

The L^AT_EX3 Sources

The L^AT_EX3 Project*

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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^AT_EX commands, which allow the L^AT_EX programmer to systematically name functions and variables, and specify the argument types of functions.

The T_EX and ϵ -T_EX 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^AT_EX3 programming language.

At present, the `expl3` modules are designed to be loaded on top of L^AT_EX 2 ϵ . In time, a L^AT_EX3 format will be produced based on this code. This allows the code to be used in L^AT_EX 2 ϵ packages *now* while a stand-alone L^AT_EX3 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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Contents

I	Introduction to <code>expl3</code> and this document	1
1	Naming functions and variables	1
1.0.1	Terminological inexactitude	3
2	Documentation conventions	3
II	The <code>l3names</code> package: A systematic naming scheme for <code>TeX</code>	4
3	Setting up the <code>L^AT_EX3</code> programming language	5
4	Using the modules	5
III	The <code>l3basics</code> package: Basic Definitions	6
5	Predicates and conditionals	6
5.1	Primitive conditionals	8
5.2	Non-primitive conditionals	9
5.3	Applications	10
6	Control sequences	10
7	Selecting and discarding tokens from the input stream	11
7.1	Extending the interface	12
7.2	Selecting tokens from delimited arguments	13
8	That which belongs in other modules but needs to be defined earlier	13
9	Defining functions	14
9.1	Defining new functions using primitive parameter text	15
9.2	Defining new functions using the signature	16
9.3	Defining functions using primitive parameter text	18
9.4	Defining functions using the signature (no checks)	19
9.5	Undefining functions	21
9.6	Copying function definitions	21
9.7	Internal functions	22

10 The innards of a function	22
11 Grouping and scanning	23
12 Checking the engine	24
IV The <code>l3expan</code> package: Controlling Expansion of Function Arguments	24
13 Brief overview	24
14 Defining new variants	24
14.1 Methods for defining variants	25
15 Introducing the variants	26
16 Manipulating the first argument	27
17 Manipulating two arguments	28
18 Manipulating three arguments	28
19 Preventing expansion	29
20 Unbraced expansion	30
V The <code>l3prg</code> package: Program control structures	30
21 Conditionals and logical operations	30
22 Defining a set of conditional functions	31
23 The boolean data type	32
24 Boolean expressions	33
25 Case switches	35
26 Generic loops	36
27 Choosing modes	36

28 Alignment safe grouping and scanning	37
29 Producing n copies	37
30 Sorting	38
VI The l3quark package: “Quarks”	38
31 Functions	39
32 Recursion	39
33 Constants	40
VII The l3token package: A token of my appreciation...	40
34 Character tokens	41
35 Generic tokens	44
35.1 Useless code: because we can!	47
36 Peeking ahead at the next token	48
VIII The l3int package: Integers/counters	49
37 Functions	49
38 Formatting a counter value	51
38.1 Internal functions	51
39 Variable and constants	52
40 Conversion	53
IX The l3num package: Integers in macros	54
41 Functions	54
42 Formatting a counter value	56

43 Variable and constants	56
44 Primitive functions	56
X The l3intexpr package: Integer expressions	56
45 Functions	57
46 Primitive functions	58
XI The l3skip package: Dimension and skip registers	59
47 Skip registers	60
47.1 Functions	60
47.2 Formatting a skip register value	62
47.3 Variable and constants	62
48 Dim registers	62
48.1 Functions	62
48.2 Variable and constants	64
49 Muskip	65
XII The l3tl package: Token Lists	65
50 Functions	66
51 Predicates and conditionals	69
52 Working with the contents of token lists	71
53 Variables and constants	72
54 Searching for and replacing tokens	73
55 Heads or tails?	73
XIII The l3toks package: Token Registers	74

56 Allocation and use	75
57 Adding to the contents of token registers	77
58 Predicates and conditionals	78
59 Variable and constants	79
XIV The l3seq package: Sequences	79
60 Functions for creating/initialising sequences	79
61 Adding data to sequences	80
62 Working with sequences	81
63 Predicates and conditionals	82
64 Internal functions	83
65 Functions for ‘Sequence Stacks’	83
XV The l3clist package: Comma separated lists	84
66 Functions for creating/initialising comma-lists	85
67 Putting data in	86
68 Getting data out	86
69 Mapping functions	87
70 Predicates and conditionals	88
71 Higher level functions	89
72 Functions for ‘comma-list stacks’	89
73 Internal functions	90
XVI The l3prop package: Property Lists	90

74 Functions	91
75 Predicates and conditionals	93
76 Internal functions	93
 XVII The l3io package: Low-level file i/o	 94
77 Functions for output streams	95
77.1 Immediate writing	95
77.2 Deferred writing	96
77.3 Special characters for writing	96
78 Functions for input streams	97
79 Constants	98
 XVIII The l3msg package: Communicating with the user	 98
80 Creating new messages	98
81 Message classes	99
82 Redirecting messages	100
83 Support functions for output	101
84 Low-level functions	101
85 Kernel-specific functions	102
86 Variables and constants	103
 XIX The l3box package: Boxes	 104
87 Generic functions	104
88 Horizontal mode	106
89 Vertical mode	107

XX	The <code>l3xref</code> package: Cross references	108
XXI	The <code>l3keyval</code> package: Key-value parsing	109
90	Functions	110
XXII	The <code>l3keys</code> package: Key-value support	111
90.1	Creating keys	112
90.2	Sub-dividing keys	115
90.3	Multiple choices	115
90.4	Setting keys	116
90.5	Examining keys: internal representation	116
90.6	Internal functions	117
90.7	Variables and constants	119
XXIII	The <code>l3calc</code> package: Infix notation arithmetic in \LaTeX3	119
91	User functions	120
XXIV	The <code>l3file</code> package: File Loading	122
92	Loading files	122
93	Variables and constants	123
XXV	Implementation	123
94	<code>l3names</code> implementation	124
94.1	Internal functions	124
94.2	Package loading	124
94.3	Catcode assignments	125
94.4	Setting up primitive names	125
94.5	Reassignment of primitives	126
94.6	<code>expl3</code> code switches	136

94.7	Package loading	137
94.8	Finishing up	140
94.9	Showing memory usage	142
95	l3basics implementation	143
95.1	Renaming some T _E X primitives (again)	143
95.2	Defining functions	144
95.3	Selecting tokens	145
95.4	Gobbling tokens from input	146
95.5	Expansion control from l3expan	147
95.6	Conditional processing and definitions	147
95.7	Dissecting a control sequence	151
95.8	Exist or free	153
95.9	Defining and checking (new) functions	155
95.10	More new definitions	157
95.11	Copying definitions	159
95.12	Undefining functions	160
95.13	Engine specific definitions	160
95.14	Scratch functions	161
95.15	Defining functions from a given number of arguments	161
95.16	Using the signature to define functions	163
96	l3expan implementation	166
96.1	Internal functions and variables	166
96.2	Module code	166
96.3	General expansion	167
96.4	Hand-tuned definitions	170
96.5	Definitions with the ‘general’ technique	171
96.6	Preventing expansion	172
96.7	Defining function variants	173
96.8	Last-unbraced versions	174

97 l3prg implementation	175
97.1 Variables	175
97.2 Module code	176
97.3 Choosing modes	176
97.4 Producing n copies	177
97.5 Booleans	180
97.6 Parsing boolean expressions	182
97.7 Case switch	186
97.8 Sorting	188
98 l3quark implementation	190
99 l3token implementation	193
99.1 Documentation of internal functions	193
99.2 Module code	194
99.3 Character tokens	194
99.4 Generic tokens	196
99.5 Peeking ahead at the next token	203
100 l3int implementation	209
100.1 Internal functions and variables	209
100.2 Module loading and primitives definitions	209
100.3 Allocation and setting	210
100.4 Defining constants	216
100.5 Scanning and conversion	217
101 l3num implementation	220
102 l3intexpr implementation	222
103 l3skip implementation	226
103.1 Skip registers	226
103.2 Dimen registers	230
103.3 Muskips	232

1043tl implementation	232
104.1Functions	233
104.2Variables and constants	238
104.3Predicates and conditionals	238
104.4Working with the contents of token lists	243
104.5Checking for and replacing tokens	247
104.6Heads or tails?	250
1053toks implementation	251
105.1Allocation and use	252
105.2Adding to token registers' contents	254
105.3Predicates and conditionals	255
105.4Variables and constants	256
1063seq implementation	256
106.1Allocating and initialisation	256
106.2Predicates and conditionals	257
106.3Getting data out	258
106.4Putting data in	259
106.5Mapping	260
106.6Manipulation	261
106.7Sequence stacks	261
1073clist implementation	262
107.1Allocation and initialisation	262
107.2Predicates and conditionals	263
107.3Retrieving data	264
107.4Storing data	265
107.5Mapping	266
107.6Higher level functions	268
107.7Stack operations	269
1083prop implementation	270
108.1Functions	270
108.2Predicates and conditionals	273
108.3Mapping functions	274

1093io implementation	275
109.1Output streams	276
109.2Input streams	278
1103msg implementation	279
110.1Variables and constants	280
110.2Output helper functions	281
110.3Generic functions	282
110.4General functions	284
110.5Redirection functions	288
110.6Kernel-specific functions	288
1113box implementation	291
111.1Generic boxes	291
111.2Vertical boxes	293
111.3Horizontal boxes	294
1123xref implementation	295
112.1Internal functions and variables	295
112.2Module code	296
1133xref test file	299
1143keyval implementation	300
114.1Internal functions and variables	300
114.2Module code	300
114.2.1 Variables and constants	307
114.2.2 Internal functions	308
114.2.3 Properties	316
114.2.4 Messages	318
1153calc implementation	319
115.1Variables	319
115.2Internal functions	320
115.3Module code	320
115.4Higher level commands	329

1163file implementation	332
Index	336

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 L^AT_EX3 programming language is found in [expl3.pdf](#).

1 Naming functions and variables

L^AT_EX3 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 T_EX 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 *csname*, and indicates that the argument will be turned into a csname 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 T_EX 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 csname 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 T_EX `\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 *TeX 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 module¹ 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.
- dim** ‘Rigid’ lengths.
- int** Integer-valued count register.
- num** A ‘fake’ integer type using only macros. Useful for setting up allocation routines.
- prop** Property list.
- skip** ‘Rubber’ lengths.
- seq** ‘Sequence’: a data-type used to implement lists (with access at both ends) and stacks.
- stream** An input or output stream (for reading from or writing to, respectively).
- tl** Token list variables: placeholder for a token list.
- toks** Token register.

¹The 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.

1.0.1 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 mayn’t 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 `TEX`book 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.

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

`\cs_to_str:N *` `\cs_to_str:N` $\langle cs \rangle$

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 $\langle cs \rangle$, shorthand for a $\langle control\ sequence \rangle$.

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` $\langle true\ code \rangle$ $\langle false\ code \rangle$

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 $\langle true\ code \rangle$ and $\langle false\ code \rangle$ will be shown. The two variant forms `T` and `F` take only $\langle true\ code \rangle$ and $\langle false\ code \rangle$, 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 \TeX . In these cases, the text will include an extra ‘ **\TeX hackers note**’ section:

`\token_to_str:N *` `\token_to_str:N` $\langle token \rangle$

The normal description text.

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

Part II

The `l3names` package

A systematic naming scheme for T_EX

3 Setting up the L^AT_EX3 programming language

This module is at the core of the L^AT_EX3 programming language. It performs the following tasks:

- defines new names for all T_EX primitives;
- defines catcode regimes for programming;
- provides settings for when the code is used in a format;
- provides tools for when the code is used as a package within a L^AT_EX 2_ε context.

4 Using the modules

The modules documented in `source3` are designed to be used on top of L^AT_EX 2_ε 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^AT_EX3 format, but work in this area is incomplete and not included in this documentation.

As the modules use a coding syntax different from standard L^AT_EX it provides a few functions for setting it up.

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

`\ExplSyntaxOn <code> \ExplSyntaxOff`

Issues a catcode regime where spaces are ignored and colon and underscore are letters. A space character may be input with `~` instead.

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

`\ExplSyntaxNamesOn <code> \ExplSyntaxNamesOff`

Issues a catcode regime where colon and underscore are letters, but spaces remain the same.

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

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

The package `l3names` (this module) provides `\ProvidesExplPackage` which is a wrapper for `\ProvidesPackage` and sets up the L^AT_EX3 catcode settings for programming automatically. Similar for the relationship between `\ProvidesExplClass` and `\ProvidesClass`. Spaces are not ignored in the arguments of these commands.

<code>\GetIdInfo</code> <code>\filename</code> <code>\filenameext</code> <code>\filedate</code> <code>\fileversion</code> <code>\filetimestamp</code> <code>\fileauthor</code> <code>\filedescription</code>	<code>\RequirePackage{13names}</code> <code>\GetIdInfo \$Id: < cvs or svn info field> \$ {<description>}</code>
---	--

Extracts all information from a CVS or SVN field. Spaces are not ignored in these fields. The information pieces are stored in separate control sequences with `\filename` for the part of the file name leading up to the period, `\filenameext` for the extension, `\filedate` for date, `\fileversion` for version, `\filetimestamp` for the time and `\fileauthor` for the author.

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 L^AT_EX catcodes and the L^AT_EX3 catcode 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{\filename}{\filedate}{\fileversion}{\filedescription}
```

Part III

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.

5 Predicates and conditionals

L^AT_EX3 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 *<true arg>* or the *<false arg>*. These arguments are denoted with T and F respectively. An example would be

```
\cs_if_free:cTF{abc} {<true code>} {<false code>}
```

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 *<true code>* and/or *<false code>* 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 <true code> \else:
<false code> \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
} {<true code>} {<false code>}
```

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.²

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 **T_EX** and **L^AT_EX**. 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.

²If defined using the interface provided.

5.1 Primitive conditionals

The ε -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 `\intexpr_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: <true code> \else: <false code> \fi:</code>
<code>\reverse_if:N</code>	★	<code>\if_false: <true code> \else: <false code> \fi:</code>
		<code>\reverse_if:N <primitive conditional></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 `\intexpr` for more.

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

<code>\if_meaning:w</code>	★	<code>\if_meaning:w <arg₁> <arg₂> <true code> \else: <false code> \fi:</code>
----------------------------	---	---

`\if_meaning:w` executes `<true code>` when `<arg1>` and `<arg2>` are the same, otherwise it executes `<false code>`. `<arg1>` and `<arg2>` 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_charcode:w</code>	★	<code>\if:w <token₁> <token₂> <true code> \else: <false code> \fi:</code>
<code>\if_catcode:w</code>	★	<code>\if_catcode:w <token₁> <token₂> <true code> \else: <false code> \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 <predicate> <true code> \else: <false code> \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 `<predicate>` but to make the coding clearer this should be done through `\if_bool:N`.)

<code>\if_bool:N *</code>

`\if_bool:N <boolean> <true code> \else: <false code> \fi:`

This function takes a boolean variable and branches according to the result.

<code>\if_cs_exist:N *</code>
<code>\if_cs_exist:w *</code>

`\if_cs_exist:N <cs> <true code> \else: <false code> \fi:
\if_cs_exist:w <tokens> \cs_end: <true code> \else: <false
code> \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 `\scan_stop:!` This can be useful when dealing with control sequences which cannot be entered as a single token.

<code>\if_mode_horizontal: *</code>	<code>*</code>
<code>\if_mode_vertical: *</code>	<code>*</code>
<code>\if_mode_math: *</code>	<code>*</code>
<code>\if_mode_inner: *</code>	<code>*</code>

`\if_mode_horizontal: <true code> \else: <false code> \fi:`

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

5.2 Non-primitive conditionals

<code>\cs_if_eq_name_p:NN</code>

`\cs_if_eq_name_p:NN <cs1> <cs2>`

Returns ‘true’ if $\langle cs_1 \rangle$ and $\langle cs_2 \rangle$ are textually the same, i.e. have the same name, otherwise it returns ‘false’.

<code>\cs_if_eq_p:NN *</code>
<code>\cs_if_eq_p:cN *</code>
<code>\cs_if_eq_p:Nc *</code>
<code>\cs_if_eq_p:cc *</code>
<code>\cs_if_eq:NNTF *</code>
<code>\cs_if_eq:cNTF *</code>
<code>\cs_if_eq:NcTF *</code>
<code>\cs_if_eq:ccTF *</code>

`\cs_if_eq_p:NNTF <cs1> <cs2>
\cs_if_eq:NNTF <cs1> <cs2> {<true code>} {<false code>}`

These functions check if $\langle cs_1 \rangle$ and $\langle cs_2 \rangle$ have same meaning.

<code>\cs_if_free_p:N *</code>
<code>\cs_if_free_p:c *</code>
<code>\cs_if_free:NTF *</code>
<code>\cs_if_free:cTF *</code>

`\cs_if_free_p:N <cs>
\cs_if_free:NTF <cs> {<true code>} {<false code>}`

Returns ‘true’ if $\langle cs \rangle$ is either undefined or equal to `\tex_relax:D` (the function that is assigned to newly created control sequences by T_EX when `\cs:w ... \cs_end:` is used). In addition to this, ‘true’ is only returned if $\langle cs \rangle$ does not have a signature equal to D, i.e., ‘do not use’ functions are not free to be redefined.

<code>\cs_if_exist_p:N *</code>	<code>\cs_if_exist_p:N <cs></code> <code>\cs_if_exist:NTF <cs> {\true code} {\false code}</code>
<code>\cs_if_exist_p:c *</code>	
<code>\cs_if_exist:NTF *</code>	
<code>\cs_if_exist:cTF *</code>	

These functions check if $\langle cs \rangle$ exists, i.e., if $\langle cs \rangle$ is present in the hash table and is not the primitive `\tex_relax:D`.

<code>\cs_if_do_not_use_p:N *</code>	<code>\cs_if_do_not_use_p:N <cs></code>
--------------------------------------	---

These functions check if $\langle cs \rangle$ has the arg spec D for ‘do not use’. There are no TF-type conditionals for this function as it is only used internally and not expected to be widely used. (For now, anyway.)

<code>\chk_if_free_cs:N</code>	<code>\chk_if_free_cs:N <cs></code>
--------------------------------	---

This function checks that $\langle cs \rangle$ is *free* according to the criteria for `\cs_if_free_p:N` above. If not, an error is generated.

<code>\chk_if_exist_cs:N</code>	<code>\chk_if_exist_cs:N <cs></code>
<code>\chk_if_exist_cs:c</code>	

This function checks that $\langle cs \rangle$ is defined. If it is not an error is generated.

<code>\c_true_bool</code>
<code>\c_false_bool</code>

Constants that represent ‘true’ or ‘false’, respectively. Used to implement predicates.

5.3 Applications

<code>\str_if_eq_p:nn *</code>	<code>\str_if_eq_p:nn {\string_1} {\string_2}</code>
--------------------------------	--

Expands to ‘true’ if $\langle string_1 \rangle$ is the same as $\langle string_2 \rangle$, otherwise ‘false’. Ignores spaces within the strings.

<code>\str_if_eq_var_p:nf *</code>	<code>\str_if_eq_var_p:nf {\string_1} {\string_2}</code>
------------------------------------	--

A variant of `\str_if_eq_p:nn` which has the advantage of obeying spaces in at least the second argument.

6 Control sequences

<code>\cs:w</code>	<code>*</code>	<code>\cs:w <tokens> \cs_end:</code>
<code>\cs_end:</code>	<code>*</code>	

This is the T_EX internal way of generating a control sequence from some token list. $\langle tokens \rangle$ get expanded and must ultimately result in a sequence of characters.

T_EXhackers note: These functions are the primitives `\csname` and `\endcsname`. `\cs:w` is considered weird because it expands tokens until it reaches `\cs_end:`.

<code>\cs_show:N</code>	<code>\cs_show:N <cs></code>
<code>\cs_show:c</code>	<code>\cs_show:c {<arg>}</code>

This function shows in the console output the *meaning* of the control sequence `<cs>` or that created by `<arg>`.

T_EXhackers note: This is T_EX's `\show` and associated csname version of it.

<code>\cs_meaning:N</code>	<code>\cs_meaning:N <cs></code>
<code>\cs_meaning:c</code>	<code>\cs_meaning:c {<arg>}</code>

This function expands to the *meaning* of the control sequence `<cs>` or that created by `<arg>`.

T_EXhackers note: This is T_EX's `\meaning` and associated csname version of it.

7 Selecting and discarding tokens from the input stream

The conditional processing cannot be implemented without being able to gobble and select which tokens to use from the input stream.

<code>\use:n</code>	★
<code>\use:nn</code>	★
<code>\use:nnn</code>	★
<code>\use:nnnn</code>	★

`\use:n {<arg>}`

Functions that returns all of their arguments to the input stream after removing the surrounding braces around each argument.

T_EXhackers note: `\use:n` is L^AT_EX 2_ε's `\@firstofone/\@iden`.

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

`\use:c {<cs>}`

Function that returns to the input stream the control sequence created from its argument. Requires two expansions before a control sequence is returned.

T_EXhackers note: `\use:c` is L^AT_EX 2_ε's `\@nameuse`.

<code>\use_none:n</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:n</code> $\{\langle arg_1 \rangle\}$
<code>\use_none:nnnnnnnnn</code>	*	<code>\use_none:nn</code> $\{\langle arg_1 \rangle\}$ $\{\langle arg_2 \rangle\}$

These functions gobble the tokens or brace groups from the input stream.

TeXhackers note: `\use_none:n`, `\use_none:nn`, `\use_none:nnnn` are L^AT_EX 2_ε's `\@gobble`, `\@gobbletwo`, and `\@gobblefour`.

<code>\use_i:nn</code>	*	
<code>\use_ii:nn</code>	*	<code>\use_i:nn</code> $\{\langle code_1 \rangle\}$ $\{\langle code_2 \rangle\}$

Functions that execute the first or second argument respectively, after removing the surrounding braces. Primarily used to implement conditionals.

TeXhackers note: These are L^AT_EX 2_ε's `\@firstoftwo` and `\@secondoftwo`, respectively.

<code>\use_i:nnn</code>	*	
<code>\use_ii:nnn</code>	*	
<code>\use_iii:nnn</code>	*	<code>\use_i:nnn</code> $\{\langle arg_1 \rangle\}$ $\{\langle arg_2 \rangle\}$ $\{\langle arg_3 \rangle\}$

Functions that pick up one of three arguments and execute them after removing the surrounding braces.

TeXhackers note: L^AT_EX 2_ε has only `\@thirdofthree`.

<code>\use_i:nnnn</code>	*	
<code>\use_ii:nnnn</code>	*	
<code>\use_iii:nnnn</code>	*	
<code>\use_iv:nnnn</code>	*	<code>\use_i:nnnn</code> $\{\langle arg_1 \rangle\}$ $\{\langle arg_2 \rangle\}$ $\{\langle arg_3 \rangle\}$ $\{\langle arg_4 \rangle\}$

Functions that pick up one of four arguments and execute them after removing the surrounding braces.

7.1 Extending the interface

<code>\use_i_ii:nnn</code>	*	<code>\use_i_ii:nnn</code> $\{\langle arg_1 \rangle\}$ $\{\langle arg_2 \rangle\}$ $\{\langle arg_3 \rangle\}$
----------------------------	---	--

This function used in the expansion module reads three arguments and returns (without braces) the first and second argument while discarding the third argument.

If you wish to select multiple arguments while discarding others, use a syntax like this. Its definition is

```
\cs_set:Npn \use_i_ii:nnn #1#2#3 {#1#2}
```

7.2 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>*</code>
<code>\use_none_delimit_by_q_stop:w</code>	<code>*</code>
<code>\use_none_delimit_by_q_recursion_stop:w</code>	<code>*</code>

`\use_none_delimit_by_q_nil:w <balanced text> \q_nil:`

Gobbles *<balanced text>*. Useful in gobbling the remainder in a list structure or terminating recursion.

<code>\use_i_delimit_by_q_nil:nw</code>	<code>*</code>
<code>\use_i_delimit_by_q_stop:nw</code>	<code>*</code>
<code>\use_i_delimit_by_q_recursion_stop:nw</code>	<code>*</code>

`\use_i_delimit_by_q_nil:nw {<arg>} <balanced text> \q_nil:`

Gobbles *<balanced text>* and executes *<arg>* afterwards. This can also be used to get the first item in a token list.

<code>\use_i_after_fi:nw</code>	<code>*</code>	<code>\use_i_after_fi:nw {<arg>} \fi:</code>
<code>\use_i_after_else:nw</code>	<code>*</code>	<code>\use_i_after_else:nw {<arg>} \else: <balanced text> \fi:</code>
<code>\use_i_after_or:nw</code>	<code>*</code>	<code>\use_i_after_or:nw {<arg>} \or: <balanced text> \fi:</code>
<code>\use_i_after_orelse:nw</code>	<code>*</code>	<code>\use_i_after_orelse:nw {<arg>} \or:/\else: <balanced text> \fi:</code>

Executes *<arg>* after executing closing out `\fi:`. `\use_i_after_orelse:nw` can be used anywhere where `\use_i_after_else:nw` or `\use_i_after_or:nw` are used.

8 That which belongs in other modules but needs to be defined earlier

<code>\exp_after:wN</code>	<code>*</code>
----------------------------	----------------

`\exp_after:wN <token12`

Expands *<token_{2 once and then continues processing from *<token_{1.}*}*

T_EXhackers note: This is T_EX's `\expandafter`.

<code>\exp_not:N</code>	<code>*</code>
<code>\exp_not:n</code>	<code>*</code>

`\exp_not:N <token>`
`\exp_not:n {<tokens>}`

In an expanding context, this function prevents *<token>* or *<tokens>* from expanding.

T_EXhackers note: These are T_EX’s `\noexpand` and ε -T_EX’s `\unexpanded`, respectively.

<code>\prg_do_nothing: *</code>

This is as close as we get to a null operation or no-op.

T_EXhackers note: Definition as in L^AT_EX’s `\empty` but not used for the same thing.

<code>\iow_log:x</code>	<code>\iow_log:x {<message>}</code> <code>\iow_shipout_x:Nn <write_stream> {<message>}</code>
<code>\iow_term:x</code>	
<code>\iow_shipout_x:Nn</code>	

Writes `<message>` to either to log or the terminal.

<code>\msg_kernel_bug:x</code>

`\msg_kernel_bug:x {<message>}`
Internal function for calling errors in our code.

<code>\cs_record_meaning:N</code>

Placeholder for a function to be defined by `l3chk`.

<code>\c_minus_one</code>	Numeric constants.
<code>\c_zero</code>	
<code>\c_sixteen</code>	

9 Defining functions

There are two types of function definitions in L^AT_EX3: versions that check if the function name is still unused, and versions that simply make the definition. The latter are used for internal scratch functions that get new meanings all over the place.

For each type there is an additional choice to be made: Does the function to be defined contain delimited arguments? The answer in 99% of the cases is no. For this type the programmer will know the number of arguments and in most cases use the argument signature to signal this, e.g., `\foo_bar:nnn` presumably takes three arguments. We therefore also provide functions that automatically detect how many arguments are required and construct the parameter text on the fly.

A definition of a new function can be done locally and globally. Currently nearly all function definitions are done locally on top level, in other words they are global but don’t show it. Therefore I think it may be better to remove the local variants in the future and declare all checked function definitions global.

T_EXhackers note: While T_EX makes all definition functions directly available to the user L^AT_EX3 hides them very carefully to avoid the problems with definitions that are overwritten accidentally. Many functions that are in T_EX a combination of prefixes and definition functions are provided as individual functions.

A slew of functions are defined in the following sections for defining new functions.

Here's a quick summary to get an idea of what's available:

`\cs_(g)(new/set)(_protected)(_nopar):(N/c)(p)(n/x)`

That stands for, respectively, the following variations:

g Global or local;

new/set Define a new function or re-define an existing one;

protected Prevent expansion of the function in **x** arguments;

nopar Restrict the argument(s) from containing `\par`;

N/c Either a control sequence or a 'csname';

p Either the a primitive TeX argument or the number of arguments is detected from the argument signature, i.e., `\foo:nnn` is assumed to have three arguments `#1#2#3`;

n/x Either an unexpanded or an expanded definition.

That adds up to 128 variations (!). However, the system is very logical and only a handful will usually be required often.

9.1 Defining new functions using primitive parameter text

<code>\cs_new:Npn</code>
<code>\cs_new:Npx</code>
<code>\cs_new:cpn</code>
<code>\cs_new:cpx</code>

`\cs_new:Npn <cs> <parms> {<code>}`

Defines a function that may contain `\par` tokens in the argument(s) when called. This is not allowed for normal functions.

<code>\cs_gnew:Npn</code>
<code>\cs_gnew:Npx</code>
<code>\cs_gnew:cpn</code>
<code>\cs_gnew:cpx</code>

`\cs_gnew:Npn <cs> <parms> {<code>}`

Global versions of the above functions.

<code>\cs_new_nopar:Npn</code>
<code>\cs_new_nopar:Npx</code>
<code>\cs_new_nopar:cpn</code>
<code>\cs_new_nopar:cpx</code>

`\cs_new_nopar:Npn <cs> <parms> {<code>}`

Defines a new function, making sure that `<cs>` is unused so far. `<parms>` may consist of arbitrary parameter specification in TeX syntax. It is under the responsibility of the programmer to name the new function according to the rules laid out in the previous section. `<code>` is either passed literally or may be subject to expansion (under the **x** variants).

<code>\cs_gnew_nopar:Npn</code>
<code>\cs_gnew_nopar:Npx</code>
<code>\cs_gnew_nopar:cpn</code>
<code>\cs_gnew_nopar:cpx</code>

`\cs_gnew_nopar:Npn <cs> <parms> {\code}`

Like `\cs_new_nopar:Npn` but defines the new function globally. See comments above.

<code>\cs_new_protected:Npn</code>
<code>\cs_new_protected:Npx</code>
<code>\cs_new_protected:cpn</code>
<code>\cs_new_protected:cpx</code>

`\cs_new_protected:Npn <cs> <parms> {\code}`

Defines a function that is both robust and may contain `\par` tokens in the argument(s) when called.

<code>\cs_gnew_protected:Npn</code>
<code>\cs_gnew_protected:Npx</code>
<code>\cs_gnew_protected:cpn</code>
<code>\cs_gnew_protected:cpx</code>

`\cs_gnew_protected:Npn <cs> <parms> {\code}`

Global versions of the above functions.

<code>\cs_new_protected_nopar:Npn</code>
<code>\cs_new_protected_nopar:Npx</code>
<code>\cs_new_protected_nopar:cpn</code>
<code>\cs_new_protected_nopar:cpx</code>

`\cs_new_protected_nopar:Npn <cs> <parms> {\code}`

Defines a function that does not expand when inside an `x` type expansion.

<code>\cs_gnew_protected_nopar:Npn</code>
<code>\cs_gnew_protected_nopar:Npx</code>
<code>\cs_gnew_protected_nopar:cpn</code>
<code>\cs_gnew_protected_nopar:cpx</code>

`\cs_gnew_protected_nopar:Npn <cs> <parms> {\code}`

Global versions of the above functions.

9.2 Defining new functions using the signature

<code>\cs_new:Nn</code>
<code>\cs_new:Nx</code>
<code>\cs_new:cn</code>
<code>\cs_new:cx</code>

`\cs_new:Nn <cs> {\code}`

Defines a new function, making sure that `<cs>` is unused so far. The parameter text is automatically detected from the length of the function signature. If `<cs>` is missing a colon in its name, an error is raised. It is under the responsibility of the programmer to

name the new function according to the rules laid out in the previous section. $\langle code \rangle$ is either passed literally or may be subject to expansion (under the x variants).

T_EXhackers note: Internally, these use T_EX’s `\long`. These forms are recommended for low-level definitions as experience has shown that `\par` tokens often turn up in programming situations that wouldn’t have been expected.

<code>\cs_gnew:Nn</code>
<code>\cs_gnew:Nx</code>
<code>\cs_gnew:cn</code>
<code>\cs_gnew:cx</code>

`\cs_gnew:Nn <cs> {\code}`

Global versions of the above functions.

<code>\cs_new_nopar:Nn</code>
<code>\cs_new_nopar:Nx</code>
<code>\cs_new_nopar:cn</code>
<code>\cs_new_nopar:cx</code>

`\cs_new_nopar:Nn <cs> {\code}`

Version of the above in which `\par` is not allowed to appear within the argument(s) of the defined functions.

<code>\cs_gnew_nopar:Nn</code>
<code>\cs_gnew_nopar:Nx</code>
<code>\cs_gnew_nopar:cn</code>
<code>\cs_gnew_nopar:cx</code>

`\cs_gnew_nopar:Nn <cs> {\code}`

Global versions of the above functions.

<code>\cs_new_protected:Nn</code>
<code>\cs_new_protected:Nx</code>
<code>\cs_new_protected:cn</code>
<code>\cs_new_protected:cx</code>

`\cs_new_protected:Nn <cs> {\code}`

Defines a function that is both robust and may contain `\par` tokens in the argument(s) when called.

<code>\cs_gnew_protected:Nn</code>
<code>\cs_gnew_protected:Nx</code>
<code>\cs_gnew_protected:cn</code>
<code>\cs_gnew_protected:cx</code>

`\cs_gnew_protected:Nn <cs> {\code}`

Global versions of the above functions.

<code>\cs_new_protected_nopar:Nn</code>
<code>\cs_new_protected_nopar:Nx</code>
<code>\cs_new_protected_nopar:cn</code>
<code>\cs_new_protected_nopar:cx</code>

`\cs_new_protected_nopar:Nn <cs> {\code}`

Defines a function that does not expand when inside an `x` type expansion. `\par` is not allowed in the argument(s) of the defined function.

<code>\cs_gnew_protected_nopar:Nn</code> <code>\cs_gnew_protected_nopar:Nx</code> <code>\cs_gnew_protected_nopar:cn</code> <code>\cs_gnew_protected_nopar:cx</code>	<code>\cs_gnew_protected_nopar:Nn <cs> {<code>}</code>
--	--

Global versions of the above functions.

9.3 Defining functions using primitive parameter text

Besides the function definitions that check whether or not their argument is an unused function we need function definitions that overwrite currently used definitions. The following functions are provided for this purpose.

<code>\cs_set:Npn</code> <code>\cs_set:Npx</code> <code>\cs_set:cpn</code> <code>\cs_set:cpx</code>	<code>\cs_set:Npn <cs> <parms> {<code>}</code>
--	--

Like `\cs_set_nopar:Npn` but allows `\par` tokens in the arguments of the function being defined.

T_EXhackers note: These are equivalent to T_EX's `\long\def` and so on. These forms are recommended for low-level definitions as experience has shown that `\par` tokens often turn up in programming situations that wouldn't have been expected.

<code>\cs_gset:Npn</code> <code>\cs_gset:Npx</code> <code>\cs_gset:cpn</code> <code>\cs_gset:cpx</code>	<code>\cs_gset:Npn <cs> <parms> {<code>}</code>
--	---

Global variant of `\cs_set:Npn`.

<code>\cs_set_nopar:Npn</code> <code>\cs_set_nopar:Npx</code> <code>\cs_set_nopar:cpn</code> <code>\cs_set_nopar:cpx</code>	<code>\cs_set_nopar:Npn <cs> <parms> {<code>}</code>
--	--

Like `\cs_new_nopar:Npn` etc. but does not check the `<cs>` name.

T_EXhackers note: `\cs_set_nopar:Npn` is the L^AT_EX3 name for T_EX's `\def` and `\cs_set_nopar:Npx` corresponds to the primitive `\edef`. The `\cs_set_nopar:cpn` function was known in L^AT_EX2 as `\@namedef`. `\cs_set_nopar:cpx` has no equivalent.

<code>\cs_gset_nopar:Npn</code>
<code>\cs_gset_nopar:Npx</code>
<code>\cs_gset_nopar:cpn</code>
<code>\cs_gset_nopar:cpx</code>

`\cs_gset_nopar:Npn <cs> <parms> {<code>}`

Like `\cs_set_nopar:Npn` but defines the `<cs>` globally.

TeXhackers note: `\cs_gset_nopar:Npn` and `\cs_gset_nopar:Npx` are TeX's `\gdef` and `\xdef`.

<code>\cs_set_protected:Npn</code>
<code>\cs_set_protected:Npx</code>
<code>\cs_set_protected:cpn</code>
<code>\cs_set_protected:cpx</code>

`\cs_set_protected:Npn <cs> <parms> {<code>}`

Naturally robust macro that won't expand in an `x` type argument. These varieties allow `\par` tokens in the arguments of the function being defined.

<code>\cs_gset_protected:Npn</code>
<code>\cs_gset_protected:Npx</code>
<code>\cs_gset_protected:cpn</code>
<code>\cs_gset_protected:cpx</code>

`\cs_gset_protected:Npn <cs> <parms> {<code>}`

Global versions of the above functions.

<code>\cs_set_protected_nopar:Npn</code>
<code>\cs_set_protected_nopar:Npx</code>
<code>\cs_set_protected_nopar:cpn</code>
<code>\cs_set_protected_nopar:cpx</code>

`\cs_set_protected_nopar:Npn <cs> <parms> {<code>}`

Naturally robust macro that won't expand in an `x` type argument. If you want for some reason to expand it inside an `x` type expansion, prefix it with `\exp_after:wN \prg_do_nothing:.`

<code>\cs_gset_protected_nopar:Npn</code>
<code>\cs_gset_protected_nopar:Npx</code>
<code>\cs_gset_protected_nopar:cpn</code>
<code>\cs_gset_protected_nopar:cpx</code>

`\cs_gset_protected_nopar:Npn <cs> <parms> {<code>}`

Global versions of the above functions.

9.4 Defining functions using the signature (no checks)

As above but now detecting the parameter text from inspecting the signature.

<code>\cs_set:Nn</code>
<code>\cs_set:Nx</code>
<code>\cs_set:cn</code>
<code>\cs_set:cx</code>

`\cs_set:Nn <cs> {<code>}`

Like `\cs_set_nopar:Nn` but allows `\par` tokens in the arguments of the function being defined.

<code>\cs_gset:Nn</code>
<code>\cs_gset:Nx</code>
<code>\cs_gset:cn</code>
<code>\cs_gset:cx</code>

`\cs_gset:Nn <cs> {<code>}`

Global variant of `\cs_set:Nn`.

<code>\cs_set_nopar:Nn</code>
<code>\cs_set_nopar:Nx</code>
<code>\cs_set_nopar:cn</code>
<code>\cs_set_nopar:cx</code>

`\cs_set_nopar:Nn <cs> {<code>}`

Like `\cs_new_nopar:Nn` etc. but does not check the `<cs>` name.

<code>\cs_gset_nopar:Nn</code>
<code>\cs_gset_nopar:Nx</code>
<code>\cs_gset_nopar:cn</code>
<code>\cs_gset_nopar:cx</code>

`\cs_gset_nopar:Nn <cs> {<code>}`

Like `\cs_set_nopar:Nn` but defines the `<cs>` globally.

<code>\cs_set_protected:Nn</code>
<code>\cs_set_protected:cn</code>
<code>\cs_set_protected:Nx</code>
<code>\cs_set_protected:cx</code>

`\cs_set_protected:Nn <cs> {<code>}`

Naturally robust macro that won't expand in an `x` type argument. These varieties also allow `\par` tokens in the arguments of the function being defined.

<code>\cs_gset_protected:Nn</code>
<code>\cs_gset_protected:cn</code>
<code>\cs_gset_protected:Nx</code>
<code>\cs_gset_protected:cx</code>

`\cs_gset_protected:Nn <cs> {<code>}`

Global versions of the above functions.

<code>\cs_set_protected_nopar:Nn</code>
<code>\cs_set_protected_nopar:cn</code>
<code>\cs_set_protected_nopar:Nx</code>
<code>\cs_set_protected_nopar:cx</code>

`\cs_set_protected_nopar:Nn <cs> {<code>}`

Naturally robust macro that won't expand in an `x` type argument. This also comes as a `long` version. If you for some reason want to expand it inside an `x` type expansion, prefix it with `\exp_after:wN \prg_do_nothing:.`

<code>\cs_gset_protected_nopar:Nn</code> <code>\cs_gset_protected_nopar:cn</code> <code>\cs_gset_protected_nopar:Nx</code> <code>\cs_gset_protected_nopar:cx</code>	<code>\cs_gset_protected_nopar:Nn <cs> {<code>}</code>
--	--

Global versions of the above functions.

9.5 Undefining functions

<code>\cs_gundefine:N</code> <code>\cs_gundefine:c</code>	<code>\cs_gundefine:N <cs></code>
--	---

Undefines the control sequence globally.

9.6 Copying function definitions

<code>\cs_new_eq:NN</code> <code>\cs_new_eq:cN</code> <code>\cs_new_eq:Nc</code> <code>\cs_new_eq:cc</code> <code>\cs_gnew_eq:NN</code> <code>\cs_gnew_eq:cN</code> <code>\cs_gnew_eq:Nc</code> <code>\cs_gnew_eq:cc</code>	<code>\cs_new_eq:NN <cs₁₂</code>
--	---

Gives the function $\langle cs_1 \rangle$ locally or globally the current meaning of $\langle cs_2 \rangle$. If $\langle cs_1 \rangle$ already exists then an error is called.

<code>\cs_set_eq:NN</code> <code>\cs_set_eq:cN</code> <code>\cs_set_eq:Nc</code> <code>\cs_set_eq:cc</code> <code>\cs_gset_eq:NN</code> <code>\cs_gset_eq:cN</code> <code>\cs_gset_eq:Nc</code> <code>\cs_gset_eq:cc</code>	<code>\cs_set_eq:cN <cs₁₂</code>
--	---

Gives the function $\langle cs_1 \rangle$ the current meaning of $\langle cs_2 \rangle$. Again, we may always do this globally.

<code>\cs_set_eq:NwN</code>	<code>\cs_set_eq:NwN <cs_{12 <code>\cs_set_eq:NwN <cs₁₂</code>}</code>
-----------------------------	---

These functions assign the meaning of $\langle cs_2 \rangle$ locally or globally to the function $\langle cs_1 \rangle$.

Because the \TeX primitive operation is being used which may have an equal sign and (a certain number of) spaces between $\langle cs_1 \rangle$ and $\langle cs_2 \rangle$ the name contains a `w`. (Not happy about this convention!).

\TeX hackers note: `\cs_set_eq:NwN` is the \LaTeX 3 name for \TeX 's `\let`.

9.7 Internal functions

<code>\pref_global:D</code> <code>\pref_long:D</code> <code>\pref_protected:D</code>	<code>\pref_global:D \cs_set_nopar:Npn</code>
--	---

Prefix functions that can be used in front of some definition functions (namely ...). The result of prefixing a function definition with `\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 in `\writes` etc.

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 \cs_set_nopar:Npn`.

\TeX hackers note: These prefixes are the primitives `\global`, `\long`, and `\protected`. The `\outer` prefix isn't used at all within \LaTeX 3 because ... (it causes more hassle than it's worth? It's never proved useful in any meaningful way?)

10 The innards of a function

<code>\cs_to_str:N *</code>	<code>\cs_to_str:N \langle cs \rangle</code>
-----------------------------	--

This function returns the name of $\langle cs \rangle$ as a sequence of letters with the escape character removed.

<code>\token_to_str:N *</code> <code>\token_to_str:c *</code>	<code>\token_to_str:N \langle arg \rangle</code>
--	--

This function return the name of $\langle arg \rangle$ as a sequence of letters including the escape character.

\TeX hackers note: This is \TeX 's `\string`.

<code>\token_to_meaning:N *</code>	<code>\token_to_meaning:N \langle arg \rangle</code>
------------------------------------	--

This function returns the type and definition of $\langle arg \rangle$ as a sequence of letters.

T_EXhackers note: This is T_EX’s `\meaning`.

<code>\cs_get_function_name:N</code> <code>*</code>	<code>\cs_get_function_name:N \<fn>:\<args></code>
<code>\cs_get_function_signature:N</code> <code>*</code>	

The `name` variant strips off the leading escape character and the trailing argument specification (including the colon) to return `\<fn>`. The `signature` variants does the same but returns the signature `\<args>` instead.

<code>\cs_split_function:NN</code> <code>*</code>	<code>\cs_split_function:NN \<fn>:\<args> \<post process></code>
---	--

Strips off the leading escape character, splits off the signature without the colon, informs whether or not a colon was present and then prefixes these results with `\<post process>`, i.e., `\<post process>\{<name>\}\{<signature>\}\<true>/\<false>`. For example, `\cs_get_function_name:N` is nothing more than `\cs_split_function:NN \<fn>:\<args> \use_i:nnn`.

<code>\cs_get_arg_count_from_signature:N</code> <code>*</code>	<code>\cs_get_arg_count_from_signature:N \<fn>:\<args></code>
--	---

Returns the number of chars in `\<args>`, signifying the number of arguments that the function uses.

Other functions regarding arbitrary tokens can be found in the `l3token` module.

11 Grouping and scanning

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

This function stops T_EX’s scanning ahead when ending a number.

T_EXhackers note: This is the T_EX primitive `\relax` renamed.

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

Encloses `\<...>` inside a group.

T_EXhackers note: These are the T_EX primitives `\begingroup` and `\endgroup` renamed.

<code>\group_execute_after:N</code>	<code>\group_execute_after:N \<token></code>
-------------------------------------	--

Adds `\<token>` to the list of tokens to be inserted after the current group ends (through an explicit or implicit `\group_end:`).

T_EXhackers note: This is T_EX’s `\aftergroup`.

12 Checking the engine

<code>\xetex_if_engine:TF *</code>

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

This function detects if we're running a XeTeX-based format.

<code>\luatex_if_engine:TF *</code>

`\luatex_if_engine:TF {\true code} {\false code}`

This function detects if we're running a LuaTeX-based format.

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

 Boolean variables used for the above functions.

Part IV

The l3expan package

Controlling Expansion of Function Arguments

13 Brief overview

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^AT_EX3 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.

14 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` wouldn't be 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.

14.1 Methods for defining variants

	<code>\cs_generate_variant:Nn</code>	<i><function></i>	<i><variant argument></i>
<code>\cs_generate_variant:Nn</code>	<code>\cs_generate_variant:Nn</code>	<code>\foo:Nn</code>	<code>{c}</code>
	<code>\cs_generate_variant:Nn</code>	<code>\foo:Nn</code>	<code>{c,Nx,cx}</code>

This function greatly simplify the task of defining variations on a base function with differing expansion control. The first example is equivalent to writing

```

\cs_set_nopar:Npn \foo:cn { \exp_args:Nc \foo:Nn }

```

If used with a comma-separated list of variants, it does so for each variant form, i.e., the second example is equivalent to

```

\cs_set_nopar:Npn \foo:cn { \exp_args:Nc \foo:Nn }
\cs_set_nopar:Npn \foo:Nx { \exp_args:NNx \foo:Nn }
\cs_set_nopar:Npn \foo:cx { \exp_args:Ncx \foo:Nn }

```

Internal functions

<code>\cs_generate_internal_variant:n</code>	<code>\cs_generate_internal_variant:n</code>	<code>{<args>}</code>
--	--	-----------------------------

Defines the appropriate `\exp_args:N<args>` function, if necessary, to perform the expansion control specified by *<args>*.

15 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 very fast.
- In general `n`, `x`, and `o` (if not in the last position) will need special processing which is not fast and not expandable, i.e., functions of this type may not work correctly in arguments that are itself subject to `x` expansion. Therefore it is best to use the “expandable” functions (i.e., those that contain only `c`, `N`, `o` or `f` in the last position) whenever possible.

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 `<toks>` register. In this example we assume `\l_tmpa_tl` contains the text string `lur`. The straight forward approach is

```
\toks_set:No \l_tmpa_toks {\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_tmpa_toks` and not `\cs_set_eq:NwN \aaa = \blurb` as we probably wanted. Using `\toks_set:Nx` is not an option as that will die horribly. Instead we can do a

```
\toks_set:Nf \l_tmpa_toks {\cs_set_eq:Nc \aaa {b \l_tmpa_tl b}}
```

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

```
\cs_set_nopar:Npn \toks_set:Nf {\exp_args:NNf \toks_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!

When pdfTeX 1.50 arrives, it will contain a primitive for performing the equivalent of an `x` expansion after only one expansion and most importantly: as an expandable operation.

`\exp_arg:x` `\exp_arg:x {⟨arg⟩}`
`⟨arg⟩` is expanded fully using an `x` expansion.

16 Manipulating the first argument

`\exp_args:No *` `\exp_args:No ⟨funct⟩ ⟨arg1⟩ ⟨arg2⟩ ...`
The first argument of `⟨funct⟩` (i.e., `⟨arg1⟩`) is expanded once, the result is surrounded by braces and passed to `⟨funct⟩`. `⟨funct⟩` may have more than one argument—all others are passed unchanged.

`\exp_args:Nc *`
`\exp_args:cc *` `\exp_args:Nc ⟨funct⟩ ⟨arg1⟩ ⟨arg2⟩ ...`
The first argument of `⟨funct⟩` (i.e., `⟨arg1⟩`) is expanded until only characters remain. (An internal error occurs if something else is the result of this expansion.) Then the result is turned into a control sequence and passed to `⟨funct⟩` as the first argument. `⟨funct⟩` may have more than one argument—all others are passed unchanged.

In the `:cc` variant, the `⟨funct⟩` control sequence itself is constructed (with the same process as described above) before `⟨arg1⟩` is turned into a control sequence and passed as its argument.

