $\backslash prg\_return\_false:$
---------------------------------------------------------------------------------	---------------------------------------------------------------------

These functions define the logical state at the end of a conditional. As such, they should appear within the code for a conditional statement generated by `\prg_set_conditional:Npnn`, *etc.*

## 22 The boolean data type

This section describes a boolean data type which is closely connected to conditional processing as sometimes you want to execute some code depending on the value of a switch (*e.g.*, draft/final) and other times you perhaps want to use it as a predicate function in an `\if_predicate:w` test. The problem of the primitive `\if_false:` and `\if_true:` tokens is that it is not always safe to pass them around as they may interfere with scanning for termination of primitive conditional processing. Therefore, we employ

two canonical booleans: `\c_true_bool` or `\c_false_bool`. Besides preventing problems as described above, it also allows us to implement a simple boolean parser supporting the logical operations And, Or, Not, *etc.* which can then be used on both the boolean type and predicate functions.

All conditional `\bool_` functions are expandable and expect the input to also be fully expandable (which will generally mean being constructed from predicate functions, possibly nested).

<code>\bool_new:N</code> <code>\bool_new:c</code>	<code>\bool_new:N &lt;boolean&gt;</code>
------------------------------------------------------	------------------------------------------

Creates a new `<boolean>` or raises an error if the name is already taken. The declaration is global. The `<boolean>` will initially be `false`.

<code>\bool_set_false:N</code> <code>\bool_set_false:c</code>	<code>\bool_set_false:N &lt;boolean&gt;</code>
------------------------------------------------------------------	------------------------------------------------

Sets `<boolean>` logically `false` within the current `TeX` group.

<code>\bool_gset_false:N</code> <code>\bool_gset_false:c</code>	<code>\bool_sget_false:N &lt;boolean&gt;</code>
--------------------------------------------------------------------	-------------------------------------------------

Sets `<boolean>` logically `false` globally.

<code>\bool_set_true:N</code> <code>\bool_set_true:c</code>	<code>\bool_set_true:N &lt;boolean&gt;</code>
----------------------------------------------------------------	-----------------------------------------------

Sets `<boolean>` logically `true` within the current `TeX` group.

<code>\bool_gset_true:N</code> <code>\bool_gset_true:c</code>	<code>\bool_gset_true:N &lt;boolean&gt;</code>
------------------------------------------------------------------	------------------------------------------------

Sets `<boolean>` logically `true` globally.

<code>\bool_set_eq:NN</code> <code>\bool_set_eq:cN</code> <code>\bool_set_eq:Nc</code> <code>\bool_set_eq:cc</code>	<code>\bool_set_eq:NN &lt;boolean1&gt; &lt;boolean2&gt;</code>
------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------

Sets the content of `<boolean1>` equal to that of `<boolean2>`. This assignment is restricted to the current `TeX` group level.

<code>\bool_gset_eq:NN</code> <code>\bool_gset_eq:cN</code> <code>\bool_gset_eq:Nc</code> <code>\bool_gset_eq:cc</code>	<code>\bool_gset_eq:NN &lt;boolean1&gt; &lt;boolean2&gt;</code>
----------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------

Sets the content of  $\langle boolean1 \rangle$  equal to that of  $\langle boolean2 \rangle$ . This assignment is global and so is not limited by the current  $\text{\TeX}$  group level.

$\backslash\text{bool\_set:Nn}$ $\backslash\text{bool\_set:cn}$
--------------------------------------------------------------------

 $\backslash\text{bool\_set:Nn } \langle boolean \rangle \{ \langle boolexpr \rangle \}$ 

Evaluates the  $\langle boolean \text{ expression} \rangle$  as described for  $\backslash\text{bool\_if:n(TF)}$ , and sets the  $\langle boolean \rangle$  variable to the logical truth of this evaluation. This assignment is local.

$\backslash\text{bool\_gset:Nn}$ $\backslash\text{bool\_gset:cn}$
----------------------------------------------------------------------

 $\backslash\text{bool\_gset:Nn } \langle boolean \rangle \{ \langle boolexpr \rangle \}$ 

Evaluates the  $\langle boolean \text{ expression} \rangle$  as described for  $\backslash\text{bool\_if:n(TF)}$ , and sets the  $\langle boolean \rangle$  variable to the logical truth of this evaluation. This assignment is global.

$\backslash\text{bool\_if\_p:N}$ ★ $\backslash\text{bool\_if:NTF}$ ★ $\backslash\text{bool\_if\_p:c}$ ★ $\backslash\text{bool\_if:cTF}$ ★	$\backslash\text{bool\_if\_p:N } \{ \langle boolean \rangle \}$ $\backslash\text{bool\_if:NTF } \{ \langle boolean \rangle \} \{ \langle true \text{ code} \rangle \} \{ \langle false \text{ code} \rangle \}$
----------------------------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Tests the current truth of  $\langle boolean \rangle$ , and continues expansion based on this result.

$\backslash\text{l\_tmpa\_bool}$
----------------------------------

A scratch boolean for local assignment. It is never used by the kernel code, and so is safe for use with any  $\text{\LaTeX}$ -defined function. However, it may be overwritten by other non-kernel code and so should only be used for short-term storage.

$\backslash\text{g\_tmpa\_bool}$
----------------------------------

A scratch boolean for global assignment. It is never used by the kernel code, and so is safe for use with any  $\text{\LaTeX}$ -defined function. However, it may be overwritten by other non-kernel code and so should only be used for short-term storage.

## 23 Boolean expressions

As we have a boolean datatype and predicate functions returning boolean  $\langle true \rangle$  or  $\langle false \rangle$  values, it seems only fitting that we also provide a parser for  $\langle boolean \text{ expressions} \rangle$ .

A boolean expression is an expression which given input in the form of predicate functions and boolean variables, return boolean  $\langle true \rangle$  or  $\langle false \rangle$ . It supports the logical operations And, Or and Not as the well-known infix operators  $\&\&$ ,  $\|\|$  and  $!$ . In addition to this, parentheses can be used to isolate sub-expressions. For example,

```

\int_compare_p:n { 1 = 1 } &&
(
  \int_compare_p:n { 2 = 3 } \|\|
  \int_compare_p:n { 4 = 4 } \|\|

```

```

        \int_compare_p:n { 1 = \error } % is skipped
    ) &&
    ! ( \int_compare_p:n { 2 = 4 } )

```

is a valid boolean expression. Note that minimal evaluation is carried out whenever possible so that whenever a truth value cannot be changed any more, the remaining tests within the current group are skipped.

<code>\bool_if_p:n</code> ★	<code>\bool_if_p:n {&lt;boolean expression&gt;}</code>
<code>\bool_if:nTF</code> ★	<code>\bool_if:nTF {&lt;boolean expression&gt;} {&lt;true code&gt;} {&lt;false code&gt;}</code>

Tests the current truth of *<boolean expression>*, and continues expansion based on this result. The *<boolean expression>* should consist of a series of predicates or boolean variables with the logical relationship between these defined using `&&` (“And”), `||` (“Or”), `!` (“Not”) and parentheses. Minimal evaluation is used in the processing, so that once a result is defined there is not further expansion of the tests. For example

```

\bool_if_p:n
{
  \int_compare_p:nNn { 1 } = { 1 }
  &&
  (
    \int_compare_p:nNn { 2 } = { 3 } ||
    \int_compare_p:nNn { 4 } = { 4 } ||
    \int_compare_p:nNn { 1 } = { \error } % is skipped
  )
  &&
  ! ( \int_compare_p:nNn { 2 } = { 4 } )
}

```

will be `true` and will not evaluate `\int_compare_p:nNn { 1 } = { \error }`. The logical Not applies to the next single predicate or group. As shown above, this means that any predicates requiring an argument have to be given within parentheses.

<code>\bool_not_p:n</code> ★	<code>\bool_not_p:n {&lt;boolean expression&gt;}</code>
------------------------------	---------------------------------------------------------

Function version of `!(<boolean expression>)` within a boolean expression.

<code>\bool_xor_p:nn</code> ★	<code>\bool_xor_p:nn {&lt;boolexpr<sub>1</sub>&gt;} {&lt;boolexpr<sub>1</sub>&gt;}</code>
-------------------------------	-------------------------------------------------------------------------------------------

Implements an “exclusive or” operation between two boolean expressions. There is no infix operation for this logical operator.

## 24 Logical loops

Loops using either boolean expressions or stored boolean values.

<code>\bool_until_do:Nn</code> ★	<code>\bool_until_do:Nn {&lt;boolean&gt;} {&lt;code&gt;}</code>
<code>\bool_until_do:cn</code> ★	

This function firsts checks the logical value of the *<boolean>*. If it is **false** the *<code>* is placed in the input stream and expanded. After the completion of the *<code>* the truth of the *<boolean>* is re-evaluated. The process will then loop until the *<boolean>* is **true**.

<code>\bool_while_do:Nn</code> ★	<code>\bool_while_do:Nn {&lt;boolean&gt;} {&lt;code&gt;}</code>
<code>\bool_while_do:cn</code> ★	

This function firsts checks the logical value of the *<boolean>*. If it is **true** the *<code>* is placed in the input stream and expanded. After the completion of the *<code>* the truth of the *<boolean>* is re-evaluated. The process will then loop until the *<boolean>* is **false**.

<code>\bool_until_do:nn</code> ★	<code>\bool_until_do:nn {&lt;boolean expression&gt;} {&lt;code&gt;}</code>
----------------------------------	----------------------------------------------------------------------------

This function firsts checks the logical value of the *<boolean expression>* (as described for `\bool_if:nTF`). If it is **false** the *<code>* is placed in the input stream and expanded. After the completion of the *<code>* the truth of the *<boolean expression>* is re-evaluated. The process will then loop until the *<boolean expression>* is **true**.

<code>\bool_while_do:nn</code> ★	<code>\bool_while_do:nn {&lt;boolean expression&gt;} {&lt;code&gt;}</code>
----------------------------------	----------------------------------------------------------------------------

This function firsts checks the logical value of the *<boolean expression>* (as described for `\bool_if:nTF`). If it is **true** the *<code>* is placed in the input stream and expanded. After the completion of the *<code>* the truth of the *<boolean expression>* is re-evaluated. The process will then loop until the *<boolean expression>* is **false**.

## 25 Switching by case

For cases where a number of cases need to be considered a family of case-selecting functions are available.

<code>\prg_case_int:nnn</code> ★	<pre> \prg_case_int:nnn   {&lt;test integer expression&gt;}   {     {&lt;intexpr case<sub>1</sub>&gt;} {&lt;code case<sub>1</sub>&gt;}     {&lt;intexpr case<sub>2</sub>&gt;} {&lt;code case<sub>2</sub>&gt;}     ...     {&lt;intexpr case<sub>n</sub>&gt;} {&lt;code case<sub>n</sub>&gt;}   }   {&lt;else case&gt;}       </pre>
----------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

This function evaluates the *<test integer expression>* and compares this in turn to each



of the  $\langle integer\ expression\ cases \rangle$ . If the two are equal then the associated  $\langle code \rangle$  is left in the input stream. If none of the tests are `true` then the `else` code will be left in the input stream. For example

```
\prg_case_int:nnn
{ 2 * 5 }
{
  { 5 }      { Small }
  { 4 + 6 }   { Medium }
  { -2 * 10 } { Negative }
}
{ No idea! }
```

will leave “Medium” in the input stream.

```
\prg_case_dim:nnn
{<test dimension expression>}
{
  {<dimexpr case1>} {<code case1>}
  {<dimexpr case2>} {<code case2>}
  ...
  {<dimexpr casen>} {<code casen>}
}
{<else case>}
```

`\prg_case_dim:nnn` ★

This function evaluates the  $\langle test\ dimension\ expression \rangle$  and compares this in turn to each of the  $\langle dimension\ expression\ cases \rangle$ . If the two are equal then the associated  $\langle code \rangle$  is left in the input stream. If none of the tests are `true` then the `else` code will be left in the input stream.

```
\prg_case_str:nnn
{<test string>}
{
  {<string case1>} {<code case1>}
  {<string case2>} {<code case2>}
  ...
  {<string casen>} {<code casen>}
}
{<else case>}
```

`\prg_case_str:nnn` ★  
`\prg_case_str:onnn` ★  
`\prg_case_str:xxnn` ★

This function compares the  $\langle test\ string \rangle$  in turn with each of the  $\langle string\ cases \rangle$ . If the two are equal (as described for `\str_if_eq:nnTF`) then the associated  $\langle code \rangle$  is left in the input stream. If none of the tests are `true` then the `else` code will be left in the input stream. The `xx` variant is fully expandable, in the same way as the underlying

`\str_if_eq:xxTF` test.

```

\prg_case_tl:Nnn
  <test token list variable>
  {
    <token list variable case1> {\code case1}
    <token list variable case2> {\code case2}
    ...
    <token list variable case_n> {\code case_n}
  }
\prg_case_tl:cnn
  {\else case}

```

This function compares the *<test token list variable>* in turn with each of the *<token list variable cases>*. If the two are equal (as described for `\tl_if_eq:nnTF` then the associated *<code>* is left in the input stream. If none of the tests are **true** then the **else code** will be left in the input stream.

## 26 Producing $n$ copies

```

\prg_replicate:nn ★ \prg_replicate:nn {\integer expression} {\tokens}

```

Evaluates the *<integer expression>* (which should be zero or positive) and creates the resulting number of copies of the *<tokens>*. The function is both expandable and safe for nesting. It yields its result after two expansion steps.

```

\prg_stepwise_function:nnnN ★ \prg_stepwise_function:nnnN {\initial value} {\step}
  {\final value} {\function}

```

This function first evaluates the *<initial value>*, *<step>* and *<final value>*, all of which should be integer expressions. The *<function>* is then placed in front of each *<value>* from the *<initial value>* to the *<final value>* in turn (using *<step>* between each *<value>*). Thus *<function>* should absorb one numerical argument. For example

```

\cs_set_nopar:Npn \my_func:n #1 { I~saw~#1 \\\ }
\prg_stepwise_function:nnnN { 1 } { 5 } { 1 } \my_func:n

```

would print

```

I saw 1
I saw 2
I saw 3
I saw 4
I saw 5

```

<code>\prg_stepwise_inline:nnnn</code>	<code>\prg_stepwise_inline:nnnn {\langle initial value \rangle} {\langle step \rangle} {\langle final value \rangle} {\langle code \rangle}</code>
----------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------

This function first evaluates the  $\langle initial value \rangle$ ,  $\langle step \rangle$  and  $\langle final value \rangle$ , all of which should be integer expressions. The  $\langle code \rangle$  is then placed in front of each  $\langle value \rangle$  from the  $\langle initial value \rangle$  to the  $\langle final value \rangle$  in turn (using  $\langle step \rangle$  between each  $\langle value \rangle$ ). Thus the  $\langle code \rangle$  should define a function of one argument ( $\#1$ ).

<code>\prg_stepwise_variable:nnnNn</code>	<code>\prg_stepwise_variable:nnnNn {\langle initial value \rangle} {\langle step \rangle} {\langle final value \rangle} \langle tl var \rangle {\langle code \rangle}</code>
-------------------------------------------	------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

This function first evaluates the  $\langle initial value \rangle$ ,  $\langle step \rangle$  and  $\langle final value \rangle$ , all of which should be integer expressions. The  $\langle code \rangle$  is inserted into the input stream, with the  $\langle tl var \rangle$  defined as the current  $\langle value \rangle$ . Thus the  $\langle code \rangle$  should make use of the  $\langle tl var \rangle$ .

## 27 Detecting T<sub>E</sub>X's mode

<code>\mode_if_horizontal_p: *</code>	<code>\mode_if_horizontal_p:</code>
<code>\mode_if_horizontal:TF *</code>	<code>\mode_if_horizontal:TF {\langle true code \rangle} {\langle false code \rangle}</code>

Detects if T<sub>E</sub>X is currently in horizontal mode.

<code>\mode_if_inner_p: *</code>	<code>\mode_if_inner_p:</code>
<code>\mode_if_inner:TF *</code>	<code>\mode_if_inner:TF {\langle true code \rangle} {\langle false code \rangle}</code>

Detects if T<sub>E</sub>X is currently in inner mode.

<code>\mode_if_math:TF *</code>	<code>\mode_if_math:TF {\langle true code \rangle} {\langle false code \rangle}</code>
---------------------------------	----------------------------------------------------------------------------------------

Detects if T<sub>E</sub>X is currently in maths mode.

<code>\mode_if_vertical_p: *</code>	<code>\mode_if_vertical_p:</code>
<code>\mode_if_vertical:TF *</code>	<code>\mode_if_vertical:TF {\langle true code \rangle} {\langle false code \rangle}</code>

Detects if T<sub>E</sub>X is currently in vertical mode.

## 28 Internal programming functions

<code>\group_align_safe_begin: *</code>	<code>\group_align_safe_begin:</code>
<code>\group_align_safe_end: *</code>	<code>... \group_align_safe_end:</code>

These functions are used to enclose material in a TeX alignment environment within a specially-constructed group. This group is designed in such a way that it does not add brace groups to the output but does act as a group for the `&` token inside `\tex_halign:D`. This is necessary to allow grabbing of tokens for testing purposes, as TeX uses group level to determine the effect of alignment tokens. Without the special grouping, the use of a function such as `\peek_after:Nw` will result in a forbidden comparison of the internal `\endtemplate` token, yielding a fatal error. Each `\group_align_safe_begin:` must be matched by a `\group_align_safe_end:`, although this does not have to occur within the same function.

<code>\scan_align_safe_stop:</code>	<code>\scan_align_safe_stop:</code>
-------------------------------------	-------------------------------------

This function gets TeX on the right track inside an alignment cell but without destroying any kerning.

<code>\prg_variable_get_scope:N</code> ★	<code>\prg_variable_get_scope:N &lt;variable&gt;</code>
------------------------------------------	---------------------------------------------------------

Returns the scope (g for global, blank otherwise) for the `<variable>`.

<code>\prg_variable_get_type:N</code> ★	<code>\prg_variable_get_type:N &lt;variable&gt;</code>
-----------------------------------------	--------------------------------------------------------

Returns the type of `<variable>` (tl, int, etc.)

## 29 Experimental programmings functions

<code>\prg_quicksort:n</code>	<code>\prg_quicksort:n { &lt;item<sub>1</sub>&gt; } { &lt;item<sub>2</sub>&gt; } ... { &lt;item<sub>n</sub>&gt; } }</code>
-------------------------------	----------------------------------------------------------------------------------------------------------------------------

Performs a quicksort on the token list. The comparisons are performed by the function `\prg_quicksort_compare:nnTF` which is up to the programmer to define. When the sorting process is over, all items are given as argument to the function `\prg_quicksort_function:n` which the programmer also controls.

<code>\prg_quicksort_function:n</code> <code>\prg_quicksort_compare:nnTF</code>	<code>\prg_quicksort_function:n { &lt;element&gt; }</code> <code>\prg_quicksort_compare:nnTF { &lt;element<sub>1</sub>&gt; } { &lt;element<sub>2</sub>&gt; }</code>
------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------------------------------------------------------------------------

The two functions the programmer must define before calling `\prg_quicksort:n`. As an example we could define

```
\cs_set_nopar:Npn\prg_quicksort_function:n #1{{#1}}
\cs_set_nopar:Npn\prg_quicksort_compare:nnTF #1#2#3#4 {\int_compare:nNnTF{#1}>{#2}}
```

Then the function call

```
\prg_quicksort:n {876234520}
```

would return {0}{2}{2}{3}{4}{5}{6}{7}{8}. An alternative example where one sorts a list of words, `\prg_quicksort_compare:nnTF` could be defined as

```
\cs_set_nopar:Npn\prg_quicksort_compare:nnTF #1#2 {
  \int_compare:nNnTF{\tl_compare:nn{#1}{#2}}>\c_zero }
```

## Part VII

# The l3quark package

## Quarks

A special type of constants in L<sup>A</sup>T<sub>E</sub>X3 are “quarks”. These are control sequences that expand to themselves and should therefore *never* be executed directly in the code. This would result in an endless loop!

They are meant to be used as delimiter is weird functions (for example as the stop token (*i.e.* `\q_stop`). They also permit the following ingenious trick: when you pick up a token in a temporary, and you want to know whether you have picked up a particular quark, all you have to do is compare the temporary to the quark using `\if_meaning:w`. A set of special quark testing functions is set up below. All the quark testing functions are expandable although the ones testing only single tokens are much faster.

By convention all constants of type quark start out with `\q_`.

## 30 Defining quarks

`\quark_new:N` `\quark_new:N <quark>`

Creates a new `<quark>` which expands only to `<quark>`. The `<quark>` will be defined globally, and an error message will be raised if the name was already taken.

`\q_stop` Used as a marker for delimited arguments, such as

```
\cs_set:Npn \tmp:w #1#2 \q_stop {#1}
```

`\q_mark` Used as a marker for delimited arguments when `\q_stop` is already in use.

`\q_nil` Quark to mark a null value in structured variables or functions. Used as an end delimiter when this may itself may need to be tested (in contrast to `\q_stop`, which is only ever used as a delimiter).

`\q_no_value` A canonical value for a missing value, when one is requested from a data structure. This is therefore used as a “return” value by functions such as `\prop_get:NnN` if there is no data to return.

## 31 Quark tests

The method used to define quarks means that the single token (N) tests are faster than the multi-token (n) tests. The later should therefore only be used when the argument can definitely take more than a single token.

<code>\quark_if_nil_p:N</code> ★	<code>\quark_if_nil_p:N &lt;token&gt;</code>
<code>\quark_if_nil:N</code> ★	<code>\quark_if_nil:N &lt;token&gt; {\true code} {\false code}</code>

Tests if the `<token>` is equal to `\q_nil`.

<code>\quark_if_nil_p:n</code> ★	
<code>\quark_if_nil:n</code> ★	
<code>\quark_if_nil_p:o</code> ★	
<code>\quark_if_nil:o</code> ★	
<code>\quark_if_nil_p:V</code> ★	<code>\quark_if_nil_p:n {\token list}</code>
<code>\quark_if_nil:V</code> ★	<code>\quark_if_nil:nTF {\token list} {\true code} {\false code}</code>

Tests if the `<token list>` contains only `\q_nil` (distinct from `<token list>` being empty or containing `\q_nil` plus one or more other tokens).

<code>\quark_if_no_value_p:N</code> ★	
<code>\quark_if_no_value:N</code> ★	
<code>\quark_if_no_value_p:c</code> ★	<code>\quark_if_no_value_p:N &lt;token&gt;</code>
<code>\quark_if_no_value:c</code> ★	<code>\quark_if_no_value:N &lt;token&gt; {\true code} {\false code}</code>

Tests if the `<token>` is equal to `\q_no_value`.

<code>\quark_if_no_value_p:n</code> ★	<code>\quark_if_no_value_p:n {\token list}</code>
<code>\quark_if_no_value:n</code> ★	<code>\quark_if_no_value:nTF {\token list} {\true code} {\false code}</code>

Tests if the `<token list>` contains only `\q_no_value` (distinct from `<token list>` being empty or containing `\q_no_value` plus one or more other tokens).

## 32 Recursion

This module provides a uniform interface to intercepting and terminating loops as when one is doing tail recursion. The building blocks follow below.

`\q_recursion_tail` This quark is appended to the data structure in question and appears as a real element there. This means it gets any list separators around it.

`\q_recursion_stop` This quark is added *after* the data structure. Its purpose is to make it possible to terminate the recursion at any point easily.

`\quark_if_recursion_tail_stop:N` `\quark_if_recursion_tail_stop:N {\token}`

Tests if  $\langle token \rangle$  contains only the marker `\q_recursion_tail`, and if so terminates the recursion this is part of using `\use_none_delimit_by_q_recursion_stop:w`. The recursion input must include the marker tokens `\q_recursion_tail` and `\q_recursion_stop` as the last two items.

`\quark_if_recursion_tail_stop:n`  
`\quark_if_recursion_tail_stop:o` `\quark_if_recursion_tail_stop:n {\tokens}`

Tests if  $\langle tokens \rangle$  consists of the single token `\q_recursion_tail`, and if so terminates the recursion this is part of using `\use_none_delimit_by_q_recursion_stop:w`. The recursion input must include the marker tokens `\q_recursion_tail` and `\q_recursion_stop` as the last two items.

`\quark_if_recursion_tail_stop_do:Nn` `\quark_if_recursion_tail_stop_do:nn {\token}`  
`\quark_if_recursion_tail_stop_do:Nn` `\quark_if_recursion_tail_stop_do:nn {\insertion}`

Tests if  $\langle token \rangle$  contains only the marker `\q_recursion_tail`, and if so terminates the recursion this is part of using `\use_none_delimit_by_q_recursion_stop:w`. The recursion input must include the marker tokens `\q_recursion_tail` and `\q_recursion_stop` as the last two items. The  $\langle insertion \rangle$  code is then added to the input stream after the recursion has ended.

`\quark_if_recursion_tail_stop_do:nn`  
`\quark_if_recursion_tail_stop_do:nn` `\quark_if_recursion_tail_stop_do:nn {\tokens}`  
`\quark_if_recursion_tail_stop_do:nn` `\quark_if_recursion_tail_stop_do:nn {\insertion}`

Tests if  $\langle tokens \rangle$  consists of the single token `\q_recursion_tail`, and if so terminates the recursion this is part of using `\use_none_delimit_by_q_recursion_stop:w`. The recursion input must include the marker tokens `\q_recursion_tail` and `\q_recursion_stop` as the last two items. The  $\langle insertion \rangle$  code is then added to the input stream after the recursion has ended.

### 33 Internal quark functions

<code>\use_none_delimit_by_q_recursion_stop:w</code>	<code>\use_none_delimit_by_q_recursion_stop:w ⟨tokens⟩ \q_recursion_stop</code>
------------------------------------------------------	-------------------------------------------------------------------------------------

Used to prematurely terminate a recursion using `\q_recursion_stop` as the end marker, removing any remaining *⟨tokens⟩* from the input stream.

<code>\use_i_delimit_by_q_recursion_stop:nw</code>	<code>\use_i_delimit_by_q_recursion_stop:nw {⟨insertion⟩} ⟨tokens⟩ \q_recursion_stop</code>
----------------------------------------------------	-------------------------------------------------------------------------------------------------

Used to prematurely terminate a recursion using `\q_recursion_stop` as the end marker, removing any remaining *⟨tokens⟩* from the input stream. The *⟨insertion⟩* is then made into the input stream after the end of the recursion.

## Part VIII

# The l3token package

## Token manipulation

This module deals with tokens. Now this is perhaps not the most precise description so let's try with a better description: When programming in  $\text{\TeX}$ , it is often desirable to know just what a certain token is: is it a control sequence or something else. Similarly one often needs to know if a control sequence is expandable or not, a macro or a primitive, how many arguments it takes etc. Another thing of great importance (especially when it comes to document commands) is looking ahead in the token stream to see if a certain character is present and maybe even remove it or disregard other tokens while scanning. This module provides functions for both and as such will have two primary function categories: `\token` for anything that deals with tokens and `\peek` for looking ahead in the token stream.

Most of the time we will be using the term “token” but most of the time the function we're describing can equally well be used on a control sequence as such one is one token as well.

We shall refer to list of tokens as `tlists` and such lists represented by a single control sequence is a “token list variable” `tl var`. Functions for these two types are found in the `l3tl` module.



## 34 All possible tokens

Let us start by reviewing every case that a given token can fall into. It is very important to distinguish two aspects of a token: its meaning, and what it looks like.

For instance, `\if:w`, `\if_charcode:w`, and `\tex_if:D` are three for the same internal operation of TeX, namely the primitive testing the next two characters for equality of their character code. They behave identically in many situations. However, TeX distinguishes them when searching for a delimited argument. Namely, the example function `\show_until_if:w` defined below will take everything until `\if:w` as an argument, despite the presence of other copies of `\if:w` under different names.

```
\cs_new:Npn \show_until_if:w #1 \if:w { \tl_show:n {#1} }
\show_until_if:w \tex_if:D \if_charcode:w \if:w
```

## 35 Character tokens

<pre>\char_set_catcode_escape:N \char_set_catcode_group_begin:N \char_set_catcode_group_end:N \char_set_catcode_math_toggle:N \char_set_catcode_alignment:N \char_set_catcode_end_line:N \char_set_catcode_parameter:N \char_set_catcode_math_superscript:N \char_set_catcode_math_subscript:N \char_set_catcode_ignore:N \char_set_catcode_space:N \char_set_catcode_letter:N \char_set_catcode_other:N \char_set_catcode_active:N \char_set_catcode_comment:N \char_set_catcode_invalid:N</pre>	<pre>\char_set_catcode_letter:N &lt;character&gt;</pre>
---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	---------------------------------------------------------

Sets the category code of the  $\langle character \rangle$  to that indicated in the function name. Depending on the current category code of the  $\langle token \rangle$  the escape token may also be needed:

```
\char_set_catcode_other:N \%
```

The assignment is local.

<pre> \char_set_catcode_escape:n \char_set_catcode_group_begin:n \char_set_catcode_group_end:n \char_set_catcode_math_toggle:n \char_set_catcode_alignment:n \char_set_catcode_end_line:n \char_set_catcode_parameter:n \char_set_catcode_math_superscript:n \char_set_catcode_math_subscript:n \char_set_catcode_ignore:n \char_set_catcode_space:n \char_set_catcode_letter:n \char_set_catcode_other:n \char_set_catcode_active:n \char_set_catcode_comment:n \char_set_catcode_invalid:n </pre>	<pre> \char_set_catcode_letter:n {\integer expression} </pre>
-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	---------------------------------------------------------------

Sets the category code of the  $\langle character \rangle$  which has character code as given by the  $\langle integer expression \rangle$ . This version can be used to set up characters which cannot otherwise be given (*cf.* the N-type variants). The assignment is local.

<pre> \char_set_catcode:nn </pre>	<pre> \char_set_catcode:nn {\intexpr<sub>1</sub>} {\intexpr<sub>2</sub>} </pre>
-----------------------------------	---------------------------------------------------------------------------------

These functions set the category code of the  $\langle character \rangle$  which has character code as given by the  $\langle integer expression \rangle$ . The first  $\langle integer expression \rangle$  is the character code and the second is the category code to apply. The setting applies within the current T<sub>E</sub>X group. In general, the symbolic functions `\char_make_⟨type⟩` should be preferred, but there are cases where these lower-level functions may be useful.

<pre> \char_value_catcode:n ★ </pre>	<pre> \char_value_catcode:n {\integer expression} </pre>
--------------------------------------	----------------------------------------------------------

Expands to the current category code of the  $\langle character \rangle$  with character code given by the  $\langle integer expression \rangle$ .

<pre> \char_show_value_catcode:n </pre>	<pre> \char_show_value_catcode:n {\integer expression} </pre>
-----------------------------------------	---------------------------------------------------------------

Displays the current category code of the  $\langle character \rangle$  with character code given by the  $\langle integer expression \rangle$  on the terminal.

<pre> \char_set_lccode:nn </pre>	<pre> \char_set_lcode:nn {\intexpr<sub>1</sub>} {\intexpr<sub>2</sub>} </pre>
----------------------------------	-------------------------------------------------------------------------------

This function set up the behaviour of  $\langle character \rangle$  when found inside `\tl_to_lowercase:n`,

such that  $\langle character1 \rangle$  will be converted into  $\langle character2 \rangle$ . The two  $\langle characters \rangle$  may be specified using an  $\langle integer expression \rangle$  for the character code concerned. This may include the T<sub>E</sub>X ‘ $\langle character \rangle$ ’ method for converting a single character into its character code:

```
\char_set_lccode:nn { '\A } { '\a } % Standard behaviour
\char_set_lccode:nn { '\A } { '\A + 32 }
\char_set_lccode:nn { 50 } { 60 }
```

The setting applies within the current T<sub>E</sub>X group.

`\char_value_lccode:n` ★ `\char_value_lccode:n { $\langle integer expression \rangle$ }`

Expands to the current lower case code of the  $\langle character \rangle$  with character code given by the  $\langle integer expression \rangle$ .

`\char_show_value_lccode:n` `\char_show_value_lccode:n { $\langle integer expression \rangle$ }`

Displays the current lower case code of the  $\langle character \rangle$  with character code given by the  $\langle integer expression \rangle$  on the terminal.

`\char_set_uccode:nn` `\char_set_uccode:nn { $\langle intexpr_1 \rangle$ } { $\langle intexpr_2 \rangle$ }`

This function set up the behaviour of  $\langle character \rangle$  when found inside `\tl_to_uppercase:n`, such that  $\langle character1 \rangle$  will be converted into  $\langle character2 \rangle$ . The two  $\langle characters \rangle$  may be specified using an  $\langle integer expression \rangle$  for the character code concerned. This may include the T<sub>E</sub>X ‘ $\langle character \rangle$ ’ method for converting a single character into its character code:

```
\char_set_uccode:nn { '\a } { '\A } % Standard behaviour
\char_set_uccode:nn { '\A } { '\A - 32 }
\char_set_uccode:nn { 60 } { 50 }
```

The setting applies within the current T<sub>E</sub>X group.

`\char_value_uccode:n` ★ `\char_value_uccode:n { $\langle integer expression \rangle$ }`

Expands to the current upper case code of the  $\langle character \rangle$  with character code given by the  $\langle integer expression \rangle$ .

`\char_show_value_uccode:n` `\char_show_value_uccode:n { $\langle integer expression \rangle$ }`

Displays the current upper case code of the  $\langle character \rangle$  with character code given by the  $\langle integer expression \rangle$  on the terminal.

`\char_set_mathcode:nn`  $\backslash\text{char\_set\_mathcode:nn } \{\langle intexpr_1 \rangle\} \{\langle intexpr_2 \rangle\}$

This function sets up the math code of  $\langle character \rangle$ . The  $\langle character \rangle$  is specified as an  $\langle integer expression \rangle$  which will be used as the character code of the relevant character. The setting applies within the current T<sub>E</sub>X group.

`\char_value_mathcode:n`  $\backslash\text{char\_value\_mathcode:n } \{\langle integer expression \rangle\}$

Expands to the current math code of the  $\langle character \rangle$  with character code given by the  $\langle integer expression \rangle$ .

`\char_show_value_mathcode:n`  $\backslash\text{char\_show\_value\_mathcode:n } \{\langle integer expression \rangle\}$

Displays the current math code of the  $\langle character \rangle$  with character code given by the  $\langle integer expression \rangle$  on the terminal.

`\char_set_sfcode:nn`  $\backslash\text{char\_set\_sfcode:nn } \{\langle intexpr_1 \rangle\} \{\langle intexpr_2 \rangle\}$

This function sets up the space factor for the  $\langle character \rangle$ . The  $\langle character \rangle$  is specified as an  $\langle integer expression \rangle$  which will be used as the character code of the relevant character. The setting applies within the current T<sub>E</sub>X group.

`\char_value_sfcode:n`  $\backslash\text{char\_value\_sfcode:n } \{\langle integer expression \rangle\}$

Expands to the current space factor for the  $\langle character \rangle$  with character code given by the  $\langle integer expression \rangle$ .

`\char_show_value_sfcode:n`  $\backslash\text{char\_show\_value\_sfcode:n } \{\langle integer expression \rangle\}$

Displays the current space factor for the  $\langle character \rangle$  with character code given by the  $\langle integer expression \rangle$  on the terminal.

## 36 Generic tokens

`\token_new:Nn`  $\backslash\text{token\_new:Nn } \langle token_1 \rangle \{\langle token_2 \rangle\}$

Defines  $\langle token1 \rangle$  to globally be a snapshot of  $\langle token2 \rangle$ . This will be an implicit representation of  $\langle token2 \rangle$ .

<code>\c_group_begin_token</code>
<code>\c_group_end_token</code>
<code>\c_math_toggle_token</code>
<code>\c_alignment_token</code>
<code>\c_parameter_token</code>
<code>\c_math_superscript_token</code>
<code>\c_math_subscript_token</code>
<code>\c_space_token</code>

These are implicit tokens which have the category code described by their name. They are used internally for test purposes but are also available to the programmer for other uses.

<code>\c_catcode_letter_token</code>
<code>\c_catcode_other_token</code>

These are implicit tokens which have the category code described by their name. They are used internally for test purposes and should not be used other than for category code tests.

<code>\c_catcode_active_tl</code>
-----------------------------------

A token list containing an active token. This is used internally for test purposes and should not be used other than in appropriately-constructed category code tests.

## 37 Converting tokens

<code>\token_to_meaning:N</code>	★	<code>\token_to_meaning:N</code>	$\langle token \rangle$
----------------------------------	---	----------------------------------	-------------------------

Inserts the current meaning of the  $\langle token \rangle$  into the input stream as a series of characters of category code 12 (other). This will be the primitive  $\text{\TeX}$  description of the  $\langle token \rangle$ , thus for example both functions defined by `\cs_set_nopar:Npn` and token list variables defined using `\tl_new:N` will be described as `macros`.

**$\text{\TeX}$ hackers note:** This is the  $\text{\TeX}$  primitive `\meaning`.

<code>\token_to_str:N</code>	★	<code>\token_to_str:N</code>	$\langle token \rangle$
<code>\token_to_str:c</code>	★		

Converts the given  $\langle token \rangle$  into a series of characters with category code 12 (other). The current escape character will be the first character in the sequence, although this will

also have category code 12 (the escape character is part of the  $\langle token \rangle$ ). This function requires only a single expansion.

**T<sub>E</sub>Xhackers note:** `\token_to_str:N` is the T<sub>E</sub>X primitive `\string` renamed.

## 38 Token conditionals

<code>\token_if_group_begin_p:N</code> ★ <code>\token_if_group_begin:NTF</code> ★	<code>\token_if_group_begin_p:N</code> $\langle token \rangle$ <code>\token_if_group_begin:NTF</code> $\langle token \rangle$ $\{\langle true\ code \rangle\}$ $\{\langle false\ code \rangle\}$
--------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Tests if  $\langle token \rangle$  has the category code of a begin group token (`{` when normal T<sub>E</sub>X category codes are in force). Note that an explicit begin group token cannot be tested in this way, as it is not a valid N-type argument.

<code>\token_if_group_end_p:N</code> ★ <code>\token_if_group_end:NTF</code> ★	<code>\token_if_group_end_p:N</code> $\langle token \rangle$ <code>\token_if_group_end:NTF</code> $\langle token \rangle$ $\{\langle true\ code \rangle\}$ $\{\langle false\ code \rangle\}$
----------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Tests if  $\langle token \rangle$  has the category code of an end group token (`}` when normal T<sub>E</sub>X category codes are in force). Note that an explicit end group token cannot be tested in this way, as it is not a valid N-type argument.

<code>\token_if_math_toggle_p:N</code> ★ <code>\token_if_math_toggle:NTF</code> ★	<code>\token_if_math_toggle_p:N</code> $\langle token \rangle$ <code>\token_if_math_toggle:NTF</code> $\langle token \rangle$ $\{\langle true\ code \rangle\}$ $\{\langle false\ code \rangle\}$
--------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Tests if  $\langle token \rangle$  has the category code of a math shift token (`$` when normal T<sub>E</sub>X category codes are in force).

<code>\token_if_alignment_p:N</code> ★ <code>\token_if_alignment:NTF</code> ★	<code>\token_if_alignment_p:N</code> $\langle token \rangle$ <code>\token_if_alignment:NTF</code> $\langle token \rangle$ $\{\langle true\ code \rangle\}$ $\{\langle false\ code \rangle\}$
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Tests if  $\langle token \rangle$  has the category code of an alignment token (`&` when normal T<sub>E</sub>X category codes are in force).

<code>\token_if_parameter_p:N</code> ★ <code>\token_if_parameter:NTF</code> ★	<code>\token_if_parameter_p:N</code> $\langle token \rangle$ <code>\token_if_parameter:NTF</code> $\langle token \rangle$ $\{\langle true\ code \rangle\}$ $\{\langle false\ code \rangle\}$
----------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Tests if  $\langle token \rangle$  has the category code of a macro parameter token (# when normal T<sub>E</sub>X category codes are in force).

$\backslash token\_if\_math\_superscript\_p:N$ ★ $\backslash token\_if\_math\_superscript:N\textcolor{red}{TF}$ ★	$\backslash token\_if\_math\_superscript\_p:N \langle token \rangle$ $\backslash token\_if\_math\_superscript:N\textcolor{red}{TF} \langle token \rangle \{\langle true\ code \rangle\}$ $\{\langle false\ code \rangle\}$
----------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Tests if  $\langle token \rangle$  has the category code of a superscript token (^ when normal T<sub>E</sub>X category codes are in force).

$\backslash token\_if\_math\_subscript\_p:N$ ★ $\backslash token\_if\_math\_subscript:N\textcolor{red}{TF}$ ★	$\backslash token\_if\_math\_subscript\_p:N \langle token \rangle$ $\backslash token\_if\_math\_subscript:N\textcolor{red}{TF} \langle token \rangle \{\langle true\ code \rangle\}$ $\{\langle false\ code \rangle\}$
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Tests if  $\langle token \rangle$  has the category code of a subscript token (\_ when normal T<sub>E</sub>X category codes are in force).

$\backslash token\_if\_space\_p:N$ ★ $\backslash token\_if\_space:N\textcolor{red}{TF}$ ★	$\backslash token\_if\_space\_p:N \langle token \rangle$ $\backslash token\_if\_space:N\textcolor{red}{TF} \langle token \rangle \{\langle true\ code \rangle\}$ $\{\langle false\ code \rangle\}$
----------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Tests if  $\langle token \rangle$  has the category code of a space token. Note that an explicit space token with character code 32 cannot be tested in this way, as it is not a valid N-type argument.

$\backslash token\_if\_letter\_p:N$ ★ $\backslash token\_if\_letter:N\textcolor{red}{TF}$ ★	$\backslash token\_if\_letter\_p:N \langle token \rangle$ $\backslash token\_if\_letter:N\textcolor{red}{TF} \langle token \rangle \{\langle true\ code \rangle\}$ $\{\langle false\ code \rangle\}$
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Tests if  $\langle token \rangle$  has the category code of a letter token.

$\backslash token\_if\_other\_p:N$ ★ $\backslash token\_if\_other:N\textcolor{red}{TF}$ ★	$\backslash token\_if\_other\_p:N \langle token \rangle$ $\backslash token\_if\_other:N\textcolor{red}{TF} \langle token \rangle \{\langle true\ code \rangle\}$ $\{\langle false\ code \rangle\}$
----------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Tests if  $\langle token \rangle$  has the category code of an “other” token.

$\backslash token\_if\_active\_p:N$ ★ $\backslash token\_if\_active:N\textcolor{red}{TF}$ ★	$\backslash token\_if\_active\_p:N \langle token \rangle$ $\backslash token\_if\_active:N\textcolor{red}{TF} \langle token \rangle \{\langle true\ code \rangle\}$ $\{\langle false\ code \rangle\}$
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Tests if  $\langle token \rangle$  has the category code of an active character.

$\backslash token\_if\_eq\_catcode\_p:NN$ ★ $\backslash token\_if\_eq\_catcode:NN\textcolor{red}{TF}$ ★	$\backslash token\_if\_eq\_catcode\_p:NN \langle token1 \rangle \langle token2 \rangle$ $\backslash token\_if\_eq\_catcode:NN\textcolor{red}{TF} \langle token1 \rangle \langle token2 \rangle$ $\{\langle true\ code \rangle\} \{\langle false\ code \rangle\}$
------------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Tests if the two  $\langle tokens \rangle$  have the same category code.

<code>\token_if_eq_charcode_p:NN</code>	★	<code>\token_if_eq_charcode_p:NN</code>	$\langle token1 \rangle$	$\langle token2 \rangle$
<code>\token_if_eq_charcode:NNTF</code>	★	<code>\token_if_eq_charcode:NNTF</code>	$\langle token1 \rangle$	$\langle token2 \rangle$

`{\true code}} {\false code}}`

Tests if the two  $\langle tokens \rangle$  have the same character code.

<code>\token_if_eq_meaning_p:NN</code>	★	<code>\token_if_eq_meaning_p:NN</code>	$\langle token1 \rangle$	$\langle token2 \rangle$
<code>\token_if_eq_meaning:NNTF</code>	★	<code>\token_if_eq_meaning:NNTF</code>	$\langle token1 \rangle$	$\langle token2 \rangle$

`{\true code}} {\false code}}`

Tests if the two  $\langle tokens \rangle$  have the same meaning when expanded.

<code>\token_if_macro_p:N</code>	★	<code>\token_if_macro_p:N</code>	$\langle token \rangle$
<code>\token_if_macro:NNTF</code>	★	<code>\token_if_macro:NNTF</code>	$\langle token \rangle$

`{\true code}} {\false code}}`

Tests if the  $\langle token \rangle$  is a  $\text{\TeX}$  macro.

<code>\token_if_cs_p:N</code>	★	<code>\token_if_cs_p:N</code>	$\langle token \rangle$
<code>\token_if_cs:NNTF</code>	★	<code>\token_if_cs:NNTF</code>	$\langle token \rangle$

`{\true code}} {\false code}}`

Tests if the  $\langle token \rangle$  is a control sequence.

<code>\token_if_expandable_p:N</code>	★	<code>\token_if_expandable_p:N</code>	$\langle token \rangle$
<code>\token_if_expandable:NNTF</code>	★	<code>\token_if_expandable:NNTF</code>	$\langle token \rangle$

`{\true code}} {\false code}}`

Tests if the  $\langle token \rangle$  is expandable. This test returns  $\langle false \rangle$  for an undefined token.

<code>\token_if_long_macro_p:N</code>	★	<code>\token_if_long_macro_p:N</code>	$\langle token \rangle$
<code>\token_if_long_macro:NNTF</code>	★	<code>\token_if_long_macro:NNTF</code>	$\langle token \rangle$

`{\true code}} {\false code}}`

Tests if the  $\langle token \rangle$  is a long macro.

<code>\token_if_protected_macro_p:N</code>	★	<code>\token_if_protected_macro_p:N</code>	$\langle token \rangle$
<code>\token_if_protected_macro:NNTF</code>	★	<code>\token_if_protected_macro:NNTF</code>	$\langle token \rangle$

`{\true code}} {\false code}}`



Tests if the  $\langle token \rangle$  is a protected macro: a macro which is both protected and long will return logical **false**.

$\backslash token\_if\_protected\_long\_macro\_p:N$ ★ $\backslash token\_if\_protected\_long\_macro:N\textcolor{red}{TF}$ ★	$\backslash token\_if\_protected\_long\_macro\_p:N \langle token \rangle$ $\backslash token\_if\_protected\_long\_macro:N\textcolor{red}{TF} \langle token \rangle$ $\{\langle true\ code \rangle\} \{\langle false\ code \rangle\}$
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Tests if the  $\langle token \rangle$  is a protected long macro.

$\backslash token\_if\_chardef\_p:N$ ★ $\backslash token\_if\_chardef:N\textcolor{red}{TF}$ ★	$\backslash token\_if\_chardef\_p:N \langle token \rangle$ $\backslash token\_if\_chardef:N\textcolor{red}{TF} \langle token \rangle$ $\{\langle true\ code \rangle\} \{\langle false\ code \rangle\}$
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Tests if the  $\langle token \rangle$  is defined to be a chardef.

$\backslash token\_if\_mathchardef\_p:N$ ★ $\backslash token\_if\_mathchardef:N\textcolor{red}{TF}$ ★	$\backslash token\_if\_mathchardef\_p:N \langle token \rangle$ $\backslash token\_if\_mathchardef:N\textcolor{red}{TF} \langle token \rangle$ $\{\langle true\ code \rangle\} \{\langle false\ code \rangle\}$
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Tests if the  $\langle token \rangle$  is defined to be a mathchardef.

$\backslash token\_if\_dim\_register\_p:N$ ★ $\backslash token\_if\_dim\_register:N\textcolor{red}{TF}$ ★	$\backslash token\_if\_dim\_register\_p:N \langle token \rangle$ $\backslash token\_if\_dim\_register:N\textcolor{red}{TF} \langle token \rangle$ $\{\langle true\ code \rangle\} \{\langle false\ code \rangle\}$
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Tests if the  $\langle token \rangle$  is defined to be a dimension register.

$\backslash token\_if\_int\_register\_p:N$ ★ $\backslash token\_if\_int\_register:N\textcolor{red}{TF}$ ★	$\backslash token\_if\_int\_register\_p:N \langle token \rangle$ $\backslash token\_if\_int\_register:N\textcolor{red}{TF} \langle token \rangle$ $\{\langle true\ code \rangle\} \{\langle false\ code \rangle\}$
--------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Tests if the  $\langle token \rangle$  is defined to be a integer register.

$\backslash token\_if\_skip\_register\_p:N$ ★ $\backslash token\_if\_skip\_register:N\textcolor{red}{TF}$ ★	$\backslash token\_if\_skip\_register\_p:N \langle token \rangle$ $\backslash token\_if\_skip\_register:N\textcolor{red}{TF} \langle token \rangle$ $\{\langle true\ code \rangle\} \{\langle false\ code \rangle\}$
----------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Tests if the  $\langle token \rangle$  is defined to be a skip register.

$\backslash token\_if\_toks\_register\_p:N$ ★ $\backslash token\_if\_toks\_register:N\textcolor{red}{TF}$ ★	$\backslash token\_if\_toks\_register\_p:N \langle token \rangle$ $\backslash token\_if\_toks\_register:N\textcolor{red}{TF} \langle token \rangle$ $\{\langle true\ code \rangle\} \{\langle false\ code \rangle\}$
----------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Tests if the  $\langle token \rangle$  is defined to be a toks register (not used by L<sup>A</sup>T<sub>E</sub>X3).

$\backslash token\_if\_primitive\_p:N$ ★	$\backslash token\_if\_primitive\_p:N \langle token \rangle$
$\backslash token\_if\_primitive:N\textit{TF}$ ★	$\backslash token\_if\_primitive:N\textit{TF} \langle token \rangle$ $\{\langle true\ code \rangle\} \{\langle false\ code \rangle\}$

Tests if the  $\langle token \rangle$  is an engine primitive.

## 39 Peeking ahead at the next token

There is often a need to look ahead at the next token in the input stream while leaving it in place. This is handled using the “peek” functions. The generic  $\backslash peek\_after:Nw$  is provided along with a family of predefined tests for common cases. As peeking ahead does *not* skip spaces the predefined tests include both a space-respecting and space-skipping version.

$\backslash peek\_after:Nw$	$\backslash peek\_after:Nw \langle function \rangle \langle token \rangle$
-----------------------------	----------------------------------------------------------------------------

Locally sets the test variable  $\backslash l\_peek\_token$  equal to  $\langle token \rangle$  (as an implicit token, *not* as a token list), and then expands the  $\langle function \rangle$ . The  $\langle token \rangle$  will remain in the input stream as the next item after the  $\langle function \rangle$ . The  $\langle token \rangle$  here may be  $\sqcup$ ,  $\{$  or  $\}$  (assuming normal T<sub>E</sub>X category codes), *i.e.* it is not necessarily the next argument which would be grabbed by a normal function.

$\backslash peek\_gafter:Nw$	$\backslash peek\_gafter:Nw \langle function \rangle \langle token \rangle$
------------------------------	-----------------------------------------------------------------------------

Globally sets the test variable  $\backslash g\_peek\_token$  equal to  $\langle token \rangle$  (as an implicit token, *not* as a token list), and then expands the  $\langle function \rangle$ . The  $\langle token \rangle$  will remain in the input stream as the next item after the  $\langle function \rangle$ . The  $\langle token \rangle$  here may be  $\sqcup$ ,  $\{$  or  $\}$  (assuming normal T<sub>E</sub>X category codes), *i.e.* it is not necessarily the next argument which would be grabbed by a normal function.

$\backslash l\_peek\_token$	Token set by $\backslash peek\_after:Nw$ and available for testing as described above.
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$\backslash g\_peek\_token$	Token set by $\backslash peek\_gafter:Nw$ and available for testing as described above.
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$\backslash peek\_catcode:N\textit{TF}$	$\backslash peek\_catcode:N\textit{TF} \langle test\ token \rangle \{\langle true\ code \rangle\} \{\langle false\ code \rangle\}$
-----------------------------------------	------------------------------------------------------------------------------------------------------------------------------------

Tests if the next  $\langle token \rangle$  in the input stream has the same category code as the  $\langle test\ token \rangle$  (as defined by the test  $\backslash token\_if\_eq\_catcode:N\textit{TF}$ ). Spaces are respected by

the test and the  $\langle token \rangle$  will be left in the input stream after the  $\langle true\ code \rangle$  or  $\langle false\ code \rangle$  (as appropriate to the result of the test).

<code>\peek_catcode_ignore_spaces:NTF</code>	<code>\peek_catcode_ignore_spaces:NTF <math>\langle test\ token \rangle</math> {<math>\langle true\ code \rangle</math>} {<math>\langle false\ code \rangle</math>}</code>
----------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Tests if the next  $\langle token \rangle$  in the input stream has the same category code as the  $\langle test\ token \rangle$  (as defined by the test `\token_if_eq_catcode:NNTF`). Spaces are ignored by the test and the  $\langle token \rangle$  will be left in the input stream after the  $\langle true\ code \rangle$  or  $\langle false\ code \rangle$  (as appropriate to the result of the test).

<code>\peek_catcode_remove:NTF</code>	<code>\peek_catcode_remove:NTF <math>\langle test\ token \rangle</math> {<math>\langle true\ code \rangle</math>} {<math>\langle false\ code \rangle</math>}</code>
---------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Tests if the next  $\langle token \rangle$  in the input stream has the same category code as the  $\langle test\ token \rangle$  (as defined by the test `\token_if_eq_catcode:NNTF`). Spaces are respected by the test and the  $\langle token \rangle$  will be removed from the input stream if the test is true. The function will then place either the  $\langle true\ code \rangle$  or  $\langle false\ code \rangle$  in the input stream (as appropriate to the result of the test).

<code>\peek_catcode_remove_ignore_spaces:NTF</code>	<code>\peek_catcode_remove_ignore_spaces:NTF <math>\langle test\ token \rangle</math> {<math>\langle true\ code \rangle</math>} {<math>\langle false\ code \rangle</math>}</code>
-----------------------------------------------------	---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Tests if the next  $\langle token \rangle$  in the input stream has the same category code as the  $\langle test\ token \rangle$  (as defined by the test `\token_if_eq_catcode:NNTF`). Spaces are ignored by the test and the  $\langle token \rangle$  will be removed from the input stream if the test is true. The function will then place either the  $\langle true\ code \rangle$  or  $\langle false\ code \rangle$  in the input stream (as appropriate to the result of the test).

<code>\peek_charcode:NTF</code>	<code>\peek_charcode:NTF <math>\langle test\ token \rangle</math> {<math>\langle true\ code \rangle</math>} {<math>\langle false\ code \rangle</math>}</code>
---------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------

Tests if the next  $\langle token \rangle$  in the input stream has the same character code as the  $\langle test\ token \rangle$  (as defined by the test `\token_if_eq_charcode:NNTF`). Spaces are respected by the test and the  $\langle token \rangle$  will be left in the input stream after the  $\langle true\ code \rangle$  or  $\langle false\ code \rangle$  (as appropriate to the result of the test).

<code>\peek_charcode_ignore_spaces:NTF</code>	<code>\peek_charcode_ignore_spaces:NTF <math>\langle test\ token \rangle</math> {<math>\langle true\ code \rangle</math>} {<math>\langle false\ code \rangle</math>}</code>
-----------------------------------------------	---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Tests if the next  $\langle token \rangle$  in the input stream has the same character code as the  $\langle test\ token \rangle$  (as defined by the test `\token_if_eq_charcode:NNTF`). Spaces are ignored by the test and the  $\langle token \rangle$  will be left in the input stream after the  $\langle true\ code \rangle$  or  $\langle false\ code \rangle$  (as appropriate to the result of the test).

<code>\peek_charcode_remove:NTF</code>	<code>\peek_charcode_remove:NTF <math>\langle test\ token \rangle</math> {<math>\langle true\ code \rangle</math>} {<math>\langle false\ code \rangle</math>}</code>
----------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Tests if the next *<token>* in the input stream has the same character code as the *<test token>* (as defined by the test `\token_if_eq_charcode:NNTF`). Spaces are respected by the test and the *<token>* will be removed from the input stream if the test is true. The function will then place either the *<true code>* or *<false code>* in the input stream (as appropriate to the result of the test).

<code>\peek_charcode_remove_ignore_spaces:NNTF</code>	<code>\peek_charcode_remove_ignore_spaces:NNTF &lt;test token&gt; {&lt;true code&gt;} {&lt;false code&gt;}</code>
-------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------

Tests if the next *<token>* in the input stream has the same character code as the *<test token>* (as defined by the test `\token_if_eq_charcode:NNTF`). Spaces are ignored by the test and the *<token>* will be removed from the input stream if the test is true. The function will then place either the *<true code>* or *<false code>* in the input stream (as appropriate to the result of the test).

<code>\peek_meaning:NNTF</code>	<code>\peek_meaning:NNTF &lt;test token&gt; {&lt;true code&gt;} {&lt;false code&gt;}</code>
---------------------------------	---------------------------------------------------------------------------------------------

Tests if the next *<token>* in the input stream has the same meaning as the *<test token>* (as defined by the test `\token_if_eq_meaning:NNTF`). Spaces are respected by the test and the *<token>* will be left in the input stream after the *<true code>* or *<false code>* (as appropriate to the result of the test).

<code>\peek_meaning_ignore_spaces:NNTF</code>	<code>\peek_meaning_ignore_spaces:NNTF &lt;test token&gt; {&lt;true code&gt;} {&lt;false code&gt;}</code>
-----------------------------------------------	-----------------------------------------------------------------------------------------------------------

Tests if the next *<token>* in the input stream has the same meaning as the *<test token>* (as defined by the test `\token_if_eq_meaning:NNTF`). Spaces are ignored by the test and the *<token>* will be left in the input stream after the *<true code>* or *<false code>* (as appropriate to the result of the test).

<code>\peek_meaning_remove:NNTF</code>	<code>\peek_meaning_remove:NNTF &lt;test token&gt; {&lt;true code&gt;} {&lt;false code&gt;}</code>
----------------------------------------	----------------------------------------------------------------------------------------------------

Tests if the next *<token>* in the input stream has the same meaning as the *<test token>* (as defined by the test `\token_if_eq_meaning:NNTF`). Spaces are respected by the test and the *<token>* will be removed from the input stream if the test is true. The function will then place either the *<true code>* or *<false code>* in the input stream (as appropriate to the result of the test).

<code>\peek_meaning_remove_ignore_spaces:NNTF</code>	<code>\peek_meaning_remove_ignore_spaces:NNTF &lt;test token&gt; {&lt;true code&gt;} {&lt;false code&gt;}</code>
------------------------------------------------------	------------------------------------------------------------------------------------------------------------------

Tests if the next *<token>* in the input stream has the same meaning as the *<test token>* (as defined by the test `\token_if_eq_meaning:NNTF`). Spaces are ignored by the test and the *<token>* will be removed from the input stream if the test is true. The function will then place either the *<true code>* or *<false code>* in the input stream (as appropriate to the result of the test).

## 40 Decomposing a macro definition

These functions decompose  $\text{\TeX}$  macros into their constituent parts: if the  $\langle token \rangle$  passed is not a macro then no decomposition can occur. In the later case, all three functions leave  $\backslash scan\_stop$ : in the input stream.

$\backslash token\_get\_arg\_spec:N$  ★

 $\backslash token\_get\_arg\_spec:N \langle token \rangle$ 

If the  $\langle token \rangle$  is a macro, this function will leave the primitive  $\text{\TeX}$  argument specification in input stream as a string of tokens of category code 12 (with spaces having category code 10). Thus for example for a token  $\backslash next$  defined by

```
 $\backslash cs\_set:Npn \backslash next \#1\#2 \{ x \#1 y \#2 \}$ 
```

will leave  $\#1\#2$  in the input stream. If the  $\langle token \rangle$  is not a macro then  $\backslash scan\_stop$ : will be left in the input stream

**$\text{\TeX}$ hackers note:** If the arg spec. contains the string  $\rightarrow$ , then the **spec** function will produce incorrect results.

$\backslash token\_get\_replacement\_text:N$  ★

 $\backslash token\_get\_replacement\_text:N \langle token \rangle$ 

If the  $\langle token \rangle$  is a macro, this function will leave the replacement text in input stream as a string of tokens of category code 12 (with spaces having category code 10). Thus for example for a token  $\backslash next$  defined by

```
 $\backslash cs\_set:Npn \backslash next \#1\#2 \{ x \#1\sim y \#2 \}$ 
```

will leave  $x\#1 y\#2$  in the input stream. If the  $\langle token \rangle$  is not a macro then  $\backslash scan\_stop$ : will be left in the input stream

$\backslash token\_get\_prefix\_spec:N$  ★

 $\backslash token\_get\_prefix\_spec:N \langle token \rangle$ 

If the  $\langle token \rangle$  is a macro, this function will leave the  $\text{\TeX}$  prefixes applicable in input stream as a string of tokens of category code 12 (with spaces having category code 10). Thus for example for a token  $\backslash next$  defined by

```
 $\backslash cs\_set:Npn \backslash next \#1\#2 \{ x \#1\sim y \#2 \}$ 
```

will leave  $\backslash long$  in the input stream. If the  $\langle token \rangle$  is not a macro then  $\backslash scan\_stop$ : will be left in the input stream

## 41 Experimental token functions

<code>\char_active_set:Npn</code>
<code>\char_active_set:Npx</code>

`\char_active_set:Npn <char> <parameters> {<code>}`

Makes  $\langle char \rangle$  an active character to expand to  $\langle code \rangle$  as replacement text. Within the  $\langle code \rangle$ , the  $\langle parameters \rangle$  ( $\#1$ ,  $\#2$ , *etc.*) will be replaced by those absorbed. This definition is local to the current T<sub>E</sub>X group.

<code>\char_active_gset:Npn</code>
<code>\char_active_gset:Npx</code>

`\char_active_gset:Npn <char> <parameters> {<code>}`

Makes  $\langle char \rangle$  an active character to expand to  $\langle code \rangle$  as replacement text. Within the  $\langle code \rangle$ , the  $\langle parameters \rangle$  ( $\#1$ ,  $\#2$ , *etc.*) will be replaced by those absorbed. This definition is global.

<code>\char_active_set_eq:NN</code>
-------------------------------------

`\char_active_set_eq:NN <char> <function>`

Makes  $\langle char \rangle$  an active character equivalent in meaning to the  $\langle function \rangle$  (which may itself be an active character). This definition is local to the current T<sub>E</sub>X group.

<code>\char_active_gset_eq:NN</code>
--------------------------------------

`\char_active_gset_eq:NN <char> <function>`

Makes  $\langle char \rangle$  an active character equivalent in meaning to the  $\langle function \rangle$  (which may itself be an active character). This definition is global.

<code>\peek_N_type:TF</code>
------------------------------

`\peek_N_type:TF {<true code>} {<false code>}`

Tests if the next  $\langle token \rangle$  in the input stream can be safely grabbed as an N-type argument. The test will be  $\langle false \rangle$  if the next  $\langle token \rangle$  is either an explicit or implicit begin-group or end-group token (with any character code), or an explicit or implicit space character (with character code 32 and category code 10), and  $\langle true \rangle$  in all other cases. Note that a  $\langle true \rangle$  result ensures that the next  $\langle token \rangle$  is a valid N-type argument. However, if the next  $\langle token \rangle$  is for instance `\c_space_token`, the test will take the  $\langle false \rangle$  branch, even though the next  $\langle token \rangle$  is in fact a valid N-type argument. The  $\langle token \rangle$  will be left in the input stream after the  $\langle true code \rangle$  or  $\langle false code \rangle$  (as appropriate to the result of the test).

## Part IX

# The l3int package

# Integers

Calculation and comparison of integer values can be carried out using literal numbers, `int` registers, constants and integers stored in token list variables. The standard operators `+`, `-`, `/` and `*` and parentheses can be used within such expressions to carry arithmetic operations. This module carries out these functions on *integer expressions* (“`int expr`”).

## 42 Integer expressions

`\int_eval:n *` `\int_eval:n {⟨integer expression⟩}`

Evaluates the *⟨integer expression⟩*, expanding any integer and token list variables within the *⟨expression⟩* to their content (without requiring `\int_use:N/\tl_use:N`) and applying the standard mathematical rules. For example both

```
\int_eval:n { 5 + 4 * 3 - ( 3 + 4 * 5 ) }
```

and

```
\tl_new:N \l_my_tl  
\tl_set:Nn \l_my_tl { 5 }  
\int_new:N \l_my_int  
\int\set:Nn \l_my_int { 4 }  
\int_eval:n { \l_my_tl + \l_my_int * 3 - ( 3 + 4 * 5 ) }
```

both evaluate to  $-6$ . The *{⟨integer expression⟩}* may contain the operators `+`, `-`, `*` and `/`, along with parenthesis ( and ). After two expansions, `\int_eval:n` yields a *⟨integer denotation⟩* which is left in the input stream. This is *not* an *⟨internal integer⟩*, and therefore requires suitable termination if used in a T<sub>E</sub>X-style integer assignment.

`\int_abs:n *` `\int_abs:n {⟨integer expression⟩}`

Evaluates the *⟨integer expression⟩* as described for `\int_eval:n` and leaves the absolute value of the result in the input stream as an *⟨integer denotation⟩* after two expansions.

`\int_div_round:nn *` `\int_div_round:nn {⟨intexpr1⟩} {⟨intexpr2⟩}`

Evaluates the two *⟨integer expressions⟩* as described earlier, then calculates the result of dividing the first value by the second, round any remainder. Note that this is identical

to using `/` directly in an *integer expression*. The result is left in the input stream as a *integer denotation* after two expansions.

<code>\int_div_truncate:nn</code> ★	<code>\int_div_truncate:nn {\langle intexpr_1 \rangle} {\langle intexpr_2 \rangle}</code>
-------------------------------------	-------------------------------------------------------------------------------------------

Evaluates the two *integer expressions* as described earlier, then calculates the result of dividing the first value by the second, truncating any remainder. Note that division using `/` rounds the result. The result is left in the input stream as a *integer denotation* after two expansions.

<code>\int_max:nn</code> ★	<code>\int_max:nn {\langle intexpr_1 \rangle} {\langle intexpr_2 \rangle}</code>
<code>\int_min:nn</code> ★	<code>\int_min:nn {\langle intexpr_1 \rangle} {\langle intexpr_2 \rangle}</code>

Evaluates the *integer expressions* as described for `\int_eval:n` and leaves either the larger or smaller value in the input stream as an *integer denotation* after two expansions.

<code>\int_mod:nn</code> ★	<code>\int_mod:nn {\langle intexpr_1 \rangle} {\langle intexpr_2 \rangle}</code>
----------------------------	----------------------------------------------------------------------------------

Evaluates the two *integer expressions* as described earlier, then calculates the integer remainder of dividing the first expression by the second. This is left in the input stream as an *integer denotation* after two expansions.

## 43 Creating and initialising integers

<code>\int_new:N</code>	<code>\int_new:N \langle integer \rangle</code>
<code>\int_new:c</code>	

Creates a new *integer* or raises an error if the name is already taken. The declaration is global. The *integer* will initially be equal to 0.

<code>\int_const:Nn</code>	<code>\int_const:Nn \langle integer \rangle {\langle integer expression \rangle}</code>
<code>\int_const:cn</code>	

Creates a new constant *integer* or raises an error if the name is already taken. The



value of the  $\langle integer \rangle$  will be set globally to the  $\langle integer expression \rangle$ .

<code>\int_zero:N</code>
<code>\int_zero:c</code>

`\int_zero:N  $\langle integer \rangle$` 

Sets  $\langle integer \rangle$  to 0 within the scope of the current TeX group.

<code>\int_gzero:N</code>
<code>\int_gzero:c</code>

`\int_gzero:N  $\langle integer \rangle$` 

Sets  $\langle integer \rangle$  to 0 globally, *i.e.* not restricted by the current TeX group level.

<code>\int_set_eq:NN</code>
<code>\int_set_eq:cN</code>
<code>\int_set_eq:Nc</code>
<code>\int_set_eq:cc</code>

`\int_set_eq:NN  $\langle integer1 \rangle$   $\langle integer2 \rangle$` 

Sets the content of  $\langle integer1 \rangle$  equal to that of  $\langle integer2 \rangle$ . This assignment is restricted to the current TeX group level.

<code>\int_gset_eq:NN</code>
<code>\int_gset_eq:cN</code>
<code>\int_gset_eq:Nc</code>
<code>\int_gset_eq:cc</code>

`\int_gset_eq:NN  $\langle integer1 \rangle$   $\langle integer2 \rangle$` 

Sets the content of  $\langle integer1 \rangle$  equal to that of  $\langle integer2 \rangle$ . This assignment is global and so is not limited by the current TeX group level.

## 44 Setting and incrementing integers

<code>\int_add:Nn</code>
<code>\int_add:cn</code>

`\int_add:Nn  $\langle integer \rangle$  { $\langle integer expression \rangle$ }`

Adds the result of the  $\langle integer expression \rangle$  to the current content of the  $\langle integer \rangle$ . This assignment is local.

<code>\int_gadd:Nn</code>
<code>\int_gadd:cn</code>

`\int_gadd:Nn  $\langle integer \rangle$  { $\langle integer expression \rangle$ }`

Adds the result of the  $\langle integer expression \rangle$  to the current content of the  $\langle integer \rangle$ . This

assignment is global.

<code>\int_decr:N</code>
<code>\int_decr:c</code>

`\int_decr:N <integer>`

Decreases the value stored in `<integer>` by 1 within the scope of the current TeX group.

<code>\int_gdecr:N</code>
<code>\int_gdecr:c</code>

`\int_incr:N <integer>`

Decreases the value stored in `<integer>` by 1 globally (*i.e.* not limited by the current group level).

<code>\int_incr:N</code>
<code>\int_incr:c</code>

`\int_incr:N <integer>`

Increases the value stored in `<integer>` by 1 within the scope of the current TeX group.

<code>\int_gincr:N</code>
<code>\int_gincr:c</code>

`\int_incr:N <integer>`

Increases the value stored in `<integer>` by 1 globally (*i.e.* not limited by the current group level).

<code>\int_set:Nn</code>
<code>\int_set:cn</code>

`\int_set:Nn <integer> {<integer expression>}`

Sets `<integer>` to the value of `<integer expression>`, which must evaluate to an integer (as described for `\int_eval:n`). This assignment is restricted to the current TeX group.

<code>\int_gset:Nn</code>
<code>\int_gset:cn</code>

`\int_gset:Nn <integer> {<integer expression>}`

Sets `<integer>` to the value of `<integer expression>`, which must evaluate to an integer (as described for `\int_eval:n`). This assignment is global and is not limited to the current TeX group level.

<code>\int_sub:Nn</code>
<code>\int_sub:cn</code>

`\int_sub:Nn <integer> {<integer expression>}`

Subtracts the result of the `<integer expression>` to the current content of the `<integer>`. This assignment is local.

<code>\int_gsub:Nn</code>
<code>\int_gsub:cn</code>

`\int_gsub:Nn <integer> {<integer expression>}`

Subtracts the result of the `<integer expression>` to the current content of the `<integer>`. This assignment is global.

## 45 Using integers

<code>\int_use:N</code> ★	<code>\int_use:N &lt;integer&gt;</code>
<code>\int_use:c</code> ★	

Recovers the content of a *<integer>* and places it directly in the input stream. An error will be raised if the variable does not exist or if it is invalid. Can be omitted in places where a *<integer>* is required (such as in the first and third arguments of `\int_compare:nNnTF`).

**TeXhackers note:** `\int_use:N` is the TeX primitive `\the`: this is one of several L<sup>A</sup>T<sub>E</sub>X3 names for this primitive.

## 46 Integer expression conditionals

<code>\int_compare_p:nNn</code> ★	<code>\int_compare:nNnTF</code> <code>{&lt;intexpr<sub>1</sub>&gt;} &lt;relation&gt; {&lt;intexpr<sub>2</sub>&gt;}</code> <code>{&lt;intexpr<sub>1</sub>&gt;} &lt;relation&gt; {&lt;intexpr<sub>2</sub>&gt;}</code> <code>{&lt;true code&gt;} {&lt;false code&gt;}</code>
<code>\int_compare:nNnTF</code> ★	

This function first evaluates each of the *<integer expressions>* as described for `\int_eval:n`. The two results are then compared using the *<relation>*:

Equal	=
Greater than	>
Less than	<

<code>\int_compare_p:n</code> ★	<code>\int_compare:nTF</code> <code>{&lt;intexpr<sub>1</sub>&gt;} &lt;relation&gt; {&lt;intexpr<sub>2</sub>&gt;}</code> <code>{&lt;intexpr<sub>1</sub>&gt;} &lt;relation&gt; {&lt;intexpr<sub>2</sub>&gt;}</code> <code>{&lt;true code&gt;} {&lt;false code&gt;}</code>
<code>\int_compare:nTF</code> ★	

This function first evaluates each of the *<integer expressions>* as described for `\int_eval:n`. The two results are then compared using the *<relation>*:

Equal	= or ==
Greater than or equal to	=>
Greater than	>
Less than or equal to	=<
Less than	<
Not equal	!=

<code>\int_if_even_p:n</code>	★	
<code>\int_if_even:nTF</code>	★	
<code>\int_if_odd_p:n</code>	★	<code>\int_if_odd_p:n {⟨integer expression⟩}</code>
<code>\int_if_odd:nTF</code>	★	<code>\int_if_odd:nTF {⟨integer expression⟩}</code>
		<code>{⟨true code⟩} {⟨false code⟩}</code>

This function first evaluates the *⟨integer expression⟩* as described for `\int_eval:n`. It then evaluates if this is odd or even, as appropriate.

## 47 Integer expression loops

<code>\int_do_while:nNnn</code>	★	<code>\int_do_while:nNnn</code>
		<code>{⟨intexpr<sub>1</sub>⟩} ⟨relation⟩ {⟨intexpr<sub>2</sub>⟩} {⟨code⟩}</code>

Evaluates the relationship between the two *⟨integer expressions⟩* as described for `\int_compare:nNnTF`, and then places the *⟨code⟩* in the input stream if the *⟨relation⟩* is **true**. After the *⟨code⟩* has been processed by T<sub>E</sub>X the test will be repeated, and a loop will occur until the test is **false**.

<code>\int_do_until:nNnn</code>	★	<code>\int_do_until:nNnn</code>
		<code>{⟨intexpr<sub>1</sub>⟩} ⟨relation⟩ {⟨intexpr<sub>2</sub>⟩} {⟨code⟩}</code>

Evaluates the relationship between the two *⟨integer expressions⟩* as described for `\int_compare:nNnTF`, and then places the *⟨code⟩* in the input stream if the *⟨relation⟩* is **false**. After the *⟨code⟩* has been processed by T<sub>E</sub>X the test will be repeated, and a loop will occur until the test is **true**.

<code>\int_until_do:nNnn</code>	★	<code>\int_until_do:nNnn</code>
		<code>{⟨intexpr<sub>1</sub>⟩} ⟨relation⟩ {⟨intexpr<sub>2</sub>⟩} {⟨code⟩}</code>

Places the *⟨code⟩* in the input stream for T<sub>E</sub>X to process, and then evaluates the relationship between the two *⟨integer expressions⟩* as described for `\int_compare:nNnTF`. If the test is **false** then the *⟨code⟩* will be inserted into the input stream again and a loop will occur until the *⟨relation⟩* is **true**.

<code>\int_while_do:nNnn</code>	★	<code>\int_while_do:nNnn</code>
		<code>{⟨intexpr<sub>2</sub>⟩} {⟨code⟩} {⟨intexpr<sub>1</sub>⟩} ⟨relation⟩</code>

Places the *⟨code⟩* in the input stream for T<sub>E</sub>X to process, and then evaluates the relationship between the two *⟨integer expressions⟩* as described for `\int_compare:nNnTF`. If the test is **true** then the *⟨code⟩* will be inserted into the input stream again and a loop will occur until the *⟨relation⟩* is **false**.

<code>\int_do_while:nn</code>	★	<code>\int_do_while:nNnn</code>
		<code>{⟨intexpr<sub>1</sub>⟩} ⟨relation⟩ {⟨intexpr<sub>2</sub>⟩} {⟨code⟩}</code>

Evaluates the relationship between the two *⟨integer expressions⟩* as described for `\int_compare:nTF`, and then places the *⟨code⟩* in the input stream if the *⟨relation⟩* is **true**.

After the  $\langle code \rangle$  has been processed by T<sub>E</sub>X the test will be repeated, and a loop will occur until the test is **false**.

<code>\int_do_until:nn</code> ★	<code>\int_do_until:nn</code> <code>{ \intexpr1 \intrelation \intexpr2 } {\intcode}</code>
---------------------------------	-----------------------------------------------------------------------------------------------

Evaluates the relationship between the two  $\langle integer\ expressions \rangle$  as described for `\int_compare:nTF`, and then places the  $\langle code \rangle$  in the input stream if the  $\langle relation \rangle$  is **false**. After the  $\langle code \rangle$  has been processed by T<sub>E</sub>X the test will be repeated, and a loop will occur until the test is **true**.

<code>\int_until_do:nn</code> ★	<code>\int_until_do:nn</code> <code>{ \intexpr1 \intrelation \intexpr2 } {\intcode}</code>
---------------------------------	-----------------------------------------------------------------------------------------------

Places the  $\langle code \rangle$  in the input stream for T<sub>E</sub>X to process, and then evaluates the relationship between the two  $\langle integer\ expressions \rangle$  as described for `\int_compare:nTF`. If the test is **false** then the  $\langle code \rangle$  will be inserted into the input stream again and a loop will occur until the  $\langle relation \rangle$  is **true**.

<code>\int_while_do:nn</code> ★	<code>\int_while_do:nn</code> <code>{ \intexpr1 \intrelation</code> <code>\intexpr2 } {\intcode}</code>
---------------------------------	---------------------------------------------------------------------------------------------------------------

Places the  $\langle code \rangle$  in the input stream for T<sub>E</sub>X to process, and then evaluates the relationship between the two  $\langle integer\ expressions \rangle$  as described for `\int_compare:nTF`. If the test is **true** then the  $\langle code \rangle$  will be inserted into the input stream again and a loop will occur until the  $\langle relation \rangle$  is **false**.

## 48 Formatting integers

Integers can be placed into the output stream with formatting. These conversions apply to any integer expressions.

<code>\int_to_arabic:n</code> ★	<code>\int_to_arabic:n {\intinteger\ expression}</code>
---------------------------------	---------------------------------------------------------

Places the value of the  $\langle integer\ expression \rangle$  in the input stream as digits, with category code 12 (other).

<code>\int_to_alph:n</code> ★	<code>\int_to_alph:n {\intinteger\ expression}</code>
<code>\int_to_Alph:n</code> ★	<code>\int_to_alph:n {\intinteger\ expression}</code>

Evaluates the  $\langle integer\ expression \rangle$  and converts the result into a series of letters, which are then left in the input stream. The conversion rule uses the 26 letters of the English alphabet, in order. Thus

```
\int_to_alph:n { 1 }
```

places **a** in the input stream,

```
\int_to_alph:n { 26 }
```

is represented as **z** and

```
\int_to_alph:n { 27 }
```

is converted to **aa**. For conversions using other alphabets, use `\int_convert_to_symbols:nnn` to define an alphabet-specific function. The basic `\int_to_alph:n` and `\int_to_Alph:n` functions should not be modified.

	<code>\int_to_symbols:nnn</code>
<code>\int_to_symbols:nnn</code>	$\langle integer\ expression \rangle$ $\langle total\ symbols \rangle$ $\langle value\ to\ symbol\ mapping \rangle$

This is the low-level function for conversion of an  $\langle integer\ expression \rangle$  into a symbolic form (which will often be letters). The  $\langle total\ symbols \rangle$  available should be given as an integer expression. Values are actually converted to symbols according to the  $\langle value\ to\ symbol\ mapping \rangle$ . This should be given as  $\langle total\ symbols \rangle$  pairs of entries, a number and the appropriate symbol. Thus the `\int_to_alph:n` function is defined as

```
\cs_new:Npn \int_to_alph:n #1
{
  \int_convert_to_sybols:nnn {#1} { 26 }
  {
    { 1 } { a }
    { 2 } { b }
    { 3 } { c }
    { 4 } { d }
    { 5 } { e }
    { 6 } { f }
    { 7 } { g }
    { 8 } { h }
    { 9 } { i }
    { 10 } { j }
    { 11 } { k }
    { 12 } { l }
    { 13 } { m }
    { 14 } { n }
    { 15 } { o }
    { 16 } { p }
    { 17 } { q }
    { 18 } { r }
    { 19 } { s }
```

```

        { 20 } { t }
        { 21 } { u }
        { 22 } { v }
        { 23 } { w }
        { 24 } { x }
        { 25 } { y }
        { 26 } { z }
    }
}

```

`\int_to_binary:n *` `\int_to_binary:n {<integer expression>}`

Calculates the value of the *<integer expression>* and places the binary representation of the result in the input stream.

`\int_to_hexadecimal:n *` `\int_to_hexadecimal:n {<integer expression>}`

Calculates the value of the *<integer expression>* and places the hexadecimal (base 16) representation of the result in the input stream. Upper case letters are used for digits beyond 9.

`\int_to_octal:n *` `\int_to_octal:n {<integer expression>}`

Calculates the value of the *<integer expression>* and places the octal (base 8) representation of the result in the input stream.

`\int_to_base:nn *` `\int_to_base:nn {<integer expression>} {<base>}`

Calculates the value of the *<integer expression>* and converts it into the appropriate representation in the *<base>*; the later may be given as an integer expression. For bases greater than 10 the higher “digits” are represented by the upper case letters from the English alphabet. The maximum *<base>* value is 36.

**T<sub>E</sub>Xhackers note:** This is a generic version of `\int_to_binary:n`, *etc.*

`\int_to_roman:n *`  
`\int_to_Roman:n *` `\int_to_roman:n {<integer expression>}`

Places the value of the *<integer expression>* in the input stream as Roman numerals, either lower case (`\int_to_roman:n`) or upper case (`\int_to_Roman:n`). The Roman numerals are letters with category code 11 (letter).

## 49 Converting from other formats to integers

`\int_from_alpha:n ★` `\int_from_alpha:n {<letters>}`

Converts the *<letters>* into the integer (base 10) representation and leaves this in the input stream. The *<letters>* are treated using the English alphabet only, with “a” equal to 1 through to “z” equal to 26. Either lower or upper case letters may be used. This is the inverse function of `\int_to_alpha:n`.

`\int_from_binary:n ★` `\int_from_binary:n {<binary number>}`

Converts the *<binary number>* into the integer (base 10) representation and leaves this in the input stream.

`\int_from_hexadecimal:n ★` `\int_from_hexadecimal:n {<hexadecimal number>}`

Converts the *<hexadecimal number>* into the integer (base 10) representation and leaves this in the input stream. Digits greater than 9 may be represented in the *<hexadecimal number>* by upper or lower case letters.

`\int_from_octal:n ★` `\int_from_octal:n {<octal number>}`

Converts the *<octal number>* into the integer (base 10) representation and leaves this in the input stream.

`\int_from_roman:n ★` `\int_from_roman:n {<roman numeral>}`

Converts the *<roman numeral>* into the integer (base 10) representation and leaves this in the input stream. The *<roman numeral>* may be in upper or lower case; if the numeral is not valid then the resulting value will be  $-1$ .

`\int_from_base:nn ★` `\int_from_base:nn {<number>}`  
`{<base>}`

Converts the *<number>* in *<base>* into the appropriate value in base 10. The *<number>* should consist of digits and letters (either lower or upper case), plus optionally a leading sign. The maximum *<base>* value is 36.

## 50 Viewing integers

`\int_show:N`  
`\int_show:c` `\int_show:N <integer>`

Displays the value of the *<integer>* on the terminal.



## 51 Constant integers

```
\c_minus_one  
\c_zero  
\c_one  
\c_two  
\c_three  
\c_four  
\c_five  
\c_six  
\c_seven  
\c_eight  
\c_nine  
\c_ten  
\c_eleven  
\c_twelve  
\c_thirteen  
\c_fourteen  
\c_fifteen  
\c_sixteen  
\c_thirty_two  
\c_one_hundred  
\c_two_hundred_fifty_five  
\c_two_hundred_fifty_six  
\c_one_thousand  
\c_ten_thousand
```

Integer values used with primitive tests and assignments: self-terminating nature makes these more convenient and faster than literal numbers.

`\c_max_int` The maximum value that can be stored as an integer.

`\c_max_register_int` Maximum number of registers.

## 52 Scratch integers

```
\l_tmpa_int  
\l_tmpb_int  
\l_tmpc_int
```

Scratch integer for local assignment. These are never used by the kernel code, and so are safe for use with any  $\text{\LaTeX}3$ -defined function. However, they may be

overwritten by other non-kernel code and so should only be used for short-term storage.

<code>\g_tmpa_int</code> <code>\g_tmpb_int</code>	Scratch integer for global assignment. These are never used by the kernel code, and so are safe for use with any L <sup>A</sup> T <sub>E</sub> X3-defined function. However, they may be overwritten by other non-kernel code and so should only be used for short-term storage.
------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

## 53 Internal functions

<code>int_get_digits:n</code> ★	<code>\int_get_digits:n &lt;value&gt;</code> Parses the <i>&lt;value&gt;</i> to leave the absolute <i>&lt;value&gt;</i> in the input stream. This may therefore be used to remove multiple sign tokens from the <i>&lt;value&gt;</i> (which may be symbolic).
---------------------------------	------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

<code>int_get_sign:n</code> ★	<code>\int_get_sign:n &lt;value&gt;</code> Parses the <i>&lt;value&gt;</i> to leave a single sign token (either + or -) in the input stream. This may therefore be used to sanitise sign tokens from the <i>&lt;value&gt;</i> (which may be symbolic).
-------------------------------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

<code>int_to_letter:n</code> ★	<code>\int_to_letter:n &lt;integer value&gt;</code> For <i>&lt;integer values&gt;</i> from 0 to 9, leaves the <i>&lt;value&gt;</i> in the input stream unchanged. For <i>&lt;integer values&gt;</i> from 10 to 35, leaves the appropriate upper case letter (from the standard English alphabet) in the input stream: for example, 10 is converted to A, 11 to B, <i>etc.</i>
--------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

<code>\int_to_roman:w</code> ★	<code>\int_to_roman:w &lt;integer&gt;</code> <i>&lt;space&gt;</i> or <i>&lt;non-expandable token&gt;</i> Converts <i>&lt;integer&gt;</i> to it lower case Roman representation. Expansion ends when a space or non-expandable token is found. Note that this function produces a string of letters with category code 12 and that protected functions <i>are</i> expanded by this process. Negative <i>&lt;integer&gt;</i> values result in no output, although the function does not terminate expansion until a suitable endpoint is found in the same way as for positive numbers.
--------------------------------	---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

**T<sub>E</sub>Xhackers note:** This is the T<sub>E</sub>X primitive `\romannumeral` renamed.

<code>\if_num:w</code> ★ <code>\if_int_compare:w</code> ★	<code>\if_num:w &lt;integer1&gt; &lt;relation&gt; &lt;integer2&gt;</code> <code>&lt;true code&gt;</code> <code>\else:</code> <code>&lt;false code&gt;</code> <code>\fi:</code> Compare two integers using <i>&lt;relation&gt;</i> , which must be one of =, < or > with category code 12. The <code>\else:</code> branch is optional.
--------------------------------------------------------------	------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

**T<sub>E</sub>Xhackers note:** These are both names for the T<sub>E</sub>X primitive `\ifnum`.

	<code>\if_case:w</code>	<code>&lt;integer&gt;</code>	<code>&lt;case0&gt;</code>
		<code>\or: &lt;case1&gt;</code>	
		<code>\or: ...</code>	
<div style="border: 1px solid black; padding: 2px; display: inline-block;"> <code>\if_case:w</code> ★  <code>\or:</code> ★ </div>		<code>\else: &lt;default&gt;</code>	
	<code>\fi:</code>		

Selects a case to execute based on the value of the `<integer>`. The first case (`<case0>`) is executed if `<integer>` is 0, the second (`<case1>`) if the `<integer>` is 1, *etc.* The `<integer>` may be a literal, a constant or an integer expression (*e.g.* using `\int_eval:n`).

**T<sub>E</sub>Xhackers note:** These are the T<sub>E</sub>X primitives `\ifcase` and `\or`.

<div style="border: 1px solid black; padding: 2px; display: inline-block;"> <code>\int_value:w</code> ★ </div>	<code>\int_value:w</code>	<code>&lt;integer&gt;</code>
	<code>\int_value:w</code>	<code>&lt;tokens&gt; &lt;optional space&gt;</code>

Expands `<tokens>` until an `<integer>` is formed. One space may be gobbled in the process.

**T<sub>E</sub>Xhackers note:** This is the T<sub>E</sub>X primitive `\number`.

<div style="border: 1px solid black; padding: 2px; display: inline-block;"> <code>\int_eval:w</code> ★  <code>\int_eval_end:</code> ★ </div>	<code>\int_eval:w</code>	<code>&lt;intexpr&gt;</code>	<code>\int_eval_end:</code>
--------------------------------------------------------------------------------------------------------------------------------------------------	--------------------------	------------------------------	-----------------------------

Evaluates `<integer expression>` as described for `\int_eval:n`. The evaluation stops when an unexpandable token which is not a valid part of an integer is read or when `\int_eval_end:` is reached. The latter is gobbled by the scanner mechanism: `\int_eval_end:` itself is unexpandable but used correctly the entire construct is expandable.

**T<sub>E</sub>Xhackers note:** This is the  $\varepsilon$ -T<sub>E</sub>X primitive `\numexpr`.

	<code>\if_int_odd:w</code>	<code>&lt;tokens&gt;</code>	<code>&lt;optional space&gt;</code>
		<code>&lt;true code&gt;</code>	
		<code>\else:</code>	
		<code>&lt;true code&gt;</code>	
<div style="border: 1px solid black; padding: 2px; display: inline-block;"> <code>\if_int_odd:w</code> ★ </div>	<code>\fi:</code>		

Expands `<tokens>` until a non-numeric token or a space is found, and tests whether the resulting `<integer>` is odd. If so, `<true code>` is executed. The `\else:` branch is optional.

**T<sub>E</sub>Xhackers note:** This is the T<sub>E</sub>X primitive `\ifodd`.

## Part X

# The l3skip package

## Dimensions and skips

L<sup>A</sup>T<sub>E</sub>X3 provides two general length variables: `dim` and `skip`. Lengths stored as `dim` variables have a fixed length, whereas `skip` lengths have a rubber (stretch/shrink) component. In addition, the `muskip` type is available for use in math mode: this is a special form of `skip` where the lengths involved are determined by the current math font (in  $\mu$ ). There are common features in the creation and setting of length variables, but for clarity the functions are grouped by variable type.