`\exp_args:Nv *` `\exp_args:Nv ⟨funct⟩ ⟨register⟩`
The first argument of `⟨funct⟩` (i.e., `⟨register⟩`) is expanded to its value. By value we mean a number stored in an `int` or `num` register, the length value of a `dim`, `skip` or `muskip` register, the contents of a `toks` register or the unexpanded contents of a `tl var.` register. The value is passed onto `⟨funct⟩` in braces.

`\exp_args:Nv *` `\exp_args:Nv ⟨funct⟩ {⟨register⟩}`
Like the `V` type except the register is given by a list of characters from which a control sequence name is generated.

`\exp_args:Nx` `\exp_args:Nx ⟨funct⟩ ⟨arg1⟩ ⟨arg2⟩ ...`
The first argument of `⟨funct⟩` (i.e., `⟨arg1⟩`) is fully expanded until only unexpandable tokens remain, the result is surrounded by braces and passed to `⟨funct⟩`. `⟨funct⟩` may have more than one argument—all others are passed unchanged. As mentioned before, this type of function is relatively slow.

<code>\exp_args:Nf *</code>

`\exp_args:Nf <funct> <arg1> <arg2> ...`

The first argument of $\langle\textit{funct}\rangle$ (i.e., $\langle\textit{arg}_1\rangle$) undergoes full expansion until the first unexpandable token is encountered, the result is surrounded by braces and passed to $\langle\textit{funct}\rangle$. $\langle\textit{funct}\rangle$ may have more than one argument—all others are passed unchanged. Beware of its special behavior as explained above.

17 Manipulating two arguments

<code>\exp_args:NNx</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>

`\exp_args:Nnx <funct> <arg1> <arg2> ...`

The above functions all manipulate the first two arguments of $\langle\textit{funct}\rangle$. They are all slow and non-expandable.

<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: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:Nco *</code>
<code>\exp_args:Ncf *</code>
<code>\exp_args:Ncc *</code>
<code>\exp_args:Nff *</code>
<code>\exp_args:Nfo *</code>
<code>\exp_args:NVV *</code>

`\exp_args:NNo <funct> <arg1> <arg2> ...`

These are the fast and expandable functions for the first two arguments.

18 Manipulating three arguments

So far not all possible functions are provided and even the selection below may be reduced in the future as far as the non-expandable functions are concerned.

<code>\exp_args:NNnx</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>

`\exp_args:Nnnx <funct> <arg1> <arg2> <arg3> ...`

All the above functions are non-expandable.

<code>\exp_args:NNNo *</code>
<code>\exp_args:NNNV *</code>
<code>\exp_args:NNoo *</code>
<code>\exp_args:NNno *</code>
<code>\exp_args:Nnno *</code>
<code>\exp_args:Nnnc *</code>
<code>\exp_args:Nooo *</code>
<code>\exp_args:Nccc *</code>
<code>\exp_args:NcNc *</code>
<code>\exp_args:NcNo *</code>
<code>\exp_args:Ncco *</code>

`\exp_args:NNoo <funct> <arg1> <arg2> <arg3> ...`

These are the fast and expandable functions for the first three arguments.

19 Preventing expansion

<code>\exp_not:N</code>
<code>\exp_not:c</code>
<code>\exp_not:n</code>

`\exp_not:N <token>`
`\exp_not:n {<token list>}`

This function will prohibit the expansion of *<token>* in situation where *<token>* would otherwise be replaced by its definition, e.g., inside an argument that is handled by the **x** convention.

T_EXhackers note: `\exp_not:N` is the primitive `\noexpand` renamed and `\exp_not:n` is the ϵ -T_EX primitive `\unexpanded`.

<code>\exp_not:o</code>
<code>\exp_not:d</code>
<code>\exp_not:f</code>

`\exp_not:o {<token list>}`

Same as `\exp_not:n` except *<token list>* is expanded once for the **o** type and twice for the **d** type and the result of this expansion is then prohibited from being expanded further.

<code>\exp_not:V</code>
<code>\exp_not:v</code>

`\exp_not:V <register>`
`\exp_not:v {<token list>}`

The value of *<register>* is retrieved and then passed on to `\exp_not:n` which will prohibit

further expansion. The `v` type first creates a control sequence from $\langle token\ list \rangle$ but is otherwise identical to `V`.

```
\exp_stop_f: \langle f expansion \rangle ... \exp_stop_f:
```

This function stops an `f` type expansion. An example use is one such as

```
\tl_set:Nf \l_tmpa_tl {
  \if_case:w \l_tmpa_int
    \or: \use_i_after_orelse:nw {\exp_stop_f: \textbullet}
    \or: \use_i_after_orelse:nw {\exp_stop_f: \textendash}
    \else: \use_i_after_fi:nw {\exp_stop_f: else-item}
  \fi:
}
```

This ensures the expansion is stopped right after finishing the conditional but without expanding `\textbullet` etc.

T_EXhackers note: This function is a space token but it is better to distinguish this expansion stopping token from a desired space token when writing code.

20 Unbraced expansion

```
\exp_last_unbraced:Nf
\exp_last_unbraced:NV
\exp_last_unbraced:Nv
\exp_last_unbraced:NcV
\exp_last_unbraced:NNNo
\exp_last_unbraced:NNV
\exp_last_unbraced:NNNo \exp_last_unbraced:NV \langle token \rangle \langle variable name \rangle
```

There are a small number of occasions where the last argument in an expansion run must be expanded unbraced. These functions should only be used inside functions, *not* for creating variants.

Part V

The l3prg package

Program control structures

21 Conditionals and logical operations

Conditional processing in L^AT_EX3 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 $\langle true \rangle$ and $\langle false \rangle$ but other states are possible, say an $\langle error \rangle$ state for erroneous input, e.g., text as input in a function comparing integers.

L^AT_EX3 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 $\langle true \rangle$ or $\langle false \rangle$. 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 $\langle true \rangle$ or $\langle false \rangle$ 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 $\langle true \rangle$ or $\langle false \rangle$ depending on the result. Important to note here is that the arguments are executed after exiting the underlying `\if... \fi:` structure

22 Defining a set of conditional functions

`\prg_return_true:`

`\prg_return_false:`

These functions exit conditional processing when used in conjunction with the generating functions listed below.

`\prg_set_conditional:Nnn`

`\prg_set_conditional:Npnn`

`\prg_new_conditional:Nnn`

`\prg_new_conditional:Npnn`

`\prg_set_protected_conditional:Nnn`

`\prg_set_protected_conditional:Npnn`

`\prg_new_protected_conditional:Nnn`

`\prg_new_protected_conditional:Npnn`

`\prg_set_eq_conditional:NNn`

`\prg_new_eq_conditional:NNn`

`\prg_set_conditional:Nnn <test> <conds> <code>`

`\prg_set_conditional:Npnn <test> <param> <conds> <code>`

This defines a conditional *<base function>* which upon evaluation using `\prg_return_true:` and `\prg_return_false:` to finish branches, returns a state. Currently the states are either $\langle true \rangle$ or $\langle false \rangle$ although this can change as more states may be introduced, say an $\langle error \rangle$ state. $\langle conds \rangle$ is a comma separated list possibly consisting of p for denoting a predicate function returning the boolean $\langle true \rangle$ or $\langle false \rangle$ values and TF, T and F for the functions that act on the tokens following in the input stream. The `:Nnn` form implicitly determines the number of arguments from the function being defined whereas the `:Npnn` form expects a primitive parameter text.

An example can easily clarify matters here:

```
\prg_set_conditional:Nnn \foo_if_bar:NN {p,TF,T} {
  \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.

23 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 <bool></code>
--	---------------------------------------

Define a new boolean variable. The initial value is `<false>`. A boolean is actually just either `\c_true_bool` or `\c_false_bool`.

<code>\bool_set_true:N</code> <code>\bool_set_true:c</code> <code>\bool_set_false:N</code> <code>\bool_set_false:c</code> <code>\bool_gset_true:N</code> <code>\bool_gset_true:c</code> <code>\bool_gset_false:N</code> <code>\bool_gset_false:c</code>	<code>\bool_gset_false:N <bool></code>
--	--

Set `<bool>` either `<true>` or `<false>`. We can also do this globally.

<code>\bool_set_eq:NN</code>
<code>\bool_set_eq:Nc</code>
<code>\bool_set_eq:cN</code>
<code>\bool_set_eq:cc</code>
<code>\bool_gset_eq:NN</code>
<code>\bool_gset_eq:Nc</code>
<code>\bool_gset_eq:cN</code>
<code>\bool_gset_eq:cc</code>

`\bool_set_eq:NN` $\langle bool_1 \rangle$ $\langle bool_2 \rangle$
Set $\langle bool_1 \rangle$ equal to the value of $\langle bool_2 \rangle$.

<code>\bool_if_p:N *</code>
<code>\bool_if:NTF *</code>
<code>\bool_if_p:c *</code>
<code>\bool_if:cTF *</code>

`\bool_if:NTF` $\langle bool \rangle$ $\{\langle true \rangle\}$ $\{\langle false \rangle\}$
`\bool_if_p:N` $\langle bool \rangle$

Test the truth value of $\langle bool \rangle$ and execute the $\langle true \rangle$ or $\langle false \rangle$ code. `\bool_if_p:N` is a predicate function for use in `\if_predicate:w` tests or `\bool_if:NTF`-type functions described below.

<code>\bool_while_do:Nn</code>
<code>\bool_while_do:cn</code>
<code>\bool_until_do:Nn</code>
<code>\bool_until_do:cn</code>
<code>\bool_do_while:Nn</code>
<code>\bool_do_while:cn</code>
<code>\bool_do_until:Nn</code>
<code>\bool_do_until:cn</code>

`\bool_while_do:Nn` $\langle bool \rangle$ $\{\langle code \rangle\}$
`\bool_until_do:Nn` $\langle bool \rangle$ $\{\langle code \rangle\}$

The ‘while’ versions execute $\langle code \rangle$ as long as the boolean is true and the ‘until’ versions execute $\langle code \rangle$ as long as the boolean is false. The `while_do` functions execute the body after testing the boolean and the `do_while` functions executes the body first and then tests the boolean.

24 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 *boolean expressions*.

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,

```
\intexpr_compare_p:n {1=1} &&
(
  \intexpr_compare_p:n {2=3} ||
  \intexpr_compare_p:n {4=4} ||
  \intexpr_compare_p:n {1=\error} % is skipped
) &&
!(\intexpr_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 anymore, the remaining tests within the current group are skipped.

<code>\bool_if_p:n *</code>	<code>\bool_if:nTF {<boolean expression>} {<true>}</code>
<code>\bool_if:nTF *</code>	<code>{<false>}</code>

The functions evaluate the truth value of *<boolean expression>* where each predicate is separated by `&&` or `||` denoting logical ‘And’ and ‘Or’ functions. `(` and `)` denote grouping of sub-expressions while `!` is used to as a prefix to either negate a single expression or a group. Hence

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

from above returns *<true>*.

Logical operators take higher precedence the later in the predicate they appear. “*<x> || <y> && <z>*” is interpreted as the equivalent of “*<x> OR [<y> AND <z>]*” (but now we have grouping you shouldn’t write this sort of thing, anyway).

<code>\bool_not_p:n *</code>	<code>\bool_not_p:n {<boolean expression>}</code>
------------------------------	---

Longhand for writing `!(<boolean expression>)` within a boolean expression. Might not stick around.

<code>\bool_xor_p:nn *</code>	<code>\bool_xor_p:nn {<boolean expression>} {<boolean expression>}</code>
-------------------------------	---

Implements an ‘exclusive or’ operation between two boolean expressions. There is no infix operation for this.

<code>\bool_set:Nn</code>	<code>\bool_set:Nn <bool> {<boolean expression>}</code>
<code>\bool_set:cn</code>	
<code>\bool_gset:Nn</code>	
<code>\bool_gset:cn</code>	

Sets *<bool>* to the logical outcome of evaluating *<boolean expression>*.

25 Case switches

```

\prg_case_int:nnn {\integer expr} {
  {\integer expr_1} {\code_1}
  {\integer expr_2} {\code_2}
  ...
  {\integer expr_n} {\code_n}
\prg_case_int:nnn * } {\else case}

```

This function evaluates the first $\langle integer\ expr \rangle$ and then compares it to the values found in the list. Thus the expression

```

\prg_case_int:nnn{2*5}{
  {5}{Small} {4+6}{Medium} {-2*10}{Negative}
}{Other}

```

evaluates first the term to look for and then tries to find this value in the list of values. If the value is found, the code on its right is executed after removing the remainder of the list. If the value is not found, the $\langle else\ case \rangle$ is executed. The example above will return “Medium”.

The function is expandable and is written in such a way that **f** style expansion can take place cleanly, i.e., no tokens from within the function are left over.

```

\prg_case_int:nnn {\dim expr} {
  {\dim expr_1} {\code_1}
  {\dim expr_2} {\code_2}
  ...
  {\dim expr_n} {\code_n}
\prg_case_dim:nnn * } {\else case}

```

This function works just like `\prg_case_int:nnn` except it works for $\langle dim \rangle$ registers.

```

\prg_case_str:nnn {\string} {
  {\string_1} {\code_1}
  {\string_2} {\code_2}
  ...
  {\string_n} {\code_n}
\prg_case_str:nnn * } {\else case}

```

This function works just like `\prg_case_int:nnn` except it compares strings. Each string is evaluated fully using **x** style expansion.

The function is expandable³ and is written in such a way that **f** style expansion can take place cleanly, i.e., no tokens from within the function are left over.

```

\prg_case_tl:Nnn \tl var. {
  \tl var.1} {\code_1} \tl var.2} {\code_2} ... \tl var.n}
{\code_n}
\prg_case_tl:Nnn * } {\else case}

```

This function works just like `\prg_case_int:nnn` except it compares token list variables.

The function is expandable⁴ and is written in such a way that **f** style expansion can take place cleanly, i.e., no tokens from within the function are left over.

³Provided you use pdfTeX v1.30 or later

⁴Provided you use pdfTeX v1.30 or later

26 Generic loops

<code>\bool_while_do:nn</code> <code>\bool_until_do:nn</code> <code>\bool_do_while:nn</code> <code>\bool_do_until:nn</code>	<code>\bool_while_do:nn {<boolean expression>} {<code>}</code> <code>\bool_until_do:nn {<boolean expression>} {<code>}</code>
--	--

The ‘while’ versions execute the code as long as *<boolean expression>* is true and the ‘until’ versions execute *<code>* as long as *<boolean expression>* is false. The `while_do` functions execute the body after testing the boolean and the `do_while` functions executes the body first and then tests the boolean.

27 Choosing modes

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

Determines if T_EX is in vertical mode or not and executes either *<true code>* or *<false code>* accordingly.

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

Determines if T_EX is in horizontal mode or not and executes either *<true code>* or *<false code>* accordingly.

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

Determines if T_EX is in inner mode or not and executes either *<true code>* or *<false code>* accordingly.

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

Determines if T_EX is in math mode or not and executes either *<true code>* or *<false code>* accordingly.

T_EXhackers note: This version will choose the right branch even at the beginning of an alignment cell.

28 Alignment safe grouping and scanning

<code>\scan_align_safe_stop:</code>

`\scan_align_safe_stop:`

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

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

`\group_align_safe_begin: <...> \group_align_safe_end:`

Encloses `<...>` inside a group but is safe inside an alignment cell. See the implementation of `\peek_token_generic:NNTF` for an application.

29 Producing n copies

There are often several different requirements for producing multiple copies of something. Sometimes one might want to produce a number of identical copies of a sequence of tokens whereas at other times the goal is to simulate a for loop as known from most real programming languages.

<code>\prg_replicate:nn *</code>

`\prg_replicate:nn {<number>} {<arg>}`

Creates `<number>` copies of `<arg>`. Note that it is expandable.

<code>\prg_stepwise_function:nnnN *</code>
--

`\prg_stepwise_function:nnnN {<start>} {<step>} {<end>} {<function>}`

This function performs `<action>` once for each step starting at `<start>` and ending once `<end>` is passed. `<function>` is placed directly in front of a brace group holding the current number so it should usually be a function taking one argument.

<code>\prg_stepwise_inline:nnnn</code>
--

`\prg_stepwise_inline:nnnn {<start>} {<step>} {<end>} {<action>}`

Same as `\prg_stepwise_function:nnnN` except here `<action>` is performed each time with `##1` as a placeholder for the number currently being tested. This function is not expandable and it is nestable.

<code>\prg_stepwise_variable:nnnNn</code>

`\prg_stepwise_variable:nnnNn {<start>} {<step>} {<end>} {<temp-var>} {<action>}`

Same as `\prg_stepwise_inline:nnnn` except here the current value is stored in `<temp-var>` and the programmer can use it in `<action>`. This function is not expandable.

30 Sorting

<code>\prg_quicksort:n</code>	<code>\prg_quicksort:n { {\langle item_1 \rangle} {\langle item_2 \rangle} ... {\langle item n \rangle} }</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_function:n {\langle element \rangle}</code>
<code>\prg_quicksort_compare:nnTF</code>	<code>\prg_quicksort_compare:nnTF {\langle element_1 \rangle} {\langle element_2 \rangle}</code>

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

```
\cs_set_nopar:Nn\prg_quicksort_function:n {{#1}}
\cs_set_nopar:Nn\prg_quicksort_compare:nnTF {\intexpr_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:Nn\prg_quicksort_compare:nnTF {
\intexpr_compare:nNnTF{\tl_compare:nn{#1}{#2}}>\c_zero }
```

Part VI

The l3quark package

“Quarks”

A special type of constants in L^AT_EX3 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_`.

The documentation needs some updating.

31 Functions

<code>\quark_new:N</code>

`\quark_new:N <quark>`

Defines `<quark>` to be a new constant of type `quark`.

<code>\quark_if_no_value_p:n *</code>	<code>\quark_if_no_value:nTF <token list> <true code> <false code></code> <code>\quark_if_no_value_p:N *</code> <code>\quark_if_no_value:NTF <tl var.> <true code> <false code></code>
<code>\quark_if_no_value:nTF *</code>	
<code>\quark_if_no_value_p:N *</code>	
<code>\quark_if_no_value:NTF *</code>	

This tests whether or not `<token list>` contains only the quark `\q_no_value`.

If `<token list>` to be tested is stored in a token list variable use `\quark_if_no_value:NTF`, or `\quark_if_no_value:NF` or check the value directly with `\if_meaning:w`. All those cases are faster than `\quark_if_no_value:nTF` so should be preferred.⁵

T_EXhackers note: But be aware of the fact that `\if_meaning:w` can result in an overflow of T_EX's parameter stack since it leaves the corresponding `\fi:` on the input until the whole replacement text is processed. It is therefore better in recursions to use `\quark_if_no_value:NTF` as it will remove the conditional prior to processing the T or F case and so allows tail-recursion.

<code>\quark_if_nil_p:N *</code>
<code>\quark_if_nil:NTF *</code>

`\quark_if_nil:NTF <token> <true code> <false code>`

This tests whether or not `<token>` is equal to the quark `\q_nil`.

This is a useful test for recursive loops which typically has `\q_nil` as an end marker.

<code>\quark_if_nil_p:n *</code>	<code>\quark_if_nil:nTF <tokens> <true code> <false code></code>
<code>\quark_if_nil_p:V *</code>	
<code>\quark_if_nil_p:o *</code>	
<code>\quark_if_nil:nTF *</code>	
<code>\quark_if_nil:VTF *</code>	
<code>\quark_if_nil:oTF *</code>	

This tests whether or not `<tokens>` is equal to the quark `\q_nil`.

This is a useful test for recursive loops which typically has `\q_nil` as an end marker.

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.

⁵Clarify semantic of the “n” case ... i think it is not implement according to what we originally intended /FMi

`\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.

<code>\quark_if_recursion_tail_stop:N *</code> <code>\quark_if_recursion_tail_stop:n *</code> <code>\quark_if_recursion_tail_stop:o *</code>	<code>\quark_if_recursion_tail_stop:n {⟨list element⟩}</code> <code>\quark_if_recursion_tail_stop:N ⟨list element⟩</code>
--	--

This tests whether or not *⟨list element⟩* is equal to `\q_recursion_tail` and then exits, i.e., it gobbles the remainder of the list up to and including `\q_recursion_stop` which *must* be present.

If *⟨list element⟩* is not under your complete control it is advisable to use the `n`. If you wish to use the `N` form you *must* ensure it is really a single token such as if you have

`\tl_set:Nn \l_tmpa_tl { ⟨list element⟩ }`

<code>\quark_if_recursion_tail_stop_do:Nn *</code> <code>\quark_if_recursion_tail_stop_do:nn *</code> <code>\quark_if_recursion_tail_stop_do:on *</code>	<code>\quark_if_recursion_tail_stop_do:nn</code> <code> {⟨list element⟩} {⟨post action⟩}</code> <code>\quark_if_recursion_tail_stop_do:Nn</code> <code> ⟨list element⟩ {⟨post action⟩}</code>
--	--

Same as `\quark_if_recursion_tail_stop:N` except here the second argument is executed after the recursion has been terminated.

33 Constants

`\q_no_value` The canonical ‘missing value quark’ that is returned by certain functions to denote that a requested value is not found in the data structure.

`\q_stop` This constant is used as a a marker in parameter text. This allows a scanning function to find the end of some input string.

`\q_nil` This constant represent the nil pointer in pointer structures.

`\q_error` Delimits the end of the computation for purposes of error recovery.

`\q_mark` Used in parameter text when we need a scanning boundary that is distinct from `\q_stop`.

Part VII

The l3token package

A token of my appreciation...

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 T_EX, 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 Character tokens

<code>\char_set_catcode:nn</code>	
<code>\char_set_catcode:w</code>	
<code>\char_value_catcode:n</code>	<code>\char_set_catcode:nn {<char number>} {<number>}</code>
<code>\char_value_catcode:w</code>	<code>\char_set_catcode:w <char> = <number></code>
<code>\char_show_value_catcode:n</code>	<code>\char_value_catcode:n {<char number>}</code>
<code>\char_show_value_catcode:w</code>	<code>\char_show_value_catcode:n {<char number>}</code>

`\char_set_catcode:nn` sets the category code of a character, `\char_value_catcode:n` returns its value for use in integer tests and `\char_show_value_catcode:n` pausing the typesetting and prints the value on the terminal and in the log file. The `:w` form should be avoided. (Will: should we then just not mention it?)

`\char_set_catcode` is more usefully abstracted below.

T_EXhackers note: `\char_set_catcode:w` is the T_EX primitive `\catcode` renamed.

<code>\char_make_escape:n</code>	
<code>\char_make_begin_group:n</code>	
<code>\char_make_end_group:n</code>	
<code>\char_make_math_shift:n</code>	
<code>\char_make_alignment:n</code>	
<code>\char_make_end_line:n</code>	
<code>\char_make_parameter:n</code>	
<code>\char_make_math_superscript:n</code>	
<code>\char_make_math_subscript:n</code>	
<code>\char_make_ignore:n</code>	
<code>\char_make_space:n</code>	
<code>\char_make_letter:n</code>	
<code>\char_make_other:n</code>	
<code>\char_make_active:n</code>	
<code>\char_make_comment:n</code>	<code>\char_make_letter:n {⟨character number⟩}</code>
<code>\char_make_invalid:n</code>	<code>\char_make_letter:n {64}</code>
	<code>\char_make_letter:n {'\@}</code>

Sets the catcode of the character referred to by its *⟨character number⟩*.

<code>\char_make_escape:N</code>	
<code>\char_make_begin_group:N</code>	
<code>\char_make_end_group:N</code>	
<code>\char_make_math_shift:N</code>	
<code>\char_make_alignment:N</code>	
<code>\char_make_end_line:N</code>	
<code>\char_make_parameter:N</code>	
<code>\char_make_math_superscript:N</code>	
<code>\char_make_math_subscript:N</code>	
<code>\char_make_ignore:N</code>	
<code>\char_make_space:N</code>	
<code>\char_make_letter:N</code>	
<code>\char_make_other:N</code>	
<code>\char_make_active:N</code>	
<code>\char_make_comment:N</code>	<code>\char_make_letter:N {⟨character⟩}</code>
<code>\char_make_invalid:N</code>	<code>\char_make_letter:N @</code>
	<code>\char_make_letter:N %</code>

Sets the catcode of the *⟨character⟩*, which may have to be escaped.

T_EXhackers note: `\char_make_other:N` is L^AT_EX 2_ε's `\@makeother`.

<code>\char_set_lccode:nn</code>	
<code>\char_set_lccode:w</code>	
<code>\char_value_lccode:n</code>	<code>\char_set_lccode:nn {⟨char⟩} {⟨number⟩}</code>
<code>\char_value_lccode:w</code>	<code>\char_set_lccode:w ⟨char⟩ = ⟨number⟩</code>
<code>\char_show_value_lccode:n</code>	<code>\char_value_lccode:n {⟨char⟩}</code>
<code>\char_show_value_lccode:w</code>	<code>\char_show_value_lccode:n {⟨char⟩}</code>

Set the lower caser representation of $\langle char \rangle$ for when $\langle char \rangle$ is being converted in `\tl_to_lowercase:n`. As above, the `:w` form is only for people who really, really know what they are doing.

T_EXhackers note: `\char_set_lccode:w` is the T_EX primitive `\lccode` renamed.

<pre> \char_set_uccode:nn \char_set_uccode:w \char_value_uccode:n \char_value_uccode:w \char_show_value_uccode:n \char_show_value_uccode:w </pre>	<pre> \char_set_uccode:nn {\langle char \rangle} {\langle number \rangle} \char_set_uccode:w \langle char \rangle = \langle number \rangle \char_value_uccode:n {\langle char \rangle} \char_show_value_uccode:n {\langle char \rangle} </pre>
---	--

Set the uppercase representation of $\langle char \rangle$ for when $\langle char \rangle$ is being converted in `\tl_to_uppercase:n`. As above, the `:w` form is only for people who really, really know what they are doing.

T_EXhackers note: `\char_set_uccode:w` is the T_EX primitive `\uccode` renamed.

<pre> \char_set_sfcode:nn \char_set_sfcode:w \char_value_sfcode:n \char_value_sfcode:w \char_show_value_sfcode:n \char_show_value_sfcode:w </pre>	<pre> \char_set_sfcode:nn {\langle char \rangle} {\langle number \rangle} \char_set_sfcode:w \langle char \rangle = \langle number \rangle \char_value_sfcode:n {\langle char \rangle} \char_show_value_sfcode:n {\langle char \rangle} </pre>
---	--

Set the space factor for $\langle char \rangle$.

T_EXhackers note: `\char_set_sfcode:w` is the T_EX primitive `\sfcode` renamed.

<pre> \char_set_mathcode:nn \char_set_mathcode:w \char_gset_mathcode:nn \char_gset_mathcode:w \char_value_mathcode:n \char_value_mathcode:w \char_show_value_mathcode:n \char_show_value_mathcode:w </pre>	<pre> \char_set_mathcode:nn {\langle char \rangle} {\langle number \rangle} \char_set_mathcode:w \langle char \rangle = \langle number \rangle \char_value_mathcode:n {\langle char \rangle} \char_show_value_mathcode:n {\langle char \rangle} </pre>
--	--

Set the math code for $\langle char \rangle$.

T_EXhackers note: `\char_set_mathcode:w` is the T_EX primitive `\mathcode` renamed.

35 Generic tokens

<code>\token_new:Nn</code>

`\token_new:Nn <token1> {<token2>}`

Defines $\langle token_1 \rangle$ to globally be a snapshot of $\langle token_2 \rangle$. This will be an implicit representation of $\langle token_2 \rangle$.

<code>\c_group_begin_token</code>
<code>\c_group_end_token</code>
<code>\c_math_shift_token</code>
<code>\c_alignment_tab_token</code>
<code>\c_parameter_token</code>
<code>\c_math_superscript_token</code>
<code>\c_math_subscript_token</code>
<code>\c_space_token</code>
<code>\c_letter_token</code>
<code>\c_other_char_token</code>
<code>\c_active_char_token</code>

Some useful constants. They have category codes 1, 2, 3, 4, 6, 7, 8, 10, 11, 12, and 13 respectively. They are all implicit tokens.

<code>\token_if_group_begin_p:N *</code>
<code>\token_if_group_begin:NTF *</code>

`\token_if_group_begin:NTF <token> {<true>} {<false>}`

Check if $\langle token \rangle$ is a begin group token.

<code>\token_if_group_end_p:N *</code>
<code>\token_if_group_end:NTF *</code>

`\token_if_group_end:NTF <token> {<true>} {<false>}`

Check if $\langle token \rangle$ is an end group token.

<code>\token_if_math_shift_p:N *</code>
<code>\token_if_math_shift:NTF *</code>

`\token_if_math_shift:NTF <token> {<true>} {<false>}`

Check if $\langle token \rangle$ is a math shift token.

<code>\token_if_alignment_tab_p:N *</code>
<code>\token_if_alignment_tab:NTF *</code>

`\token_if_alignment_tab:NTF <token> {<true>} {<false>}`

Check if $\langle token \rangle$ is an alignment tab token.

<code>\token_if_parameter_p:N *</code>
<code>\token_if_parameter:NTF *</code>

`\token_if_parameter:NTF <token> {<true>} {<false>}`

Check if $\langle token \rangle$ is a parameter token.

$\backslash\text{token_if_math_superscript_p:N} \star$ $\backslash\text{token_if_math_superscript:N}\underline{TF} \star$	$\backslash\text{token_if_math_superscript:N}\underline{TF} \langle token \rangle \{\langle true \rangle\} \{\langle false \rangle\}$
---	--

Check if $\langle token \rangle$ is a math superscript token.

$\backslash\text{token_if_math_subscript_p:N} \star$ $\backslash\text{token_if_math_subscript:N}\underline{TF} \star$	$\backslash\text{token_if_math_subscript:N}\underline{TF} \langle token \rangle \{\langle true \rangle\} \{\langle false \rangle\}$
---	--

Check if $\langle token \rangle$ is a math subscript token.

$\backslash\text{token_if_space_p:N} \star$ $\backslash\text{token_if_space:N}\underline{TF} \star$	$\backslash\text{token_if_space:N}\underline{TF} \langle token \rangle \{\langle true \rangle\} \{\langle false \rangle\}$
---	--

Check if $\langle token \rangle$ is a space token.

$\backslash\text{token_if_letter_p:N} \star$ $\backslash\text{token_if_letter:N}\underline{TF} \star$	$\backslash\text{token_if_letter:N}\underline{TF} \langle token \rangle \{\langle true \rangle\} \{\langle false \rangle\}$
---	---

Check if $\langle token \rangle$ is a letter token.

$\backslash\text{token_if_other_char_p:N} \star$ $\backslash\text{token_if_other_char:N}\underline{TF} \star$	$\backslash\text{token_if_other_char:N}\underline{TF} \langle token \rangle \{\langle true \rangle\} \{\langle false \rangle\}$
---	--

Check if $\langle token \rangle$ is an other char token.

$\backslash\text{token_if_active_char_p:N} \star$ $\backslash\text{token_if_active_char:N}\underline{TF} \star$	$\backslash\text{token_if_active_char:N}\underline{TF} \langle token \rangle \{\langle true \rangle\} \{\langle false \rangle\}$
---	---

Check if $\langle token \rangle$ is an active char token.

$\backslash\text{token_if_eq_meaning_p:NN} \star$ $\backslash\text{token_if_eq_meaning:NN}\underline{TF} \star$	$\backslash\text{token_if_eq_meaning:NN}\underline{TF} \langle token_1 \rangle \langle token_2 \rangle \{\langle true \rangle\} \{\langle false \rangle\}$
---	---

Check if the meaning of two tokens are identical.

$\backslash\text{token_if_eq_catcode_p:NN} \star$ $\backslash\text{token_if_eq_catcode:NN}\underline{TF} \star$	$\backslash\text{token_if_eq_catcode:NN}\underline{TF} \langle token_1 \rangle \langle token_2 \rangle \{\langle true \rangle\} \{\langle false \rangle\}$
---	---

Check if the category codes of two tokens are equal. If both tokens are control sequences the test will be true.

$\backslash\text{token_if_eq_charcode_p:NN} \star$ $\backslash\text{token_if_eq_charcode:NN}\underline{TF} \star$	$\backslash\text{token_if_eq_catcode:NN}\underline{TF} \langle token_1 \rangle \langle token_2 \rangle \{\langle true \rangle\} \{\langle false \rangle\}$
---	---

Check if the character codes of two tokens are equal. If both tokens are control sequences the test will be true.

<code>\token_if_macro_p:N *</code> <code>\token_if_macro:NTF *</code>	<code>\token_if_macro:NTF <token> {\true} {\false}</code>
--	---

Check if $\langle token \rangle$ is a macro.

<code>\token_if_cs_p:N *</code> <code>\token_if_cs:NTF *</code>	<code>\token_if_cs:NTF <token> {\true} {\false}</code>
--	--

Check if $\langle token \rangle$ is a control sequence or not. This can be useful for situations where the next token in the input stream is being looked at and you want to determine what should be done to it.

<code>\token_if_expandable_p:N *</code> <code>\token_if_expandable:NTF *</code>	<code>\token_if_expandable:NTF <token> {\true} {\false}</code>
--	--

Check if $\langle token \rangle$ is expandable or not. Note that $\langle token \rangle$ can very well be an active character.

The next set of functions here are for picking apart control sequences. Sometimes it is useful to know if a control sequence has arguments and if so, how many. Similarly its status with respect to `\long` or `\protected` is good to have. Finally it can be very useful to know if a control sequence is of a certain type: Is this $\langle toks \rangle$ register we're trying to to something with really a $\langle toks \rangle$ register at all?

<code>\token_if_long_macro_p:N *</code> <code>\token_if_long_macro:NTF *</code>	<code>\token_if_long_macro:NTF <token> {\true} {\false}</code>
--	--

Check if $\langle token \rangle$ is a “long” macro.

<code>\token_if_protected_macro_p:N *</code> <code>\token_if_protected_macro:NTF *</code>	<code>\token_if_protected_macro:NTF <token> {\true} {\false}</code>
--	---

Check if $\langle token \rangle$ is a “protected” macro. This test does *not* return $\langle true \rangle$ if the macro is also “long”, see below.

<code>\token_if_protected_long_macro_p:N *</code> <code>\token_if_protected_long_macro:NTF *</code>	<code>\token_if_protected_long_macro:NTF <token> {\true} {\false}</code>
--	--

Check if $\langle token \rangle$ is a “protected long” macro.

<code>\token_if_chardef_p:N *</code> <code>\token_if_chardef:NTF *</code>	<code>\token_if_chardef:NTF <token> {\true} {\false}</code>
--	---

Check if $\langle token \rangle$ is defined to be a chardef.

<code>\token_if_mathchardef_p:N *</code> <code>\token_if_mathchardef:NTF *</code>	<code>\token_if_mathchardef:NTF <token> {\true} {\false}</code>
--	---

Check if $\langle token \rangle$ is defined to be a mathchardef.

<code>\token_if_int_register_p:N *</code> <code>\token_if_int_register:NTF *</code>	<code>\token_if_int_register:NTF <token> {\true} {\false}</code>
--	--

Check if $\langle token \rangle$ is defined to be an integer register.

<code>\token_if_dim_register_p:N *</code> <code>\token_if_dim_register:NTF *</code>	<code>\token_if_dim_register:NTF <token> {\true} {\false}</code>
--	--

Check if $\langle token \rangle$ is defined to be a dimension register.

<code>\token_if_skip_register_p:N *</code> <code>\token_if_skip_register:NTF *</code>	<code>\token_if_skip_register:NTF <token> {\true} {\false}</code>
--	---

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

<code>\token_if_toks_register_p:N *</code> <code>\token_if_toks_register:NTF *</code>	<code>\token_if_toks_register:NTF <token> {\true} {\false}</code>
--	---

Check if $\langle token \rangle$ is defined to be a toks register.

<code>\token_get_prefix_spec:N *</code> <code>\token_get_arg_spec:N *</code> <code>\token_get_replacement_spec:N *</code>	<code>\token_get_arg_spec:N <token></code>
---	--

If token is a macro with definition `\cs_set:Npn\next #1#2{x'#1--#2'y}`, the `prefix` function will return the string `\long`, the `arg` function returns the string `#1#2` and the `replacement` function returns the string `x'#1--#2'y`. If $\langle token \rangle$ isn't a macro, these functions return the `\scan_stop:` token.

If the `arg_spec` contains the string `->`, then the `spec` function will produce incorrect results.

35.1 Useless code: because we can!

<code>\token_if_primitive_p:N *</code> <code>\token_if_primitive:NTF *</code>	<code>\token_if_primitive:NTF <token> {\true} {\false}</code>
--	---

Check if $\langle token \rangle$ is a primitive. Probably not a very useful function.

36 Peeking ahead at the next token

```
\l_peek_token
\g_peek_token
\l_peek_search_token
```

Some useful variables. Initially they are set to ?.

```
\peek_after:NN
\peek_gafter:NN \peek_after:NN <function><token>
```

Assign $\langle token \rangle$ to $\backslash l_peek_token$ and then run $\langle function \rangle$ which should perform some sort of test on this token. Leaves $\langle token \rangle$ in the input stream. $\backslash peek_gafter:NN$ does this globally to the token $\backslash g_peek_token$.

T_EXhackers note: This is the primitive $\backslash futurelet$ turned into a function.

```
\peek_meaning:N $\underline{TF}$ 
\peek_meaning_ignore_spaces:N $\underline{TF}$ 
\peek_meaning_remove:N $\underline{TF}$ 
\peek_meaning_remove_ignore_spaces:N $\underline{TF}$  \peek_meaning:N $\underline{TF}$  <token> {\true} {\false}
```

$\backslash peek_meaning:N\mathcal{TF}$ checks (by using $\backslash if_meaning:w$) if $\langle token \rangle$ equals the next token in the input stream and executes either $\langle true\ code \rangle$ or $\langle false\ code \rangle$ accordingly. $\backslash peek_meaning_remove:N\mathcal{TF}$ does the same but additionally removes the token if found. The $ignore_spaces$ versions skips blank spaces before making the decision.

T_EXhackers note: This is equivalent to L^AT_EX 2_ε's $\backslash @ifnextchar$.

```
\peek_charcode:N $\underline{TF}$ 
\peek_charcode_ignore_spaces:N $\underline{TF}$ 
\peek_charcode_remove:N $\underline{TF}$ 
\peek_charcode_remove_ignore_spaces:N $\underline{TF}$  \peek_charcode:N $\underline{TF}$  <token> {\true} {\false}
```

Same as for the $\backslash peek_meaning:N\mathcal{TF}$ functions above but these use $\backslash if_charcode:w$ to compare the tokens.

```
\peek_catcode:N $\underline{TF}$ 
\peek_catcode_ignore_spaces:N $\underline{TF}$ 
\peek_catcode_remove:N $\underline{TF}$ 
\peek_catcode_remove_ignore_spaces:N $\underline{TF}$  \peek_catcode:N $\underline{TF}$  <token> {\true} {\false}
```

Same as for the $\backslash peek_meaning:N\mathcal{TF}$ functions above but these use $\backslash if_catcode:w$ to compare the tokens.

<code>\peek_token_generic:NNTF</code> <code>\peek_token_remove_generic:NNTF</code>	<code>\peek_token_generic:NNTF</code> $\langle token \rangle$ $\langle function \rangle$ $\{\langle true \rangle\}$ $\{\langle false \rangle\}$
---	---

`\peek_token_generic:NNTF` looks ahead and checks if the next token in the input stream is equal to $\langle token \rangle$. It uses $\langle function \rangle$ to make that decision. `\peek_token_remove_generic:NNTF` does the same thing but additionally removes $\langle token \rangle$ from the input stream if it is found. This also works if $\langle token \rangle$ is either `\c_group_begin_token` or `\c_group_end_token`.

<code>\peek_execute_branches_meaning:</code> <code>\peek_execute_branches_charcode:</code> <code>\peek_execute_branches_catcode:</code>	<code>\peek_execute_branches_meaning:</code>
---	--

These functions compare the token we are searching for with the token found (after optional ignoring of specific tokens). They come in the usual three versions when T_EX is comparing tokens: meaning, character code, and category code.

Part VIII

The l3int package

Integers/counters

L^AT_EX3 maintains two type of integer registers for internal use. One (associated with the name `num`) for low level uses in the allocation mechanism using macros only and `int`: the one described here.

The `int` type uses the built-in counter registers of T_EX and is therefore relatively fast compared to the `num` type and should be preferred in all cases as there is little chance we should ever run out of registers when being based on at least ε -T_EX.

37 Functions

<code>\int_new:N</code> <code>\int_new:c</code>	<code>\int_new:N</code> $\langle int \rangle$
--	---

Globally defines $\langle int \rangle$ to be a new variable of type `int` although you can still choose if it should be a `\l_` or `\g_` type. There is no way to define constant counters with these functions.

T_EXhackers note: `\int_new:N` is the equivalent to plain T_EX's `\newcount`. However, the internal register allocation is done differently.

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

`\int_incr:N $\langle int \rangle$`

Increments $\langle int \rangle$ by one. For global variables the global versions should be used.

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

`\int_decr:N $\langle int \rangle$`

Decrements $\langle int \rangle$ by one. For global variables the global versions should be used.

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

`\int_set:Nn $\langle int \rangle$ { $\langle integer\ expr \rangle$ }`

These functions will set the $\langle int \rangle$ register to the $\langle integer\ expr \rangle$ value. This value can contain simple calc-like expressions as provided by ϵ -TeX.

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

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

These functions sets the $\langle int \rangle$ register to zero either locally or globally.

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

`\int_add:Nn $\langle int \rangle$ { $\langle integer\ expr \rangle$ }`

These functions will add to the $\langle int \rangle$ register the value $\langle integer\ expr \rangle$. If the second argument is a $\langle int \rangle$ register too, the surrounding braces can be left out.

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

`\int_gsub:Nn $\langle int \rangle$ { $\langle integer\ expr \rangle$ }`

These functions will subtract from the $\langle int \rangle$ register the value $\langle integer\ expr \rangle$. If the second argument is a $\langle int \rangle$ register too, the surrounding braces can be left out.

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

`\int_use:N $\langle int \rangle$`

This function returns the integer value kept in $\langle int \rangle$ in a way suitable for further processing.

TeXhackers note: The function `\int_use:N` could be implemented directly as the TeX primitive `\tex_the:D` which is also responsible to produce the values for other internal quantities.

We have chosen to use individual functions for counters, dimensions etc. to allow checks and to make the code more self-explaining.

<code>\int_show:N</code> <code>\int_show:c</code>
--

`\int_show:N <int>`

This function pauses the compilation and displays the integer value kept in $\langle int \rangle$ in the console output and log file.

T_EXhackers note: The function `\int_show:N` could be implemented directly as the T_EX primitive `\tex_showthe:D` which is also responsible to produce the values for other internal quantities. We have chosen to use individual functions for counters, dimensions etc. to allow checks and to make the code more self-explaining.

38 Formatting a counter value

<code>\int_to_arabic:n *</code> <code>\int_to_alph:n *</code> <code>\int_to_Alph:n *</code> <code>\int_to_roman:n *</code> <code>\int_to_Roman:n *</code> <code>\int_to_symbol:n *</code>
--

`\int_to_alph:n {<integer>}`
`\int_to_alph:n <int>`

If some $\langle integer \rangle$ or the the current value of a $\langle int \rangle$ should be displayed or typeset in a special ways (e.g., as uppercase roman numerals) these function can be used. We need braces if the argument is a simple $\langle integer \rangle$, they can be omitted in case of a $\langle int \rangle$. By default the letters produced by `\int_to_roman:n` and `\int_to_Roman:n` have catcode 11.

All functions are fully expandable and will therefore produce the correct output when used inside of deferred writes, etc. In case the number in an `alph` or `Alph` function is greater than the default base number (26) it follows a simple conversion rule so that 27 is turned into `aa`, 50 into `ax` and so on and so forth. These two functions can be modified quite easily to take a different base number and conversion rule so that other languages can be supported.

T_EXhackers note: These are more or less the internal L^AT_EX2 functions `\@arabic`, `\@alph`, `\@Alph`, `\@roman`, `\@Roman`, and `\@fnsymbol` except that `\int_to_symbol:n` is also allowed outside math mode.

38.1 Internal functions

<code>\int_to_roman:w *</code>

`\int_to_roman:w <integer> <space> or <non-expandable token>`

Converts $\langle integer \rangle$ to it lowercase roman representation. Note that it produces a string of letters with catcode 12.

T_EXhackers note: This is the T_EX primitive `\romannumeral` renamed.

<code>\int_to_number:w *</code>	<code>\int_to_number:w <integer> <space></code>
---------------------------------	---

Converts `<integer>` to its numerical string. Note that it produces a string of letters with catcode 12.

T_EXhackers note: This is the T_EX primitive `\number` renamed.

<code>\int_roman_lcuc_mapping:Nnn</code>	<code>\int_roman_lcuc_mapping:Nnn <roman_char> {\<licr>}</code>
<code>\int_to_roman_lcuc:NN</code>	<code>{\<LICR>}</code>

<code>\int_to_roman_lcuc:NN</code>	<code>\int_to_roman_lcuc:NN <roman_char> <char></code>
------------------------------------	--

`\int_roman_lcuc_mapping:Nnn` specifies how the roman numeral `<roman_char>` (i, v, x, l, c, d, or m) should be interpreted when converting the number. `<licr>` is the lower case and `<LICR>` is the uppercase mapping. `\int_to_roman_lcuc:NN` is a recursive function converting the roman numerals.

<code>\int_convert_number_with_rule:nnN</code>	<code>\int_convert_number_with_rule:nnN {\<int₁>} {\<int₂>}</code> <code><function></code> <code>\int_alph_default_conversion_rule:n {\<int>}</code>
<code>\int_alph_default_conversion_rule:n</code>	
<code>\int_Alph_default_conversion_rule:n</code>	
<code>\int_symbol_math_conversion_rule:n</code>	
<code>\int_symbol_text_conversion_rule:n</code>	

`\int_convert_number_with_rule:nnN` converts `<int1>` into letters, symbols, whatever as defined by `<function>`. `<int2>` denotes the base number for the conversion.

39 Variable and constants

<code>\int_const:Nn</code>	<code>\int_const:Nn \c_<value> {\<value>}</code>
----------------------------	--

Defines an integer constant of a certain `<value>`. If the constant is negative or very large it internally uses an `<int>` register.

```

\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_hundred_one
\c_twohundred_fifty_five
\c_twohundred_fifty_six
\c_thousand
\c_ten_thousand
\c_ten_thousand_one
\c_ten_thousand_two
\c_ten_thousand_three
\c_ten_thousand_four
\c_twenty_thousand

```

Set of constants denoting useful values.

T_EXhackers note: Some of these constants have been available under L^AT_EX2 under names like `\m@ne`, `\z@`, `\@ne`, `\tw@`, `\thr@@`, etc.

```
\c_max_int
```

Constant that denote the maximum value which can be stored in an *int* register.

```

\l_tmpa_int
\l_tmpb_int
\l_tmpc_int
\g_tmpa_int
\g_tmpb_int

```

Scratch register for immediate use. They are not used by conditionals or predicate functions.

40 Conversion

```
\int_convert_from_base_ten:nn
```

`\int_convert_from_base_ten:nn {<number>} {<base>}`

Converts the base 10 number $\langle number \rangle$ into its equivalent representation written in base $\langle base \rangle$. Expandable.

<code>\int_convert_to_base_ten:nn</code> <code>\num_convert_to_base_ten:cn</code>
--

`\int_convert_to_base_ten:nn { $\langle number \rangle$ } { $\langle base \rangle$ }`

Converts the base $\langle base \rangle$ number $\langle number \rangle$ into its equivalent representation written in base 10. $\langle number \rangle$ can consist of digits and ascii letters. Expandable.

Part IX

The l3num package

Integers in macros

Instead of using counter registers for manipulation of integer values it is sometimes useful to keep such values in macros. For this L^AT_EX3 offers the type “num”.

One reason is the limited number of registers inside T_EX. However, when using ε-T_EX this is no longer an issue. It remains to be seen if there are other compelling reasons to keep this module.

It turns out there might be as with a $\langle num \rangle$ data type, the allocation module can do its bookkeeping without the aid of $\langle int \rangle$ registers.

41 Functions

<code>\num_new:N</code> <code>\num_new:c</code>
--

`\num_new:N { $\langle num \rangle$ }`

Defines $\langle num \rangle$ to be a new variable of type num (initialized to zero). There is no way to define constant counters with these functions.

<code>\num_incr:N</code> <code>\num_incr:c</code> <code>\num_gincr:N</code> <code>\num_gincr:c</code>
--

`\num_incr:N { $\langle num \rangle$ }`

Increments $\langle num \rangle$ by one. For global variables the global versions should be used.

<code>\num_decr:N</code> <code>\num_decr:c</code> <code>\num_gdecr:N</code> <code>\num_gdecr:c</code>
--

`\num_decr:N { $\langle num \rangle$ }`

Decrements $\langle num \rangle$ by one. For global variables the global versions should be used.

<code>\num_zero:N</code>
<code>\num_zero:c</code>
<code>\num_gzero:N</code>
<code>\num_gzero:c</code>

`\num_zero:N ⟨num⟩`

Resets $\langle num \rangle$ to zero. For global variables the global versions should be used.

<code>\num_set:Nn</code>
<code>\num_set:cn</code>
<code>\num_gset:Nn</code>
<code>\num_gset:cn</code>

`\num_set:Nn ⟨num⟩ {⟨integer⟩}`

These functions will set the $\langle num \rangle$ register to the $\langle integer \rangle$ value.

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

`\num_gset_eq:NN ⟨num1⟩ ⟨num2⟩`

These functions will set the $\langle num_1 \rangle$ register equal to $\langle num_2 \rangle$.