### 54 Creating and initialising dim variables

<code>\dim_new:N</code>
<code>\dim_new:c</code>

`\dim_new:N <dimension>`

Creates a new  $\langle dimension \rangle$  or raises an error if the name is already taken. The declaration is global. The  $\langle dimension \rangle$  will initially be equal to 0pt.

<code>\dim_zero:N</code>
<code>\dim_zero:c</code>

`\dim_zero:N <dimension>`

Sets  $\langle dimension \rangle$  to 0pt within the scope of the current T<sub>E</sub>X group.

<code>\dim_gzero:N</code>
<code>\dim_gzero:c</code>

`\dim_gzero:N <dimension>`

Sets  $\langle dimension \rangle$  to 0pt globally, *i.e.* not restricted by the current T<sub>E</sub>X group level.

### 55 Setting dim variables

<code>\dim_add:Nn</code>
<code>\dim_add:cn</code>

`\dim_add:Nn <dimension> {<dimension expression>}`

Adds the result of the  $\langle dimension expression \rangle$  to the current content of the  $\langle dimension \rangle$ . This assignment is local.

<code>\dim_gadd:Nn</code>
<code>\dim_gadd:cn</code>

`\dim_gadd:Nn <dimension> {<dimension expression>}`

Adds the result of the  $\langle dimension expression \rangle$  to the current content of the  $\langle dimension \rangle$ .

This assignment is global.

<code>\dim_set:Nn</code> <code>\dim_set:cn</code>	<code>\dim_set:Nn &lt;dimension&gt; {&lt;dimension expression&gt;}</code>
------------------------------------------------------	---------------------------------------------------------------------------

Sets  $\langle dimension \rangle$  to the value of  $\langle dimension expression \rangle$ , which must evaluate to a length with units. This assignment is restricted to the current TeX group.

<code>\dim_gset:Nn</code> <code>\dim_gset:cn</code>	<code>\dim_gset:Nn &lt;dimension&gt; {&lt;dimension expression&gt;}</code>
--------------------------------------------------------	----------------------------------------------------------------------------

Sets  $\langle dimension \rangle$  to the value of  $\langle dimension expression \rangle$ , which must evaluate to a length with units and may include a rubber component (for example 1 cm plus 0.5 cm. This assignment is global and is not limited to the current TeX group level.

<code>\dim_set_eq:NN</code> <code>\dim_set_eq:cN</code> <code>\dim_set_eq:Nc</code> <code>\dim_set_eq:cc</code>	<code>\dim_set_eq:NN &lt;dimension1&gt; &lt;dimension2&gt;</code>
--------------------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------

Sets the content of  $\langle dimension1 \rangle$  equal to that of  $\langle dimension2 \rangle$ . This assignment is restricted to the current TeX group level.

<code>\dim_gset_eq:NN</code> <code>\dim_gset_eq:cN</code> <code>\dim_gset_eq:Nc</code> <code>\dim_gset_eq:cc</code>	<code>\dim_gset_eq:NN &lt;dimension1&gt; &lt;dimension2&gt;</code>
------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------

Sets the content of  $\langle dimension1 \rangle$  equal to that of  $\langle dimension2 \rangle$ . This assignment is global and so is not limited by the current TeX group level.

<code>\dim_set_max:Nn</code> <code>\dim_set_max:cn</code>	<code>\dim_set_max:Nn &lt;dimension&gt; {&lt;dimension expression&gt;}</code>
--------------------------------------------------------------	-------------------------------------------------------------------------------

Compares the current value of the  $\langle dimension \rangle$  with that of the  $\langle dimension expression \rangle$ , and sets the  $\langle dimension \rangle$  to the larger of these two value. This assignment is local to the current TeX group.

<code>\dim_gset_max:Nn</code> <code>\dim_gset_max:cn</code>	<code>\dim_gset_max:Nn &lt;dimension&gt; {&lt;dimension expression&gt;}</code>
----------------------------------------------------------------	--------------------------------------------------------------------------------

Compares the current value of the  $\langle dimension \rangle$  with that of the  $\langle dimension expression \rangle$ , and sets the  $\langle dimension \rangle$  to the larger of these two value. This assignment is global.

<code>\dim_set_min:Nn</code> <code>\dim_set_min:cn</code>	<code>\dim_set_min:Nn &lt;dimension&gt; {&lt;dimension expression&gt;}</code>
--------------------------------------------------------------	-------------------------------------------------------------------------------

Compares the current value of the  $\langle dimension \rangle$  with that of the  $\langle dimension expression \rangle$ ,

and sets the  $\langle dimension \rangle$  to the smaller of these two value. This assignment is local to the current  $\text{\TeX}$  group.

<code>\dim_gset_min:Nn</code>
<code>\dim_gset_min:cn</code>

`\dim_gset_min:Nn  $\langle dimension \rangle$  { $\langle dimension expression \rangle$ }`

Compares the current value of the  $\langle dimension \rangle$  with that of the  $\langle dimension expression \rangle$ , and sets the  $\langle dimension \rangle$  to the smaller of these two value. This assignment is global.

<code>\dim_sub:Nn</code>
<code>\dim_sub:cn</code>

`\dim_sub:Nn  $\langle dimension \rangle$  { $\langle dimension expression \rangle$ }`

Subtracts the result of the  $\langle dimension expression \rangle$  to the current content of the  $\langle dimension \rangle$ . This assignment is local.

<code>\dim_gsub:Nn</code>
<code>\dim_gsub:cn</code>

`\dim_gsub:Nn  $\langle dimension \rangle$  { $\langle dimension expression \rangle$ }`

Subtracts the result of the  $\langle dimension expression \rangle$  to the current content of the  $\langle dimension \rangle$ . This assignment is global.

## 56 Utilities for dimension calculations

<code>\dim_ratio:nn</code>
----------------------------

`\dim_ratio:nn { $\langle dimexpr_1 \rangle$ } { $\langle dimexpr_2 \rangle$ }`

Parses the two  $\langle dimension expressions \rangle$  and converts the ratio of the two to a form suitable for use inside a  $\langle dimension expression \rangle$ . This ratio is then left in the input stream, allowing syntax such as

```
\dim_set:Nn \l_my_dim
{ 10 pt * \dim_ratio:nn { 5 pt } { 10 pt } }
```

The output of `\dim_ratio:nn` on full expansion is a ration expression between two integers, with all distances converted to scaled points. Thus

```
\tl_set:Nx \l_my_tl { \dim_ratio:nn { 5 pt } { 10 pt } }
\tl_show:N \l_my_tl
```

will display 327680/655360 on the terminal.

## 57 Dimension expression conditionals

	<code>\dim_compare_p:nNn</code>	
	<code>{\dimexpr_1} \langle relation \rangle {\dimexpr_2}</code>	
<code>\dim_compare_p:nNn</code> ★	<code>\dim_compare:nNnTF</code>	
<code>\dim_compare:nNnTF</code> ★	<code>{\dimexpr_1} \langle relation \rangle {\dimexpr_2}</code>	
	<code>{\langle true code \rangle} {\langle false code \rangle}</code>	

This function first evaluates each of the *dimension expressions* as described for `\dim_eval:n`. The two results are then compared using the *relation*:

Equal	=
Greater than	>
Less than	<

	<code>\dim_compare_p:n</code>	
	<code>{ \dimexpr_1 \langle relation \rangle \dimexpr_2 }</code>	
<code>\dim_compare_p:n</code> ★	<code>\dim_compare:nTF</code>	
<code>\dim_compare:nTF</code> ★	<code>{ \dimexpr_1 \langle relation \rangle \dimexpr_2 }</code>	
	<code>{\langle true code \rangle} {\langle false code \rangle}</code>	

This function first evaluates each of the *dimension expressions* as described for `\dim_eval:n`. The two results are then compared using the *relation*:

Equal	= or ==
Greater than or equal to	=>
Greater than	>
Less than or equal to	=<
Less than	<
Not equal	!=

## 58 Dimension expression loops

<code>\dim_do_while:nNnn</code> ★	<code>\dim_do_while:nNnn</code>
	<code>{\dimexpr_1} \langle relation \rangle {\dimexpr_2} {\code}</code>

Evaluates the relationship between the two *dimension expressions* as described for `\dim_compare:nNnTF`, and then places the *code* in the input stream if the *relation* is **true**. After the *code* has been processed by T<sub>E</sub>X the test will be repeated, and a loop will occur until the test is **false**.

<code>\dim_do_until:nNnn</code> ★	<code>\dim_do_until:nNnn</code>
	<code>{\dimexpr_1} \langle relation \rangle {\dimexpr_2} {\code}</code>

Evaluates the relationship between the two *<dimension expressions>* as described for `\dim_compare:nNnTF`, and then places the *<code>* in the input stream if the *<relation>* is **false**. After the *<code>* has been processed by T<sub>E</sub>X the test will be repeated, and a loop will occur until the test is **true**.

<code>\dim_until_do:nNnn</code> ★	<code>\dim_until_do:nNnn</code> <code>{&lt;dimexpr1&gt; &lt;relation&gt; {&lt;dimexpr2&gt;} {&lt;code&gt;}}</code>
-----------------------------------	-----------------------------------------------------------------------------------------------------------------------

Places the *<code>* in the input stream for T<sub>E</sub>X to process, and then evaluates the relationship between the two *<dimension expressions>* as described for `\dim_compare:nNnTF`. If the test is **false** then the *<code>* will be inserted into the input stream again and a loop will occur until the *<relation>* is **true**.

<code>\dim_while_do:nNnn</code> ★	<code>\dim_while_do:nNnn</code> <code>{&lt;dimexpr1&gt; &lt;relation&gt; {&lt;dimexpr2&gt;} {&lt;code&gt;}}</code>
-----------------------------------	-----------------------------------------------------------------------------------------------------------------------

Places the *<code>* in the input stream for T<sub>E</sub>X to process, and then evaluates the relationship between the two *<dimension expressions>* as described for `\dim_compare:nNnTF`. If the test is **true** then the *<code>* will be inserted into the input stream again and a loop will occur until the *<relation>* is **false**.

<code>\dim_do_while:nn</code> ★	<code>\dim_do_while:nn</code> <code>{ &lt;dimexpr1&gt; &lt;relation&gt; &lt;dimexpr2&gt; } {&lt;code&gt;}</code>
---------------------------------	---------------------------------------------------------------------------------------------------------------------

Evaluates the relationship between the two *<dimension expressions>* as described for `\dim_compare:nTF`, and then places the *<code>* in the input stream if the *<relation>* is **true**. After the *<code>* has been processed by T<sub>E</sub>X the test will be repeated, and a loop will occur until the test is **false**.

<code>\dim_do_until:nn</code> ★	<code>\dim_do_until:nn</code> <code>{ &lt;dimexpr1&gt; &lt;relation&gt; &lt;dimexpr2&gt; } {&lt;code&gt;}</code>
---------------------------------	---------------------------------------------------------------------------------------------------------------------

Evaluates the relationship between the two *<dimension expressions>* as described for `\dim_compare:nTF`, and then places the *<code>* in the input stream if the *<relation>* is **false**. After the *<code>* has been processed by T<sub>E</sub>X the test will be repeated, and a loop will occur until the test is **true**.

<code>\dim_until_do:nn</code> ★	<code>\dim_until_do:nn</code> <code>{ &lt;dimexpr1&gt; &lt;relation&gt; &lt;dimexpr2&gt; } {&lt;code&gt;}</code>
---------------------------------	---------------------------------------------------------------------------------------------------------------------

Places the *<code>* in the input stream for T<sub>E</sub>X to process, and then evaluates the relationship between the two *<dimension expressions>* as described for `\dim_compare:nTF`. If the test is **false** then the *<code>* will be inserted into the input stream again and a loop will occur until the *<relation>* is **true**.

<code>\dim_while_do:nn</code> ★	<code>\dim_while_do:nn</code> <code>{ &lt;dimexpr1&gt; &lt;relation&gt; &lt;dimexpr2&gt; } {&lt;code&gt;}</code>
---------------------------------	---------------------------------------------------------------------------------------------------------------------

Places the *<code>* in the input stream for T<sub>E</sub>X to process, and then evaluates the relationship between the two *<dimension expressions>* as described for `\dim_compare:nTF`. If the test is **true** then the *<code>* will be inserted into the input stream again and a loop will occur until the *<relation>* is **false**.



## 59 Using dim expressions and variables

`\dim_eval:n` ★ `\dim_eval:n {⟨dimension expression⟩}`

Evaluates the *⟨dimension expression⟩*, expanding any dimensions and token list variables within the *⟨expression⟩* to their content (without requiring `\dim_use:N/\tl_use:N`) and applying the standard mathematical rules. The result of the calculation is left in the input stream as a *⟨dimension denotation⟩* after two expansions. This will be expressed in points (`\pt`), and will require suitable termination if used in a T<sub>E</sub>X-style assignment as it is *not* an *⟨internal dimension⟩*.

`\dim_use:N` ★  
`\dim_use:c` ★ `\dim_use:N ⟨dimension⟩`

Recovers the content of a *⟨dimension⟩* and places it directly in the input stream. An error will be raised if the variable does not exist or if it is invalid. Can be omitted in places where a *⟨dimension⟩* is required (such as in the argument of `\dim_eval:n`).

**T<sub>E</sub>Xhackers note:** `\dim_use:N` is the T<sub>E</sub>X primitive `\the`: this is one of several L<sup>A</sup>T<sub>E</sub>X3 names for this primitive.

## 60 Viewing dim variables

`\dim_show:N`  
`\dim_show:c` `\dim_show:N ⟨dimension⟩`

Displays the value of the *⟨dimension⟩* on the terminal.

## 61 Constant dimensions

`\c_max_dim` The maximum value that can be stored as a dimension or skip (these are equivalent).

`\c_zero_dim` A zero length as a dimension or a skip (these are equivalent).

## 62 Scratch dimensions

<code>\l_tmpa_dim</code>
<code>\l_tmpb_dim</code>
<code>\l_tmpc_dim</code>

Scratch dimension for local assignment. These are never used by the kernel code, and so are safe for use with any L<sup>A</sup>T<sub>E</sub>X3-defined function. However, they may be overwritten by other non-kernel code and so should only be used for short-term storage.

<code>\g_tmpa_dim</code>
<code>\g_tmpb_dim</code>

Scratch dimension for global assignment. These are never used by the kernel code, and so are safe for use with any L<sup>A</sup>T<sub>E</sub>X3-defined function. However, they may be overwritten by other non-kernel code and so should only be used for short-term storage.

## 63 Creating and initialising skip variables

<code>\skip_new:N</code>
<code>\skip_new:c</code>

`\skip_new:N`  $\langle skip \rangle$

Creates a new  $\langle skip \rangle$  or raises an error if the name is already taken. The declaration is global. The  $\langle skip \rangle$  will initially be equal to 0pt.

<code>\skip_zero:N</code>
<code>\skip_zero:c</code>

`\skip_zero:N`  $\langle skip \rangle$

Sets  $\langle skip \rangle$  to 0pt within the scope of the current T<sub>E</sub>X group.

<code>\skip_gzero:N</code>
<code>\skip_gzero:c</code>

`\skip_gzero:N`  $\langle skip \rangle$

Sets  $\langle skip \rangle$  to 0pt globally, *i.e.* not restricted by the current T<sub>E</sub>X group level.

## 64 Setting skip variables

<code>\skip_add:Nn</code>
<code>\skip_add:cn</code>

`\skip_add:Nn`  $\langle skip \rangle$   $\{ \langle skip \text{ expression} \rangle \}$

Adds the result of the  $\langle skip \text{ expression} \rangle$  to the current content of the  $\langle skip \rangle$ . This assign-

ment is local.

<code>\skip_gadd:Nn</code>
<code>\skip_gadd:cn</code>

`\skip_gadd:Nn <skip> {(skip expression)}`

Adds the result of the *<skip expression>* to the current content of the *<skip>*. This assignment is global.

<code>\skip_set:Nn</code>
<code>\skip_set:cn</code>

`\skip_set:Nn <skip> {(skip expression)}`

Sets *<skip>* to the value of *<skip expression>*, which must evaluate to a length with units and may include a rubber component (for example 1 cm plus 0.5 cm. This assignment is restricted to the current T<sub>E</sub>X group.

<code>\skip_gset_eq:NN</code>
<code>\skip_gset_eq:cN</code>
<code>\skip_gset_eq:Nc</code>
<code>\skip_gset_eq:cc</code>

`\skip_gset_eq:NN <skip1> <skip2>`

Sets the content of *<skip1>* equal to that of *<skip2>*. This assignment is global and so is not limited by the current T<sub>E</sub>X group level.

<code>\skip_gset:Nn</code>
<code>\skip_gset:cn</code>

`\skip_gset:Nn <skip> {(skip expression)}`

Sets *<skip>* to the value of *<skip expression>*, which must evaluate to a length with units and may include a rubber component (for example 1 cm plus 0.5 cm. This assignment is global and is not limited to the current T<sub>E</sub>X group level.

<code>\skip_set_eq:NN</code>
<code>\skip_set_eq:cN</code>
<code>\skip_set_eq:Nc</code>
<code>\skip_set_eq:cc</code>

`\skip_set_eq:NN <skip1> <skip2>`

Sets the content of *<skip1>* equal to that of *<skip2>*. This assignment is restricted to the current T<sub>E</sub>X group level.

<code>\skip_sub:Nn</code>
<code>\skip_sub:cn</code>

`\skip_sub:Nn <skip> {(skip expression)}`

Subtracts the result of the *<skip expression>* to the current content of the *<skip>*. This assignment is local.

<code>\skip_gsub:Nn</code>
<code>\skip_gsub:cn</code>

`\skip_gsub:Nn <skip> {(skip expression)}`

Subtracts the result of the *<skip expression>* to the current content of the *<skip>*. This assignment is global.

## 65 Skip expression conditionals

	<code>\skip_if_eq_p:nn</code>	<code>{\skipexpr<sub>1</sub>}\{\skipexpr<sub>2</sub>}</code>
	<code>\dim_compare:nTF</code>	<code>{\skipexpr<sub>1</sub>}\{\skipexpr<sub>2</sub>}</code>
<code>\skip_if_eq_p:nn</code> ★		<code>{\true code}\{\false code}</code>
<code>\skip_if_eq:nnTF</code> ★		

This function first evaluates each of the *<skip expressions>* as described for `\skip_eval:n`. The two results are then compared for exact equality, *i.e.* both the fixed and rubber components must be the same for the test to be true.

<code>\skip_if_infinite_glue_p:n</code> ★	<code>\skip_if_infinite_glue_p:n {\skipexpr}</code>
<code>\skip_if_infinite_glue:nTF</code> ★	<code>\skip_if_infinite_glue:nTF {\skipexpr}</code>
	<code>{\true code}\{\false code}</code>

Evaluates the *<skip expression>* as described for `\skip_eval:n`, and then tests if this contains an infinite stretch or shrink component (or both).

## 66 Using skip expressions and variables

<code>\skip_eval:n</code> ★	<code>\skip_eval:n {\skip expression}</code>
-----------------------------	----------------------------------------------

Evaluates the *<skip expression>*, expanding any skips and token list variables within the *<expression>* to their content (without requiring `\skip_use:N/\tl_use:N`) and applying the standard mathematical rules. The result of the calculation is left in the input stream as a *<glue denotation>* after two expansions. This will be expressed in points (`pt`), and will require suitable termination if used in a TeX-style assignment as it is *not* an *<internal glue>*.

<code>\skip_use:N</code> ★	
<code>\skip_use:c</code> ★	<code>\skip_use:N &lt;skip&gt;</code>

Recovers the content of a *<skip>* and places it directly in the input stream. An error will be raised if the variable does not exist or if it is invalid. Can be omitted in places where a *<dimension>* is required (such as in the argument of `\skip_eval:n`).

**TeXhackers note:** `\skip_use:N` is the TeX primitive `\the`: this is one of several L<sup>A</sup>T<sub>E</sub>X3 names for this primitive.

## 67 Viewing skip variables

<code>\skip_show:N</code>
<code>\skip_show:c</code>

`\skip_show:N <skip>`  
Displays the value of the `<skip>` on the terminal.

## 68 Constant skips

<code>\c_max_skip</code>
--------------------------

The maximum value that can be stored as a dimension or skip (these are equivalent).

<code>\c_zero_skip</code>
---------------------------

A zero length as a dimension or a skip (these are equivalent).

## 69 Scratch skips

<code>\l_tmpa_skip</code>
<code>\l_tmpb_skip</code>
<code>\l_tmpc_skip</code>

Scratch skip for local assignment. These are never used by the kernel code, and so are safe for use with any `LATEX3`-defined function. However, they may be overwritten by other non-kernel code and so should only be used for short-term storage.

<code>\g_tmpa_skip</code>
<code>\g_tmpb_skip</code>

Scratch skip for global assignment. These are never used by the kernel code, and so are safe for use with any `LATEX3`-defined function. However, they may be overwritten by other non-kernel code and so should only be used for short-term storage.

## 70 Creating and initialising muskip variables

<code>\muskip_new:N</code>
<code>\muskip_new:c</code>

`\muskip_new:N <muskip>`  
Creates a new `<muskip>` or raises an error if the name is already taken. The declaration

is global. The  $\langle muskip \rangle$  will initially be equal to 0 mu.

<code>\muskip_zero:N</code>	<code>\skip_zero:N <math>\langle muskip \rangle</math></code>
<code>\muskip_zero:c</code>	

Sets  $\langle muskip \rangle$  to 0 mu within the scope of the current T<sub>E</sub>X group.

<code>\muskip_gzero:N</code>	<code>\muskip_gzero:N <math>\langle muskip \rangle</math></code>
<code>\muskip_gzero:c</code>	

Sets  $\langle muskip \rangle$  to 0 mu globally, *i.e.* not restricted by the current T<sub>E</sub>X group level.

## 71 Setting muskip variables

<code>\muskip_add:Nn</code>	<code>\muskip_add:Nn <math>\langle muskip \rangle</math> {<math>\langle muskip expression \rangle</math>}</code>
<code>\muskip_add:cn</code>	

Adds the result of the  $\langle muskip expression \rangle$  to the current content of the  $\langle muskip \rangle$ . This assignment is local.

<code>\muskip_gadd:Nn</code>	<code>\muskip_gadd:Nn <math>\langle muskip \rangle</math> {<math>\langle muskip expression \rangle</math>}</code>
<code>\muskip_gadd:cn</code>	

Adds the result of the  $\langle muskip expression \rangle$  to the current content of the  $\langle muskip \rangle$ . This assignment is global.

<code>\muskip_set:Nn</code>	<code>\muskip_set:Nn <math>\langle muskip \rangle</math> {<math>\langle muskip expression \rangle</math>}</code>
<code>\muskip_set:cn</code>	

Sets  $\langle muskip \rangle$  to the value of  $\langle muskip expression \rangle$ , which must evaluate to a math length with units and may include a rubber component (for example 1 mu plus 0.5 mu. This assignment is restricted to the current T<sub>E</sub>X group.

<code>\muskip_gset:Nn</code>	<code>\muskip_gset:Nn <math>\langle muskip \rangle</math> {<math>\langle muskip expression \rangle</math>}</code>
<code>\muskip_gset:cn</code>	

Sets  $\langle muskip \rangle$  to the value of  $\langle muskip expression \rangle$ , which must evaluate to a math length with units and may include a rubber component (for example 1 mu plus 0.5 mu. This assignment is global and is not limited to the current T<sub>E</sub>X group level.

<code>\muskip_set_eq:NN</code>	<code>\muskip_set_eq:NN <math>\langle muskip1 \rangle</math> <math>\langle muskip2 \rangle</math></code>
<code>\muskip_set_eq:cN</code>	
<code>\muskip_set_eq:Nc</code>	
<code>\muskip_set_eq:cc</code>	

Sets the content of  $\langle muskip1 \rangle$  equal to that of  $\langle muskip2 \rangle$ . This assignment is restricted

to the current  $\text{\TeX}$  group level.

$\backslash\text{muskip\_gset\_eq:N}$ $\backslash\text{muskip\_gset\_eq:cN}$ $\backslash\text{muskip\_gset\_eq:Nc}$ $\backslash\text{muskip\_gset\_eq:cc}$	$\backslash\text{muskip\_gset\_eq:N}$ $\langle\text{muskip1}\rangle$ $\langle\text{muskip2}\rangle$
---------------------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------

Sets the content of  $\langle\text{muskip1}\rangle$  equal to that of  $\langle\text{muskip2}\rangle$ . This assignment is global and so is not limited by the current  $\text{\TeX}$  group level.

$\backslash\text{muskip\_sub:Nn}$ $\backslash\text{muskip\_sub:cn}$	$\backslash\text{muskip\_sub:Nn}$ $\langle\text{muskip}\rangle$ $\{\langle\text{muskip expression}\rangle\}$
------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------

Subtracts the result of the  $\langle\text{muskip expression}\rangle$  to the current content of the  $\langle\text{skip}\rangle$ . This assignment is local.

$\backslash\text{muskip\_gsub:Nn}$ $\backslash\text{muskip\_gsub:cn}$	$\backslash\text{muskip\_gsub:Nn}$ $\langle\text{muskip}\rangle$ $\{\langle\text{muskip expression}\rangle\}$
--------------------------------------------------------------------------	---------------------------------------------------------------------------------------------------------------

Subtracts the result of the  $\langle\text{muskip expression}\rangle$  to the current content of the  $\langle\text{muskip}\rangle$ . This assignment is global.

## 72 Using muskip expressions and variables

$\backslash\text{muskip\_eval:n}$ ★	$\backslash\text{muskip\_eval:n}$ $\{\langle\text{muskip expression}\rangle\}$
-------------------------------------	--------------------------------------------------------------------------------

Evaluates the  $\langle\text{muskip expression}\rangle$ , expanding any skips and token list variables within the  $\langle\text{expression}\rangle$  to their content (without requiring  $\backslash\text{muskip\_use:N}/\text{\texttt{tl\_use:N}}$ ) and applying the standard mathematical rules. The result of the calculation is left in the input stream as a  $\langle\text{mu glue denotation}\rangle$  after two expansions. This will be expressed in  $\mu$ , and will require suitable termination if used in a  $\text{\TeX}$ -style assignment as it is *not* an  $\langle\text{internal mu glue}\rangle$ .

$\backslash\text{muskip\_use:N}$ ★ $\backslash\text{muskip\_use:c}$ ★	$\backslash\text{muskip\_use:N}$ $\langle\text{muskip}\rangle$
--------------------------------------------------------------------------	----------------------------------------------------------------

Recovers the content of a  $\langle\text{skip}\rangle$  and places it directly in the input stream. An error will be raised if the variable does not exist or if it is invalid. Can be omitted in places where a  $\langle\text{dimension}\rangle$  is required (such as in the argument of  $\backslash\text{muskip\_eval:n}$ ).

**$\text{\TeX}$ hackers note:**  $\backslash\text{muskip\_use:N}$  is the  $\text{\TeX}$  primitive  $\backslash\text{the}$ : this is one of several  $\text{\LaTeX}$ 3 names for this primitive.

## 73 Inserting skips into the output

<code>\skip_horizontal:N</code>	
<code>\skip_horizontal:c</code>	<code>\skip_horizontal:N &lt;skip&gt;</code>
<code>\skip_horizontal:n</code>	<code>\skip_horizontal:n {&lt;skipexpr&gt;}</code>

Inserts a horizontal *<skip>* into the current list.

**T<sub>E</sub>Xhackers note:** `\skip_horizontal:N` is the T<sub>E</sub>X primitive `\hskip` renamed.

<code>\skip_vertical:N</code>	
<code>\skip_vertical:c</code>	<code>\skip_vertical:N &lt;skip&gt;</code>
<code>\skip_vertical:n</code>	<code>\skip_vertical:n {&lt;skipexpr&gt;}</code>

Inserts a vertical *<skip>* into the current list.

**T<sub>E</sub>Xhackers note:** `\skip_vertical:N` is the T<sub>E</sub>X primitive `\vskip` renamed.

## 74 Viewing muskip variables

<code>\muskip_show:N</code>	
<code>\muskip_show:c</code>	<code>\muskip_show:N &lt;muskip&gt;</code>

Displays the value of the *<muskip>* on the terminal.

## 75 Internal functions

<code>\if_dim:w</code>	<code>&lt;dimen1&gt; &lt;relation&gt; &lt;dimen1&gt;</code>
	<code>&lt;true code&gt;</code>
	<code>\else:</code>
	<code>&lt;false&gt;</code>
<code>\if_dim:w</code>	<code>\fi:</code>

Compare two dimensions. The *<relation>* is one of *<*, *=* or *>* with category code 12.

**T<sub>E</sub>Xhackers note:** This is the T<sub>E</sub>X primitive `\ifdim`.

<code>\dim_eval:w</code>	★	
<code>\dim_eval_end:</code>	★	<code>\dim_eval:w &lt;dimexpr&gt; \dim_eval_end:</code>

Evaluates *<dimension expression>* as described for `\dim_eval:n`. The evaluation stops



when an unexpandable token which is not a valid part of a dimension is read or when `\dim_eval_end:` is reached. The latter is gobbled by the scanner mechanism: `\dim_eval_end:` itself is unexpandable but used correctly the entire construct is expandable.

**TeXhackers note:** This is the  $\varepsilon$ -TeX primitive `\dimexpr`.

## 76 Experimental skip functions

<code>\skip_split_finite_else_action:nnNN</code>	<code>{\langle skipexpr \rangle}</code> <code>{\langle action \rangle}</code> <code>\langle dimen1 \rangle \langle dimen2 \rangle</code>
--------------------------------------------------	------------------------------------------------------------------------------------------------------------------------------------------------

Checks if the  $\langle skipexpr \rangle$  contains finite glue. If it does then it assigns  $\langle dimen1 \rangle$  the stretch component and  $\langle dimen2 \rangle$  the shrink component. If it contains infinite glue set  $\langle dimen1 \rangle$  and  $\langle dimen2 \rangle$  to 0pt and place #2 into the input stream: this is usually an error or warning message of some sort.

## Part XI

# The l3tl package

## Token lists

TeX works with tokens, and L<sup>A</sup>TeX3 therefore provides a number of functions to deal with token lists. Token lists may be present direct in the argument to a function:

```
\foo:n { a collection of \tokens }
```

or may be stored for processing in a so-called “token list variable”, which have the suffix `tl`: the argument to a function:

```
\foo:N \l_some_tl
```

In both cases, functions are available to test and manipulate the lists of tokens, and these have the module prefix `tl`. In many cases, function which can be applied to token list variables are paired with similar functions for application to explicit lists of tokens: the two “views” of a token list are therefore collected together here.

A token list can be seen either as a list of “items”, or a list of “tokens”. An item is whatever `\use_none:n` grabs as its argument: either a single token or a brace group, with optional leading explicit space characters (each item is thus itself a token list). A token is either a normal `N` argument, or `,`, `{`, or `}` (assuming normal `TEX` category codes). Thus for example

```
{ Hello } ~ world
```

contains six items (`Hello`, `w`, `o`, `r`, `l` and `d`), but thirteen tokens (`{`, `H`, `e`, `l`, `l`, `o`, `}`, `~`, `w`, `o`, `r`, `l` and `d`). Functions which act on items are often faster than their analogue acting directly on tokens.

## 77 Creating and initialising token list variables

<code>\tl_new:N</code>
<code>\tl_new:c</code>

`\tl_new:N <tl var>`

Creates a new `<tl var>` or raises an error if the name is already taken. The declaration is global. The `<tl var>` will initially be empty.

<code>\tl_const:Nn</code>
<code>\tl_const:Nx</code>
<code>\tl_const:cn</code>
<code>\tl_const:cx</code>

`\tl_const:Nn <tl var> {<token list>}`

Creates a new constant `<tl var>` or raises an error if the name is already taken. The value of the `<tl var>` will be set globally to the `<token list>`.

<code>\tl_clear:N</code>
<code>\tl_clear:c</code>

`\tl_clear:N <tl var>`

Clears all entries from the `<tl var>` within the scope of the current `TEX` group.

<code>\tl_gclear:N</code>
<code>\tl_gclear:c</code>

`\tl_gclear:N <tl var>`

Clears all entries from the `<tl var>` globally.

<code>\tl_clear_new:N</code>
<code>\tl_clear_new:c</code>

`\tl_clear_new:N <tl var>`

If the `<tl var>` already exists, clears it within the scope of the current `TEX` group. If the `<tl var>` is not defined, it will be created (using `\tl_new:N`). Thus the sequence is

guaranteed to be available and clear within the current  $\text{\TeX}$  group. The  $\langle tl\ var\rangle$  will exist globally, but the content outside of the current  $\text{\TeX}$  group is not specified.

$\backslash\text{tl\_gclear\_new:N}$
$\backslash\text{tl\_gclear\_new:c}$

 $\backslash\text{tl\_gclear\_new:N}\ \langle tl\ var\rangle$ 

If the  $\langle tl\ var\rangle$  already exists, clears it globally. If the  $\langle tl\ var\rangle$  is not defined, it will be created (using  $\backslash\text{tl\_new:N}$ ). Thus the sequence is guaranteed to be available and globally clear.

$\backslash\text{tl\_set\_eq:NN}$
$\backslash\text{tl\_set\_eq:cN}$
$\backslash\text{tl\_set\_eq:Nc}$
$\backslash\text{tl\_set\_eq:cc}$

 $\backslash\text{tl\_set\_eq:NN}\ \langle tl\ var1\rangle\ \langle tl\ var2\rangle$ 

Sets the content of  $\langle tl\ var1\rangle$  equal to that of  $\langle tl\ var2\rangle$ . This assignment is restricted to the current  $\text{\TeX}$  group level.

$\backslash\text{tl\_gset\_eq:NN}$
$\backslash\text{tl\_gset\_eq:cN}$
$\backslash\text{tl\_gset\_eq:Nc}$
$\backslash\text{tl\_gset\_eq:cc}$

 $\backslash\text{tl\_gset\_eq:NN}\ \langle tl\ var1\rangle\ \langle tl\ var2\rangle$ 

Sets the content of  $\langle tl\ var1\rangle$  equal to that of  $\langle tl\ var2\rangle$ . This assignment is global and so is not limited by the current  $\text{\TeX}$  group level.

## 78 Adding data to token list variables

$\backslash\text{tl\_set:Nn}$
$\backslash\text{tl\_set:NV}$
$\backslash\text{tl\_set:Nv}$
$\backslash\text{tl\_set:No}$
$\backslash\text{tl\_set:Nf}$
$\backslash\text{tl\_set:Nx}$
$\backslash\text{tl\_set:cn}$
$\backslash\text{tl\_set:NV}$
$\backslash\text{tl\_set:Nv}$
$\backslash\text{tl\_set:co}$
$\backslash\text{tl\_set:cf}$
$\backslash\text{tl\_set:cx}$

 $\backslash\text{tl\_set:Nn}\ \langle tl\ var\rangle\ \{\langle tokens\rangle\}$ 

Sets  $\langle tl\ var\rangle$  to contain  $\langle tokens\rangle$ , removing any previous content from the variable. This

assignment is restricted to the current T<sub>E</sub>X group.

<code>\tl_gset:Nn</code>
<code>\tl_gset:NV</code>
<code>\tl_gset:Nv</code>
<code>\tl_gset:No</code>
<code>\tl_gset:Nf</code>
<code>\tl_gset:Nx</code>
<code>\tl_gset:cn</code>
<code>\tl_gset:cV</code>
<code>\tl_gset:cv</code>
<code>\tl_gset:co</code>
<code>\tl_gset:cf</code>
<code>\tl_gset:cx</code>

`\tl_gset:Nn <tl var> {<tokens>}`

Sets  $\langle tl\ var \rangle$  to contain  $\langle tokens \rangle$ , removing any previous content from the variable. This assignment is global and is not limited to the current T<sub>E</sub>X group level.

<code>\tl_put_left:Nn</code>
<code>\tl_put_left:NV</code>
<code>\tl_put_left:No</code>
<code>\tl_put_left:Nx</code>
<code>\tl_put_left:cn</code>
<code>\tl_put_left:cV</code>
<code>\tl_put_left:co</code>
<code>\tl_put_left:cx</code>

`\tl_put_left:Nn <tl var> {<tokens>}`

Appends  $\langle tokens \rangle$  to the left side of the current content of  $\langle tl\ var \rangle$ . This modification is restricted to the current T<sub>E</sub>X group level.

<code>\tl_gput_left:Nn</code>
<code>\tl_gput_left:NV</code>
<code>\tl_gput_left:No</code>
<code>\tl_gput_left:Nx</code>
<code>\tl_gput_left:cn</code>
<code>\tl_gput_left:cV</code>
<code>\tl_gput_left:co</code>
<code>\tl_gput_left:cx</code>

`\tl_gput_left:Nn <tl var> {<tokens>}`

Globally appends  $\langle tokens \rangle$  to the left side of the current content of  $\langle tl\ var \rangle$ . This modi-

fication is not limited by T<sub>E</sub>X grouping.

<code>\tl_put_right:Nn</code>
<code>\tl_put_right:NV</code>
<code>\tl_put_right:No</code>
<code>\tl_put_right:Nx</code>
<code>\tl_put_right:cn</code>
<code>\tl_put_right:cV</code>
<code>\tl_put_right:co</code>
<code>\tl_put_right:cx</code>

`\tl_put_right:Nn <tl var> {<tokens>}`

Appends *<tokens>* to the right side of the current content of *<tl var>*. This modification is restricted to the current T<sub>E</sub>X group level.

<code>\tl_gput_right:Nn</code>
<code>\tl_gput_right:NV</code>
<code>\tl_gput_right:No</code>
<code>\tl_gput_right:Nx</code>
<code>\tl_gput_right:cn</code>
<code>\tl_gput_right:cV</code>
<code>\tl_gput_right:co</code>
<code>\tl_gput_right:cx</code>

`\tl_gput_right:Nn <tl var> {<tokens>}`

Globally appends *<tokens>* to the right side of the current content of *<tl var>*. This modification is not limited by T<sub>E</sub>X grouping.

## 79 Modifying token list variables

<code>\tl_replace_once:Nnn</code>
<code>\tl_replace_once:cnn</code>

`\tl_replace_once:Nnn <tl var> {<old tokens>}  
{<new tokens>}`

Replaces the first (leftmost) occurrence of *<old tokens>* in the *<tl var>* with *<new tokens>*. *<Old tokens>* cannot contain `{`, `}` or `#` (assuming normal T<sub>E</sub>X category codes). The assignment is restricted to the current T<sub>E</sub>X group.

<code>\tl_greplace_once:Nnn</code>
<code>\tl_greplace_once:cnn</code>

`\tl_greplace_once:Nnn <tl var> {<old tokens>}  
{<new tokens>}`

Replaces the first (leftmost) occurrence of *<old tokens>* in the *<tl var>* with *<new tokens>*. *<Old tokens>* cannot contain `{`, `}` or `#` (assuming normal T<sub>E</sub>X category codes). The

assignment is applied globally.

<code>\tl_replace_all:Nnn</code> <code>\tl_replace_all:cnn</code>	<code>\tl_replace_all:Nnn &lt;tl var&gt; {&lt;old tokens&gt;}</code> <code>{&lt;new tokens&gt;}</code>
----------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------

Replaces all occurrences of *<old tokens>* in the *<tl var>* with *<new tokens>*. *<Old tokens>* cannot contain `{`, `}` or `#` (assuming normal T<sub>E</sub>X category codes). As this function operates from left to right, the pattern *<old tokens>* may remain after the replacement (see `\tl_remove_all:Nn` for an example). The assignment is restricted to the current T<sub>E</sub>X group.

<code>\tl_greplace_all:Nnn</code> <code>\tl_greplace_all:cnn</code>	<code>\tl_greplace_all:Nnn &lt;tl var&gt; {&lt;old tokens&gt;}</code> <code>{&lt;new tokens&gt;}</code>
------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------------

Replaces all occurrences of *<old tokens>* in the *<tl var>* with *<new tokens>*. *<Old tokens>* cannot contain `{`, `}` or `#` (assuming normal T<sub>E</sub>X category codes). As this function operates from left to right, the pattern *<old tokens>* may remain after the replacement (see `\tl_remove_all:Nn` for an example). The assignment is applied globally.

<code>\tl_remove_once:Nn</code> <code>\tl_remove_once:cn</code>	<code>\tl_remove_once:Nn &lt;tl var&gt; {&lt;tokens&gt;}</code>
--------------------------------------------------------------------	-----------------------------------------------------------------

Removes the first (leftmost) occurrence of *<tokens>* from the *<tl var>*. *<Tokens>* cannot contain `{`, `}` or `#` (assuming normal T<sub>E</sub>X category codes). The assignment is restricted to the current T<sub>E</sub>X group.

<code>\tl_gremove_once:Nn</code> <code>\tl_gremove_once:cn</code>	<code>\tl_gremove_once:Nn &lt;tl var&gt; {&lt;tokens&gt;}</code>
----------------------------------------------------------------------	------------------------------------------------------------------

Removes the first (leftmost) occurrence of *<tokens>* from the *<tl var>*. *<Tokens>* cannot contain `{`, `}` or `#` (assuming normal T<sub>E</sub>X category codes). The assignment is applied globally.

<code>\tl_remove_all:Nn</code> <code>\tl_remove_all:cn</code>	<code>\tl_remove_all:Nn &lt;tl var&gt; {&lt;tokens&gt;}</code>
------------------------------------------------------------------	----------------------------------------------------------------

Removes all occurrences of *<tokens>* from the *<tl var>*. *<Tokens>* cannot contain `{`, `}` or `#` (assuming normal T<sub>E</sub>X category codes). As this function operates from left to right, the pattern *<tokens>* may remain after the removal, for instance,

```
\tl_set:Nn \l_tmpa_tl {abbccd} \tl_remove_all:Nn \l_tmpa_tl {bc}
```

will result in `\l_tmpa_tl` containing `abcd`. The assignment is restricted to the current T<sub>E</sub>X group.

<code>\tl_gremove_all:Nn</code> <code>\tl_gremove_all:cn</code>	<code>\tl_gremove_all:Nn &lt;tl var&gt; {&lt;tokens&gt;}</code>
--------------------------------------------------------------------	-----------------------------------------------------------------

Removes all occurrences of *<tokens>* from the *<tl var>*. *<Tokens>* cannot contain `{`, `}` or `#`

(assuming normal T<sub>E</sub>X category codes). As this function operates from left to right, the pattern  $\langle tokens \rangle$  may remain after the removal (see `\tl_remove_all:Nn` for an example). The assignment is applied globally.

## 80 Reassigning token list category codes

<code>\tl_set_rescan:Nnn</code> <code>\tl_set_rescan:Nno</code> <code>\tl_set_rescan:Nnx</code> <code>\tl_set_rescan:cnn</code> <code>\tl_set_rescan:cno</code> <code>\tl_set_rescan:cnx</code>	<code>\tl_set_rescan:Nnn &lt;tl var&gt; {\setup}</code> <code>  {\tokens}}</code>
----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------

Sets  $\langle tl var \rangle$  to contain  $\langle tokens \rangle$ , applying the category code régime specified in the  $\langle setup \rangle$  before carrying out the assignment. This allows the  $\langle tl var \rangle$  to contain material with category codes other than those that apply when  $\langle tokens \rangle$  are absorbed. The assignment is local to the current T<sub>E</sub>X group. See also `\tl_rescan:nn`.

<code>\tl_gset_rescan:Nnn</code> <code>\tl_gset_rescan:Nno</code> <code>\tl_gset_rescan:Nnx</code> <code>\tl_gset_rescan:cnn</code> <code>\tl_gset_rescan:cno</code> <code>\tl_gset_rescan:cnx</code>	<code>\tl_gset_rescan:Nnn &lt;tl var&gt; {\setup}</code> <code>  {\tokens}}</code>
----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	---------------------------------------------------------------------------------------

Sets  $\langle tl var \rangle$  to contain  $\langle tokens \rangle$ , applying the category code régime specified in the  $\langle setup \rangle$  before carrying out the assignment. This allows the  $\langle tl var \rangle$  to contain material with category codes other than those that apply when  $\langle tokens \rangle$  are absorbed. The assignment is global. See also `\tl_rescan:nn`.

<code>\tl_rescan:nn</code>	<code>\tl_rescan:nn {\setup} {\tokens}}</code>
----------------------------	------------------------------------------------

Rescans  $\langle tokens \rangle$  applying the category code régime specified in the  $\langle setup \rangle$ , and leaves the resulting tokens in the input stream. See also `\tl_set_rescan:Nnn`.

## 81 Reassigning token list character codes

<code>\tl_to_lowercase:n</code>	<code>\tl_to_lowercase:n {\tokens}}</code>
---------------------------------	--------------------------------------------

Works through all of the  $\langle tokens \rangle$ , replacing each character with the lower case equivalent as defined by `\char_set_lccode:nn`. Characters with no defined lower case character code are left unchanged. This process does not alter the category code assigned to the  $\langle tokens \rangle$ .

**T<sub>E</sub>Xhackers note:** This is the T<sub>E</sub>X primitive `\lowercase` renamed. As a result, this function takes place on execution and not on expansion.

<code>\tl_to_uppercase:n</code>	<code>\tl_to_uppercase:n {\tokens}</code>
---------------------------------	-------------------------------------------

Works through all of the  $\langle tokens \rangle$ , replacing each character with the upper case equivalent as defined by `\char_set_uccode:nn`. Characters with no defined lower case character code are left unchanged. This process does not alter the category code assigned to the  $\langle tokens \rangle$ .

**T<sub>E</sub>Xhackers note:** This is the T<sub>E</sub>X primitive `\uppercase` renamed. As a result, this function takes place on execution and not on expansion.

## 82 Token list conditionals

<code>\tl_if_blank_p:n</code> ★	<code>\tl_if_blank_p:n {\token list}</code> <code>\tl_if_blank:nTF {\token list} {\true code} {\false code}</code>
<code>\tl_if_blank:nTF</code> ★	
<code>\tl_if_blank_p:V</code> ★	
<code>\tl_if_blank:VTF</code> ★	
<code>\tl_if_blank_p:o</code> ★	
<code>\tl_if_blank:oTF</code> ★	

Tests if the  $\langle token list \rangle$  consists only of blank spaces (*i.e.* contains no item). The test is **true** if  $\langle token list \rangle$  is zero or more explicit tokens of character code 32 and category



code 10, and is `false` otherwise.

<code>\tl_if_empty_p:N</code>	★	
<code>\tl_if_empty:N<math>\underline{TF}</math></code>	★	
<code>\tl_if_empty_p:c</code>	★	
<code>\tl_if_empty:c<math>\underline{TF}</math></code>	★	
		<code>\tl_if_empty_p:N &lt;tl var&gt;</code>
		<code>\tl_if_empty:N<math>\underline{TF}</math> &lt;tl var&gt; {&lt;true code&gt;} {&lt;false code&gt;}</code>

Tests if the *<token list variable>* is entirely empty (*i.e.* contains no tokens at all).

<code>\tl_if_empty_p:n</code>	★	
<code>\tl_if_empty:n<math>\underline{TF}</math></code>	★	
<code>\tl_if_empty_p:V</code>	★	
<code>\tl_if_empty:V<math>\underline{TF}</math></code>	★	
<code>\tl_if_empty_p:o</code>	★	
<code>\tl_if_empty:o<math>\underline{TF}</math></code>	★	
		<code>\tl_if_empty_p:n {&lt;token list&gt;}</code>
		<code>\tl_if_empty:n<math>\underline{TF}</math> {&lt;token list&gt;} {&lt;true code&gt;} {&lt;false code&gt;}</code>

Tests if the *<token list>* is entirely empty (*i.e.* contains no tokens at all).

<code>\tl_if_eq_p:NN</code>	★	
<code>\tl_if_eq:NN<math>\underline{TF}</math></code>	★	
<code>\tl_if_eq_p:Nc</code>	★	
<code>\tl_if_eq:Nc<math>\underline{TF}</math></code>	★	
<code>\tl_if_eq_p:cN</code>	★	
<code>\tl_if_eq:cN<math>\underline{TF}</math></code>	★	
<code>\tl_if_eq_p:cc</code>	★	
<code>\tl_if_eq:cc<math>\underline{TF}</math></code>	★	
		<code>\tl_if_eq_p:NN {&lt;tl var<sub>1</sub>&gt;} {&lt;tl var<sub>2</sub>&gt;}</code>
		<code>\tl_if_eq:NN<math>\underline{TF}</math> {&lt;tl var<sub>1</sub>&gt;} {&lt;tl var<sub>2</sub>&gt;} {&lt;true code&gt;} {&lt;false code&gt;}</code>

Compares the content of two *<token list variables>* and is logically `true` if the two contain the same list of tokens (*i.e.* identical in both the list of characters they contain and the category codes of those characters). Thus for example

```
\tl_set:Nn \l_tmpa_tl { abc }
\tl_set:Nx \l_tmpb_tl { \tl_to_str:n { abc } }
\tl_if_eq_p:NN \l_tmpa_tl \l_tmpb_tl
```

is logically `false`.

		<code>\tl_if_eq:nn<math>\underline{TF}</math> &lt;token list1&gt; {&lt;token list2&gt;} {&lt;true code&gt;} {&lt;false code&gt;}</code>
<code>\tl_if_eq:nn<math>\underline{TF}</math></code>		

Tests if *<token list1>* and *<token list2>* are equal, both in respect of character codes and category codes.

<code>\tl_if_in:Nn<math>\underline{TF}</math></code>		
<code>\tl_if_in:cn<math>\underline{TF}</math></code>		
		<code>\tl_if_in:Nn<math>\underline{TF}</math> &lt;tl var&gt; {&lt;token list&gt;} {&lt;true code&gt;} {&lt;false code&gt;}</code>

Tests if the *<token list>* is found in the content of the *<token list variable>*. The *<token*

*list* cannot contain the tokens {, } or # (assuming the usual T<sub>E</sub>X category codes apply).

<code>\tl_if_in:nnTF</code> <code>\tl_if_in:VnTF</code> <code>\tl_if_in:onTF</code> <code>\tl_if_in:onTF</code>	<code>\tl_if_in:nnTF</code> <code>{\langle token list_1 \rangle}</code> <code>{\langle token list_2 \rangle}</code> <code>{\langle true code \rangle}</code> <code>{\langle false code \rangle}</code>
--------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Tests if  $\langle token list_2 \rangle$  is found inside  $\langle token list_1 \rangle$ . The  $\langle token list \rangle$  cannot contain the tokens {, } or # (assuming the usual T<sub>E</sub>X category codes apply).

<code>\tl_if_single_p:N</code> ★ <code>\tl_if_single:NTF</code> ★ <code>\tl_if_single_p:c</code> ★ <code>\tl_if_single:cTF</code> ★	<code>\tl_if_single_p:N</code> <code>{\langle tl var \rangle}</code> <code>\tl_if_single:NTF</code> <code>{\langle tl var \rangle}</code> <code>{\langle true code \rangle}</code> <code>{\langle false code \rangle}</code>
----------------------------------------------------------------------------------------------------------------------------------------------	---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Tests if the content of the  $\langle tl var \rangle$  consists of a single item, *i.e.* is either a single normal token (excluding spaces, and brace tokens) or a single brace group, surrounded by optional spaces on both sides. In other words, such a token list has length 1 according to `\tl_length:N`.

<code>\tl_if_single_p:n</code> ★ <code>\tl_if_single:nTF</code> ★	<code>\tl_if_single_p:n</code> <code>{\langle token list \rangle}</code> <code>\tl_if_single:nTF</code> <code>{\langle token list \rangle}</code> <code>{\langle true code \rangle}</code> <code>{\langle false code \rangle}</code>
----------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Tests if the token list has exactly one item, *i.e.* is either a single normal token or a single brace group, surrounded by optional spaces on both sides. In other words, such a token list has length 1 according to `\tl_length:n`.

<code>\tl_if_single_token_p:n</code> ★ <code>\tl_if_single_token:nTF</code> ★	<code>\tl_if_single_token_p:n</code> <code>{\langle token list \rangle}</code> <code>\tl_if_single_token:nTF</code> <code>{\langle token list \rangle}</code> <code>{\langle true code \rangle}</code> <code>{\langle false code \rangle}</code>
----------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Tests if the token list consists of exactly one token, *i.e.* is either a single space character or a single “normal” token. Token groups { $\dots$ } are not single tokens.

## 83 Mapping to token lists

<code>\tl_map_function:NN</code> ★ <code>\tl_map_function:cN</code> ★	<code>\tl_map_function:NN</code> $\langle tl var \rangle$ $\langle function \rangle$
--------------------------------------------------------------------------	--------------------------------------------------------------------------------------

Applies  $\langle function \rangle$  to every  $\langle item \rangle$  in the  $\langle tl var \rangle$ . The  $\langle function \rangle$  will receive one argument for each iteration. This may be a number of tokens if the  $\langle item \rangle$  was stored

within braces. Hence the  $\langle function \rangle$  should anticipate receiving  $n$ -type arguments. See also `\tl_map_function:nN`.

<code>\tl_map_function:nN</code> ★	<code>\tl_map_function:nN</code> $\langle token list \rangle$ $\langle function \rangle$
------------------------------------	------------------------------------------------------------------------------------------

Applies  $\langle function \rangle$  to every  $\langle item \rangle$  in the  $\langle token list \rangle$ , The  $\langle function \rangle$  will receive one argument for each iteration. This may be a number of tokens if the  $\langle item \rangle$  was stored within braces. Hence the  $\langle function \rangle$  should anticipate receiving  $n$ -type arguments. See also `\tl_map_function:NN`.

<code>\tl_map_inline:Nn</code>	<code>\tl_map_inline:Nn</code> $\langle tl var \rangle$ $\{ \langle inline function \rangle \}$
<code>\tl_map_inline:cn</code>	

Applies the  $\langle inline function \rangle$  to every  $\langle item \rangle$  stored within the  $\langle tl var \rangle$ . The  $\langle inline function \rangle$  should consist of code which will receive the  $\langle item \rangle$  as #1. One in line mapping can be nested inside another. See also `\tl_map_function:Nn`.

<code>\tl_map_inline:nn</code>	<code>\tl_map_inline:nn</code> $\langle token list \rangle$ $\{ \langle inline function \rangle \}$
--------------------------------	-----------------------------------------------------------------------------------------------------

Applies the  $\langle inline function \rangle$  to every  $\langle item \rangle$  stored within the  $\langle token list \rangle$ . The  $\langle inline function \rangle$  should consist of code which will receive the  $\langle item \rangle$  as #1. One in line mapping can be nested inside another. See also `\tl_map_function:nn`.

<code>\tl_map_variable:NNn</code>	<code>\tl_map_variable:NNn</code> $\langle tl var \rangle$ $\langle variable \rangle$ $\{ \langle function \rangle \}$
<code>\tl_map_variable:cNn</code>	

Applies the  $\langle function \rangle$  to every  $\langle item \rangle$  stored within the  $\langle tl var \rangle$ . The  $\langle function \rangle$  should consist of code which will receive the  $\langle item \rangle$  stored in the  $\langle variable \rangle$ . One variable mapping can be nested inside another. See also `\tl_map_inline:Nn`.

<code>\tl_map_variable:nNn</code>	<code>\tl_map_variable:nNn</code> $\langle token list \rangle$ $\langle variable \rangle$ $\{ \langle function \rangle \}$
-----------------------------------	----------------------------------------------------------------------------------------------------------------------------

Applies the  $\langle function \rangle$  to every  $\langle item \rangle$  stored within the  $\langle token list \rangle$ . The  $\langle function \rangle$  should consist of code which will receive the  $\langle item \rangle$  stored in the  $\langle variable \rangle$ . One variable mapping can be nested inside another. See also `\tl_map_inline:nn`.

<code>\tl_map_break: ★</code>	<code>\tl_map_break:</code>
-------------------------------	-----------------------------

Used to terminate a `\tl_map...` function before all entries in the  $\langle token list variable \rangle$  have been processed. This will normally take place within a conditional statement, for example

```
\tl_map_inline:Nn \l_my_tl
{
```

```

\str_if_eq:nnTF { #1 } { bingo }
{ \tl_map_break: }
{
  % Do something useful
}
}

```

Use outside of a `\tl_map...` scenario will lead low level  $\TeX$  errors.

## 84 Using token lists

<code>\tl_to_str:N</code> ★	<code>\tl_to_str:N</code> $\langle$ <i>tl var</i> $\rangle$
<code>\tl_to_str:c</code> ★	

Converts the content of the  $\langle$ *tl var* $\rangle$  into a series of characters with category code 12 (other) with the exception of spaces, which retain category code 10 (space). This  $\langle$ *string* $\rangle$  is then left in the input stream.

<code>\tl_to_str:n</code> ★	<code>\tl_to_str:n</code> $\{$ $\langle$ <i>tokens</i> $\rangle$ $\}$
-----------------------------	-----------------------------------------------------------------------

Converts the given  $\langle$ *tokens* $\rangle$  into a series of characters with category code 12 (other) with the exception of spaces, which retain category code 10 (space). This  $\langle$ *string* $\rangle$  is then left in the input stream. Note that this function requires only a single expansion.

**$\TeX$ hackers note:** This is the  $\varepsilon$ - $\TeX$  primitive `\detokenize`.

<code>\tl_use:N</code> ★	<code>\tl_use:N</code> $\langle$ <i>tl var</i> $\rangle$
<code>\tl_use:c</code> ★	

Recovers the content of a  $\langle$ *tl var* $\rangle$  and places it directly in the input stream. An error will be raised if the variable does not exist or if it is invalid. Note that it is possible to use a  $\langle$ *tl var* $\rangle$  directly without an accessor function.

## 85 Working with the content of token lists

<code>\tl_length:n</code> ★	<code>\tl_length:n</code> $\{$ $\langle$ <i>tokens</i> $\rangle$ $\}$
<code>\tl_length:V</code> ★	
<code>\tl_length:o</code> ★	

Counts the number of  $\langle$ *items* $\rangle$  in  $\langle$ *tokens* $\rangle$  and leaves this information in the input stream. Unbraced tokens count as one element as do each token group  $\{ \dots \}$ . This process will

ignore any unprotected spaces within  $\langle tokens \rangle$ . See also  $\backslash\mathrm{tl\_length:N}$ . This function requires three expansions, giving an  $\langle integer\ denotation \rangle$ .

$\backslash\mathrm{tl\_length:N}$ ★
$\backslash\mathrm{tl\_length:c}$ ★

 $\backslash\mathrm{tl\_length:N} \{ \langle \mathrm{tl\ var} \rangle \}$ 

Counts the number of token groups in the  $\langle \mathrm{tl\ var} \rangle$  and leaves this information in the input stream. Unbraced tokens count as one element as do each token group  $\{ \dots \}$ . This process will ignore any unprotected spaces within  $\langle tokens \rangle$ . See also  $\backslash\mathrm{tl\_length:n}$ . This function requires three expansions, giving an  $\langle integer\ denotation \rangle$ .

$\backslash\mathrm{tl\_reverse:n}$ ★
$\backslash\mathrm{tl\_reverse:V}$ ★
$\backslash\mathrm{tl\_reverse:o}$ ★

 $\backslash\mathrm{tl\_reverse:n} \{ \langle \mathrm{token\ list} \rangle \}$ 

Reverses the order of the  $\langle items \rangle$  in the  $\langle \mathrm{token\ list} \rangle$ , so that  $\langle item_1 \rangle \langle item_2 \rangle \langle item_3 \rangle \dots \langle item_n \rangle$  becomes  $\langle item_n \rangle \dots \langle item_3 \rangle \langle item_2 \rangle \langle item_1 \rangle$ . This process will preserve unprotected space within the  $\langle \mathrm{token\ list} \rangle$ . Tokens are not reversed within braced token groups, which keep their outer set of braces. In situations where performance is important, consider  $\backslash\mathrm{tl\_reverse\_items:n}$ . See also  $\backslash\mathrm{tl\_reverse:N}$ .

$\backslash\mathrm{tl\_reverse:N}$
$\backslash\mathrm{tl\_reverse:c}$

 $\backslash\mathrm{tl\_reverse:N} \{ \langle \mathrm{tl\ var} \rangle \}$ 

Reverses the order of the  $\langle items \rangle$  stored in  $\langle \mathrm{tl\ var} \rangle$ , so that  $\langle item_1 \rangle \langle item_2 \rangle \langle item_3 \rangle \dots \langle item_n \rangle$  becomes  $\langle item_n \rangle \dots \langle item_3 \rangle \langle item_2 \rangle \langle item_1 \rangle$ . This process will preserve unprotected spaces within the  $\langle \mathrm{token\ list\ variable} \rangle$ . Braced token groups are copied without reversing the order of tokens, but keep the outer set of braces. The reversal is local to the current  $\mathrm{T}_{\mathrm{E}}\mathrm{X}$  group. See also  $\backslash\mathrm{tl\_reverse:n}$ .

$\backslash\mathrm{tl\_reverse\_items:n}$ ★
---------------------------------------------

 $\backslash\mathrm{tl\_reverse\_items:n} \{ \langle \mathrm{token\ list} \rangle \}$ 

Reverses the order of the  $\langle items \rangle$  stored in  $\langle \mathrm{tl\ var} \rangle$ , so that  $\{ \langle item_1 \rangle \} \{ \langle item_2 \rangle \} \{ \langle item_3 \rangle \} \dots \{ \langle item_n \rangle \}$  becomes  $\{ \langle item_n \rangle \} \dots \{ \langle item_3 \rangle \} \{ \langle item_2 \rangle \} \{ \langle item_1 \rangle \}$ . This process will remove any unprotected space within the  $\langle \mathrm{token\ list} \rangle$ . Braced token groups are copied without reversing the order of tokens, and keep the outer set of braces. Items which are initially not braced are copied with braces in the result. In cases where preserving spaces is important, consider  $\backslash\mathrm{tl\_reverse:n}$  or  $\backslash\mathrm{tl\_reverse\_tokens:n}$ .

$\backslash\mathrm{tl\_trim\_spaces:n}$ ★
-------------------------------------------

 $\backslash\mathrm{tl\_trim\_spaces:n} \langle \mathrm{token\ list} \rangle$ 

Removes any leading and trailing explicit space characters from the  $\langle \mathrm{token\ list} \rangle$  and leaves the result in the input stream. This process requires two expansions.

**$\mathrm{T}_{\mathrm{E}}\mathrm{X}$ hackers note:** The result is return within the  $\backslash\mathrm{etex\_unexpanded:D}$  primitive ( $\backslash\mathrm{exp\_not:n}$ ), which means that the token list will not expand further when appearing in an x-type argument expansion.

<code>\tl_trim_spaces:N</code> <code>\tl_trim_spaces:c</code>
------------------------------------------------------------------

`\tl_trim_spaces:N <tl var>`

Removes any leading and trailing explicit space characters from the content of the  $\langle tl\ var\rangle$  within the current  $\text{\TeX}$  group.

<code>\tl_gtrim_spaces:N</code> <code>\tl_gtrim_spaces:c</code>
--------------------------------------------------------------------

`\tl_gtrim_spaces:N <tl var>`

Removes any leading and trailing explicit space characters from the content of the  $\langle tl\ var\rangle$  globally.

## 86 The first token from a token list

Functions which deal with either only the very first token of a token list or everything except the first token.

<code>\tl_head:n</code> ★ <code>\tl_head:V</code> ★ <code>\tl_head:v</code> ★ <code>\tl_head:f</code> ★
------------------------------------------------------------------------------------------------------------------

`\tl_head:n {<tokens>}`

Leaves in the input stream the first non-space token from the  $\langle tokens\rangle$ . Any leading space tokens will be discarded, and thus for example

```
\tl_head:n { abc }
```

and

```
\tl_head:n { ~ abc }
```

will both leave `a` in the input stream. An empty list of  $\langle tokens\rangle$  or one which consists only of space (category code 10) tokens will result in `\tl_head:n` leaving nothing in the input stream.

<code>\tl_head:w</code> ★
---------------------------

`\tl_head:w <tokens> \q_stop`

Leaves in the input stream the first non-space token from the  $\langle tokens\rangle$ . An empty list of  $\langle tokens\rangle$  or one which consists only of space (category code 10) tokens will result in an error, and thus  $\langle tokens\rangle$  must *not* be “blank” as determined by `\tl_if_blank:n(TF)`.

This function requires only a single expansion, and thus is suitable for use within an o-type expansion. In general, `\tl_head:n` should be preferred if the number of expansions is not critical.

<code>\tl_tail:n</code>	★
<code>\tl_tail:V</code>	★
<code>\tl_tail:v</code>	★
<code>\tl_tail:f</code>	★

`\tl_tail:n {<tokens>}`

Discards the all leading space tokens and the first non-space token in the `<tokens>`, and leaves the remaining tokens in the input stream. Thus for example

```
\tl_tail:n { abc }
```

and

```
\tl_tail:n { ~ abc }
```

will both leave `bc` in the input stream. An empty list of `<tokens>` or one which consists only of space (category code 10) tokens will result in `\tl_tail:n` leaving nothing in the input stream.

<code>\tl_tail:w</code>	★
-------------------------	---

`\tl_tail:w {<tokens>} \q_stop`

Discards the all leading space tokens and the first non-space token in the `<tokens>`, and leaves the remaining tokens in the input stream. An empty list of `<tokens>` or one which consists only of space (category code 10) tokens will result in an error, and thus `<tokens>` must *not* be “blank” as determined by `\tl_if_blank:n(TF)`. This function requires only a single expansion, and thus is suitable for use within an o-type expansion. In general, `\tl_tail:n` should be preferred if the number of expansions is not critical.

<code>\str_head:n</code>	★
<code>\str_tail:n</code>	★

`\str_head:n {<tokens>}`  
`\str_tail:n {<tokens>}`

Converts the `<tokens>` into a string, as described for `\tl_to_str:n`. The `\str_head:n` function then leaves the first character of this string in the input stream. The `\str_tail:n` function leaves all characters except the first in the input stream. The first character may be a space. If the `<tokens>` argument is entirely empty, nothing is left in the input stream.

<code>\tl_if_head_eq_catcode_p:nN</code>	★
<code>\tl_if_head_eq_catcode:nNTF</code>	★

`\tl_if_head_eq_catcode_p:nN {<token list>} <test token>`  
`\tl_if_head_eq_catcode:nNTF {<token list>} <test token>`  
`{<true code>} {<false code>}`

Tests if the first  $\langle token \rangle$  in the  $\langle token list \rangle$  has the same category code as the  $\langle test token \rangle$ . In the case where  $\langle token list \rangle$  is empty, its head is considered to be  $\backslash q\_nil$ , and the test will be true if  $\langle test token \rangle$  is a control sequence.

$\backslash tl\_if\_head\_eq\_charcode\_p:nN$ ★ $\backslash tl\_if\_head\_eq\_charcode:nNTF$ ★ $\backslash tl\_if\_head\_eq\_charcode\_p:fN$ ★ $\backslash tl\_if\_head\_eq\_charcode:fNTF$ ★	$\backslash tl\_if\_head\_eq\_charcode\_p:nN \{ \langle token list \rangle \} \langle test token \rangle$ $\backslash tl\_if\_head\_eq\_charcode:nNTF \{ \langle token list \rangle \} \langle test token \rangle$ $\{ \langle true code \rangle \} \{ \langle false code \rangle \}$
--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Tests if the first  $\langle token \rangle$  in the  $\langle token list \rangle$  has the same character code as the  $\langle test token \rangle$ . In the case where  $\langle token list \rangle$  is empty, its head is considered to be  $\backslash q\_nil$ , and the test will be true if  $\langle test token \rangle$  is a control sequence.

$\backslash tl\_if\_head\_eq\_meaning\_p:nN$ ★ $\backslash tl\_if\_head\_eq\_meaning:nNTF$ ★	$\backslash tl\_if\_head\_eq\_meaning\_p:nN \{ \langle token list \rangle \} \langle test token \rangle$ $\backslash tl\_if\_head\_eq\_meaning:nNTF \{ \langle token list \rangle \} \langle test token \rangle$ $\{ \langle true code \rangle \} \{ \langle false code \rangle \}$
-------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Tests if the first  $\langle token \rangle$  in the  $\langle token list \rangle$  has the same meaning as the  $\langle test token \rangle$ . In the case where  $\langle token list \rangle$  is empty, its head is considered to be  $\backslash q\_nil$ , and the test will be true if  $\langle test token \rangle$  has the same meaning as  $\backslash q\_nil$ .

$\backslash tl\_if\_head\_group\_p:n$ ★ $\backslash tl\_if\_head\_group:nTF$ ★	$\backslash tl\_if\_head\_group\_p:n \{ \langle token list \rangle \}$ $\backslash tl\_if\_head\_group:nTF \{ \langle token list \rangle \}$ $\{ \langle true code \rangle \} \{ \langle false code \rangle \}$
-----------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Tests if the first  $\langle token \rangle$  in the  $\langle token list \rangle$  is an explicit begin-group character (with category code 1 and any character code), in other words, if the  $\langle token list \rangle$  starts with a brace group. In particular, the test is false if the  $\langle token list \rangle$  starts with an implicit token such as  $\backslash c\_group\_begin\_token$ , or if it empty. This function is useful to implement actions on token lists on a token by token basis.

$\backslash tl\_if\_head\_N\_type\_p:n$ ★ $\backslash tl\_if\_head\_N\_type:nTF$ ★	$\backslash tl\_if\_head\_N\_type\_p:n \{ \langle token list \rangle \}$ $\backslash tl\_if\_head\_N\_type:nTF \{ \langle token list \rangle \}$ $\{ \langle true code \rangle \} \{ \langle false code \rangle \}$
---------------------------------------------------------------------------------------	---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Tests if the first  $\langle token \rangle$  in the  $\langle token list \rangle$  is a normal N-type argument. In other words, it is neither an explicit space character (with category code 10 and character code 32) nor an explicit begin-group character (with category code 1 and any character code). An empty argument yields false, as it does not have a “normal” first token. This function is useful to implement actions on token lists on a token by token basis.

$\backslash tl\_if\_head\_space\_p:n$ ★ $\backslash tl\_if\_head\_space:nTF$ ★	$\backslash tl\_if\_head\_space\_p:n \{ \langle token list \rangle \}$ $\backslash tl\_if\_head\_space:nTF \{ \langle token list \rangle \}$ $\{ \langle true code \rangle \} \{ \langle false code \rangle \}$
-----------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------



Tests if the first  $\langle token \rangle$  in the  $\langle token list \rangle$  is an explicit space character (with category code 10 and character code 32). If  $\langle token list \rangle$  starts with an implicit token such as `\c_space_token`, the test will yield false, as well as if the argument is empty. This function is useful to implement actions on token lists on a token by token basis.

**T<sub>E</sub>Xhackers note:** When T<sub>E</sub>X reads a character of category code 10 for the first time, it is converted to an explicit space token, with character code 32, regardless of the initial character code. “Funny” spaces with a different category code, can be produced using `\tex_lowercase:D`. Explicit spaces are also produced as a result of `\token_to_str:N`, `\tl_to_str:n`, etc.

## 87 Viewing token lists

<code>\tl_show:N</code>
<code>\tl_show:c</code>

`\tl_show:N <tl var>`

Displays the content of the  $\langle tl var \rangle$  on the terminal.

**T<sub>E</sub>Xhackers note:** `\tl_show:N` is the T<sub>E</sub>X primitive `\show`.

<code>\tl_show:n</code>
-------------------------

`\tl_show:n <token list>`

Displays the  $\langle token list \rangle$  on the terminal.

**T<sub>E</sub>Xhackers note:** `\tl_show:n` is the  $\varepsilon$ -T<sub>E</sub>X primitive `\showtokens`.

## 88 Constant token lists

<code>\c_job_name_tl</code>
-----------------------------

Constant that gets the “job name” assigned when T<sub>E</sub>X starts.

**T<sub>E</sub>Xhackers note:** This is the new name for the primitive `\jobname`. It is a constant that is set by T<sub>E</sub>X and should not be overwritten by the package.

<code>\c_empty_tl</code>
--------------------------

Constant that is always empty.

<code>\c_space_tl</code>
--------------------------

A space token contained in a token list (compare this with `\c_space_token`). For use where an explicit space is required.

## 89 Scratch token lists

<code>\l_tmpa_tl</code> <code>\l_tmpb_tl</code>
----------------------------------------------------

Scratch token lists for local assignment. These are never used by the kernel code, and so are safe for use with any L<sup>A</sup>T<sub>E</sub>X3-defined function. However, they may be overwritten by other non-kernel code and so should only be used for short-term storage.

<code>\g_tmpa_tl</code> <code>\g_tmpb_tl</code>
----------------------------------------------------

Scratch token lists for global assignment. These are never used by the kernel code, and so are safe for use with any L<sup>A</sup>T<sub>E</sub>X3-defined function. However, they may be overwritten by other non-kernel code and so should only be used for short-term storage.

## 90 Experimental token list functions

<code>\tl_reverse_tokens:n</code> ★
-------------------------------------

`\tl_reverse_tokens:n {<tokens>}`

This function, which works directly on T<sub>E</sub>X tokens, reverses the order of the *<tokens>*: the first will be the last and the last will become first. Spaces are preserved. The reversal also operates within brace groups, but the braces themselves are not exchanged, as this would lead to an unbalanced token list. For instance, `\tl_reverse_tokens:n {a~{b()}}` leaves `{() (b)~a` in the input stream. This function requires two steps of expansion.

<code>\tl_length_tokens:n</code> ★
------------------------------------

`\tl_length_tokens:n {<tokens>}`

Counts the number of T<sub>E</sub>X tokens in the *<tokens>* and leaves this information in the input stream. Every token, including spaces and braces, contributes one to the total; thus for instance, the length of `a~{bc}` is 6. This function requires three expansions, giving an *<integer denotation>*.

<code>\tl_expandable_uppercase:n</code> ★ <code>\tl_expandable_lowercase:n</code> ★
----------------------------------------------------------------------------------------

`\tl_expandable_uppercase:n {<tokens>}`  
`\tl_expandable_lowercase:n {<tokens>}`

The `\tl_expandable_uppercase:n` function works through all of the *<tokens>*, replacing characters in the range a–z (with arbitrary category code) by the corresponding letter in the range A–Z, with category code 11 (letter). Similarly, `\tl_expandable_lowercase:n` replaces characters in the range A–Z by letters in the range a–z, and leaves other tokens unchanged. This function requires two steps of expansion.

**T<sub>E</sub>Xhackers note:** Begin-group and end-group characters are normalized and become { and }, respectively.

## 91 Internal functions

<code>\q_tl_act_mark</code>
<code>\q_tl_act_stop</code>

Quarks which are only used for the particular purposes of `\tl_act_...` functions.

## Part XII

# The l3seq package

## Sequences and stacks

L<sup>A</sup>T<sub>E</sub>X3 implements a “sequence” data type, which contain an ordered list of entries which may contain any *⟨balanced text⟩*. It is possible to map functions to sequences such that the function is applied to every item in the sequence.

Sequences are also used to implement stack functions in L<sup>A</sup>T<sub>E</sub>X3. This is achieved using a number of dedicated stack functions.

## 92 Creating and initialising sequences

<code>\seq_new:N</code>
<code>\seq_new:c</code>

`\seq_new:N ⟨sequence⟩`  
Creates a new *⟨sequence⟩* or raises an error if the name is already taken. The declaration is global. The *⟨sequence⟩* will initially contain no items.

<code>\seq_clear:N</code>
<code>\seq_clear:c</code>

`\seq_clear:N ⟨sequence⟩`  
Clears all items from the *⟨sequence⟩* within the scope of the current T<sub>E</sub>X group.

<code>\seq_gclear:N</code>
<code>\seq_gclear:c</code>

`\seq_gclear:N ⟨sequence⟩`

Clears all entries from the  $\langle sequence \rangle$  globally.

<code>\seq_clear_new:N</code>
<code>\seq_clear_new:c</code>

`\seq_clear_new:N  $\langle sequence \rangle$` 

If the  $\langle sequence \rangle$  already exists, clears it within the scope of the current TeX group. If the  $\langle sequence \rangle$  is not defined, it will be created (using `\seq_new:N`). Thus the sequence is guaranteed to be available and clear within the current TeX group. The  $\langle sequence \rangle$  will exist globally, but the content outside of the current TeX group is not specified.

<code>\seq_gclear_new:N</code>
<code>\seq_gclear_new:c</code>

`\seq_gclear_new:N  $\langle sequence \rangle$` 

If the  $\langle sequence \rangle$  already exists, clears it globally. If the  $\langle sequence \rangle$  is not defined, it will be created (using `\seq_new:N`). Thus the sequence is guaranteed to be available and globally clear.

<code>\seq_set_eq:NN</code>
<code>\seq_set_eq:cN</code>
<code>\seq_set_eq:Nc</code>
<code>\seq_set_eq:cc</code>

`\seq_set_eq:NN  $\langle sequence1 \rangle$   $\langle sequence2 \rangle$` 

Sets the content of  $\langle sequence1 \rangle$  equal to that of  $\langle sequence2 \rangle$ . This assignment is restricted to the current TeX group level.

<code>\seq_gset_eq:NN</code>
<code>\seq_gset_eq:cN</code>
<code>\seq_gset_eq:Nc</code>
<code>\seq_gset_eq:cc</code>

`\seq_gset_eq:NN  $\langle sequence1 \rangle$   $\langle sequence2 \rangle$` 

Sets the content of  $\langle sequence1 \rangle$  equal to that of  $\langle sequence2 \rangle$ . This assignment is global and so is not limited by the current TeX group level.

<code>\seq_concat:NNN</code>
<code>\seq_concat:ccc</code>

`\seq_concat:NNN  $\langle sequence1 \rangle$   $\langle sequence2 \rangle$   $\langle sequence3 \rangle$` 

Concatenates the content of  $\langle sequence2 \rangle$  and  $\langle sequence3 \rangle$  together and saves the result in  $\langle sequence1 \rangle$ . The items in  $\langle sequence2 \rangle$  will be placed at the left side of the new sequence. This operation is local to the current TeX group and will remove any existing content in  $\langle sequence1 \rangle$ .

<code>\seq_gconcat:NNN</code>
<code>\seq_gconcat:ccc</code>

`\seq_gconcat:NNN  $\langle sequence1 \rangle$   $\langle sequence2 \rangle$   $\langle sequence3 \rangle$` 

Concatenates the content of  $\langle sequence2 \rangle$  and  $\langle sequence3 \rangle$  together and saves the result in  $\langle sequence1 \rangle$ . The items in  $\langle sequence2 \rangle$  will be placed at the left side of the new sequence. This operation is global and will remove any existing content in  $\langle sequence1 \rangle$ .

## 93 Appending data to sequences

<code>\seq_put_left:Nn</code>
<code>\seq_put_left:NV</code>
<code>\seq_put_left:Nv</code>
<code>\seq_put_left:No</code>
<code>\seq_put_left:Nx</code>
<code>\seq_put_left:cn</code>
<code>\seq_put_left:cV</code>
<code>\seq_put_left:cv</code>
<code>\seq_put_left:co</code>
<code>\seq_put_left:cx</code>

`\seq_put_left:Nn <sequence> {<item>}`

Appends the  $\langle item \rangle$  to the left of the  $\langle sequence \rangle$ . The assignment is restricted to the current  $\text{\TeX}$  group.

<code>\seq_gput_left:Nn</code>
<code>\seq_gput_left:NV</code>
<code>\seq_gput_left:Nv</code>
<code>\seq_gput_left:No</code>
<code>\seq_gput_left:Nx</code>
<code>\seq_gput_left:cn</code>
<code>\seq_gput_left:cV</code>
<code>\seq_gput_left:cv</code>
<code>\seq_gput_left:co</code>
<code>\seq_gput_left:cx</code>

`\seq_gput_left:Nn <sequence> {<item>}`

Appends the  $\langle item \rangle$  to the left of the  $\langle sequence \rangle$ . The assignment is global.

<code>\seq_put_right:Nn</code>
<code>\seq_put_right:NV</code>
<code>\seq_put_right:Nv</code>
<code>\seq_put_right:No</code>
<code>\seq_put_right:Nx</code>
<code>\seq_put_right:cn</code>
<code>\seq_put_right:cV</code>
<code>\seq_put_right:cv</code>
<code>\seq_put_right:co</code>
<code>\seq_put_right:cx</code>

`\seq_put_right:Nn <sequence> {<item>}`

Appends the  $\langle item \rangle$  to the right of the  $\langle sequence \rangle$ . The assignment is restricted to the

current  $\text{\TeX}$  group.

<code>\seq_gput_right:Nn</code>
<code>\seq_gput_right:NV</code>
<code>\seq_gput_right:Nv</code>
<code>\seq_gput_right:No</code>
<code>\seq_gput_right:Nx</code>
<code>\seq_gput_right:cn</code>
<code>\seq_gput_right:cV</code>
<code>\seq_gput_right:cv</code>
<code>\seq_gput_right:co</code>
<code>\seq_gput_right:cx</code>

`\seq_gput_right:Nn <sequence> {<item>}`

Appends the  $\langle item \rangle$  to the right of the  $\langle sequence \rangle$ . The assignment is global.

## 94 Recovering items from sequences

Items can be recovered from either the left or the right of sequences. For implementation reasons, the actions at the left of the sequence are faster than those acting on the right. These functions all assign the recovered material locally, *i.e.* setting the  $\langle token list variable \rangle$  used with `\tl_set:Nn` and *never* `\tl_gset:Nn`.

<code>\seq_get_left:NN</code>
<code>\seq_get_left:cN</code>

`\seq_get_left:NN <sequence> <token list variable>`

Stores the left-most item from a  $\langle sequence \rangle$  in the  $\langle token list variable \rangle$  without removing it from the  $\langle sequence \rangle$ . The  $\langle token list variable \rangle$  is assigned locally. If  $\langle sequence \rangle$  is empty an error will be raised.

<code>\seq_get_right:NN</code>
<code>\seq_get_right:cN</code>

`\seq_get_right:NN <sequence> <token list variable>`

Stores the right-most item from a  $\langle sequence \rangle$  in the  $\langle token list variable \rangle$  without removing it from the  $\langle sequence \rangle$ . The  $\langle token list variable \rangle$  is assigned locally. If  $\langle sequence \rangle$  is empty an error will be raised.

<code>\seq_pop_left:NN</code>
<code>\seq_pop_left:cN</code>

`\seq_pop_left:NN <sequence> <token list variable>`

Pops the left-most item from a  $\langle sequence \rangle$  into the  $\langle token list variable \rangle$ , *i.e.* removes the item from the sequence and stores it in the  $\langle token list variable \rangle$ . Both of the variables are assigned locally. If  $\langle sequence \rangle$  is empty an error will be raised.

<code>\seq_gpop_left:NN</code>
<code>\seq_gpop_left:cN</code>

`\seq_gpop_left:NN <sequence> <token list variable>`

Pops the left-most item from a  $\langle sequence \rangle$  into the  $\langle token list variable \rangle$ , *i.e.* removes

the item from the sequence and stores it in the  $\langle token\ list\ variable \rangle$ . The  $\langle sequence \rangle$  is modified globally, while the assignment of the  $\langle token\ list\ variable \rangle$  is local. If  $\langle sequence \rangle$  is empty an error will be raised.

<code>\seq_pop_right:NN</code> <code>\seq_pop_right:cN</code>	<code>\seq_pop_right:NN <math>\langle sequence \rangle</math> <math>\langle token\ list\ variable \rangle</math></code>
------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------

Pops the right-most item from a  $\langle sequence \rangle$  into the  $\langle token\ list\ variable \rangle$ , *i.e.* removes the item from the sequence and stores it in the  $\langle token\ list\ variable \rangle$ . Both of the variables are assigned locally. If  $\langle sequence \rangle$  is empty an error will be raised.

<code>\seq_gpop_right:NN</code> <code>\seq_gpop_right:cN</code>	<code>\seq_gpop_right:NN <math>\langle sequence \rangle</math> <math>\langle token\ list\ variable \rangle</math></code>
--------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------

Pops the right-most item from a  $\langle sequence \rangle$  into the  $\langle token\ list\ variable \rangle$ , *i.e.* removes the item from the sequence and stores it in the  $\langle token\ list\ variable \rangle$ . The  $\langle sequence \rangle$  is modified globally, while the assignment of the  $\langle token\ list\ variable \rangle$  is local. If  $\langle sequence \rangle$  is empty an error will be raised.

## 95 Modifying sequences

While sequences are normally used as ordered lists, it may be necessary to modify the content. The functions here may be used to update sequences, while retaining the order of the unaffected entries.

<code>\seq_remove_duplicates:N</code> <code>\seq_remove_duplicates:c</code>	<code>\seq_remove_duplicates:N <math>\langle sequence \rangle</math></code>
--------------------------------------------------------------------------------	-----------------------------------------------------------------------------

Removes duplicate items from the  $\langle sequence \rangle$ , leaving the left most copy of each item in the  $\langle sequence \rangle$ . The  $\langle item \rangle$  comparison takes place on a token basis, as for `\tl_if_eq:nn(TF)`. The removal is local to the current  $\text{\TeX}$  group.

**$\text{\TeX}$ hackers note:** This function iterates through every item in the  $\langle sequence \rangle$  and does a comparison with the  $\langle items \rangle$  already checked. It is therefore relatively slow with large sequences.

<code>\seq_gremove_duplicates:N</code> <code>\seq_gremove_duplicates:c</code>	<code>\seq_gremove_duplicates:N <math>\langle sequence \rangle</math></code>
----------------------------------------------------------------------------------	------------------------------------------------------------------------------

Removes duplicate items from the  $\langle sequence \rangle$ , leaving the left most copy of each item in the  $\langle sequence \rangle$ . The  $\langle item \rangle$  comparison takes place on a token basis, as for `\tl_if_eq:nn(TF)`. The removal is applied globally.

**T<sub>E</sub>Xhackers note:** This function iterates through every item in the  $\langle sequence \rangle$  and does a comparison with the  $\langle items \rangle$  already checked. It is therefore relatively slow with large sequences.

<code>\seq_remove_all:Nn</code> <code>\seq_remove_all:cn</code>	<code>\seq_remove_all:Nn &lt;sequence&gt; {&lt;item&gt;}</code>
--------------------------------------------------------------------	-----------------------------------------------------------------

Removes every occurrence of  $\langle item \rangle$  from the  $\langle sequence \rangle$ . The  $\langle item \rangle$  comparison takes place on a token basis, as for `\tl_if_eq:nn(TF)`. The removal is local to the current T<sub>E</sub>X group.

<code>\seq_gremove_all:Nn</code> <code>\seq_gremove_all:cn</code>	<code>\seq_gremove_all:Nn &lt;sequence&gt; {&lt;item&gt;}</code>
----------------------------------------------------------------------	------------------------------------------------------------------

Removes each occurrence of  $\langle item \rangle$  from the  $\langle sequence \rangle$ . The  $\langle item \rangle$  comparison takes place on a token basis, as for `\tl_if_eq:nn(TF)`. The removal is applied globally.

## 96 Sequence conditionals

<code>\seq_if_empty_p:N</code> ★ <code>\seq_if_empty:NTF</code> ★ <code>\seq_if_empty_p:c</code> ★ <code>\seq_if_empty:cTF</code> ★	<code>\seq_if_empty_p:N &lt;sequence&gt;</code> <code>\seq_if_empty:NTF &lt;sequence&gt; {&lt;true code&gt;} {&lt;false code&gt;}</code>
----------------------------------------------------------------------------------------------------------------------------------------------	---------------------------------------------------------------------------------------------------------------------------------------------

Tests if the  $\langle sequence \rangle$  is empty (containing no items).

<code>\seq_if_in:NnTF</code> <code>\seq_if_in:NVTF</code> <code>\seq_if_in:NvTF</code> <code>\seq_if_in:NoTF</code> <code>\seq_if_in:NxTF</code> <code>\seq_if_in:cnTF</code> <code>\seq_if_in:cVTF</code> <code>\seq_if_in:cvTF</code> <code>\seq_if_in:coTF</code> <code>\seq_if_in:cxTF</code>	<code>\seq_if_in:NnTF &lt;sequence&gt; {&lt;item&gt;}</code> <code>{&lt;true code&gt;} {&lt;false code&gt;}</code>
------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------

Tests if the  $\langle item \rangle$  is present in the  $\langle sequence \rangle$ .



## 97 Mapping to sequences

<code>\seq_map_function:NN</code> ☆ <code>\seq_map_function:cN</code> ☆	<code>\seq_map_function:NN</code> $\langle sequence \rangle$ $\langle function \rangle$
----------------------------------------------------------------------------	-----------------------------------------------------------------------------------------

Applies  $\langle function \rangle$  to every  $\langle item \rangle$  stored in the  $\langle sequence \rangle$ . The  $\langle function \rangle$  will receive one argument for each iteration. The  $\langle items \rangle$  are returned from left to right. The function `\seq_map_inline:Nn` is in general more efficient than `\seq_map_function:NN`. One mapping may be nested inside another.

<code>\seq_map_inline:Nn</code> <code>\seq_map_inline:cn</code>	<code>\seq_map_inline:Nn</code> $\langle sequence \rangle$ $\{\langle inline function \rangle\}$
--------------------------------------------------------------------	--------------------------------------------------------------------------------------------------

Applies  $\langle inline function \rangle$  to every  $\langle item \rangle$  stored within the  $\langle sequence \rangle$ . The  $\langle inline function \rangle$  should consist of code which will receive the  $\langle item \rangle$  as #1. One in line mapping can be nested inside another. The  $\langle items \rangle$  are returned from left to right.

<code>\seq_map_variable:NNn</code> <code>\seq_map_variable:Ncn</code> <code>\seq_map_variable:cNn</code> <code>\seq_map_variable:ccn</code>	<code>\seq_map_variable:NNn</code> $\langle sequence \rangle$ $\langle tl var. \rangle$ $\{\langle function using tl var. \rangle\}$
------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------------------------

Stores each entry in the  $\langle sequence \rangle$  in turn in the  $\langle tl var. \rangle$  and applies the  $\langle function using tl var. \rangle$ . The  $\langle function \rangle$  will usually consist of code making use of the  $\langle tl var. \rangle$ , but this is not enforced. One variable mapping can be nested inside another. The  $\langle items \rangle$  are returned from left to right.

<code>\seq_map_break:</code> ☆	<code>\seq_map_break:</code>
--------------------------------	------------------------------

Used to terminate a `\seq_map_...` function before all entries in the  $\langle sequence \rangle$  have been processed. This will normally take place within a conditional statement, for example

```
\seq_map_inline:Nn \l_my_seq
{
  \str_if_eq:nnTF { #1 } { bingo }
  { \seq_map_break: }
  {
    % Do something useful
  }
}
```

Use outside of a `\seq_map_...` scenario will lead to low level T<sub>E</sub>X errors.

**T<sub>E</sub>Xhackers note:** When the mapping is broken, additional tokens may be inserted by the internal macro `\seq_break_point:n` before further items are taken from the input stream. This will depend on the design of the mapping function.