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

`\num_gset_eq:NN ⟨num1⟩ ⟨num2⟩`

These functions will globally set the $\langle num_1 \rangle$ register equal to $\langle num_2 \rangle$.

<code>\num_add:Nn</code>
<code>\num_add:cn</code>
<code>\num_gadd:Nn</code>
<code>\num_gadd:cn</code>

`\num_add:Nn ⟨num⟩ {⟨integer⟩}`

These functions will add to the $\langle num \rangle$ register the value $\langle integer \rangle$. If the second argument is a $\langle num \rangle$ register too, the surrounding braces can be left out.

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

`\num_use:N ⟨num⟩`

This function returns the integer value kept in $\langle num \rangle$ in a way suitable for further processing.

T_EXhackers note: Since these $\langle num \rangle$ s are implemented as macros, the function `\num_use:N` is effectively a noop and mainly there for consistency with similar functions in other modules.

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

`\num_show:N ⟨num⟩`

This function pauses the compilation and displays the integer value kept in $\langle num \rangle$ on the console output.

<code>\num_elt_count:n</code>	<code>\num_elt_count:n</code> $\{ \langle \textit{balanced text} \rangle \}$
<code>\num_elt_count_prop:Nn</code>	<code>\num_elt_count_prop:Nn</code> $\langle \textit{prop} \rangle \{ \langle \textit{balanced text} \rangle \}$

Discards their arguments and puts a +1 in the input stream. Used to count elements in a token list.

42 Formatting a counter value

See the `l3int` module for ways of doing this.

43 Variable and constants

<code>\c_max_register_num</code>	Maximum number of registers; possibly engine-specific.
----------------------------------	--

<code>\l_tmpa_num</code> <code>\l_tmpb_num</code> <code>\l_tmpc_num</code> <code>\g_tmpa_num</code> <code>\g_tmpb_num</code>	Scratch register for immediate use. They are not used by conditionals or predicate functions.
--	---

44 Primitive functions

<code>\if_num:w</code>	<code>\if_num:w</code> $\langle \textit{number}_1 \rangle \langle \textit{rel} \rangle \langle \textit{number}_2 \rangle \langle \textit{true} \rangle \backslash\textit{else:} \langle \textit{false} \rangle \backslash\textit{fi:}$
------------------------	--

Compare two numbers. It is recommended to use `\intexpr_eval:n` to correctly evaluate and terminate these numbers. $\langle \textit{rel} \rangle$ is one of $<$, $=$ or $>$ with catcode 12.

T_EXhackers note: This is the T_EX primitive `\ifnum`.

<code>\if_case:w</code> <code>\or:</code>	<code>\if_case:w</code> $\langle \textit{number} \rangle \langle \textit{case}_0 \rangle \backslash\textit{or:} \langle \textit{case}_1 \rangle \backslash\textit{or:} \dots \backslash\textit{else:} \langle \textit{default} \rangle \backslash\textit{fi:}$
--	--

Chooses case $\langle \textit{number} \rangle$. If you wish to use negative numbers as well, you can offset them with `\intexpr_eval:n`.

T_EXhackers note: These are the T_EX primitives `\ifcase` and `\or`.

Part X

The l3intexpr package

Integer expressions

This module sets up evaluation of integer expressions and allows mixing `int` and `num` registers.

An integer expression is one that contains integers in the form of numbers, registers containing numbers, i.e., `int` and `num` registers plus constants like `\c_one`, standard operators `+`, `-`, `/` and `*` and parentheses to group sub-expressions.

45 Functions

`\intexpr_eval:n *`

`\intexpr_eval:n {<int expr>}`

The result of this expansion is a properly terminated *<number>*, i.e., one that can be used with `\if_case:w` and others. For example,

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

evaluates to `-6`. The result is returned after two expansions so if you find that you need to pass on the result to another function using the expansion engine, the recommendation is to use an `f` type expansion if in an expandable context or `x` otherwise.

`\intexpr_compare_p:n *`
`\intexpr_compare:nTF *`

`\intexpr_compare_p:n {<int expr1> <rel> <int expr2>}`

Compares *<int expr₁>* with *<int expr₂>* using C-like relational operators, i.e.

Less than	<code><</code>	Less than or equal	<code><=</code>
Greater than	<code>></code>	Greater than or equal	<code>>=</code>
Equal	<code>==</code> or <code>=</code>	Not equal	<code>!=</code>

Both integer expressions are evaluated fully in the process. Note the syntax, which allows natural input in the style of

`\intexpr_compare_p:n {5+3 != \l_tmpb_int}`

`=` is added for the sake of \TeX users accustomed to using a single equal sign.

`\intexpr_compare_p:nNn *`
`\intexpr_compare:nNnTF *`

`\intexpr_compare_p:nNn {<int expr1>}<rel>{<int expr2>}`

Compares *<int expr₁>* with *<int expr₂>* using one of the relations `=`, `>` or `<`. This is faster than the variant above but at the cost of requiring a little more typing and not supporting the extended set of relational operators. Note that if both expressions are normal integer variables as in

`\intexpr_compare:nNnTF \l_temp_int < \c_zero {negative}{non-negative}`

you can safely omit the braces.

<code>\intexpr_max:nn *</code>	<code>\intexpr_max:nn {<int expr₁>} {<int expr₂>}</code>
<code>\intexpr_min:nn *</code>	

Return the largest or smallest of two integer expressions.

<code>\intexpr_abs:n *</code>	<code>\intexpr_abs:n {<int expr>}</code>
-------------------------------	---

Return the numerical value of an integer expression.

<code>\intexpr_if_odd:nTF *</code>	<code>\intexpr_if_odd:nTF {<int expr>} {<true>} {<false>}</code>
<code>\intexpr_if_odd_p:n *</code>	
<code>\intexpr_if_even:nTF *</code>	
<code>\intexpr_if_even_p:n *</code>	

These functions test if an integer expression is even or odd.

<code>\intexpr_div_truncate:nn *</code>	<code>\intexpr_div_truncate:n {<int expr>} {<int expr>}</code>
<code>\intexpr_div_round:nn *</code>	
<code>\intexpr_mod:nn *</code>	

If you want the result of a division to be truncated use `\intexpr_div_truncate:nn`. `\intexpr_div_round:nn` is added for completeness. `\intexpr_mod:nn` returns the remainder of a division.

46 Primitive functions

<code>\intexpr_value:w</code>	<code>\intexpr_value:w <integer></code>
<code>\intexpr_value:w</code>	<code>\intexpr_value:w <tokens> <optional space></code>

Expands `<tokens>` until an `<integer>` is formed. One space may be gobbled in the process.

T_EXhackers note: This is the T_EX primitive `\number`.

<code>\intexpr_eval:w</code>	<code>\intexpr_eval:w <int expr> \intexpr_eval_end:</code>
<code>\intexpr_eval_end:</code>	

Evaluates `<int expr>`. The evaluation stops when an unexpandable token of catcode other than 12 is reached or `\intexpr_end:` is read. The latter is gobbled by the scanner mechanism.

T_EXhackers note: This is the ϵ -T_EX primitive `\numexpr`.

<code>\if_intexpr_compare:w</code>	<code>\if_intexpr_compare:w <number> <rel> <number> <true></code> <code>\else: <false> \fi:</code>
------------------------------------	---

Compare two numbers. It is recommended to use `\intexpr_eval:n` to correctly evaluate and terminate these numbers. `<rel>` is one of `<`, `=` or `>` with catcode 12.

T_EXhackers note: This is the T_EX primitive `\ifnum`.

<code>\if_intexpr_odd:w</code>	<code>\if_intexpr_odd:w <number> <true> \else: <false> \fi:</code>
--------------------------------	--

Execute `<true>` if `<number>` is odd, `<false>` otherwise.

T_EXhackers note: This is the T_EX primitive `\ifodd`.

<code>\if_intexpr_case:w</code> <code>\or:</code>	<code>\if_intexpr_case:w <number> <case> \or: <case> \or: ...</code> <code>\else:</code> <code><default> \fi:</code>
--	--

Chooses case `<number>`. If you wish to use negative numbers as well, you can offset them with `\intexpr_eval:n`.

T_EXhackers note: These are the T_EX primitives `\ifcase` and `\or`.

<code>\intexpr_while_do:nn</code> <code>\intexpr_until_do:nn</code> <code>\intexpr_do_while:nn</code> <code>\intexpr_do_until:nn</code>	<code>\intexpr_while_do:nn {<int expr> <rel> <int expr>} {<code>}</code>
--	--

`\intexpr_while_do:nn` tests the integer expressions against each other using a C-like `<rel>` as in `\intexpr_compare_p:n` and if true performs the `<code>` until the test fails. `\intexpr_do_while:nn` is similar but executes the `<code>` first and then performs the check, thus ensuring that the body is executed at least once. The ‘until’ versions are similar but continue the loop as long as the test is false. They could be omitted as it is just a matter of switching the arguments in the test.

<code>\intexpr_while_do:nNnn</code> <code>\intexpr_until_do:nNnn</code> <code>\intexpr_do_while:nNnn</code> <code>\intexpr_do_until:nNnn</code>	<code>\intexpr_while_do:nNnn <int expr> <rel> <int expr> {<code>}</code>
--	--

Exactly as above but instead using the syntax of `\intexpr_compare_p:nNn`.

Part XI

The l3skip package

Dimension and skip registers

L^AT_EX3 knows about two types of length registers for internal use: rubber lengths (**skips**) and rigid lengths (**dims**).

47 Skip registers

47.1 Functions

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

`\skip_new:N <skip>`

Defines $\langle skip \rangle$ to be a new variable of type **skip**.

T_EXhackers note: `\skip_new:N` is the equivalent to plain T_EX's `\newskip`. However, the internal register allocation is done differently.

<code>\skip_zero:N</code>
<code>\skip_zero:c</code>
<code>\skip_gzero:N</code>
<code>\skip_gzero:c</code>

`\skip_zero:N <skip>`

Locally or globally reset $\langle skip \rangle$ to zero. For global variables the global versions should be used.

<code>\skip_set:Nn</code>
<code>\skip_set:cn</code>
<code>\skip_gset:Nn</code>
<code>\skip_gset:cn</code>

`\skip_set:Nn <skip> {<skip value>}`

These functions will set the $\langle skip \rangle$ register to the $\langle length \rangle$ value.

<code>\skip_add:Nn</code>
<code>\skip_add:cn</code>
<code>\skip_gadd:Nn</code>
<code>\skip_gadd:cn</code>

`\skip_add:Nn <skip> {<length>}`

These functions will add to the $\langle skip \rangle$ register the value $\langle length \rangle$. If the second argument is a $\langle skip \rangle$ register too, the surrounding braces can be left out.

<code>\skip_sub:Nn</code>
<code>\skip_gsub:Nn</code>

`\skip_gsub:Nn <skip> {<length>}`

These functions will subtract from the $\langle skip \rangle$ register the value $\langle length \rangle$. If the second argument is a $\langle skip \rangle$ register too, the surrounding braces can be left out.

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

`\skip_use:N <skip>`

This function returns the length value kept in `<skip>` in a way suitable for further processing.

T_EXhackers note: The function `\skip_use:N` could be implemented directly as the T_EX primitive `\tex_the:D` which is also responsible to produce the values for other internal quantities. We have chosen to use individual functions for counters, dimensions etc. to allow checks and to make the code more self-explanatory.

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

`\skip_show:N <skip>`

This function pauses the compilation and displays the length value kept in `<skip>` in the console output and log file.

T_EXhackers note: The function `\skip_show:N` could be implemented directly as the T_EX primitive `\tex_showthe:D` which is also responsible to produce the values for other internal quantities. We have chosen to use individual functions for counters, dimensions etc. to allow checks and to make the code more self-explaining.

<code>\skip_horizontal:N</code>	<code>\skip_horizontal:N <skip></code> <code>\skip_horizontal:n {<length>}</code>
<code>\skip_horizontal:c</code>	
<code>\skip_horizontal:n</code>	
<code>\skip_vertical:N</code>	
<code>\skip_vertical:c</code>	
<code>\skip_vertical:n</code>	

The `hor` functions insert `<skip>` or `<length>` with the T_EX primitive `\hskip`. The `vertical` variants do the same with `\vskip`. The `n` versions evaluate `<length>` with `\skip_eval:n`.

<code>\skip_if_infinite_glue_p:n</code>
<code>\skip_if_infinite_glue:nTF</code>

`\skip_if_infinite_glue:nTF {<skip>} {<true>} {<false>}`

Checks if `<skip>` contains infinite stretch or shrink components and executes either `<true>` or `<false>`. Also works on input like `3pt plus .5in`.

<code>\skip_split_finite_else_action:nnNN</code>	<code>\skip_split_finite_else_action:nnNN {<skip>} {<action>}</code>
	<code><dimen₁> <dimen₂></code>

Checks if `<skip>` contains finite glue. If it does then it assigns `<dimen1>` the stretch component and `<dimen2>` the shrink component. If it contains infinite glue set `<dimen1>` and `<dimen2>` to zero and execute `#2` which is usually an error or warning message of some sort.

<code>\skip_eval:n *</code>

`\skip_eval:n {<skip expr>}`

Evaluates the value of `<skip expr>` so that `\skip_eval:n {5pt plus 3fil + 3pt minus 1fil}` puts `8.0pt plus 3.0fil minus 1.0fil` back into the input stream. Expandable.

T_EXhackers note: This is the ε -T_EX primitive `\glueexpr` turned into a function taking an argument.

47.2 Formatting a skip register value

47.3 Variable and constants

<code>\c_max_skip</code>	Constant that denotes the maximum value which can be stored in a $\langle skip \rangle$ register.
--------------------------	---

<code>\c_zero_skip</code>	Set of constants denoting useful values.
---------------------------	--

<code>\l_tmpa_skip</code> <code>\l_tmpb_skip</code> <code>\l_tmpc_skip</code> <code>\g_tmpa_skip</code> <code>\g_tmpb_skip</code>	Scratch register for immediate use.
---	-------------------------------------

48 Dim registers

48.1 Functions

<code>\dim_new:N</code> <code>\dim_new:c</code>	<code>\dim_new:N</code> $\langle dim \rangle$
--	---

Defines $\langle dim \rangle$ to be a new variable of type `dim`.

T_EXhackers note: `\dim_new:N` is the equivalent to plain T_EX's `\newdimen`. However, the internal register allocation is done differently.

<code>\dim_zero:N</code> <code>\dim_zero:c</code> <code>\dim_gzero:N</code> <code>\dim_gzero:c</code>	<code>\dim_zero:N</code> $\langle dim \rangle$
--	--

Locally or globally reset $\langle dim \rangle$ to zero. For global variables the global versions should be used.

<code>\dim_set:Nn</code> <code>\dim_set:Nc</code> <code>\dim_set:cn</code> <code>\dim_gset:Nn</code> <code>\dim_gset:Nc</code> <code>\dim_gset:cn</code> <code>\dim_gset:cc</code>	<code>\dim_set:Nn</code> $\langle dim \rangle$ $\{ \langle dim \text{ value} \rangle \}$
--	--

These functions will set the $\langle dim \rangle$ register to the $\langle dim \text{ value} \rangle$ value.

<code>\dim_add:Nn</code>
<code>\dim_add:Nc</code>
<code>\dim_add:cn</code>
<code>\dim_gadd:Nn</code>
<code>\dim_gadd:cn</code>

`\dim_add:Nn` $\langle dim \rangle$ $\{ \langle length \rangle \}$

These functions will add to the $\langle dim \rangle$ register the value $\langle length \rangle$. If the second argument is a $\langle dim \rangle$ register too, the surrounding braces can be left out.

<code>\dim_sub:Nn</code>
<code>\dim_sub:Nc</code>
<code>\dim_sub:cn</code>
<code>\dim_gsub:Nn</code>
<code>\dim_gsub:cn</code>

`\dim_gsub:Nn` $\langle dim \rangle$ $\{ \langle length \rangle \}$

These functions will subtract from the $\langle dim \rangle$ register the value $\langle length \rangle$. If the second argument is a $\langle dim \rangle$ register too, the surrounding braces can be left out.

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

`\dim_use:N` $\langle dim \rangle$

This function returns the length value kept in $\langle dim \rangle$ in a way suitable for further processing.

T_EXhackers note: The function `\dim_use:N` could be implemented directly as the T_EX primitive `\tex_the:D` which is also responsible to produce the values for other internal quantities. We have chosen to use individual functions for counters, dimensions etc. to allow checks and to make the code more self-explanatory.

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

`\dim_show:N` $\langle skip \rangle$

This function pauses the compilation and displays the length value kept in $\langle skip \rangle$ in the console output and log file.

T_EXhackers note: The function `\dim_show:N` could be implemented directly as the T_EX primitive `\tex_showthe:D` which is also responsible to produce the values for other internal quantities. We have chosen to use individual functions for counters, dimensions etc. to allow checks and to make the code more self-explaining.

<code>\dim_eval:n</code>

`\dim_eval:n` $\{ \langle dim \ expr \rangle \}$

Evaluates the value of a dimension expression so that `\dim_eval:n {5pt+3pt}` puts 8pt back into the input stream. Expandable.

T_EXhackers note: This is the ε -T_EX primitive `\dimexpr` turned into a function taking an argument.

<code>\if_dim:w</code>	<code>\if_dim:w <dimen_1> <rel> <dimen_2> <true> \else: <false> \fi:</code>
------------------------	---

Compare two dimensions. It is recommended to use `\dim_eval:n` to correctly evaluate and terminate these numbers. `<rel>` is one of `<`, `=` or `>` with catcode 12.

T_EXhackers note: This is the T_EX primitive `\ifdim`.

<code>\dim_compare:nNnTF *</code>	<code>\dim_compare:nNnTF {<dim expr>} <rel> {<dim expr>}</code>
<code>\dim_compare_p:nNn *</code>	

These functions test two dimension expressions against each other. They are both evaluated by `\dim_eval:n`. Note that if both expressions are normal dimension variables as in

```
\dim_compare:nNnTF \l_temp_dim < \c_zero_skip {negative}{non-negative}
```

you can safely omit the braces.

T_EXhackers note: This is the T_EX primitive `\ifdim` turned into a function.

<code>\dim_while_do:nNnn</code>	<code>\dim_while_do:nNnn <dim expr> <rel> <dim expr> <code></code>
<code>\dim_until_do:nNnn</code>	
<code>\dim_do_while:nNnn</code>	
<code>\dim_do_until:nNnn</code>	

`\dim_while_do:nNnn` tests the dimension expressions and if true performs `<code>` repeatedly while the test remains true. `\dim_do_while:nNnn` is similar but executes the body first and then performs the check, thus ensuring that the body is executed at least once. The ‘until’ versions are similar but continue the loop as long as the test is false.

48.2 Variable and constants

<code>\c_max_dim</code>	Constant that denotes the maximum value which can be stored in a <code><dim></code> register.
-------------------------	---

<code>\c_zero_dim</code>	Set of constants denoting useful values.
--------------------------	--

<code>\l_tmpa_dim</code>	Scratch register for immediate use.
<code>\l_tmpb_dim</code>	
<code>\l_tmpc_dim</code>	
<code>\l_tmpe_dim</code>	
<code>\g_tmpa_dim</code>	
<code>\g_tmpe_dim</code>	

49 Muskip

<code>\muskip_new:N</code>

`\muskip_new:N <muskip>`

Defines `<muskip>` to be a new variable of type `muskip`.

T_EXhackers note: `\muskip_new:N` is the equivalent to plain T_EX's `\newmuskip`. However, the internal register allocation is done differently.

<code>\muskip_set:Nn</code>
<code>\muskip_gset:Nn</code>

`\muskip_set:Nn <muskip> {<muskip value>}`
`\muskip_gset:Nn <muskip> {<length>}`

These functions will set the `<muskip>` register to the `<length>` value.

<code>\muskip_add:Nn</code>
<code>\muskip_gadd:Nn</code>

`\muskip_add:Nn <muskip> {<length>}`
`\muskip_gadd:Nn <muskip> {<length>}`

These functions will add to the `<muskip>` register the value `<length>`. If the second argument is a `<muskip>` register too, the surrounding braces can be left out.

<code>\muskip_sub:Nn</code>
<code>\muskip_gsub:Nn</code>

`\muskip_sub:Nn <muskip> {<length>}`
`\muskip_gsub:Nn <muskip> {<length>}`

These functions will subtract from the `<muskip>` register the value `<length>`. If the second argument is a `<muskip>` register too, the surrounding braces can be left out.

<code>\muskip_use:N</code>

`\muskip_use:N <muskip>`

This function returns the length value kept in `<muskip>` in a way suitable for further processing.

T_EXhackers note: See note for `\dim_use:N`.

Part XII

The l3tl package

Token Lists

L^AT_EX3 stores token lists in variables also called ‘token lists’. Variables of this type get the suffix `tl` and functions of this type have the prefix `tl`. To use a token list variable you simply call the corresponding variable.

Often you find yourself with not a token list variable but an arbitrary token list which has to undergo certain tests. We will *also* prefix these functions with `tl`. While token list variables are always single tokens, token lists are always surrounded by braces.

50 Functions

<code>\tl_new:N</code>
<code>\tl_new:c</code>
<code>\tl_new:Nn</code>
<code>\tl_new:cn</code>
<code>\tl_new:Nx</code>

`\tl_new:Nn <tl var.> {<initial token list>}`

Defines $\langle tl\ var.\rangle$ to be a new variable to store a token list. $\langle initial\ token\ list\rangle$ is the initial value of $\langle tl\ var.\rangle$. This makes it possible to assign values to a constant token list variable.

The form `\tl_new:N` initializes the token list variable with an empty value.

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

`\tl_use:N <tl var.>`

Function that inserts the $\langle tl\ var.\rangle$ into the processing stream. Instead of `\tl_use:N` simply placing the $\langle tl\ var.\rangle$ into the input stream is also supported. `\tl_use:c` will complain if the $\langle tl\ var.\rangle$ hasn't been declared previously!

<code>\tl_show:N</code>
<code>\tl_show:c</code>
<code>\tl_show:n</code>

`\tl_show:N <tl var.>`
`\tl_show:n {<token list>}`

Function that pauses the compilation and displays the $\langle tl\ var.\rangle$ or $\langle token\ list\rangle$ on the console output and in the log file.

<code>\tl_set:Nn</code>
<code>\tl_set:Nc</code>
<code>\tl_set:NV</code>
<code>\tl_set:No</code>
<code>\tl_set:Nv</code>
<code>\tl_set:Nf</code>
<code>\tl_set:Nx</code>
<code>\tl_set:cn</code>
<code>\tl_set:co</code>
<code>\tl_set:cV</code>
<code>\tl_set:cx</code>
<code>\tl_gset:Nn</code>
<code>\tl_gset:Nc</code>
<code>\tl_gset:No</code>
<code>\tl_gset:NV</code>
<code>\tl_gset:Nv</code>
<code>\tl_gset:Nx</code>
<code>\tl_gset:cn</code>
<code>\tl_gset:cx</code>

`\tl_set:Nn <tl var.> {<token list>}`

Defines $\langle tl\ var.\rangle$ to hold the token list $\langle token\ list\rangle$. Global variants of this command assign the value globally the other variants expand the $\langle token\ list\rangle$ up to a certain level before the assignment or interpret the $\langle token\ list\rangle$ as a character list and form a control sequence out of it.

<code>\tl_clear:N</code>
<code>\tl_clear:c</code>
<code>\tl_gclear:N</code>
<code>\tl_gclear:c</code>

`\tl_clear:N <tl var.>`

The `<tl var.>` is locally or globally cleared. The `c` variants will generate a control sequence name which is then interpreted as `<tl var.>` before clearing.

<code>\tl_clear_new:N</code>
<code>\tl_clear_new:c</code>
<code>\tl_gclear_new:N</code>
<code>\tl_gclear_new:c</code>

`\tl_clear_new:N <tl var.>`

These functions check if `<tl var.>` exists. If it does it will be cleared; if it doesn't it will be allocated.

<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>

`\tl_put_left:Nn <tl var.> {<token list>}`

These functions will append `<token list>` to the left of `<tl var.>`. `<token list>` might be subject to expansion before assignment.

<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>

`\tl_put_right:Nn <tl var.> {<token list>}`

These functions append `<token list>` to the right of `<tl var.>`.

<code>\tl_gput_left:Nn</code>
<code>\tl_gput_left:No</code>
<code>\tl_gput_left:NV</code>
<code>\tl_gput_left:Nx</code>
<code>\tl_gput_left:cn</code>
<code>\tl_gput_left:cV</code>

`\tl_gput_left:Nn <tl var.> {<token list>}`

These functions will append `<token list>` globally to the left of `<tl var.>`.

<code>\tl_gput_right:Nn</code>
<code>\tl_gput_right:No</code>
<code>\tl_gput_right:NV</code>
<code>\tl_gput_right:Nx</code>
<code>\tl_gput_right:cn</code>
<code>\tl_gput_right:co</code>
<code>\tl_gput_right:cV</code>

`\tl_gput_right:Nn <tl var.> {<token list>}`

These functions will globally append *<token list>* to the right of *<tl var.>*.

A word of warning is appropriate here: Token list variables are implemented as macros and as such currently inherit some of the peculiarities of how T_EX handles #s in the argument of macros. In particular, the following actions are legal

```

\tl_set:Nn \l_tmpa_tl{##1}
\tl_put_right:Nn \l_tmpa_tl{##2}
\tl_set:No \l_tmpb_tl{\l_tmpa_tl ##3}

```

x type expansions where macros being expanded contain #s do not work and will not work until there is an `\expanded` primitive in the engine. If you want them to work you must double #s another level.

<code>\tl_set_eq:NN</code>
<code>\tl_set_eq:Nc</code>
<code>\tl_set_eq:cN</code>
<code>\tl_set_eq:cc</code>
<code>\tl_gset_eq:NN</code>
<code>\tl_gset_eq:Nc</code>
<code>\tl_gset_eq:cN</code>
<code>\tl_gset_eq:cc</code>

`\tl_set_eq:NN <tl var.12`

Fast form for `\tl_set:No <tl var.12`

when *<tl var._{2 is known to be a variable of type `tl`.}*

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

`\tl_to_str:N <tl var.>`

This function returns the token list kept in *<tl var.>* as a string list with all characters catcoded to ‘other’.

<code>\tl_to_str:n</code>

`\tl_to_str:n {<token list>}`

This function turns its argument into a string where all characters have catcode ‘other’.

T_EXhackers note: This is the ε -T_EX primitive `\detokenize`.

<code>\tl_rescan:nn</code>

`\tl_rescan:nn {<catcode setup>} {<token list>}`

Returns the result of re-tokenising *<token list>* with the catcode setup (and whatever other redefinitions) specified. This is useful because the catcodes of characters are ‘frozen’ when

first tokenised; this allows their meaning to be changed even after they’ve been read as an argument. Also see `\tl_set_rescan:Nnn` below.

TeXhackers note: This is a wrapper around ϵ -TeX’s `\scantokens`.

<code>\tl_set_rescan:Nnn</code> <code>\tl_set_rescan:Nnx</code> <code>\tl_gset_rescan:Nnn</code> <code>\tl_gset_rescan:Nnx</code>	<code>\tl_set_rescan:Nnn <tl var.> {<catcode setup>} {<token list>}</code>
--	--

Sets $\langle tl\ var.\rangle$ to the result of re-tokenising $\langle token\ list\rangle$ with the catcode setup (and whatever other redefinitions) specified.

TeXhackers note: This is a wrapper around ϵ -TeX’s `\scantokens`.

51 Predicates and conditionals

<code>\tl_if_empty_p:N *</code> <code>\tl_if_empty_p:c *</code>	<code>\tl_if_empty_p:N <tl var.></code>
--	---

This predicate returns ‘true’ if $\langle tl\ var.\rangle$ is ‘empty’ i.e., doesn’t contain any tokens.

<code>\tl_if_empty:NTF *</code> <code>\tl_if_empty:cTF *</code>	<code>\tl_if_empty:NTF <tl var.> {<true code>} {<false code>}</code>
--	--

Execute $\langle true\ code\rangle$ if $\langle tl\ var.\rangle$ is empty and $\langle false\ code\rangle$ if it contains any tokens.

<code>\tl_if_eq_p:NN *</code> <code>\tl_if_eq_p:cN *</code> <code>\tl_if_eq_p:Nc *</code> <code>\tl_if_eq_p:cc *</code>	<code>\tl_if_eq_p:NN <tl var.₁> <tl var.₂></code>
--	---

Predicate function which returns ‘true’ if the two token list variables are identical and ‘false’ otherwise.

<code>\tl_if_eq:NNTF *</code> <code>\tl_if_eq:cNTF *</code> <code>\tl_if_eq:NcTF *</code> <code>\tl_if_eq:ccTF *</code>	<code>\tl_if_eq:NTTF <tl var.₁> <tl var.₂> {<true code>} {<false code>}</code>
--	--

Execute $\langle true\ code\rangle$ if $\langle tl\ var.₁\rangle$ holds the same token list as $\langle tl\ var.₂\rangle$ and $\langle false\ code\rangle$ otherwise.

```

\tl_if_eq:nnTF *
\tl_if_eq:nVTF *
\tl_if_eq:noTF *
\tl_if_eq:VnTF *
\tl_if_eq:onTF *
\tl_if_eq:VVTF *
\tl_if_eq:ooTF *
\tl_if_eq:xxTF *
\tl_if_eq:xnTF *
\tl_if_eq:nxTF *
\tl_if_eq:xVTF *
\tl_if_eq:xoTF *
\tl_if_eq:VxTF *
\tl_if_eq:oxTF *

```

```
\tl_if_eq:nnTF {<tlst1>} {<tlst2>} {<true code>} {<false code>}
```

Execute $\langle true\ code \rangle$ if the two token lists $\langle tlst_1 \rangle$ and $\langle tlst_2 \rangle$ are identical. These functions are expandable if a new enough version of pdfTeX is being used.

```

\tl_if_eq_p:nn *
\tl_if_eq_p:nV *
\tl_if_eq_p:no *
\tl_if_eq_p:Vn *
\tl_if_eq_p:on *
\tl_if_eq_p:VV *
\tl_if_eq_p:oo *
\tl_if_eq_p:xx *
\tl_if_eq_p:xn *
\tl_if_eq_p:nx *
\tl_if_eq_p:xV *
\tl_if_eq_p:xo *
\tl_if_eq_p:Vx *
\tl_if_eq_p:ox *

```

```
\tl_if_eq_p:nn {<tlst1>} {<tlst2>}
```

Predicates function which returns ‘true’ if the two token list are identical and ‘false’ otherwise. These are only defined if a new enough version of pdfTeX is in use.

```

\tl_if_empty_p:n *
\tl_if_empty_p:V *
\tl_if_empty_p:o *
\tl_if_empty:nTF
\tl_if_empty:VTF
\tl_if_empty:oTF

```

```
\tl_if_empty:nTF {<token list>} {<true code>} {<false code>}
```

Execute $\langle true\ code \rangle$ if $\langle token\ list \rangle$ doesn’t contain any tokens and $\langle false\ code \rangle$ otherwise.

```

\tl_if_blank_p:n *
\tl_if_blank:nTF *
\tl_if_blank_p:V *
\tl_if_blank_p:o *
\tl_if_blank:VTF *
\tl_if_blank:oTF *

```

```
\tl_if_blank:nTF {<token list>} {<true code>} {<false code>}
```

Execute $\langle true\ code \rangle$ if $\langle token\ list \rangle$ is blank meaning that it is either empty or contains only blank spaces.

$\backslash\mathrm{tl_to_lowercase:n}$ $\backslash\mathrm{tl_to_uppercase:n}$	$\backslash\mathrm{tl_to_lowercase:n}\ \{\langle token\ list \rangle\}$
--	---

$\backslash\mathrm{tl_to_lowercase:n}$ converts all tokens in $\langle token\ list \rangle$ to their lower case representation. Similar for $\backslash\mathrm{tl_to_uppercase:n}$.

T_EXhackers note: These are the T_EX primitives $\backslash\mathrm{lowercase}$ and $\backslash\mathrm{uppercase}$ renamed.

52 Working with the contents of token lists

$\backslash\mathrm{tl_map_function:nN}\ \star$ $\backslash\mathrm{tl_map_function:NN}$ $\backslash\mathrm{tl_map_function:cN}$	$\backslash\mathrm{tl_map_function:nN}\ \{\langle token\ list \rangle\}\ \langle function \rangle$ $\backslash\mathrm{tl_map_function:NN}\ \langle tl\ var. \rangle\ \langle function \rangle$
--	---

Runs through all elements in a $\langle token\ list \rangle$ from left to right and places $\langle function \rangle$ in front of each element. As this function will also pick up elements in brace groups, the element is returned with braces and hence $\langle function \rangle$ should be a function with a $:n$ suffix even though it may very well only deal with a single token.

This function uses a purely expandable loop function and will stay so as long as $\langle function \rangle$ is expandable too.

$\backslash\mathrm{tl_map_inline:nn}$ $\backslash\mathrm{tl_map_inline:Nn}$ $\backslash\mathrm{tl_map_inline:cn}$	$\backslash\mathrm{tl_map_inline:nn}\ \{\langle token\ list \rangle\}\ \{\langle inline\ function \rangle\}$ $\backslash\mathrm{tl_map_inline:Nn}\ \langle tl\ var. \rangle\ \{\langle inline\ function \rangle\}$
---	---

Allows a syntax like $\backslash\mathrm{tl_map_inline:nn}\ \{\langle token\ list \rangle\}\ \{\backslash\mathrm{token_to_str:N}\ \#\mathrm{1}\}$. This renders it non-expandable though. Remember to double the $\#$ s for each level.

$\backslash\mathrm{tl_map_variable:nNn}$ $\backslash\mathrm{tl_map_variable:NNn}$ $\backslash\mathrm{tl_map_variable:cNn}$	$\backslash\mathrm{tl_map_variable:nNn}\ \{\langle token\ list \rangle\}\ \langle temp \rangle\ \{\langle action \rangle\}$ $\backslash\mathrm{tl_map_variable:NNn}\ \langle tl\ var. \rangle\ \langle temp \rangle\ \{\langle action \rangle\}$
--	---

Assigns $\langle temp \rangle$ to each element on $\langle token\ list \rangle$ and executes $\langle action \rangle$. As there is an assignment in this process it is not expandable.

T_EXhackers note: This is the L^AT_EX2 function $\backslash\mathrm{etfor}$ but with a more sane syntax. Also it works by tail recursion and so is faster as lists grow longer.

$\backslash\mathrm{tl_map_break:}$	$\backslash\mathrm{tl_map_break:}$
--------------------------------------	--------------------------------------

For breaking out of a loop. Must not be nested inside a primitive $\backslash\mathrm{if}$ structure.

<code>\tl_reverse:n</code>	
<code>\tl_reverse:V</code>	
<code>\tl_reverse:o</code>	<code>\tl_reverse:n {⟨token₁⟩⟨token₂⟩...⟨token_n⟩}</code>
<code>\tl_reverse:N</code>	<code>\tl_reverse:N ⟨tl var.⟩</code>

Reverse the token list (or the token list in the $\langle tl\ var.\rangle$) to result in $\langle token_n\rangle\ldots\langle token_2\rangle\langle token_1\rangle$. Note that spaces in this token list are gobbled in the process.

Note also that braces are lost in the process of reversing a $\langle tl\ var.\rangle$. That is, `\tl_set:Nn \l_tmpa_tl {a{bcd}e} \tl_reverse:N \l_tmpa_tl` will result in `ebcda`. This behaviour is probably more of a bug than a feature.

<code>\tl_elt_count:n</code>	<code>★</code>	
<code>\tl_elt_count:V</code>	<code>★</code>	
<code>\tl_elt_count:o</code>	<code>★</code>	<code>\tl_elt_count:n {⟨token list⟩}</code>
<code>\tl_elt_count:N</code>	<code>★</code>	<code>\tl_elt_count:N ⟨tl var.⟩</code>

Returns the number of elements in the token list. Brace groups encountered count as one element. Note that spaces in this token list are gobbled in the process.

53 Variables and constants

<code>\c_job_name_tl</code>	Constant that gets the ‘job name’ assigned when $\mathrm{T}_{\mathrm{E}}\mathrm{X}$ starts.
-----------------------------	---

$\mathrm{T}_{\mathrm{E}}\mathrm{X}$ hackers note: This is the new name for the primitive `\jobname`. It is a constant that is set by $\mathrm{T}_{\mathrm{E}}\mathrm{X}$ and should not be overwritten by the package.

<code>\c_empty_tl</code>	Constant that is always empty.
--------------------------	--------------------------------

$\mathrm{T}_{\mathrm{E}}\mathrm{X}$ hackers note: This was named `\empty` in $\mathrm{L}^{\mathrm{A}}\mathrm{T}_{\mathrm{E}}\mathrm{X}2$ and `\empty` in plain $\mathrm{T}_{\mathrm{E}}\mathrm{X}$.

<code>\l_tmpa_tl</code>	
<code>\l_tmpb_tl</code>	
<code>\g_tmpa_tl</code>	
<code>\g_tmpb_tl</code>	Scratch register for immediate use. They are not used by conditionals or predicate functions.

<code>\l_tl_replace_toks</code>	Internal register used in the replace functions.
---------------------------------	--

<code>\l_testa_tl</code>	
<code>\l_testb_tl</code>	
<code>\g_testa_tl</code>	
<code>\g_testb_tl</code>	Registers used for conditional processing if the engine doesn’t support arbitrary string comparison.

<code>\g_tl_inline_level_num</code>	Internal register used in the inline map functions.
-------------------------------------	---

54 Searching for and replacing tokens

<code>\tl_if_in:NnTF</code>
<code>\tl_if_in:cnTF</code>
<code>\tl_if_in:nnTF</code>
<code>\tl_if_in:VnTF</code>
<code>\tl_if_in:onTF</code>

`\tl_if_in:NnTF <tl var.> {<item>} {<true code>} {<false code>}`

Function that tests if $\langle item \rangle$ is in $\langle tl var. \rangle$. Depending on the result either $\langle true code \rangle$ or $\langle false code \rangle$ is executed. Note that $\langle item \rangle$ cannot contain brace groups nor $\#_6$ tokens.

<code>\tl_replace_in:Nnn</code>
<code>\tl_replace_in:cnn</code>
<code>\tl_greplace_in:Nnn</code>
<code>\tl_greplace_in:cnn</code>

`\tl_replace_in:Nnn <tl var.> {<item1>} {<item2>}`

Replaces the leftmost occurrence of $\langle item_1 \rangle$ in $\langle tl var. \rangle$ with $\langle item_2 \rangle$ if present, otherwise the $\langle tl var. \rangle$ is left untouched. Note that $\langle item_1 \rangle$ cannot contain brace groups nor $\#_6$ tokens, and $\langle item_2 \rangle$ cannot contain $\#_6$ tokens.

<code>\tl_replace_all_in:Nnn</code>
<code>\tl_replace_all_in:cnn</code>
<code>\tl_greplace_all_in:Nnn</code>
<code>\tl_greplace_all_in:cnn</code>

`\tl_replace_all_in:Nnn <tl var.> {<item1>} {<item2>}`

Replaces *all* occurrences of $\langle item_1 \rangle$ in $\langle tl var. \rangle$ with $\langle item_2 \rangle$. Note that $\langle item_1 \rangle$ cannot contain brace groups nor $\#_6$ tokens, and $\langle item_2 \rangle$ cannot contain $\#_6$ tokens.

<code>\tl_remove_in:Nn</code>
<code>\tl_remove_in:cn</code>
<code>\tl_gremove_in:Nn</code>
<code>\tl_gremove_in:cn</code>

`\tl_remove_in:Nn <tl var.> {<item>}`

Removes the leftmost occurrence of $\langle item \rangle$ from $\langle tl var. \rangle$ if present. Note that $\langle item \rangle$ cannot contain brace groups nor $\#_6$ tokens.

<code>\tl_remove_all_in:Nn</code>
<code>\tl_remove_all_in:cn</code>
<code>\tl_gremove_all_in:Nn</code>
<code>\tl_gremove_all_in:cn</code>

`\tl_remove_all_in:Nn <tl var.> {<item>}`

Removes *all* occurrences of $\langle item \rangle$ from $\langle tl var. \rangle$. Note that $\langle item \rangle$ cannot contain brace groups nor $\#_6$ tokens.

55 Heads or tails?

Here are some functions for grabbing either the head or tail of a list and perform some tests on it.

<code>\tl_head:n</code>	<code>*</code>	
<code>\tl_head:V</code>	<code>*</code>	
<code>\tl_tail:n</code>	<code>*</code>	
<code>\tl_tail:V</code>	<code>*</code>	
<code>\tl_tail:f</code>	<code>*</code>	
<code>\tl_head_i:n</code>	<code>*</code>	
<code>\tl_head_iii:n</code>	<code>*</code>	
<code>\tl_head_iii:f</code>	<code>*</code>	
<code>\tl_head:w</code>	<code>*</code>	
<code>\tl_tail:w</code>	<code>*</code>	
<code>\tl_head_i:w</code>	<code>*</code>	<code>\tl_head:n { \token_1\token_2}\dots\token_n }</code>
<code>\tl_head_iii:w</code>	<code>*</code>	<code>\tl_tail:n { \token_1\token_2}\dots\token_n }</code>
		<code>\tl_head:w \token_1\token_2}\dots\token_n \q_nil</code>

These functions return either the head or the tail of a list, thus in the above example `\tl_head:n` would return $\langle token_1 \rangle$ and `\tl_tail:n` would return $\langle token_2 \rangle \dots \langle token_n \rangle$. `\tl_head_iii:n` returns the first three tokens. The `:w` versions require some care as they use a delimited argument internally.

T_EXhackers note: These are the Lisp functions `car` and `cdr` but with L^AT_EX3 names.

<code>\tl_if_head_eq_meaning_p:nN</code>	<code>*</code>	
<code>\tl_if_head_eq_meaning:nNTF</code>	<code>*</code>	<code>\tl_if_head_eq_meaning:nNTF { \token list } \token</code>
		<code>{ \true } { \false }</code>

Returns $\langle true \rangle$ if the first token in $\langle token list \rangle$ is equal to $\langle token \rangle$ and $\langle false \rangle$ otherwise. The `meaning` version compares the two tokens with `\if_meaning:w`.

<code>\tl_if_head_eq_charcode_p:nN</code>	<code>*</code>	
<code>\tl_if_head_eq_charcode_p:fN</code>	<code>*</code>	
<code>\tl_if_head_eq_charcode:nNTF</code>	<code>*</code>	<code>\tl_if_head_eq_charcode:nNTF { \token list } \token</code>
<code>\tl_if_head_eq_charcode:fNTF</code>	<code>*</code>	<code>{ \true } { \false }</code>

Returns $\langle true \rangle$ if the first token in $\langle token list \rangle$ is equal to $\langle token \rangle$ and $\langle false \rangle$ otherwise. The `meaning` version compares the two tokens with `\if_charcode:w` but it prevents expansion of them. If you want them to expand, you can use an `f` type expansion first (define `\tl_if_head_eq_charcode:fNTF` or similar).

<code>\tl_if_head_eq_catcode_p:nN</code>	<code>*</code>	
<code>\tl_if_head_eq_catcode:nNTF</code>	<code>*</code>	<code>\tl_if_head_eq_catcode:nNTF { \token list } \token</code>
		<code>{ \true } { \false }</code>

Returns $\langle true \rangle$ if the first token in $\langle token list \rangle$ is equal to $\langle token \rangle$ and $\langle false \rangle$ otherwise. This version uses `\if_catcode:w` for the test but is otherwise identical to the `charcode` version.

Part XIII

The l3toks package

Token Registers

There is a second form beside token list variables in which L^AT_EX3 stores token lists, namely the internal T_EX token registers. Functions dealing with these registers got the prefix `\toks_`. Unlike token list variables we have an accessing function as one can see below.

The main difference between $\langle toks \rangle$ (token registers) and $\langle tl var. \rangle$ (token list variable) is their behavior regarding expansion. While $\langle tl vars \rangle$ expand fully (i.e., until only unexpandable tokens are left) inside an argument that is subject to expansion (i.e., denoted by \mathbf{x}) $\langle toks \rangle$'s expand always only up to one level, i.e., passing their contents without further expansion.

There are fewer restrictions on the contents of a token register over a token list variable. So while $\langle token list \rangle$ is used to describe the contents of both of these, bear in mind that slightly different lists of tokens are allowed in each case. The best (only?) example is that a $\langle toks \rangle$ can contain the `#` character (i.e., characters of catcode 6), whereas a $\langle tl var. \rangle$ will require its input to be sanitised before that is possible.

If you're not sure which to use between a $\langle tl var. \rangle$ or a $\langle toks \rangle$, consider what data you're trying to hold. If you're dealing with function parameters involving `#`, or building some sort of data structure then you probably want a $\langle toks \rangle$ (e.g., `\l3prop` uses $\langle toks \rangle$ to store its property lists).

If you're storing ad-hoc data for later use (possibly from direct user input) then usually a $\langle tl var. \rangle$ will be what you want.

56 Allocation and use

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

`\toks_new:N \langle toks \rangle`

Defines $\langle toks \rangle$ to be a new token list register.

T_EXhackers note: This is the L^AT_EX3 allocation for what was called `\newtoks` in plain T_EX.

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

`\toks_use:N \langle toks \rangle`

Accesses the contents of $\langle toks \rangle$. Contrary to token list variables $\langle toks \rangle$ can't be access simply by calling them directly.

T_EXhackers note: Something like `\the \langle toks \rangle`.

<code>\toks_set:Nn</code>
<code>\toks_set:NV</code>
<code>\toks_set:Nv</code>
<code>\toks_set:No</code>
<code>\toks_set:Nx</code>
<code>\toks_set:Nf</code>
<code>\toks_set:cn</code>
<code>\toks_set:co</code>
<code>\toks_set:cV</code>
<code>\toks_set:cv</code>
<code>\toks_set:cx</code>
<code>\toks_set:cf</code>

`\toks_set:Nn <toks> {<token list>}`

Defines $\langle toks \rangle$ to hold the token list $\langle token list \rangle$.

T_EXhackers note: `\toks_set:Nn` could have been specified in plain T_EX by $\langle toks \rangle = \{ \langle token list \rangle \}$ but all other functions have no counterpart in plain T_EX. Additionally the functions above the global variants described below will check for correct local and global assignments, something that isn't available in plain T_EX.

<code>\toks_gset:Nn</code>
<code>\toks_gset:NV</code>
<code>\toks_gset:No</code>
<code>\toks_gset:Nx</code>
<code>\toks_gset:cn</code>
<code>\toks_gset:cV</code>
<code>\toks_gset:co</code>
<code>\toks_gset:cx</code>

`\toks_gset:Nn <toks> {<token list>}`

Defines $\langle toks \rangle$ to globally hold the token list $\langle token list \rangle$.

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

`\toks_set_eq:NN <toks1> <toks2>`

Set $\langle toks_1 \rangle$ to the value of $\langle toks_2 \rangle$. Don't try to use `\toks_set:Nn` for this purpose if the second argument is also a token register.

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

`\toks_gset_eq:NN <toks1> <toks2>`

The $\langle toks_1 \rangle$ globally set to the value of $\langle toks_2 \rangle$. Don't try to use `\toks_gset:Nn` for this purpose if the second argument is also a token register.

<code>\toks_clear:N</code>
<code>\toks_clear:c</code>
<code>\toks_gclear:N</code>
<code>\toks_gclear:c</code>

`\toks_clear:N <toks>`

The $\langle toks \rangle$ is locally or globally cleared.

<code>\toks_use_clear:N</code>
<code>\toks_use_clear:c</code>
<code>\toks_use_gclear:N</code>
<code>\toks_use_gclear:c</code>

`\toks_use_clear:N $\langle toks \rangle$`

Accesses the contents of $\langle toks \rangle$ and clears (locally or globally) it afterwards. Actually the clearing operation is done in a way that does not prohibit the access of the following tokens in the input stream with functions stored in the token register. In other words this function is not exactly the same as calling `\toks_use:N $\langle toks \rangle$ \toks_clear:N $\langle toks \rangle$` in sequence.

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

`\toks_show:N $\langle toks \rangle$`

Displays the contents of $\langle toks \rangle$ in the terminal output and log file. # signs in the $\langle toks \rangle$ will be shown doubled.

TeXhackers note: Something like `\showthe $\langle toks \rangle$` .

57 Adding to the contents of token registers

<code>\toks_put_left:Nn</code>
<code>\toks_put_left:NV</code>
<code>\toks_put_left:No</code>
<code>\toks_put_left:Nx</code>
<code>\toks_put_left:cn</code>
<code>\toks_put_left:cV</code>
<code>\toks_put_left:co</code>

`\toks_put_left:Nn $\langle toks \rangle$ $\{ \langle token list \rangle \}$`

These functions will append $\langle token list \rangle$ to the left of $\langle toks \rangle$. Assignment is done locally. If possible append to the right since this operation is faster.

<code>\toks_gput_left:Nn</code>
<code>\toks_gput_left:NV</code>
<code>\toks_gput_left:No</code>
<code>\toks_gput_left:Nx</code>
<code>\toks_gput_left:cn</code>
<code>\toks_gput_left:cV</code>
<code>\toks_gput_left:co</code>

`\toks_gput_left:Nn $\langle toks \rangle$ $\{ \langle token list \rangle \}$`

These functions will append $\langle token list \rangle$ to the left of $\langle toks \rangle$. Assignment is done globally. If possible append to the right since this operation is faster.