<code>\seq_map_break:n</code> ☆
---------------------------------

`\seq_map_break:n {⟨tokens⟩}`

Used to terminate a `\seq_map_...` function before all entries in the *⟨sequence⟩* have been processed, inserting the *⟨tokens⟩* after the mapping has ended. This will normally take place within a conditional statement, for example

```
\seq_map_inline:Nn \l_my_seq
{
  \str_if_eq:nnTF { #1 } { bingo }
  { \seq_map_break:n { <tokens> } }
  {
    % Do something useful
  }
}
```

Use outside of a `\seq_map_...` scenario will lead to low level T<sub>E</sub>X errors.

**T<sub>E</sub>Xhackers note:** When the mapping is broken, additional tokens may be inserted by the internal macro `\seq_break_point:n` before the *⟨tokens⟩* are inserted into the input stream. This will depend on the design of the mapping function.

## 98 Sequences as stacks

Sequences can be used as stacks, where data is pushed to and popped from the top of the sequence. (The left of a sequence is the top, for performance reasons.) The stack functions for sequences are not intended to be mixed with the general ordered data functions detailed in the previous section: a sequence should either be used as an ordered data type or as a stack, but not in both ways.

<code>\seq_get:NN</code>
<code>\seq_get:cN</code>

`\seq_get:NN ⟨sequence⟩ ⟨token list variable⟩`

Reads the top item from a *⟨sequence⟩* into the *⟨token list variable⟩* without removing it from the *⟨sequence⟩*. The *⟨token list variable⟩* is assigned locally. If *⟨sequence⟩* is empty an error will be raised.

<code>\seq_pop:NN</code>
<code>\seq_pop:cN</code>

`\seq_pop:NN ⟨sequence⟩ ⟨token list variable⟩`

Pops the top item from a *⟨sequence⟩* into the *⟨token list variable⟩*. Both of the variables

are assigned locally. If  $\langle sequence \rangle$  is empty an error will be raised.

<code>\seq_gpop:NN</code>	<code>\seq_gpop:NN <math>\langle sequence \rangle</math> <math>\langle token list variable \rangle</math></code>
<code>\seq_gpop:cN</code>	

Pops the top item from a  $\langle sequence \rangle$  into the  $\langle token list variable \rangle$ . The  $\langle sequence \rangle$  is modified globally, while the  $\langle token list variable \rangle$  is assigned locally. If  $\langle sequence \rangle$  is empty an error will be raised.

<code>\seq_push:Nn</code>
<code>\seq_push:NV</code>
<code>\seq_push:Nv</code>
<code>\seq_push:No</code>
<code>\seq_push:Nx</code>
<code>\seq_push:cn</code>
<code>\seq_push:cV</code>
<code>\seq_push:cv</code>
<code>\seq_push:co</code>
<code>\seq_push:cx</code>

`\seq_push:Nn  $\langle sequence \rangle$   $\{\langle item \rangle\}$`

Adds the  $\{\langle item \rangle\}$  to the top of the  $\langle sequence \rangle$ . The assignment is restricted to the current  $\text{\TeX}$  group.

<code>\seq_gpush:Nn</code>
<code>\seq_gpush:NV</code>
<code>\seq_gpush:Nv</code>
<code>\seq_gpush:No</code>
<code>\seq_gpush:Nx</code>
<code>\seq_gpush:cn</code>
<code>\seq_gpush:cV</code>
<code>\seq_gpush:cv</code>
<code>\seq_gpush:co</code>
<code>\seq_gpush:cx</code>

`\seq_gpush:Nn  $\langle sequence \rangle$   $\{\langle item \rangle\}$`

Pushes the  $\langle item \rangle$  onto the end of the top of the  $\langle sequence \rangle$ . The assignment is global.

## 99 Viewing sequences

<code>\seq_show:N</code>	<code>\seq_show:N <math>\langle sequence \rangle</math></code>
<code>\seq_show:c</code>	

Displays the entries in the  $\langle sequence \rangle$  in the terminal.

## 100 Experimental sequence functions

This section contains functions which may or may not be retained, depending on how useful they are found to be.

<code>\seq_get_left:NNTF</code>	<code>\seq_get_left:NNTF &lt;sequence&gt; &lt;token list variable&gt;</code>
<code>\seq_get_left:cNTF</code>	<code>{&lt;true code&gt;} {&lt;false code&gt;}</code>

If the *<sequence>* is empty, leaves the *<false code>* in the input stream and leaves the *<token list variable>* unchanged. If the *<sequence>* is non-empty, stores the left-most item from a *<sequence>* in the *<token list variable>* without removing it from a *<sequence>*. The *<token list variable>* is assigned locally.

<code>\seq_get_right:NNTF</code>	<code>\seq_get_right:NNTF &lt;sequence&gt; &lt;token list variable&gt;</code>
<code>\seq_get_right:cNTF</code>	<code>{&lt;true code&gt;} {&lt;false code&gt;}</code>

If the *<sequence>* is empty, leaves the *<false code>* in the input stream and leaves the *<token list variable>* unchanged. If the *<sequence>* is non-empty, stores the right-most item from a *<sequence>* in the *<token list variable>* without removing it from a *<sequence>*. The *<token list variable>* is assigned locally.

<code>\seq_pop_left:NNTF</code>	<code>\seq_pop_left:NNTF &lt;sequence&gt; &lt;token list variable&gt;</code>
<code>\seq_pop_left:cNTF</code>	<code>{&lt;true code&gt;} {&lt;false code&gt;}</code>

If the *<sequence>* is empty, leaves the *<false code>* in the input stream and leaves the *<token list variable>* unchanged. If the *<sequence>* is non-empty, pops the left-most item from a *<sequence>* in the *<token list variable>*, *i.e.* removes the item from a *<sequence>*. Both the *<sequence>* and the *<token list variable>* are assigned locally.

<code>\seq_gpop_left:NNTF</code>	<code>\seq_gpop_left:NNTF &lt;sequence&gt; &lt;token list variable&gt;</code>
<code>\seq_gpop_left:cNTF</code>	<code>{&lt;true code&gt;} {&lt;false code&gt;}</code>

If the *<sequence>* is empty, leaves the *<false code>* in the input stream and leaves the *<token list variable>* unchanged. If the *<sequence>* is non-empty, pops the left-most item from a *<sequence>* in the *<token list variable>*, *i.e.* removes the item from a *<sequence>*. The *<sequence>* is modified globally, while the *<token list variable>* is assigned locally.

<code>\seq_pop_right:NNTF</code>	<code>\seq_pop_right:NNTF &lt;sequence&gt; &lt;token list variable&gt;</code>
<code>\seq_pop_right:cNTF</code>	<code>{&lt;true code&gt;} {&lt;false code&gt;}</code>

If the *<sequence>* is empty, leaves the *<false code>* in the input stream and leaves the *<token list variable>* unchanged. If the *<sequence>* is non-empty, pops the right-most item from a *<sequence>* in the *<token list variable>*, *i.e.* removes the item from a *<sequence>*. Both the *<sequence>* and the *<token list variable>* are assigned locally.

<code>\seq_gpop_right:NNTF</code>	<code>\seq_gpop_right:NNTF &lt;sequence&gt; &lt;token list variable&gt;</code>
<code>\seq_gpop_right:cNTF</code>	<code>{&lt;true code&gt;} {&lt;false code&gt;}</code>

If the  $\langle sequence \rangle$  is empty, leaves the  $\langle false\ code \rangle$  in the input stream and leaves the  $\langle token\ list\ variable \rangle$  unchanged. If the  $\langle sequence \rangle$  is non-empty, pops the right-most item from a  $\langle sequence \rangle$  in the  $\langle token\ list\ variable \rangle$ , *i.e.* removes the item from a  $\langle sequence \rangle$ . The  $\langle sequence \rangle$  is modified globally, while the  $\langle token\ list\ variable \rangle$  is assigned locally.

<code>\seq_length:N</code> ★	<code>\seq_length:N</code> $\langle sequence \rangle$
<code>\seq_length:c</code> ★	

Leaves the number of items in the  $\langle sequence \rangle$  in the input stream as an  $\langle integer\ denotation \rangle$ . The total number of items in a  $\langle sequence \rangle$  will include those which are empty and duplicates, *i.e.* every item in a  $\langle sequence \rangle$  is unique.

<code>\seq_item:Nn</code> ★	<code>\seq_item:Nn</code> $\langle sequence \rangle$ $\{ \langle integer\ expression \rangle \}$
<code>\seq_item:cn</code> ★	

Indexing items in the  $\langle sequence \rangle$  from 0 at the top (left), this function will evaluate the  $\langle integer\ expression \rangle$  and leave the appropriate item from the sequence in the input stream. If the  $\langle integer\ expression \rangle$  is negative, indexing occurs from the bottom (right) of the sequence. When the  $\langle integer\ expression \rangle$  is larger than the number of items in the  $\langle sequence \rangle$  (as calculated by `\seq_length:N`) then the function will expand to nothing.

<code>\seq_use:N</code> ★	<code>\seq_use:N</code> $\langle sequence \rangle$
<code>\seq_use:c</code> ★	

Places each  $\langle item \rangle$  in the  $\langle sequence \rangle$  in turn in the input stream. This occurs in an expandable fashion, and is implemented as a mapping. This means that the process may be prematurely terminated using `\seq_map_break:` or `\seq_map_break:n`. The  $\langle items \rangle$  in the  $\langle sequence \rangle$  will be used from left (top) to right (bottom).

<code>\seq_mapthread_function:NNN</code> ★	<code>\seq_mapthread_function:NNN</code> $\langle seq1 \rangle$ $\langle seq2 \rangle$ $\langle function \rangle$
<code>\seq_mapthread_function:NcN</code> ★	
<code>\seq_mapthread_function:cNN</code> ★	
<code>\seq_mapthread_function:ccN</code> ★	

Applies  $\langle function \rangle$  to every pair of items  $\langle seq1\text{-}item \rangle$ – $\langle seq2\text{-}item \rangle$  from the two sequences, returning items from both sequences from left to right. The  $\langle function \rangle$  will receive two **n**-type arguments for each iteration. The mapping will terminate when the end of either sequence is reached (*i.e.* whichever sequence has fewer items determines how many iterations occur).

<code>\seq_set_from_clist:NN</code>	<code>\seq_set_from_clist:NN</code> $\langle sequence \rangle$ $\langle comma\text{-}list \rangle$
<code>\seq_set_from_clist:cN</code>	
<code>\seq_set_from_clist:Nc</code>	
<code>\seq_set_from_clist:cc</code>	
<code>\seq_set_from_clist:Nn</code>	
<code>\seq_set_from_clist:cn</code>	

Sets the  $\langle sequence \rangle$  within the current  $\text{\TeX}$  group to be equal to the content of the  $\langle comma-list \rangle$ .

$\backslash seq\_gset\_from\_clist:NN$ $\backslash seq\_gset\_from\_clist:cN$ $\backslash seq\_gset\_from\_clist:Nc$ $\backslash seq\_gset\_from\_clist:cc$ $\backslash seq\_gset\_from\_clist:Nn$ $\backslash seq\_gset\_from\_clist:cn$	$\backslash seq\_gset\_from\_clist:NN \langle sequence \rangle \langle comma-list \rangle$
----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------

Sets the  $\langle sequence \rangle$  globally to equal to the content of the  $\langle comma-list \rangle$ .

$\backslash seq\_set\_reverse:N$ $\backslash seq\_gset\_reverse:N$	$\backslash seq\_set\_reverse:N \langle sequence \rangle$
-----------------------------------------------------------------------	-----------------------------------------------------------

Reverses the order of items in the  $\langle sequence \rangle$ , and assigns the result to  $\langle sequence \rangle$ , locally or globally according to the variant chosen.

$\backslash seq\_set\_split:Nnn$ $\backslash seq\_gset\_split:Nnn$	$\backslash seq\_set\_split:Nnn \langle sequence \rangle$ $\{ \langle delimiter \rangle \} \{ \langle token list \rangle \}$
-----------------------------------------------------------------------	---------------------------------------------------------------------------------------------------------------------------------

This function splits the  $\langle token list \rangle$  into  $\langle items \rangle$  separated by  $\langle delimiter \rangle$ , ignoring all explicit space characters from both sides of each  $\langle item \rangle$ , then removing one set of outer braces if any. The result is assigned to  $\langle sequence \rangle$ , locally or globally according to the function chosen. The  $\langle delimiter \rangle$  may not contain  $\{$ ,  $\}$  or  $\#$  (assuming  $\text{\TeX}$ 's normal category code régime).

## 101 Internal sequence functions

$\backslash seq\_if\_empty\_err\_break:N$	$\backslash seq\_if\_empty\_err\_break:N \langle sequence \rangle$
-------------------------------------------	--------------------------------------------------------------------

Tests if the  $\langle sequence \rangle$  is empty, and if so issues an error message before skipping over any tokens up to  $\backslash seq\_break\_point:n$ . This function is used to avoid more serious errors which would otherwise occur if some internal functions were applied to an empty  $\langle sequence \rangle$ .

$\backslash seq\_item:n$ ★	$\backslash seq\_item:n \langle item \rangle$
----------------------------	-----------------------------------------------

The internal token used to begin each sequence entry. If expanded outside of a mapping or manipulation function, an error will be raised. The definition should always be set globally.

$\backslash seq\_push\_item\_def:n$ $\backslash seq\_push\_item\_def:x$	$\backslash seq\_push\_item\_def:n \{ \langle code \rangle \}$
----------------------------------------------------------------------------	----------------------------------------------------------------

Saves the definition of `\seq_item:n` and redefines it to accept one parameter and expand to  $\langle code \rangle$ . This function should always be balanced by use of `\seq_pop_item_def:`.

`\seq_pop_item_def:` `\seq_pop_item_def:`

Restores the definition of `\seq_item:n` most recently saved by `\seq_push_item_def:n`. This function should always be used in a balanced pair with `\seq_push_item_def:n`.

`\seq_break:`  $\star$  `\seq_break:`

Used to terminate sequence functions by gobbling all tokens up to `\seq_break_point:n`. This function is a copy of `\seq_map_break:`, but is used in situations which are not mappings.

`\seq_break:n`  $\star$  `\seq_break:n`  $\{ \langle tokens \rangle \}$

Used to terminate sequence functions by gobbling all tokens up to `\seq_break_point:n`, then inserting the  $\langle tokens \rangle$  before continuing reading the input stream. This function is a copy of `\seq_map_break:n`, but is used in situations which are not mappings.

`\seq_break_point:n`  $\star$  `\seq_break_point:n`  $\langle tokens \rangle$

Used to mark the end of a recursion or mapping: the functions `\seq_map_break:` and `\seq_map_break:n` use this to break out of the loop. After the loop ends, the  $\langle tokens \rangle$  are inserted into the input stream. This occurs even if the the break functions are *not* applied: `\seq_break_point:n` is functionally-equivalent in these cases to `\use:n`.

## Part XIII

# The l3clist package

## Comma separated lists

Comma lists contain ordered data where items can be added to the left or right end of the list. The resulting ordered list can then be mapped over using `\clist_map_function:NN`. Several items can be added at once, and spaces are removed from both sides of each item on input. Hence,

```
\clist_new:N \l_my_clist
\clist_put_left:Nn \l_my_clist { ~ a ~ , ~ {b} ~ }
\clist_put_right:Nn \l_my_clist { ~ { c ~ } , d }
```

results in `\l_my_clist` containing `a,{b},{c~},d`. Comma lists cannot contain empty items, thus

```
\clist_clear_new:N \l_my_clist
\clist_put_right:Nn \l_my_clist { , ~ , , }
\clist_if_empty:NTF \l_my_clist { true } { false }
```

will leave `true` in the input stream. To include an item which contains a comma, or starts or ends with a space, surround it with braces.

## 102 Creating and initialising comma lists

<code>\clist_new:N</code>
<code>\clist_new:c</code>

`\clist_new:N <comma list>`

Creates a new *<comma list>* or raises an error if the name is already taken. The declaration is global. The *<comma list>* will initially contain no items.

<code>\clist_clear:N</code>
<code>\clist_clear:c</code>

`\clist_clear:N <comma list>`

Clears all items from the *<comma list>* within the scope of the current  $\text{\TeX}$  group.

<code>\clist_gclear:N</code>
<code>\clist_gclear:c</code>

`\clist_gclear:N <comma list>`

Clears all entries from the *<comma list>* globally.

<code>\clist_clear_new:N</code>
<code>\clist_clear_new:c</code>

`\clist_clear_new:N <comma list>`

If the *<comma list>* already exists, clears it within the scope of the current  $\text{\TeX}$  group. If the *<comma list>* is not defined, it will be created (using `\clist_new:N`). Thus the comma list is guaranteed to be available and clear within the current  $\text{\TeX}$  group. The *<comma list>* will exist globally, but the content outside of the current  $\text{\TeX}$  group is not specified.

<code>\clist_gclear_new:N</code>
<code>\clist_gclear_new:c</code>

`\clist_gclear_new:N <comma list>`

If the *<comma list>* already exists, clears it globally. If the *<comma list>* is not defined, it



will be created (using `\clist_new:N`). Thus the comma list is guaranteed to be available and globally clear.

<code>\clist_set_eq:NN</code> <code>\clist_set_eq:cN</code> <code>\clist_set_eq:Nc</code> <code>\clist_set_eq:cc</code>	<code>\clist_set_eq:NN &lt;comma list1&gt; &lt;comma list2&gt;</code>
----------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------

Sets the content of  $\langle comma list1 \rangle$  equal to that of  $\langle comma list2 \rangle$ . This assignment is restricted to the current  $\text{\TeX}$  group level.

<code>\clist_gset_eq:NN</code> <code>\clist_gset_eq:cN</code> <code>\clist_gset_eq:Nc</code> <code>\clist_gset_eq:cc</code>	<code>\clist_gset_eq:NN &lt;comma list1&gt; &lt;comma list2&gt;</code>
--------------------------------------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------

Sets the content of  $\langle comma list1 \rangle$  equal to that of  $\langle comma list2 \rangle$ . This assignment is global and so is not limited by the current  $\text{\TeX}$  group level.

<code>\clist_concat:NNN</code> <code>\clist_concat:ccc</code>	<code>\clist_concat:NNN &lt;comma list1&gt; &lt;comma list2&gt;</code> <code>&lt;comma list3&gt;</code>
------------------------------------------------------------------	------------------------------------------------------------------------------------------------------------

Concatenates the content of  $\langle comma list2 \rangle$  and  $\langle comma list3 \rangle$  together and saves the result in  $\langle comma list1 \rangle$ . The items in  $\langle comma list2 \rangle$  will be placed at the left side of the new comma list. This operation is local to the current  $\text{\TeX}$  group and will remove any existing content in  $\langle comma list1 \rangle$ .

<code>\clist_gconcat:NNN</code> <code>\clist_gconcat:ccc</code>	<code>\clist_gconcat:NNN &lt;comma list1&gt; &lt;comma list2&gt;</code> <code>&lt;comma list3&gt;</code>
--------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------

Concatenates the content of  $\langle comma list2 \rangle$  and  $\langle comma list3 \rangle$  together and saves the result in  $\langle comma list1 \rangle$ . The items in  $\langle comma list2 \rangle$  will be placed at the left side of the new comma list. This operation is global and will remove any existing content in  $\langle comma list1 \rangle$ .

## 103 Appending items to comma lists

<code>\clist_put_left:Nn</code> <code>\clist_put_left:NV</code> <code>\clist_put_left:No</code> <code>\clist_put_left:Nx</code> <code>\clist_put_left:cn</code> <code>\clist_put_left:cV</code> <code>\clist_put_left:co</code> <code>\clist_put_left:cx</code>	<code>\clist_put_left:Nn &lt;comma list&gt; {\langle item1 \rangle, \dots, \langle item_n \rangle}</code>
--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------

Appends the  $\langle items \rangle$  to the left of the  $\langle comma list \rangle$ . Spaces are removed from both sides

of each item. The assignment is restricted to the current  $\text{\TeX}$  group.

<code>\clist_gput_left:Nn</code>
<code>\clist_gput_left:NV</code>
<code>\clist_gput_left:No</code>
<code>\clist_gput_left:Nx</code>
<code>\clist_gput_left:cn</code>
<code>\clist_gput_left:cV</code>
<code>\clist_gput_left:co</code>
<code>\clist_gput_left:cx</code>

`\clist_gput_left:Nn <comma list> {\<item1>,...,<item_n>}`

Appends the  $\langle items \rangle$  to the left of the  $\langle comma list \rangle$ . Spaces are removed from both sides of each item. The assignment is global.

<code>\clist_put_right:Nn</code>
<code>\clist_put_right:NV</code>
<code>\clist_put_right:No</code>
<code>\clist_put_right:Nx</code>
<code>\clist_put_right:cn</code>
<code>\clist_put_right:cV</code>
<code>\clist_put_right:co</code>
<code>\clist_put_right:cx</code>

`\clist_put_right:Nn <comma list> {\<item1>,...,<item_n>}`

Appends the  $\langle items \rangle$  to the right of the  $\langle comma list \rangle$ . Spaces are removed from both sides of each item. The assignment is restricted to the current  $\text{\TeX}$  group.

<code>\clist_gput_right:Nn</code>
<code>\clist_gput_right:NV</code>
<code>\clist_gput_right:No</code>
<code>\clist_gput_right:Nx</code>
<code>\clist_gput_right:cn</code>
<code>\clist_gput_right:cV</code>
<code>\clist_gput_right:co</code>
<code>\clist_gput_right:cx</code>

`\clist_gput_right:Nn <comma list> {\<item1>,...,<item_n>}`

Appends the  $\langle item \rangle$  to the right of the  $\langle comma list \rangle$ . Spaces are removed from both sides of each item. The assignment is global.

## 104 Using comma lists

<code>\clist_use:N</code> ★
<code>\clist_use:c</code> ★

`\clist_use:N <comma list>`

Places the  $\langle comma list \rangle$  directly into the input stream, thus treating it as a  $\langle token list \rangle$ .

## 105 Modifying comma lists

While comma lists are normally used as ordered lists, it may be necessary to modify the content. The functions here may be used to update comma lists, while retaining the order of the unaffected entries.

<code>\clist_remove_duplicates:N</code>
<code>\clist_remove_duplicates:c</code>

`\clist_remove_duplicates:N <comma list>`

Removes duplicate items from the *<comma list>*, leaving the left most copy of each item in the *<comma list>*. The *<item>* comparison takes place on a token basis, as for `\tl_if_eq:nn(TF)`. The removal is local to the current  $\TeX$  group.

**$\TeX$ hackers note:** This function iterates through every item in the *<comma list>* and does a comparison with the *<items>* already checked. It is therefore relatively slow with large comma lists. Furthermore, it will not work if any of the items in the *<comma list>* contains `{`, `}`, or `#` (assuming the usual  $\TeX$  category codes apply).

<code>\clist_gremove_duplicates:N</code>
<code>\clist_gremove_duplicates:c</code>

`\clist_gremove_duplicates:N <comma list>`

Removes duplicate items from the *<comma list>*, leaving the left most copy of each item in the *<comma list>*. The *<item>* comparison takes place on a token basis, as for `\tl_if_eq:nn(TF)`. The removal is applied globally.

**$\TeX$ hackers note:** This function iterates through every item in the *<comma list>* and does a comparison with the *<items>* already checked. It is therefore relatively slow with large comma lists. Furthermore, it will not work if any of the items in the *<comma list>* contains `{`, `}`, or `#` (assuming the usual  $\TeX$  category codes apply).

<code>\clist_remove_all:Nn</code>
<code>\clist_remove_all:cn</code>

`\clist_remove_all:Nn <comma list> {<item>}`

Removes every occurrence of *<item>* from the *<comma list>*. The *<item>* comparison takes place on a token basis, as for `\tl_if_eq:nn(TF)`. The removal is local to the current  $\TeX$  group.

**$\TeX$ hackers note:** The *<item>* may not contain `{`, `}`, or `#` (assuming the usual  $\TeX$  category codes apply).

<code>\clist_gremove_all:Nn</code> <code>\clist_gremove_all:cn</code>	<code>\clist_gremove_all:Nn &lt;comma list&gt; {&lt;item&gt;}</code>
--------------------------------------------------------------------------	----------------------------------------------------------------------

Removes each occurrence of  $\langle item \rangle$  from the  $\langle comma list \rangle$ . The  $\langle item \rangle$  comparison takes place on a token basis, as for `\tl_if_eq:nn(TF)`. The removal is applied globally.

**T<sub>E</sub>Xhackers note:** The  $\langle item \rangle$  may not contain `{`, `}`, or `#` (assuming the usual T<sub>E</sub>X category codes apply).

## 106 Comma list conditionals

<code>\clist_if_empty_p:N</code> ★ <code>\clist_if_empty:N<math>\underline{TF}</math></code> ★ <code>\clist_if_empty_p:c</code> ★ <code>\clist_if_empty:c<math>\underline{TF}</math></code> ★	<code>\clist_if_empty_p:N &lt;comma list&gt;</code> <code>\clist_if_empty:N<math>\underline{TF}</math> &lt;comma list&gt;</code> <code>{&lt;true code&gt;} {&lt;false code&gt;}</code>
--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Tests if the  $\langle comma list \rangle$  is empty (containing no items).

<code>\clist_if_eq_p:NN</code> ★ <code>\clist_if_eq:NN<math>\underline{TF}</math></code> ★ <code>\clist_if_eq_p:Nc</code> ★ <code>\clist_if_eq:Nc<math>\underline{TF}</math></code> ★ <code>\clist_if_eq_p:cN</code> ★ <code>\clist_if_eq:cN<math>\underline{TF}</math></code> ★ <code>\clist_if_eq_p:cc</code> ★ <code>\clist_if_eq:cc<math>\underline{TF}</math></code> ★	<code>\clist_if_eq_p:NN {&lt;clist<sub>1</sub>&gt;} {&lt;clist<sub>2</sub>&gt;}</code> <code>\clist_if_eq:NN<math>\underline{TF}</math> {&lt;clist<sub>1</sub>&gt;} {&lt;clist<sub>2</sub>&gt;} {&lt;true code&gt;}</code> <code>{&lt;false code&gt;}</code>
--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Compares the content of two  $\langle comma lists \rangle$  and is logically **true** if the two contain the same list of entries in the same order.

<code>\clist_if_in:Nn<math>\underline{TF}</math></code> <code>\clist_if_in:NV<math>\underline{TF}</math></code> <code>\clist_if_in:No<math>\underline{TF}</math></code> <code>\clist_if_in:cn<math>\underline{TF}</math></code> <code>\clist_if_in:cV<math>\underline{TF}</math></code> <code>\clist_if_in:co<math>\underline{TF}</math></code> <code>\clist_if_in:nn<math>\underline{TF}</math></code> <code>\clist_if_in:nV<math>\underline{TF}</math></code> <code>\clist_if_in:no<math>\underline{TF}</math></code>	<code>\clist_if_in:Nn<math>\underline{TF}</math> &lt;comma list&gt; {&lt;item&gt;}</code> <code>{&lt;true code&gt;} {&lt;false code&gt;}</code>
-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------

Tests if the  $\langle item \rangle$  is present in the  $\langle comma list \rangle$ .

**T<sub>E</sub>Xhackers note:** The  $\langle item \rangle$  may not contain  $\{$ ,  $\}$ , or  $\#$  (assuming the usual T<sub>E</sub>X category codes apply).

## 107 Mapping to comma lists

The functions described in this section apply a specified function to each item of a comma list.

When the comma list is given explicitly, as an  $n$ -type argument, spaces are trimmed around each item. If the result of trimming spaces is empty, the item is ignored. Otherwise, if the item is surrounded by braces, one set is removed, and the result is passed to the mapped function. Thus, if your comma list that is being mapped is  $\{a, \{b\}, \{ \}, \{c\}, \}$  then the arguments passed to the mapped function are ‘a’, ‘{b}’, an empty argument, and ‘c’.

When the comma list is given as an  $N$ -type argument, spaces have already been trimmed on input, and items are simply stripped of one set of braces if any. This case is more efficient than using  $n$ -type comma lists.

$\backslash\text{clist\_map\_function:N}$ ☆ $\backslash\text{clist\_map\_function:c}$ ☆ $\backslash\text{clist\_map\_function:n}$ ☆	$\backslash\text{clist\_map\_function:N}$ $\langle comma\ list \rangle$ $\langle function \rangle$
-------------------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------

Applies  $\langle function \rangle$  to every  $\langle item \rangle$  stored in the  $\langle comma\ list \rangle$ . The  $\langle function \rangle$  will receive one argument for each iteration. The  $\langle items \rangle$  are returned from left to right. The function  $\backslash\text{clist\_map\_inline:N}$  is in general more efficient than  $\backslash\text{clist\_map\_function:N}$ . One mapping may be nested inside another.

$\backslash\text{clist\_map\_inline:N}$ $\backslash\text{clist\_map\_inline:c}$ $\backslash\text{clist\_map\_inline:n}$	$\backslash\text{clist\_map\_inline:N}$ $\langle comma\ list \rangle$ $\{ \langle inline\ function \rangle \}$
-------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------

Applies  $\langle inline\ function \rangle$  to every  $\langle item \rangle$  stored within the  $\langle comma\ list \rangle$ . The  $\langle inline\ function \rangle$  should consist of code which will receive the  $\langle item \rangle$  as #1. One in line mapping can be nested inside another. The  $\langle items \rangle$  are returned from left to right.

$\backslash\text{clist\_map\_variable:NN}$ $\backslash\text{clist\_map\_variable:cN}$ $\backslash\text{clist\_map\_variable:nN}$	$\backslash\text{clist\_map\_variable:NN}$ $\langle comma\ list \rangle$ $\langle tl\ var. \rangle$ $\{ \langle function\ using\ tl\ var. \rangle \}$
----------------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------------

Stores each entry in the  $\langle comma\ list \rangle$  in turn in the  $\langle tl\ var. \rangle$  and applies the  $\langle function\ using\ tl\ var. \rangle$ . The  $\langle function \rangle$  will usually consist of code making use of the  $\langle tl\ var. \rangle$ , but

this is not enforced. One variable mapping can be nested inside another. The  $\langle items \rangle$  are returned from left to right.

`\clist_map_break: ☆`

`\clist_map_break:`

Used to terminate a `\clist_map...` function before all entries in the  $\langle comma list \rangle$  have been processed. This will normally take place within a conditional statement, for example

```
\clist_map_inline:Nn \l_my_clist
{
  \str_if_eq:nnTF { #1 } { bingo }
  { \clist_map_break: }
  {
    % Do something useful
  }
}
```

Use outside of a `\clist_map...` scenario will lead to low level  $\text{\TeX}$  errors.

**$\text{\TeX}$ hackers note:** When the mapping is broken, additional tokens may be inserted by the internal macro `\clist_break_point:n` before further items are taken from the input stream. This will depend on the design of the mapping function.

`\clist_map_break:n ☆`

`\clist_map_break:n { $\langle tokens \rangle$ }`

Used to terminate a `\clist_map...` function before all entries in the  $\langle comma list \rangle$  have been processed, inserting the  $\langle tokens \rangle$  after the mapping has ended. This will normally take place within a conditional statement, for example

```
\clist_map_inline:Nn \l_my_clist
{
  \str_if_eq:nnTF { #1 } { bingo }
  { \clist_map_break:n { <tokens> } }
  {
    % Do something useful
  }
}
```

Use outside of a `\clist_map...` scenario will lead to low level  $\text{\TeX}$  errors.

**$\text{\TeX}$ hackers note:** When the mapping is broken, additional tokens may be inserted by the internal macro `\clist_break_point:n` before the  $\langle tokens \rangle$  are inserted into the input stream. This will depend on the design of the mapping function.

## 108 Comma lists as stacks

Comma lists can be used as stacks, where data is pushed to and popped from the top of the comma list. (The left of a comma list is the top, for performance reasons.) The stack functions for comma lists are not intended to be mixed with the general ordered data functions detailed in the previous section: a comma list should either be used as an ordered data type or as a stack, but not in both ways.

## 109 Comma lists as stacks

<code>\clist_get:NN</code>
<code>\clist_get:cN</code>

`\clist_get:NN` *<comma list>* *<token list variable>*

Stores the left-most item from a *<comma list>* in the *<token list variable>* without removing it from the *<comma list>*. The *<token list variable>* is assigned locally.

<code>\clist_get:NN</code>
<code>\clist_get:cN</code>

`\clist_get:NN` *<comma list>* *<token list variable>*

Stores the right-most item from a *<comma list>* in the *<token list variable>* without removing it from the *<comma list>*. The *<token list variable>* is assigned locally.

<code>\clist_pop:NN</code>
<code>\clist_pop:cN</code>

`\clist_pop:NN` *<comma list>* *<token list variable>*

Pops the left-most item from a *<comma list>* into the *<token list variable>*, *i.e.* removes the item from the comma list and stores it in the *<token list variable>*. Both of the variables are assigned locally.

<code>\clist_gpop:NN</code>
<code>\clist_gpop:cN</code>

`\clist_gpop:NN` *<comma list>* *<token list variable>*

Pops the left-most item from a *<comma list>* into the *<token list variable>*, *i.e.* removes the item from the comma list and stores it in the *<token list variable>*. The *<comma list>* is modified globally, while the assignment of the *<token list variable>* is local.

<code>\clist_push:Nn</code>
<code>\clist_push:NV</code>
<code>\clist_push:No</code>
<code>\clist_push:Nx</code>
<code>\clist_push:cn</code>
<code>\clist_push:cV</code>
<code>\clist_push:co</code>
<code>\clist_push:cx</code>

`\clist_push:Nn` *<comma list>* *{<item>}*

Adds the *{<item>}* to the top of the *<comma list>*. The assignment is restricted to the

current  $\text{\TeX}$  group.

<code>\clist_gpush:Nn</code>
<code>\clist_gpush:NV</code>
<code>\clist_gpush:No</code>
<code>\clist_gpush:Nx</code>
<code>\clist_gpush:cn</code>
<code>\clist_gpush:cV</code>
<code>\clist_gpush:co</code>
<code>\clist_gpush:cx</code>

`\clist_gpush:Nn <comma list> {<item>}`

Pushes the  $\langle item \rangle$  onto the end of the top of the  $\langle comma list \rangle$ . The assignment is global.

## 110 Viewing comma lists

<code>\clist_show:N</code>
<code>\clist_show:c</code>

`\clist_show:N <comma list>`

Displays the entries in the  $\langle comma list \rangle$  in the terminal.

## 111 Experimental comma list functions

This section contains functions which may or may not be retained, depending on how useful they are found to be.

<code>\clist_length:N</code>	★
<code>\clist_length:c</code>	★
<code>\clist_length:n</code>	★

`\clist_length:N <comma list>`

Leaves the number of items in the  $\langle comma list \rangle$  in the input stream as an  $\langle integer denotation \rangle$ . The total number of items in a  $\langle comma list \rangle$  will include those which are empty and duplicates, *i.e.* every item in a  $\langle comma list \rangle$  is unique.

<code>\clist_item:Nn</code>	★
<code>\clist_item:cn</code>	★
<code>\clist_item:nn</code>	★

`\clist_item:Nn <comma list> {<integer expression>}`

Indexing items in the  $\langle comma list \rangle$  from 0 at the top (left), this function will evaluate the  $\langle integer expression \rangle$  and leave the appropriate item from the comma list in the input stream. If the  $\langle integer expression \rangle$  is negative, indexing occurs from the bottom (right) of the comma list. When the  $\langle integer expression \rangle$  is larger than the number of items in



the  $\langle comma list \rangle$  (as calculated by `\clist_length:N`) then the function will expand to nothing.

<code>\clist_set_from_seq:NN</code> <code>\clist_set_from_seq:cN</code> <code>\clist_set_from_seq:Nc</code> <code>\clist_set_from_seq:cc</code>	<code>\clist_set_from_seq:NN</code> $\langle comma list \rangle$ $\langle sequence \rangle$
----------------------------------------------------------------------------------------------------------------------------------------------------------	---------------------------------------------------------------------------------------------

Sets the  $\langle comma list \rangle$  within the current  $\text{\TeX}$  group to be equal to the content of the  $\langle sequence \rangle$ .

<code>\clist_gset_from_seq:NN</code> <code>\clist_gset_from_seq:cN</code> <code>\clist_gset_from_seq:Nc</code> <code>\clist_gset_from_seq:cc</code>	<code>\clist_gset_from_seq:NN</code> $\langle comma list \rangle$ $\langle sequence \rangle$
--------------------------------------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------

Sets the  $\langle comma list \rangle$  globally to equal to the content of the  $\langle sequence \rangle$ .

## 112 Deprecated comma-list functions

<code>\clist_trim_spaces:N</code> <code>\clist_trim_spaces:c</code>	<code>\clist_trim_spaces:N</code> $\langle comma list \rangle$
------------------------------------------------------------------------	----------------------------------------------------------------

Removes leading and trailing spaces from each  $\langle item \rangle$  in the  $\langle comma list \rangle$  within the current  $\text{\TeX}$  group. This space-removal process takes place as described for `\tl_trim_spaces:n`.

<code>\clist_gtrim_spaces:N</code> <code>\clist_gtrim_spaces:c</code>	<code>\clist_gtrim_spaces:N</code> $\langle comma list \rangle$
--------------------------------------------------------------------------	-----------------------------------------------------------------

Removes leading and trailing spaces from each  $\langle item \rangle$  in the  $\langle comma list \rangle$  globally. This space-removal process takes place as described for `\tl_trim_spaces:n`.

<code>\clist_trim_spaces:n</code> ☆	<code>\clist_trim_spaces:N</code> $\langle comma list \rangle$
-------------------------------------	----------------------------------------------------------------

Removes leading and trailing spaces from each  $\langle item \rangle$  in the  $\langle comma list \rangle$ , leaving the resulting modified list in the input stream.

## Part XIV

# The l3prop package

## Property lists

L<sup>A</sup>T<sub>E</sub>X3 implements a “property list” data type, which contain an unordered list of entries each of which consists of a  $\langle key \rangle$  and an associated  $\langle value \rangle$ . The  $\langle key \rangle$  and  $\langle value \rangle$  may both be any  $\langle balanced\ text \rangle$ . It is possible to map functions to property lists such that the function is applied to every key–value pair within the list.

Each entry in a property list must have a unique  $\langle key \rangle$ : if an entry is added to a property list which already contains the  $\langle key \rangle$  then the new entry will overwrite the existing one. The  $\langle keys \rangle$  are compared on a string basis, using the same method as `\str_if_eq:nn`.

Property lists are intended for storing key-based information for use within code. This is in contrast to key–value lists, which are a form of *input* parsed by the `keys` module.

## 113 Creating and initialising property lists

<code>\prop_new:N</code>
<code>\prop_new:c</code>

`\prop_new:N \langle property\ list \rangle`

Creates a new  $\langle property\ list \rangle$  or raises an error if the name is already taken. The declaration is global. The  $\langle property\ lists \rangle$  will initially contain no entries.

<code>\prop_clear:N</code>
<code>\prop_clear:c</code>

`\prop_clear:N \langle property\ list \rangle`

Clears all entries from the  $\langle property\ list \rangle$  within the scope of the current T<sub>E</sub>X group.

<code>\prop_gclear:N</code>
<code>\prop_gclear:c</code>

`\prop_gclear:N \langle property\ list \rangle`

Clears all entries from the  $\langle property\ list \rangle$  globally.

<code>\prop_clear_new:N</code>
<code>\prop_clear_new:c</code>

`\prop_clear_new:N \langle property\ list \rangle`

If the  $\langle property\ list \rangle$  already exists, clears it within the scope of the current T<sub>E</sub>X group. If the  $\langle property\ list \rangle$  is not defined, it will be created (using `\prop_new:N`). Thus the property list is guaranteed to be available and clear within the current T<sub>E</sub>X group. The

$\langle property list \rangle$  will exist globally, but the content outside of the current  $\text{\TeX}$  group is not specified.

$\backslash prop\_gclear\_new:N$ $\backslash prop\_gclear\_new:c$
----------------------------------------------------------------------

 $\backslash prop\_gclear\_new:N \langle property list \rangle$ 

If the  $\langle property list \rangle$  already exists, clears it globally. If the  $\langle property list \rangle$  is not defined, it will be created (using  $\backslash prop\_new:N$ ). Thus the property list is guaranteed to be available and globally clear.

$\backslash prop\_set\_eq:NN$ $\backslash prop\_set\_eq:cN$ $\backslash prop\_set\_eq:Nc$ $\backslash prop\_set\_eq:cc$
----------------------------------------------------------------------------------------------------------------------------------

 $\backslash prop\_set\_eq:NN \langle property list1 \rangle \langle property list2 \rangle$ 

Sets the content of  $\langle property list1 \rangle$  equal to that of  $\langle property list2 \rangle$ . This assignment is restricted to the current  $\text{\TeX}$  group level.

$\backslash prop\_gset\_eq:NN$ $\backslash prop\_gset\_eq:cN$ $\backslash prop\_gset\_eq:Nc$ $\backslash prop\_gset\_eq:cc$
--------------------------------------------------------------------------------------------------------------------------------------

 $\backslash prop\_gset\_eq:NN \langle property list1 \rangle \langle property list2 \rangle$ 

Sets the content of  $\langle property list1 \rangle$  equal to that of  $\langle property list2 \rangle$ . This assignment is global and so is not limited by the current  $\text{\TeX}$  group level.

## 114 Adding entries to property lists

$\backslash prop\_put:Nnn$ $\backslash prop\_put:NnV$ $\backslash prop\_put:Nno$ $\backslash prop\_put:Nnx$ $\backslash prop\_put:NVn$ $\backslash prop\_put:NVV$ $\backslash prop\_put:Non$ $\backslash prop\_put:Noo$ $\backslash prop\_put:cnn$ $\backslash prop\_put:cnV$ $\backslash prop\_put:cno$ $\backslash prop\_put:cnx$ $\backslash prop\_put:cVn$ $\backslash prop\_put:cVV$ $\backslash prop\_put:con$ $\backslash prop\_put:coo$
----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

 $\backslash prop\_put:Nnn \langle property list \rangle \{ \langle key \rangle \} \{ \langle value \rangle \}$ 

Adds an entry to the  $\langle property list \rangle$  which may be accessed using the  $\langle key \rangle$  and which

has  $\langle value \rangle$ . Both the  $\langle key \rangle$  and  $\langle value \rangle$  may contain any  $\langle balanced text \rangle$ . The  $\langle key \rangle$  is stored after processing with `\tl_to_str:n`, meaning that category codes are ignored. If the  $\langle key \rangle$  is already present in the  $\langle property list \rangle$ , the existing entry is overwritten by the new  $\langle value \rangle$ . The assignment is restricted to the current  $\text{\TeX}$  group.

<code>\prop_gput:Nnn</code>
<code>\prop_gput:NnV</code>
<code>\prop_gput:Nno</code>
<code>\prop_gput:Nnx</code>
<code>\prop_gput:NVn</code>
<code>\prop_gput:NVV</code>
<code>\prop_gput:Non</code>
<code>\prop_gput:Noo</code>
<code>\prop_gput:cnn</code>
<code>\prop_gput:cnV</code>
<code>\prop_gput:cno</code>
<code>\prop_gput:cnx</code>
<code>\prop_gput:cVn</code>
<code>\prop_gput:cVV</code>
<code>\prop_gput:con</code>
<code>\prop_gput:coo</code>

`\prop_gput:Nnn <property list> {<key>} {<value>}`

Adds an entry to the  $\langle property list \rangle$  which may be accessed using the  $\langle key \rangle$  and which has  $\langle value \rangle$ . Both the  $\langle key \rangle$  and  $\langle value \rangle$  may contain any  $\langle balanced text \rangle$ . The  $\langle key \rangle$  is stored after processing with `\tl_to_str:n`, meaning that category codes are ignored. If the  $\langle key \rangle$  is already present in the  $\langle property list \rangle$ , the existing entry is overwritten by the new  $\langle value \rangle$ . The assignment is global.

<code>\prop_put_if_new:Nnn</code>
<code>\prop_put_if_new:cnn</code>

`\prop_put_if_new:Nnn <property list> {<key>} {<value>}`

If the  $\langle key \rangle$  is present in the  $\langle property list \rangle$  then no action is taken. If the  $\langle key \rangle$  is not present in the  $\langle property list \rangle$  then a new entry is added. Both the  $\langle key \rangle$  and  $\langle value \rangle$  may contain any  $\langle balanced text \rangle$ . The  $\langle key \rangle$  is stored after processing with `\tl_to_str:n`, meaning that category codes are ignored. The assignment is restricted to the current  $\text{\TeX}$  group.

<code>\prop_gput_if_new:Nnn</code>
<code>\prop_gput_if_new:cnn</code>

`\prop_gput_if_new:Nnn <property list> {<key>} {<value>}`

If the  $\langle key \rangle$  is present in the  $\langle property list \rangle$  then no action is taken. If the  $\langle key \rangle$  is not present in the  $\langle property list \rangle$  then a new entry is added. Both the  $\langle key \rangle$  and  $\langle value \rangle$  may contain any  $\langle balanced text \rangle$ . The  $\langle key \rangle$  is stored after processing with `\tl_to_str:n`, meaning that category codes are ignored. The assignment is global.

## 115 Recovering values from property lists

<code>\prop_get:NnN</code>
<code>\prop_get:NVN</code>
<code>\prop_get:NoN</code>
<code>\prop_get:cnN</code>
<code>\prop_get:cVN</code>
<code>\prop_get:coN</code>

`\prop_get:NnN <property list> {<key>} <tl var>`

Recovers the *<value>* stored with *<key>* from the *<property list>*, and places this in the *<token list variable>*. If the *<key>* is not found in the *<property list>* then the *<token list variable>* will contain the special marker `\q_no_value`. The *<token list variable>* is set within the current  $\text{\TeX}$  group. See also `\prop_get:NnNTF`.