<code>\toks_put_right:Nn</code>
<code>\toks_put_right:NV</code>
<code>\toks_put_right:No</code>
<code>\toks_put_right:Nx</code>
<code>\toks_put_right:cV</code>
<code>\toks_put_right:cn</code>
<code>\toks_put_right:co</code>

`\toks_put_right:Nn <toks> {<token list>}`

These functions will append *<token list>* to the right of *<toks>*. Assignment is done locally.

<code>\toks_put_right:Nf</code>

`\toks_put_right:Nf <toks> {<token list>}`

Variant of the above. `:Nf` is used by `template.dtx` and will perhaps be moved to that package.

<code>\toks_gput_right:Nn</code>
<code>\toks_gput_right:NV</code>
<code>\toks_gput_right:No</code>
<code>\toks_gput_right:Nx</code>
<code>\toks_gput_right:cn</code>
<code>\toks_gput_right:cV</code>
<code>\toks_gput_right:co</code>

`\toks_gput_right:Nn <toks> {<token list>}`

These functions will append *<token list>* to the right of *<toks>*. Assignment is done globally.

58 Predicates and conditionals

<code>\toks_if_empty_p:N *</code>
<code>\toks_if_empty:N\overline{TF} *</code>
<code>\toks_if_empty_p:c *</code>
<code>\toks_if_empty:c\overline{TF} *</code>

`\toks_if_empty:N \overline{TF} <toks> {<true code>} {<false code>}`

Expandable test for whether *<toks>* is empty.

<code>\toks_if_eq:N\overline{NTF} *</code>
<code>\toks_if_eq:Nc\overline{TF} *</code>
<code>\toks_if_eq:c\overline{NTF} *</code>
<code>\toks_if_eq:cc\overline{TF} *</code>
<code>\toks_if_eq_p:NN *</code>
<code>\toks_if_eq_p:cN *</code>
<code>\toks_if_eq_p:Nc *</code>
<code>\toks_if_eq_p:cc *</code>

`\toks_if_eq:N \overline{NTF} <toks12`

Expandably tests if *<toks_{1 and *<toks_{2 are equal.}*}*

59 Variable and constants

`\c_empty_toks` Constant that is always empty.

`\l_tmpa_toks`
`\l_tmpb_toks`
`\l_tmpc_toks`
`\g_tmpa_toks`
`\g_tmpb_toks`
`\g_tmpc_toks`

Scratch register for immediate use. They are not used by conditionals or predicate functions.

`\l_tl_replace_toks` A placeholder for contents of functions replacing contents of strings.

Part XIV

The l3seq package

Sequences

L^AT_EX3 implements a data type called ‘sequences’. These are special token lists that can be accessed via special function on the ‘left’. Appending tokens is possible at both ends. Appended token lists can be accessed only as a union. The token lists that form the individual items of a sequence might contain any tokens except two internal functions that are used to structure sequences (see section internal functions below). It is also possible to map functions on such sequences so that they are executed for every item on the sequence.

All functions that return items from a sequence in some $\langle tl\ var.\rangle$ assume that the $\langle tl\ var.\rangle$ is local. See remarks below if you need a global returned value.

The defined functions are not orthogonal in the sense that every possible variation possible is actually available. If you need a new variant use the expansion functions described in the package `l3expan` to build it.

Adding items to the left of a sequence can currently be done with either something like `\seq_put_left:Nn` or with a “stack” function like `\seq_push:Nn` which has the same effect. Maybe one should therefore remove the “left” functions totally.

60 Functions for creating/initialising sequences

`\seq_new:N`
`\seq_new:c` `\seq_new:N \langle sequence\rangle`

Defines $\langle sequence\rangle$ to be a variable of type `seq`.

<code>\seq_clear:N</code>
<code>\seq_clear:c</code>
<code>\seq_gclear:N</code>
<code>\seq_gclear:c</code>

`\seq_clear:N` $\langle sequence \rangle$

These functions locally or globally clear $\langle sequence \rangle$.

<code>\seq_clear_new:N</code>
<code>\seq_clear_new:c</code>
<code>\seq_gclear_new:N</code>
<code>\seq_gclear_new:c</code>

`\seq_clear_new:N` $\langle sequence \rangle$

These functions locally or globally clear $\langle sequence \rangle$ if it exists or otherwise allocates it.

<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` $\langle seq_1 \rangle$ $\langle seq_2 \rangle$

Function that locally makes $\langle seq_1 \rangle$ identical to $\langle seq_2 \rangle$.

<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` $\langle seq_1 \rangle$ $\langle seq_2 \rangle$

Function that globally makes $\langle seq_1 \rangle$ identical to $\langle seq_2 \rangle$.

<code>\seq_gconcat:NNN</code>
<code>\seq_gconcat:ccc</code>

`\seq_gconcat:NNN` $\langle seq_1 \rangle$ $\langle seq_2 \rangle$ $\langle seq_3 \rangle$

Function that concatenates $\langle seq_2 \rangle$ and $\langle seq_3 \rangle$ and globally assigns the result to $\langle seq_1 \rangle$.

61 Adding data to sequences

<code>\seq_put_left:Nn</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:co</code>

`\seq_put_left:Nn` $\langle sequence \rangle$ $\langle token list \rangle$

Locally appends $\langle token list \rangle$ as a single item to the left of $\langle sequence \rangle$. $\langle token list \rangle$ might get expanded before appending according to the variant.

<code>\seq_put_right:Nn</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:co</code>

`\seq_put_right:Nn` *<sequence>* *<token list>*

Locally appends *<token list>* as a single item to the right of *<sequence>*. *<token list>* might get expanded before appending according to the variant.

<code>\seq_gput_left:Nn</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:co</code>

`\seq_gput_left:Nn` *<sequence>* *<token list>*

Globally appends *<token list>* as a single item to the left of *<sequence>*.

<code>\seq_gput_right:Nn</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:co</code>

`\seq_gput_right:Nn` *<sequence>* *<token list>*

Globally appends *<token list>* as a single item to the right of *<sequence>*.

<code>\seq_gput_right:Nc</code>

Variant of the above used in the `xor` package. Will probably be moved soon to that package. (Sep 2008)

62 Working with sequences

<code>\seq_get:NN</code>
<code>\seq_get:cN</code>

`\seq_get:NN` *<sequence>* *<tl var.>*

Functions that locally assign the left-most item of *<sequence>* to the token list variable *<tl var.>*. Item is not removed from *<sequence>*! If you need a global return value you need to code something like this:

```
\seq_get:NN <sequence> \l_tmpa_tl
\tl_gset_eq:NN <global tl var.> \l_tmpa_tl
```

But if this kind of construction is used often enough a separate function should be provided.

<code>\seq_map_variable:NNn</code>
<code>\seq_map_variable:cNn</code>

`\seq_map_variable:NNn <sequence> <tl var.> {<code using tl var.>}`

Every element in $\langle sequence \rangle$ is assigned to $\langle tl var. \rangle$ and then $\langle code using tl var. \rangle$ is executed. The operation is not expandable which means that it can't be used within write operations etc. However, this function can be nested which the others can't.

<code>\seq_map_function:NN</code>
<code>\seq_map_function:cN</code>

`\seq_map_function:NN <sequence> <function>`

This function applies $\langle function \rangle$ (which must be a function with one argument) to every item of $\langle sequence \rangle$. $\langle function \rangle$ is not executed within a sub-group so that side effects can be achieved locally. The operation is not expandable which means that it can't be used within write operations etc.

In the current implementation the next functions are more efficient and should be preferred.

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

`\seq_map_inline:Nn <sequence> {<inline function>}`

Applies $\langle inline function \rangle$ (which should be the direct coding for a function with one argument (i.e. use #1 as the place holder for this argument)) to every item of $\langle sequence \rangle$. $\langle inline function \rangle$ is not executed within a sub-group so that side effects can be achieved locally. The operation is not expandable which means that it can't be used within write operations etc.

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

`\seq_show:N <sequence>`

Function that pauses the compilation and displays $\langle seq \rangle$ in the terminal output and in the log file. (Usually used for diagnostic purposes.)

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

`\seq_display:N <sequence>`

As with `\seq_show:N` but pretty prints the output one line per element.

<code>\seq_remove_duplicates:N</code>
<code>\seq_gremove_duplicates:N</code>

`\seq_gremove_duplicates:N <seq>`

Function that removes any duplicate entries in $\langle seq \rangle$.

63 Predicates and conditionals

<code>\seq_if_empty_p:N *</code>
<code>\seq_if_empty_p:c *</code>

`\seq_if_empty_p:N <sequence>`

This predicate returns 'true' if $\langle sequence \rangle$ is 'empty' i.e., doesn't contain any items. Note that this is 'false' even if the $\langle sequence \rangle$ only contains a single empty item.

<code>\seq_if_empty:NTF</code>
<code>\seq_if_empty:cTF</code>

`\seq_if_empty:NTF <sequence> {\true code} {\false code}`

Set of conditionals that test whether or not a particular $\langle sequence \rangle$ is empty and if so executes either $\langle true code \rangle$ or $\langle false code \rangle$.

<code>\seq_if_in:NnTF</code>
<code>\seq_if_in:cnTF</code>
<code>\seq_if_in:cVTF</code>
<code>\seq_if_in:coTF</code>
<code>\seq_if_in:cxTF</code>

`\seq_if_in:NnTF <sequence> {\item} {\true code} {\false code}`

Functions that test if $\langle item \rangle$ is in $\langle sequence \rangle$. Depending on the result either $\langle true code \rangle$ or $\langle false code \rangle$ is executed.

64 Internal functions

<code>\seq_if_empty_err:N</code>

`\seq_if_empty_err:N <sequence>`

Signals an L^AT_EX3 error if $\langle sequence \rangle$ is empty.

<code>\seq_pop_aux:nnNN</code>

`\seq_pop_aux:nnNN <assign1> <assign2> <sequence> <tl var.>`

Function that assigns the left-most item of $\langle sequence \rangle$ to $\langle tl var. \rangle$ using $\langle assign_1 \rangle$ and assigns the tail to $\langle sequence \rangle$ using $\langle assign_2 \rangle$. This function could be used to implement a global return function.

<code>\seq_get_aux:w</code>
<code>\seq_pop_aux:w</code>
<code>\seq_put_aux:Nnn</code>
<code>\seq_put_aux:w</code>

Functions used to implement put and get operations. They are not for meant for direct use.

<code>\seq_map_break:</code>
<code>\seq_map_break:n</code>

Functions used to implement mapping operations. They are not for meant for direct use.

<code>\seq_elt:w</code>
<code>\seq_elt_end:</code>

Functions (usually used as constants) that separates items within a sequence. They might get special meaning during mapping operations and are not supposed to show up as tokens within an item appended to a sequence.

65 Functions for ‘Sequence Stacks’

Special sequences in L^AT_EX3 are ‘stacks’ with their usual operations of ‘push’, ‘pop’, and ‘top’. They are internally implemented as sequences and share some of the functions (like `\seq_new:N` etc.)

<code>\seq_push:Nn</code>
<code>\seq_push:NV</code>
<code>\seq_push:No</code>
<code>\seq_push:cn</code>
<code>\seq_gpush:Nn</code>
<code>\seq_gpush:NV</code>
<code>\seq_gpush:No</code>
<code>\seq_gpush:Nv</code>
<code>\seq_gpush:cn</code>

`\seq_push:Nn` $\langle stack \rangle$ $\{ \langle token list \rangle \}$

Locally or globally pushes $\langle token list \rangle$ as a single item onto the $\langle stack \rangle$.

<code>\seq_pop:NN</code>
<code>\seq_pop:cN</code>
<code>\seq_gpop:NN</code>
<code>\seq_gpop:cN</code>

`\seq_pop:NN` $\langle stack \rangle$ $\langle tl var. \rangle$

Functions that assign the top item of $\langle stack \rangle$ to $\langle tl var. \rangle$ and removes it from $\langle stack \rangle$!

<code>\seq_top:NN</code>
<code>\seq_top:cN</code>

`\seq_top:NN` $\langle stack \rangle$ $\langle tl var. \rangle$

Functions that locally assign the top item of $\langle stack \rangle$ to the $\langle tl var. \rangle$. Item is *not* removed from $\langle stack \rangle$!

Part XV

The l3clist package

Comma separated lists

L^AT_EX3 implements a data type called ‘clist (comma-lists)’. These are special token lists that can be accessed via special function on the ‘left’. Appending tokens is possible at both ends. Appended token lists can be accessed only as a union. The token lists that form the individual items of a comma-list might contain any tokens except for commas that are used to structure comma-lists (braces are need if commas are part of the value). It is also possible to map functions on such comma-lists so that they are executed for every item of the comma-list.

All functions that return items from a comma-list in some $\langle tl var. \rangle$ assume that the $\langle tl var. \rangle$ is local. See remarks below if you need a global returned value.

The defined functions are not orthogonal in the sense that every possible variation possible is actually available. If you need a new variant use the expansion functions described in the package `l3expan` to build it.

Adding items to the left of a comma-list can currently be done with either something like `\clist_put_left:Nn` or with a “stack” function like `\clist_push:Nn` which has the same effect. Maybe one should therefore remove the “left” functions totally.

66 Functions for creating/initialising comma-lists

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

`\clist_new:N <comma-list>`

Defines $\langle comma-list \rangle$ to be a variable of type `clist`.

<code>\clist_clear:N</code>
<code>\clist_clear:c</code>
<code>\clist_gclear:N</code>
<code>\clist_gclear:c</code>

`\clist_clear:N <comma-list>`

These functions locally or globally clear $\langle comma-list \rangle$.

<code>\clist_clear_new:N</code>
<code>\clist_clear_new:c</code>
<code>\clist_gclear_new:N</code>
<code>\clist_gclear_new:c</code>

`\clist_clear_new:N <comma-list>`

These functions locally or globally clear $\langle comma-list \rangle$ if it exists or otherwise allocates it.

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

`\clist_set_eq:NN <clist1> <clist2>`

Function that locally makes $\langle clist_1 \rangle$ identical to $\langle clist_2 \rangle$.

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

`\clist_gset_eq:NN <clist1> <clist2>`

Function that globally makes $\langle clist_1 \rangle$ identical to $\langle clist_2 \rangle$.

<code>\clist_set_from_seq:NN</code>
<code>\clist_gset_from_seq:NN</code>

`\clist_set_from_seq:NN <clist> <seq>`

Transforms sequence $\langle seq \rangle$ into comma-list variable $\langle clist \rangle$.

67 Putting data in

<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:co</code>
<code>\clist_put_left:cV</code>

`\clist_put_left:Nn <comma-list> <token list>`

Locally appends *<token list>* as a single item to the left of *<comma-list>*. *<token list>* might get expanded before appending according to the variant used.

<code>\clist_put_right:Nn</code>
<code>\clist_put_right:No</code>
<code>\clist_put_right:NV</code>
<code>\clist_put_right:Nx</code>
<code>\clist_put_right:cn</code>
<code>\clist_put_right:co</code>
<code>\clist_put_right:cV</code>

`\clist_put_right:Nn <comma-list> <token list>`

Locally appends *<token list>* as a single item to the right of *<comma-list>*. *<token list>* might get expanded before appending according to the variant used.

<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>

`\clist_gput_left:Nn <comma-list> <token list>`

Globally appends *<token list>* as a single item to the right of *<comma-list>*.

<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>

`\clist_gput_right:Nn <comma-list> <token list>`

Globally appends *<token list>* as a single item to the right of *<comma-list>*.

68 Getting data out

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

`\clist_use:N <clist>`

Function that inserts the $\langle clist \rangle$ into the processing stream. Mainly useful if one knows what the $\langle clist \rangle$ contains, e.g., for displaying the content of template parameters.

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

`\clist_show:N $\langle clist \rangle$`

Function that pauses the compilation and displays $\langle clist \rangle$ in the terminal output and in the log file. (Usually used for diagnostic purposes.)

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

`\clist_display:N $\langle clist \rangle$`

As with `\clist_show:N` but pretty prints the output one line per element.

<code>\clist_get:NN</code>
<code>\clist_get:cN</code>

`\clist_get:NN $\langle comma-list \rangle$ $\langle tl var. \rangle$`

Functions that locally assign the left-most item of $\langle comma-list \rangle$ to the token list variable $\langle tl var. \rangle$. Item is not removed from $\langle comma-list \rangle$! If you need a global return value you need to code something like this:

```
\clist_get:NN  $\langle comma-list \rangle$  \l_tmpa_tl
\tl_gset_eq:NN  $\langle global tl var. \rangle$  \l_tmpa_tl
```

But if this kind of construction is used often enough a separate function should be provided.

69 Mapping functions

We provide three types of mapping functions, each with their own strengths. The `\clist_map_function:NN` is expandable whereas `\clist_map_inline:Nn` type uses `##1` as a placeholder for the current item in $\langle clist \rangle$. Finally we have the `\clist_map_variable:NNn` type which uses a user-defined variable as placeholder. Both the `_inline` and `_variable` versions are nestable.

<code>\clist_map_function:NN</code>
<code>\clist_map_function:cN</code>
<code>\clist_map_function:nN</code>

`\clist_map_function:NN $\langle comma-list \rangle$ $\langle function \rangle$`

This function applies $\langle function \rangle$ (which must be a function with one argument) to every item of $\langle comma-list \rangle$. $\langle function \rangle$ is not executed within a sub-group so that side effects can be achieved locally. The operation is expandable which means that it can be used within write operations etc.

<code>\clist_map_inline:Nn</code>
<code>\clist_map_inline:cn</code>
<code>\clist_map_inline:nn</code>

`\clist_map_inline:Nn $\langle comma-list \rangle$ { $\langle inline function \rangle$ }`

Applies $\langle inline\ function \rangle$ (which should be the direct coding for a function with one argument (i.e. use `##1` as the placeholder for this argument)) to every item of $\langle comma-list \rangle$. $\langle inline\ function \rangle$ is not executed within a sub-group so that side effects can be achieved locally. The operation is not expandable which means that it can't be used within write operations etc. These functions can be nested.

<code>\clist_map_variable:NNn</code> <code>\clist_map_variable:cNn</code> <code>\clist_map_variable:nNn</code>	<code>\clist_map_variable:NNn</code> $\langle comma-list \rangle$ $\langle temp-var \rangle$ $\{ \langle action \rangle \}$
--	---

Assigns $\langle temp-var \rangle$ to each element in $\langle clist \rangle$ and then executes $\langle action \rangle$ which should contain $\langle temp-var \rangle$. As the operation performs an assignment, it is not expandable.

TeXhackers note: These functions resemble the L^AT_EX 2_ε function `\@for` but does not borrow the somewhat strange syntax.

<code>\clist_map_break:</code>	<code>\clist_map_break:</code>
--------------------------------	--------------------------------

For breaking out of a loop. To be used inside TF type functions as in the example below.

```
\cs_new_nopar:Npn \test_function:n #1 {
  \intexpr_compare:nTF {#1 > 3} {\clist_map_break:}{‘‘#1’’}
}
\clist_map_function:nN {1,2,3,4,5,6,7,8}\test_function:n
```

This would return ‘‘1’’‘‘2’’‘‘3’’.

70 Predicates and conditionals

<code>\clist_if_empty_p:N</code> <code>\clist_if_empty_p:c</code>	<code>\clist_if_empty_p:N</code> $\langle comma-list \rangle$
--	---

This predicate returns ‘true’ if $\langle comma-list \rangle$ is ‘empty’ i.e., doesn’t contain any tokens.

<code>\clist_if_empty:NTF *</code> <code>\clist_if_empty:cTF *</code>	<code>\clist_if_empty:NTF</code> $\langle comma-list \rangle$ $\{ \langle true\ code \rangle \}$ $\{ \langle false\ code \rangle \}$
--	--

Set of conditionals that test whether or not a particular $\langle comma-list \rangle$ is empty and if so executes either $\langle true\ code \rangle$ or $\langle false\ code \rangle$.

<code>\clist_if_eq_p:NN *</code> <code>\clist_if_eq_p:cN *</code> <code>\clist_if_eq_p:Nc *</code> <code>\clist_if_eq_p:cc *</code>	<code>\clist_if_eq_p:N</code> $\langle comma-list_1 \rangle$ $\langle comma-list_2 \rangle$
--	---

This predicate returns ‘true’ if the two comma lists are identical.

<code>\clist_if_eq:NNTF *</code>	<code>\clist_if_eq:NNTF <comma-list₁> <comma-list₂> {<true code>} {<false code>}</code>
<code>\clist_if_eq:cNTF *</code>	
<code>\clist_if_eq:NcTF *</code>	
<code>\clist_if_eq:ccTF *</code>	

Check if $\langle comma-list_1 \rangle$ and $\langle comma-list_2 \rangle$ are equal and execute either $\langle true code \rangle$ or $\langle false code \rangle$ accordingly.

<code>\clist_if_in:NnTF</code>	<code>\clist_if_in:NnTF <comma-list> {<item>} {<true code>} {<false code>}</code>
<code>\clist_if_in:NVTF</code>	
<code>\clist_if_in:NoTF</code>	
<code>\clist_if_in:cnTF</code>	
<code>\clist_if_in:cVTF</code>	
<code>\clist_if_in:coTF</code>	

Function that tests if $\langle item \rangle$ is in $\langle comma-list \rangle$. Depending on the result either $\langle true code \rangle$ or $\langle false code \rangle$ is executed.

71 Higher level functions

<code>\clist_concat:NNN</code>	<code>\clist_gconcat:NNN <clist₁> <clist₂> <clist₃></code>
<code>\clist_concat:ccc</code>	
<code>\clist_gconcat:NNN</code>	
<code>\clist_gconcat:ccc</code>	

Function that concatenates $\langle clist_2 \rangle$ and $\langle clist_3 \rangle$ and locally or globally assigns the result to $\langle clist_1 \rangle$.

<code>\clist_remove_duplicates:N</code>	<code>\clist_gremove_duplicates:N <clist></code>
<code>\clist_gremove_duplicates:N</code>	

Function that removes any duplicate entries in $\langle clist \rangle$.

<code>\clist_remove_element:Nn</code>	<code>\clist_gremove_element:Nn <clist> <element></code>
<code>\clist_gremove_element:Nn</code>	

Function that removes $\langle element \rangle$ from $\langle clist \rangle$, if present.

T_EXhackers note: This is similar in concept to `\@removeelement`, except that the syntax is clearer and the initial and final lists have the same name automatically.

72 Functions for ‘comma-list stacks’

Special comma-lists in L^AT_EX3 are ‘stacks’ with their usual operations of ‘push’, ‘pop’, and ‘top’. They are internally implemented as comma-lists and share some of the functions (like `\clist_new:N` etc.)

<code>\clist_push:Nn</code>
<code>\clist_push:NV</code>
<code>\clist_push:No</code>
<code>\clist_push:cn</code>
<code>\clist_gpush:Nn</code>
<code>\clist_gpush:NV</code>
<code>\clist_gpush:No</code>
<code>\clist_gpush:cn</code>

`\clist_push:Nn` $\langle stack \rangle$ $\{\langle token list \rangle\}$

Locally or globally pushes $\langle token list \rangle$ as a single item onto the $\langle stack \rangle$. $\langle token list \rangle$ might get expanded before the operation.

<code>\clist_pop:NN</code>
<code>\clist_pop:cn</code>
<code>\clist_gpop:NN</code>
<code>\clist_gpop:cn</code>

`\clist_pop:NN` $\langle stack \rangle$ $\langle tl var. \rangle$

Functions that assign the top item of $\langle stack \rangle$ to the token list variable $\langle tl var. \rangle$ and removes it from $\langle stack \rangle$!

<code>\clist_top:NN</code>
<code>\clist_top:cn</code>

`\clist_top:NN` $\langle stack \rangle$ $\langle tl var. \rangle$

Functions that locally assign the top item of $\langle stack \rangle$ to the token list variable $\langle tl var. \rangle$. Item is not removed from $\langle stack \rangle$!

73 Internal functions

<code>\clist_if_empty_err:N</code>

`\clist_if_empty_err:N` $\langle comma-list \rangle$

Signals an L^AT_EX3 error if $\langle comma-list \rangle$ is empty.

<code>\clist_pop_aux:nnNN</code>

`\clist_pop_aux:nnNN` $\langle assign_1 \rangle$ $\langle assign_2 \rangle$ $\langle comma-list \rangle$ $\langle tl var. \rangle$

Function that assigns the left-most item of $\langle comma-list \rangle$ to $\langle tl var. \rangle$ using $\langle assign_1 \rangle$ and assigns the tail to $\langle comma-list \rangle$ using $\langle assign_2 \rangle$. This function could be used to implement a global return function.

<code>\clist_get_aux:w</code>
<code>\clist_pop_aux:w</code>
<code>\clist_pop_auxi:w</code>
<code>\clist_put_aux:NNnnNn</code>

Functions used to implement put and get operations. They are not for meant for direct use.

Part XVI

The l3prop package

Property Lists

L^AT_EX3 implements a data structure called a ‘property list’ which allows arbitrary information to be stored and accessed using keywords rather than numerical indexing.

A property list might contain a set of keys such as **name**, **age**, and **ID**, which each have individual values that can be saved and retrieved.

74 Functions

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

`\prop_new:N <prop>`

Defines *<prop>* to be a variable of type *<prop>*.

<code>\prop_clear:N</code>
<code>\prop_clear:c</code>
<code>\prop_gclear:N</code>
<code>\prop_gclear:c</code>

`\prop_clear:N <prop>`

These functions locally or globally clear *<prop>*.

<code>\prop_put:Nnn</code>
<code>\prop_put:NnV</code>
<code>\prop_put:NVn</code>
<code>\prop_put:NVV</code>
<code>\prop_put:cnn</code>
<code>\prop_gput:Nnn</code>
<code>\prop_gput:Nno</code>
<code>\prop_gput:NnV</code>
<code>\prop_gput:Nnx</code>
<code>\prop_gput:cnn</code>
<code>\prop_gput:ccx</code>

`\prop_put:Nnn <prop> {<key>} {<token list>}`

Locally or globally associates *<token list>* with *<key>* in the *<prop>* *<prop>*. If *<key>* has already a meaning within *<prop>* this value is overwritten.

The *<key>* must not contain unescaped **#** tokens but the *<token list>* may.

<code>\prop_gput_if_new:Nnn</code>

`\prop_gput_if_new:Nnn <prop> {<key>} {<token list>}`

Globally associates *<token list>* with *<key>* in the *<prop>* *<prop>* but only if *<key>* has so far no meaning within *<prop>*. Silently ignored if *<key>* is already set in the *<prop>*.

<code>\prop_get:NnN</code>
<code>\prop_get:cnN</code>
<code>\prop_gget:NnN</code>
<code>\prop_gget:cnN</code>

`\prop_get:NnN <prop> {<key>} <tl var.>`

If $\langle info \rangle$ is the information associated with $\langle key \rangle$ in the $\langle prop \rangle$ $\langle prop \rangle$ then the token list variable $\langle tl var. \rangle$ gets $\langle info \rangle$ assigned. Otherwise its value is the special quark `\q_no_value`. The assignment is done either locally or globally.

<code>\prop_set_eq:NN</code>
<code>\prop_set_eq:cN</code>
<code>\prop_set_eq:Nc</code>
<code>\prop_set_eq:cc</code>
<code>\prop_gset_eq:NN</code>
<code>\prop_gset_eq:cN</code>
<code>\prop_gset_eq:Nc</code>
<code>\prop_gset_eq:cc</code>

`\prop_set_eq:NN <prop1> <prop2>`

A fast assignment of $\langle prop \rangle$ s.

<code>\prop_get_gdel:NnN</code>

`\prop_get_gdel:NnN <prop> {<key>} <tl var.>`

Like `\prop_get:NnN` but additionally removes $\langle key \rangle$ (and its $\langle info \rangle$) from $\langle prop \rangle$.

<code>\prop_del:Nn</code>
<code>\prop_gdel:Nn</code>

`\prop_del:Nn <prop> {<key>}`

Locally or globally deletes $\langle key \rangle$ and its $\langle info \rangle$ from $\langle prop \rangle$ if found. Otherwise does nothing.

<code>\prop_map_function:NN *</code>
<code>\prop_map_function:cN *</code>
<code>\prop_map_function:Nc *</code>
<code>\prop_map_function:cc *</code>

`\prop_map_function:NN <prop> <function>`

Maps $\langle function \rangle$ which should be a function with two arguments ($\langle key \rangle$ and $\langle info \rangle$) over every $\langle key \rangle$ $\langle info \rangle$ pair of $\langle prop \rangle$. Expandable.

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

`\prop_map_inline:Nn <prop> {<inline function>}`

Just like `\prop_map_function:NN` but with the function of two arguments supplied as inline code. Within $\langle inline function \rangle$ refer to the arguments via #1 ($\langle key \rangle$) and #2 ($\langle info \rangle$). Nestable.

<code>\prop_map_break:</code>

`\prop_map_inline:Nn <prop> {
... \<break test>:T {\prop_map_break:} }`

For breaking out of a loop. To be used inside TF-type functions as shown in the example above.

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

`\prop_show:N <prop>`

Pauses the compilation and shows $\langle prop \rangle$ on the terminal output and in the log file.

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

`\prop_display:N <prop>`

As with `\prop_show:N` but pretty prints the output one line per property pair.

75 Predicates and conditionals

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

`\prop_if_empty_p:N <prop> {\true code} {\false code}`

Predicates to test whether or not a particular $\langle prop \rangle$ is empty.

<code>\prop_if_empty:NTF *</code>
<code>\prop_if_empty:cTF *</code>

`\prop_if_empty:NTF <prop> {\true code} {\false code}`

Set of conditionals that test whether or not a particular $\langle prop \rangle$ is empty.

<code>\prop_if_eq_p:NN *</code>
<code>\prop_if_eq_p:cN *</code>
<code>\prop_if_eq_p:Nc *</code>
<code>\prop_if_eq_p:cc *</code>
<code>\prop_if_eq:NNTF *</code>
<code>\prop_if_eq:cNTF *</code>
<code>\prop_if_eq:NcTF *</code>
<code>\prop_if_eq:ccTF *</code>

`\prop_if_eq:NMF <prop1> <prop2> {\false code}`

Execute $\langle false code \rangle$ if $\langle prop_1 \rangle$ doesn't hold the same token list as $\langle prop_2 \rangle$. Only expandable for new versions of pdfTeX.

<code>\prop_if_in:NnTF</code>
<code>\prop_if_in:NVTF</code>
<code>\prop_if_in:NoTF</code>
<code>\prop_if_in:cnTF</code>
<code>\prop_if_in:ccTF</code>

`\prop_if_in:NnTF <prop> {\key} {\true code} {\false code}`

Tests if $\langle key \rangle$ is used in $\langle prop \rangle$ and then either executes $\langle true code \rangle$ or $\langle false code \rangle$.

76 Internal functions

<code>\q_prop</code>

`\q_prop` Quark used to delimit property lists internally.

`\prop_put_aux:w`
`\prop_put_if_new_aux:w`

Internal functions implementing the put operations.

`\prop_get_aux:w`
`\prop_gget_aux:w`
`\prop_get_del_aux:w`
`\prop_del_aux:w`

Internal functions implementing the get and delete operations.

`\prop_if_in_aux:w`

Internal function implementing the key test operation.

`\prop_map_function_aux:w`

Internal function implementing the map operations.

`\g_prop_inline_level_num`

Fake integer used in internal name for function used inside `\prop_map_inline:NN`.

`\prop_split_aux:Nnn`

`\prop_split_aux:Nnn` $\langle prop \rangle$ $\langle key \rangle$ $\langle cmd \rangle$

Internal function that invokes $\langle cmd \rangle$ with 3 arguments: 1st is the beginning of $\langle prop \rangle$ before $\langle key \rangle$, 2nd is the value associated with $\langle key \rangle$, 3rd is the rest of $\langle prop \rangle$ after $\langle key \rangle$. If there is no key $\langle key \rangle$ in $\langle prop \rangle$, then the 2 arg is `\q_no_value` and the 3rd arg is empty; otherwise the 3rd argument has the two extra tokens $\langle key \rangle$ `\q_no_value` at the end.

This function is used to implement various get operations.

Part XVII

The l3io package

Low-level file i/o

TeX is capable of reading from and writing up to 16 individual streams. These i/o operations are accessible in L^AT_EX3 with functions from the `\io..` modules. In most cases it will be sufficient for the programmer to use the functions provided by the auxiliary file module, but here are the necessary functions for manipulating private streams.

Sometimes it is not known beforehand how much text is going to be written with a single call. As a result some internal TeX buffer may overflow. To avoid this kind of problem, L^AT_EX3 maintains beside direct write operations like `\iow_now:Nx` also so called “long” writes where the output is broken into individual lines on every blank in the text to be written. The resulting files are difficult to read for humans but since they usually serve only as internal storage this poses no problem.

Beside the functions that immediately act (e.g., `\iow_now:Nx`, etc.) we also have deferred operations that are saved away until the next page is finished. This allow to expand the $\langle tokens \rangle$ at the right time to get correct page numbers etc.

77 Functions for output streams

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

`\iow_new:N <stream>`

Defines $\langle stream \rangle$ to be a new identifier denoting an output stream for use in subsequent functions.

T_EXhackers note: `\iow_new:N` corresponds to the plain T_EX `\newwrite` allocation routine.

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

`\iow_open:Nn <stream> {<file name>}`

Opens output stream $\langle stream \rangle$ to write to $\langle file name \rangle$. The output stream is immediately available for use. If the $\langle stream \rangle$ was already used as an output stream to some other file, this file gets closed first.⁶ Also, all output streams still open at the end of the T_EX run will be automatically closed.

<code>\iow_close:N</code>

`\iow_close:N <stream>`

Closes output stream $\langle stream \rangle$.

77.1 Immediate writing

<code>\iow_now:Nx</code>
<code>\iow_now:Nn</code>

`\iow_now:Nx <stream> {<tokens>}`

`\iow_now:Nx` immediately writes the expansion of $\langle tokens \rangle$ to the output stream $\langle stream \rangle$. If $\langle stream \rangle$ is not open output goes to the terminal. The variant `\iow_now:Nn` writes out $\langle tokens \rangle$ without any further expansion.

T_EXhackers note: These are the equivalent of T_EX's `\immediate\write` with and without expansion control.

<code>\iow_log:n</code>
<code>\iow_log:x</code>
<code>\iow_term:x</code>
<code>\iow_term:n</code>

`\iow_log:x {<tokens>}`

These functions write to the log file (also known as the transcript file) or to the terminal respectively. They are equivalent to `\iow_now:Nx` where $\langle stream \rangle$ is the transcript file (`\c_iow_log_stream`) or the terminal (`\c_iow_term_stream`).

<code>\iow_now_buffer_safe:Nn</code>
<code>\iow_now_buffer_safe:Nx</code>

`\iow_now_buffer_safe:Nn <stream> {<tokens>}`

⁶This is a precaution since on some OS it is possible to open the same file for output more than once which then results in some internal errors at the end of the run.

Like `\iow_now:Nx` but splits $\langle tokens \rangle$ at every blank into separate lines. When potentially (very) long token lists are being written, this avoids the problem of buffer overflow when reading back the file.

<code>\iow_now_when_avail:Nn</code>	<code>\iow_now_when_avail:Nn $\langle stream \rangle$ {\mathit{tokens}}</code>
<code>\iow_now_when_avail:cn</code>	

This special function first checks if the $\langle stream \rangle$ is open for writing. If not it does nothing otherwise it behaves like `\iow_now:Nn`.

77.2 Deferred writing

<code>\iow_shipout:Nn</code>	<code>\iow_shipout_x:Nn $\langle stream \rangle$ {\mathit{tokens}}</code>
<code>\iow_shipout:Nx</code>	

These functions write $\langle tokens \rangle$ to the specified $\langle stream \rangle$, but unlike with `\iow_now:Nn` which write the material immediately, `\iow_shipout:Nn` waits until the processing of the current page has finished.

<code>\iow_shipout_x:Nn</code>	<code>\iow_shipout_x:Nn $\langle stream \rangle$ {\mathit{tokens}}</code>
<code>\iow_shipout_x:Nx</code>	

More useful than the `\iow_shipout:Nn` functions, these functions also write $\langle tokens \rangle$ to $\langle stream \rangle$ at the end of the processing of the current page; however, before $\langle tokens \rangle$ are written they are subjected to a further `x` expansion stage.

This is useful for writing messages that depend on counters (such as the page number) that are not known until the page has been completed.

`\iow_shipout_x:Nn` always needs `{}` around the second argument.

T_EXhackers note: `\iow_shipout_x:Nn` is equivalent to T_EX's `\write`.

77.3 Special characters for writing

<code>\iow_newline:</code>	<code>\iow_newline:</code>
----------------------------	----------------------------

Function that produces a new line when used within the $\langle token list \rangle$ that gets written some output stream in non-verbatim mode.

<code>\iow_space:</code>	<code>\iow_space:</code>
--------------------------	--------------------------

Function that produces a space when used within the $\langle token list \rangle$ that gets written to some output stream in an expanding mode.

<code>\iow_char:N</code>	<code>\iow_space:N \mathit{char}</code>
	<code>\iow_space:N \%</code>

Inserts $\langle char \rangle$ into the output stream. Useful when trying to write difficult characters such as `%`, `{`, `}`, etc., in messages.

78 Functions for input streams

`\ior_new:N` `\ior_new:N` $\langle stream \rangle$

This function defines $\langle stream \rangle$ to be a new input stream constant.

TeXhackers note: This is the new name and new implementation for plain TeX's `\newread`.

`\ior_open:Nn` `\ior_open:Nn` $\langle stream \rangle$ $\{\langle file name \rangle\}$

This function opens $\langle stream \rangle$ as an input stream for the external file $\langle file name \rangle$. If $\langle file name \rangle$ doesn't exist or is an empty file the stream is considered to be fully read, a condition which can be tested with `\ior_if_eof:NTF` etc. If $\langle stream \rangle$ was already used to read from some other file this file will be closed first. The input stream is ready for immediate use.

`\ior_close:N` `\ior_close:N` $\langle stream \rangle$

This function closes the read stream $\langle stream \rangle$.

TeXhackers note: This is a new name for `\closein` but it is considered bad practice to make use of this knowledge :-)

`\ior_if_eof_p:N` \star
`\ior_if_eof:NTF` \star `\ior_if_eof:NTF` $\langle stream \rangle$ $\{\langle true code \rangle\}$ $\{\langle false code \rangle\}$

Conditional that tests if some input stream is fully read. The condition is also true if the input stream is not open.

`\if_eof:w` `\if_eof:w` $\langle stream \rangle$ $\langle true code \rangle$ `\else:` $\langle false code \rangle$ `\fi:`

TeXhackers note: This is the primitive `\ifeof` but we allow only a $\langle stream \rangle$ and not a plain number after it.

`\ior_to:NN`
`\ior_gto:NN` `\ior_to:NN` $\langle stream \rangle$ $\langle tl var. \rangle$

Functions that reads one or more lines (until an equal number of left and right braces are found) from the input stream $\langle stream \rangle$ and places the result locally or globally into the token list variable. If $\langle stream \rangle$ is not open, input is requested from the terminal.

79 Constants

<code>\c_iow_comment_char</code>
<code>\c_iow_lbrace_char</code>
<code>\c_iow_rbrace_char</code>

Constants that can be used to represent comment character, left and right brace in token lists that should be written to a file.

<code>\c_iow_term_stream</code>
<code>\c_ior_term_stream</code>

Input or output stream denoting the terminal. If used as an input stream the user is prompted with the name of the token list variable (that is used in the call `\ior_to:NN` or `\ior_gto:NN`) followed by an equal sign. If you don't want an automatic prompt of this sort "misuse" `\c_iow_log_stream` as an input stream.

<code>\c_iow_log_stream</code>
<code>\c_ior_log_stream</code>

Output stream that writes only to the transcript file (e.g., the `.log` file on most systems). You may "misuse" this stream as an input stream. In this case it acts as a terminal stream without user prompting.

Part XVIII

The l3msg package

Communicating with the user

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 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.

80 Creating new messages

All messages have to be created before they can be used. Inside the message text, spaces are *not* ignored. A space where T_EX would normally gobble one can be created using `\` ,

and a new line with `\\`. New lines may have “continuation” text added by the output system.

```
\msg_new:nnnnn
\msg_new:nnnn
\msg_new:nnn
\msg_set:nnnnn
\msg_set:nnnn
\msg_set:nnn
```

`\msg_new:nnnn <module> <name> <text> <more text> <code>`
Creates new message `<name>` for `<module>` to produce `<text>` initially, `<more text>` if requested by the user and to insert `<code>` after the message when used as an error. `<text>` and `<more text>` can use up to two macro parameters (`#1` and `#2`), which are supplied by the message system. Inside `<text>` and `<more text>` spaces are not ignored.

81 Message classes

Creating message output requires the message to be given a class.

```
\msg_class_new:nn
\msg_class_set:nn
```

`\msg_class_new:nn <class> <code>`
Creates new `<class>` to output a message, using `<code>` to process the message text.

The module defines several common message classes. The following describes the standard behaviour of each class if no redirection of the class or message is active.

```
\msg_fatal:nxxx
\msg_fatal:nnx
\msg_fatal:nn
```

`\msg_fatal:nxxx <module> <name> <arg one> <arg two>`
Issues `<module>` error message `<name>`, passing `<arg one>` and `<arg two>` to the text-creating functions. The `TEX` run then halts.

```
\msg_error:nxxx
\msg_error:nnx
\msg_error:nn
```

`\msg_error:nxxx <module> <name> <arg one> <arg two>`
Issues `<module>` error message `<name>`, passing `<arg one>` and `<arg two>` to the text-creating functions.

T_EXhackers note: The standard output here is similar to `\PackageError`.

```
\msg_warning:nxxx
\msg_warning:nnx
\msg_warning:nn
```

`\msg_warning:nxxx <module> <name> <arg one> <arg two>`
Prints `<module>` message `<name>` to the terminal, passing `<arg one>` and `<arg two>` to the text-creating functions.

T_EXhackers note: The standard output here is similar to `\PackageWarningNoLine`.

```
\msg_info:nnxx  
\msg_info:nnx  
\msg_info:nn
```

`\msg_info:nnxx` *<module>* *<name>* *<arg one>* *<arg two>*
Prints *<module>* message *<name>* to the log, passing *<arg one>* and *<arg two>* to the text-creating functions.

T_EXhackers note: The standard output here is similar to `\PackageInfoNoLine`.

```
\msg_log:nnxx  
\msg_log:nnx  
\msg_log:nn
```

`\msg_log:nnxx` *<module>* *<name>* *<arg one>* *<arg two>*
Prints *<module>* message *<name>* to the log, passing *<arg one>* and *<arg two>* to the text-creating functions. No continuation text is added.

```
\msg_trace:nnxx  
\msg_trace:nnx  
\msg_trace:nn
```

`\msg_trace:nnxx` *<module>* *<name>* *<arg one>* *<arg two>*
Prints *<module>* message *<name>* to the log, passing *<arg one>* and *<arg two>* to the text-creating functions. No continuation text is added.

```
\msg_none:nnxx  
\msg_none:nnx  
\msg_none:nn
```

`\msg_none:nnxx` *<module>* *<name>* *<arg one>* *<arg two>*
Does nothing: used for redirecting other message classes.

82 Redirecting messages

```
\msg_redirect_class:nn
```

`\msg_redirect_class:nn` *<class one>* *<class two>*

Redirect all messages of *<class one>* to appear as those of *<class two>*.

```
\msg_redirect_module:nnn
```

`\msg_redirect_module:nnn` *<class one>* *<module>* *<class two>*

Redirect *<module>* messages of *<class one>* to appear in *<class two>*.