<code>\prop_pop:NnN</code>
<code>\prop_pop:NoN</code>
<code>\prop_pop:cnN</code>
<code>\prop_pop:coN</code>

`\prop_pop:NnN <property list> {<key>} <tl var>`

Recovers the *<value>* stored with *<key>* from the *<property list>*, and places this in the *<token list variable>*. If the *<key>* is not found in the *<property list>* then the *<token list variable>* will contain the special marker `\q_no_value`. The *<key>* and *<value>* are then deleted from the property list. Both assignments are local.

<code>\prop_gpop:NnN</code>
<code>\prop_gpop:NoN</code>
<code>\prop_gpop:cnN</code>
<code>\prop_gpop:coN</code>

`\prop_gpop:NnN <property list> {<key>} <tl var>`

Recovers the *<value>* stored with *<key>* from the *<property list>*, and places this in the *<token list variable>*. If the *<key>* is not found in the *<property list>* then the *<token list variable>* will contain the special marker `\q_no_value`. The *<key>* and *<value>* are then deleted from the property list. The *<property list>* is modified globally, while the assignment of the *<token list variable>* is local.

## 116 Modifying property lists

<code>\prop_del:Nn</code>
<code>\prop_del:NV</code>
<code>\prop_del:cn</code>
<code>\prop_del:cV</code>

`\prop_del:Nn <property list> {<key>}`

Deletes the entry listed under *<key>* from the *<property list>* which may be accessed. If the *<key>* is not found in the *<property list>* no change occurs, *i.e* there is no need to test

for the existence of a key before deleting it. The deletion is restricted to the current  $\text{\TeX}$  group.

$\backslash\text{prop\_gdel:Nn}$
$\backslash\text{prop\_gdel:NV}$
$\backslash\text{prop\_gdel:cn}$
$\backslash\text{prop\_gdel:cV}$

 $\backslash\text{prop\_gdel:Nn}$   $\langle\text{property list}\rangle$   $\{\langle\text{key}\rangle\}$ 

Deletes the entry listed under  $\langle\text{key}\rangle$  from the  $\langle\text{property list}\rangle$  which may be accessed. If the  $\langle\text{key}\rangle$  is not found in the  $\langle\text{property list}\rangle$  no change occurs, *i.e* there is no need to test for the existence of a key before deleting it. The deletion is not restricted to the current  $\text{\TeX}$  group: it is global.

## 117 Property list conditionals

$\backslash\text{prop\_if\_empty\_p:N}$	$\star$
$\backslash\text{prop\_if\_empty:N}\underline{\text{TF}}$	$\star$
$\backslash\text{prop\_if\_empty\_p:c}$	$\star$
$\backslash\text{prop\_if\_empty:c}\underline{\text{TF}}$	$\star$

 $\backslash\text{prop\_if\_empty\_p:N}$   $\langle\text{property list}\rangle$   
 $\backslash\text{prop\_if\_empty:N}\underline{\text{TF}}$   $\langle\text{property list}\rangle$   
 $\{\langle\text{true code}\rangle\} \{\langle\text{false code}\rangle\}$ 

Tests if the  $\langle\text{property list}\rangle$  is empty (containing no entries).

$\backslash\text{prop\_if\_in\_p:Nn}$	$\star$
$\backslash\text{prop\_if\_in:Nn}\underline{\text{TF}}$	$\star$
$\backslash\text{prop\_if\_in\_p:NV}$	$\star$
$\backslash\text{prop\_if\_in:NV}\underline{\text{TF}}$	$\star$
$\backslash\text{prop\_if\_in\_p:No}$	$\star$
$\backslash\text{prop\_if\_in:No}\underline{\text{TF}}$	$\star$
$\backslash\text{prop\_if\_in\_p:cn}$	$\star$
$\backslash\text{prop\_if\_in:cn}\underline{\text{TF}}$	$\star$
$\backslash\text{prop\_if\_in\_p:cV}$	$\star$
$\backslash\text{prop\_if\_in:cV}\underline{\text{TF}}$	$\star$
$\backslash\text{prop\_if\_in\_p:co}$	$\star$
$\backslash\text{prop\_if\_in:co}\underline{\text{TF}}$	$\star$

 $\backslash\text{prop\_if\_in:NnTF}$   $\langle\text{property list}\rangle$   $\{\langle\text{key}\rangle\}$   
 $\{\langle\text{true code}\rangle\} \{\langle\text{false code}\rangle\}$ 

Tests if the  $\langle\text{key}\rangle$  is present in the  $\langle\text{property list}\rangle$ , making the comparison using the method described by  $\backslash\text{str\_if\_eq:nnTF}$ .

**$\text{\TeX}$ hackers note:** This function iterates through every key-value pair in the  $\langle\text{property list}\rangle$  and is therefore slower than using the non-expandable  $\backslash\text{prop\_get:NnNTF}$ .

## 118 Recovering values from property lists with branching

The functions in this section combine tests for the presence of a key in a property list with recovery of the associated value. This makes them useful for cases where different cases follow dependent on the presence or absence of a key in a property list. They offer increased readability and performance over separate testing and recovery phases.

```
\prop_get:NnNTF
\prop_get:NVNTF
\prop_get:NoNTF
\prop_get:cnNTF
\prop_get:cVNTF
\prop_get:coNTF
```

```
\prop_get:NnNTF <property list> {<key>}
  <token list variable> {(true code)} {(false code)}
```

If the *<key>* is not present in the *<property list>*, leaves the *<false code>* in the input stream and leaves the *<token list variable>* unchanged. If the *<key>* is present in the *<property list>*, stores the corresponding *<value>* in the *<token list variable>* without removing it from the *<property list>*. The *<token list variable>* is assigned locally.

```
\prop_pop:NnNTF
\prop_pop:cnNTF
```

```
\prop_pop:NnNTF <property list> {<key>}
  <token list variable> {(true code)} {(false code)}
```

If the *<key>* is not present in the *<property list>*, leaves the *<false code>* in the input stream and leaves the *<token list variable>* unchanged. If the *<key>* is present in the *<property list>*, pops the corresponding *<value>* in the *<token list variable>*, *i.e.* removes the item from the *<property list>*. Both the *<property list>* and the *<token list variable>* are assigned locally.

## 119 Mapping to property lists

```
\prop_map_function:NN ☆
\prop_map_function:cN ☆
```

```
\prop_map_function:NN <property list> <function>
```

Applies *<function>* to every *<entry>* stored in the *<property list>*. The *<function>* will receive two argument for each iteration.: the *<key>* and associated *<value>*. The order in which *<entries>* are returned is not defined and should not be relied upon.

```
\prop_map_inline:Nn
\prop_map_inline:cn
```

```
\prop_map_inline:Nn <property list> {(inline function)}
```

Applies *<inline function>* to every *<entry>* stored within the *<property list>*. The *<inline*

*function*) should consist of code which will receive the  $\langle key \rangle$  as #1 and the  $\langle value \rangle$  as #2. The order in which  $\langle entries \rangle$  are returned is not defined and should not be relied upon.

`\prop_map_break: ☆` `\prop_map_break:`

Used to terminate a `\prop_map...` function before all entries in the  $\langle property list \rangle$  have been processed. This will normally take place within a conditional statement, for example

```
\prop_map_inline:Nn \l_my_prop
{
  \str_if_eq:nnTF { #1 } { bingo }
  { \prop_map_break: }
  {
    % Do something useful
  }
}
```

Use outside of a `\prop_map...` scenario will lead low level T<sub>E</sub>X errors.

`\prop_map_break:n ★` `\prop_map_break:n { $\langle tokens \rangle$ }`

Used to terminate a `\prop_map...` function before all entries in the  $\langle property list \rangle$  have been processed, inserting the  $\langle tokens \rangle$  after the mapping has ended. This will normally take place within a conditional statement, for example

```
\prop_map_inline:Nn \l_my_prop
{
  \str_if_eq:nnTF { #1 } { bingo }
  { \prop_map_break:n { <tokens> } }
  {
    % Do something useful
  }
}
```

Use outside of a `\prop_map...` scenario will lead low level T<sub>E</sub>X errors.

## 120 Viewing property lists

`\prop_show:N`  
`\prop_show:c` `\prop_show:N  $\langle property list \rangle$`

Displays the entries in the  $\langle property list \rangle$  in the terminal.



## 121 Experimental property list functions

This section contains functions which may or may not be retained, depending on how useful they are found to be.

$\backslash\text{prop\_gpop:NnNTF}$ $\backslash\text{prop\_gpop:cnNTF}$	$\backslash\text{prop\_gpop:NnNTF}$ $\langle\text{property list}\rangle$ $\{\langle\text{key}\rangle\}$ $\langle\text{token list variable}\rangle$ $\{\langle\text{true code}\rangle\}$ $\{\langle\text{false code}\rangle\}$
----------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

If the  $\langle\text{key}\rangle$  is not present in the  $\langle\text{property list}\rangle$ , leaves the  $\langle\text{false code}\rangle$  in the input stream and leaves the  $\langle\text{token list variable}\rangle$  unchanged. If the  $\langle\text{key}\rangle$  is present in the  $\langle\text{property list}\rangle$ , pops the corresponding  $\langle\text{value}\rangle$  in the  $\langle\text{token list variable}\rangle$ , *i.e.* removes the item from the  $\langle\text{property list}\rangle$ . The  $\langle\text{property list}\rangle$  is modified globally, while the  $\langle\text{token list variable}\rangle$  is assigned locally.

$\backslash\text{prop\_map\_tokens:Nn}$ ★ $\backslash\text{prop\_map\_tokens:cn}$ ★	$\backslash\text{prop\_map\_tokens:Nn}$ $\langle\text{property list}\rangle$ $\{\langle\text{code}\rangle\}$
----------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------

Analogue of  $\backslash\text{prop\_map\_function:Nn}$  which maps several tokens instead of a single function. Useful in particular when mapping through a property list while keeping track of a given key.

$\backslash\text{prop\_get:Nn}$ ★ $\backslash\text{prop\_get:cn}$ ★	$\backslash\text{prop\_get:Nn}$ $\langle\text{property list}\rangle$ $\{\langle\text{key}\rangle\}$
------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------

Expands to the  $\langle\text{value}\rangle$  corresponding to the  $\langle\text{key}\rangle$  in the  $\langle\text{property list}\rangle$ . If the  $\langle\text{key}\rangle$  is missing, this has an empty expansion.

**T<sub>E</sub>Xhackers note:** This function is slower than the non-expandable analogue  $\backslash\text{prop\_get:NnN}$ .

## 122 Internal property list functions

$\backslash\text{q\_prop}$	The internal token used to separate out property list entries, separating both the $\langle\text{key}\rangle$ from the $\langle\text{value}\rangle$ and also one entry from another.
----------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

$\backslash\text{c\_empty\_prop}$	A permanently-empty property list used for internal comparisons.
-----------------------------------	------------------------------------------------------------------

$\backslash\text{prop\_split:Nnn}$	$\backslash\text{prop\_split:Nnn}$ $\langle\text{property list}\rangle$ $\{\langle\text{key}\rangle\}$ $\{\langle\text{code}\rangle\}$
------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------

Splits the  $\langle\text{property list}\rangle$  at the  $\langle\text{key}\rangle$ , giving three groups: the  $\langle\text{extract}\rangle$  of  $\langle\text{property list}\rangle$  before the  $\langle\text{key}\rangle$ , the  $\langle\text{value}\rangle$  associated with the  $\langle\text{key}\rangle$  and the  $\langle\text{extract}\rangle$  of the  $\langle\text{property list}\rangle$

*list* after the *value*. The first *extract* retains the internal structure of a property list. The second is only missing the leading separator `\q_prop`. This ensures that the concatenation of the two *extracts* is a property list. If the *key* is not present in the *property list* then the second group will contain the marker `\q_no_value` and the third is empty. Once the split has occurred, the *code* is inserted followed by the three groups: thus the *code* should properly absorb three arguments. The *key* comparison takes place as described for `\str_if_eq:nn`.

<code>\prop_split:NnTF</code>	<code>\prop_spilt:NnTF</code>	<code>&lt;property list&gt; {&lt;key&gt;}</code>
<code>{&lt;true code&gt;} {&lt;false code&gt;}</code>		

Splits the *property list* at the *key*, giving three groups: the *extract* of *property list* before the *key*, the *value* associated with the *key* and the *extract* of the *property list* after the *value*. The first *extract* retains the internal structure of a property list. The second is only missing the leading separator `\q_prop`. This ensures that the concatenation of the two *extracts* is a property list. If the *key* is present in the *property list* then the *true code* is left in the input stream, followed by the three groups: thus the *true code* should properly absorb three arguments. If the *key* is not present in the *property list* then the *false code* is left in the input stream, with no trailing material. The *key* comparison takes place as described for `\str_if_eq:nn`.

## Part XV

# The l3box package

## Boxes

There are three kinds of box operations: horizontal mode denoted with prefix `\hbox_`, vertical mode with prefix `\vbox_`, and the generic operations working in both modes with prefix `\box_`.

## 123 Creating and initialising boxes

<code>\box_new:N</code>	<code>\box_new:N</code>	<code>&lt;box&gt;</code>
<code>\box_new:c</code>		

Creates a new *box* or raises an error if the name is already taken. The declaration is global. The *box* will initially be void.

<code>\box_clear:N</code>	<code>\box_clear:N</code>	<code>&lt;box&gt;</code>
<code>\box_clear:c</code>		

Clears the content of the *box* by setting the box equal to `\c_void_box` within the

current  $\text{\TeX}$  group level.

$\backslash\text{box\_gclear:N}$
$\backslash\text{box\_gclear:c}$

 $\backslash\text{box\_gclear:N } \langle\text{box}\rangle$ 

Clears the content of the  $\langle\text{box}\rangle$  by setting the box equal to  $\backslash\text{c\_void\_box}$  globally.

$\backslash\text{box\_clear\_new:N}$
$\backslash\text{box\_clear\_new:c}$

 $\backslash\text{box\_clear\_new:N } \langle\text{box}\rangle$ 

If the  $\langle\text{box}\rangle$  is not defined, globally creates it. If the  $\langle\text{box}\rangle$  is defined, clears the content of the  $\langle\text{box}\rangle$  by setting the box equal to  $\backslash\text{c\_void\_box}$  within the current  $\text{\TeX}$  group level.

$\backslash\text{box\_gclear\_new:N}$
$\backslash\text{box\_gclear\_new:c}$

 $\backslash\text{box\_gclear\_new:N } \langle\text{box}\rangle$ 

If the  $\langle\text{box}\rangle$  is not defined, globally creates it. If the  $\langle\text{box}\rangle$  is defined, clears the content of the  $\langle\text{box}\rangle$  by setting the box equal to  $\backslash\text{c\_void\_box}$  globally.

$\backslash\text{box\_set\_eq:NN}$
$\backslash\text{box\_set\_eq:cN}$
$\backslash\text{box\_set\_eq:Nc}$
$\backslash\text{box\_set\_eq:cc}$

 $\backslash\text{box\_set\_eq:NN } \langle\text{box1}\rangle \langle\text{box2}\rangle$ 

Sets the content of  $\langle\text{box1}\rangle$  equal to that of  $\langle\text{box2}\rangle$ . This assignment is restricted to the current  $\text{\TeX}$  group level.

$\backslash\text{box\_gset\_eq:NN}$
$\backslash\text{box\_gset\_eq:cN}$
$\backslash\text{box\_gset\_eq:Nc}$
$\backslash\text{box\_gset\_eq:cc}$

 $\backslash\text{box\_gset\_eq:NN } \langle\text{box1}\rangle \langle\text{box2}\rangle$ 

Sets the content of  $\langle\text{box1}\rangle$  equal to that of  $\langle\text{box2}\rangle$  globally.

$\backslash\text{box\_set\_eq\_clear:NN}$
$\backslash\text{box\_set\_eq\_clear:cN}$
$\backslash\text{box\_set\_eq\_clear:Nc}$
$\backslash\text{box\_set\_eq\_clear:cc}$

 $\backslash\text{box\_set\_eq\_clear:NN } \langle\text{box1}\rangle \langle\text{box2}\rangle$ 

Sets the content of  $\langle\text{box1}\rangle$  within the current  $\text{\TeX}$  group equal to that of  $\langle\text{box2}\rangle$ , then clears  $\langle\text{box2}\rangle$  globally.

$\backslash\text{box\_gset\_eq\_clear:NN}$
$\backslash\text{box\_gset\_eq\_clear:cN}$
$\backslash\text{box\_gset\_eq\_clear:Nc}$
$\backslash\text{box\_gset\_eq\_clear:cc}$

 $\backslash\text{box\_gset\_eq\_clear:NN } \langle\text{box1}\rangle \langle\text{box2}\rangle$

Sets the content of  $\langle box1 \rangle$  equal to that of  $\langle box2 \rangle$ , then clears  $\langle box2 \rangle$ . These assignments are global.

## 124 Using boxes

<code>\box_use:N</code> <code>\box_use:c</code>	<code>\box_use:N \langle box \rangle</code>
----------------------------------------------------	---------------------------------------------

Inserts the current content of the  $\langle box \rangle$  onto the current list for typesetting.

**T<sub>E</sub>Xhackers note:** This is the T<sub>E</sub>X primitive `\copy`.

<code>\box_use_clear:N</code> <code>\box_use_clear:c</code>	<code>\box_use_clear:N \langle box \rangle</code>
----------------------------------------------------------------	---------------------------------------------------

Inserts the current content of the  $\langle box \rangle$  onto the current list for typesetting, then globally clears the content of the  $\langle box \rangle$ .

**T<sub>E</sub>Xhackers note:** This is the T<sub>E</sub>X primitive `\box`.

<code>\box_move_right:nn</code> <code>\box_move_left:nn</code>	<code>\box_move_right:nn {&lt;dimexpr&gt;} {&lt;box function&gt;}</code>
-------------------------------------------------------------------	--------------------------------------------------------------------------

This function operates in vertical mode, and inserts the material specified by the  $\langle box \text{ function} \rangle$  such that its reference point is displaced horizontally by the given  $\langle dimexpr \rangle$  from the reference point for typesetting, to the right or left as appropriate. The  $\langle box \text{ function} \rangle$  should be a box operation such as `\box_use:N \langle box \rangle` or a “raw” box specification such as `\vbox:n { xyz }`.

<code>\box_move_up:nn</code> <code>\box_move_down:nn</code>	<code>\box_move_up:nn {&lt;dimexpr&gt;} {&lt;box function&gt;}</code>
----------------------------------------------------------------	-----------------------------------------------------------------------

This function operates in horizontal mode, and inserts the material specified by the  $\langle box \text{ function} \rangle$  such that its reference point is displaced vertical by the given  $\langle dimexpr \rangle$  from the reference point for typesetting, up or down as appropriate. The  $\langle box \text{ function} \rangle$  should be a box operation such as `\box_use:N \langle box \rangle` or a “raw” box specification such as `\vbox:n { xyz }`.

## 125 Measuring and setting box dimensions

<code>\box_dp:N</code> <code>\box_dp:c</code>	<code>\box_dp:N \langle box \rangle</code>
--------------------------------------------------	--------------------------------------------

Calculates the depth (below the baseline) of the  $\langle box \rangle$  and leaves this in the input stream.

The output of this function is suitable for use in a  $\langle dimension\ expression \rangle$  for calculations.

**T<sub>E</sub>Xhackers note:** This is the T<sub>E</sub>X primitive `\dp`.

<code>\box_ht:N</code>
<code>\box_ht:c</code>

`\box_ht:N  $\langle box \rangle$` 

Calculates the height (above the baseline) of the  $\langle box \rangle$  and leaves this in the input stream. The output of this function is suitable for use in a  $\langle dimension\ expression \rangle$  for calculations.

**T<sub>E</sub>Xhackers note:** This is the T<sub>E</sub>X primitive `\ht`.

<code>\box_wd:N</code>
<code>\box_wd:c</code>

`\box_wd:N  $\langle box \rangle$` 

Calculates the width of the  $\langle box \rangle$  and leaves this in the input stream. The output of this function is suitable for use in a  $\langle dimension\ expression \rangle$  for calculations.

**T<sub>E</sub>Xhackers note:** This is the T<sub>E</sub>X primitive `\wd`.

<code>\box_set_dp:Nn</code>
<code>\box_set_dp:cn</code>

`\box_set_dp:Nn  $\langle box \rangle$   $\{ \langle dimension\ expression \rangle \}$` 

Set the depth (below the baseline) of the  $\langle box \rangle$  to the value of the  $\{ \langle dimension\ expression \rangle \}$ . This is a global assignment.

<code>\box_set_ht:Nn</code>
<code>\box_set_ht:cn</code>

`\box_set_ht:Nn  $\langle box \rangle$   $\{ \langle dimension\ expression \rangle \}$` 

Set the height (above the baseline) of the  $\langle box \rangle$  to the value of the  $\{ \langle dimension\ expression \rangle \}$ . This is a global assignment.

<code>\box_set_wd:Nn</code>
<code>\box_set_wd:cn</code>

`\box_set_wd:Nn  $\langle box \rangle$   $\{ \langle dimension\ expression \rangle \}$` 

Set the width of the  $\langle box \rangle$  to the value of the  $\{ \langle dimension\ expression \rangle \}$ . This is a global assignment.

## 126 Affine transformations

Affine transformations are changes which (informally) preserve straight lines. Simple translations are affine transformations, but are better handled in T<sub>E</sub>X by doing the translation first, then inserting an unmodified box. On the other hand, rotation and resizing

of boxed material can best be handled by modifying boxes. These transformations are described here.

<code>\box_resize:Nnn</code>
<code>\box_resize:cnn</code>

`\box_resize:Nnn <box> {<x-size>} {<y-size>}`

Resize the  $\langle box \rangle$  to  $\langle x-size \rangle$  horizontally and  $\langle y-size \rangle$  vertically (both of the sizes are dimension expressions). The  $\langle y-size \rangle$  is the vertical size (height plus depth) of the box. The updated  $\langle box \rangle$  will be an hbox, irrespective of the nature of the  $\langle box \rangle$  before the resizing is applied. Negative sizes will cause the material in the  $\langle box \rangle$  to be reversed in direction, but the reference point of the  $\langle box \rangle$  will be unchanged. The resizing applies within the current  $\text{\TeX}$  group level.

**This function is experimental**

<code>\box_resize_to_ht_plus_dp:Nn</code>
<code>\box_resize_to_ht_plus_dp:cn</code>

`\box_resize_to_ht_plus_dp:Nnn <box> {<y-size>}`

Resize the  $\langle box \rangle$  to  $\langle y-size \rangle$  vertically, scaling the horizontal size by the same amount ( $\langle y-size \rangle$  is a dimension expression). The  $\langle y-size \rangle$  is the vertical size (height plus depth) of the box. The updated  $\langle box \rangle$  will be an hbox, irrespective of the nature of the  $\langle box \rangle$  before the resizing is applied. A negative size will cause the material in the  $\langle box \rangle$  to be reversed in direction, but the reference point of the  $\langle box \rangle$  will be unchanged. The resizing applies within the current  $\text{\TeX}$  group level.

**This function is experimental**

<code>\box_resize_to_wd:Nn</code>
<code>\box_resize_to_wd:cn</code>

`\box_resize_to_wd:Nnn <box> {<x-size>}`

Resize the  $\langle box \rangle$  to  $\langle x-size \rangle$  horizontally, scaling the vertical size by the same amount ( $\langle x-size \rangle$  is a dimension expression). The updated  $\langle box \rangle$  will be an hbox, irrespective of the nature of the  $\langle box \rangle$  before the resizing is applied. A negative size will cause the material in the  $\langle box \rangle$  to be reversed in direction, but the reference point of the  $\langle box \rangle$  will be unchanged. The resizing applies within the current  $\text{\TeX}$  group level.

**This function is experimental**

<code>\box_rotate:Nn</code>
<code>\box_rotate:cn</code>

`\box_rotate:Nn <box> {<angle>}`

Rotates the  $\langle box \rangle$  by  $\langle angle \rangle$  (in degrees) anti-clockwise about its reference point. The reference point of the updated box will be moved horizontally such that it is at the left side of the smallest rectangle enclosing the rotated material. The updated  $\langle box \rangle$  will be an hbox, irrespective of the nature of the  $\langle box \rangle$  before the rotation is applied. The rotation applies within the current  $\text{\TeX}$  group level.

**This function is experimental**

<code>\box_scale:Nnn</code> <code>\box_scale:cnn</code>	<code>\box_scale:Nnn &lt;box&gt; {&lt;x-scale&gt;} {&lt;y-scale&gt;}</code>
------------------------------------------------------------	-----------------------------------------------------------------------------

Scales the  $\langle box \rangle$  by factors  $\langle x-scale \rangle$  and  $\langle y-scale \rangle$  in the horizontal and vertical directions, respectively (both scales are integer expressions). The updated  $\langle box \rangle$  will be an hbox, irrespective of the nature of the  $\langle box \rangle$  before the scaling is applied. Negative scalings will cause the material in the  $\langle box \rangle$  to be reversed in direction, but the reference point of the  $\langle box \rangle$  will be unchanged. The scaling applies within the current  $\text{\TeX}$  group level.

**This function is experimental**

## 127 Box conditionals

<code>\box_if_empty_p:N</code> ★ <code>\box_if_empty:NTF</code> ★ <code>\box_if_empty_p:c</code> ★ <code>\box_if_empty:cTF</code> ★	<code>\box_if_empty_p:N &lt;box&gt;</code> <code>\box_if_empty:NTF &lt;box&gt; {&lt;true code&gt;} {&lt;false code&gt;}</code>
----------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------------------

Tests if  $\langle box \rangle$  is a empty (equal to `\c_empty_box`).

<code>\box_if_horizontal_p:N</code> ★ <code>\box_if_horizontal:NTF</code> ★ <code>\box_if_horizontal_p:c</code> ★ <code>\box_if_horizontal:cTF</code> ★	<code>\box_if_horizontal_p:N &lt;box&gt;</code> <code>\box_if_horizontal:NTF &lt;box&gt; {&lt;true code&gt;} {&lt;false code&gt;}</code>
------------------------------------------------------------------------------------------------------------------------------------------------------------------	---------------------------------------------------------------------------------------------------------------------------------------------

Tests if  $\langle box \rangle$  is a horizontal box.

<code>\box_if_vertical_p:N</code> ★ <code>\box_if_vertical:NTF</code> ★ <code>\box_if_vertical_p:c</code> ★ <code>\box_if_vertical:cTF</code> ★	<code>\box_if_vertical_p:N &lt;box&gt;</code> <code>\box_if_vertical:NTF &lt;box&gt; {&lt;true code&gt;} {&lt;false code&gt;}</code>
----------------------------------------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------------------------

Tests if  $\langle box \rangle$  is a vertical box.

## 128 The last box inserted

<code>\l_last_box</code>	This is a box containing the last item added to the current partial list, except in the case of the main vertical list (main galley), in which case this box is always
--------------------------	------------------------------------------------------------------------------------------------------------------------------------------------------------------------

void. Notice that although this is not a constant, it is *not* settable by the programmer but is instead varied by  $\text{\TeX}$ .

**$\text{\TeX}$ hackers note:** This is the  $\text{\TeX}$  primitive `\lastbox` renamed.

## 129 Constant boxes

`\c_empty_box` This is a permanently empty box, which is neither set as horizontal nor vertical.

## 130 Scratch boxes

`\l_tmpa_tl`  
`\l_tmpb_tl` Scratch boxes for local assignment. These are never used by the kernel code, and so are safe for use with any  $\text{\LaTeX}$ 3-defined function. However, they may be overwritten by other non-kernel code and so should only be used for short-term storage.

## 131 Viewing box contents

`\box_show:N`  
`\box_show:c` `\box_show:N <box>`  
Writes the contents of `<box>` to the log file.

**$\text{\TeX}$ hackers note:** This is the  $\text{\TeX}$  primitive `\showbox`.

## 132 Horizontal mode boxes

`\hbox:n` `\hbox:n {<contents>}`  
Typesets the `<contents>` into a horizontal box of natural width and then includes this box in the current list for typesetting.

**$\text{\TeX}$ hackers note:** This is the  $\text{\TeX}$  primitive `\hbox`.



<code>\hbox_to_wd:nn</code>
-----------------------------

`\hbox_to_wd:nn {<dimexpr>} {<contents>}`

Typesets the  $\langle contents \rangle$  into a horizontal box of width  $\langle dimexpr \rangle$  and then includes this box in the current list for typesetting.

<code>\hbox_to_zero:n</code>
------------------------------

`\hbox_to_zero:n {<contents>}`

Typesets the  $\langle contents \rangle$  into a horizontal box of zero width and then includes this box in the current list for typesetting.

<code>\hbox_set:Nn</code>
<code>\hbox_set:cn</code>

`\hbox_set:Nn <box> {<contents>}`

Typesets the  $\langle contents \rangle$  at natural width and then stores the result inside the  $\langle box \rangle$ . The assignment is local.

<code>\hbox_gset:Nn</code>
<code>\hbox_gset:cn</code>

`\hbox_gset:Nn <box> {<contents>}`

Typesets the  $\langle contents \rangle$  at natural width and then stores the result inside the  $\langle box \rangle$ . The assignment is global.

<code>\hbox_set_to_wd:Nnn</code>
<code>\hbox_set_to_wd:cnn</code>

`\hbox_set_to_wd:Nnn <box> {<dimexpr>} {<contents>}`

Typesets the  $\langle contents \rangle$  to the width given by the  $\langle dimexpr \rangle$  and then stores the result inside the  $\langle box \rangle$ . The assignment is local.

<code>\hbox_gset_to_wd:Nnn</code>
<code>\hbox_gset_to_wd:cnn</code>

`\hbox_gset_to_wd:Nnn <box> {<dimexpr>} {<contents>}`

Typesets the  $\langle contents \rangle$  to the width given by the  $\langle dimexpr \rangle$  and then stores the result inside the  $\langle box \rangle$ . The assignment is global.

<code>\hbox_overlap_right:n</code>
------------------------------------

`\hbox_overlap_right:n {<contents>}`

Typesets the  $\langle contents \rangle$  into a horizontal box of zero width such that material will protrude to the right of the insertion point.

<code>\hbox_overlap_left:n</code>
-----------------------------------

`\hbox_overlap_left:n {<contents>}`

Typesets the  $\langle contents \rangle$  into a horizontal box of zero width such that material will protrude to the left of the insertion point.

<code>\hbox_set_inline_begin:N</code>
<code>\hbox_set_inline_begin:c</code>
<code>\hbox_set_inline_end:</code>

`\hbox_set_inline_begin:N <box> <contents>`  
`\hbox_set_inline_end:`

Typesets the  $\langle contents \rangle$  at natural width and then stores the result inside the  $\langle box \rangle$ . The assignment is local. In contrast to `\hbox_set:Nn` this function does not absorb the argument when finding the  $\langle content \rangle$ , and so can be used in circumstances where the  $\langle content \rangle$  may not be a simple argument.

<code>\hbox_gset_inline_begin:N</code> <code>\hbox_gset_inline_begin:c</code> <code>\hbox_gset_inline_end:</code>	<code>\hbox_gset_inline_begin:N &lt;box&gt; &lt;contents&gt;</code> <code>\hbox_gset_inline_end:</code>
-------------------------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------------

Typesets the  $\langle contents \rangle$  at natural width and then stores the result inside the  $\langle box \rangle$ . The assignment is global. In contrast to `\hbox_set:Nn` this function does not absorb the argument when finding the  $\langle content \rangle$ , and so can be used in circumstances where the  $\langle content \rangle$  may not be a simple argument.

<code>\hbox_unpack:N</code> <code>\hbox_unpack:c</code>	<code>\hbox_unpack:N &lt;box&gt;</code>
------------------------------------------------------------	-----------------------------------------

Unpacks the content of the horizontal  $\langle box \rangle$ , retaining any stretching or shrinking applied when the  $\langle box \rangle$  was set.

**TeXhackers note:** This is the TeX primitive `\unhcopy`.

<code>\hbox_unpack_clear:N</code> <code>\hbox_unpack_clear:c</code>	<code>\hbox_unpack_clear:N &lt;box&gt;</code>
------------------------------------------------------------------------	-----------------------------------------------

Unpacks the content of the horizontal  $\langle box \rangle$ , retaining any stretching or shrinking applied when the  $\langle box \rangle$  was set. The  $\langle box \rangle$  is then cleared globally.

**TeXhackers note:** This is the TeX primitive `\unhbox`.

## 133 Vertical mode boxes

Vertical boxes inherit their baseline from their contents. The standard case is that the baseline of the box is at the same position as that of the last item added to the box. This means that the box will have no depth unless the last item added to it had depth. As a result most vertical boxes have a large height value and small or zero depth. The exception are `_top` boxes, where the reference point is that of the first item added. These tend to have a large depth and small height, although the later will typically be non-zero.

<code>\vbox:n</code>	<code>\vbox:n {&lt;contents&gt;}</code>
----------------------	-----------------------------------------

Typesets the  $\langle contents \rangle$  into a vertical box of natural height and includes this box in the current list for typesetting.

**T<sub>E</sub>Xhackers note:** This is the T<sub>E</sub>X primitive `\vbox`.

<code>\vbox_top:n</code>
--------------------------

`\vbox_top:n {<contents>}`

Typesets the `<contents>` into a vertical box of natural height and includes this box in the current list for typesetting. The baseline of the box will be equal to that of the *first* item added to the box.

**T<sub>E</sub>Xhackers note:** This is the T<sub>E</sub>X primitive `\vtop`.

<code>\vbox_to_ht:nn</code>
-----------------------------

`\vbox_to_ht:nn {<dimexpr>} {<contents>}`

Typesets the `<contents>` into a vertical box of height `<dimexpr>` and then includes this box in the current list for typesetting.

<code>\vbox_to_zero:n</code>
------------------------------

`\vbox_to_zero:n {<contents>}`

Typesets the `<contents>` into a vertical box of zero height and then includes this box in the current list for typesetting.

<code>\vbox_set:Nn</code>
<code>\vbox_set:cn</code>

`\vbox_set:Nn <box> {<contents>}`

Typesets the `<contents>` at natural height and then stores the result inside the `<box>`. The assignment is local.

<code>\vbox_gset:Nn</code>
<code>\vbox_gset:cn</code>

`\vbox_gset:Nn <box> {<contents>}`

Typesets the `<contents>` at natural height and then stores the result inside the `<box>`. The assignment is global.

<code>\vbox_set_top:Nn</code>
<code>\vbox_set_top:cn</code>

`\vbox_set_top:Nn <box> {<contents>}`

Typesets the `<contents>` at natural height and then stores the result inside the `<box>`. The baseline of the box will be equal to that of the *first* item added to the box. The assignment is local.

<code>\vbox_gset_top:Nn</code>
<code>\vbox_gset_top:cn</code>

`\vbox_gset_top:Nn <box> {<contents>}`

Typesets the `<contents>` at natural height and then stores the result inside the `<box>`.

The baseline of the box will be equal to that of the *first* item added to the box. The assignment is global.

<code>\vbox_set_to_ht:Nnn</code> <code>\vbox_set_to_ht:cnn</code>	<code>\vbox_set_to_ht:Nnn &lt;box&gt; {&lt;dimexpr&gt;} {&lt;contents&gt;}</code>
----------------------------------------------------------------------	-----------------------------------------------------------------------------------

Typesets the  $\langle contents \rangle$  to the height given by the  $\langle dimexpr \rangle$  and then stores the result inside the  $\langle box \rangle$ . The assignment is local.

<code>\vbox_gset_to_ht:Nnn</code> <code>\vbox_gset_to_ht:cnn</code>	<code>\vbox_gset_to_ht:Nnn &lt;box&gt; {&lt;dimexpr&gt;} {&lt;contents&gt;}</code>
------------------------------------------------------------------------	------------------------------------------------------------------------------------

Typesets the  $\langle contents \rangle$  to the height given by the  $\langle dimexpr \rangle$  and then stores the result inside the  $\langle box \rangle$ . The assignment is global.

<code>\vbox_set_inline_begin:N</code> <code>\vbox_set_inline_begin:c</code> <code>\vbox_set_inline_end:</code>	<code>\vbox_set_inline_begin:N &lt;box&gt; &lt;contents&gt;</code> <code>\vbox_set_inline_end:</code>
----------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------

Typesets the  $\langle contents \rangle$  at natural height and then stores the result inside the  $\langle box \rangle$ . The assignment is local. In contrast to `\vbox_set:Nn` this function does not absorb the argument when finding the  $\langle content \rangle$ , and so can be used in circumstances where the  $\langle content \rangle$  may not be a simple argument.

<code>\vbox_gset_inline_begin:N</code> <code>\vbox_gset_inline_begin:c</code> <code>\vbox_gset_inline_end:</code>	<code>\vbox_gset_inline_begin:N &lt;box&gt; &lt;contents&gt;</code> <code>\vbox_gset_inline_end:</code>
-------------------------------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------------

Typesets the  $\langle contents \rangle$  at natural height and then stores the result inside the  $\langle box \rangle$ . The assignment is global. In contrast to `\vbox_set:Nn` this function does not absorb the argument when finding the  $\langle content \rangle$ , and so can be used in circumstances where the  $\langle content \rangle$  may not be a simple argument.

<code>\vbox_set_split_to_ht:NNn</code>	<code>\vbox_set_split_to_ht:NNn &lt;box1&gt; &lt;box2&gt; {&lt;dimexpr&gt;}</code>
----------------------------------------	------------------------------------------------------------------------------------

Sets  $\langle box1 \rangle$  to contain material to the height given by the  $\langle dimexpr \rangle$  by removing content from the top of  $\langle box2 \rangle$  (which must be a vertical box).

**T<sub>E</sub>Xhackers note:** This is the T<sub>E</sub>X primitive `\vsplit`.

<code>\vbox_unpack:N</code> <code>\vbox_unpack:c</code>	<code>\vbox_unpack:N &lt;box&gt;</code>
------------------------------------------------------------	-----------------------------------------

Unpacks the content of the vertical  $\langle box \rangle$ , retaining any stretching or shrinking applied when the  $\langle box \rangle$  was set.

**T<sub>E</sub>Xhackers note:** This is the T<sub>E</sub>X primitive `\unvcopy`.

<code>\vbox_unpack_clear:N</code> <code>\vbox_unpack_clear:c</code>
------------------------------------------------------------------------

`\vbox_unpack:N <box>`

Unpacks the content of the vertical `<box>`, retaining any stretching or shrinking applied when the `<box>` was set. The `<box>` is then cleared globally.

**T<sub>E</sub>Xhackers note:** This is the T<sub>E</sub>X primitive `\unvbox`.

## 134 Primitive box conditionals

```
\if_hbox:N <box>
  <true code>
\else:
  <false code>
\if_hbox:N ★ \fi:
```

Tests if `<box>` is a horizontal box.

**T<sub>E</sub>Xhackers note:** This is the T<sub>E</sub>X primitive `\ifhbox`.

```
\if_vbox:N <box>
  <true code>
\else:
  <false code>
\if_vbox:N ★ \fi:
```

Tests if `<box>` is a vertical box.

**T<sub>E</sub>Xhackers note:** This is the T<sub>E</sub>X primitive `\ifvbox`.

```
\if_box_empty:N <box>
  <true code>
\else:
  <false code>
\if_box_empty:N ★ \fi:
```

Tests if `<box>` is an empty (void) box.

**T<sub>E</sub>Xhackers note:** This is the T<sub>E</sub>X primitive `\ifvoid`.

## Part XVI

# The l3coffins package

## Coffin code layer

The material in this module provides the low-level support system for coffins. For details about the design concept of a coffin, see the xcoffins module (in the l3experimental bundle).

### 135 Creating and initialising coffins

<code>\coffin_new:N</code>
<code>\coffin_new:c</code>

`\coffin_new:N <coffin>`

Creates a new  $\langle coffin \rangle$  or raises an error if the name is already taken. The declaration is global. The  $\langle coffin \rangle$  will initially be empty.

<code>\coffin_clear:N</code>
<code>\coffin_clear:c</code>

`\coffin_clear:N <coffin>`

Clears the content of the  $\langle coffin \rangle$  within the current T<sub>E</sub>X group level.

<code>\coffin_set_eq:NN</code>
<code>\coffin_set_eq:Nc</code>
<code>\coffin_set_eq:cN</code>
<code>\coffin_set_eq:cc</code>

`\coffin_set_eq:NN <coffin1> <coffin2>`

Sets both the content and poles of  $\langle coffin1 \rangle$  equal to those of  $\langle coffin2 \rangle$  within the current T<sub>E</sub>X group level.

### 136 Setting coffin content and poles

<code>\hcoffin_set:Nn</code>
<code>\hcoffin_set:cn</code>

`\hcoffin_set:Nn <coffin> {<material>}`

Typesets the  $\langle material \rangle$  in horizontal mode, storing the result in the  $\langle coffin \rangle$ . The standard poles for the  $\langle coffin \rangle$  are then set up based on the size of the typeset material.

<code>\vcoffin_set:Nnn</code>
<code>\vcoffin_set:cnn</code>

`\vcoffin_set:Nnn <coffin> {<width>} {<material>}`

Typesets the  $\langle material \rangle$  in vertical mode constrained to the given  $\langle width \rangle$  and stores the

result in the  $\langle coffin \rangle$ . The standard poles for the  $\langle coffin \rangle$  are then set up based on the size of the typeset material.

$\backslash coffin\_set\_horizontal\_pole:Nnn$ $\backslash coffin\_set\_horizontal\_pole:cnn$	$\backslash coffin\_set\_horizontal\_pole:Nnn \langle coffin \rangle$ $\{ \langle pole \rangle \} \{ \langle offset \rangle \}$
--------------------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------------------------------------

Sets the  $\langle pole \rangle$  to run horizontally through the  $\langle coffin \rangle$ . The  $\langle pole \rangle$  will be located at the  $\langle offset \rangle$  from the bottom edge of the bounding box of the  $\langle coffin \rangle$ . The  $\langle offset \rangle$  should be given as a dimension expression; this may include the terms  $\backslash TotalHeight$ ,  $\backslash Height$ ,  $\backslash Depth$  and  $\backslash Width$ , which will evaluate to the appropriate dimensions of the  $\langle coffin \rangle$ .

$\backslash coffin\_set\_vertical\_pole:Nnn$ $\backslash coffin\_set\_vertical\_pole:cnn$	$\backslash coffin\_set\_vertical\_pole:Nnn \langle coffin \rangle$ $\{ \langle pole \rangle \} \{ \langle offset \rangle \}$
----------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------

Sets the  $\langle pole \rangle$  to run vertically through the  $\langle coffin \rangle$ . The  $\langle pole \rangle$  will be located at the  $\langle offset \rangle$  from the left-hand edge of the bounding box of the  $\langle coffin \rangle$ . The  $\langle offset \rangle$  should be given as a dimension expression; this may include the terms  $\backslash TotalHeight$ ,  $\backslash Height$ ,  $\backslash Depth$  and  $\backslash Width$ , which will evaluate to the appropriate dimensions of the  $\langle coffin \rangle$ .

## 137 Coffin transformations

$\backslash coffin\_resize:Nnn$ $\backslash coffin\_resize:cnn$	$\backslash coffin\_resize:Nnn \langle coffin \rangle \{ \langle width \rangle \} \{ \langle total-height \rangle \}$
--------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------

Resized the  $\langle coffin \rangle$  to  $\langle width \rangle$  and  $\langle total-height \rangle$ , both of which should be given as dimension expressions. These may include the terms  $\backslash TotalHeight$ ,  $\backslash Height$ ,  $\backslash Depth$  and  $\backslash Width$ , which will evaluate to the appropriate dimensions of the  $\langle coffin \rangle$ .

**This function is experimental.**

$\backslash coffin\_rotate:Nn$ $\backslash coffin\_rotate:cn$	$\backslash coffin\_rotate:Nn \langle coffin \rangle \{ \langle angle \rangle \}$
------------------------------------------------------------------	-----------------------------------------------------------------------------------

Rotates the  $\langle coffin \rangle$  by the given  $\langle angle \rangle$  (given in degrees counter-clockwise). This process will rotate both the coffin content and poles. Multiple rotations will not result in the bounding box of the coffin growing unnecessarily.

$\backslash coffin\_scale:Nnn$ $\backslash coffin\_scale:cnn$	$\backslash coffin\_scale:Nnn \langle coffin \rangle \{ \langle x-scale \rangle \} \{ \langle y-scale \rangle \}$
------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------

Scales the  $\langle coffin \rangle$  by a factors  $\langle x-scale \rangle$  and  $\langle y-scale \rangle$  in the horizontal and vertical directions, respectively. The two scale factors should be given as real numbers.

**This function is experimental.**

## 138 Joining and using coffins

<code>\coffin_attach:NnnNnnnn</code> <code>\coffin_attach:cnnNnnnn</code> <code>\coffin_attach:Nnncnnnn</code> <code>\coffin_attach:cnnccnnnn</code>	<code>\coffin_attach:NnnNnnnn</code> <code>\coffin1 {&lt;coffin1-pole1&gt;} {&lt;coffin1-pole2&gt;}</code> <code>\coffin2 {&lt;coffin2-pole1&gt;} {&lt;coffin2-pole2&gt;}</code> <code>{&lt;x-offset&gt;} {&lt;y-offset&gt;}</code>
---------------------------------------------------------------------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

This function carries out alignment such that the bounding box of  $\langle coffin1 \rangle$  is not altered, *i.e.*  $\langle coffin2 \rangle$  can protrude outside of the bounding box of the coffin. The alignment is carried out by first calculating  $\langle handle1 \rangle$ , the point of intersection of  $\langle coffin1-pole1 \rangle$  and  $\langle coffin1-pole2 \rangle$ , and  $\langle handle2 \rangle$ , the point of intersection of  $\langle coffin2-pole1 \rangle$  and  $\langle coffin2-pole2 \rangle$ .  $\langle coffin2 \rangle$  is then attached to  $\langle coffin1 \rangle$  such that the relationship between  $\langle handle1 \rangle$  and  $\langle handle2 \rangle$  is described by the  $\langle x-offset \rangle$  and  $\langle y-offset \rangle$ . The two offsets should be given as dimension expressions.