T_EXhackers note: 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 { trace } { module } { none }
```

<code>\msg_redirect_name:nnn</code>	<code>\msg_redirect_name:nnn</code> $\langle module \rangle$ $\langle message \rangle$ $\langle class \rangle$
-------------------------------------	--

Redirect $\langle module \rangle$ $\langle message \rangle$ to appear using $\langle class \rangle$.

83 Support functions for output

<code>\msg_line_context:</code>	<code>\msg_line_context:</code>
---------------------------------	---------------------------------

Prints the current line number preceded by `\c_msg_on_line_tl`.

<code>\msg_line_number:</code>	<code>\msg_line_number:</code>
--------------------------------	--------------------------------

Prints the current line number.

<code>\msg_newline:</code> <code>\msg_two_newlines:</code>	<code>\msg_newline:</code>
---	----------------------------

Print one or two newlines with no continuation information.

<code>\msg_space:</code> <code>\msg_two_spaces:</code> <code>\msg_four_spaces:</code>	<code>\msg_space:</code>
---	--------------------------

Print one, two or four spaces: needed where a literal space would otherwise be gobbled by T_EX.

84 Low-level functions

The low-level functions do not make assumptions about module names. The output functions here produce messages directly, and do not respond to redirection.

<code>\msg_generic_new:nnnn</code> <code>\msg_generic_new:nnn</code> <code>\msg_generic_new:nn</code> <code>\msg_generic_set:nnnn</code> <code>\msg_generic_set:nnn</code> <code>\msg_generic_set:nn</code>	<code>\msg_generic_new:nnnn</code> $\langle name \rangle$ $\langle text \rangle$ $\langle more text \rangle$ $\langle code \rangle$
--	---

Creates new message $\langle name \rangle$ to produce $\langle text \rangle$ initially, $\langle more text \rangle$ if requested by the user and to insert $\langle code \rangle$ after the message when used as an error. $\langle text \rangle$ and $\langle more text \rangle$ can use up to two macro parameters (#1 and #2), which are supplied by the message system. Inside $\langle text \rangle$ and $\langle more text \rangle$ spaces are not ignored.

<code>\msg_direct_interrupt:xxxxn</code>	<code>\msg_direct_interrupt:xxxxn</code> $\langle first line \rangle$ $\langle text \rangle$ $\langle continuation \rangle$ $\langle more text \rangle$ $\langle code \rangle$
--	---

Executes a T_EX error, interrupting compilation. The *⟨first line⟩* is displayed followed by *⟨text⟩* and the input prompt. *⟨more text⟩* is displays if requested by the user, and *⟨code⟩* is inserted after the message. If *⟨more text⟩* is blank a default is supplied. Each line of *⟨text⟩* (broken with `\\`) begins with *⟨continuation⟩*.

<code>\msg_direct_log:xx</code> <code>\msg_direct_term:xx</code>	<code>\msg_direct_log:xx</code> <i>⟨text⟩</i> <i>⟨continuation⟩</i>
---	---

Prints *⟨text⟩* to either the log or terminal. New lines (broken with `\\`) start with *⟨continuation⟩*.

85 Kernel-specific functions

<code>\msg_kernel_new:nnnn</code> <code>\msg_kernel_new:nnn</code> <code>\msg_kernel_new:nn</code> <code>\msg_kernel_set:nnnn</code> <code>\msg_kernel_set:nnn</code> <code>\msg_kernel_set:nn</code>	<code>\msg_kernel_new:nnn</code> <i>⟨name⟩</i> <i>⟨text⟩</i> <i>⟨more text⟩</i> <i>⟨code⟩</i>
--	---

Creates new kernel message *⟨name⟩* to produce *⟨text⟩* initially, *⟨more text⟩* if requested by the user and to insert *⟨code⟩* after the message when used as an error. *⟨text⟩* and *⟨more text⟩* can use up to two macro parameters (#1 and #2), which are supplied by the message system.

<code>\msg_kernel_fatal:nxx</code> <code>\msg_kernel_fatal:nx</code> <code>\msg_kernel_fatal:n</code>	<code>\msg_kernel_fatal:nxx</code> <i>⟨name⟩</i> <i>⟨arg one⟩</i> <i>⟨arg two⟩</i>
---	--

Issues kernel error message *⟨name⟩*, passing *⟨arg one⟩* and *⟨arg two⟩* to the text-creating functions. The T_EX run then halts. Cannot be redirected.

<code>\msg_kernel_error:nxx</code> <code>\msg_kernel_error:nx</code> <code>\msg_kernel_error:n</code>	<code>\msg_kernel_error:nxx</code> <i>⟨name⟩</i> <i>⟨arg one⟩</i> <i>⟨arg two⟩</i>
---	--

Issues kernel error message *⟨name⟩*, passing *⟨arg one⟩* and *⟨arg two⟩* to the text-creating functions. Cannot be redirected.

<code>\msg_kernel_warning:nxx</code> <code>\msg_kernel_warning:nx</code> <code>\msg_kernel_warning:n</code>	<code>\msg_kernel_warning:nxx</code> <i>⟨name⟩</i> <i>⟨arg one⟩</i> <i>⟨arg two⟩</i>
---	--

Prints kernel message *⟨name⟩* to the terminal, passing *⟨arg one⟩* and *⟨arg two⟩* to the text-creating functions.

<code>\msg_kernel_info:nxx</code> <code>\msg_kernel_info:nx</code> <code>\msg_kernel_info:n</code>	<code>\msg_kernel_info:nxx</code> $\langle name \rangle$ $\langle arg one \rangle$ $\langle arg two \rangle$
--	--

Prints kernel message $\langle name \rangle$ to the log, passing $\langle arg one \rangle$ and $\langle arg two \rangle$ to the text-creating functions.

<code>\msg_kernel_bug:x</code>	<code>\msg_kernel_bug:x</code> $\langle text \rangle$
--------------------------------	---

Short-cut for “This is a LaTeX bug: check coding” errors.

86 Variables and constants

<code>\c_msg_fatal_tl</code> <code>\c_msg_error_tl</code> <code>\c_msg_warning_tl</code> <code>\c_msg_info_tl</code>	Simple headers for errors.
---	----------------------------

<code>\c_msg_fatal_text_tl</code> <code>\c_msg_help_text_tl</code> <code>\c_msg_kernel_bug_text_tl</code> <code>\c_msg_kernel_bug_more_text_tl</code> <code>\c_msg_no_info_text_tl</code> <code>\c_msg_return_text_tl</code>	Various pieces of text for use in messages, which are not changed by the code here although they could be to alter the language.
---	--

<code>\c_msg_on_line_tl</code>	The “on line” phrase for line numbers.
--------------------------------	--

<code>\c_msg_text_prefix_tl</code> <code>\c_msg_more_text_prefix_tl</code> <code>\c_msg_code_prefix_tl</code>	Header information for storing the “paths” to parts of a message.
---	---

<code>\l_msg_class_tl</code> <code>\l_msg_current_class_tl</code>	Information about message method, used for filtering.
--	---

<code>\l_msg_names_clist</code>	List of all of the message names defined.
---------------------------------	---

<code>\l_msg_redirect_classes_prop</code> <code>\l_msg_redirect_names_prop</code>	Re-direction lists containing the class of message to convert an different one.
--	---

<code>\l_msg_redirect_classes_clist</code>	List so that filtering does not loop.
--	---------------------------------------

Part XIX

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_`.

87 Generic functions

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

`\box_new:N <box>`

Defines `<box>` to be a new variable of type `box`.

T_EXhackers note: `\box_new:N` is the equivalent of plain T_EX's `\newbox`. However, the internal register allocation is done differently.

<code>\if_hbox:N</code>
<code>\if_vbox:N</code>
<code>\if_box_empty:N</code>

`\if_hbox:N <box> {true code}\else: {false code}\fi:`
`\if_vbox:N <box> {true code}\else: {false code}\fi:`
`\if_box_empty:N <box> {true code}\else: {false code}\fi:`

`\if_hbox:N` and `\if_vbox:N` check if `<box>` is an horizontal or vertical box resp. `\if_box_empty:N` tests if `<box>` is empty (void) and executes `code` according to the test outcome.

T_EXhackers note: These are the T_EX primitives `\ifhbox`, `\ifvbox` and `\ifvoid`.

<code>\box_if_horizontal_p:N</code>
<code>\box_if_horizontal_p:c</code>
<code>\box_if_horizontal:NTF</code>
<code>\box_if_horizontal:cTF</code>

`\box_if_horizontal:NTF <box> {true code} {false code}`

Tests if `<box>` is an horizontal box and executes `<code>` accordingly.

<code>\box_if_vertical_p:N</code>
<code>\box_if_vertical_p:c</code>
<code>\box_if_vertical:NTF</code>
<code>\box_if_vertical:cTF</code>

`\box_if_vertical:NTF <box> {true code} {false code}`

Tests if `<box>` is a vertical box and executes `<code>` accordingly.

<code>\box_if_empty_p:N</code>
<code>\box_if_empty_p:c</code>
<code>\box_if_empty:NTF</code>
<code>\box_if_empty:cTF</code>

`\box_if_empty:N TF $\langle box \rangle$ $\{\langle true code \rangle\}$ $\{\langle false code \rangle\}$`
Tests if $\langle box \rangle$ is empty (void) and executes `code` according to the test outcome.

TeXhackers note: `\box_if_empty:N TF` is the L^AT_EX3 function name for `\ifvoid`.

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

`\box_set_eq:NN $\langle box_1 \rangle$ $\langle box_2 \rangle$`
Sets $\langle box_1 \rangle$ equal to $\langle box_2 \rangle$. Note that this eradicates the contents of $\langle box_2 \rangle$ afterwards.

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

`\box_gset_eq:NN $\langle box_1 \rangle$ $\langle box_2 \rangle$`
Globally sets $\langle box_1 \rangle$ equal to $\langle box_2 \rangle$.

<code>\box_set_to_last:N</code>
<code>\box_set_to_last:c</code>
<code>\box_gset_to_last:N</code>
<code>\box_gset_to_last:c</code>

`\box_set_to_last:N $\langle box \rangle$`
Sets $\langle box \rangle$ equal to the previous box `\l_last_box` and removes `\l_last_box` from the current list (unless in outer vertical or math mode).

<code>\box_move_right:nn</code>
<code>\box_move_left:nn</code>
<code>\box_move_up:nn</code>
<code>\box_move_down:nn</code>

`\box_move_left:nn $\{\langle dimen \rangle\}$ $\{\langle box function \rangle\}$`
Moves $\langle box function \rangle$ $\langle dimen \rangle$ in the direction specified. $\langle box function \rangle$ is either an operation on a box such as `\box_use:N` or a “raw” box specification like `\vbox:n{xyz}`.

<code>\box_clear:N</code>
<code>\box_clear:c</code>
<code>\box_gclear:N</code>
<code>\box_gclear:c</code>

`\box_clear:N $\langle box \rangle$`
Clears $\langle box \rangle$ by setting it to the constant `\c_void_box`. `\box_gclear:N` does it globally.

<code>\box_use:N</code>
<code>\box_use:c</code>
<code>\box_use_clear:N</code>
<code>\box_use_clear:c</code>

`\box_use:N $\langle box \rangle$`
`\box_use_clear:N $\langle box \rangle$`
`\box_use:N` puts a copy of $\langle box \rangle$ on the current list while `\box_use_clear:N` puts the box on the current list and then eradicates the contents of it.

T_EXhackers note: `\box_use:N` and `\box_use_clear:N` are the T_EX primitives `\copy` and `\box` with new (descriptive) names.

<code>\box_ht:N</code>
<code>\box_ht:c</code>
<code>\box_dp:N</code>
<code>\box_dp:c</code>
<code>\box_wd:N</code>
<code>\box_wd:c</code>

`\box_ht:N` $\langle box \rangle$

Returns the height, depth, and width of $\langle box \rangle$ for use in dimension settings.

T_EXhackers note: These are the T_EX primitives `\ht`, `\dp` and `\wd`.

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

`\box_show:N` $\langle box \rangle$

Writes the contents of $\langle box \rangle$ to the log file.

T_EXhackers note: This is the T_EX primitive `\showbox`.

<code>\c_empty_box</code>
<code>\l_tmpa_box</code>
<code>\l_tmpb_box</code>

`\c_empty_box` is the constantly empty box. The others are scratch boxes.

<code>\l_last_box</code>

`\l_last_box` is more or less a read-only box register managed by the engine. It denotes the last box on the current list if there is one, otherwise it is void. You can set other boxes to this box, with the result that the last box on the current list is removed at the same time (so it is with variable with side-effects).

88 Horizontal mode

<code>\hbox:n</code>

`\hbox:n` $\{\langle contents \rangle\}$

Places a `hbox` of natural size.

<code>\hbox_set:Nn</code>
<code>\hbox_set:cn</code>
<code>\hbox_gset:Nn</code>
<code>\hbox_gset:cn</code>

`\hbox_set:Nn` $\langle box \rangle$ $\{\langle contents \rangle\}$

Sets $\langle box \rangle$ to be a vertical mode box containing $\langle contents \rangle$. It has its natural size.

`\hbox_gset:Nn` does it globally.

<code>\hbox_set_to_wd:Nnn</code> <code>\hbox_set_to_wd:cnn</code> <code>\hbox_gset_to_wd:Nnn</code> <code>\hbox_gset_to_wd:cnn</code>	<code>\hbox_set_to_wd:Nnn</code> $\langle box \rangle$ $\{\langle dimen \rangle\}$ $\{\langle contents \rangle\}$
--	---

Sets $\langle box \rangle$ to contain $\langle contents \rangle$ and have width $\langle dimen \rangle$. `\hbox_gset_to_wd:Nn` does it globally.

<code>\hbox_to_wd:nn</code> <code>\hbox_to_zero:n</code>	<code>\hbox_to_wd:nn</code> $\{\langle dimen \rangle\}$ $\langle contents \rangle$ <code>\hbox_to_zero:n</code> $\langle contents \rangle$
---	---

Places a $\langle box \rangle$ of width $\langle dimen \rangle$ containing $\langle contents \rangle$. `\hbox_to_zero:n` is a shorthand for a width of zero.

<code>\hbox_set_inline_begin:N</code> <code>\hbox_set_inline_begin:c</code> <code>\hbox_set_inline_end:</code> <code>\hbox_gset_inline_begin:N</code> <code>\hbox_gset_inline_begin:c</code> <code>\hbox_gset_inline_end:</code>	<code>\hbox_set_inline_begin:N</code> $\langle box \rangle$ $\langle contents \rangle$ <code>\hbox_set_inline_end:</code>
---	--

Sets $\langle box \rangle$ to contain $\langle contents \rangle$. This type is useful for use in environment definitions.

<code>\hbox_unpack:N</code> <code>\hbox_unpack:c</code> <code>\hbox_unpack_clear:N</code> <code>\hbox_unpack_clear:c</code>	<code>\hbox_unpack:N</code> $\langle box \rangle$
--	---

`\hbox_unpack:N` unpacks the contents of the $\langle box \rangle$ register and `\hbox_unpack_clear:N` also clears the $\langle box \rangle$ after unpacking it.

T_EXhackers note: These are the T_EX primitives `\unhcopy` and `\unhbox`.

89 Vertical mode

<code>\vbox:n</code>	<code>\vbox:n</code> $\{\langle contents \rangle\}$
----------------------	---

Places a `\vbox` of natural size with baseline equal to the baseline of the last line in the box.

<code>\vbox_set:Nn</code> <code>\vbox_set:cn</code> <code>\vbox_gset:Nn</code> <code>\vbox_gset:cn</code>	<code>\vbox_set:Nn</code> $\langle box \rangle$ $\{\langle contents \rangle\}$
--	--

Sets $\langle box \rangle$ to be a vertical mode box containing $\langle contents \rangle$. It has its natural size. `\vbox_gset:Nn` does it globally.

<code>\vbox_set_to_ht:Nnn</code> <code>\vbox_set_to_ht:cnn</code> <code>\vbox_gset_to_ht:Nnn</code> <code>\vbox_gset_to_ht:cnn</code> <code>\vbox_gset_to_ht:ccn</code>	<code>\vbox_set_to_ht:Nnn</code> $\langle box \rangle$ $\{\langle dimen \rangle\}$ $\{\langle contents \rangle\}$
---	---

Sets $\langle box \rangle$ to contain $\langle contents \rangle$ and have total height $\langle dimen \rangle$. `\vbox_gset_to_ht:Nn` does it globally.

<code>\vbox_set_inline_begin:N</code> <code>\vbox_set_inline_end:</code> <code>\vbox_gset_inline_begin:N</code> <code>\vbox_gset_inline_end:</code>	<code>\vbox_set_inline_begin:N</code> $\langle box \rangle$ $\langle contents \rangle$ <code>\vbox_set_inline_end:</code>
--	--

Sets $\langle box \rangle$ to contain $\langle contents \rangle$. This type is useful for use in environment definitions.

<code>\vbox_set_split_to_ht:NNn</code>	<code>\vbox_set_split_to_ht:NNn</code> $\langle box_1 \rangle$ $\langle box_2 \rangle$ $\{\langle dimen \rangle\}$
--	--

Sets $\langle box_1 \rangle$ to contain the top $\langle dimen \rangle$ part of $\langle box_2 \rangle$.

T_EXhackers note: This is the T_EX primitive `\vsplit`.

<code>\vbox_to_ht:nn</code> <code>\vbox_to_zero:n</code>	<code>\vbox_to_ht:nn</code> $\{\langle dimen \rangle\}$ $\langle contents \rangle$ <code>\vbox_to_zero:n</code> $\langle contents \rangle$
---	---

Places a $\langle box \rangle$ of size $\langle dimen \rangle$ containing $\langle contents \rangle$.

<code>\vbox_unpack:N</code> <code>\vbox_unpack:c</code> <code>\vbox_unpack_clear:N</code> <code>\vbox_unpack_clear:c</code>	<code>\vbox_unpack:N</code> $\langle box \rangle$
--	---

`\vbox_unpack:N` unpacks the contents of the $\langle box \rangle$ register and `\vbox_unpack_clear:N` also clears the $\langle box \rangle$ after unpacking it.

T_EXhackers note: These are the T_EX primitives `\unvcopy` and `\unvbox`.

Part XX

The l3xref package

Cross references

<code>\xref_set_label:n</code>	<code>\xref_set_label:n</code> $\{\langle name \rangle\}$
--------------------------------	---

Sets a label in the text. Note that this function does not do anything else than setting the correct labels. In particular, it does not try to fix any spacing around the write node; this is a task for the `galley2` module.

`\xref_new:nn` `\xref_new:nn {<type>} {<value>}`

Defines a new cross reference type `<type>`. This defines the token list variable `\l_xref_curr_<type>_tl` with default value `<value>` which gets written fully expanded when `\xref_set_label:n` is called.

`\xref_deferred_new:nn` `\xref_deferred_new:nn {<type>} {<value>}`

Same as `\xref_new:n` except for this one, the value written happens when `TEX` ships out the page. Page numbers use this one obviously.

`\xref_get_value:nn *` `\xref_get_value:nn {<type>} {<name>}`

Extracts the cross reference information of type `<type>` for the label `<name>`. This operation is expandable.

Part XXI

The `l3keyval` package

Key-value parsing

This module only provides functions for extracting keys and values from a list. How this information is used is up to the programmer. The `l3keys` module provides a higher-level interface for managing run-time key-value input.

A *<keyval list>* is a list consisting of

```
key 1 = value 1 ,
key 2           ,
key 3 = value 3 ,
```

The function names for retrieving the keys and values are long but explain what they do. All these functions start with the name `\KV_parse_`. If a value is surrounded by braces, one level (and only one) is removed from the value. This is useful if you need to input a value which contains `=` or `,`. There are two primary actions we can take on a *<keyval list>*.

- A *<keyval list>* can be sanitized so that top level active commas or equal signs are converted into catcode 12. When declaring templates in the preamble one can probably safely assume that there are no active commas or equals; these things should only be active in the document. The name for this is either `no_sanitize` or `sanitize`.

- Spaces on either side of a key or value can be trimmed. When using the L^AT_EX3 programming interface, spaces are automatically ignored so there it would be a waste of time to search for extra spaces since there would be none. At the document level however, spaces must be removed. The name for this is either `no_space_removal` or `space_removal`. Note that when `space_removal` is called you get an additional option where you can decide if one level of braces should be stripped from the key and/or value; see the description of the boolean `\l_KV_remove_one_level_of_braces_bool` for details.

During the parsing process, keys or values are not expanded and no #s are doubled. When the parsing process is over, the keys and values are executed in the form

```
\KV_key_value_elt:nn{key 1}{value 1}
\KV_key_no_value_elt:n{key 2}
\KV_key_value_elt:nn{key 3}{value 3}
```

It is up to the programmer to provide a suitable definition of these two functions before starting the parsing process.

90 Functions

`\KV_parse_no_space_removal_no_sanitize:n`

`\KV_parse_no_space_removal_no_sanitize:n {<keyval list>}`

Parses the keys and values literally. For use when spaces are ignored and = and , have normal catcodes.

`\KV_parse_space_removal_no_sanitize:n`

`\KV_parse_space_removal_no_sanitize:n {<keyval list>}`

As above but also removes spaces around keys and values. For use when spaces are not ignored.

`\KV_parse_space_removal_sanitize:n`

`\KV_parse_space_removal_sanitize:n {<keyval list>}`

As above but additionally also replaces top-level active = and , with harmless versions.

`\l_KV_remove_one_level_of_braces_bool`

This boolean controls whether or not one level of braces is stripped from the key and value. The default value for this boolean is `<true>` so that exactly one level of braces is stripped. For certain applications it is desirable to keep the braces in which case the programmer just has to set the boolean false temporarily. Setting this boolean has no effect when you call the `no_space_removal` functions since not stripping braces is a rare request and would clutter the otherwise elegant code of the `no_space_removal` functions for very little gain. If you need to preserve braces choose the slower `space_removal` functions.

<code>\KV_key_no_value_elt:n</code>	<code>\KV_key_no_value_elt:n {\langle key \rangle}</code>
<code>\KV_key_value_elt:nn</code>	<code>\KV_key_value_elt:n {\langle key \rangle} {\langle value \rangle}</code>

Functions returned by the `\KV_parse_` functions. The default definition of these two functions is an error message!

Part XXII

The l3keys package

Key–value support

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}.
```

For the programmer, the original `keyval` package gives only the most basic interface for this work. All key macros have to be created one at a time, and as a result the `kvoptions` and `xkeyval` packages have been written to extend the ease of creating keys. A very different approach has been provided by the `pgfkeys` package, which uses a key–value list to generate keys.

The `l3keys` package is aimed at creating a programming interface for key–value controls in L^AT_EX3. Keys are created using a key–value interface, in a similar manner to `pgfkeys`. 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 .set      = \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` is used within a document function. For L^AT_EX 2_ε, a generic set up function could be created with

```
\newcommand*\SomePackageSetup[1]{%
  \@nameuse{keys_set:nn}{module}{#1}%
}
```

or to use key–value input as the optional argument for a macro:

```
\newcommand*\SomePackageMacro[2][]{%
  \begingroup
    \@nameuse{keys_set:nn}{module}{#1}%
    % Main code for \SomePackageMacro
  \endgroup
}
```

The same concepts using xparse for L^AT_EX 3 use:

```
\DeclareDocumentCommand \SomePackageSetup { m } {
  \keys_set:nn { module } { #1 }
}
\DeclareDocumentCommand \SomePackageMacro { o m } {
  \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 90.2, it is suggested that the character “/” is reserved for sub-division of keys into logical groups. Macros 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`.

90.1 Creating keys

`\keys_define:nn` `\keys_define:nn {<module>} {<keyval list>}`

Parses the *<keyval list>* and defines the keys listed there for *<module>*. This function is designed for use in code, and therefore does not check the category codes of characters or ignore spaces.

Setting up and altering keys is carried out using one or more properties. The properties determine how a key acts, and may require zero, one or two argument: this is indicated

by an argument specifier, in the same way as a standard L^AT_EX3 function. If only a single argument is required, braces around `n` arguments can be omitted.⁷

`.bool:N` $\langle key \rangle$ `.bool:N = $\langle bool \rangle$`

Defines $\langle key \rangle$ to set $\langle bool \rangle$ to $\langle value \rangle$ (which must be either `true` or `false`).

`.choice:` $\langle key \rangle$ `.choice:`

Sets $\langle key \rangle$ to act as a multiple choice key. Creating choices is discussed in section 90.3.

`.code:n`
`.code:x` $\langle key \rangle$ `.code:n = $\langle code \rangle$`

Stores the $\langle code \rangle$ for execution when $\langle key \rangle$ is called. The $\langle code \rangle$ can include one parameter (`#1`), which will be the $\langle value \rangle$ given for the $\langle key \rangle$.

`.code:Nn`
`.code:Nx` $\langle key \rangle$ `.code:Nn = $\langle number \rangle$ $\langle code \rangle$`

Stores the $\langle code \rangle$ for execution when $\langle key \rangle$ is called. The $\langle code \rangle$ can include $\langle number \rangle$ parameters, which can be in the standard T_EX range 0–9. If too few parameters are given when the key is used, sufficient empty groups will be supplied to prevent an error occurring.

`.default:n`
`.default:V` $\langle key \rangle$ `.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 = World
}
\keys_set:nn { module} {
  key = Fred, % Prints "Hello Fred"
  key,      % Prints "Hello World"
  key = ,   % Prints "Hello "
}
```

T_EXhackers note: The $\langle default \rangle$ is stored as a token list variable.

`.function:N` $\langle key \rangle$ `.function:N = $\langle function \rangle$`

The input for $\langle key \rangle$ is used to define $\langle function \rangle$, which internally uses `\cs_set:Nn`. The effect is the same as `$\langle key \rangle$.code:n = { \cs_set:Nn $\langle function \rangle$ {#1} } .` The

⁷This is a general feature of key–value input methods.

$\langle function \rangle$ should be an internal function, as the number of arguments is detected from the argument specifier. If the $\langle function \rangle$ is not defined, it is initialised to empty.

<code>.generate_choices:nn</code> <code>.generate_choices:nx</code>	$\langle key \rangle$.generate_choices:nn = $\langle comma\ list \rangle$ $\langle code \rangle$
--	---

Makes $\langle key \rangle$ a multiple choice key, accepting the choices specified in $\langle comma\ list \rangle$. Each choice will execute $\langle code \rangle$ if it given. Within $\langle code \rangle$, the name of the current choice is available as `\l_keys_choice_tl`, and its position in the $\langle comma\ list \rangle$ as `\l_keys_choice_int`. Multiple choices are discussed further in section 90.3.

<code>.initial:n</code> <code>.initial:V</code>	$\langle key \rangle$.initial:n = $\langle initial \rangle$
--	--

Sets $\langle key \rangle$ using the $\langle initial \rangle$ value given. This can only be given after the $\langle key \rangle$ is created.

<code>.meta:n</code> <code>.meta:x</code>	$\langle key \rangle$.meta:n = $\langle keys \rangle$
--	--

Makes $\langle key \rangle$ a meta-key, which will set several other $\langle keys \rangle$ in one go. If $\langle key \rangle$ is given with a value, it is passed through to the subsidiary $\langle keys \rangle$ for processing.

<code>.set:N</code> <code>.set_x:N</code>	$\langle key \rangle$.set:N = $\langle variable \rangle$
--	---

Defines $\langle key \rangle$ to store the value given in $\langle variable \rangle$. The type and scope (local or global) of $\langle variable \rangle$ are determined from the name. The x version performs an expanded assignment. For example

```
\keys_define:nn { module } {
  key-one .set:N = \l_module_tmpa_tl, % Locally sets a tl var.
  key-two .set:N = \g_module_tmpa_toks % Globally sets a toks
}
\keys_set:nn { module } {
  key-one = Value, % \l_module_tmpa_tl contains "Value"
  key-two = Stuff % \g_module_tmpa_toks contains "Stuff"
}
```

Assignments are automatically global for global variables.

A $\langle variable \rangle_set:Nn$ function must exist to allow setting of the $\langle variable \rangle$. An error will result if this is not the case. The `.set_x:N` version can only be applied to variable types which have a $\langle variable \rangle_set:Nx$ function: other cases will result in an error.

<code>.value_forbidden:</code> <code>.value_required:</code>	$\langle key \rangle$.value_forbidden:
---	---

Flags for forbidding and requiring a $\langle value \rangle$ for $\langle key \rangle$. Any $\langle value \rangle$ given will be ignored.

90.2 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.

90.3 Multiple choices

Multiple 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 `.generate_choices:nn` property:

```
\keys_define:nn { module } {  
  key .generate_choices:nn = {  
    choice-a, choice-b, choice-c  
  } {  
    You~gave~choice~‘‘\l_keys_choice_tl’’ ,~  
    which~is~in~position~\l_keys_choice_int  
    \~in~the~list.  
  }  
}
```

<code>\l_keys_choice_tl</code> <code>\l_keys_choice_int</code>

Inside the code block, 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 1.

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 choices:n,
  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`.

90.4 Setting keys

`\keys_set:nn`
`\keys_set:nV`
`\keys_set:nv`

`\keys_set:nn {<module>} {<keyval list>}`

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. In contrast to `\keys_define:nn`, this function does check category codes and ignore spaces, and is therefore suitable for user input.

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_path_tl'~to~'#1'
}
```

`\l_keys_key_tl`

When processing an unknown key, the name of the key is available as `\l_keys_key_tl`. Note that this will have been processed using `\tl_to_str:N`. The value passed to the key (if any) is available as the macro parameter `#1`.

90.5 Examining keys: internal representation

`\keys_if_exist:nnTF`

`\keys_if_exist:nnTF {<module>} {<key>} {<true code>} {<false code>}`

Tests if `<key>` exists for `<module>`, by checking for the existence of the internal function `\keys > <module>/<key>.cmd:w`.

`\keys_show:nn`

`\keys_show:nn {<module>} {<key>}`

Shows the internal representation of a `<key>`. The function which executes a `<key>` is called `\keys > <module>/<key>.cmd:w`.

90.6 Internal functions

`\keys_arguments_tidy:w` `\keys_arguments_tidy:w <args> \q_keys_stop`

Clears *<args>* from the stack: used to clean up after executing a key.

`\keys_bool_set:N`
`\keys_bool_set_inverse:N` `\keys_bool_set:N <bool>`

Creates code to set *<bool>* when *<key>* is given.

`\keys_choice_make:` `\keys_choice_make:`

Makes *<key>* a choice key.

`\keys_choices_generate:nx` `\keys_choices_generate:nx {<comma list>} {<code>}`

Makes *<comma list>* choices for *<key>*, each using *<code>*.

`\keys_choice_find:n` `\keys_choice_find:n {<choice>}`

Searches for *<choice>* as a sub-key of *<key>*.

`\keys_cmd_set:nNn`
`\keys_cmd_set:nNx` `\keys_cmd_set:nNn {<path>} <num args> {<code>}`

Creates a function for *<path>*, taking *<num args>* and using *<code>*.

`\keys_default_set:n`
`\keys_default_set:V` `\keys_default_set:n {<default>}`

Sets *<default>* for *<key>*.

`\keys_define_elt:n`
`\keys_define_elt:nn` `\keys_define_elt:nn {<key>} {<value>}`

Processing functions for key–value pairs when defining keys.

`\keys_define_key:n` `\keys_define_key:n {<key>}`

Defines *<key>*.

`\keys_execute:` `\keys_execute:`

Executes *<key>*.

`\keys_execute_unknown:` `\keys_execute_unknown:`

Handles unknown *<key>* names.

<code>\keys_if_value_requirement:nTF</code>	<code>\keys_if_value_requirement:nTF {<requirement>} {<true code>} {<false code>}</code>
---	--

Check if $\langle requirement \rangle$ applies to $\langle key \rangle$.

<code>\keys_initial_value:n</code>	<code>\keys_initial_value:n {<value>}</code>
<code>\keys_initial_value:V</code>	

Sets $\langle value \rangle$ as initial contents for $\langle key \rangle$.

<code>\keys_meta_make:n</code>	<code>\keys_meta_make:n {<keys>}</code>
<code>\keys_meta_make:x</code>	

Makes $\langle key \rangle$ a meta-key to set $\langle keys \rangle$.

<code>\keys_property_find:n</code>	<code>\keys_property_find:n {<key>}</code>
------------------------------------	--

Separates $\langle key \rangle$ from $\langle property \rangle$.

<code>\keys_property_new:nn</code>	<code>\keys_property_new:nn {<property>} {<code>}</code>
------------------------------------	--

Makes a new $\langle property \rangle$ expanding to $\langle code \rangle$

<code>\keys_property_undefine:n</code>	<code>\keys_property_undefine:n {<property>}</code>
--	---

Deletes $\langle property \rangle$ of $\langle key \rangle$.

<code>\keys_set_elt:n</code>	<code>\keys_set_elt:nn {<key>} {<value>}</code>
<code>\keys_set_elt:nn</code>	

Processing functions for key–value pairs when setting keys.

<code>\keys_tmp:w</code>	<code>\keys_tmp:w <args></code>
--------------------------	---------------------------------------

Used to store $\langle code \rangle$ to execute a $\langle key \rangle$.

<code>\keys_value_or_default:n</code>	<code>\keys_value_or_default:n {<value>}</code>
---------------------------------------	---

Sets `\l_keys_value_toks` to $\langle value \rangle$, or $\langle default \rangle$ if $\langle value \rangle$ was not given and if $\langle default \rangle$ is available.

<code>\keys_value_requirement:n</code>	<code>\keys_value_requirement:n {<requirement>}</code>
--	--

Sets $\langle key \rangle$ to have $\langle requirement \rangle$ concerning $\langle value \rangle$.

<code>\keys_variable_set:NN</code>	<code>\keys_variable_set:NN</code> $\langle expansion \rangle$ $\langle var \rangle$
------------------------------------	--

Sets $\langle key \rangle$ to assign $\langle value \rangle$ to $\langle variable \rangle$

<code>\keys_variable_get_scope:N</code> *	<code>\keys_variable_get_scope:N</code> $\langle var \rangle$
<code>\keys_variable_get_type:N</code> *	

Returns the scope (g or blank) or the type of $\langle var \rangle$.

90.7 Variables and constants

<code>\c_keys_properties_root_tl</code>	The root paths for keys and properties.
<code>\c_keys_root_tl</code>	

<code>\c_keys_value_forbidden_tl</code>	Marker text containers.
<code>\c_keys_value_required_tl</code>	

<code>\l_keys_module_tl</code>	Various key paths need to be stored.
<code>\l_keys_path_tl</code>	
<code>\l_keys_property_tl</code>	

<code>\l_keys_nesting_seq</code>	To allow safe nesting of <code>\keys_define:nn</code> and <code>\keys_set:nn</code> .
<code>\l_keys_nesting_tl</code>	

<code>\l_keys_no_value_bool</code>	A marker for “no value” as key input.
------------------------------------	---------------------------------------

<code>\l_keys_value_toks</code>	Holds the currently supplied value.
---------------------------------	-------------------------------------

<code>\q_keys_stop</code>	A quark for delimiting arguments.
---------------------------	-----------------------------------

Part XXIII

The l3calc package

Infix notation arithmetic in L^AT_EX3

This is pretty much a straight adaption of the `calc` package and as such has same syntax for the $\langle calc expression \rangle$. However, there are some noticeable differences.

- The `calc` expression is expanded fully, which means there are no problems with unfinished conditionals. However, the contents of `\widthof` etc. is not expanded at all. This includes uses in traditional L^AT_EX as in the `array` package, which tries to do an `\edef` several times. The code used in `l3calc` provides self-protection for these cases.
- Muskip registers are supported although they can only be used in `\ratio` if already evaluating a muskip expression. For the other three register types, you can use points.
- All results are rounded, not truncated. More precisely, the primitive T_EX operations `\divide` and `\multiply` are not used. The only instance where one will observe an effect is when dividing integers.

This version of `l3calc` is now a complete replacement for the original `calc` package providing the same functionality and will prevent the original `calc` package from loading.

91 User functions

```
\maxof
\minof
\widthof
\heightof
\depthof
\totalheightof
\ratio
\real
\setlength
\gsetlength
\addtolength
\gaddtolength
\setcounter
\addtocounter
\stepcounter
```

See documentation for L^AT_EX 2_ε package `calc`.

```
\calc_maxof:nn
\calc_minof:nn
\calc_widthof:n
\calc_heightof:n
\calc_depthof:n
\calc_totalheightof:n
\calc_ratio:nn
\calc_real:n
\calc_setcounter:nn
\calc_addtocounter:nn
\calc_stepcounter:n
```

Equivalent commands as the above in the `expl3` namespace.

```
\calc_int_set:Nn
\calc_int_gset:Nn
\calc_int_add:Nn
\calc_int_gadd:Nn
\calc_int_sub:Nn
\calc_int_gsub:Nn
```

```
\calc_int_set:Nn <int> {\<calc expression>}
```

Evaluates $\langle calc\ expression \rangle$ and either adds or subtracts it from $\langle int \rangle$ or sets $\langle int \rangle$ to it. These operations can also be global.

```
\calc_dim_set:Nn
\calc_dim_gset:Nn
\calc_dim_add:Nn
\calc_dim_gadd:Nn
\calc_dim_sub:Nn
\calc_dim_gsub:Nn
```

```
\calc_dim_set:Nn <dim> {\<calc expression>}
```

Evaluates $\langle calc\ expression \rangle$ and either adds or subtracts it from $\langle dim \rangle$ or sets $\langle dim \rangle$ to it. These operations can also be global.

```
\calc_skip_set:Nn
\calc_skip_gset:Nn
\calc_skip_add:Nn
\calc_skip_gadd:Nn
\calc_skip_sub:Nn
\calc_skip_gsub:Nn
```

```
\calc_skip_set:Nn <skip> {\<calc expression>}
```

Evaluates $\langle calc\ expression \rangle$ and either adds or subtracts it from $\langle skip \rangle$ or sets $\langle skip \rangle$ to it. These operations can also be global.

```
\calc_muskip_set:Nn
\calc_muskip_gset:Nn
\calc_muskip_add:Nn
\calc_muskip_gadd:Nn
\calc_muskip_sub:Nn
\calc_muskip_gsub:Nn
```

```
\calc_muskip_set:Nn <muskip> {\<calc expression>}
```

Evaluates $\langle calc\ expression \rangle$ and either adds or subtracts it from $\langle muskip \rangle$ or sets $\langle muskip \rangle$ to it. These operations can also be global.

```
\calc_calculate_box_size:nnn
```

```
\calc_calculate_box_size:nnn {\<dim-set>}
{\<item1> <item2> ... <itemn>} {\<contents>}
```

Sets $\langle contents \rangle$ in a temporary box `\l_tmpa_box`. Then $\langle dim-set \rangle$ is put in front of a loop that inserts $+\langle item_i \rangle$ in front of `\l_tmpa_box` and this is evaluated. For instance, if we wanted to determine the total height of the text `xyz` and store it in `\l_tmpa_dim`, we would call it as.

```
\calc_calculate_box_size:nnn
{\dim_set:Nn\l_tmpa_dim}{\box_ht:N\box_dp:N}{xyz}
```

Similarly, if we wanted the difference between height and depth, we could call it as

```
\calc_calculate_box_size:nnn
  {\dim_set:Nn\l_tmpa_dim}{\box_ht:N{-\box_dp:N}}{xyz}
```

Part XXIV

The l3file package

File Loading

92 Loading files

The need to test if a file is available and to load a file if found is covered at a low level here.

<pre>\file_if_exist_p:n \file_if_exist:nTF</pre>	<pre>\file_if_exist:nTF <file> <true code> <false code></pre>
--	---

Tests if $\langle file \rangle$ exists.

T_EXhackers note: This is L^AT_EX 2_ε's `\IfFileExists`, although it does not return name of the file (*cf.* `\@filef@und`).

<pre>\file_add_path:nN</pre>	<pre>\file_add_path:nN <file> <tl var.></pre>
------------------------------	---

Searches for $\langle file \rangle$ on the T_EX path and using `\l_file_search_path_clist`. If $\langle file \rangle$ is found, $\langle tl var. \rangle$ is set to the file name plus any path information needed. If $\langle file \rangle$ is not found, $\langle tl var. \rangle$ will be blank.

T_EXhackers note: This is similar to obtaining `\@filef@und` from L^AT_EX 2_ε's `\IfFileExists`.

<pre>\file_input:n</pre>	<pre>\file_input:n <file></pre>
--------------------------	---------------------------------------

Inputs $\langle file \rangle$ if it found (according to the same rule as for `\file_if_exist:n`).

T_EXhackers note: This acts in a similar way to L^AT_EX 2_ε's `\input`, as it will not lead to a T_EX loop if the file is not found.

<pre>\file_input_no_record:n</pre>	<pre>\file_input_no_record:n <file></pre>
------------------------------------	---

Inputs $\langle file \rangle$ if it found (according to the same rule as for `\file_if_exist:n`, but does

not add it to `\g_file_record_clist`. The file is still added to `\g_file_record_full_clist`.

T_EXhackers note: This is similar to L^AT_EX 2_ε's `\@input@`.

<code>\file_input_no_check:n</code> <code>\file_input_no_check_no_record:n</code>	<code>\file_input_no_check:n</code> <i><file></i>
--	---

Inputs *<file>* directly without checking if it exists. The `no_record` version does not record the input in

T_EXhackers note:`\g_file_record_clist`. These are simple wrappers around the T_EX `\input` primitive

<code>\file_list:</code> <code>\file_list_full:</code>	<code>\file_list:</code> <i><file></i>
---	--

Lists files loaded in current L^AT_EX run: the `full` version lists all files.

93 Variables and constants

<code>\g_file_record_clist</code> <code>\g_file_record_full_clist</code>	Used to track the files that have been loaded.
---	--

<code>\l_file_search_path_clist</code>	List of paths to search for a file in addition to those searched by T _E X.
--	---

T_EXhackers note: This is `\input@path` in L^AT_EX 2_ε.

<code>\l_file_test_read_stream</code>	Input stream used to carry out file tests.
---------------------------------------	--

<code>\l_file_tmp_bool</code>	Internal scratch switch.
-------------------------------	--------------------------

<code>\l_file_tmp_tl</code>	Internal scratch token list variable.
-----------------------------	---------------------------------------

Part XXV

Implementation

94 l3names implementation

This is the base part of L^AT_EX 3 defining things like `catcodes` and redefining the T_EX primitives, as well as setting up the code to load `expl3` modules in L^AT_EX 2_ε.

94.1 Internal functions

<code>\ExplSyntaxStatus</code>
<code>\ExplSyntaxPopStack</code>
<code>\ExplSyntaxStack</code>

Functions used to track the state of the catcode regime.

<code>\@pushfilename</code>
<code>\@popfilename</code>

Re-definitions of L^AT_EX's file-loading functions to support `\ExplSyntax`.

94.2 Package loading

Before anything else, check that we're using ϵ -T_EX; no point continuing otherwise.

```
1 <*initex | package>
2 \begingroup
3 \def\firstoftwo#1#2{#1}
4 \def\secondoftwo#1#2{#2}
5 \def\etexmissingerror{Not running under e-TeX}
6 \def\etexmissinghelp{%
7   This package requires e-TeX.^^J%
8   Try compiling the document with 'elatex' instead of 'latex'.^^J%
9   When using pdfTeX, try 'pdfelatex' instead of 'pdflatex'%
10 }%
11 \expandafter\ifx\csname eTeXversion\endcsname\relax
12   \expandafter\secondoftwo\else\expandafter\firstoftwo\fi
13   {\endgroup}{%
14 <initex>      \expandafter\errhelp\expandafter{\etexmissinghelp}%
15 <initex>      \expandafter\errmessage\expandafter{\etexmissingerror}%
16 <package>    \PackageError{l3names}{\etexmissingerror}{\etexmissinghelp}%
17             \endgroup
18             \endinput
19   }
20 </initex | package>
```

94.3 Catcode assignments

Catcodes for `begingroup`, `endgroup`, macro parameter, superscript, and `tab`, are all assigned before the start of the documented code. (See the beginning of `l3names.dtx`.)

Reason for `\endlinechar=32` is that a line ending with a backslash will be interpreted as the token `_` which seems most natural and since spaces are ignored it works as we intend elsewhere.

Before we do this we must however record the settings for the catcode regime as it was when we start changing it.

```
21 <*initex | package>
22 \edef\ExplSyntaxOff{
23   \unexpanded{\ifodd \ExplSyntaxStatus\relax
24     \def\ExplSyntaxStatus{0}
25   }
26   \catcode 126=\the \catcode 126 \relax
27   \catcode 32=\the \catcode 32 \relax
28   \catcode 9=\the \catcode 9 \relax
29   \endlinechar =\the \endlinechar \relax
30   \catcode 95=\the \catcode 95 \relax
31   \catcode 58=\the \catcode 58 \relax
32   \noexpand\fi
33 }
34 \catcode126=10\relax % tilde is a space char.
35 \catcode32=9\relax   % space is ignored
36 \catcode9=9\relax    % tab also ignored
37 \endlinechar=32\relax % endline is space
38 \catcode95=11\relax  % underscore letter
39 \catcode58=11\relax  % colon letter
```

94.4 Setting up primitive names

Here is the function that renames $\mathrm{T}_{\mathrm{E}}\mathrm{X}$'s primitives.

Normally the old name is left untouched, but the possibility of undefining the original names is made available by `docstrip` and package options. If nothing else, this gives a way of checking what ‘old code’ a package depends on...

If the package option ‘`removeoldnames`’ is used then some trick code is run after the end of this file, to skip past the code which has been inserted by $\mathrm{L}^{\mathrm{A}}\mathrm{T}_{\mathrm{E}}\mathrm{X} 2_{\epsilon}$ to manage the file name stack, this code would break if run once the $\mathrm{T}_{\mathrm{E}}\mathrm{X}$ primitives have been undefined. (What a surprise!) **The option has been temporarily disabled.**

To get things started, give a new name for `\let`.

```
40 \let \tex_let:D \let
41 </initex | package>
```

and now an internal function to possibly remove the old name: for the moment.

```
42 <*initex>
43 \long \def \name_undefine:N #1 {
```

```

44 \tex_let:D #1 \c_undefined
45 }
46 </initex>

47 <*package>
48 \DeclareOption{removeoldnames}{
49   \long\def\name_undefine:N#1{
50     \tex_let:D#1\c_undefined}}

51 \DeclareOption{keepoldnames}{
52   \long\def\name_undefine:N#1{}}

53 \ExecuteOptions{keepoldnames}

54 \ProcessOptions
55 </package>

```

The internal function to give the new name and possibly undefine the old name.

```

56 <*initex | package>
57 \long \def \name_primitive:NN #1#2 {
58   \tex_let:D #2 #1
59   \name_undefine:N #1
60 }

```

94.5 Reassignment of primitives

In the current incarnation of this package, all T_EX primitives are given a new name of the form `\tex_oldname:D`. But first three special cases which have symbolic original names. These are given modified new names, so that they may be entered without catcode tricks.

```

61 \name_primitive:NN \          \tex_space:D
62 \name_primitive:NN \/\       \tex_italiccor:D
63 \name_primitive:NN \-       \tex_hyphen:D

```

Now all the other primitives.