<code>\coffin_join:NnnNnnnn</code> <code>\coffin_join:cnnNnnnn</code> <code>\coffin_join:Nnncnnnn</code> <code>\coffin_join:cnnccnnnn</code>	<code>\coffin_join:NnnNnnnn</code> <code>\coffin1 {&lt;coffin1-pole1&gt;} {&lt;coffin1-pole2&gt;}</code> <code>\coffin2 {&lt;coffin2-pole1&gt;} {&lt;coffin2-pole2&gt;}</code> <code>{&lt;x-offset&gt;} {&lt;y-offset&gt;}</code>
-------------------------------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

This function carries out alignment such that the bounding box of  $\langle coffin1 \rangle$  after the process will expand. The new bounding box will cover the area contain the bounding boxes of the two original coffins. The alignment is carried out by first calculating  $\langle handle1 \rangle$ , the point of intersection of  $\langle coffin1-pole1 \rangle$  and  $\langle coffin1-pole2 \rangle$ , and  $\langle handle2 \rangle$ , the point of intersection of  $\langle coffin2-pole1 \rangle$  and  $\langle coffin2-pole2 \rangle$ .  $\langle coffin2 \rangle$  is then attached to  $\langle coffin1 \rangle$  such that the relationship between  $\langle handle1 \rangle$  and  $\langle handle2 \rangle$  is described by the  $\langle x-offset \rangle$  and  $\langle y-offset \rangle$ . The two offsets should be given as dimension expressions.

<code>\coffin_typeset:Nnnnn</code> <code>\coffin_typeset:cnnnn</code>	<code>\coffin_typeset:Nnnnn &lt;coffin&gt; {&lt;pole1&gt;} {&lt;pole2&gt;}</code> <code>{&lt;x-offset&gt;} {&lt;y-offset&gt;}</code>
--------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------------------------

Typesetting is carried out by first calculating  $\langle handle \rangle$ , the point of intersection of  $\langle pole1 \rangle$  and  $\langle pole2 \rangle$ . The coffin is then typeset such that the relationship between the current reference point in the document and the  $\langle handle \rangle$  is described by the  $\langle x-offset \rangle$  and  $\langle y-offset \rangle$ . The two offsets should be given as dimension expressions. Typesetting a coffin is therefore analogous to carrying out an alignment where the “parent” coffin is the current insertion point.



## 139 Coffin diagnostics

<code>\coffin_display_handles:cn</code>
<code>\coffin_display_handles:cn</code>

`\coffin_display_handles:Nn <coffin> {<colour>}`

This function first calculates the intersections between all of the  $\langle poles \rangle$  of the  $\langle coffin \rangle$  to give a set of  $\langle handles \rangle$ . It then prints the  $\langle coffin \rangle$  at the current location in the source, with the position of the  $\langle handles \rangle$  marked on the coffin. The  $\langle handles \rangle$  will be labelled as part of this process: the locations of the  $\langle handles \rangle$  and the labels are both printed in the  $\langle colour \rangle$  specified.

<code>\coffin_mark_handle:Nnnn</code>
<code>\coffin_mark_handle:cnnn</code>

`\coffin_mark_handle:Nnnn <coffin> {<pole1>} {<pole2>} {<colour>}`

This function first calculates the  $\langle handle \rangle$  for the  $\langle coffin \rangle$  as defined by the intersection of  $\langle pole_1 \rangle$  and  $\langle pole_2 \rangle$ . It then marks the position of the  $\langle handle \rangle$  on the  $\langle coffin \rangle$ . The  $\langle handle \rangle$  will be labelled as part of this process: the location of the  $\langle handle \rangle$  and the label are both printed in the  $\langle colour \rangle$  specified.

<code>\coffin_show_structure:N</code>
<code>\coffin_show_structure:c</code>

`\coffin_show_structure:N <coffin>`

This function shows the structural information about the  $\langle coffin \rangle$  in the terminal. The width, height and depth of the typeset material are given, along with the location of all of the poles of the coffin.

Notice that the poles of a coffin are defined by four values: the  $x$  and  $y$  co-ordinates of a point that the pole passes through and the  $x$ - and  $y$ -components of a vector denoting the direction of the pole. It is the ratio between the later, rather than the absolute values, which determines the direction of the pole.

## Part XVII

# The l3drivers package

## Colour support

This module provides support for colour in L<sup>A</sup>T<sub>E</sub>X3. At present, the material here is mainly intended to support a small number of low-level requirements in other l3kernel modules.

## 140 Colour in boxes

Controlling the colour of text in boxes requires a small number of control functions, so that the boxed material uses the colour at the point where it is set, rather than where it is used.

<code>\color_group_begin:</code>	<code>\color_group_begin:</code>
<code>\color_group_end:</code>	<code>...</code>
	<code>\color_group_end:</code>

Creates a colour group: one used to “trap” colour settings.

<code>\color_ensure_current:</code>	<code>\color_ensure_current:</code>
-------------------------------------	-------------------------------------

Ensures that material inside a box will use the foreground colour at the point where the box is set, rather than that in force when the box is used. This function should usually be used within a `\color_group_begin: ... \color_group_end: group`.

## Part XVIII

# The l3io package

## Input–output operations

Reading and writing from file streams is handled in L<sup>A</sup>T<sub>E</sub>X3 using functions with prefixes `\iow_...` (file reading) and `\ior_...` (file writing). Many of the basic functions are very similar, with reading and writing using the same syntax and function concepts. As a result, the reading and writing functions are documented together where this makes sense.

As T<sub>E</sub>X is limited to 16 input streams and 16 output streams, direct use of the streams by the programmer is not supported in L<sup>A</sup>T<sub>E</sub>X3. Instead, an internal pool of streams is maintained, and these are allocated and deallocated as needed by other modules. As a result, the programmer should close streams when they are no longer needed, to release them for other processes.

Reading from or writing to a file requires a  $\langle stream \rangle$  to be used. This is a csname which refers to the file being processed, and is independent of the name of the file (except of course that the file name is needed when the file is opened).

## 141 Opening and closing streams

<code>\ior_open:Nn</code>	<code>\ior_open:Nn <math>\langle stream \rangle</math> <math>\{\langle file name \rangle\}</math></code>
<code>\ior_open:cn</code>	

Opens  $\langle file\ name \rangle$  for reading using  $\langle stream \rangle$  as the control sequence for file access. If the  $\langle stream \rangle$  was already open it is closed before the new operation begins. The  $\langle stream \rangle$  is available for access immediately and will remain allocated to  $\langle file\ name \rangle$  until a `\ior_close:N` instruction is given or the file ends.

<code>\iow_open:Nn</code>
<code>\iow_open:cn</code>

`\iow_open:Nn  $\langle stream \rangle$   $\{\langle file\ name \rangle\}$` 

Opens  $\langle file\ name \rangle$  for writing using  $\langle stream \rangle$  as the control sequence for file access. If the  $\langle stream \rangle$  was already open it is closed before the new operation begins. The  $\langle stream \rangle$  is available for access immediately and will remain allocated to  $\langle file\ name \rangle$  until a `\iow_close:N` instruction is given or the file ends. Opening a file for writing will clear any existing content in the file (*i.e.* writing is *not* additive).

<code>\ior_close:N</code>
<code>\ior_close:c</code>

`\ior_close:N  $\langle stream \rangle$` 

Closes the  $\langle stream \rangle$ . Streams should always be closed when they are finished with as this ensures that they remain available to other programmer. The name of the  $\langle stream \rangle$  will be freed at this stage, to ensure that any further attempts to read from it results in an error.

<code>\iow_close:N</code>
<code>\iow_close:c</code>

`\iow_close:N  $\langle stream \rangle$` 

Closes the  $\langle stream \rangle$ . Streams should always be closed when they are finished with as this ensures that they remain available to other programmer. The name of the  $\langle stream \rangle$  will be freed at this stage, to ensure that any further attempts to write to it results in an error.

<code>\ior_list_streams:</code>	<code>\ior_list_streams:</code>
<code>\iow_list_streams:</code>	<code>\iow_list_streams:</code>

Displays a list of the file names associated with each open stream: intended for tracking down problems.

## 142 Writing to files

<code>\iow_now:Nn</code>
<code>\iow_now:Nx</code>

`\iow_now:Nn  $\langle stream \rangle$   $\{\langle tokens \rangle\}$` 

This functions writes  $\langle tokens \rangle$  to the specified  $\langle stream \rangle$  immediately (*i.e.* the write operation is called on expansion of `\iow_now:Nn`).

**T<sub>E</sub>Xhackers note:** `\iow_now:Nx` is a protected macro which expands to the two T<sub>E</sub>X primitives `\immediate\write`.

<code>\iow_log:n</code> <code>\iow_log:x</code>	<code>\iow_log:n {⟨tokens⟩}</code>
----------------------------------------------------	------------------------------------

This function writes the given  $\langle tokens \rangle$  to the log (transcript) file immediately: it is a dedicated version of `\iow_now:Nn`.

<code>\iow_term:n</code> <code>\iow_term:x</code>	<code>\iow_term:n {⟨tokens⟩}</code>
------------------------------------------------------	-------------------------------------

This function writes the given  $\langle tokens \rangle$  to the terminal file immediately: it is a dedicated version of `\iow_now:Nn`.

<code>\iow_now_when_avail:Nn</code> <code>\iow_now_when_avail:Nx</code>	<code>\iow_now_when_avail:Nn ⟨stream⟩ {⟨tokens⟩}</code>
----------------------------------------------------------------------------	---------------------------------------------------------

If  $\langle stream \rangle$  is open, writes the  $\langle tokens \rangle$  to the  $\langle stream \rangle$  in the same manner as `\iow_now:Nn`. If the  $\langle stream \rangle$  is not open, the  $\langle tokens \rangle$  are simply thrown away.

<code>\iow_shipout:Nn</code> <code>\iow_shipout:Nx</code>	<code>\iow_shipout:Nn ⟨stream⟩ {⟨tokens⟩}</code>
--------------------------------------------------------------	--------------------------------------------------

This functions writes  $\langle tokens \rangle$  to the specified  $\langle stream \rangle$  when the current page is finalised (*i.e.* at shipout). The x-type variants expand the  $\langle tokens \rangle$  at the point where the function is used but *not* when the resulting tokens are written to the  $\langle stream \rangle$  (*cf.* `\iow_shipout_x:Nn`).

<code>\iow_shipout_x:Nn</code> <code>\iow_shipout_x:Nx</code>	<code>\iow_shipout_x:Nn ⟨stream⟩ {⟨tokens⟩}</code>
------------------------------------------------------------------	----------------------------------------------------

This functions writes  $\langle tokens \rangle$  to the specified  $\langle stream \rangle$  when the current page is finalised (*i.e.* at shipout). The  $\langle tokens \rangle$  are expanded at the time of writing in addition to any expansion when the function is used. This makes these functions suitable for including material finalised during the page building process (such as the page number integer).

**T<sub>E</sub>Xhackers note:** `\iow_shipout_x:Nn` is the T<sub>E</sub>X primitive `\write` renamed.

<code>\iow_char:N</code> ★	<code>\iow_char:N ⟨token⟩</code>
----------------------------	----------------------------------

Inserts  $\langle token \rangle$  into the output stream. Useful when trying to write difficult characters such as %, {, }, *etc.* in messages, for example:

```
\iow_now:Nx \g_my_stream { \iow_char:N \{ text \iow_char:N \} }
```

The function has no effect if writing is taking place without expansion (*e.g.* in the second argument of `\iow_now:Nn`).

`\iow_newline: *` `\iow_newline:`

Function to add a new line within the  $\langle tokens \rangle$  written to a file. The function has no effect if writing is taking place without expansion (*e.g.* in the second argument of `\iow_now:Nn`).

## 143 Wrapping lines in output

`\iow_wrap:xxxxN`  $\langle text \rangle$   $\langle run-on text \rangle$   $\langle run-on length \rangle$   
`\iow_wrap:xxxxN`  $\langle set up \rangle$   $\langle function \rangle$

This function will wrap the  $\langle text \rangle$  to a fixed number of characters per line. At the start of each line which is wrapped, the  $\langle run-on text \rangle$  will be inserted. The line length targeted will be the value of `\l_iow_line_length_int` minus the  $\langle run-on length \rangle$ . The later value should be the number of characters in the  $\langle run-on text \rangle$ . Additional functions may be added to the wrapping by using the  $\langle set up \rangle$ , which is executed before the wrapping takes place. The result of the wrapping operation is passed as a braced argument to the  $\langle function \rangle$ , which will typically be a wrapper around a writing operation. Within the  $\langle text \rangle$ , `\` may be used to force a new line and `\`  may be used to represent a forced space (for example after a control sequence). Both the wrapping process and the subsequent write operation will perform x-type expansion. For this reason, material which is to be written “as is” should be given as the argument to `\token_to_str:N` or `\tl_to_str:n` (as appropriate) within the  $\langle text \rangle$ . The output of `\iow_wrap:xxxxN` (*i.e.* the argument passed to the  $\langle function \rangle$ ) will consist of characters of category code 12 (other) and 10 (space) only. This means that the output will *not* expand further when written to a file.

`\l_iow_line_length_int` The maximum length of a line to be written by the `\iow_wrap:xxxxN` function. This value depends on the T<sub>E</sub>X system in use: the standard value is 78, which is typically correct for unmodified T<sub>E</sub>Xlive and MiK<sub>T</sub>E<sub>X</sub> systems.

`\c_catcode_other_space_tl` Token list containing one character with category code 12, (“other”), and character code 32 (space).

## 144 Reading from files

`\ior_to:NN` `\ior_to:NN`  $\langle stream \rangle$   $\langle token list variable \rangle$

Functions that reads one or more lines (until an equal number of left and right braces are

found) from the input  $\langle stream \rangle$  and stores the result locally in the  $\langle token list \rangle$  variable. If the  $\langle stream \rangle$  is not open, input is requested from the terminal. The material read from the  $\langle stream \rangle$  will be tokenized by T<sub>E</sub>X according to the category codes in force when the function is used.

**T<sub>E</sub>Xhackers note:** The is protected macro which expands to the T<sub>E</sub>X primitive `\read` along with the `to` keyword.

<code>\ior_gto:NN</code>	<code>\ior_gto:NN <math>\langle stream \rangle</math> <math>\langle token list variable \rangle</math></code>
--------------------------	---------------------------------------------------------------------------------------------------------------

Functions that reads one or more lines (until an equal number of left and right braces are found) from the input  $\langle stream \rangle$  and stores the result globally in the  $\langle token list \rangle$  variable. If the  $\langle stream \rangle$  is not open, input is requested from the terminal. The material read from the  $\langle stream \rangle$  will be tokenized by T<sub>E</sub>X according to the category codes in force when the function is used.

**T<sub>E</sub>Xhackers note:** The is protected macro which expands to the T<sub>E</sub>X primitives `\global \read` along with the `to` keyword.

<code>\ior_str_to:NN</code>	<code>\ior_str_to:NN <math>\langle stream \rangle</math> <math>\langle token list variable \rangle</math></code>
-----------------------------	------------------------------------------------------------------------------------------------------------------

Functions that reads one or more lines (until an equal number of left and right braces are found) from the input  $\langle stream \rangle$  and stores the result locally in the  $\langle token list \rangle$  variable. If the  $\langle stream \rangle$  is not open, input is requested from the terminal. The material read from the  $\langle stream \rangle$  as a series of tokens with category code 12 (other), with the exception of space characters which are given category code 10 (space).

**T<sub>E</sub>Xhackers note:** The is protected macro which expands to the  $\varepsilon$ -T<sub>E</sub>X primitive `\readline` along with the `to` keyword.

<code>\ior_str_gto:NN</code>	<code>\ior_str_gto:NN <math>\langle stream \rangle</math> <math>\langle token list variable \rangle</math></code>
------------------------------	-------------------------------------------------------------------------------------------------------------------

Functions that reads one or more lines (until an equal number of left and right braces are found) from the input  $\langle stream \rangle$  and stores the result globally in the  $\langle token list \rangle$  variable. If the  $\langle stream \rangle$  is not open, input is requested from the terminal. The material read from the  $\langle stream \rangle$  as a series of tokens with category code 12 (other), with the exception of space characters which are given category code 10 (space).

**T<sub>E</sub>Xhackers note:** The is protected macro which expands to the primitives `\global \readline` along with the `to` keyword.

<code>\ior_if_eof_p:N</code> ★	<code>\ior_if_eof_p:N <math>\langle stream \rangle</math></code>
<code>\ior_if_eof:NTF</code> ★	<code>\ior_if_eof:NTF <math>\langle stream \rangle</math> <math>\{ \langle true code \rangle \} \{ \langle false code \rangle \}</math></code>

Tests if the end of a  $\langle stream \rangle$  has been reached during a reading operation. The test will

also return a `true` value if the  $\langle stream \rangle$  is not open or the  $\langle file\ name \rangle$  associated with a  $\langle stream \rangle$  does not exist at all.

## 145 Internal input–output functions

```

\if_eof:w \langle stream \rangle
  \langle true code \rangle
\else:
  \langle false code \rangle
\if_eof:w ★ \fi:

```

Tests if the  $\langle stream \rangle$  returns “end of file”, which is true for non-existent files. The `\else:` branch is optional.

**T<sub>E</sub>Xhackers note:** This is the T<sub>E</sub>X primitive `\ifeof`.

```

\ior_raw_new:N
\ior_raw_new:c \ior_raw_new:N \langle stream \rangle

```

Directly allocates a new stream for reading, bypassing the stack system. This is to be used only when a new stream is required at a T<sub>E</sub>X level, when a new stream is requested by the stack itself.

```

\iow_raw_new:N
\iow_raw_new:c \iow_raw_new:N \langle stream \rangle

```

Directly allocates a new stream for writing, bypassing the stack system. This is to be used only when a new stream is required at a T<sub>E</sub>X level, when a new stream is requested by the stack itself.

## Part XIX

# The l3msg package

## Messages

Messages need to be passed to the user by modules, either when errors occur or to indicate how the code is proceeding. The `l3msg` module provides a consistent method for doing this (as opposed to writing directly to the terminal or log).

The system used by `l3msg` to create messages divides the process into two distinct parts. Named messages are created in the first part of the process; at this stage, no decision is

made about the type of output that the message will produce. The second part of the process is actually producing a message. At this stage a choice of message *class* has to be made, for example **error**, **warning** or **info**.

By separating out the creation and use of messages, several benefits are available. First, the messages can be altered later without needing details of where they are used in the code. This makes it possible to alter the language used, the detail level and so on. Secondly, the output which results from a given message can be altered. This can be done on a message class, module or message name basis. In this way, message behaviour can be altered and messages can be entirely suppressed.

## 146 Creating new messages

All messages have to be created before they can be used. All message setting is local, with the general assumption that messages will be managed as part of module set up outside of any TeX grouping.

The text of messages will automatically be wrapped to the length available in the console. As a result, formatting is only needed where it will help to show meaning. In particular, `\` may be used to force a new line and `\_` forces an explicit space.

<code>\msg_new:nnnn</code>	<code>\msg_new:nnnn {&lt;module&gt;} {&lt;message&gt;} {&lt;text&gt;}</code>
<code>\msg_new:nnn</code>	<code>{&lt;more text&gt;}</code>

Creates a *<message>* for a given *<module>*. The message will be defined to first give *<text>* and then *<more text>* if the user requests it. If no *<more text>* is available then a standard text is given instead. Within *<text>* and *<more text>* four parameters (**#1** to **#4**) can be used: these will be supplied at the time the message is used. The parameters will be expanded when the message is used. Within the *<text>* and *<more text>* `\` can be used to start a new line. An error will be raised if the *<message>* already exists.

<code>\msg_set:nnnn</code>	<code>\msg_set:nnnn {&lt;module&gt;} {&lt;message&gt;} {&lt;text&gt;}</code>
<code>\msg_set:nnn</code>	<code>{&lt;more text&gt;}</code>

Sets up the text for a *<message>* for a given *<module>*. The message will be defined to first give *<text>* and then *<more text>* if the user requests it. If no *<more text>* is available then a standard text is given instead. Within *<text>* and *<more text>* four parameters (**#1** to **#4**) can be used: these will be supplied at the time the message is used. The parameters will be expanded when the message is used. Within the *<text>* and *<more text>* `\` can be used to start a new line.

## 147 Contextual information for messages

<code>\msg_line_context: *</code>	<code>\msg_line_context:</code>
-----------------------------------	---------------------------------



Prints the current line number when a message is given, and thus suitable for giving context to messages. The number itself is preceded by the text `on line`.

`\msg_line_number: ★` `\msg_line_number:`

Prints the current line number when a message is given.

`\c_msg_return_text_tl` Standard text to indicate that the user should try pressing `<return>` to continue. The standard definition reads:

Try typing `<return>` to proceed.

If that doesn't work, type `X <return>` to quit.

`\c_msg_trouble_text_tl` Standard text to indicate that the more errors are likely and that aborting the run is advised. The standard definition reads:

More errors will almost certainly follow:  
the LaTeX run should be aborted.

`\msg_fatal_text:n ★` `\msg_fatal_text:n {<module>}`

Produces the standard text:

Fatal `<module>` error

This function can be redefined to alter the language in which the message is give, using `#1` as the name of the `<module>` to be included.

`\msg_critical_text:n ★` `\msg_critical_text:n {<module>}`

Produces the standard text:

Critical `<module>` error

This function can be redefined to alter the language in which the message is give, using `#1` as the name of the `<module>` to be included.

`\msg_error_text:n ★` `\msg_error_text:n {<module>}`

Produces the standard text:

`<module>` error

This function can be redefined to alter the language in which the message is give, using #1 as the name of the *<module>* to be included.

```
\msg_warning_text:n ★ \msg_warning_text:n {<module>}
```

Produces the standard text:

```
<module> warning
```

This function can be redefined to alter the language in which the message is give, using #1 as the name of the *<module>* to be included.

```
\msg_info_text:n ★ \msg_info_text:n {<module>}
```

Produces the standard text:

```
<module> info
```

This function can be redefined to alter the language in which the message is give, using #1 as the name of the *<module>* to be included.

## 148 Issuing messages

Messages behave differently depending on the message class. A number of standard message classes are supplied, but more can be created.

When issuing messages, any arguments passed should use `\tl_to_str:n` or `\token_to_str:N` to prevent unwanted expansion of the material.

```
\msg_class_set:nn \msg_class_set:nn {<class>} {<code>}
```

Sets a *<class>* to output a message, using *<code>* to process the message text. The *<class>* should be a text value, while the *<code>* may be any arbitrary material. The *<code>* will receive 6 arguments: the module name (#1), the message name (#2) and the four arguments taken by the message text (#3 to #6).

The kernel defines several common message classes. The following describes the standard behaviour of each class if no redirection of the class or message is active. In all cases, the message may be issued supplying 0 to 4 arguments. The code will ensure that there an

no errors if the number of arguments supplied here does not match the number in the definition of the message (although of course the sense of the message may be impaired).

<code>\msg_fatal:nnxxxx</code>	
<code>\msg_fatal:nnxxx</code>	
<code>\msg_fatal:nnxx</code>	
<code>\msg_fatal:nnx</code>	
<code>\msg_fatal:nn</code>	<code>\msg_fatal:nnxxxx {&lt;module&gt;} {&lt;message&gt;} {&lt;arg one&gt;} {&lt;arg two&gt;} {&lt;arg three&gt;} {&lt;arg four&gt;}</code>

Issues *<module>* error *<message>*, passing *<arg one>* to *<arg four>* to the text-creating functions. After issuing a fatal error the T<sub>E</sub>X run will halt.

<code>\msg_critical:nnxxxx</code>	
<code>\msg_critical:nnxxx</code>	
<code>\msg_critical:nnxx</code>	
<code>\msg_critical:nnx</code>	
<code>\msg_critical:nn</code>	<code>\msg_critical:nnxxxx {&lt;module&gt;} {&lt;message&gt;} {&lt;arg one&gt;} {&lt;arg two&gt;} {&lt;arg three&gt;} {&lt;arg four&gt;}</code>

Issues *<module>* error *<message>*, passing *<arg one>* to *<arg four>* to the text-creating functions. After issuing the message reading the current input file will stop. This may halt the T<sub>E</sub>X run (if the current file is the main file) or may abort reading a sub-file.

<code>\msg_error:nnxxxx</code>	
<code>\msg_error:nnxxx</code>	
<code>\msg_error:nnxx</code>	
<code>\msg_error:nnx</code>	
<code>\msg_error:nn</code>	<code>\msg_error:nnxxxx {&lt;module&gt;} {&lt;message&gt;} {&lt;arg one&gt;} {&lt;arg two&gt;} {&lt;arg three&gt;} {&lt;arg four&gt;}</code>

Issues *<module>* error *<message>*, passing *<arg one>* to *<arg four>* to the text-creating functions. The error will stop processing and issue the text at the terminal. After user input, the run will continue.

<code>\msg_warning:nnxxxx</code>	
<code>\msg_warning:nnxxx</code>	
<code>\msg_warning:nnxx</code>	
<code>\msg_warning:nnx</code>	
<code>\msg_warning:nn</code>	<code>\msg_warning:nnxxxx {&lt;module&gt;} {&lt;message&gt;} {&lt;arg one&gt;} {&lt;arg two&gt;} {&lt;arg three&gt;} {&lt;arg four&gt;}</code>

Issues *<module>* warning *<message>*, passing *<arg one>* to *<arg four>* to the text-creating functions. The warning text will be added to the log file, but the T<sub>E</sub>X run will not be interrupted.

<code>\msg_info:nnxxxx</code>	
<code>\msg_info:nnxxx</code>	
<code>\msg_info:nnxx</code>	
<code>\msg_info:nnx</code>	
<code>\msg_info:nn</code>	<code>\msg_info:nnxxxx {&lt;module&gt;} {&lt;message&gt;} {&lt;arg one&gt;} {&lt;arg two&gt;} {&lt;arg three&gt;} {&lt;arg four&gt;}</code>

Issues  $\langle module \rangle$  information  $\langle message \rangle$ , passing  $\langle arg one \rangle$  to  $\langle arg four \rangle$  to the text-creating functions. The information text will be added to the log file.

<code>\msg_log:nnxxxx</code>
<code>\msg_log:nnxxx</code>
<code>\msg_log:nnxx</code>
<code>\msg_log:nnx</code>
<code>\msg_log:nn</code>

```
\msg_log:nnxxxx { $\langle module \rangle$ } { $\langle message \rangle$ } { $\langle arg one \rangle$ }
{ $\langle arg two \rangle$ } { $\langle arg three \rangle$ } { $\langle arg four \rangle$ }
```

Issues  $\langle module \rangle$  information  $\langle message \rangle$ , passing  $\langle arg one \rangle$  to  $\langle arg four \rangle$  to the text-creating functions. The information text will be added to the log file: the output is briefer than `\msg_info:nnxxxx`.

<code>\msg_none:nnxxxx</code>
<code>\msg_none:nnxxx</code>
<code>\msg_none:nnxx</code>
<code>\msg_none:nnx</code>
<code>\msg_none:nn</code>

```
\msg_none:nnxxxx { $\langle module \rangle$ } { $\langle message \rangle$ } { $\langle arg one \rangle$ }
{ $\langle arg two \rangle$ } { $\langle arg three \rangle$ } { $\langle arg four \rangle$ }
```

Does nothing: used as a message class to prevent any output at all (see the discussion of message redirection).

## 149 Redirecting messages

Each message has a “name”, which can be used to alter the behaviour of the message when it is given. Thus we might have

```
\msg_new:nnnn { module } { my-message } { Some~text } { Some~more~text }
```

to define a message, with

```
\msg_error:nn { module } { my-message }
```

when it is used. With no filtering, this will raise an error. However, we could alter the behaviour with

```
\msg_redirect_class:nn { error } { warning }
```

to turn all errors into warnings, or with

```
\msg_redirect_module:nnn { module } { error } { warning }
```

to alter just those messages for module, or even

```
\msg_redirect_name:nnn { module } { my-message } { warning }
```

to target just one message.

```
\msg_redirect_class:nn \msg_redirect_class:nn {<class one>} {<class two>}
```

Changes the behaviour of messages of *<class one>* so that they are processed using the code for those of *<class two>*. Multiple redirections are possible. Redirection to a missing class or infinite loops will raise errors when the messages are used, rather than at the point of redirection.

```
\msg_redirect_module:nnn \msg_redirect_module:nnn {<module>} {<class one>}  
{<class two>}
```

Redirects message of *<class one>* for *<module>* to act as though they were from *<class two>*. Messages of *<class one>* from sources other than *<module>* are not affected by this redirection. This function can be used to make some messages “silent” by default. For example, all of the `trace` messages of *<module>* could be turned off with:

```
\msg_redirect_module:nnn { module } { trace } { none }
```

```
\msg_redirect_name:nnn \msg_redirect_name:nn {<module>} {<message>} {<class>}
```

Redirects a specific *<message>* from a specific *<module>* to act as a member of *<class>* of messages. This function can be used to make a selected message “silent” without changing global parameters:

```
\msg_redirect_name:nnn { module } { annoying-message } { none }
```

## 150 Low-level message functions

The lower-level message functions should usually be accessed from the higher-level system. However, there are occasions where direct access to these functions is desirable.

```
\msg_newline: ★  
\msg_two_newlines: ★ \msg_newline:
```

Forces a new line in a message. This is a low-level function, which will not include any additional printing information in the message: contrast with `\\` in messages. The `two` version adds two lines.

`\msg_interrupt:xxx` `\msg_interrupt:xxx {<first line>} {<text>} {<extra text>}`  
 Interrupts the  $\TeX$  run, issuing a formatted message comprising `<first line>` and `<text>` laid out in the format

```
!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!
!
! <first line>
!
! <text>
!.....
```

where the `<text>` will be wrapped to fit within the current line length. The user may then request more information, at which stage the `<extra text>` will be shown in the terminal in the format

```
|,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,
| <extra text>
|.....
```

where the `<extra text>` will be wrapped to fit within the current line length.

`\msg_log:x` `\msg_log:x {<text>}`  
 Writes to the log file with the `<text>` laid out in the format

```
.....
. <text>
.....
```

where the `<text>` will be wrapped to fit within the current line length.

`\msg_term:x` `\msg_term:x {<text>}`  
 Writes to the terminal and log file with the `<text>` laid out in the format

```
*****
* <text>
*****
```

where the `<text>` will be wrapped to fit within the current line length.

## 151 Kernel-specific functions

Messages from L<sup>A</sup>T<sub>E</sub>X3 itself are handled by the general message system, but have their own functions. This allows some text to be pre-defined, and also ensures that serious errors can be handled properly.

<code>\msg_kernel_new:nnnn</code> <code>\msg_kernel_new:nnn</code>	<code>\msg_kernel_new:nnnn {&lt;module&gt;} {&lt;message&gt;} {&lt;text&gt;}</code> <code>{&lt;more text&gt;}</code>
-----------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------

Creates a kernel *<message>* for a given *<module>*. The message will be defined to first give *<text>* and then *<more text>* if the user requests it. If no *<more text>* is available then a standard text is given instead. Within *<text>* and *<more text>* four parameters (#1 to #4) can be used: these will be supplied at the time the message is used. The parameters will be expanded when the message is used. Within the *<text>* and *<more text>* `\` can be used to start a new line. An error will be raised if the *<message>* already exists.

<code>\msg_kernel_set:nnnn</code> <code>\msg_kernel_set:nnn</code>	<code>\msg_kernel_set:nnnn {&lt;module&gt;} {&lt;message&gt;} {&lt;text&gt;}</code> <code>{&lt;more text&gt;}</code>
-----------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------

Sets up the text for a kernel *<message>* for a given *<module>*. The message will be defined to first give *<text>* and then *<more text>* if the user requests it. If no *<more text>* is available then a standard text is given instead. Within *<text>* and *<more text>* four parameters (#1 to #4) can be used: these will be supplied at the time the message is used. The parameters will be expanded when the message is used. Within the *<text>* and *<more text>* `\` can be used to start a new line.

<code>\msg_kernel_fatal:nnxxxx</code> <code>\msg_kernel_fatal:nnxxx</code> <code>\msg_kernel_fatal:nnxx</code> <code>\msg_kernel_fatal:nnx</code> <code>\msg_kernel_fatal:nn</code>	<code>\msg_kernel_fatal:nnxxxx {&lt;module&gt;} {&lt;message&gt;} {&lt;arg</code> <code>one&gt;}</code> <code>{&lt;arg two&gt;} {&lt;arg three&gt;} {&lt;arg four&gt;}</code>
-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Issues kernel *<module>* error *<message>*, passing *<arg one>* to *<arg four>* to the text-creating functions. After issuing a fatal error the T<sub>E</sub>X run will halt. Cannot be redirected.

<code>\msg_kernel_error:nnxxxx</code> <code>\msg_kernel_error:nnxxx</code> <code>\msg_kernel_error:nnxx</code> <code>\msg_kernel_error:nnx</code> <code>\msg_kernel_error:nn</code>	<code>\msg_kernel_error:nnxxxx {&lt;module&gt;} {&lt;message&gt;} {&lt;arg</code> <code>one&gt;}</code> <code>{&lt;arg two&gt;} {&lt;arg three&gt;} {&lt;arg four&gt;}</code>
-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Issues kernel *<module>* error *<message>*, passing *<arg one>* to *<arg four>* to the text-creating

functions. The error will stop processing and issue the text at the terminal. After user input, the run will continue. Cannot be redirected.

<pre> \msg_kernel_warning:nnxxxx \msg_kernel_warning:nnxxx \msg_kernel_warning:nnxx \msg_kernel_warning:nnx \msg_kernel_warning:nn </pre>	<pre> \msg_kernel_warning:nnxxxx {&lt;module&gt;} {&lt;message&gt;} {&lt;arg one&gt;}} {&lt;arg two&gt;} {&lt;arg three&gt;} {&lt;arg four&gt;} </pre>
-------------------------------------------------------------------------------------------------------------------------------------------	--------------------------------------------------------------------------------------------------------------------------------------------------------

Issues kernel *<module>* warning *<message>*, passing *<arg one>* to *<arg four>* to the text-creating functions. The warning text will be added to the log file, but the T<sub>E</sub>X run will not be interrupted.

<pre> \msg_kernel_info:nnxxxx \msg_kernel_info:nnxxx \msg_kernel_info:nnxx \msg_kernel_info:nnx \msg_kernel_info:nn </pre>	<pre> \msg_kernel_info:nnxxxx {&lt;module&gt;} {&lt;message&gt;} {&lt;arg one&gt;}} {&lt;arg two&gt;} {&lt;arg three&gt;} {&lt;arg four&gt;} </pre>
----------------------------------------------------------------------------------------------------------------------------	-----------------------------------------------------------------------------------------------------------------------------------------------------

Issues kernel *<module>* information *<message>*, passing *<arg one>* to *<arg four>* to the text-creating functions. The information text will be added to the log file.

## 152 Expandable errors

In a few places, the L<sup>A</sup>T<sub>E</sub>X3 kernel needs to produce errors in an expansion only context. This must be handled very differently from normal error messages, as none of the tools to print to the terminal or the log file are expandable.

<pre> \msg_expandable_error:n </pre>	<pre> \msg_expandable_error:n {&lt;error message&gt;} </pre>
--------------------------------------	--------------------------------------------------------------

Issues an “Undefined error” message from T<sub>E</sub>X itself, and prints the *<error message>*. The *<error message>* must be short: it is cropped at the end of one line.

**T<sub>E</sub>Xhackers note:** This function expands to an empty token list after two steps. Tokens inserted in response to T<sub>E</sub>X’s prompt are read with the current category code setting, and inserted just after the place where the error message was issued.

## Part XX

# The l3keys package



# Key–value interfaces

The key–value method is a popular system for creating large numbers of settings for controlling function or package behaviour. For the user, the system normally results in input of the form

```
\PackageControlMacro{
  key-one = value one,
  key-two = value two
}
```

or

```
\PackageMacro[
  key-one = value one,
  key-two = value two
]{argument}.
```

The high level functions here are intended as a method to create key–value controls. Keys are themselves created using a key–value interface, minimising the number of functions and arguments required. Each key is created by setting one or more *properties* of the key:

```
\keys_define:nn { module }
{
  key-one .code:n = code including parameter #1,
  key-two .tl_set:N = \l_module_store_tl
}
```

These values can then be set as with other key–value approaches:

```
\keys_set:nn { module }
{
  key-one = value one,
  key-two = value two
}
```

At a document level, `\keys_set:nn` will be used within a document function, for example

```
\DeclareDocumentCommand \SomePackageSetup { m }
{ \keys_set:nn { module } { #1 } }
\DeclareDocumentCommand \SomePackageMacro { o m }
{ \keys_set:nn { module } { #1 } }
```

```

{
  \group_begin:
    \keys_set:nn { module } { #1 }
    % Main code for \SomePackageMacro
  \group_end:
}

```

Key names may contain any tokens, as they are handled internally using `\tl_to_str:n`. As will be discussed in section 154, it is suggested that the character `/` is reserved for sub-division of keys into logical groups. Functions and variables are *not* expanded when creating key names, and so

```

\tl_set:Nn \l_module_tmp_tl { key }
\keys_define:nn { module }
{
  \l_module_tmp_tl .code:n = code
}

```

will create a key called `\l_module_tmp_tl`, and not one called `key`.

## 153 Creating keys

`\keys_define:nn` `\keys_define:nn {<module>} {<keyval list>}`

Parses the *<keyval list>* and defines the keys listed there for *<module>*. The *<module>* name should be a text value, but there are no restrictions on the nature of the text. In practice the *<module>* should be chosen to be unique to the module in question (unless deliberately adding keys to an existing module).

The *<keyval list>* should consist of one or more key names along with an associated key *property*. The properties of a key determine how it acts. The individual properties are described in the following text; a typical use of `\keys_define:nn` might read

```

\keys_define:nn { mymodule }
{
  keyname .code:n = Some~code~using~#1,
  keyname .value_required:
}

```

where the properties of the key begin from the `.` after the key name.

The various properties available take either no arguments at all, or require exactly one argument. This is indicated in the name of the property using an argument specification.

In the following discussion, each property is illustrated attached to an arbitrary  $\langle key \rangle$ , which when used may be supplied with a  $\langle value \rangle$ . All key *definitions* are local.

`.bool_set:N`  $\langle key \rangle$  .bool\_set:N =  $\langle boolean \rangle$

Defines  $\langle key \rangle$  to set  $\langle boolean \rangle$  to  $\langle value \rangle$  (which must be either **true** or **false**). If the variable does not exist, it will be created at the point that the key is set up. The  $\langle boolean \rangle$  will be assigned locally.

`.bool_gset:N`  $\langle key \rangle$  .bool\_gset:N =  $\langle boolean \rangle$

Defines  $\langle key \rangle$  to set  $\langle boolean \rangle$  to  $\langle value \rangle$  (which must be either **true** or **false**). If the variable does not exist, it will be created at the point that the key is set up. The  $\langle boolean \rangle$  will be assigned globally.

`.bool_set_inverse:N`  $\langle key \rangle$  .bool\_set\_inverse:N =  $\langle boolean \rangle$

Defines  $\langle key \rangle$  to set  $\langle boolean \rangle$  to the logical inverse of  $\langle value \rangle$  (which must be either **true** or **false**). If the  $\langle boolean \rangle$  does not exist, it will be created at the point that the key is set up. The  $\langle boolean \rangle$  will be assigned locally.

**This property is experimental.**

`.bool_gset_inverse:N`  $\langle key \rangle$  .bool\_gset\_inverse:N =  $\langle boolean \rangle$

Defines  $\langle key \rangle$  to set  $\langle boolean \rangle$  to the logical inverse of  $\langle value \rangle$  (which must be either **true** or **false**). If the  $\langle boolean \rangle$  does not exist, it will be created at the point that the key is set up. The  $\langle boolean \rangle$  will be assigned globally.

**This property is experimental.**

`.choice:`  $\langle key \rangle$  .choice:

Sets  $\langle key \rangle$  to act as a choice key. Each valid choice for  $\langle key \rangle$  must then be created, as discussed in section 155.

`.choices:nn`  $\langle key \rangle$  .choices:nn  $\langle choices \rangle$   $\langle code \rangle$

Sets  $\langle key \rangle$  to act as a choice key, and defines a series  $\langle choices \rangle$  which are implemented using the  $\langle code \rangle$ . Inside  $\langle code \rangle$ , `\l_keys_choice_tl` will be the name of the choice made, and `\l_keys_choice_int` will be the position of the choice in the list of  $\langle choices \rangle$  (indexed from 0). Choices are discussed in detail in section 155.

**This property is experimental.**

`.choice_code:n`  
`.choice_code:x`  $\langle key \rangle$  .choice\_code:n =  $\langle code \rangle$

Stores  $\langle code \rangle$  for use when `.generate_choices:n` creates one or more choice sub-keys

of the current key. Inside  $\langle code \rangle$ ,  $\backslash l\_keys\_choice\_t1$  will expand to the name of the choice made, and  $\backslash l\_keys\_choice\_int$  will be the position of the choice in the list given to  $.generate\_choices:n$ . Choices are discussed in detail in section 155.

<code>.code:n</code>
<code>.code:x</code>

 $\langle key \rangle .code:n = \langle code \rangle$ 

Stores the  $\langle code \rangle$  for execution when  $\langle key \rangle$  is used. The  $\langle code \rangle$  can include one parameter (#1), which will be the  $\langle value \rangle$  given for the  $\langle key \rangle$ . The x-type variant will expand  $\langle code \rangle$  at the point where the  $\langle key \rangle$  is created.

<code>.default:n</code>
<code>.default:V</code>

 $\langle key \rangle .default:n = \langle default \rangle$ 

Creates a  $\langle default \rangle$  value for  $\langle key \rangle$ , which is used if no value is given. This will be used if only the key name is given, but not if a blank  $\langle value \rangle$  is given:

```
\keys_define:nn { module }
{
  key .code:n      = Hello~#1,
  key .default:n = World
}
\keys_set:nn { module }
{
  key = Fred, % Prints 'Hello Fred'
  key,      % Prints 'Hello World'
  key = ,    % Prints 'Hello '
}
```

<code>.dim_set:N</code>
<code>.dim_set:c</code>

 $\langle key \rangle .dim\_set:N = \langle dimension \rangle$ 

Defines  $\langle key \rangle$  to set  $\langle dimension \rangle$  to  $\langle value \rangle$  (which must a dimension expression). If the variable does not exist, it will be created at the point that the key is set up. The  $\langle dimension \rangle$  will be assigned locally.

<code>.dim_gset:N</code>
<code>.dim_gset:c</code>

 $\langle key \rangle .dim\_gset:N = \langle dimension \rangle$ 

Defines  $\langle key \rangle$  to set  $\langle dimension \rangle$  to  $\langle value \rangle$  (which must a dimension expression). If the variable does not exist, it will be created at the point that the key is set up. The  $\langle dimension \rangle$  will be assigned globally.

<code>.fp_set:N</code>
<code>.fp_set:c</code>

 $\langle key \rangle .fp\_set:N = \langle floating\ point \rangle$ 

Defines  $\langle key \rangle$  to set  $\langle floating\ point \rangle$  to  $\langle value \rangle$  (which must a floating point number). If

the variable does not exist, it will be created at the point that the key is set up. The  $\langle integer \rangle$  will be assigned locally.

```
.fp_gset:N
.fp_gset:c <key> .fp_gset:N = <floating point>
```

Defines  $\langle key \rangle$  to set  $\langle floating-point \rangle$  to  $\langle value \rangle$  (which must a floating point number). If the variable does not exist, it will be created at the point that the key is set up. The  $\langle integer \rangle$  will be assigned globally.

```
.generate_choices:n <key> .generate_choices:n = {\list}
```

This property will mark  $\langle key \rangle$  as a multiple choice key, and will use the  $\langle list \rangle$  to define the choices. The  $\langle list \rangle$  should consist of a comma-separated list of choice names. Each choice will be set up to execute  $\langle code \rangle$  as set using `.choice_code:n` (or `.choice_code:x`). Choices are discussed in detail in section 155.

```
.int_set:N
.int_set:c <key> .int_set:N = <integer>
```

Defines  $\langle key \rangle$  to set  $\langle integer \rangle$  to  $\langle value \rangle$  (which must be an integer expression). If the variable does not exist, it will be created at the point that the key is set up. The  $\langle integer \rangle$  will be assigned locally.

```
.int_gset:N
.int_gset:c <key> .int_gset:N = <integer>
```

Defines  $\langle key \rangle$  to set  $\langle integer \rangle$  to  $\langle value \rangle$  (which must be an integer expression). If the variable does not exist, it will be created at the point that the key is set up. The  $\langle integer \rangle$  will be assigned globally.

```
.meta:n
.meta:x <key> .meta:n = {\keyval list}
```

Makes  $\langle key \rangle$  a meta-key, which will set  $\langle keyval list \rangle$  in one go. If  $\langle key \rangle$  is given with a value at the time the key is used, then the value will be passed through to the subsidiary  $\langle keys \rangle$  for processing (as #1).

```
.multichoice: <key> .multichoice:
```

Sets  $\langle key \rangle$  to act as a multiple choice key. Each valid choice for  $\langle key \rangle$  must then be created, as discussed in section 155.