```

64 \name_primitive:NN \let      \tex_let:D
65 \name_primitive:NN \def      \tex_def:D
66 \name_primitive:NN \edef     \tex_edef:D
67 \name_primitive:NN \gdef     \tex_gdef:D
68 \name_primitive:NN \xdef     \tex_xdef:D
69 \name_primitive:NN \chardef  \tex_chardef:D
70 \name_primitive:NN \countdef \tex_countdef:D
71 \name_primitive:NN \dimendef \tex_dimendef:D
72 \name_primitive:NN \skipdef  \tex_skipdef:D
73 \name_primitive:NN \muskipdef \tex_muskipdef:D
74 \name_primitive:NN \mathchardef \tex_mathchardef:D
75 \name_primitive:NN \toksdef  \tex_toksdef:D
76 \name_primitive:NN \futurelet \tex_futurelet:D
77 \name_primitive:NN \advance  \tex_advance:D
78 \name_primitive:NN \divide   \tex_divide:D
79 \name_primitive:NN \multiply \tex_multiply:D
80 \name_primitive:NN \font     \tex_font:D

```

81	\name_primitive:NN	\fam	\tex_fam:D
82	\name_primitive:NN	\global	\tex_global:D
83	\name_primitive:NN	\long	\tex_long:D
84	\name_primitive:NN	\outer	\tex_outer:D
85	\name_primitive:NN	\setlanguage	\tex_setlanguage:D
86	\name_primitive:NN	\globaldefs	\tex_globaldefs:D
87	\name_primitive:NN	\afterassignment	\tex_afterassignment:D
88	\name_primitive:NN	\aftergroup	\tex_aftergroup:D
89	\name_primitive:NN	\expandafter	\tex_expandafter:D
90	\name_primitive:NN	\noexpand	\tex_noexpand:D
91	\name_primitive:NN	\begingroup	\tex_begingroup:D
92	\name_primitive:NN	\endgroup	\tex_endgroup:D
93	\name_primitive:NN	\halign	\tex_halign:D
94	\name_primitive:NN	\valign	\tex_valign:D
95	\name_primitive:NN	\cr	\tex_cr:D
96	\name_primitive:NN	\crcr	\tex_crcr:D
97	\name_primitive:NN	\noalign	\tex_noalign:D
98	\name_primitive:NN	\omit	\tex_omit:D
99	\name_primitive:NN	\span	\tex_span:D
100	\name_primitive:NN	\tabskip	\tex_tabskip:D
101	\name_primitive:NN	\everycr	\tex_everycr:D
102	\name_primitive:NN	\if	\tex_if:D
103	\name_primitive:NN	\ifcase	\tex_ifcase:D
104	\name_primitive:NN	\ifcat	\tex_ifcat:D
105	\name_primitive:NN	\ifnum	\tex_ifnum:D
106	\name_primitive:NN	\ifodd	\tex_ifodd:D
107	\name_primitive:NN	\ifdim	\tex_ifdim:D
108	\name_primitive:NN	\ifeof	\tex_ifeof:D
109	\name_primitive:NN	\ifhbox	\tex_ifhbox:D
110	\name_primitive:NN	\ifvbox	\tex_ifvbox:D
111	\name_primitive:NN	\ifvoid	\tex_ifvoid:D
112	\name_primitive:NN	\ifx	\tex_ifx:D
113	\name_primitive:NN	\iffalse	\tex_iffalse:D
114	\name_primitive:NN	\iftrue	\tex_iftrue:D
115	\name_primitive:NN	\ifhmode	\tex_ifhmode:D
116	\name_primitive:NN	\ifmmode	\tex_ifmmode:D
117	\name_primitive:NN	\ifvmode	\tex_ifvmode:D
118	\name_primitive:NN	\ifinner	\tex_ifinner:D
119	\name_primitive:NN	\else	\tex_else:D
120	\name_primitive:NN	\fi	\tex_fi:D
121	\name_primitive:NN	\or	\tex_or:D
122	\name_primitive:NN	\immediate	\tex_immediate:D
123	\name_primitive:NN	\closeout	\tex_closeout:D
124	\name_primitive:NN	\openin	\tex_openin:D
125	\name_primitive:NN	\openout	\tex_openout:D
126	\name_primitive:NN	\read	\tex_read:D
127	\name_primitive:NN	\write	\tex_write:D
128	\name_primitive:NN	\closein	\tex_closein:D
129	\name_primitive:NN	\newlinechar	\tex_newlinechar:D
130	\name_primitive:NN	\input	\tex_input:D
131	\name_primitive:NN	\endinput	\tex_endinput:D
132	\name_primitive:NN	\inputlineno	\tex_inputlineno:D
133	\name_primitive:NN	\errmessage	\tex_errmessage:D
134	\name_primitive:NN	\message	\tex_message:D

135	\name_primitive:NN	\show	\tex_show:D
136	\name_primitive:NN	\showthe	\tex_showthe:D
137	\name_primitive:NN	\showbox	\tex_showbox:D
138	\name_primitive:NN	\showlists	\tex_showlists:D
139	\name_primitive:NN	\errhelp	\tex_errhelp:D
140	\name_primitive:NN	\errorcontextlines	\tex_errorcontextlines:D
141	\name_primitive:NN	\tracingcommands	\tex_tracingcommands:D
142	\name_primitive:NN	\tracinglostchars	\tex_tracinglostchars:D
143	\name_primitive:NN	\tracingmacros	\tex_tracingmacros:D
144	\name_primitive:NN	\tracingonline	\tex_tracingonline:D
145	\name_primitive:NN	\tracingoutput	\tex_tracingoutput:D
146	\name_primitive:NN	\tracingpages	\tex_tracingpages:D
147	\name_primitive:NN	\tracingparagraphs	\tex_tracingparagraphs:D
148	\name_primitive:NN	\tracingrestores	\tex_tracingrestores:D
149	\name_primitive:NN	\tracingstats	\tex_tracingstats:D
150	\name_primitive:NN	\pausing	\tex_pausing:D
151	\name_primitive:NN	\showboxbreadth	\tex_showboxbreadth:D
152	\name_primitive:NN	\showboxdepth	\tex_showboxdepth:D
153	\name_primitive:NN	\batchmode	\tex_batchmode:D
154	\name_primitive:NN	\errorstopmode	\tex_errorstopmode:D
155	\name_primitive:NN	\nonstopmode	\tex_nonstopmode:D
156	\name_primitive:NN	\scrollmode	\tex_scrollmode:D
157	\name_primitive:NN	\end	\tex_end:D
158	\name_primitive:NN	\csname	\tex_csname:D
159	\name_primitive:NN	\endcsname	\tex_endcsname:D
160	\name_primitive:NN	\ignorespaces	\tex_ignorespaces:D
161	\name_primitive:NN	\relax	\tex_relax:D
162	\name_primitive:NN	\the	\tex_the:D
163	\name_primitive:NN	\mag	\tex_mag:D
164	\name_primitive:NN	\language	\tex_language:D
165	\name_primitive:NN	\mark	\tex_mark:D
166	\name_primitive:NN	\topmark	\tex_topmark:D
167	\name_primitive:NN	\firstmark	\tex_firstmark:D
168	\name_primitive:NN	\botmark	\tex_botmark:D
169	\name_primitive:NN	\splitfirstmark	\tex_splitfirstmark:D
170	\name_primitive:NN	\splitbotmark	\tex_splitbotmark:D
171	\name_primitive:NN	\fontname	\tex_fontname:D
172	\name_primitive:NN	\escapechar	\tex_escapechar:D
173	\name_primitive:NN	\endlinechar	\tex_endlinechar:D
174	\name_primitive:NN	\mathchoice	\tex_mathchoice:D
175	\name_primitive:NN	\delimiter	\tex_delimiter:D
176	\name_primitive:NN	\mathaccent	\tex_mathaccent:D
177	\name_primitive:NN	\mathchar	\tex_mathchar:D
178	\name_primitive:NN	\mskip	\tex_mskip:D
179	\name_primitive:NN	\radical	\tex_radical:D
180	\name_primitive:NN	\vcenter	\tex_vcenter:D
181	\name_primitive:NN	\mkern	\tex_mkern:D
182	\name_primitive:NN	\above	\tex_above:D
183	\name_primitive:NN	\abovewithdelims	\tex_abovewithdelims:D
184	\name_primitive:NN	\atop	\tex_atop:D
185	\name_primitive:NN	\atopwithdelims	\tex_atopwithdelims:D
186	\name_primitive:NN	\over	\tex_over:D
187	\name_primitive:NN	\overwithdelims	\tex_overwithdelims:D
188	\name_primitive:NN	\displaystyle	\tex_displaystyle:D

189	<code>\name_primitive:NN \textstyle</code>	<code>\tex_textstyle:D</code>
190	<code>\name_primitive:NN \scriptstyle</code>	<code>\tex_scriptstyle:D</code>
191	<code>\name_primitive:NN \scriptscriptstyle</code>	<code>\tex_scriptscriptstyle:D</code>
192	<code>\name_primitive:NN \nonscript</code>	<code>\tex_nonscript:D</code>
193	<code>\name_primitive:NN \eqno</code>	<code>\tex_eqno:D</code>
194	<code>\name_primitive:NN \leqno</code>	<code>\tex_leqno:D</code>
195	<code>\name_primitive:NN \abovedisplayshortskip</code>	<code>\tex_abovedisplayshortskip:D</code>
196	<code>\name_primitive:NN \abovedisplayskip</code>	<code>\tex_abovedisplayskip:D</code>
197	<code>\name_primitive:NN \belowdisplayshortskip</code>	<code>\tex_belowdisplayshortskip:D</code>
198	<code>\name_primitive:NN \belowdisplayskip</code>	<code>\tex_belowdisplayskip:D</code>
199	<code>\name_primitive:NN \displaywidowpenalty</code>	<code>\tex_displaywidowpenalty:D</code>
200	<code>\name_primitive:NN \displayindent</code>	<code>\tex_displayindent:D</code>
201	<code>\name_primitive:NN \displaywidth</code>	<code>\tex_displaywidth:D</code>
202	<code>\name_primitive:NN \everydisplay</code>	<code>\tex_everydisplay:D</code>
203	<code>\name_primitive:NN \predisplaysize</code>	<code>\tex_predisplaysize:D</code>
204	<code>\name_primitive:NN \predisplaypenalty</code>	<code>\tex_predisplaypenalty:D</code>
205	<code>\name_primitive:NN \postdisplaypenalty</code>	<code>\tex_postdisplaypenalty:D</code>
206	<code>\name_primitive:NN \mathbin</code>	<code>\tex_mathbin:D</code>
207	<code>\name_primitive:NN \mathclose</code>	<code>\tex_mathclose:D</code>
208	<code>\name_primitive:NN \mathinner</code>	<code>\tex_mathinner:D</code>
209	<code>\name_primitive:NN \mathop</code>	<code>\tex_mathop:D</code>
210	<code>\name_primitive:NN \displaylimits</code>	<code>\tex_displaylimits:D</code>
211	<code>\name_primitive:NN \limits</code>	<code>\tex_limits:D</code>
212	<code>\name_primitive:NN \nolimits</code>	<code>\tex_nolimits:D</code>
213	<code>\name_primitive:NN \mathopen</code>	<code>\tex_mathopen:D</code>
214	<code>\name_primitive:NN \mathord</code>	<code>\tex_mathord:D</code>
215	<code>\name_primitive:NN \mathpunct</code>	<code>\tex_mathpunct:D</code>
216	<code>\name_primitive:NN \mathrel</code>	<code>\tex_mathrel:D</code>
217	<code>\name_primitive:NN \overline</code>	<code>\tex_overline:D</code>
218	<code>\name_primitive:NN \underline</code>	<code>\tex_underline:D</code>
219	<code>\name_primitive:NN \left</code>	<code>\tex_left:D</code>
220	<code>\name_primitive:NN \right</code>	<code>\tex_right:D</code>
221	<code>\name_primitive:NN \binoppenalty</code>	<code>\tex_binoppenalty:D</code>
222	<code>\name_primitive:NN \relpenalty</code>	<code>\tex_relpenalty:D</code>
223	<code>\name_primitive:NN \delimitershortfall</code>	<code>\tex_delimitershortfall:D</code>
224	<code>\name_primitive:NN \delimiterfactor</code>	<code>\tex_delimiterfactor:D</code>
225	<code>\name_primitive:NN \nulldelimiterspace</code>	<code>\tex_nulldelimiterspace:D</code>
226	<code>\name_primitive:NN \everymath</code>	<code>\tex_everymath:D</code>
227	<code>\name_primitive:NN \mathsurround</code>	<code>\tex_mathsurround:D</code>
228	<code>\name_primitive:NN \medmuskip</code>	<code>\tex_medmuskip:D</code>
229	<code>\name_primitive:NN \thinmuskip</code>	<code>\tex_thinmuskip:D</code>
230	<code>\name_primitive:NN \thickmuskip</code>	<code>\tex_thickmuskip:D</code>
231	<code>\name_primitive:NN \scriptspace</code>	<code>\tex_scriptspace:D</code>
232	<code>\name_primitive:NN \noboundary</code>	<code>\tex_noboundary:D</code>
233	<code>\name_primitive:NN \accent</code>	<code>\tex_accent:D</code>
234	<code>\name_primitive:NN \char</code>	<code>\tex_char:D</code>
235	<code>\name_primitive:NN \discretionary</code>	<code>\tex_discretionary:D</code>
236	<code>\name_primitive:NN \hfil</code>	<code>\tex_hfil:D</code>
237	<code>\name_primitive:NN \hfilneg</code>	<code>\tex_hfilneg:D</code>
238	<code>\name_primitive:NN \hfill</code>	<code>\tex_hfill:D</code>
239	<code>\name_primitive:NN \hskip</code>	<code>\tex_hskip:D</code>
240	<code>\name_primitive:NN \hss</code>	<code>\tex_hss:D</code>
241	<code>\name_primitive:NN \vfil</code>	<code>\tex_vfil:D</code>
242	<code>\name_primitive:NN \vfilneg</code>	<code>\tex_vfilneg:D</code>

243	\name_primitive:NN	\vfill	\tex_vfill:D
244	\name_primitive:NN	\vskip	\tex_vskip:D
245	\name_primitive:NN	\vss	\tex_vss:D
246	\name_primitive:NN	\unskip	\tex_unskip:D
247	\name_primitive:NN	\kern	\tex_kern:D
248	\name_primitive:NN	\unkern	\tex_unkern:D
249	\name_primitive:NN	\hrule	\tex_hrule:D
250	\name_primitive:NN	\vrule	\tex_vrule:D
251	\name_primitive:NN	\leaders	\tex_leaders:D
252	\name_primitive:NN	\cleaders	\tex_cleaders:D
253	\name_primitive:NN	\xleaders	\tex_xleaders:D
254	\name_primitive:NN	\lastkern	\tex_lastkern:D
255	\name_primitive:NN	\lastskip	\tex_lastskip:D
256	\name_primitive:NN	\indent	\tex_indent:D
257	\name_primitive:NN	\par	\tex_par:D
258	\name_primitive:NN	\noindent	\tex_noindent:D
259	\name_primitive:NN	\vadjust	\tex_vadjust:D
260	\name_primitive:NN	\baselineskip	\tex_baselineskip:D
261	\name_primitive:NN	\lineskip	\tex_lineskip:D
262	\name_primitive:NN	\lineskiplimit	\tex_lineskiplimit:D
263	\name_primitive:NN	\clubpenalty	\tex_clubpenalty:D
264	\name_primitive:NN	\widowpenalty	\tex_widowpenalty:D
265	\name_primitive:NN	\exhyphenpenalty	\tex_exhyphenpenalty:D
266	\name_primitive:NN	\hyphenpenalty	\tex_hyphenpenalty:D
267	\name_primitive:NN	\linepenalty	\tex_linepenalty:D
268	\name_primitive:NN	\doublehyphendemerits	\tex_doublehyphendemerits:D
269	\name_primitive:NN	\finalhyphendemerits	\tex_finalhyphendemerits:D
270	\name_primitive:NN	\adjdemerits	\tex_adjdemerits:D
271	\name_primitive:NN	\hangafter	\tex_hangafter:D
272	\name_primitive:NN	\hangindent	\tex_hangindent:D
273	\name_primitive:NN	\parshape	\tex_parshape:D
274	\name_primitive:NN	\hsize	\tex_hsize:D
275	\name_primitive:NN	\lefthyphenmin	\tex_lefthyphenmin:D
276	\name_primitive:NN	\righthyphenmin	\tex_righthyphenmin:D
277	\name_primitive:NN	\leftskip	\tex_leftskip:D
278	\name_primitive:NN	\rightskip	\tex_rightskip:D
279	\name_primitive:NN	\looseness	\tex_looseness:D
280	\name_primitive:NN	\parskip	\tex_parskip:D
281	\name_primitive:NN	\parindent	\tex_parindent:D
282	\name_primitive:NN	\uchyph	\tex_uchyph:D
283	\name_primitive:NN	\emergencystretch	\tex_emergencystretch:D
284	\name_primitive:NN	\pretolerance	\tex_pretolerance:D
285	\name_primitive:NN	\tolerance	\tex_tolerance:D
286	\name_primitive:NN	\spaceskip	\tex_spaceskip:D
287	\name_primitive:NN	\xspaceskip	\tex_xspaceskip:D
288	\name_primitive:NN	\parfillskip	\tex_parfillskip:D
289	\name_primitive:NN	\everypar	\tex_everypar:D
290	\name_primitive:NN	\prevgraf	\tex_prevgraf:D
291	\name_primitive:NN	\spacefactor	\tex_spacefactor:D
292	\name_primitive:NN	\shipout	\tex_shipout:D
293	\name_primitive:NN	\vsize	\tex_vsize:D
294	\name_primitive:NN	\interlinepenalty	\tex_interlinepenalty:D
295	\name_primitive:NN	\brokenpenalty	\tex_brokenpenalty:D
296	\name_primitive:NN	\topskip	\tex_topskip:D

297	\name_primitive:NN	\maxdeadcycles	\tex_maxdeadcycles:D
298	\name_primitive:NN	\maxdepth	\tex_maxdepth:D
299	\name_primitive:NN	\output	\tex_output:D
300	\name_primitive:NN	\deadcycles	\tex_deadcycles:D
301	\name_primitive:NN	\pagedepth	\tex_pagedepth:D
302	\name_primitive:NN	\pagestretch	\tex_pagestretch:D
303	\name_primitive:NN	\pagefilstretch	\tex_pagefilstretch:D
304	\name_primitive:NN	\pagefillstretch	\tex_pagefillstretch:D
305	\name_primitive:NN	\pagefilllstretch	\tex_pagefilllstretch:D
306	\name_primitive:NN	\pageshrink	\tex_pageshrink:D
307	\name_primitive:NN	\pagegoal	\tex_pagegoal:D
308	\name_primitive:NN	\pagetotal	\tex_pagetotal:D
309	\name_primitive:NN	\outputpenalty	\tex_outputpenalty:D
310	\name_primitive:NN	\hoffset	\tex_hoffset:D
311	\name_primitive:NN	\voffset	\tex_voffset:D
312	\name_primitive:NN	\insert	\tex_insert:D
313	\name_primitive:NN	\holdinginserts	\tex_holdinginserts:D
314	\name_primitive:NN	\floatingpenalty	\tex_floatingpenalty:D
315	\name_primitive:NN	\insertpenalties	\tex_insertpenalties:D
316	\name_primitive:NN	\lower	\tex_lower:D
317	\name_primitive:NN	\moveleft	\tex_moveleft:D
318	\name_primitive:NN	\moveright	\tex_moveright:D
319	\name_primitive:NN	\raise	\tex_raise:D
320	\name_primitive:NN	\copy	\tex_copy:D
321	\name_primitive:NN	\lastbox	\tex_lastbox:D
322	\name_primitive:NN	\vsplit	\tex_vsplit:D
323	\name_primitive:NN	\unhbox	\tex_unhbox:D
324	\name_primitive:NN	\unhcopy	\tex_unhcopy:D
325	\name_primitive:NN	\unvbox	\tex_unvbox:D
326	\name_primitive:NN	\unvcopy	\tex_unvcopy:D
327	\name_primitive:NN	\setbox	\tex_setbox:D
328	\name_primitive:NN	\hbox	\tex_hbox:D
329	\name_primitive:NN	\vbox	\tex_vbox:D
330	\name_primitive:NN	\vtop	\tex_vtop:D
331	\name_primitive:NN	\prevdepth	\tex_prevdepth:D
332	\name_primitive:NN	\badness	\tex_badness:D
333	\name_primitive:NN	\hbadness	\tex_hbadness:D
334	\name_primitive:NN	\vbadness	\tex_vbadness:D
335	\name_primitive:NN	\hfuzz	\tex_hfuzz:D
336	\name_primitive:NN	\vfuzz	\tex_vfuzz:D
337	\name_primitive:NN	\overfullrule	\tex_overfullrule:D
338	\name_primitive:NN	\boxmaxdepth	\tex_boxmaxdepth:D
339	\name_primitive:NN	\splitmaxdepth	\tex_splitmaxdepth:D
340	\name_primitive:NN	\splittopskip	\tex_splittopskip:D
341	\name_primitive:NN	\everyhbox	\tex_everyhbox:D
342	\name_primitive:NN	\everyvbox	\tex_everyvbox:D
343	\name_primitive:NN	\nullfont	\tex_nullfont:D
344	\name_primitive:NN	\textfont	\tex_textfont:D
345	\name_primitive:NN	\scriptfont	\tex_scriptfont:D
346	\name_primitive:NN	\scriptscriptfont	\tex_scriptscriptfont:D
347	\name_primitive:NN	\fontdimen	\tex_fontdimen:D
348	\name_primitive:NN	\hyphenchar	\tex_hyphenchar:D
349	\name_primitive:NN	\skewchar	\tex_skewchar:D
350	\name_primitive:NN	\defaultthyphenchar	\tex_defaultthyphenchar:D

351	\name_primitive:NN	\defaultskewchar	\tex_defaultskewchar:D
352	\name_primitive:NN	\number	\tex_number:D
353	\name_primitive:NN	\romannumeral	\tex_romannumeral:D
354	\name_primitive:NN	\string	\tex_string:D
355	\name_primitive:NN	\lowercase	\tex_lowercase:D
356	\name_primitive:NN	\uppercase	\tex_uppercase:D
357	\name_primitive:NN	\meaning	\tex_meaning:D
358	\name_primitive:NN	\penalty	\tex_penalty:D
359	\name_primitive:NN	\unpenalty	\tex_unpenalty:D
360	\name_primitive:NN	\lastpenalty	\tex_lastpenalty:D
361	\name_primitive:NN	\special	\tex_special:D
362	\name_primitive:NN	\dump	\tex_dump:D
363	\name_primitive:NN	\patterns	\tex_patterns:D
364	\name_primitive:NN	\hyphenation	\tex_hyphenation:D
365	\name_primitive:NN	\time	\tex_time:D
366	\name_primitive:NN	\day	\tex_day:D
367	\name_primitive:NN	\month	\tex_month:D
368	\name_primitive:NN	\year	\tex_year:D
369	\name_primitive:NN	\jobname	\tex_jobname:D
370	\name_primitive:NN	\everyjob	\tex_everyjob:D
371	\name_primitive:NN	\count	\tex_count:D
372	\name_primitive:NN	\dimen	\tex_dimen:D
373	\name_primitive:NN	\skip	\tex_skip:D
374	\name_primitive:NN	\toks	\tex_toks:D
375	\name_primitive:NN	\muskip	\tex_muskip:D
376	\name_primitive:NN	\box	\tex_box:D
377	\name_primitive:NN	\wd	\tex_wd:D
378	\name_primitive:NN	\ht	\tex_ht:D
379	\name_primitive:NN	\dp	\tex_dp:D
380	\name_primitive:NN	\catcode	\tex_catcode:D
381	\name_primitive:NN	\delcode	\tex_delcode:D
382	\name_primitive:NN	\sfcode	\tex_sfcode:D
383	\name_primitive:NN	\lccode	\tex_lccode:D
384	\name_primitive:NN	\uccode	\tex_uccode:D
385	\name_primitive:NN	\mathcode	\tex_mathcode:D

Since L^AT_EX3 requires at least the ϵ -T_EX extensions, we also rename the additional primitives. These are all given the prefix `\etex_`.

386	\name_primitive:NN	\ifdefined	\etex_ifdefined:D
387	\name_primitive:NN	\ifcsname	\etex_ifcsname:D
388	\name_primitive:NN	\unless	\etex_unless:D
389	\name_primitive:NN	\eTeXversion	\etex_eTeXversion:D
390	\name_primitive:NN	\eTeXrevision	\etex_eTeXrevision:D
391	\name_primitive:NN	\marks	\etex_marks:D
392	\name_primitive:NN	\topmarks	\etex_topmarks:D
393	\name_primitive:NN	\firstmarks	\etex_firstmarks:D
394	\name_primitive:NN	\botmarks	\etex_botmarks:D
395	\name_primitive:NN	\splitfirstmarks	\etex_splitfirstmarks:D
396	\name_primitive:NN	\splitbotmarks	\etex_splitbotmarks:D
397	\name_primitive:NN	\unexpanded	\etex_unexpanded:D
398	\name_primitive:NN	\detokenize	\etex_detokenize:D
399	\name_primitive:NN	\scantokens	\etex_scantokens:D
400	\name_primitive:NN	\showtokens	\etex_showtokens:D
401	\name_primitive:NN	\readline	\etex_readline:D

402	\name_primitive:NN	\tracingassigns	\etex_tracingassigns:D
403	\name_primitive:NN	\tracingscantokens	\etex_tracingscantokens:D
404	\name_primitive:NN	\tracingnesting	\etex_tracingnesting:D
405	\name_primitive:NN	\tracingifs	\etex_tracingifs:D
406	\name_primitive:NN	\currentiflevel	\etex_currentiflevel:D
407	\name_primitive:NN	\currentifbranch	\etex_currentifbranch:D
408	\name_primitive:NN	\currentifttype	\etex_currentifttype:D
409	\name_primitive:NN	\tracinggroups	\etex_tracinggroups:D
410	\name_primitive:NN	\currentgrouplevel	\etex_currentgrouplevel:D
411	\name_primitive:NN	\currentgrouptype	\etex_currentgrouptype:D
412	\name_primitive:NN	\showgroups	\etex_showgroups:D
413	\name_primitive:NN	\showifs	\etex_showifs:D
414	\name_primitive:NN	\interactionmode	\etex_interactionmode:D
415	\name_primitive:NN	\lastnodetype	\etex_lastnodetype:D
416	\name_primitive:NN	\iffontchar	\etex_iffontchar:D
417	\name_primitive:NN	\fontcharht	\etex_fontcharht:D
418	\name_primitive:NN	\fontchardp	\etex_fontchardp:D
419	\name_primitive:NN	\fontcharwd	\etex_fontcharwd:D
420	\name_primitive:NN	\fontcharic	\etex_fontcharic:D
421	\name_primitive:NN	\parshapeindent	\etex_parshapeindent:D
422	\name_primitive:NN	\parshapelength	\etex_parshapelength:D
423	\name_primitive:NN	\parshapedimen	\etex_parshapedimen:D
424	\name_primitive:NN	\numexpr	\etex_numexpr:D
425	\name_primitive:NN	\dimexpr	\etex_dimexpr:D
426	\name_primitive:NN	\glueexpr	\etex_glueexpr:D
427	\name_primitive:NN	\muexpr	\etex_muexpr:D
428	\name_primitive:NN	\gluestretch	\etex_gluestretch:D
429	\name_primitive:NN	\glueshrink	\etex_glueshrink:D
430	\name_primitive:NN	\gluestretchorder	\etex_gluestretchorder:D
431	\name_primitive:NN	\glueshrinkorder	\etex_glueshrinkorder:D
432	\name_primitive:NN	\gluetomu	\etex_gluetomu:D
433	\name_primitive:NN	\mutoglu	\etex_mutoglu:D
434	\name_primitive:NN	\lastlinefit	\etex_lastlinefit:D
435	\name_primitive:NN	\interlinepenalties	\etex_interlinepenalties:D
436	\name_primitive:NN	\clubpenalties	\etex_clubpenalties:D
437	\name_primitive:NN	\widowpenalties	\etex_widowpenalties:D
438	\name_primitive:NN	\displaywidowpenalties	\etex_displaywidowpenalties:D
439	\name_primitive:NN	\middle	\etex_middle:D
440	\name_primitive:NN	\savinghyphcodes	\etex_savinghyphcodes:D
441	\name_primitive:NN	\savingvdiscards	\etex_savingvdiscards:D
442	\name_primitive:NN	\pagediscards	\etex_pagediscards:D
443	\name_primitive:NN	\splitdiscards	\etex_splitdiscards:D
444	\name_primitive:NN	\TeXETstate	\etex_TeXXETstate:D
445	\name_primitive:NN	\beginL	\etex_beginL:D
446	\name_primitive:NN	\endL	\etex_endL:D
447	\name_primitive:NN	\beginR	\etex_beginR:D
448	\name_primitive:NN	\endR	\etex_endR:D
449	\name_primitive:NN	\predisplaydirection	\etex_predisplaydirection:D
450	\name_primitive:NN	\everyeof	\etex_everyeof:D
451	\name_primitive:NN	\protected	\etex_protected:D

All major distributions use pdf ϵ -TeX as engine so we add these names as well. Since the pdfTeX team has been very good at prefixing most primitives with pdf (so far only five do not start with pdf) we do not give them a double pdf prefix. The list below covers

```

452 %% integer registers:
453 \name_primitive:NN \pdfoutput \pdf_output:D
454 \name_primitive:NN \pdfminorversion \pdf_minorversion:D
455 \name_primitive:NN \pdfcompresslevel \pdf_compresslevel:D
456 \name_primitive:NN \pdfdecimaldigits \pdf_decimaldigits:D
457 \name_primitive:NN \pdfimageresolution \pdf_imageresolution:D
458 \name_primitive:NN \pdfpkresolution \pdf_pkresolution:D
459 \name_primitive:NN \pdftracingfonts \pdf_tracingfonts:D
460 \name_primitive:NN \pdfuniqueresname \pdf_uniqueresname:D
461 \name_primitive:NN \pdfadjustspacing \pdf_adjustspacing:D
462 \name_primitive:NN \pdfprotrudechars \pdf_protrudechars:D
463 \name_primitive:NN \efcode \pdf_efcode:D
464 \name_primitive:NN \lpcode \pdf_lpcode:D
465 \name_primitive:NN \rpcode \pdf_rpcode:D
466 \name_primitive:NN \pdfforcepagebox \pdf_forcepagebox:D
467 \name_primitive:NN \pdfoptionalwaysusepdfpagebox \pdf_optionalwaysusepdfpagebox:D
468 \name_primitive:NN \pdfinclusionerrorlevel \pdf_inclusionerrorlevel:D
469 \name_primitive:NN \pdfoptionpdfinclusionerrorlevel \pdf_optionpdfinclusionerrorlevel:D
470 \name_primitive:NN \pdfimagehicolor \pdf_imagehicolor:D
471 \name_primitive:NN \pdfimageapplygamma \pdf_imageapplygamma:D
472 \name_primitive:NN \pdfgamma \pdf_gamma:D
473 \name_primitive:NN \pdfimagegamma \pdf_imagegamma:D
474 %% dimen registers:
475 \name_primitive:NN \pdfhorigin \pdf_horigin:D
476 \name_primitive:NN \pdfvorigin \pdf_vorigin:D
477 \name_primitive:NN \pdfpagewidth \pdf_pagewidth:D
478 \name_primitive:NN \pdfpageheight \pdf_pageheight:D
479 \name_primitive:NN \pdflinkmargin \pdf_linkmargin:D
480 \name_primitive:NN \pdfdestmargin \pdf_destmargin:D
481 \name_primitive:NN \pdfthreadmargin \pdf_threadmargin:D
482 %% token registers:
483 \name_primitive:NN \pdfpagesattr \pdf_pagesattr:D
484 \name_primitive:NN \pdfpageattr \pdf_pageattr:D
485 \name_primitive:NN \pdfpageresources \pdf_pageresources:D
486 \name_primitive:NN \pdfpkmode \pdf_pkmode:D
487 %% expandable commands:
488 \name_primitive:NN \pdftexrevision \pdf_texrevision:D
489 \name_primitive:NN \pdftexbanner \pdf_texbanner:D
490 \name_primitive:NN \pdfcreationdate \pdf_creationdate:D
491 \name_primitive:NN \pdfpageref \pdf_pageref:D
492 \name_primitive:NN \pdfxformname \pdf_xformname:D
493 \name_primitive:NN \pdffontname \pdf_fontname:D
494 \name_primitive:NN \pdffontobjnum \pdf_fontobjnum:D
495 \name_primitive:NN \pdffontsize \pdf_fontsize:D
496 \name_primitive:NN \pdfincludechars \pdf_includechars:D
497 \name_primitive:NN \leftmarginkern \pdf_leftmarginkern:D
498 \name_primitive:NN \rightmarginkern \pdf_rightmarginkern:D
499 \name_primitive:NN \pdfescapestring \pdf_escapestring:D
500 \name_primitive:NN \pdfescapename \pdf_escapename:D
501 \name_primitive:NN \pdfescapehex \pdf_escapehex:D
502 \name_primitive:NN \pdfunescapehex \pdf_unescapehex:D
503 \name_primitive:NN \pdfstrcmp \pdf_strcmp:D

```

```

504 \name_primitive:NN \pdfuniformdeviate \pdf_uniformdeviate:D
505 \name_primitive:NN \pdfnormaldeviate \pdf_normaldeviate:D
506 \name_primitive:NN \pdfmdfivesum \pdf_mdfivesum:D
507 \name_primitive:NN \pdffilemoddate \pdf_filemoddate:D
508 \name_primitive:NN \pdffilesize \pdf_filesize:D
509 \name_primitive:NN \pdffiledump \pdf_filedump:D
510 %% read-only integers:
511 \name_primitive:NN \pdftexversion \pdf_texversion:D
512 \name_primitive:NN \pdflastobj \pdf_lastobj:D
513 \name_primitive:NN \pdflastxform \pdf_lastxform:D
514 \name_primitive:NN \pdflastximage \pdf_lastximage:D
515 \name_primitive:NN \pdflastximagepages \pdf_lastximagepages:D
516 \name_primitive:NN \pdflastannot \pdf_lastannot:D
517 \name_primitive:NN \pdflastxpos \pdf_lastxpos:D
518 \name_primitive:NN \pdflastypos \pdf_lastypos:D
519 \name_primitive:NN \pdflastdemerits \pdf_lastdemerits:D
520 \name_primitive:NN \pdfelapsedtime \pdf_elapsedtime:D
521 \name_primitive:NN \pdfrandomseed \pdf_randomseed:D
522 \name_primitive:NN \pdfshellescape \pdf_shellescape:D
523 %% general commands:
524 \name_primitive:NN \pdfobj \pdf_obj:D
525 \name_primitive:NN \pdfrefobj \pdf_refobj:D
526 \name_primitive:NN \pdfxform \pdf_xform:D
527 \name_primitive:NN \pdfrefxform \pdf_refxform:D
528 \name_primitive:NN \pdfximage \pdf_ximage:D
529 \name_primitive:NN \pdfrefximage \pdf_refximage:D
530 \name_primitive:NN \pdfannot \pdf_annot:D
531 \name_primitive:NN \pdfstartlink \pdf_startlink:D
532 \name_primitive:NN \pdfendlink \pdf_endlink:D
533 \name_primitive:NN \pdfoutline \pdf_outline:D
534 \name_primitive:NN \pdfdest \pdf_dest:D
535 \name_primitive:NN \pdfthread \pdf_thread:D
536 \name_primitive:NN \pdfstartthread \pdf_startthread:D
537 \name_primitive:NN \pdfendthread \pdf_endthread:D
538 \name_primitive:NN \pdfsavepos \pdf_savepos:D
539 \name_primitive:NN \pdfinfo \pdf_info:D
540 \name_primitive:NN \pdfcatalog \pdf_catalog:D
541 \name_primitive:NN \pdfnames \pdf_names:D
542 \name_primitive:NN \pdfmapfile \pdf_mapfile:D
543 \name_primitive:NN \pdfmapline \pdf_mapline:D
544 \name_primitive:NN \pdffontattr \pdf_fontattr:D
545 \name_primitive:NN \pdftrailer \pdf_trailer:D
546 \name_primitive:NN \pdffontexpand \pdf_fontexpand:D
547 %%\name_primitive:NN \vadjust [<pre spec>] <filler> { <vertical mode material> } (h, m)
548 \name_primitive:NN \pdfliteral \pdf_literal:D
549 %%\name_primitive:NN \special <pdfspecial spec>
550 \name_primitive:NN \pdfresettimer \pdf_resettimer:D
551 \name_primitive:NN \pdfsetrandomseed \pdf_setrandomseed:D
552 \name_primitive:NN \pdfnoligatures \pdf_noligatures:D

```

We're ignoring XeTeX and LuaTeX right now except for a check whether they're in use:

```

553 \name_primitive:NN \XeTeXversion \xetex_version:D
554 \name_primitive:NN \directlua \luatex_directlua:D

```

XeTeX adds `\strcmp` to the set of primitives, with the same implementation as `\pdfstrcmp` but a different name. To avoid having to worry about this later, the same internal name is used.

```

555 \etex_ifdefined:D \strcmp
556 \etex_ifdefined:D \xetex_version:D
557 \name_primitive:NN \strcmp \pdf_strcmp:D
558 \tex_fi:D
559 \tex_fi:D

```

94.6 expl3 code switches

`\ExplSyntaxOn`
`\ExplSyntaxOff`
`\ExplSyntaxStatus`

Here we define functions that are used to turn on and off the special conventions used in the kernel of L^AT_EX3.

First of all, the space, tab and the return characters will all be ignored inside L^AT_EX3 code, the latter because `endline` is set to a space instead. When space characters are needed in L^AT_EX3 code the `~` character will be used for that purpose.

Specification of the desired behavior:

- `ExplSyntax` can be either On or Off.
- The On switch is `<null>` if `ExplSyntax` is on.
- The Off switch is `<null>` if `ExplSyntax` is off.
- If the On switch is issued and not `<null>`, it records the current catcode scheme just prior to it being issued.
- An Off switch restores the catcode scheme to what it was just prior to the previous On switch.

```

560 \tex_def:D \ExplSyntaxOn {
561   \tex_ifodd:D \ExplSyntaxStatus \tex_relax:D
562   \tex_else:D
563     \tex_edef:D \ExplSyntaxOff {
564       \etex_unexpanded:D{
565         \tex_ifodd:D \ExplSyntaxStatus \tex_relax:D
566         \tex_def:D \ExplSyntaxStatus{0}
567       }
568       \tex_catcode:D 126=\tex_the:D \tex_catcode:D 126 \tex_relax:D
569       \tex_catcode:D 32=\tex_the:D \tex_catcode:D 32 \tex_relax:D
570       \tex_catcode:D 9=\tex_the:D \tex_catcode:D 9 \tex_relax:D
571       \tex_endlinechar:D =\tex_the:D \tex_endlinechar:D \tex_relax:D
572       \tex_catcode:D 95=\tex_the:D \tex_catcode:D 95 \tex_relax:D
573       \tex_catcode:D 58=\tex_the:D \tex_catcode:D 58 \tex_relax:D
574       \tex_noexpand:D \tex_fi:D
575     }
576     \tex_def:D \ExplSyntaxStatus { 1 }
577     \tex_catcode:D 126=10 \tex_relax:D % tilde is a space char.
578     \tex_catcode:D 32=9 \tex_relax:D % space is ignored
579     \tex_catcode:D 9=9 \tex_relax:D % tab also ignored
580     \tex_endlinechar:D =32 \tex_relax:D % endline is space

```

```

581 \tex_catcode:D 95=11 \tex_relax:D % underscore letter
582 \tex_catcode:D 58=11 \tex_relax:D % colon letter
583 \tex_fi:D
584 }

```

At this point we better set the status.

```

585 \tex_def:D \ExplSyntaxStatus { 1 }

```

`\ExplSyntaxNamesOn` Sometimes we need to be able to use names from the kernel of L^AT_EX3 without adhering it's conventions according to space characters. These macros provide the necessary settings.

`\ExplSyntaxNamesOff`

```

586 \tex_def:D \ExplSyntaxNamesOn {
587 \tex_catcode:D '\_ =11\tex_relax:D
588 \tex_catcode:D '\: =11\tex_relax:D
589 }
590 \tex_def:D \ExplSyntaxNamesOff {
591 \tex_catcode:D '\_ =8\tex_relax:D
592 \tex_catcode:D '\: =12\tex_relax:D
593 }

```

94.7 Package loading

`\GetIdInfo` Extract all information from a cvs or svn field. The formats are slightly different but at least the information is in the same positions so we check in the date format so see if it contains a / after the four-digit year. If it does it is cvs else svn and we extract information. To be on the safe side we ensure that spaces in the argument are seen.

`\filedescription`

`\filename`

`\fileversion`

`\fileauthor`

`\filedate`

`\filenameext`

`\filetimestamp`

`\GetIdInfoAux:w`

`\GetIdInfoAuxii:w`

`\GetIdInfoAuxCVS:w`

`\GetIdInfoAuxSVN:w`

```

594 \tex_def:D \GetIdInfo {
595 \tex_begingroup:D
596 \tex_catcode:D 32=10 \tex_relax:D % needed? Probably for now.
597 \GetIdInfoMaybeMissing:w
598 }
599 \tex_def:D\GetIdInfoMaybeMissing:w$#1$#2{
600 \tex_def:D \l_tmpa_tl {#1}
601 \tex_def:D \l_tmpb_tl {Id}
602 \tex_ifx:D \l_tmpa_tl \l_tmpb_tl
603 \tex_def:D \l_tmpa_tl {
604 \tex_endgroup:D
605 \tex_def:D\filedescription{#2}
606 \tex_def:D\filename { [unknown~name] }
607 \tex_def:D\fileversion {000}
608 \tex_def:D\fileauthor { [unknown~author] }
609 \tex_def:D\filedate {0000/00/00}
610 \tex_def:D\filenameext { [unknown~ext] }
611 \tex_def:D\filetimestamp { [unknown~timestamp] }
612 }
613 \tex_else:D
614 \tex_def:D \l_tmpa_tl { \GetIdInfoAux:w$#1$#2 }
615 \tex_fi:D
616 \l_tmpa_tl
617 }

```

```

618 \tex_def:D\GetIdInfoAuxii:w$#1~#2.#3~#4~#5~#6~#7~#8$#9{
619   \tex_endgroup:D
620   \tex_def:D\filename{#2}
621   \tex_def:D\fileversion{#4}
622   \tex_def:D\filedescription{#9}
623   \tex_def:D\fileauthor{#7}
624   \GetIdInfoAuxii:w #5\tex_relax:D
625   #3\tex_relax:D#5\tex_relax:D#6\tex_relax:D
626 }

627 \tex_def:D\GetIdInfoAuxii:w #1#2#3#4#5#6\tex_relax:D{
628   \tex_ifx:D#5/
629     \tex_expandafter:D\GetIdInfoAuxCVS:w
630   \tex_else:D
631     \tex_expandafter:D\GetIdInfoAuxSVN:w
632   \tex_fi:D
633 }

634 \tex_def:D\GetIdInfoAuxCVS:w #1,v\tex_relax:D
635                               #2\tex_relax:D#3\tex_relax:D{
636   \tex_def:D\filedate{#2}
637   \tex_def:D\filenameext{#1}
638   \tex_def:D\filetimestamp{#3}

```

When creating the format we want the information in the log straight away.

```

639 <initex>\tex_immediate:D\tex_write:D-1
640 <initex> {\filename;~ v\fileversion,~\filedate;~\filedescription}
641 }
642 \tex_def:D\GetIdInfoAuxSVN:w #1\tex_relax:D#2-#3-#4
643                               \tex_relax:D#5Z\tex_relax:D{
644   \tex_def:D\filenameext{#1}
645   \tex_def:D\filedate{#2/#3/#4}
646   \tex_def:D\filetimestamp{#5}
647 <-package>\tex_immediate:D\tex_write:D-1
648 <-package> {\filename;~ v\fileversion,~\filedate;~\filedescription}
649 }
650 </initex | package>

```

Finally some corrections in the case we are running over $\text{\LaTeX} 2_{\epsilon}$.

We want to set things up so that experimental packages and regular packages can coexist with the former using the $\text{\LaTeX} 3$ programming catcode settings. Since it cannot be the task of the end user to know how a package is constructed under the hood we make it so that the experimental packages have to identify themselves. As an example it can be done as

```

\RequirePackage{l3names}
\ProvidesExplPackage{agent}{2007/08/28}{007}{bonding module}

```

or by using the $\backslash\text{file}\langle field \rangle$ informations from $\backslash\text{GetIdInfo}$ as the packages in this distribution do like this:

```

\RequirePackage{l3names}
\GetIdInfo$Id: l3names.dtx 1452 2009-08-08 14:09:32Z joseph $
    {L3 Experimental Box module}
\ProvidesExplPackage
    {\filename}{\filedate}{\fileversion}{\filedescription}

```

`\ProvidesExplPackage` First up is the identification. Rather trivial as we don't allow for options just yet.
`\ProvidesExplClass`

```

651 {*package}
652 \tex_def:D \ProvidesExplPackage#1#2#3#4{
653   \ProvidesPackage{#1}[#2~v#3~#4]
654   \ExplSyntaxOn
655 }
656 \tex_def:D \ProvidesExplClass#1#2#3#4{
657   \ProvidesClass{#1}[#2~v#3~#4]
658   \ExplSyntaxOn
659 }

```

`\@pushfilename` The idea behind the code is to record whether or not the \LaTeX 3 syntax is on or off when
`\@popfilename` about to load a file with class or package extension. This status stored in the parameter `\ExplSyntaxStatus` and set by `\ExplSyntaxOn` and `\ExplSyntaxOff` to 1 and 0 respectively is pushed onto the stack `\ExplSyntaxStack`. Then the catcodes are set back to normal, the file loaded with its options and finally the stack is popped again. The whole thing is a bit problematical. So let's take a look at what the desired behavior is: A package or class which declares itself of Expl type by using `\ProvidesExplClass` or `\ProvidesExplPackage` should automatically ensure the correct catcode scheme as soon as the identification part is over. Similarly, a package or class which uses the traditional `\ProvidesClass` or `\ProvidesPackage` commands should go back to the traditional catcode scheme. An example:

```

\RequirePackage{l3names}
\ProvidesExplPackage{foobar}{2009/05/07}{0.1}{Foobar package}
\cs_new:Nn \foo_bar:nn {#1,#2}
...
\RequirePackage{array}
...
\cs_new:Nn \foo_bar:nnn {#3,#2,#1}

```

Inside the `array` package, everything should behave as normal under traditional \LaTeX but as soon as we are back at the top level, we should use the new catcode regime.

Whenever \LaTeX inputs a package file or similar, it calls upon `\@pushfilename` to push the name, the extension and the catcode of `@` of the file it was currently processing onto a file name stack. Similarly, after inputting such a file, this file name stack is popped again and the catcode of `@` is set to what it was before. If it is a package within package, `@` maintains catcode 11 whereas if it is package within document preamble `@` is reset to what it was in the preamble (which is usually catcode 12). We wish to adopt a similar technique. Every time an Expl package or class is declared, they will issue an `\ExplSyntaxOn`. Then whenever we are about to load another file, we will first push this status onto a stack and then turn it off again. Then when done loading a file, we pop

the stack and if `ExplSyntax` was On right before, so should it be now. The only problem with this is that we cannot guarantee that we get to the file name stack very early on. Therefore, if the `ExplSyntaxStack` is empty when trying to pop it, we ensure to turn `ExplSyntax` off again.

`\@pushfilename` is prepended with a small function pushing the current `ExplSyntaxStatus` (true/false) onto a stack. Then the current catcode regime is recorded and `ExplSyntax` is switched off.

`\@popfilename` is appended with a function for popping the `ExplSyntax` stack. However, chances are we didn't get to hook into the file stack early enough so `LATEX` might try to pop the file name stack while the `ExplSyntaxStack` is empty. If the latter is empty, we just switch off `ExplSyntax`.

```

660 \tex_edef:D \@pushfilename{
661   \etex_unexpanded:D{
662     \tex_edef:D \ExplSyntaxStack{ \ExplSyntaxStatus \ExplSyntaxStack }
663     \ExplSyntaxOff
664   }
665   \etex_unexpanded:D\tex_expandafter:D{\@pushfilename }
666 }
667 \tex_edef:D \@popfilename{
668   \etex_unexpanded:D\tex_expandafter:D{\@popfilename
669     \tex_if:D 2\ExplSyntaxStack 2
670       \ExplSyntaxOff
671     \tex_else:D
672       \tex_expandafter:D\ExplSyntaxPopStack\ExplSyntaxStack\q_nil
673     \tex_fi:D
674   }
675 }
```

`\ExplSyntaxPopStack` Popping the stack is simple: Take the first token which is either 0 (false) or 1 (true) and
`\ExplSyntaxStack` test if it is odd. Save the rest. The stack is initially empty set to 0 signalling that before `l3names` was loaded, the `ExplSyntax` was off.

```

676 \tex_def:D\ExplSyntaxPopStack#1#2\q_nil{
677   \tex_def:D\ExplSyntaxStack{#2}
678   \tex_ifodd:D#1\tex_relax:D
679     \ExplSyntaxOn
680   \tex_else:D
681     \ExplSyntaxOff
682   \tex_fi:D
683 }
684 \tex_def:D \ExplSyntaxStack{0}
```

94.8 Finishing up

A few of the ‘primitives’ assigned above have already been stolen by `LATEX`, so assign them by hand to the saved real primitive.

```

685 \tex_let:D\tex_input:D      \@@input
686 \tex_let:D\tex_underline:D  \@@underline
687 \tex_let:D\tex_end:D        \@@end
```

```

688 \tex_let:D\tex_everymath:D \frozen@everymath
689 \tex_let:D\tex_everydisplay:D \frozen@everydisplay
690 \tex_let:D\tex_italiccorr:D \@@italiccorr
691 \tex_let:D\tex_hyphen:D \@@hyph

```

TeX has a nasty habit of inserting a command with the name `\par` so we had better make sure that that command at least has a definition.

```

692 \tex_let:D\par \tex_par:D

```

This is the end for `l3names` when used on top of L^AT_EX 2_ε:

```

693 \tex_ifx:D\name_undefine:N\@gobble
694 \tex_def:D\name_pop_stack:w{}
695 \tex_else:D

```

But if traditional TeX code is disabled, do this...

As mentioned above, The L^AT_EX 2_ε package mechanism will insert some code to handle the filename stack, and reset the package options, this code will die if the TeX primitives have gone, so skip past it and insert some equivalent code that will work.

First a version of `\ProvidesPackage` that can cope.

```

696 \tex_def:D\ProvidesPackage{
697 \tex_begingroup:D
698 \ExplSyntaxOff
699 \package_provides:w}

700 \tex_def:D\package_provides:w#1#2[#3]{
701 \tex_endgroup:D
702 \tex_immediate:D\tex_write:D-1{Package:~#1#2~#3}
703 \tex_expandafter:D\tex_xdef:D
704 \tex_csname:D ver@#1.sty\tex_endcsname:D{#1}}

```

In this case the catcode preserving stack is not maintained and `\ExplSyntaxOn` conventions stay in force once on. You'll need to turn then off explicitly with `\ExplSyntaxOff` (although as currently built on 2e, nothing except very experimental code will run in this mode!) Also note that `\RequirePackage` is a simple definition, just for one file, with no options.

```

705 \tex_def:D\name_pop_stack:w#1\relax{%
706 \ExplSyntaxOff
707 \tex_expandafter:D\@p@pfilename\@currnamestack\@nil
708 \tex_let:D\default@ds\unknownoptionerror
709 \tex_global:D\tex_let:D\ds@\@empty
710 \tex_global:D\tex_let:D\@declaredoptions\@empty}

711 \tex_def:D\@p@pfilename#1#2#3#4\@nil{%
712 \tex_gdef:D\@currname{#1}%
713 \tex_gdef:D\@current{#2}%
714 \tex_catcode:D'\@#3%
715 \tex_gdef:D\@currnamestack{#4}}

```

```

716 \tex_def:D\NeedsTeXFormat#1{}
717 \tex_def:D\RequirePackage#1{
718   \tex_expandafter:D\tex_ifx:D
719     \tex_csname:D ver@#1.sty\tex_endcsname:D\tex_relax:D
720     \ExplSyntaxOn
721     \tex_input:D#1.sty\tex_relax:D
722   \tex_fi:D}
723 \tex_fi:D

```

The `\futurelet` just forces the special end of file marker to vanish, so the argument of `\name_pop_stack:w` does not cause an end-of-file error. (Normally I use `\expandafter` for this trick, but here the next token is in fact `\let` and that may be undefined.)

```

724 \tex_futurelet:D\name_tmp:\name_pop_stack:w

```

expl3 dependency checks We want the expl3 bundle to be loaded ‘as one’; this command is used to ensure that one of the 13 packages isn’t loaded on its own.

```

725 <*\linitex>
726 \tex_def:D \package_check_loaded_expl: {
727   \@ifpackageloaded{expl3}{}{
728     \PackageError{expl3}{Cannot~load~the~expl3~modules~separately}{
729       The~expl3~modules~cannot~be~loaded~separately;\MessageBreak
730       please~\protect\usepackage{expl3}~instead.
731     }
732   }
733 }
734 </\linitex>
735 </package>

```

94.9 Showing memory usage

This section is from some old code from 1993; it’d be good to work out how it should be used in our code today.

During the development of the L^AT_EX3 kernel we need to be able to keep track of the memory usage. Therefore we generate empty pages while loading the kernel code, just to be able to check the memory usage.

```

736 <*\showmemory>
737 \g_trace_statistics_status=2\scan_stop:
738 \cs_set_nopar:Npn\showMemUsage{
739   \if_horizontal_mode:
740     \tex_errmessage:D{Wrong~ mode~ H:~ something~ triggered~
741       hmode~ above}
742   \else:
743     \tex_message:D{Mode ~ okay}
744   \fi:
745   \tex_shipout:D\hbox:w{}
746 }
747 \showMemUsage
748 </showmemory>

```

95 l3basics implementation

We need l3names to get things going but we actually need it very early on, so it is loaded at the very top of the file l3basics.dtx. Also, most of the code below won't run until l3expan has been loaded.

95.1 Renaming some T_EX primitives (again)

`\cs_set_eq:NwN` Having given all the tex primitives a consistent name, we need to give sensible names to the ones we actually want to use. These will be defined as needed in the appropriate modules, but do a few now, just to get started.⁸

```

749 <*package>
750 \ProvidesExplPackage
751   {\filename}{\filedate}{\fileversion}{\filedescription}
752 \package_check_loaded_expl:
753 </package>
754 <*initex | package>
755 \tex_let:D \cs_set_eq:NwN          \tex_let:D

```

```

\if_true: Then some conditionals.
\if_false:
  \or: 756 \cs_set_eq:NwN \if_true: \tex_iftrue:D
  \else: 757 \cs_set_eq:NwN \if_false: \tex_iffalse:D
  \fi: 758 \cs_set_eq:NwN \or: \tex_or:D
\reverse_if:N 759 \cs_set_eq:NwN \else: \tex_else:D
  \if:w 760 \cs_set_eq:NwN \fi: \tex_fi:D
\if_bool:N 761 \cs_set_eq:NwN \reverse_if:N \etex_unless:D
  \if:w 762 \cs_set_eq:NwN \if:w \tex_if:D
\if_predicate:w 763 \cs_set_eq:NwN \if_bool:N \tex_ifodd:D
\if_charcode:w 764 \cs_set_eq:NwN \if_predicate:w \tex_ifodd:D
\if_catcode:w 765 \cs_set_eq:NwN \if_charcode:w \tex_if:D
766 \cs_set_eq:NwN \if_catcode:w \tex_ifcat:D

```

```

\if_meaning:w
767 \cs_set_eq:NwN \if_meaning:w \tex_ifx:D

```

```

\if_mode_math: TEX lets us detect some if its modes.
\if_mode_horizontal:
  \if_mode_vertical: 768 \cs_set_eq:NwN \if_mode_math: \tex_ifmmode:D
  \if_mode_inner: 769 \cs_set_eq:NwN \if_mode_horizontal: \tex_ifhmode:D
770 \cs_set_eq:NwN \if_mode_vertical: \tex_ifvmode:D
771 \cs_set_eq:NwN \if_mode_inner: \tex_ifinner:D

```

```

\if_cs_exist:N
\if_cs_exist:w
772 \cs_set_eq:NwN \if_cs_exist:N \etex_ifdefined:D
773 \cs_set_eq:NwN \if_cs_exist:w \etex_ifcurname:D

```

⁸This renaming gets expensive in terms of csname usage, an alternative scheme would be to just use the “tex...D” name in the cases where no good alternative exists.

`\exp_after:wN` The three `\exp_` functions are used in the `l3expan` module where they are described.

```

\exp_not:N
\exp_not:n
774 \cs_set_eq:NwN \exp_after:wN \tex_expandafter:D
775 \cs_set_eq:NwN \exp_not:N \tex_noexpand:D
776 \cs_set_eq:NwN \exp_not:n \etex_unexpanded:D

```

```

\iow_shipout_x:Nn
\token_to_meaning:N
777 \cs_set_eq:NwN \iow_shipout_x:Nn \tex_write:D
\token_to_str:N 778 \cs_set_eq:NwN \token_to_meaning:N \tex_meaning:D
\token_to_str:c 779 \cs_set_eq:NwN \token_to_str:N \tex_string:D
\cs:w 780 \cs_set_eq:NwN \cs:w \tex_csname:D
\cs_end: 781 \cs_set_eq:NwN \cs_end: \tex_endcsname:D
\cs_meaning:N 782 \cs_set_eq:NwN \cs_meaning:N \tex_meaning:D
\cs_meaning:c 783 \tex_def:D \cs_meaning:c {\exp_args:Nc\cs_meaning:N}
\cs_show:N 784 \cs_set_eq:NwN \cs_show:N \tex_show:D
\cs_show:c 785 \tex_def:D \cs_show:c {\exp_args:Nc\cs_show:N}
786 \tex_def:D \token_to_str:c {\exp_args:Nc\token_to_str:N}

```

`\scan_stop:` The next three are basic functions for which there also exist versions that are safe inside alignments. These safe versions are defined in the `l3prg` module.

```

\group_begin:
\group_end:
787 \cs_set_eq:NwN \scan_stop: \tex_relax:D
788 \cs_set_eq:NwN \group_begin: \tex_begingroup:D
789 \cs_set_eq:NwN \group_end: \tex_endgroup:D

```

```

\group_execute_after:N
790 \cs_set_eq:NwN \group_execute_after:N \tex_aftergroup:D

```

```

\pref_global:D
\pref_long:D
\pref_protected:D
791 \cs_set_eq:NwN \pref_global:D \tex_global:D
792 \cs_set_eq:NwN \pref_long:D \tex_long:D
793 \cs_set_eq:NwN \pref_protected:D \etex_protected:D

```

95.2 Defining functions

We start by providing functions for the typical definition functions. First the local ones.

`\cs_set_nopar:Npn` All assignment functions in L^AT_EX3 should be naturally robust; after all, the T_EX primitives for assignments are and it can be a cause of problems if others aren't.

```

\cs_set_nopar:Npx
\cs_set:Npn
794 \cs_set_eq:NwN \cs_set_nopar:Npn \tex_def:D
\cs_set:Npx 795 \cs_set_eq:NwN \cs_set_nopar:Npx \tex_edef:D
\cs_set_protected_nopar:Npn
796 \pref_protected:D \cs_set_nopar:Npn \cs_set:Npn {
\cs_set_protected_nopar:Npx
797 \pref_long:D \cs_set_nopar:Npn
798 }
\cs_set_protected:Npn
799 \pref_protected:D \cs_set_nopar:Npn \cs_set:Npx {
800 \pref_long:D \cs_set_nopar:Npx
801 }
802 \pref_protected:D \cs_set_nopar:Npn \cs_set_protected_nopar:Npn {

```

```

803 \pref_protected:D \cs_set_nopar:Npn
804 }
805 \pref_protected:D \cs_set_nopar:Npn \cs_set_protected_nopar:Npx {
806 \pref_protected:D \cs_set_nopar:Npx
807 }
808 \cs_set_protected_nopar:Npn \cs_set_protected:Npn {
809 \pref_protected:D \pref_long:D \cs_set_nopar:Npn
810 }
811 \cs_set_protected_nopar:Npn \cs_set_protected:Npx {
812 \pref_protected:D \pref_long:D \cs_set_nopar:Npx
813 }

```

\cs_gset_nopar:Npn Global versions of the above functions.

```

\cs_gset_nopar:Npx
\cs_gset:Npn
\cs_gset:Npx
\cs_gset_protected_nopar:Npn
\cs_gset_protected_nopar:Npx
\cs_gset_protected:Npn
\cs_gset_protected:Npx
814 \cs_set_eq:NwN \cs_gset_nopar:Npn \tex_gdef:D
815 \cs_set_eq:NwN \cs_gset_nopar:Npx \tex_xdef:D
816 \cs_set_protected_nopar:Npn \cs_gset:Npn {
817 \pref_long:D \cs_gset_nopar:Npn
818 }
819 \cs_set_protected_nopar:Npn \cs_gset:Npx {
820 \pref_long:D \cs_gset_nopar:Npx
821 }
822 \cs_set_protected_nopar:Npn \cs_gset_protected_nopar:Npn {
823 \pref_protected:D \cs_gset_nopar:Npn
824 }
825 \cs_set_protected_nopar:Npn \cs_gset_protected_nopar:Npx {
826 \pref_protected:D \cs_gset_nopar:Npx
827 }
828 \cs_set_protected_nopar:Npn \cs_gset_protected:Npn {
829 \pref_protected:D \pref_long:D \cs_gset_nopar:Npn
830 }
831 \cs_set_protected_nopar:Npn \cs_gset_protected:Npx {
832 \pref_protected:D \pref_long:D \cs_gset_nopar:Npx
833 }

```

95.3 Selecting tokens

\use:c This macro grabs its argument and returns a csname from it.

```

834 \cs_set:Npn \use:c #1 { \cs:w#1\cs_end: }

```

\use:n These macro grabs its arguments and returns it back to the input (with outer braces removed). \use:n is defined earlier for bootstrapping.

```

\use:nnn
\use:nnnn
835 \cs_set:Npn \use:n #1 {#1}
836 \cs_set:Npn \use:nn #1#2 {#1#2}
837 \cs_set:Npn \use:nnn #1#2#3 {#1#2#3}
838 \cs_set:Npn \use:nnnn #1#2#3#4 {#1#2#3#4}

```

\use_i:nn These macros are needed to provide functions with true and false cases, as introduced by Michael some time ago. By using \exp_after:wN \use_i:nn \else: constructions it is

possible to write code where the true or false case is able to access the following tokens from the input stream, which is not possible if the `\c_true_bool` syntax is used.

```
839 \cs_set:Npn \use_i:nn #1#2 {#1}
840 \cs_set:Npn \use_ii:nn #1#2 {#2}
```

```
\use_i:nnn We also need something for picking up arguments from a longer list.
\use_ii:nnn
\use_iii:nnn 841 \cs_set:Npn \use_i:nnn #1#2#3{#1}
\use_i:nnnn 842 \cs_set:Npn \use_ii:nnn #1#2#3{#2}
\use_ii:nnnn 843 \cs_set:Npn \use_iii:nnn #1#2#3{#3}
\use_iii:nnnn 844 \cs_set:Npn \use_i:nnnn #1#2#3#4{#1}
\use_iv:nnnn 845 \cs_set:Npn \use_ii:nnnn #1#2#3#4{#2}
\use_i:nnnnn 846 \cs_set:Npn \use_iii:nnnn #1#2#3#4{#3}
\use_ii:nnnnn 847 \cs_set:Npn \use_iv:nnnn #1#2#3#4{#4}
\use_i:nnnnn 848 \cs_set:Npn \use_i:nnnnn #1#2#3{#1#2}
```

`\use_none_delimit_by_q_nil:w` Functions that gobble everything until they see either `\q_nil` or `\q_stop` resp.

```
\use_none_delimit_by_q_stop:w
delimit_by_q_recursion_stop:w
849 \cs_set:Npn \use_none_delimit_by_q_nil:w #1\q_nil{}
850 \cs_set:Npn \use_none_delimit_by_q_stop:w #1\q_stop{}
851 \cs_set:Npn \use_none_delimit_by_q_recursion_stop:w #1 \q_recursion_stop {}
```

`\use_i_delimit_by_q_nil:nw` Same as above but execute first argument after gobbling. Very useful when you need to skip the rest of a mapping sequence but want an easy way to control what should be expanded next.

```
852 \cs_set:Npn \use_i_delimit_by_q_nil:nw #1#2\q_nil{#1}
853 \cs_set:Npn \use_i_delimit_by_q_stop:nw #1#2\q_stop{#1}
854 \cs_set:Npn \use_i_delimit_by_q_recursion_stop:nw #1#2 \q_recursion_stop {#1}
```

`\use_i_after_fi:nw` Returns the first argument after ending the conditional.

```
\use_i_after_else:nw
\use_i_after_or:nw
\use_i_after_orelse:nw
855 \cs_set:Npn \use_i_after_fi:nw #1\fi:{\fi: #1}
856 \cs_set:Npn \use_i_after_else:nw #1\else:#2\fi:{\fi: #1}
857 \cs_set:Npn \use_i_after_or:nw #1\or: #2\fi: {\fi:#1}
858 \cs_set:Npn \use_i_after_orelse:nw #1 #2#3\fi: {\fi:#1}
```

95.4 Gobbling tokens from input

`\use_none:n` To gobble tokens from the input we use a standard naming convention: the number of tokens gobbled is given by the number of `n`'s following the `:` in the name. Although defining `\use_none:nnn` and above as separate calls of `\use_none:n` and `\use_none:nn` is slightly faster, this is very non-intuitive to the programmer who will assume that expanding such a function once will take care of gobbling all the tokens in one go.

```
\use_none:nnn
\use_none:nnnn
\use_none:nnnnn
\use_none:nnnnnn
\use_none:nnnnnnn
\use_none:nnnnnnnn
\use_none:nnnnnnnnn
859 \cs_set:Npn \use_none:n #1{}
860 \cs_set:Npn \use_none:nn #1#2{}
861 \cs_set:Npn \use_none:nnn #1#2#3{}
862 \cs_set:Npn \use_none:nnnn #1#2#3#4{}
863 \cs_set:Npn \use_none:nnnnn #1#2#3#4#5{}
864 \cs_set:Npn \use_none:nnnnnn #1#2#3#4#5#6{}
865 \cs_set:Npn \use_none:nnnnnnn #1#2#3#4#5#6#7{}
866 \cs_set:Npn \use_none:nnnnnnnn #1#2#3#4#5#6#7#8{}
867 \cs_set:Npn \use_none:nnnnnnnnn #1#2#3#4#5#6#7#8#9{}
```

95.5 Expansion control from l3expan

`\exp_args:Nc` Moved here for now as it is going to be used right away.

```
868 \cs_set:Npn \exp_args:Nc #1#2{\exp_after:wN#1\cs:w#2\cs_end:}
```

95.6 Conditional processing and definitions

Underneath any predicate function (`_p`) or other conditional forms (TF, etc.) is a built-in logic saying that it after all of the testing and processing must return the *state* this leaves `TEX` in. Therefore, a simple user interface could be something like

```
\if_meaning:w #1#2 \prg_return_true: \else:
\if_meaning:w #1#3 \prg_return_true: \else:
\prg_return_false:
\fi: \fi:
```

Usually, a `TEX` programmer would have to insert a number of `\exp_after:wN`s to ensure the state value is returned at exactly the point where the last conditional is finished. However, that obscures the code and forces the `TEX` programmer to prove that he/she knows the $2^n - 1$ table. We therefore provide the simpler interface.

`\prg_return_true:` These break statements put `TEX` in a *true* or *false* state. The idea is that the expansion of `\tex_romannumeral:D \c_zero` is *null* so we set off a `\tex_romannumeral:D`. It will on its way expand any `\else:` or `\fi:` that are waiting to be discarded anyway before finally arriving at the `\c_zero` we will place right after the conditional. After this expansion has terminated, we issue either `\if_true:` or `\if_false:` to put `TEX` in the correct state.

```
869 \cs_set:Npn \prg_return_true: { \exp_after:wN\if_true:\tex_romannumeral:D }
870 \cs_set:Npn \prg_return_false: {\exp_after:wN\if_false:\tex_romannumeral:D }
```

An extended state space could instead utilize `\tex_ifcase:D`:

```
\cs_set:Npn \prg_return_true: {
\exp_after:wN\tex_ifcase:D \exp_after:wN \c_zero \tex_romannumeral:D
}
\cs_set:Npn \prg_return_false: {
\exp_after:wN\tex_ifcase:D \exp_after:wN \c_one \tex_romannumeral:D
}
\cs_set:Npn \prg_return_error: {
\exp_after:wN\tex_ifcase:D \exp_after:wN \c_two \tex_romannumeral:D
}
```

`\prg_set_conditional:Npnn` The user functions for the types using parameter text from the programmer. Call aux function to grab parameters, split the base function into name and signature and then use, e.g., `\cs_set:Npn` to define it with.

`\prg_new_conditional:Npnn`
`\et_protected_conditional:Npnn`
`\ew_protected_conditional:Npnn`

```
871 \cs_set:Npn \prg_set_conditional:Npnn #1{
```



```

872 \prg_get_parm_aux:nw{
873   \cs_split_function:NN #1 \prg_generate_conditional_aux:nnNNnnnn
874   \cs_set:Npn {parm}
875 }
876 }
877 \cs_set:Npn \prg_new_conditional:Npnn #1{
878   \prg_get_parm_aux:nw{
879     \cs_split_function:NN #1 \prg_generate_conditional_aux:nnNNnnnn
880     \cs_new:Npn {parm}
881   }
882 }
883 \cs_set:Npn \prg_set_protected_conditional:Npnn #1{
884   \prg_get_parm_aux:nw{
885     \cs_split_function:NN #1 \prg_generate_conditional_aux:nnNNnnnn
886     \cs_set_protected:Npn {parm}
887   }
888 }
889 \cs_set:Npn \prg_new_protected_conditional:Npnn #1{
890   \prg_get_parm_aux:nw{
891     \cs_split_function:NN #1 \prg_generate_conditional_aux:nnNNnnnn
892     \cs_new_protected:Npn {parm}
893   }
894 }

```

\prg_set_conditional:Nnn
\prg_new_conditional:Nnn
\prg_set_protected_conditional:Nnn
\prg_new_protected_conditional:Nnn

The user functions for the types automatically inserting the correct parameter text based on the signature. Call aux function after calculating number of arguments, split the base function into name and signature and then use, e.g., \cs_set:Npn to define it with.

```

895 \cs_set:Npn \prg_set_conditional:Nnn #1{
896   \exp_args:Nnf \prg_get_count_aux:nn{
897     \cs_split_function:NN #1 \prg_generate_conditional_aux:nnNNnnnn
898     \cs_set:Npn {count}
899   }{\cs_get_arg_count_from_signature:N #1}
900 }
901 \cs_set:Npn \prg_new_conditional:Nnn #1{
902   \exp_args:Nnf \prg_get_count_aux:nn{
903     \cs_split_function:NN #1 \prg_generate_conditional_aux:nnNNnnnn
904     \cs_new:Npn {count}
905   }{\cs_get_arg_count_from_signature:N #1}
906 }
907
908 \cs_set:Npn \prg_set_protected_conditional:Nnn #1{
909   \exp_args:Nnf \prg_get_count_aux:nn{
910     \cs_split_function:NN #1 \prg_generate_conditional_aux:nnNNnnnn
911     \cs_set_protected:Npn {count}
912   }{\cs_get_arg_count_from_signature:N #1}
913 }
914
915 \cs_set:Npn \prg_new_protected_conditional:Nnn #1{
916   \exp_args:Nnf \prg_get_count_aux:nn{
917     \cs_split_function:NN #1 \prg_generate_conditional_aux:nnNNnnnn
918     \cs_new_protected:Npn {count}
919   }{\cs_get_arg_count_from_signature:N #1}
920 }

```

```

\prg_set_eq_conditional:NNn
\prg_new_eq_conditional:NNn

```

The obvious setting-equal functions.

```

921 \cs_set:Npn \prg_set_eq_conditional:NNn #1#2#3 {
922   \prg_set_eq_conditional_aux:NNNn \cs_set_eq:cc #1#2 {#3}
923 }
924 \cs_set:Npn \prg_new_eq_conditional:NNn #1#2#3 {
925   \prg_set_eq_conditional_aux:NNNn \cs_new_eq:cc #1#2 {#3}
926 }

```

```

\prg_get_parm_aux:nw
\prg_get_count_aux:nn

```

For the `Npnn` type we must grab the parameter text before continuing. We make this a very generic function that takes one argument before reading everything up to a left brace. Something similar for the `Nnn` type.

```

927 \cs_set:Npn \prg_get_count_aux:nn #1#2 {#1{#2}}
928 \cs_set:Npn \prg_get_parm_aux:nw #1#2#{#1{#2}}

```

```

conditional_parm_aux:nnNNnnnn
generate_conditional_parm_aux:nw

```

The workhorse here is going through a list of desired forms, i.e., p, TF, T and F. The first three arguments come from splitting up the base form of the conditional, which gives the name, signature and a boolean to signal whether or not there was a colon in the name. For the time being, we do not use this piece of information but could well throw an error. The fourth argument is how to define this function, the fifth is the text `parm` or `count` for which version to use to define the functions, the sixth is the parameters to use (possibly empty) or number of arguments, the seventh is the list of forms to define, the eighth is the replacement text which we will augment when defining the forms.

```

929 \cs_set:Npn \prg_generate_conditional_aux:nnNNnnnn #1#2#3#4#5#6#7#8{
930   \prg_generate_conditional_aux:nnw{#5}{
931     #4{#1}{#2}{#6}{#8}
932   }#7,?, \q_recursion_stop
933 }

```

Looping through the list of desired forms. First is the text `parm` or `count`, second is five arguments packed together and third is the form. Use text and form to call the correct type.

```

934 \cs_set:Npn \prg_generate_conditional_aux:nnw #1#2#3,{
935   \if:w ?#3
936     \exp_after:wN \use_none_delimit_by_q_recursion_stop:w
937   \fi:
938   \use:c{prg_generate_#3_form_#1:Nnnnn} #2
939   \prg_generate_conditional_aux:nnw{#1}{#2}
940 }

```

```

prg_generate_p_form_parm:Nnnnn
prg_generate_TF_form_parm:Nnnnn
prg_generate_T_form_parm:Nnnnn
prg_generate_F_form_parm:Nnnnn

```

How to generate the various forms. The `parm` types here takes the following arguments: 1: how to define (an N-type), 2: name, 3: signature, 4: parameter text (or empty), 5: replacement.

```

941 \cs_set:Npn \prg_generate_p_form_parm:Nnnnn #1#2#3#4#5{
942   \exp_args:Nc #1 {#2_p:#3}#4{#5 \c_zero
943     \exp_after:wN\c_true_bool\else:\exp_after:wN\c_false_bool\fi:
944   }
945 }
946 \cs_set:Npn \prg_generate_TF_form_parm:Nnnnn #1#2#3#4#5{

```

```

947 \exp_args:Nc#1 {#2:#3TF}#4{#5 \c_zero
948 \exp_after:wN \use_i:nn \else: \exp_after:wN \use_ii:nn \fi:
949 }
950 }
951 \cs_set:Npn \prg_generate_T_form_parm:Nnnnn #1#2#3#4#5{
952 \exp_args:Nc#1 {#2:#3T}#4{#5 \c_zero
953 \else:\exp_after:wN\use_none:nn\fi:\use:n
954 }
955 }
956 \cs_set:Npn \prg_generate_F_form_parm:Nnnnn #1#2#3#4#5{
957 \exp_args:Nc#1 {#2:#3F}#4{#5 \c_zero
958 \exp_after:wN\use_none:nn\fi:\use:n
959 }
960 }

```

g_generate_p_form_count:Nnnnn
generate_TF_form_count:Nnnnn
generate_T_form_count:Nnnnn
generate_F_form_count:Nnnnn

How to generate the various forms. The count types here use a number to insert the correct parameter text, otherwise like the parm functions above.

```

961 \cs_set:Npn \prg_generate_p_form_count:Nnnnn #1#2#3#4#5{
962 \cs_generate_from_arg_count:cNnn {#2_p:#3} #1 {#4}{#5 \c_zero
963 \exp_after:wN\c_true_bool\else:\exp_after:wN\c_false_bool\fi:
964 }
965 }
966 \cs_set:Npn \prg_generate_TF_form_count:Nnnnn #1#2#3#4#5{
967 \cs_generate_from_arg_count:cNnn {#2:#3TF} #1 {#4}{#5 \c_zero
968 \exp_after:wN\use_i:nn\else:\exp_after:wN\use_ii:nn\fi:
969 }
970 }
971 \cs_set:Npn \prg_generate_T_form_count:Nnnnn #1#2#3#4#5{
972 \cs_generate_from_arg_count:cNnn {#2:#3T} #1 {#4}{#5 \c_zero
973 \else:\exp_after:wN\use_none:nn\fi:\use:n
974 }
975 }
976 \cs_set:Npn \prg_generate_F_form_count:Nnnnn #1#2#3#4#5{
977 \cs_generate_from_arg_count:cNnn {#2:#3F} #1 {#4}{#5 \c_zero
978 \exp_after:wN\use_none:nn\fi:\use:n
979 }
980 }

```

g_set_eq_conditional_aux:NNNn
g_set_eq_conditional_aux:NNNw

```

981 \cs_set:Npn \prg_set_eq_conditional_aux:NNNn #1#2#3#4 {
982 \prg_set_eq_conditional_aux:NNNw #1#2#3#4,?,\q_recursion_stop
983 }

```

Manual clist loop over argument #4.

```

984 \cs_set:Npn \prg_set_eq_conditional_aux:NNNw #1#2#3#4, {
985 \if:w ? #4 \scan_stop:
986 \exp_after:wN \use_none_delimit_by_q_recursion_stop:w
987 \fi:
988 #1 {
989 \exp_args:NNc \cs_split_function:NN #2 {prg_conditional_form_#4:nnn}
990 }{

```

```

991 \exp_args:Nnc \cs_split_function:NN #3 {prg_conditional_form_#4:nnn}
992 }
993 \prg_set_eq_conditional_aux:NNWw #1{#2}{#3}
994 }

995 \cs_set:Npn \prg_conditional_form_p:nnn #1#2#3 {#1_p:#2}
996 \cs_set:Npn \prg_conditional_form_TF:nnn #1#2#3 {#1:#2TF}
997 \cs_set:Npn \prg_conditional_form_T:nnn #1#2#3 {#1:#2T}
998 \cs_set:Npn \prg_conditional_form_F:nnn #1#2#3 {#1:#2F}

```

All that is left is to define the canonical boolean true and false. I think Michael originated the idea of expandable boolean tests. At first these were supposed to expand into either TT or TF to be tested using `\if:w` but this was later changed to 00 and 01, so they could be used in logical operations. Later again they were changed to being numerical constants with values of 1 for true and 0 for false. We need this from the get-go.

```

\c_true_bool Here are the canonical boolean values.
\c_false_bool
999 \tex_chardef:D \c_true_bool = 1~
1000 \tex_chardef:D \c_false_bool = 0~

```

95.7 Dissecting a control sequence

```

\cs_to_str:N This converts a control sequence into the character string of its name, removing the
\cs_to_str_aux:w leading escape character. This turns out to be a non-trivial matter as there a different
cases:

```

- The usual case of a printable escape character;
- the case of a non-printable escape characters, e.g., when the value of `\tex_escapechar:D` is negative;
- when the escape character is a space.

The route chosen is this: If `\token_to_str:N \a` produces a non-space escape char, then this will produce two tokens. If the escape char is non-printable, only one token is produced. If the escape char is a space, then a space token plus one token character token is produced. If we augment the result of this expansion with the letters **ax** we get the following three scenarios (with $\langle X \rangle$ being a printable non-space escape character):

- $\langle X \rangle$ **ax**
- **ax**
- **ax**

In the second and third case, putting an auxiliary function in front reading unlimited arguments will treat them the same, removing the space token for us automatically. Therefore, if we test the second and third argument of what such a function reads, in case 1 we will get true and in cases 2 and 3 we will get false. If we choose to optimize

for the usual case of a printable escape char, we can do it like this (again getting TeX to remove the leading space for us):

```

1001 \cs_set_nopar:Npn \cs_to_str:N {
1002   \if:w \exp_after:wN \cs_str_aux:w\token_to_str:N \a ax\q_nil
1003   \else:
1004     \exp_after:wN \exp_after:wN\exp_after:wN \use_ii:nn
1005   \fi:
1006   \exp_after:wN \use_none:n \token_to_str:N
1007 }
1008 \cs_set:Npn \cs_str_aux:w #1#2#3#4\q_nil{#2#3}

```

`\cs_split_function:NN` This function takes a function name and splits it into name with the escape char removed and argument specification. In addition to this, a third argument, a boolean *<true>* or *<false>* is returned with *<true>* for when there is a colon in the function and *<false>* if there is not. Lastly, the second argument of `\cs_split_function:NN` is supposed to be a function taking three variables, one for name, one for signature, and one for the boolean. For example, `\cs_split_function:NN\foo_bar:cnx\use_i:nnn` as input becomes `\use_i:nnn {foo_bar}{cnx}\c_true_bool`.

Can't use a literal `:` because it has the wrong catcode here, so it's transformed from `@` with `\tex_lowercase:D`.

```

1009 \group_begin:
1010   \tex_lccode:D '\@ = '\: \scan_stop:
1011   \tex_catcode:D '\@ = 12~
1012   \tex_lowercase:D {
1013     \group_end:

```

First ensure that we actually get a properly evaluated str as we don't know how many expansions `\cs_to_str:N` requires. Insert extra colon to catch the error cases.

```

1014 \cs_set:Npn \cs_split_function:NN #1#2{
1015   \exp_after:wN \cs_split_function_aux:w
1016     \tex_romannumeral:D -'\q \cs_to_str:N #1 @a \q_nil #2
1017 }

```

If no colon in the name, #2 is a with catcode 11 and #3 is empty. If colon in the name, then either #2 is a colon or the first letter of the signature. The letters here have catcode 12. If a colon was given we need to a) split off the colon and quark at the end and b) ensure we return the name, signature and boolean true We can't use `\quark_if_no_value:NTF` yet but this is very safe anyway as all tokens have catcode 12.

```

1018 \cs_set:Npn \cs_split_function_aux:w #1@#2#3\q_nil#4{
1019   \if_meaning:w a#2
1020     \exp_after:wN \use_i:nn
1021   \else:
1022     \exp_after:wN\use_ii:nn
1023   \fi:
1024   {#4{#1}{}\c_false_bool}
1025   {\cs_split_function_auxii:w#2#3\q_nil #4{#1}}
1026 }
1027 \cs_set:Npn \cs_split_function_auxii:w #1@a\q_nil#2#3{
1028   #2{#3}{#1}\c_true_bool
1029 }

```

End of lowercase

```
1030 }
```

`\cs_get_function_name:N` Now returning the name is trivial: just discard the last two arguments. Similar for
`\cs_get_function_signature:N` signature.

```
1031 \cs_set:Npn \cs_get_function_name:N #1 {
1032   \cs_split_function:NN #1\use_i:nnn
1033 }
1034 \cs_set:Npn \cs_get_function_signature:N #1 {
1035   \cs_split_function:NN #1\use_ii:nnn
1036 }
```

95.8 Exist or free

A control sequence is said to *exist* (to be used) if has an entry in the hash table and its meaning is different from the primitive `\tex_relax:D` token. A control sequence is said to be *free* (to be defined) if it does not already exist and also meets the requirement that it does not contain a D signature. The reasoning behind this is that most of the time, a check for a free control sequence is when we wish to make a new control sequence and we do not want to let the user define a new “do not use” control sequence.

`\cs_if_exist_p:N` Two versions for checking existence. For the N form we firstly check for `\tex_relax:D`
`\cs_if_exist_p:c` and then if it is in the hash table. There is no problem when inputting something like
`\cs_if_exist:NTF` `\else:` or `\fi:` as T_EX will only ever skip input in case the token tested against is
`\cs_if_exist:cTF` `\tex_relax:D`.

```
1037 \prg_set_conditional:Npnn \cs_if_exist:N #1 {p,TF,T,F}{
1038   \if_meaning:w #1\tex_relax:D
1039   \prg_return_false:
1040   \else:
1041     \if_cs_exist:N #1
1042     \prg_return_true:
1043   \else:
1044     \prg_return_false:
1045   \fi:
1046 \fi:
1047 }
```

For the c form we firstly check if it is in the hash table and then for `\tex_relax:D` so that we do not add it to the hash table unless it was already there. Here we have to be careful as the text to be skipped if the first test is false may contain tokens that disturb the scanner. Therefore, we ensure that the second test is performed after the first one has concluded completely.

```
1048 \prg_set_conditional:Npnn \cs_if_exist:c #1 {p,TF,T,F}{
1049   \if_cs_exist:w #1 \cs_end:
1050   \exp_after:wN \use_i:nn
1051   \else:
1052     \exp_after:wN \use_ii:nn
1053   \fi:
```

```

1054 {
1055   \exp_after:wN \if_meaning:w \cs:w #1\cs_end: \tex_relax:D
1056   \prg_return_false:
1057   \else:
1058     \prg_return_true:
1059   \fi:
1060 }
1061 \prg_return_false:
1062 }

```

`\cs_if_do_not_use_p:N`
`\cs_if_do_not_use_aux:nnN`

```

1063 \cs_set:Npn \cs_if_do_not_use_p:N #1{
1064   \cs_split_function:NN #1 \cs_if_do_not_use_aux:nnN
1065 }
1066 \cs_set:Npn \cs_if_do_not_use_aux:nnN #1#2#3{
1067   \exp_after:wN\str_if_eq_p:nn \token_to_str:N D {#2}
1068 }

```

`\cs_if_free_p:N` The simple implementation is one using the boolean expression parser: If it exists or
`\cs_if_free_p:c` is do not use, then return false.

`\cs_if_free:NTF`
`\cs_if_free:cTF`

```

\prg_set_conditional:Npnn \cs_if_free:N #1{p,TF,T,F}{
  \bool_if:nTF {\cs_if_exist_p:N #1 || \cs_if_do_not_use_p:N #1}
  {\prg_return_false:}{\prg_return_true:}
}

```

However, this functionality may not be available this early on. We do something similar: The numerical values of true and false is one and zero respectively, which we can use. The problem again here is that the token we are checking may in fact be something that can disturb the scanner, so we have to be careful. We would like to do minimal evaluation so we ensure this.

```

1069 \prg_set_conditional:Npnn \cs_if_free:N #1{p,TF,T,F}{
1070   \tex_ifnum:D \cs_if_exist_p:N #1 =\c_zero
1071   \exp_after:wN \use_i:nn
1072   \else:
1073     \exp_after:wN \use_ii:nn
1074   \fi:
1075   {
1076     \tex_ifnum:D \cs_if_do_not_use_p:N #1 =\c_zero
1077     \prg_return_true:
1078     \else:
1079       \prg_return_false:
1080     \fi:
1081   }
1082   \prg_return_false:
1083 }
1084 \cs_set_nopar:Npn \cs_if_free_p:c{\exp_args:Nc\cs_if_free_p:N}
1085 \cs_set_nopar:Npn \cs_if_free:cTF{\exp_args:Nc\cs_if_free:NTF}
1086 \cs_set_nopar:Npn \cs_if_free:cT{\exp_args:Nc\cs_if_free:NT}
1087 \cs_set_nopar:Npn \cs_if_free:cF{\exp_args:Nc\cs_if_free:NF}

```

95.9 Defining and checking (new) functions

`\c_minus_one` We need the constants `\c_minus_one` and `\c_sixteen` now for writing information to the log and the terminal and `\c_zero` which is used by some functions in the `l3num` module.
`\c_zero`
`\c_sixteen` The rest are defined in the `l3int` module – at least for the ones that can be defined with `\tex_chardef:D` or `\tex_mathchardef:D`. For other constants the `l3int` module is required but it can't be used until the allocation has been set up properly! The actual allocation mechanism is in `l3alloc` and as \TeX wants to reserve count registers 0–9, the first available one is 10 so we use that for `\c_minus_one`.

```

1088 <!*linitex>
1089 \cs_set_eq:NwN \c_minus_one\m@ne
1090 </!linitex>
1091 <!*package>
1092 \tex_countdef:D \c_minus_one = 10 ~
1093 \c_minus_one = -1 ~
1094 </!package>
1095 \tex_chardef:D \c_sixteen = 16~
1096 \tex_chardef:D \c_zero = 0~

```

We provide two kinds of functions that can be used to define control sequences. On the one hand we have functions that check if their argument doesn't already exist, they are called `\..._new`. The second type of defining functions doesn't check if the argument is already defined.

Before we can define them, we need some auxiliary macros that allow us to generate error messages. The definitions here are only temporary, they will be redefined later on.

`\iow_log:x` We define a routine to write only to the log file. And a similar one for writing to both the log file and the terminal.
`\iow_term:x`

```

1097 \cs_set_nopar:Npn \iow_log:x {
1098   \tex_immediate:D \iow_shipout_x:Nn \c_minus_one
1099 }
1100 \cs_set_nopar:Npn \iow_term:x {
1101   \tex_immediate:D \iow_shipout_x:Nn \c_sixteen
1102 }

```

`\msg_kernel_bug:x` This will show internal errors.

```

1103 \cs_set_nopar:Npn \msg_kernel_bug:x #1 {
1104   \iow_term:x { This~is~a~LaTeX~bug:~check~coding! }
1105   \tex_errmessage:D {#1}
1106 }

```

`\cs_record_meaning:N` This macro will be used later on for tracing purposes. But we need some more modules to define it, so we just give some dummy definition here.

```

1107 <*trace>
1108 \cs_set:Npn \cs_record_meaning:N #1{}
1109 </trace>

```


`\chk_if_free_cs:N` This command is called by `\cs_new_nopar:Npn` and `\cs_new_eq:NN` etc. to make sure that the argument sequence is not already in use. If it is, an error is signalled. It checks if $\langle csname \rangle$ is undefined or `\scan_stop:.` Otherwise an error message is issued. We have to make sure we don't put the argument into the conditional processing since it may be an `\if...` type function!

```

1110 \cs_set_nopar:Npn \chk_if_free_cs:N #1{
1111   \cs_if_free:NF #1
1112   {
1113     \msg_kernel_bug:x {Command~name~'\token_to_str:N #1'~
1114                       already~defined!~
1115                       Current~meaning:~'\token_to_meaning:N #1
1116                       }
1117   }
1118   \<trace>
1119   \cs_record_meaning:N#1
1120   % \iow_term:x{Defining~'\token_to_str:N #1~on~%}
1121   \iow_log:x{Defining~'\token_to_str:N #1~on~
1122             line~\tex_the:D \tex_inputlineno:D}
1123   \</trace>
1124 }

```

`\chk_if_exist_cs:N` This function issues a warning message when the control sequence in its argument does not exist.
`\chk_if_exist_cs:c`

```

1125 \cs_set_nopar:Npn \chk_if_exist_cs:N #1 {
1126   \cs_if_exist:NF #1
1127   {
1128     \msg_kernel_bug:x {Command~ '\token_to_str:N #1'~
1129                       not~ yet~ defined!}
1130   }
1131 }
1132 \cs_set_nopar:Npn \chk_if_exist_cs:c {\exp_args:Nc \chk_if_exist_cs:N }

```

`\str_if_eq_p:nn` Takes 2 lists of characters as arguments and expands into `\c_true_bool` if they are equal, and `\c_false_bool` otherwise. Note that in the current implementation spaces in these strings are ignored.⁹
`\str_if_eq_p_aux:w`

```

1133 \prg_set_conditional:Npnn \str_if_eq:nn #1#2{p}{
1134   \str_if_eq_p_aux:w #1\scan_stop:\#2\scan_stop:\
1135 }
1136 \cs_set_nopar:Npn \str_if_eq_p_aux:w #1#2\#3#4\#5{
1137   \if_meaning:w#1#3
1138   \if_meaning:w#1\scan_stop:\prg_return_true: \else:
1139   \if_meaning:w#3\scan_stop:\prg_return_false: \else:
1140   \str_if_eq_p_aux:w #2\#4\#5\fi:\fi:
1141   \else:\prg_return_false: \fi:}

```

`\cs_if_eq_name_p:NN` An application of the above function, already streamlined for speed, so I put it in here. It takes two control sequences as arguments and expands into true iff they have the same name. We make it long in case one of them is `\par`!

⁹This is a function which could use `\tlist_compare:xx`.

```

1142 \prg_set_conditional:Npnn \cs_if_eq_name:NN #1#2{p}{
1143   \exp_after:wN\exp_after:wN
1144   \exp_after:wN\str_if_eq_p_aux:w
1145   \exp_after:wN\token_to_str:N
1146   \exp_after:wN#1
1147   \exp_after:wN\scan_stop:
1148   \exp_after:wN\
1149   \token_to_str:N#2\scan_stop:\}

```

`\str_if_eq_var_p:nf` A variant of `\str_if_eq_p:nn` which has the advantage of obeying spaces in at least the second argument. See `l3quark` for an application. From the hand of David Kastrup with slight modifications to make it fit with the remainder of the `expl3` language.

The macro builds a string of `\if:w \fi:` pairs from the first argument. The idea is to turn the comparison of `ab` and `cde` into

```

\tex_number:D
  \if:w \scan_stop: \if:w b\if:w a cde\scan_stop: '\fi: \fi: \fi:
13

```

The `'` is important here. If all tests are true, the `'` is read as part of the number in which case the returned number is 13 in octal notation so `\tex_number:D` returns 11. If one test returns false the `'` is never seen and then we get just 13. We wrap the whole process in an external `\if:w` in order to make it return either `\c_true_bool` or `\c_false_bool` since some parts of `l3prg` expect a predicate to return one of these two tokens.

```

1150 \prg_set_conditional:Npnn \str_if_eq_var:nf #1#2 {p} {
1151   \if:w \tex_number:D\str_if_eq_var_start:nnN{}{}#1\scan_stop:{#2}
1152 }
1153 \cs_set_nopar:Npn\str_if_eq_var_start:nnN#1#2#3{
1154   \if:w#3\scan_stop:\exp_after:wN\str_if_eq_var_stop:w\fi:
1155   \str_if_eq_var_start:nnN{\if:w#3#1}{#2\fi:}
1156 }
1157 \cs_set:Npn\str_if_eq_var_stop:w\str_if_eq_var_start:nnN#1#2#3{
1158   #1#3\scan_stop:'#213~\prg_return_true:\else:\prg_return_false:\fi:
1159 }

```

95.10 More new definitions

`\cs_new_nopar:Npn` These are like `\cs_set_nopar:Npn` and `\cs_set_eq:NN`, but they first check that the argument command is not already in use. You may use `\pref_global:D`, `\pref_long:D`, `\pref_protected:D`, and `\tex_outer:D` as prefixes.

`\cs_new_nopar:Npx`
`\cs_new:Npn`
`\cs_new:Npx`

```

\cs_new_protected_nopar:Npn 1160 \cs_set:Npn \cs_tmp:w #1#2{
\cs_new_protected_nopar:Npx 1161   \cs_set_protected_nopar:Npn #1 ##1 {
1162     \chk_if_free_cs:N ##1
1163     #2 ##1
1164   }
1165 }
1166 \cs_tmp:w \cs_new_nopar:Npn \cs_set_nopar:Npn
1167 \cs_tmp:w \cs_new_nopar:Npx\cs_set_nopar:Npx

```

```

1168 \cs_tmp:w \cs_new:Npn \cs_set:Npn
1169 \cs_tmp:w \cs_new:Npx\cs_set:Npx
1170 \cs_tmp:w \cs_new_protected_nopar:Npn \cs_set_protected_nopar:Npn
1171 \cs_tmp:w \cs_new_protected_nopar:Npx\cs_set_protected_nopar:Npx
1172 \cs_tmp:w \cs_new_protected:Npn \cs_set_protected:Npn
1173 \cs_tmp:w \cs_new_protected:Npx\cs_set_protected:Npx

```

\cs_gnew_nopar:Npn Global versions of the above functions.

```

\cs_gnew_nopar:Npx
\cs_gnew:Npn 1174 \cs_tmp:w \cs_gnew_nopar:Npn \cs_gset_nopar:Npn
\cs_gnew:Npx 1175 \cs_tmp:w \cs_gnew_nopar:Npx \cs_gset_nopar:Npx
\cs_gset:Npn 1176 \cs_tmp:w \cs_gset:Npn \cs_gset:Npn
\cs_gset:Npx 1177 \cs_tmp:w \cs_gset:Npx \cs_gset:Npx
\cs_gnew_protected_nopar:Npn 1178 \cs_tmp:w \cs_gnew_protected_nopar:Npn \cs_gset_protected_nopar:Npn
\cs_gnew_protected_nopar:Npx 1179 \cs_tmp:w \cs_gnew_protected_nopar:Npx \cs_gset_protected_nopar:Npx
\cs_gnew_protected:Npn 1180 \cs_tmp:w \cs_gnew_protected:Npn \cs_gset_protected:Npn
\cs_gnew_protected:Npx 1181 \cs_tmp:w \cs_gnew_protected:Npx \cs_gset_protected:Npx

```

\cs_set_nopar:cpn Like \cs_set_nopar:Npn and \cs_new_nopar:Npn, except that the first argument consists of the sequence of characters that should be used to form the name of the desired control sequence (the c stands for csname argument, see the expansion module). Global versions are also provided.

\cs_set_nopar:cpn⟨string⟩⟨rep-text⟩ will turn ⟨string⟩ into a csname and then assign ⟨rep-text⟩ to it by using \cs_set_nopar:Npn. This means that there might be a parameter string between the two arguments.

```

1182 \cs_set:Npn \cs_tmp:w #1#2{
1183   \cs_new_nopar:Npn #1 { \exp_args:Nc #2 }
1184 }
1185 \cs_tmp:w \cs_set_nopar:cpn \cs_set_nopar:Npn
1186 \cs_tmp:w \cs_set_nopar:cpx \cs_set_nopar:Npx
1187 \cs_tmp:w \cs_gset_nopar:cpn \cs_gset_nopar:Npn
1188 \cs_tmp:w \cs_gset_nopar:cpx \cs_gset_nopar:Npx
1189 \cs_tmp:w \cs_new_nopar:cpn \cs_new_nopar:Npn
1190 \cs_tmp:w \cs_new_nopar:cpx \cs_new_nopar:Npx
1191 \cs_tmp:w \cs_gnew_nopar:cpn \cs_gnew_nopar:Npn
1192 \cs_tmp:w \cs_gnew_nopar:cpx \cs_gnew_nopar:Npx

```

\cs_set:cpn Variants of the \cs_set:Npn versions which make a csname out of the first arguments.
\cs_set:cpx We may also do this globally.

```

\cs_gset:cpn 1193 \cs_tmp:w \cs_set:cpn \cs_set:Npn
\cs_gset:cpx 1194 \cs_tmp:w \cs_set:cpx \cs_set:Npx
\cs_new:cpn 1195 \cs_tmp:w \cs_gset:cpn \cs_gset:Npn
\cs_new:cpx 1196 \cs_tmp:w \cs_gset:cpx \cs_gset:Npx
\cs_gnew:cpn 1197 \cs_tmp:w \cs_new:cpn \cs_new:Npn
\cs_gnew:cpx 1198 \cs_tmp:w \cs_new:cpx \cs_new:Npx
1199 \cs_tmp:w \cs_gnew:cpn \cs_gnew:Npn
1200 \cs_tmp:w \cs_gnew:cpx \cs_gnew:Npx

```

\cs_set_protected_nopar:cpn Variants of the \cs_set_protected_nopar:Npn versions which make a csname out of the first arguments. We may also do this globally.
\cs_set_protected_nopar:cpx
\cs_gset_protected_nopar:cpn
\cs_gset_protected_nopar:cpx
\cs_new_protected_nopar:cpn
\cs_new_protected_nopar:cpx
\cs_gnew_protected_nopar:cpn
\cs_gnew_protected_nopar:cpx

```

1201 \cs_tmp:w \cs_set_protected_nopar:cpn \cs_set_protected_nopar:Npn
1202 \cs_tmp:w \cs_set_protected_nopar:cpx \cs_set_protected_nopar:Npx
1203 \cs_tmp:w \cs_gset_protected_nopar:cpn \cs_gset_protected_nopar:Npn
1204 \cs_tmp:w \cs_gset_protected_nopar:cpx \cs_gset_protected_nopar:Npx
1205 \cs_tmp:w \cs_new_protected_nopar:cpn \cs_new_protected_nopar:Npn
1206 \cs_tmp:w \cs_new_protected_nopar:cpx \cs_new_protected_nopar:Npx
1207 \cs_tmp:w \cs_gnew_protected_nopar:cpn \cs_gnew_protected_nopar:Npn
1208 \cs_tmp:w \cs_gnew_protected_nopar:cpx \cs_gnew_protected_nopar:Npx

```

\cs_set_protected:cpn \cs_set_protected:cpx \cs_gset_protected:cpn \cs_gset_protected:cpx \cs_new_protected:cpn \cs_new_protected:cpx \cs_gnew_protected:cpn \cs_gnew_protected:cpx Variants of the \cs_set_protected:Npn versions which make a csname out of the first arguments. We may also do this globally.

```

1209 \cs_tmp:w \cs_set_protected:cpn \cs_set_protected:Npn
1210 \cs_tmp:w \cs_set_protected:cpx \cs_set_protected:Npx
1211 \cs_tmp:w \cs_gset_protected:cpn \cs_gset_protected:Npn
1212 \cs_tmp:w \cs_gset_protected:cpx \cs_gset_protected:Npx
1213 \cs_tmp:w \cs_new_protected:cpn \cs_new_protected:Npn
1214 \cs_tmp:w \cs_new_protected:cpx \cs_new_protected:Npx
1215 \cs_tmp:w \cs_gnew_protected:cpn \cs_gnew_protected:Npn
1216 \cs_tmp:w \cs_gnew_protected:cpx \cs_gnew_protected:Npx

```

\use_0_parameter: For using parameters, i.e., when you need to define a function to process three parameters. See xparse for an application.

```

\use_1_parameter:
\use_2_parameter:
\use_3_parameter:
\use_4_parameter:
\use_5_parameter:
\use_6_parameter:
\use_7_parameter:
\use_8_parameter:
\use_9_parameter:
1217 \cs_set_nopar:cpn{use_0_parameter:}{}
1218 \cs_set_nopar:cpn{use_1_parameter:}{{##1}}
1219 \cs_set_nopar:cpn{use_2_parameter:}{{##1}{##2}}
1220 \cs_set_nopar:cpn{use_3_parameter:}{{##1}{##2}{##3}}
1221 \cs_set_nopar:cpn{use_4_parameter:}{{##1}{##2}{##3}{##4}}
1222 \cs_set_nopar:cpn{use_5_parameter:}{{##1}{##2}{##3}{##4}{##5}}
1223 \cs_set_nopar:cpn{use_6_parameter:}{{##1}{##2}{##3}{##4}{##5}{##6}}
1224 \cs_set_nopar:cpn{use_7_parameter:}{{##1}{##2}{##3}{##4}{##5}{##6}{##7}}
1225 \cs_set_nopar:cpn{use_8_parameter:}{{
1226   {##1}{##2}{##3}{##4}{##5}{##6}{##7}{##8}}
1227 \cs_set_nopar:cpn{use_9_parameter:}{{
1228   {##1}{##2}{##3}{##4}{##5}{##6}{##7}{##8}{##9}}

```

95.11 Copying definitions

\cs_set_eq:NN These macros allow us to copy the definition of a control sequence to another control sequence.

\cs_set_eq:cN The = sign allows us to define funny char tokens like = itself or \sqcup with this function. For the definition of \c_space_chartok{~} to work we need the ~ after the =.

\cs_set_eq:NN is long to avoid problems with a literal argument of \par. While \cs_new_eq:NN will probably never be correct with a first argument of \par, define it long in order to throw an ‘already defined’ error rather than ‘runaway argument’.

The c variants are not protected in order for their arguments to be constructed in the correct context.

```

1229 \cs_set_protected:Npn \cs_set_eq:NN #1 { \cs_set_eq:NwN #1=~ }

```

```

1230 \cs_set_nopar:Npn \cs_set_eq:cN { \exp_args:Nc \cs_set_eq:NN }
1231 \cs_set_nopar:Npn \cs_set_eq:Nc { \exp_args:NNc \cs_set_eq:NN }
1232 \cs_set_nopar:Npn \cs_set_eq:cc { \exp_args:Ncc \cs_set_eq:NN }

\cs_new_eq:NN
\cs_new_eq:cN
\cs_new_eq:Nc
\cs_new_eq:cc
1233 \cs_new_protected:Npn \cs_new_eq:NN #1 {
1234   \chk_if_free_cs:N #1
1235   \cs_set_eq:NN #1
1236 }
1237 \cs_new_nopar:Npn \cs_new_eq:cN { \exp_args:Nc \cs_new_eq:NN }
1238 \cs_new_nopar:Npn \cs_new_eq:Nc { \exp_args:NNc \cs_new_eq:NN }
1239 \cs_new_nopar:Npn \cs_new_eq:cc { \exp_args:Ncc \cs_new_eq:NN }

\cs_gset_eq:NN
\cs_gset_eq:cN
\cs_gset_eq:Nc
\cs_gset_eq:cc
1240 \cs_new_protected:Npn \cs_gset_eq:NN { \pref_global:D \cs_set_eq:NN }
1241 \cs_new_nopar:Npn \cs_gset_eq:Nc { \exp_args:NNc \cs_gset_eq:NN }
1242 \cs_new_nopar:Npn \cs_gset_eq:cN { \exp_args:Nc \cs_gset_eq:NN }
1243 \cs_new_nopar:Npn \cs_gset_eq:cc { \exp_args:Ncc \cs_gset_eq:NN }

\cs_gnew_eq:NN
\cs_gnew_eq:cN
\cs_gnew_eq:Nc
\cs_gnew_eq:cc
1244 \cs_new_protected:Npn \cs_gnew_eq:NN #1 {
1245   \chk_if_free_cs:N #1
1246   \pref_global:D \cs_set_eq:NN #1
1247 }
1248 \cs_new_nopar:Npn \cs_gnew_eq:cN { \exp_args:Nc \cs_gnew_eq:NN }
1249 \cs_new_nopar:Npn \cs_gnew_eq:Nc { \exp_args:NNc \cs_gnew_eq:NN }
1250 \cs_new_nopar:Npn \cs_gnew_eq:cc { \exp_args:Ncc \cs_gnew_eq:NN }

```

95.12 Undefining functions

`\cs_gundefine:N` The following function is used to free the main memory from the definition of some function that isn't in use any longer.