**This property is experimental.**

```
.multichoice:nn <key> .multichoice:nn <choices> <code>
```

Sets  $\langle key \rangle$  to act as a multiple choice key, and defines a series  $\langle choices \rangle$  which are implemented using the  $\langle code \rangle$ . Inside  $\langle code \rangle$ , `\l_keys_choice_tl` will be the name of the

choice made, and `\l_keys_choice_int` will be the position of the choice in the list of `<choices>` (indexed from 0). Choices are discussed in detail in section 155.

**This property is experimental.**

<code>.skip_set:N</code> <code>.skip_set:c</code>	<code>&lt;key&gt; .skip_set:N = &lt;skip&gt;</code>
------------------------------------------------------	-----------------------------------------------------

Defines `<key>` to set `<skip>` to `<value>` (which must be a skip expression). If the variable does not exist, it will be created at the point that the key is set up. The `<skip>` will be assigned locally.

<code>.skip_gset:N</code> <code>.skip_gset:c</code>	<code>&lt;key&gt; .skip_gset:N = &lt;skip&gt;</code>
--------------------------------------------------------	------------------------------------------------------

Defines `<key>` to set `<skip>` to `<value>` (which must be a skip expression). If the variable does not exist, it will be created at the point that the key is set up. The `<skip>` will be assigned globally.

<code>.tl_set:N</code> <code>.tl_set:c</code>	<code>&lt;key&gt; .tl_set:N = &lt;token list variable&gt;</code>
--------------------------------------------------	------------------------------------------------------------------

Defines `<key>` to set `<token list variable>` to `<value>`. If the variable does not exist, it will be created at the point that the key is set up. The `<token list variable>` will be assigned locally.

<code>.tl_gset:N</code> <code>.tl_gset:c</code>	<code>&lt;key&gt; .tl_gset:N = &lt;token list variable&gt;</code>
----------------------------------------------------	-------------------------------------------------------------------

Defines `<key>` to set `<token list variable>` to `<value>`. If the variable does not exist, it will be created at the point that the key is set up. The `<token list variable>` will be assigned globally.

<code>.tl_set_x:N</code> <code>.tl_set_x:c</code>	<code>&lt;key&gt; .tl_set_x:N = &lt;token list variable&gt;</code>
------------------------------------------------------	--------------------------------------------------------------------

Defines `<key>` to set `<token list variable>` to `<value>`, which will be subjected to an x-type expansion (*i.e.* using `\tl_set:Nx`). If the variable does not exist, it will be created at the point that the key is set up. The `<token list variable>` will be assigned locally.

<code>.tl_gset_x:N</code> <code>.tl_gset_x:c</code>	<code>&lt;key&gt; .tl_gset_x:N = &lt;token list variable&gt;</code>
--------------------------------------------------------	---------------------------------------------------------------------

Defines `<key>` to set `<token list variable>` to `<value>`, which will be subjected to an x-type

expansion (*i.e.* using `\tl_set:Nx`). If the variable does not exist, it will be created at the point that the key is set up. The *token list variable* will be assigned globally.

`.value_forbidden:`  $\langle key \rangle$  `.value_forbidden:`

Specifies that  $\langle key \rangle$  cannot receive a  $\langle value \rangle$  when used. If a  $\langle value \rangle$  is given then an error will be issued.

`.value_required:`  $\langle key \rangle$  `.value_required:`

Specifies that  $\langle key \rangle$  must receive a  $\langle value \rangle$  when used. If a  $\langle value \rangle$  is not given then an error will be issued.

## 154 Sub-dividing keys

When creating large numbers of keys, it may be desirable to divide them into several sub-groups for a given module. This can be achieved either by adding a sub-division to the module name:

```
\keys_define:nn { module / subgroup }
{ key .code:n = code }
```

or to the key name:

```
\keys_define:nn { module }
{ subgroup / key .code:n = code }
```

As illustrated, the best choice of token for sub-dividing keys in this way is `/`. This is because of the method that is used to represent keys internally. Both of the above code fragments set the same key, which has full name `module/subgroup/key`.

As will be illustrated in the next section, this subdivision is particularly relevant to making multiple choices.

## 155 Choice and multiple choice keys

The `l3keys` system supports two types of choice key, in which a series of pre-defined input values are linked to varying implementations. Choice keys are usually created so that the various values are mutually-exclusive: only one can apply at any one time. “Multiple” choice keys are also supported: these allow a selection of values to be chosen at the same time.

Mutually-exclusive choices are created by setting the `.choice:` property:

```
\keys_define:nn { module }
{ key .choice: }
```

For keys which are set up as choices, the valid choices are generated by creating sub-keys of the choice key. This can be carried out in two ways.

In many cases, choices execute similar code which is dependant only on the name of the choice or the position of the choice in the list of choices. Here, the keys can share the same code, and can be rapidly created using the `.choice_code:n` and `.generate_choices:n` properties:

```
\keys_define:nn { module }
{
  key .choice_code:n =
  {
    You~gave~choice~'\int_use:N \l_keys_choice_tl',~
    which~is~in~position~
    \int_use:N \l_keys_choice_int \c_space_tl
    in~the~list.
  },
  key .generate_choices:n =
  { choice-a, choice-b, choice-c }
}
```

Following common computing practice, `\l_keys_choice_int` is indexed from 0 (as an offset), so that the value of `\l_keys_choice_int` for the first choice in a list will be zero.

The same approach is also implemented by the *experimental* property `.choices:nn`. This combines the functionality of `.choice_code:n` and `.generate_choices:n` into one property:

```
\keys_define:nn { module }
{
  key .choices:nn =
  { choice-a, choice-b, choice-c }
  {
    You~gave~choice~'\int_use:N \l_keys_choice_tl',~
    which~is~in~position~
    \int_use:N \l_keys_choice_int \c_space_tl
    in~the~list.
  }
}
```



Note that the `.choices:nn` property should *not* be mixed with use of `.generate_choices:n`.

<code>\l_keys_choice_int</code> <code>\l_keys_choice_tl</code>
-------------------------------------------------------------------

Inside the code block for a choice generated using `.generate_choice:` or `.choices:nn`, the variables `\l_keys_choice_tl` and `\l_keys_choice_int` are available to indicate the name of the current choice, and its position in the comma list. The position is indexed from 0.

On the other hand, it is sometimes useful to create choices which use entirely different code from one another. This can be achieved by setting the `.choice:` property of a key, then manually defining sub-keys.

```
\keys_define:nn { module }
{
  key .choice:,
  key / choice-a .code:n = code-a,
  key / choice-b .code:n = code-b,
  key / choice-c .code:n = code-c,
}
```

It is possible to mix the two methods, but manually-created choices should *not* use `\l_keys_choice_tl` or `\l_keys_choice_int`. These variables do not have defined behaviour when used outside of code created using `.generate_choices:n` (*i.e.* anything might happen).

Multiple choices are created in a very similar manner to mutually-exclusive choices, using the properties `.multichoice:` and `.multichoices:nn`. As with mutually exclusive choices, multiple choices are define as sub-keys. Thus both

```
\keys_define:nn { module }
{
  key .multichoices:nn =
    { choice-a, choice-b, choice-c }
    {
      You~gave~choice~'\int_use:N \l_keys_choice_tl',~
      which~is~in~position~
      \int_use:N \l_keys_choice_int \c_space_tl
      in~the~list.
    }
}
```

and

```
\keys_define:nn { module }
{
```

```

    key .multichoice:,
    key / choice-a .code:n = code-a,
    key / choice-b .code:n = code-b,
    key / choice-c .code:n = code-c,
}

```

are valid. The `.multichoices:nn` property causes `\l_keys_choice_tl` and `\l_keys_choice_int` to be set in exactly the same way as described for `.choices:nn`.

When multiple choice keys are set, the value is treated as a comma-separated list:

```

\keys_set:nn { module }
{
    key = { a , b , c } % 'key' defined as a multiple choice
}

```

Each choice will be applied in turn, with the usual handling of unknown values.

## 156 Setting keys

<pre> \keys_set:nn \keys_set:nV \keys_set:nv \keys_set:no </pre>	<pre> \keys_set:nn {&lt;module&gt;} {&lt;keyval list&gt;} </pre>
------------------------------------------------------------------	------------------------------------------------------------------

Parses the `<keyval list>`, and sets those keys which are defined for `<module>`. The behaviour on finding an unknown key can be set by defining a special **unknown** key: this will be illustrated later.

If a key is not known, `\keys_set:nn` will look for a special **unknown** key for the same module. This mechanism can be used to create new keys from user input.

```

\keys_define:nn { module }
{
    unknown .code:n =
        You~tried~to~set~key~'\l_keys_key_tl'~to~'#1'.
}

```

<code>\l_keys_key_tl</code>	When processing an unknown key, the name of the key is available as <code>\l_keys_key_tl</code> . Note that this will have been processed using <code>\tl_to_str:n</code> .
-----------------------------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------

<code>\l_keys_path_tl</code>	When processing an unknown key, the path of the key used is available as <code>\l_keys_path_tl</code> . Note that this will have been processed using <code>\tl_to_str:n</code> .
------------------------------	-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

<code>\l_keys_value_tl</code>	When processing an unknown key, the value of the key is available as <code>\l_keys_value_tl</code> . Note that this will be empty if no value was given for the key.
-------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------------------------

## 157 Setting known keys only

The functionality described in this section is experimental and may be altered or removed, depending on feedback.

<code>\keys_set_known:nnN</code>
<code>\keys_set_known:nVN</code>
<code>\keys_set_known:nvN</code>
<code>\keys_set_known:noN</code>

`\keys_set_known:nn {<module>} {<keyval list>} <clist>`  
 Parses the *<keyval list>*, and sets those keys which are defined for *<module>*. Any keys which are unknown are not processed further by the parser. The key–value pairs for each *unknown* key name will be stored in the *<clist>*.

## 158 Utility functions for keys

<code>\keys_if_exist_p:nn</code>	★
<code>\keys_if_exist:nnTF</code>	★

`\keys_if_exist_p:nn <module> <key>`  
`\keys_if_exist:nnTF <module> <key>`  
`{<true code>} {<false code>}`

Tests if the *<key>* exists for *<module>*, *i.e.* if any code has been defined for *<key>*.

<code>\keys_if_choice_exist_p:nn</code>	★
<code>\keys_if_choice_exist:nnTF</code>	★

`\keys_if_exist_p:nnn <module> <key> <choice>`  
`\keys_if_exist:nnnTF <module> <key> <choice>`  
`{<true code>} {<false code>}`

Tests if the *<choice>* is defined for the *<key>* within the *<module>*, *i.e.* if any code has been defined for *<key>/<choice>*. The test is **false** if the *<key>* itself is not defined.

<code>\keys_show:nn</code>
----------------------------

`\keys_show:nn {<module>} {<key>}`

Shows the function which is used to actually implement a *<key>* for a *<module>*.

## 159 Low-level interface for parsing key–val lists

To re-cap from earlier, a key–value list is input of the form

```
KeyOne = ValueOne ,
KeyTwo = ValueTwo ,
KeyThree
```

where each key–value pair is separated by a comma from the rest of the list, and each key–value pair does not necessarily contain an equals sign or a value! Processing this type of input correctly requires a number of careful steps, to correctly account for braces, spaces and the category codes of separators.

While the functions described earlier are used as a high-level interface for processing such input, in especial circumstances you may wish to use a lower-level approach. The low-level parsing system converts a *⟨key–value list⟩* into *⟨keys⟩* and associated *⟨values⟩*. After the parsing phase is completed, the resulting keys and values (or keys alone) are available for further processing. This processing is not carried out by the low-level parser itself, and so the parser requires the names of two functions along with the key–value list. One function is needed to process key–value pairs (*i.e.* two arguments), and a second function if required for keys given without arguments (*i.e.* a single argument).

The parser does not double # tokens or expand any input. The tokens = and , are corrected so that the parser does not “miss” any due to category code changes. Spaces are removed from the ends of the keys and values. Values which are given in braces will have exactly one set removed, thus

```
key = {value here},
```

and

```
key = value here,
```

are treated identically.

\keyval_parse:NNn	\keyval_parse:NNn <function1> <function2> {<key–value list>}
-------------------	-----------------------------------------------------------------

Parses the *⟨key–value list⟩* into a series of *⟨keys⟩* and associated *⟨values⟩*, or keys alone (if no *⟨value⟩* was given). *⟨function1⟩* should take one argument, while *⟨function2⟩* should absorb two arguments. After \keyval\_parse:NNn has parsed the *⟨key–value list⟩*, *⟨function1⟩* will be used to process keys given with no value and *⟨function2⟩* will be used to process keys given with a value. The order of the *⟨keys⟩* in the *⟨key–value list⟩* will be preserved. Thus

```
\keyval_parse:NNn \function:n \function:nn
{ key1 = value1 , key2 = value2, key3 = , key4 }
```

will be converted into an input stream

```
\function:nn { key1 } { value1 }
\function:nn { key2 } { value2 }
\function:nn { key3 } { }
\function:n { key4 }
```

Note that there is a difference between an empty value (an equals sign followed by nothing) and a missing value (no equals sign at all).

## Part XXI

# The l3file package

## File operations

In contrast to the l3io module, which deals with the lowest level of file management, the l3file module provides a higher level interface for handling file contents. This involves providing convenient wrappers around many of the functions in l3io to make them more generally accessible.

It is important to remember that T<sub>E</sub>X will attempt to locate files using both the operating system path and entries in the T<sub>E</sub>X file database (most T<sub>E</sub>X systems use such a database). Thus the “current path” for T<sub>E</sub>X is somewhat broader than that for other programs.

## 160 File operation functions

`\g_file_current_name_tl` Contains the name of the current L<sup>A</sup>T<sub>E</sub>X file. This variable should not be modified: it is intended for information only. It will be equal to `\c_job_name_tl` at the start of a L<sup>A</sup>T<sub>E</sub>X run and will be modified each time a file is read using `\file_input:n`.

`\file_if_exist:nTF` `\file_if_exist:nTF {<file name>} {<true code>} {<false code>}`  
 Searches for `<file name>` using the current T<sub>E</sub>X search path and the additional paths controlled by `\file_path_include:n`.

**T<sub>E</sub>Xhackers note:** The `<file name>` may contain both literal items and expandable content, which should on full expansion be the desired file name. The expansion occurs when T<sub>E</sub>X searches for the file.

`\file_add_path:nN` `\file_add_path:nN {<file name>} <tl var>`  
 Searches for `<file name>` in the path as detailed for `\file_if_exist:nTF`, and if found sets the `<tl var>` the fully-qualified name of the file, *i.e.* the path and file name. If the file is not found then the `<tl var>` will be empty.

**T<sub>E</sub>Xhackers note:** The  $\langle file\ name \rangle$  may contain both literal items and expandable content, which should on full expansion be the desired file name. The expansion occurs when T<sub>E</sub>X searches for the file.

`\file_input:n` `\file_input:n { $\langle file\ name \rangle$ }`

Searches for  $\langle file\ name \rangle$  in the path as detailed for `\file_if_exist:nTF`, and if found reads in the file as additional L<sup>A</sup>T<sub>E</sub>X source. All files read are recorded for information and the file name stack is updated by this function.

**T<sub>E</sub>Xhackers note:** The  $\langle file\ name \rangle$  may contain both literal items and expandable content, which should on full expansion be the desired file name. The expansion occurs when T<sub>E</sub>X searches for the file.

`\file_path_include:n` `\file_path_include:n { $\langle path \rangle$ }`

Adds  $\langle path \rangle$  to the list of those used to search for files by the `\file_input:n` and `\file_if_exist:n` function. The assignment is local.

`\file_path_remove:n` `\file_path_remove:n { $\langle path \rangle$ }`

Removes  $\langle path \rangle$  from the list of those used to search for files by the `\file_input:n` and `\file_if_exist:n` function. The assignment is local.

`\file_list:` `\file_list:`

This function will list all files loaded using `\file_input:n` in the log file.

## 161 Internal file functions

`\g_file_stack_seq` Stores the stack of nested files loaded using `\file_input:n`. This is needed to restore the appropriate file name to `\g_file_current_name_tl` at the end of each file.

`\g_file_record_seq` Stores the name of every file loaded using `\file_input:n`. In contrast to `\g_file_stack_seq`, no items are ever removed from this sequence.

`\l_file_name_tl` Used to return the full name of a file for internal use.

`\l_file_search_path_seq` The sequence of file paths to search when loading a file.

`\l_file_search_path_saved_seq` When loaded on top of L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub>, there is a need to save the search path so that `\input@path` can be used as appropriate.

## Part XXII

# The l3fp package

## Floating-point operations

A floating point number is one which is stored as a mantissa and a separate exponent. This module implements arithmetic using radix 10 floating point numbers. This means that the mantissa should be a real number in the range  $1 \leq |x| < 10$ , with the exponent given as an integer between  $-99$  and  $99$ . In the input, the exponent part is represented starting with an `e`. As this is a low-level module, error-checking is minimal. Numbers which are too large for the floating point unit to handle will result in errors, either from `TEX` or from `LATEX`. The `LATEX` code does not check that the input will not overflow, hence the possibility of a `TEX` error. On the other hand, numbers which are too small will be dropped, which will mean that extra decimal digits will simply be lost.

When parsing numbers, any missing parts will be interpreted as zero. So for example

```
\fp_set:Nn \l_my_fp { }  
\fp_set:Nn \l_my_fp { . }  
\fp_set:Nn \l_my_fp { - }
```

will all be interpreted as zero values without raising an error.

Operations which give an undefined result (such as division by 0) will not lead to errors. Instead special marker values are returned, which can be tested for using for example `\fp_if_undefined:N(TF)`. In this way it is possible to work with asymptotic functions without first checking the input. If these special values are carried forward in calculations they will be treated as 0.

Floating point numbers are stored in the `fp` floating point variable type. This has a standard range of functions for variable management.

## 162 Floating-point variables

<code>\fp_new:N</code>
<code>\fp_new:c</code>

`\fp_new:N <floating point variable>`

Creates a new *<floating point variable>* or raises an error if the name is already taken. The declaration global. The *<floating point>* will initially be set to `+0.000000000e0` (the zero floating point).

<code>\fp_const:Nn</code>
<code>\fp_const:cn</code>

`\fp_const:Nn <floating point variable> {<value>}`

Creates a new constant *⟨floating point variable⟩* or raises an error if the name is already taken. The value of the *⟨floating point variable⟩* will be set globally to the *⟨value⟩*.

<code>\fp_set_eq:NN</code>
<code>\fp_set_eq:cN</code>
<code>\fp_set_eq:Nc</code>
<code>\fp_set_eq:cc</code>

`\fp_set_eq:NN <fp var1> <fp var2>`

Sets the value of *⟨floating point variable1⟩* equal to that of *⟨floating point variable2⟩*. This assignment is restricted to the current T<sub>E</sub>X group level.

<code>\fp_gset_eq:NN</code>
<code>\fp_gset_eq:cN</code>
<code>\fp_gset_eq:Nc</code>
<code>\fp_gset_eq:cc</code>

`\fp_gset_eq:NN <fp var1> <fp var2>`

Sets the value of *⟨floating point variable1⟩* equal to that of *⟨floating point variable2⟩*. This assignment is global and so is not limited by the current T<sub>E</sub>X group level.

<code>\fp_zero:N</code>
<code>\fp_zero:c</code>

`\fp_zero:N <floating point variable>`

Sets the *⟨floating point variable⟩* to +0.000000000e0 within the current scope.

<code>\fp_gzero:N</code>
<code>\fp_gzero:c</code>

`\fp_gzero:N <floating point variable>`

Sets the *⟨floating point variable⟩* to +0.000000000e0 globally.

<code>\fp_set:Nn</code>
<code>\fp_set:cn</code>

`\fp_set:Nn <floating point variable> {<value>}`

Sets the *⟨floating point variable⟩* variable to *⟨value⟩* within the scope of the current T<sub>E</sub>X group.

<code>\fp_gset:Nn</code>
<code>\fp_gset:cn</code>

`\fp_gset:Nn <floating point variable> {<value>}`

Sets the *⟨floating point variable⟩* variable to *⟨value⟩* globally.

<code>\fp_set_from_dim:Nn</code>
<code>\fp_set_from_dim:cn</code>

`\fp_set_from_dim:Nn <floating point variable> {<dimexpr>}`

Sets the *⟨floating point variable⟩* to the distance represented by the *⟨dimension expression⟩*



in the units points. This means that distances given in other units are first converted to points before being assigned to the *floating point variable*. The assignment is local.

<code>\fp_gset_from_dim:Nn</code> <code>\fp_gset_from_dim:cn</code>	<code>\fp_gset_from_dim:Nn</code> <i>floating point variable</i> <code>{dimexpr}</code>
------------------------------------------------------------------------	--------------------------------------------------------------------------------------------

Sets the *floating point variable* to the distance represented by the *dimension expression* in the units points. This means that distances given in other units are first converted to points before being assigned to the *floating point variable*. The assignment is global.

<code>\fp_use:N</code> ★ <code>\fp_use:c</code> ★	<code>\fp_use:N</code> <i>floating point variable</i>
------------------------------------------------------	-------------------------------------------------------

Inserts the value of the *floating point variable* into the input stream. The value will be given as a real number without any exponent part, and will always include a decimal point. For example,

```
\fp_new:Nn \test
\fp_set:Nn \test { 1.234 e 5 }
\fp_use:N \test
```

will insert 12345.00000 into the input stream. As illustrated, a floating point will always be inserted with ten significant digits given. Very large and very small values will include additional zeros for place value.

<code>\fp_show:N</code> <code>\fp_show:c</code>	<code>\fp_show:N</code> <i>floating point variable</i>
----------------------------------------------------	--------------------------------------------------------

Displays the content of the *floating point variable* on the terminal.

## 163 Conversion of floating point values to other formats

It is useful to be able to convert floating point variables to other forms. These functions are expandable, so that the material can be used in a variety of contexts. The `\fp_use:N` function should also be consulted in this context, as it will insert the value of the floating point variable as a real number.

<code>\fp_to_dim:N</code> ★ <code>\fp_to_dim:c</code> ★	<code>\fp_to_dim:N</code> <i>floating point variable</i>
------------------------------------------------------------	----------------------------------------------------------

Inserts the value of the *floating point variable* into the input stream converted into a

dimension in points.

<code>\fp_to_int:N</code>	★
<code>\fp_to_int:c</code>	★

`\fp_to_int:N` *<floating point variable>*

Inserts the integer value of the *<floating point variable>* into the input stream. The decimal part of the number will not be included, but will be used to round the integer.

<code>\fp_to_tl:N</code>	★
<code>\fp_to_tl:c</code>	★

`\fp_to_tl:N` *<floating point variable>*

Inserts a representation of the *<floating point variable>* into the input stream as a token list. The representation follows the conventions of a pocket calculator:

Floating point value	Representation
1.234000000000e0	1.234
-1.234000000000e0	-1.234
1.234000000000e3	1234
1.234000000000e13	1234e13
1.234000000000e-1	0.1234
1.234000000000e-2	0.01234
1.234000000000e-3	1.234e-3

Notice that trailing zeros are removed in this process, and that numbers which do not require a decimal part do *not* include a decimal marker.

## 164 Rounding floating point values

The module can round floating point values to either decimal places or significant figures using the usual method in which exact halves are rounded up.

<code>\fp_round_figures:Nn</code>	<code>\fp_round_figures:Nn</code> <i>&lt;floating point variable&gt;</i> <i>{&lt;target&gt;}</i>
<code>\fp_round_figures:cn</code>	

Rounds the *<floating point variable>* to the *<target>* number of significant figures (an integer expression). The rounding is carried out locally.

<code>\fp_ground_figures:Nn</code>	<code>\fp_ground_figures:Nn</code> <i>&lt;floating point variable&gt;</i> <i>{&lt;target&gt;}</i>
<code>\fp_ground_figures:cn</code>	

Rounds the  $\langle floating\ point\ variable \rangle$  to the  $\langle target \rangle$  number of significant figures (an integer expression). The rounding is carried out globally.

$\backslash\text{fp\_round\_places:Nn}$ $\backslash\text{fp\_round\_places:cn}$	$\backslash\text{fp\_round\_places:Nn}$ $\langle floating\ point\ variable \rangle$ $\{\langle target \rangle\}$
------------------------------------------------------------------------------------	------------------------------------------------------------------------------------------------------------------

Rounds the  $\langle floating\ point\ variable \rangle$  to the  $\langle target \rangle$  number of decimal places (an integer expression). The rounding is carried out locally.

$\backslash\text{fp\_ground\_places:Nn}$ $\backslash\text{fp\_ground\_places:cn}$	$\backslash\text{fp\_ground\_places:Nn}$ $\langle floating\ point\ variable \rangle$ $\{\langle target \rangle\}$
--------------------------------------------------------------------------------------	-------------------------------------------------------------------------------------------------------------------

Rounds the  $\langle floating\ point\ variable \rangle$  to the  $\langle target \rangle$  number of decimal places (an integer expression). The rounding is carried out globally.

## 165 Floating-point conditionals

$\backslash\text{fp\_if\_undefined\_p:N}$ ★ $\backslash\text{fp\_if\_undefined:N\textit{TF}}$ ★	$\backslash\text{fp\_if\_undefined\_p:N}$ $\langle fixed\text{-}point \rangle$ $\backslash\text{fp\_if\_undefined:N\textit{TF}}$ $\langle fixed\text{-}point \rangle$ $\{\langle true\ code \rangle\} \{\langle false\ code \rangle\}$
----------------------------------------------------------------------------------------------------	----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Tests if  $\langle floating\ point \rangle$  is undefined (*i.e.* equal to the special  $\backslash\text{c\_undefined\_fp}$  variable).

$\backslash\text{fp\_if\_zero:N}$ ★	$\backslash\text{fp\_if\_zero\_p:N}$ $\langle fixed\text{-}point \rangle$ $\backslash\text{fp\_if\_zero:N\textit{TF}}$ $\langle fixed\text{-}point \rangle$ $\{\langle true\ code \rangle\} \{\langle false\ code \rangle\}$
-------------------------------------	---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

Tests if  $\langle floating\ point \rangle$  is equal to zero (*i.e.* equal to the special  $\backslash\text{c\_zero\_fp}$  variable).

$\backslash\text{fp\_compare:nNn\textit{TF}}$	$\backslash\text{fp\_compare:nNn\textit{TF}}$ $\{\langle floating\ point_1 \rangle\}$ $\langle relation \rangle$ $\{\langle floating\ point_2 \rangle\}$ $\{\langle true\ code \rangle\} \{\langle false\ code \rangle\}$
-----------------------------------------------	------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------

This function compared the two  $\langle floating\ point \rangle$  values, which may be stored as **fp** variables, using the  $\langle relation \rangle$ :

Equal	=
Greater than	>
Less than	<

The tests treat undefined floating points as zero as the comparison is intended for real numbers only.

```

\fp_compare:nTF
{ \fp_compare:nTF { \floating point1 \relation \floating point2 }
  { \true code } { \false code } }

```

This function compared the two *\floating point* values, which may be stored as **fp** variables, using the *\relation*:

Equal	= or ==
Greater than	>
Greater than or equal	>=
Less than	<
Less than or equal	<=
Not equal	!=

The tests treat undefined floating points as zero as the comparison is intended for real numbers only.

## 166 Unary floating-point operations

The unary operations alter the value stored within an **fp** variable.

```

\fp_abs:N
\fp_abs:c \fp_abs:N \floating point variable

```

Converts the *\floating point variable* to its absolute value, assigning the result within the current **TeX** group.

```

\fp_gabs:N
\fp_gabs:c \fp_gabs:N \floating point variable

```

Converts the *\floating point variable* to its absolute value, assigning the result globally.

```

\fp_neg:N
\fp_neg:c \fp_neg:N \floating point variable

```

Reverse the sign of the *\floating point variable*, assigning the result within the current **TeX** group.

```

\fp_gneg:N
\fp_gneg:c \fp_gneg:N \floating point variable

```

Reverse the sign of the *\floating point variable*, assigning the result globally.

## 167 Floating-point arithmetic

Binary arithmetic operations act on the value stored in an `fp`, so for example

```
\fp_set:Nn \l_my_fp { 1.234 }  
\fp_sub:Nn \l_my_fp { 5.678 }
```

sets `\l_my_fp` to the result of  $1.234 - 5.678$  (*i.e.*  $-4.444$ ).

<code>\fp_add:Nn</code>
<code>\fp_add:cn</code>

`\fp_add:Nn <floating point> {<value>}`

Adds the *<value>* to the *<floating point>*, making the assignment within the current `TeX` group level.

<code>\fp_gadd:Nn</code>
<code>\fp_gadd:cn</code>

`\fp_gadd:Nn <floating point> {<value>}`

Adds the *<value>* to the *<floating point>*, making the assignment globally.

<code>\fp_sub:Nn</code>
<code>\fp_sub:cn</code>

`\fp_sub:Nn <floating point> {<value>}`

Subtracts the *<value>* from the *<floating point>*, making the assignment within the current `TeX` group level.

<code>\fp_gsub:Nn</code>
<code>\fp_gsub:cn</code>

`\fp_gsub:Nn <floating point> {<value>}`

Subtracts the *<value>* from the *<floating point>*, making the assignment globally.

<code>\fp_mul:Nn</code>
<code>\fp_mul:cn</code>

`\fp_mul:Nn <floating point> {<value>}`

Multiplies the *<floating point>* by the *<value>*, making the assignment within the current `TeX` group level.

<code>\fp_gmul:Nn</code>
<code>\fp_gmul:cn</code>

`\fp_gmul:Nn <floating point> {<value>}`

Multiplies the *<floating point>* by the *<value>*, making the assignment globally.

<code>\fp_div:Nn</code>
<code>\fp_div:cn</code>

`\fp_div:Nn <floating point> {<value>}`

Divides the *<floating point>* by the *<value>*, making the assignment within the current `TeX`

group level. If the  $\langle value \rangle$  is zero, the  $\langle floating point \rangle$  will be set to `\c_undefined_fp`. The assignment is local.

<code>\fp_gdiv:Nn</code>
<code>\fp_gdiv:cn</code>

`\fp_gdiv:Nn  $\langle floating point \rangle$  { $\langle value \rangle$ }`

Divides the  $\langle floating point \rangle$  by the  $\langle value \rangle$ , making the assignment globally. If the  $\langle value \rangle$  is zero, the  $\langle floating point \rangle$  will be set to `\c_undefined_fp`. The assignment is global.

## 168 Floating-point power operations

<code>\fp_pow:Nn</code>
<code>\fp_pow:cn</code>

`\fp_pow:Nn  $\langle floating point \rangle$  { $\langle value \rangle$ }`

Raises the  $\langle floating point \rangle$  to the given  $\langle value \rangle$ . If the  $\langle floating point \rangle$  is negative, then the  $\langle value \rangle$  should be either a positive real number or a negative integer. If the  $\langle floating point \rangle$  is positive, then the  $\langle value \rangle$  may be any real value. Mathematically invalid operations such as  $0^0$  will give set the  $\langle floating point \rangle$  to `\c_undefined_fp`. The assignment is local.

<code>\fp_gpow:Nn</code>
<code>\fp_gpow:cn</code>

`\fp_gpow:Nn  $\langle floating point \rangle$  { $\langle value \rangle$ }`

Raises the  $\langle floating point \rangle$  to the given  $\langle value \rangle$ . If the  $\langle floating point \rangle$  is negative, then the  $\langle value \rangle$  should be either a positive real number or a negative integer. If the  $\langle floating point \rangle$  is positive, then the  $\langle value \rangle$  may be any real value. Mathematically invalid operations such as  $0^0$  will give set the  $\langle floating point \rangle$  to `\c_undefined_fp`. The assignment is global.

## 169 Exponential and logarithm functions

<code>\fp_exp:Nn</code>
<code>\fp_exp:cn</code>

`\fp_exp:Nn  $\langle floating point \rangle$  { $\langle value \rangle$ }`

Calculates the exponential of the  $\langle value \rangle$  and assigns this to the  $\langle floating point \rangle$ . The assignment is local.

<code>\fp_gexp:Nn</code>
<code>\fp_gexp:cn</code>

`\fp_gexp:Nn  $\langle floating point \rangle$  { $\langle value \rangle$ }`

Calculates the exponential of the  $\langle value \rangle$  and assigns this to the  $\langle floating point \rangle$ . The

assignment is global.

<code>\fp_ln:Nn</code>
<code>\fp_ln:cn</code>

`\fp_ln:Nn` *<floating point>* {*<value>*}

Calculates the natural logarithm of the *<value>* and assigns this to the *<floating point>*. The assignment is local.

<code>\fp_gln:Nn</code>
<code>\fp_gln:cn</code>

`\fp_gln:Nn` *<floating point>* {*<value>*}

Calculates the natural logarithm of the *<value>* and assigns this to the *<floating point>*. The assignment is global.

## 170 Trigonometric functions

The trigonometric functions all work in radians. They accept a maximum input value of 100 000 000, as there are issues with range reduction and very large input values.

<code>\fp_sin:Nn</code>
<code>\fp_sin:cn</code>

`\fp_sin:Nn` *<floating point>* {*<value>*}

Assigns the sine of the *<value>* to the *<floating point>*. The *<value>* should be given in radians. The assignment is local.

<code>\fp_gsin:Nn</code>
<code>\fp_gsin:cn</code>

`\fp_gsin:Nn` *<floating point>* {*<value>*}

Assigns the sine of the *<value>* to the *<floating point>*. The *<value>* should be given in radians. The assignment is global.

<code>\fp_cos:Nn</code>
<code>\fp_cos:cn</code>

`\fp_cos:Nn` *<floating point>* {*<value>*}

Assigns the cosine of the *<value>* to the *<floating point>*. The *<value>* should be given in radians. The assignment is local.

<code>\fp_gcos:Nn</code>
<code>\fp_gcos:cn</code>

`\fp_gcos:Nn` *<floating point>* {*<value>*}

Assigns the cosine of the *<value>* to the *<floating point>*. The *<value>* should be given in radians. The assignment is global.

<code>\fp_tan:Nn</code>
<code>\fp_tan:cn</code>

`\fp_tan:Nn` *<floating point>* {*<value>*}

Assigns the tangent of the *<value>* to the *<floating point>*. The *<value>* should be given in

radians. The assignment is local.

<code>\fp_gtan:Nn</code>
<code>\fp_gtan:cn</code>

`\fp_gtan:Nn <floating point> {<value>}`

Assigns the tangent of the  $\langle value \rangle$  to the  $\langle floating point \rangle$ . The  $\langle value \rangle$  should be given in radians. The assignment is global.

## 171 Constant floating point values

<code>\c_e_fp</code>
----------------------

 The value of the base of natural numbers,  $e$ .

<code>\c_one_fp</code>
------------------------

 A floating point variable with permanent value 1: used for speeding up some comparisons.

<code>\c_pi_fp</code>
-----------------------

 The value of  $\pi$ .

<code>\c_undefined_fp</code>
------------------------------

 A special marker floating point variable representing the result of an operation which does not give a defined result (such as division by 0).

<code>\c_zero_fp</code>
-------------------------

 A permanently zero floating point variable.

## 172 Notes on the floating point unit

As calculation of the elemental transcendental functions is computationally expensive compared to storage of results, after calculating a trigonometric function, exponent, *etc.* the module stored the result for reuse. Thus the performance of the module for repeated operations, most probably trigonometric functions, should be much higher than if the values were re-calculated every time they were needed.

Anyone with experience of programming floating point calculations will know that this is a complex area. The aim of the unit is to be accurate enough for the likely applications in a typesetting context. The arithmetic operations are therefore intended to provide ten digit accuracy with the last digit accurate to  $\pm 1$ . The elemental transcendental functions may not provide such high accuracy in every case, although the design aim has been to provide 10 digit accuracy for cases likely to be relevant in typesetting situations. A good overview of the challenges in this area can be found in J.-M. Muller, *Elementary functions: algorithms and implementation*, 2nd edition, Birkhäuser Boston, New York, USA, 2006.



The internal representation of numbers is tuned to the needs of the underlying  $\text{\TeX}$  system. This means that the format is somewhat different from that used in, for example, computer floating point units. Programming in  $\text{\TeX}$  makes it most convenient to use a radix 10 system, using  $\text{\TeX}$  `count` registers for storage and taking advantage where possible of delimited arguments.

## Part XXIII

# The `l3luatex` package

## Lua $\text{\TeX}$ -specific functions

### 173 Breaking out to Lua

The Lua $\text{\TeX}$  engine provides access to the Lua programming language, and with it access to the “internals” of  $\text{\TeX}$ . In order to use this within the framework provided here, a family of functions is available. When used with pdf $\text{\TeX}$  or X $\text{\TeX}$  these will raise an error: use `\luatex_if_engine:T` to avoid this. Details of coding the Lua $\text{\TeX}$  engine are detailed in the Lua $\text{\TeX}$  manual.

<code>\lua_now:n</code> ★	<code>\lua_now:n {⟨token list⟩}</code>
<code>\lua_now:x</code> ★	

The `⟨token list⟩` is first tokenized by  $\text{\TeX}$ , which will include converting line ends to spaces in the usual  $\text{\TeX}$  manner and which respects currently-applicable  $\text{\TeX}$  category codes. The resulting `⟨Lua input⟩` is passed to the Lua interpreter for processing. Each `\lua_now:n` block is treated by Lua as a separate chunk. The Lua interpreter will execute the `⟨Lua input⟩` immediately, and in an expandable manner.

**$\text{\TeX}$ hackers note:** `\lua_now:x` is the Lua $\text{\TeX}$  primitive `\directlua` renamed.

<code>\lua_shipout:n</code>	<code>\lua_shipout:x {⟨token list⟩}</code>
<code>\lua_shipout:x</code>	

The `⟨token list⟩` is first tokenized by  $\text{\TeX}$ , which will include converting line ends to spaces in the usual  $\text{\TeX}$  manner and which respects currently-applicable  $\text{\TeX}$  category codes. The resulting `⟨Lua input⟩` is passed to the Lua interpreter when the current page is finalised (*i.e.* at shipout). Each `\lua_shipout:n` block is treated by Lua as a separate chunk. The Lua interpreter will execute the `⟨Lua input⟩` during the page-building routine: no  $\text{\TeX}$  expansion of the `⟨Lua input⟩` will occur at this stage.

**$\text{\TeX}$ hackers note:** At a  $\text{\TeX}$  level, the `⟨Lua input⟩` is stored as a “whatsit”.

<code>\lua_shipout_x:n</code>	<code>\lua_shipout:n {⟨token list⟩}</code>
<code>\lua_shipout_x:x</code>	

The *⟨token list⟩* is first tokenized by T<sub>E</sub>X, which will include converting line ends to spaces in the usual T<sub>E</sub>X manner and which respects currently-applicable T<sub>E</sub>X category codes. The resulting *⟨Lua input⟩* is passed to the Lua interpreter when the current page is finalised (*i.e.* at shipout). Each `\lua_shipout:n` block is treated by Lua as a separate chunk. The Lua interpreter will execute the *⟨Lua input⟩* during the page-building routine: the *⟨Lua input⟩* is expanded during this process in addition to any expansion when the argument was read. This makes these functions suitable for including material finalised during the page building process (such as the page number).

**T<sub>E</sub>Xhackers note:** `\lua_shipout_x:n` is the LuaT<sub>E</sub>X primitive `\latelua` named using the L<sup>A</sup>T<sub>E</sub>X3 scheme.

At a T<sub>E</sub>X level, the *⟨Lua input⟩* is stored as a “whatsit”.

## 174 Category code tables

As well as providing methods to break out into Lua, there are places where additional L<sup>A</sup>T<sub>E</sub>X3 functions are provided by the LuaT<sub>E</sub>X engine. In particular, LuaT<sub>E</sub>X provides category code tables. These can be used to ensure that a set of category codes are in force in a more robust way than is possible with other engines. These are therefore used by `\ExplSyntaxOn` and `\ExplSyntaxOff` when using the LuaT<sub>E</sub>X engine.

<code>\cctab_new:N</code>	<code>\cctab_new:N ⟨category code table⟩</code>
---------------------------	-------------------------------------------------

Creates a new category code table, initially with the codes as used by IniT<sub>E</sub>X.

<code>\cctab_gset:Nn</code>	<code>\cctab_gset:Nn ⟨category code table⟩ {⟨category code set up⟩}</code>
-----------------------------	--------------------------------------------------------------------------------

Sets the *⟨category code table⟩* to apply the category codes which apply when the prevailing regime is modified by the *⟨category code set up⟩*. Thus within a standard code block the starting point will be the code applied by `\c_code_cctab`. The assignment of the table is global: the underlying primitive does not respect grouping.

<code>\cctab_begin:N</code>	<code>\cctab_begin:N ⟨category code table⟩</code>
-----------------------------	---------------------------------------------------

Switches the category codes in force to those stored in the *⟨category code table⟩*. The prevailing codes before the function is called are added to a stack, for use with `\cctab_end:`.

<code>\cctab_end:</code>	<code>\cctab_end:</code>
--------------------------	--------------------------

Ends the scope of a *⟨category code table⟩* started using `\cctab_begin:N`, retuning the

codes to those in force before the matching `\cctab_begin:N` was used.

`\c_code_cctab` Category code table for the code environment. This does not include setting the behaviour of the line-end character, which is only altered by `\ExplSyntaxOn`.

`\c_document_cctab` Category code table for a standard L<sup>A</sup>T<sub>E</sub>X document. This does not include setting the behaviour of the line-end character, which is only altered by `\ExplSyntaxOff`.

`\c_initex_cctab` Category code table as set up by Init<sub>E</sub>X.

`\c_other_cctab` Category code table where all characters have category code 12 (other).

`\c_string_cctab` Category code table where all characters have category code 12 (other) with the exception of spaces, which have category code 10 (space).

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The italic numbers denote the pages where the corresponding entry is described, numbers underlined point to the definition, all others indicate the places where it is used.

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\seq_pop_right:cnTF	120	\seq_use:c	121
\seq_pop_right:NN	115	\seq_use:N	121
\seq_pop_right:NNTF	120	\skip_add:cn	86
\seq_push:cn	119	\skip_add:Nn	86
\seq_push:co	119	\skip_eval:n	88
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\tl_gset:co	96	\tl_if_eq:nnTF	101
\tl_gset:cV	96	\tl_if_eq_p:cc	101
\tl_gset:cv	96	\tl_if_eq_p:cN	101
\tl_gset:cx	96	\tl_if_eq_p:Nc	101
.tl_gset:N	178	\tl_if_eq_p:NN	101
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\tl_gset:Nn	96	\tl_if_head_eq_catcode_p:nN	107
\tl_gset:No	96	\tl_if_head_eq_charcode:fNTF	108
\tl_gset:Nv	96	\tl_if_head_eq_charcode:nNTF	108
\tl_gset:Nx	96	\tl_if_head_eq_charcode_p:fN	108
\tl_gset_eq:cc	95	\tl_if_head_eq_charcode_p:nN	108
\tl_gset_eq:cN	95	\tl_if_head_eq_meaning:nNTF	108
\tl_gset_eq:Nc	95	\tl_if_head_eq_meaning_p:nN	108
\tl_gset_eq:NN	95	\tl_if_head_group:nTF	108
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\tl_gset_rescan:cnx	99	\tl_if_head_N_type_p:n	108
\tl_gset_rescan:Nnn	99	\tl_if_head_space:nTF	108
\tl_gset_rescan:Nno	99	\tl_if_head_space_p:n	108
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.tl_gset_x:N	178	\tl_if_in:nnTF	102
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\tl_gtrim_spaces:N	106	\tl_if_in:VnTF	102
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\tl_head:w	106	\tl_if_single_p:N	102
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\tl_if_blank:oTF	100	\tl_if_single_token:nTF	102
\tl_if_blank:VTF	100	\tl_if_single_token_p:n	102
\tl_if_blank_p:n	100	\tl_length:c	105
\tl_if_blank_p:o	100	\tl_length:N	105
\tl_if_blank_p:V	100	\tl_length:n	104
\tl_if_empty:cTF	101	\tl_length:o	104
\tl_if_empty:nTF	101	\tl_length:V	104
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\tl_if_empty_p:c	101	\tl_map_function:cN	102
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\tl_put_left:co	96	\tl_set_rescan:Nnn	99
\tl_put_left:cV	96	\tl_set_rescan:Nno	99
\tl_put_left:cx	96	\tl_set_rescan:Nnx	99
\tl_put_left:Nn	96	.tl_set_x:c	178
\tl_put_left:No	96	.tl_set_x:N	178
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\tl_put_right:cn	97	\tl_show:n	109
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\tl_put_right:cV	97	\tl_tail:n	107
\tl_put_right:cx	97	\tl_tail:V	107
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\tl_remove_all:Nn	98	\tl_to_str:n	104
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\tl_replace_all:Nnn	98	\tl_trim_spaces:n	105
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\tl_set:cn	95	\token_if_cs_p:N	60
\tl_set:co	95	\token_if_dim_register:NTF	61
\tl_set:cx	95	\token_if_dim_register_p:N	61
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\tl_set:Nf	95	\token_if_eq_catcode_p:NN	59
\tl_set:Nn	95	\token_if_eq_charcode:NNTF	60
\tl_set:No	95	\token_if_eq_charcode_p:NN	60
\tl_set:NV	95	\token_if_eq_meaning:NNTF	60
\tl_set:Nv	95	\token_if_eq_meaning_p:NN	60
\tl_set:Nx	95	\token_if_expandable:NTF	60
\tl_set_eq:cc	95	\token_if_expandable_p:N	60
\tl_set_eq:cN	95	\token_if_group_begin:NTF	58
\tl_set_eq:Nc	95	\token_if_group_begin_p:N	58
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