```

1251 \cs_new_nopar:Npn \cs_gundefine:N #1{\cs_gset_eq:NN #1\c_undefined:D}
1252 \cs_new_nopar:Npn \cs_gundefine:c #1{
1253   \cs_gset_eq:cN {#1} \c_undefined:D
1254 }

```

95.13 Engine specific definitions

`\c_xetex_is_engine_bool` In some cases it will be useful to know which engine we're running. Don't provide a `_p` predicate because the `_bool` is used for the same thing.

```

\c_luatex_is_engine_bool
\if_engine:TF
\luatex_if_engine:TF
1255 \if_cs_exist:N \xetex_version:D
1256   \cs_new_eq:NN \c_xetex_is_engine_bool \c_true_bool
1257 \else:
1258   \cs_new_eq:NN \c_xetex_is_engine_bool \c_false_bool
1259 \fi:

```

```

1260 \prg_new_conditional:Npnn \xetex_if_engine: {TF,T,F} {
1261   \if_bool:N \c_xetex_is_engine_bool
1262   \prg_return_true: \else: \prg_return_false: \fi:
1263 }

1264 \if_cs_exist:N \luatex_directlua:D
1265   \cs_new_eq:NN \c_luatex_is_engine_bool \c_true_bool
1266 \else:
1267   \cs_new_eq:NN \c_luatex_is_engine_bool \c_false_bool
1268 \fi:
1269 \prg_set_conditional:Npnn \xetex_if_engine: {TF,T,F}{
1270   \if_bool:N \c_xetex_is_engine_bool \prg_return_true:
1271   \else: \prg_return_false: \fi:
1272 }
1273 \prg_set_conditional:Npnn \luatex_if_engine: {TF,T,F}{
1274   \if_bool:N \c_luatex_is_engine_bool \prg_return_true:
1275   \else: \prg_return_false: \fi:
1276 }

```

95.14 Scratch functions

`\prg_do_nothing:` I don't think this function belongs here, but one place is as good as any other. I want to use this function when I want to express 'no operation'. It is for example used in templates where depending on the users settings we have to either select an function that does something, or one that does nothing.

```

1277 \cs_new_nopar:Npn \prg_do_nothing: {}

```

95.15 Defining functions from a given number of arguments

`\et_arg_count_from_signature:N` Counting the number of tokens in the signature, i.e., the number of arguments the function should take. If there is no signature, we return that there is -1 arguments to signal an error. Otherwise we insert the string 9876543210 after the signature. If the signature is empty, the number we want is 0 so we remove the first nine tokens and return the tenth. Similarly, if the signature is `nnn` we want to remove the nine tokens `nnn987654` and return 3. Therefore, we simply remove the first nine tokens and then return the tenth.

```

1278 \cs_set:Npn \cs_get_arg_count_from_signature:N #1{
1279   \cs_split_function:NN #1 \cs_get_arg_count_from_signature_aux:nnN
1280 }
1281 \cs_set:Npn \cs_get_arg_count_from_signature_aux:nnN #1#2#3{
1282   \if_predicate:w #3 % \bool_if:NTF here
1283   \exp_after:wN \use_i:nn
1284   \else:
1285   \exp_after:wN\use_ii:nn
1286   \fi:
1287   {
1288     \exp_after:wN \cs_get_arg_count_from_signature_auxii:w
1289     \use_none:nnnnnnnn #2 9876543210\q_nil
1290   }

```

```

1291 {-1}
1292 }
1293 \cs_set:Npn \cs_get_arg_count_from_signature_auxii:w #1#2\q_nil{#1}

```

A variant form we need right away.

```

1294 \cs_set_nopar:Npn \cs_get_arg_count_from_signature:c {
1295   \exp_args:Nc \cs_get_arg_count_from_signature:N
1296 }

```

```

_generate_from_arg_count:NNnn
_e_from_arg_count_error_msg:Nn

```

We provide a constructor function for defining functions with a given number of arguments. For this we need to choose the correct parameter text and then use that when defining. Since \TeX supports from zero to nine arguments, we use a simple switch to choose the correct parameter text, ensuring the result is returned after finishing the conditional. If it is not between zero and nine, we throw an error.

1: function to define, 2: with what to define it, 3: the number of args it requires and 4: the replacement text

```

1297 \cs_set:Npn \cs_generate_from_arg_count:NNnn #1#2#3#4{
1298   \tex_ifcase:D \etex_numexpr:D #3\tex_relax:D
1299     \use_i_after_orelse:nw{#2#1}
1300   \or:
1301     \use_i_after_orelse:nw{#2#1 ##1}
1302   \or:
1303     \use_i_after_orelse:nw{#2#1 ##1##2}
1304   \or:
1305     \use_i_after_orelse:nw{#2#1 ##1##2##3}
1306   \or:
1307     \use_i_after_orelse:nw{#2#1 ##1##2##3##4}
1308   \or:
1309     \use_i_after_orelse:nw{#2#1 ##1##2##3##4##5}
1310   \or:
1311     \use_i_after_orelse:nw{#2#1 ##1##2##3##4##5##6}
1312   \or:
1313     \use_i_after_orelse:nw{#2#1 ##1##2##3##4##5##6##7}
1314   \or:
1315     \use_i_after_orelse:nw{#2#1 ##1##2##3##4##5##6##7##8}
1316   \or:
1317     \use_i_after_orelse:nw{#2#1 ##1##2##3##4##5##6##7##8##9}
1318   \else:
1319     \use_i_after_fi:nw{
1320       \cs_generate_from_arg_count_error_msg:Nn#1{#3}
1321       \use_none:n % to remove replacement text
1322     }
1323   \fi:
1324   {#4}
1325 }

```

A variant form we need right away.

```

1326 \cs_set_nopar:Npn \cs_generate_from_arg_count:cNnn {
1327   \exp_args:Nc \cs_generate_from_arg_count:NNnn
1328 }

```

The error message. Elsewhere we use the value of -1 to signal a missing colon in a function, so provide a hint for help on this.

```

1329 \cs_set:Npn \cs_generate_from_arg_count_error_msg:Nn #1#2 {
1330   \msg_kernel_bug:x {
1331     You're trying to define the command '\token_to_str:N #1'~
1332     with~ \use:n{\tex_the:D\etex_numexpr:D #2\tex_relax:D} ~
1333     arguments~ but~ I~ only~ allow~ 0-9~arguments.~Perhaps~you~
1334     forgot~to~use~a~colon~in~the~function~name?~
1335     I~ can~ probably~ not~ help~ you~ here
1336   }
1337 }

```

95.16 Using the signature to define functions

We can now combine some of the tools we have to provide a simple interface for defining functions. We define some simpler functions with user interface `\cs_set:Nn \foo_bar:nn {#1,#2}`, i.e., the number of arguments is read from the signature.

`\cs_set:Nn` We want to define `\cs_set:Nn` as

`\cs_set:Nx`

`\cs_set_nopar:Nn`

`\cs_set_nopar:Nx`

`\cs_set_protected:Nn`

`\cs_set_protected:Nx`

`\cs_set_protected_nopar:Nn`

`\cs_set_protected_nopar:Nx`

`\cs_gset:Nn`

`\cs_gset:Nx`

`\cs_gset_nopar:Nn`

`\cs_gset_nopar:Nx`

`\cs_gset_protected:Nn`

`\cs_gset_protected:Nx`

`\cs_gset_protected_nopar:Nn`

`\cs_gset_protected_nopar:Nx`

```

\cs_set_protected:Npn \cs_set:Nn #1#2{
  \cs_generate_from_arg_count:NNnn #1\cs_set:Npn
    {\cs_get_arg_count_from_signature:N #1}{#2}
}

```

In short, to define `\cs_set:Nn` we need just use `\cs_set:Npn`, everything else is the same for each variant. Therefore, we can make it simpler by temporarily defining a function to do this for us.

```

1338 \cs_set:Npn \cs_tmp:w #1#2#3{
1339   \cs_set_protected:cpx {cs_#1:#2}##1##2{
1340     \exp_not:N \cs_generate_from_arg_count:NNnn ##1
1341     \exp_after:wN \exp_not:N \cs:w cs_#1:#3 \cs_end:
1342     {\exp_not:N\cs_get_arg_count_from_signature:N ##1}{##2}
1343   }
1344 }

```

Then we define the 32 variants beginning with N.

```

1345 \cs_tmp:w {set}{Nn}{Npn}
1346 \cs_tmp:w {set}{Nx}{Npx}
1347 \cs_tmp:w {set_nopar}{Nn}{Npn}
1348 \cs_tmp:w {set_nopar}{Nx}{Npx}
1349 \cs_tmp:w {set_protected}{Nn}{Npn}
1350 \cs_tmp:w {set_protected}{Nx}{Npx}
1351 \cs_tmp:w {set_protected_nopar}{Nn}{Npn}
1352 \cs_tmp:w {set_protected_nopar}{Nx}{Npx}
1353 \cs_tmp:w {gset}{Nn}{Npn}
1354 \cs_tmp:w {gset}{Nx}{Npx}
1355 \cs_tmp:w {gset_nopar}{Nn}{Npn}

```



```

1356 \cs_tmp:w {gset_nopar}{Nx}{Npx}
1357 \cs_tmp:w {gset_protected}{Nn}{Npn}
1358 \cs_tmp:w {gset_protected}{Nx}{Npx}
1359 \cs_tmp:w {gset_protected_nopar}{Nn}{Npn}
1360 \cs_tmp:w {gset_protected_nopar}{Nx}{Npx}

```

```

\cs_new:Nn
\cs_new:Nx
\cs_new_nopar:Nn
\cs_new_nopar:Nx
\cs_new_protected:Nn
\cs_new_protected:Nx
\cs_new_protected_nopar:Nn
\cs_new_protected_nopar:Nx
\cs_gnew:Nn
\cs_gnew:Nx
\cs_gnew_nopar:Nn
\cs_gnew_nopar:Nx
\cs_gnew_protected:Nn
\cs_gnew_protected:Nx
\cs_gnew_protected_nopar:Nn
\cs_gnew_protected_nopar:Nx

```

```

1361 \cs_tmp:w {new}{Nn}{Npn}
1362 \cs_tmp:w {new}{Nx}{Npx}
1363 \cs_tmp:w {new_nopar}{Nn}{Npn}
1364 \cs_tmp:w {new_nopar}{Nx}{Npx}
1365 \cs_tmp:w {new_protected}{Nn}{Npn}
1366 \cs_tmp:w {new_protected}{Nx}{Npx}
1367 \cs_tmp:w {new_protected_nopar}{Nn}{Npn}
1368 \cs_tmp:w {new_protected_nopar}{Nx}{Npx}
1369 \cs_tmp:w {gnew}{Nn}{Npn}
1370 \cs_tmp:w {gnew}{Nx}{Npx}
1371 \cs_tmp:w {gnew_nopar}{Nn}{Npn}
1372 \cs_tmp:w {gnew_nopar}{Nx}{Npx}
1373 \cs_tmp:w {gnew_protected}{Nn}{Npn}
1374 \cs_tmp:w {gnew_protected}{Nx}{Npx}
1375 \cs_tmp:w {gnew_protected_nopar}{Nn}{Npn}
1376 \cs_tmp:w {gnew_protected_nopar}{Nx}{Npx}

```

Then something similar for the c variants.

```

\cs_set_protected:Npn \cs_set:cn #1#2{
  \cs_generate_from_arg_count:cNnn {#1}\cs_set:Npn
    {\cs_get_arg_count_from_signature:c {#1}}{#2}
}

```

```

1377 \cs_set:Npn \cs_tmp:w #1#2#3{
1378   \cs_set_protected:cpx {cs_#1:#2}##1##2{
1379     \exp_not:N\cs_generate_from_arg_count:cNnn {##1}
1380     \exp_after:wN \exp_not:N \cs:w cs_#1:#3 \cs_end:
1381     {\exp_not:N\cs_get_arg_count_from_signature:c {##1}}{##2}
1382   }
1383 }

```

```

\cs_set:cn
\cs_set:cx
\cs_set_nopar:cn
\cs_set_nopar:cx
\cs_set_protected:cn
\cs_set_protected:cx
\cs_set_protected_nopar:cn
\cs_set_protected_nopar:cx
\cs_gset:cn
\cs_gset:cx
\cs_gset_nopar:cn
\cs_gset_nopar:cx
\cs_gset_protected:cn
\cs_gset_protected:cx
\cs_gset_protected_nopar:cn
\cs_gset_protected_nopar:cx

```

The 32 c variants.

```

1384 \cs_tmp:w {set}{cn}{Npn}
1385 \cs_tmp:w {set}{cx}{Npx}
1386 \cs_tmp:w {set_nopar}{cn}{Npn}
1387 \cs_tmp:w {set_nopar}{cx}{Npx}
1388 \cs_tmp:w {set_protected}{cn}{Npn}
1389 \cs_tmp:w {set_protected}{cx}{Npx}
1390 \cs_tmp:w {set_protected_nopar}{cn}{Npn}
1391 \cs_tmp:w {set_protected_nopar}{cx}{Npx}
1392 \cs_tmp:w {gset}{cn}{Npn}
1393 \cs_tmp:w {gset}{cx}{Npx}

```

```

1394 \cs_tmp:w {gset_nopar}{cn}{Npn}
1395 \cs_tmp:w {gset_nopar}{cx}{Npx}
1396 \cs_tmp:w {gset_protected}{cn}{Npn}
1397 \cs_tmp:w {gset_protected}{cx}{Npx}
1398 \cs_tmp:w {gset_protected_nopar}{cn}{Npn}
1399 \cs_tmp:w {gset_protected_nopar}{cx}{Npx}

```

\cs_new:cn

\cs_new:cx

\cs_new_nopar:cn

\cs_new_nopar:cx

\cs_new_protected:cn

\cs_new_protected:cx

\cs_new_protected_nopar:cn

\cs_new_protected_nopar:cx

\cs_gnew:cn

\cs_gnew:cx

\cs_gnew_nopar:cn

\cs_gnew_nopar:cx

\cs_gnew_protected:cn

\cs_gnew_protected:cx

\cs_gnew_protected_nopar:cn

\cs_gnew_protected_nopar:cx

```

1400 \cs_tmp:w {new}{cn}{Npn}
1401 \cs_tmp:w {new}{cx}{Npx}
1402 \cs_tmp:w {new_nopar}{cn}{Npn}
1403 \cs_tmp:w {new_nopar}{cx}{Npx}
1404 \cs_tmp:w {new_protected}{cn}{Npn}
1405 \cs_tmp:w {new_protected}{cx}{Npx}
1406 \cs_tmp:w {new_protected_nopar}{cn}{Npn}
1407 \cs_tmp:w {new_protected_nopar}{cx}{Npx}
1408 \cs_tmp:w {gnew}{cn}{Npn}
1409 \cs_tmp:w {gnew}{cx}{Npx}
1410 \cs_tmp:w {gnew_nopar}{cn}{Npn}
1411 \cs_tmp:w {gnew_nopar}{cx}{Npx}
1412 \cs_tmp:w {gnew_protected}{cn}{Npn}
1413 \cs_tmp:w {gnew_protected}{cx}{Npx}
1414 \cs_tmp:w {gnew_protected_nopar}{cn}{Npn}
1415 \cs_tmp:w {gnew_protected_nopar}{cx}{Npx}

```

\cs_if_eq_p:NN

\cs_if_eq_p:cN

\cs_if_eq_p:Nc

\cs_if_eq_p:cc

\cs_if_eq:NN \overline{TF}

\cs_if_eq:cN \overline{TF}

\cs_if_eq:Nc \overline{TF}

\cs_if_eq:cc \overline{TF}

Check if two control sequences are identical.

```

1416 \prg_set_conditional:Npnn \cs_if_eq:NN #1#2{p,TF,T,F}{
1417   \if_meaning:w #1#2
1418   \prg_return_true: \else: \prg_return_false: \fi:
1419 }
1420 \cs_new_nopar:Npn \cs_if_eq_p:cN {\exp_args:Nc \cs_if_eq_p:NN}
1421 \cs_new_nopar:Npn \cs_if_eq:cN $\overline{TF}$  {\exp_args:Nc \cs_if_eq:NN $\overline{TF}$ }
1422 \cs_new_nopar:Npn \cs_if_eq:cNT {\exp_args:Nc \cs_if_eq:NNT}
1423 \cs_new_nopar:Npn \cs_if_eq:cNF {\exp_args:Nc \cs_if_eq:NNF}
1424 \cs_new_nopar:Npn \cs_if_eq_p:Nc {\exp_args:NNc \cs_if_eq_p:NN}
1425 \cs_new_nopar:Npn \cs_if_eq:Nc $\overline{TF}$  {\exp_args:NNc \cs_if_eq:NN $\overline{TF}$ }
1426 \cs_new_nopar:Npn \cs_if_eq:NcT {\exp_args:NNc \cs_if_eq:NNT}
1427 \cs_new_nopar:Npn \cs_if_eq:NcF {\exp_args:NNc \cs_if_eq:NNF}
1428 \cs_new_nopar:Npn \cs_if_eq_p:cc {\exp_args:Ncc \cs_if_eq_p:NN}
1429 \cs_new_nopar:Npn \cs_if_eq:cc $\overline{TF}$  {\exp_args:Ncc \cs_if_eq:NN $\overline{TF}$ }
1430 \cs_new_nopar:Npn \cs_if_eq:ccT {\exp_args:Ncc \cs_if_eq:NNT}
1431 \cs_new_nopar:Npn \cs_if_eq:ccF {\exp_args:Ncc \cs_if_eq:NNF}

```

1432 \langle /initex | package \rangle

1433 \langle *showmemory \rangle

1434 \showMemUsage

1435 \langle /showmemory \rangle

96 l3expan implementation

96.1 Internal functions and variables

`\exp_after:wN` `\exp_after:wN <token1> <token2>`

This will expand `<token2>` once before processing `<token1>`. This is similar to `\exp_args:No` except that no braces are put around the result of expanding `<token2>`.

T_EXhackers note: This is the primitive `\expandafter` which was renamed to fit into the naming conventions of L^AT_EX3.

`\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 <register>`

These functions evaluates a register as part of a `V` or `v` expansion (respectively). A register might exist as one of two things: A parameter-less non-long, non-protected macro or a built-in T_EX register such as `\count`.

`\exp_eval_error_msg:w` `\exp_eval_error_msg:w <register>`

Used to generate an error message if a variable called as part of a `v` or `V` expansion is defined as `\scan_stop:.` This typically indicates that an incorrect cs name has been used.

`\n::`
`\N::`
`\c::`
`\o::`
`\f::`
`\x::`
`\v::`
`\V::`
`\::` `\cs_set_nopar:Npn \exp_args:Ncof { \::c\::o\::f\:: }`

Internal forms for the base expansion types.

96.2 Module code

We start by ensuring that the required packages are loaded.

```

1436 <*package>
1437 \ProvidesExplPackage
1438   {\filename}{\filedate}{\fileversion}{\filedescription}
1439 \package_check_loaded_expl:
1440 </package>
1441 <*initex | package>

```

`\exp_after:wN` These are defined in `l3basics`.

```

\exp_not:N
\exp_not:n
1442 <*bootstrap>
1443 \cs_set_eq:NwN \exp_after:wN \tex_expandafter:D
1444 \cs_set_eq:NwN \exp_not:N \tex_noexpand:D
1445 \cs_set_eq:NwN \exp_not:n \etex_unexpanded:D
1446 </bootstrap>

```

96.3 General expansion

In this section a general mechanism for defining functions to handle argument handling is defined. These general expansion functions are expandable unless `x` is used. (Any version of `x` is going to have to use one of the L^AT_EX3 names for `\cs_set_nopar:Npx` at some point, and so is never going to be expandable.¹⁰)

The definition of expansion functions with this technique happens in section 96.5. In section 96.4 some common cases are coded by a more direct method for efficiency, typically using calls to `\exp_after:wN`.

`\l_exp_tl` We need a scratch token list variable. We don't use `tl` methods so that `l3expan` can be loaded earlier.

```

1447 \cs_new_nopar:Npn \l_exp_tl {}

```

This code uses internal functions with names that start with `\::` to perform the expansions. All macros are **long** as this turned out to be desirable since the tokens undergoing expansion may be arbitrary user input.

An argument manipulator `\::<Z>` always has signature `#1\:::#2#3` where `#1` holds the remaining argument manipulations to be performed, `\:::` serves as an end marker for the list of manipulations, `#2` is the carried over result of the previous expansion steps and `#3` is the argument about to be processed.

`\exp_arg_next:nnn` `\exp_arg_next_nobrace:nnn` `#1` is the result of an expansion step, `#2` is the remaining argument manipulations and `#3` is the current result of the expansion chain. This auxilliary function moves `#1` back after `#3` in the input stream and checks if any expansion is left to be done by calling `#2`. In by far the most cases we will require to add a set of braces to the result of an argument manipulation so it is more effective to do it directly here. Actually, so far only the `c` of the final argument manipulation variants does not require a set of braces.

```

1448 \cs_new:Npn \exp_arg_next:nnn#1#2#3{

```

¹⁰However, some primitives have certain characteristics that means that their arguments undergo an `x` type expansion but the primitive is in fact still expandable. We shall make it very clear when such a function is expandable.

```

1449 #2\:::{#3{#1}}
1450 }
1451 \cs_new:Npn\exp_arg_next_nobrace:nnn#1#2#3{
1452 #2\:::{#3{#1}}
1453 }

```

\::: The end marker is just another name for the identity function.

```

1454 \cs_new:Npn\:::#1{#1}

```

\::n This function is used to skip an argument that doesn't need to be expanded.

```

1455 \cs_new:Npn\::n#1\:::#2#3{
1456 #1\:::{#2{#3}}
1457 }

```

\::N This function is used to skip an argument that consists of a single token and doesn't need to be expanded.

```

1458 \cs_new:Npn\::N#1\:::#2#3{
1459 #1\:::{#2#3}
1460 }

```

\::c This function is used to skip an argument that is turned into a control sequence without expansion.

```

1461 \cs_new:Npn\::c#1\:::#2#3{
1462 \exp_after:wN\exp_arg_next_nobrace:nnn\cs:w #3\cs_end:{#1}{#2}
1463 }

```

\::o This function is used to expand an argument once.

```

1464 \cs_new:Npn\::o#1\:::#2#3{
1465 \exp_after:wN\exp_arg_next:nnn\exp_after:wN{#3}{#1}{#2}
1466 }

```

\::f This function is used to expand a token list until the first unexpandable token is found.
\exp_stop_f: The underlying \tex_romannumeral:D -'0 expands everything in its way to find something terminating the number and thereby expands the function in front of it. This scanning procedure is terminated once the expansion hits something non-expandable or a space. We introduce \exp_stop_f: to mark such an end of expansion marker; in case the scanner hits a number, this number also terminates the scanning and is left untouched. In the example shown earlier the scanning was stopped once TeX had fully expanded \cs_set_eq:Nc \aaa {b \l_tmpa_tl b} into \cs_set_eq:NwN \aaa = \blurb which then turned out to contain the non-expandable token \cs_set_eq:NwN. Since the expansion of \tex_romannumeral:D -'0 is *null*, we wind up with a fully expanded list, only TeX has not tried to execute any of the non-expandable tokens. This is what differentiates this function from the x argument type.

```

1467 \cs_new:Npn\::f#1\:::#2#3{
1468 \exp_after:wN\exp_arg_next:nnn
1469 \exp_after:wN{\tex_romannumeral:D -'0 #3}
1470 {#1}{#2}
1471 }
1472 \cs_new_nopar:Npn \exp_stop_f: {~}

```

`\::x` This function is used to expand an argument fully. If the pdfTeX primitive `\expanded` is present, we use it.

```

1473 \cs_new_eq:NN \exp_arg:x \expanded % Move eventually.
1474 \cs_if_free:NTF\exp_arg:x{
1475   \cs_new:Npn\::x#1\:::#2#3{
1476     \cs_set_nopar:Npx \l_exp_tl1{{#3}}
1477     \exp_after:wN\exp_arg_next:nnn\l_exp_tl1{#1}{#2}}
1478   }
1479   {
1480     \cs_new:Npn\::x#1\:::#2#3{
1481       \exp_after:wN\exp_arg_next:nnn
1482       \exp_after:wN{\exp_arg:x{{#3}}}{#1}{#2}
1483     }
1484   }

```

`\::v` These functions return the value of a register, i.e., one of `tl`, `num`, `int`, `skip`, `dim` and `muskip`. The `V` version expects a single token whereas `v` like `c` creates a `csname` from its argument given in braces and then evaluates it as if it was a `V`. The sequence `\tex_romannumeral:D -'0` sets off an `f` type expansion. The argument is returned in braces.

```

1485 \cs_new:Npn \::V#1\:::#2#3{
1486   \exp_after:wN\exp_arg_next:nnn
1487   \exp_after:wN{
1488     \tex_romannumeral:D -'0
1489     \exp_eval_register:N #3
1490   }
1491   {#1}{#2}
1492 }
1493 \cs_new:Npn \::v#1\:::#2#3{
1494   \exp_after:wN\exp_arg_next:nnn
1495   \exp_after:wN{
1496     \tex_romannumeral:D -'0
1497     \exp_eval_register:c {#3}
1498   }
1499   {#1}{#2}
1500 }

```

`\exp_eval_register:N` This function evaluates a register. Now a register might exist as one of two things: A parameter-less macro or a built-in TeX register such as `\count`. For the TeX registers we have to utilize a `\tex_the:D` whereas for the macros we merely have to expand them once. The trick is to find out when to use `\tex_the:D` and when not to. What we do here is try to find out whether the token will expand to something else when hit with `\exp_after:wN`. The technique is to compare the meaning of the register in question when it has been prefixed with `\exp_not:N` and the register itself. If it is a macro, the prefixed `\exp_not:N` will temporarily turn it into the primitive `\tex_relax:D`.

```

1501 \cs_set_nopar:Npn \exp_eval_register:N #1{
1502   \exp_after:wN \if_meaning:w \exp_not:N #1#1

```

If the token was not a macro it may be a malformed variable from a `c` expansion in which case it is equal to the primitive `\tex_relax:D`. In that case we throw an error. We could let TeX do it for us but that would result in the rather obscure

! You can't use '\relax' after \the.

which while quite true doesn't give many hints as to what actually went wrong. We provide something more sensible.

```

1503     \if_meaning:w \tex_relax:D #1
1504     \exp_eval_error_msg:w
1505     \fi:

```

The next bit requires some explanation. The function must be initiated by the sequence `\tex_romannumeral:D -'0` and we want to terminate this expansion chain by inserting an `\exp_stop_f:` token. However, we have to expand the register `#1` before we do that. If it is a `TeX` register, we need to execute the sequence `\exp_after:wN\exp_stop_f:\tex_the:D #1` and if it is a macro we need to execute `\exp_after:wN\exp_stop_f: #1`. We therefore issue the longer of the two sequences and if the register is a macro, we remove the `\tex_the:D`.

```

1506     \else:
1507     \exp_after:wN \use_i_ii:nnn
1508     \fi:
1509     \exp_after:wN \exp_stop_f: \tex_the:D #1
1510   }
1511   \cs_set_nopar:Npn \exp_eval_register:c #1{
1512     \exp_after:wN\exp_eval_register:N\cs:w #1\cs_end:
1513   }

```

Clean up nicely, then call the undefined control sequence. The result is an error message looking like this:

```

! Undefined control sequence.
\exp_eval_error_msg:w ...erroneous variable used!

1.55 \tl_set:Nv \l_tmpa_tl {undefined_tl}

```

```

1514 \group_begin:%
1515 \tex_catcode:D'\!=11\tex_relax:D%
1516 \tex_catcode:D'\ =11\tex_relax:D%
1517 \cs_gset:Npn\exp_eval_error_msg:w#1\tex_the:D#2{%
1518 \fi:\fi:\erroneous variable used!}%
1519 \group_end:%

```

96.4 Hand-tuned definitions

One of the most important features of these functions is that they are fully expandable and therefore allow to prefix them with `\pref_global:D` for example. This together with the fact that the 'general' concept above is slower means that we should convert whenever possible and perhaps remove all remaining occurrences by hand-encoding in the end.

```

\exp_args:No
\exp_args:NNo
\exp_args:NNNo

```

```

1520 \cs_new:Npn \exp_args:No #1#2{\exp_after:wN#1\exp_after:wN{#2}}
1521 \cs_new:Npn \exp_args:NNo #1#2#3{\exp_after:wN#1\exp_after:wN#2
1522   \exp_after:wN{#3}}
1523 \cs_new:Npn \exp_args:NNNo #1#2#3#4{\exp_after:wN#1\exp_after:wN#2
1524   \exp_after:wN#3\exp_after:wN{#4}}

```

\exp_args:Nc Here are the functions that turn their argument into csnames but are expandable.

```

\exp_args:cc
\exp_args:NNc
\exp_args:Ncc
\exp_args:Nccc
1525 \cs_set:Npn \exp_args:Nc #1#2{\exp_after:wN#1\cs:w#2\cs_end:}
1526 \cs_new:Npn \exp_args:cc #1#2{\cs:w #1\exp_after:wN\cs_end:\cs:w #2\cs_end:}
1527 \cs_new:Npn \exp_args:NNc #1#2#3{\exp_after:wN#1\exp_after:wN#2
1528   \cs:w#3\cs_end:}
1529 \cs_new:Npn \exp_args:Ncc #1#2#3{\exp_after:wN#1
1530   \cs:w#2\exp_after:wN\cs_end:\cs:w#3\cs_end:}
1531 \cs_new:Npn \exp_args:Nccc #1#2#3#4{\exp_after:wN#1
1532   \cs:w#2\exp_after:wN\cs_end:\cs:w#3\exp_after:wN
1533   \cs_end:\cs:w #4\cs_end:}

```

\exp_args:Nco If we force that the third argument always has braces, we could implement this function with less tokens and only two arguments.

```

1534 \cs_new:Npn \exp_args:Nco #1#2#3{\exp_after:wN#1\cs:w#2\exp_after:wN
1535   \cs_end:\exp_after:wN{#3}}

```

96.5 Definitions with the ‘general’ technique

```

\exp_args:Nf
\exp_args:Nv
\exp_args:Nx
1536 \cs_set_nopar:Npn \exp_args:Nf {\::f\:::}
1537 \cs_set_nopar:Npn \exp_args:Nv {\::v\:::}
1538 \cs_set_nopar:Npn \exp_args:NV {\::V\:::}
1539 \cs_set_nopar:Npn \exp_args:Nx {\::x\:::}

```

\exp_args:NNV Here are the actual function definitions, using the helper functions above.

```

\exp_args:NNv
\exp_args:NNf
\exp_args:NNx
\exp_args:NNV
\exp_args:NNx
1540 \cs_set_nopar:Npn \exp_args:NNf {\::N\::f\:::}
1541 \cs_set_nopar:Npn \exp_args:NNv {\::N\::v\:::}
1542 \cs_set_nopar:Npn \exp_args:NNV {\::N\::V\:::}
1543 \cs_set_nopar:Npn \exp_args:NNx {\::N\::x\:::}
1544
\exp_args:Ncx
1545 \cs_set_nopar:Npn \exp_args:Ncx {\::c\::x\:::}
\exp_args:Nfo
1546 \cs_set_nopar:Npn \exp_args:Nfo {\::f\::o\:::}
\exp_args:Nff
1547 \cs_set_nopar:Npn \exp_args:Nff {\::f\::f\:::}
\exp_args:Ncf
1548 \cs_set_nopar:Npn \exp_args:Ncf {\::c\::f\:::}
\exp_args:Nnf
1549 \cs_set_nopar:Npn \exp_args:Nnf {\::n\::f\:::}
\exp_args:Nno
1550 \cs_set_nopar:Npn \exp_args:Nno {\::n\::o\:::}
\exp_args:NnV
1551 \cs_set_nopar:Npn \exp_args:NnV {\::n\::V\:::}
\exp_args:Nnx
1552 \cs_set_nopar:Npn \exp_args:Nnx {\::n\::x\:::}
1553
\exp_args:Noo
1554 \cs_set_nopar:Npn \exp_args:Noc {\::o\::c\:::}
\exp_args:Noc
1555 \cs_set_nopar:Npn \exp_args:Noo {\::o\::o\:::}
\exp_args:Nox
1556 \cs_set_nopar:Npn \exp_args:Nox {\::o\::x\:::}
\exp_args:Nxx

```



```

1557
1558 \cs_set_nopar:Npn \exp_args:NVV {\:V\:V\::V\:::}
1559
1560 \cs_set_nopar:Npn \exp_args:Nxo {\:x\:o\:::}
1561 \cs_set_nopar:Npn \exp_args:Nxx {\:x\:x\:::}

\exp_args:Ncco
\exp_args:Nccx
\exp_args:Ncnx
1562 \cs_set_nopar:Npn \exp_args:NNNV {\:N\:N\::V\:::}
1563
1564 \cs_set_nopar:Npn \exp_args:NNno {\:N\:n\::o\:::}
1565 \cs_set_nopar:Npn \exp_args:NNnx {\:N\:n\::x\:::}
1566 \cs_set_nopar:Npn \exp_args:NNoo {\:N\:o\::o\:::}
1567 \cs_set_nopar:Npn \exp_args:NNox {\:N\:o\::x\:::}
1568
1569 \cs_set_nopar:Npn \exp_args:Nnnc {\:n\:n\::c\:::}
1570 \cs_set_nopar:Npn \exp_args:Nnno {\:n\:n\::o\:::}
1571 \cs_set_nopar:Npn \exp_args:Nnnx {\:n\:n\::x\:::}
1572 \cs_set_nopar:Npn \exp_args:Nnox {\:n\:o\::x\:::}
1573
1574 \cs_set_nopar:Npn \exp_args:NcNc {\:c\:N\::c\:::}
1575 \cs_set_nopar:Npn \exp_args:NcNo {\:c\:N\::o\:::}
1576 \cs_set_nopar:Npn \exp_args:Ncco {\:c\:c\::o\:::}
1577 \cs_set_nopar:Npn \exp_args:Ncco {\:c\:c\::o\:::}
1578 \cs_set_nopar:Npn \exp_args:Nccx {\:c\:c\::x\:::}
1579 \cs_set_nopar:Npn \exp_args:Ncnx {\:c\:n\::x\:::}
1580
1581 \cs_set_nopar:Npn \exp_args:Noox {\:o\:o\::x\:::}
1582 \cs_set_nopar:Npn \exp_args:Nooo {\:o\:o\::o\:::}

```

96.6 Preventing expansion

```

\exp_not:o
\exp_not:d
\exp_not:f
1583 \cs_new:Npn\exp_not:o#1{\exp_not:n\exp_after:wN{#1}}
1584 \cs_new:Npn\exp_not:d#1{
1585   \exp_not:n\exp_after:wN\exp_after:wN\exp_after:wN{#1}
1586 }
1587 \cs_new:Npn\exp_not:f#1{
1588   \exp_not:n\exp_after:wN{\tex_romannumeral:D -'0 #1}
1589 }
1590 \cs_new:Npn\exp_not:v#1{
1591   \exp_not:n\exp_after:wN{\tex_romannumeral:D -'0 \exp_eval_register:c {#1}}
1592 }
1593 \cs_new:Npn\exp_not:V#1{
1594   \exp_not:n\exp_after:wN{\tex_romannumeral:D -'0 \exp_eval_register:N #1}
1595 }

```

`\exp_not:c` A helper function.

```

1596 \cs_new:Npn\exp_not:c#1{\exp_after:wN\exp_not:N\cs:w#1\cs_end:}

```

96.7 Defining function variants

`\cs_generate_variant:Nn`
`\cs_generate_variant_aux:nnNn`
`\cs_generate_variant_aux:nnw`
`\cs_generate_variant_aux:N`

#1 : Base form of a function; e.g., `\tl_set:Nn`

#2 : One or more variant argument specifiers; e.g., `{Nx,c,cx}`

Split up the original base function to grab its name and signature consisting of k letters. Then we wish to iterate through the list of variant argument specifiers, and for each one construct a new function name using the original base name, the variant signature consisting of l letters and the last $k - l$ letters of the base signature. For example, for a base function `\tl_set:Nn` which needs a `c` variant form, we want the new signature to be `cn`.

```
1597 \cs_new:Npn \cs_generate_variant:Nn #1 {
1598   \chk_if_exist_cs:N #1
1599   \cs_split_function:NN #1 \cs_generate_variant_aux:nnNn
1600 }
```

We discard the boolean and then set off a loop through the desired variant forms.

```
1601 \cs_set:Npn \cs_generate_variant_aux:nnNn #1#2#3#4{
1602   \cs_generate_variant_aux:nnw {#1}{#2} #4,?,\q_recursion_stop
1603 }
```

Next is the real work to be done. We now have 1: base name, 2: base signature, 3: beginning of variant signature. To construct the new csname and the `\exp_args:Ncc` form, we need the variant signature. In our example, we wanted to discard the first two letters of the base signature because the variant form started with `cc`. This is the same as putting first `cc` in the signature and then `\use_none:nn` followed by the base signature `NNn`. We therefore call a small loop that outputs an `n` for each letter in the variant signature and use this to call the correct `\use_none:` variant. Firstly though, we check whether to terminate the loop.

```
1604 \cs_set:Npn \cs_generate_variant_aux:nnw #1 #2 #3, {
1605   \if:w ? #3
1606     \exp_after:wN \use_none_delimit_by_q_recursion_stop:w
1607   \fi:
```

Then check if the variant form has already been defined.

```
1608 \cs_if_free:cTF {
1609   #1:#3\use:c {use_none:\cs_generate_variant_aux:N #3 ?}#2
1610 }
1611 {
```

If not, then define it and then additionally check if the `\exp_args:N` form needed is defined.

```
1612   \cs_new_nopar:cpx {
1613     #1:#3 \use:c{use_none:\cs_generate_variant_aux:N #3 ?}#2
1614   }
1615   {
1616     \exp_not:c { \exp_args:N #3 } \exp_not:c {#1:#2}
1617   }
1618   \cs_generate_internal_variant:n {#3}
1619 }
```

Otherwise tell that it was already defined.

```

1620 {
1621   \iow_log:x{
1622     Variant~\token_to_str:c {
1623       #1:#3\use:c {use_none:\cs_generate_variant_aux:N #3 ?}#2
1624     }~already~defined;~ not~ changing~ it~on~line~
1625     \tex_the:D \tex_inputlineno:D
1626   }
1627 }

```

Recurse.

```

1628   \cs_generate_variant_aux:nnw{#1}{#2}
1629 }

```

The small loop for defining the required number of ns. Break when seeing a ?.

```

1630 \cs_set:Npn \cs_generate_variant_aux:N #1{
1631   \if:w ?#1 \exp_after:wN\use_none:nn \fi: n \cs_generate_variant_aux:N
1632 }

```

`\cs_generate_internal_variant:n` Test if `\exp_args:N #1` is already defined and if not define it via the `\::` commands using the chars in `#1`

```

1633 \cs_new:Npn \cs_generate_internal_variant:n #1 {
1634   \cs_if_free:cT { \exp_args:N #1 }{

```

We use `new` to log the definition if we have to make one.

```

1635     \cs_new:cpx { \exp_args:N #1 }
1636     { \cs_generate_internal_variant_aux:n #1 : }
1637   }
1638 }

```

`\cs_generate_internal_variant_aux:n` This command grabs char by char outputting `\::#1` (not expanded further) until we see a `::`. That colon is in fact also turned into `\:::` so that the required structure for `\exp_args...` commands is correctly terminated.

```

1639 \cs_new:Npn \cs_generate_internal_variant_aux:n #1 {
1640   \exp_not:c{::#1}
1641   \if_meaning:w #1 :
1642     \exp_after:wN \use_none:n
1643   \fi:
1644   \cs_generate_internal_variant_aux:n
1645 }

```

96.8 Last-unbraced versions

`\exp_arg_last_unbraced:nn` There are a few places where the last argument needs to be available unbraced. First some helper macros.

```

\::f_unbraced
\::o_unbraced
\::V_unbraced
\::v_unbraced
1646 \cs_new:Npn \exp_arg_last_unbraced:nn #1#2 { #2#1 }
1647 \cs_new:Npn \::f_unbraced \:::#1#2 {

```

```

1648 \exp_after:wN \exp_arg_last_unbraced:nn
1649 \exp_after:wN { \tex_romannumeral:D -'0 #2 } {#1}
1650 }
1651 \cs_new:Npn \::o_unbraced \:::#1#2 {
1652 \exp_after:wN \exp_arg_last_unbraced:nn \exp_after:wN {#2 }{#1}
1653 }
1654 \cs_new:Npn \::V_unbraced \:::#1#2 {
1655 \exp_after:wN \exp_arg_last_unbraced:nn
1656 \exp_after:wN { \tex_romannumeral:D -'0 \exp_eval_register:N #2 } {#1}
1657 }
1658 \cs_new:Npn \::v_unbraced \:::#1#2 {
1659 \exp_after:wN \exp_arg_last_unbraced:nn
1660 \exp_after:wN {
1661 \tex_romannumeral:D -'0 \exp_eval_register:c {#2}
1662 } {#1}
1663 }

```

```

\exp_last_unbraced:NV Now the business end.
\exp_last_unbraced:Nv
\exp_last_unbraced:Nf 1664 \cs_new_nopar:Npn \exp_last_unbraced:Nf { \::f_unbraced \::: }
\exp_last_unbraced:NcV 1665 \cs_new_nopar:Npn \exp_last_unbraced:Nv { \::V_unbraced \::: }
\exp_last_unbraced:NNNo 1666 \cs_new_nopar:Npn \exp_last_unbraced:Nv { \::v_unbraced \::: }
\exp_last_unbraced:NNV 1667 \cs_new_nopar:Npn \exp_last_unbraced:NcV {
\exp_last_unbraced:NNNo 1668 \::c \::V_unbraced \:::
1669 }
1670 \cs_new:Npn \exp_last_unbraced:NNNo #1#2#3 {
1671 \exp_after:wN #1 \exp_after:wN #2 #3
1672 }
1673 \cs_new_nopar:Npn \exp_last_unbraced:NNV {
1674 \::N \::V_unbraced \:::
1675 }
1676 \cs_new:Npn \exp_last_unbraced:NNNo #1#2#3#4 {
1677 \exp_after:wN #1 \exp_after:wN #2 \exp_after:wN #3 #4
1678 }
1679 </initex | package>

```

Show token usage:

```

1680 <*showmemory>
1681 \showMemUsage
1682 </showmemory>

```

97 l3prg implementation

97.1 Variables

\l_tmpa_bool	Reserved booleans.
\g_tmpa_bool	

\g_prg_inline_level_int	Global variable to track the nesting of the stepwise inline loop.
-------------------------	---

97.2 Module code

We start by ensuring that the required packages are loaded.

```

1683 <*package>
1684 \ProvidesExplPackage
1685   {\filename}{\filedate}{\fileversion}{\filedescription}
1686 \package_check_loaded_expl:
1687 </package>
1688 <*initex | package>

```

\prg_return_true: These are all defined in l3basics, as they are needed “early”. This is just a reminder that
 \prg_return_false: that is the case!

```

\prg_set_conditional:Npnn
\prg_new_conditional:Npnn
\prg_protected_conditional:Npnn
\prg_new_protected_conditional:Npnn
\prg_set_conditional:Npnn
\prg_new_conditional:Npnn
\prg_protected_conditional:Nnn
\prg_new_protected_conditional:Nnn
\prg_set_eq_conditional:NNn
\prg_new_eq_conditional:NNn

```

97.3 Choosing modes

For testing vertical mode. Strikes me here on the bus with David, that as long as we are just talking about returning true and false states, we can just use the primitive conditionals for this and gobbling the \c_zero in the input stream. However this requires knowledge of the implementation so we keep things nice and clean and use the return statements.

```

1689 \prg_set_conditional:Npnn \mode_if_vertical: {p,TF,T,F}{
1690   \if_mode_vertical:
1691   \prg_return_true: \else: \prg_return_false: \fi:
1692 }

```

\mode_if_horizontal_p: For testing horizontal mode.

```

\mode_if_horizontal:TF
1693 \prg_set_conditional:Npnn \mode_if_horizontal: {p,TF,T,F}{
1694   \if_mode_horizontal:
1695   \prg_return_true: \else: \prg_return_false: \fi:
1696 }

```

\mode_if_inner_p: For testing inner mode.

```

\mode_if_inner:TF
1697 \prg_set_conditional:Npnn \mode_if_inner: {p,TF,T,F}{
1698   \if_mode_inner:
1699   \prg_return_true: \else: \prg_return_false: \fi:
1700 }

```

\mode_if_math_p: For testing math mode. Uses the kern-save \scan_align_safe_stop:.

```

\mode_if_math:TF
1701 \prg_set_conditional:Npnn \mode_if_math: {p,TF,T,F}{
1702   \scan_align_safe_stop: \if_mode_math:
1703   \prg_return_true: \else: \prg_return_false: \fi:
1704 }

```

Alignment safe grouping and scanning

`\group_align_safe_begin:` T_EX’s alignment structures present many problems. As Knuth says himself in *T_EX: The Program*: “It’s sort of a miracle whenever `\halign` or `\valign` work, [...]” One problem relates to commands that internally issues a `\cr` but also peek ahead for the next character for use in, say, an optional argument. If the next token happens to be a `&` with category code 4 we will get some sort of weird error message because the underlying `\tex_futurelet:D` will store the token at the end of the alignment template. This could be a `&_4` giving a message like `! Misplaced \cr.` or even worse: it could be the `\endtemplate` token causing even more trouble! To solve this we have to open a special group so that T_EX still thinks it’s on safe ground but at the same time we don’t want to introduce any brace group that may find its way to the output. The following functions help with this by using code documented only in Appendix D of *The T_EXbook*...

```
1705 \cs_new_nopar:Npn \group_align_safe_begin: {
1706   \if_false:{\fi:\if_num:w'=\c_zero\fi:}
1707 \cs_new_nopar:Npn \group_align_safe_end:   {\if_num:w'=\c_zero}\fi:}
```

`\scan_align_safe_stop:` When T_EX is in the beginning of an align cell (right after the `\cr`) it is in a somewhat strange mode as it is looking ahead to find an `\tex_omit:D` or `\tex_noalign:D` and hasn’t looked at the preamble yet. Thus an `\tex_ifmmode:D` test will always fail unless we insert `\scan_stop:` to stop T_EX’s scanning ahead. On the other hand we don’t want to insert a `\scan_stop:` every time as that will destroy kerning between letters¹¹ Unfortunately there is no way to detect if we’re in the beginning of an alignment cell as they have different characteristics depending on column number etc. However we *can* detect if we’re in an alignment cell by checking the current group type and we can also check if the previous node was a character or ligature. What is done here is that `\scan_stop:` is only inserted iff a) we’re in the outer part of an alignment cell and b) the last node *wasn’t* a char node or a ligature node.

```
1708 \cs_new_nopar:Npn \scan_align_safe_stop: {
1709   \intexpr_compare:nNnT \etex_currentgrouptype:D = \c_six
1710   {
1711     \intexpr_compare:nNnF \etex_lastnodetype:D = \c_zero
1712     {
1713       \intexpr_compare:nNnF \etex_lastnodetype:D = \c_seven
1714       \scan_stop:
1715     }
1716   }
1717 }
```

97.4 Producing *n* copies

`\prg_replicate:nn` This function uses a cascading csname technique by David Kastrup (who else :-)

`\prg_replicate_aux:N` The idea is to make the input 25 result in first adding five, and then 20 copies of the

`\prg_replicate_first_aux:N` code to be replicated. The technique uses cascading csnames which means that we start building several csnames so we end up with a list of functions to be called in reverse order. This is important here (and other places) because it means that we can for

¹¹Unless we enforce an extra pass with an appropriate value of `\pretolerance`.

instance make the function that inserts five copies of something to also hand down ten to the next function in line. This is exactly what happens here: in the example with 25 then the next function is the one that inserts two copies but it sees the ten copies handed down by the previous function. In order to avoid the last function to insert say, 100 copies of the original argument just to gobble them again we define separate functions to be inserted first. Finally we must ensure that the cascade comes to a peaceful end so we make it so that the original csnames `TeX` is creating is simply `\prg_do_nothing:` expanding to nothing.

This function has one flaw though: Since it constantly passes down ten copies of its previous argument it will severely affect the main memory once you start demanding hundreds of thousands of copies. Now I don't think this is a real limitation for any ordinary use. An alternative approach is to create a string of `m`'s with `\int_to_roman:w` which can be done with just four macros but that method has its own problems since it can exhaust the string pool. Also, it is considerably slower than what we use here so the few extra csnames are well spent I would say.

```

1718 \cs_new_nopar:Npn \prg_replicate:nn #1{
1719   \cs:w prg_do_nothing:
1720   \exp_after:wN\prg_replicate_first_aux:N
1721   \tex_romannumeral:D -'\q \intexpr_eval:n{#1} \cs_end:
1722   \cs_end:
1723 }
1724 \cs_new_nopar:Npn \prg_replicate_aux:N#1{
1725   \cs:w prg_replicate_#1:n\prg_replicate_aux:N
1726 }
1727 \cs_new_nopar:Npn \prg_replicate_first_aux:N#1{
1728   \cs:w prg_replicate_first_#1:n\prg_replicate_aux:N
1729 }

```

Then comes all the functions that do the hard work of inserting all the copies.

```

1730 \cs_new_nopar:Npn \prg_replicate_ :n #1{}% no, this is not a typo!
1731 \cs_new:cpn {prg_replicate_0:n}#1{\cs_end:{#1#1#1#1#1#1#1#1#1#1}}
1732 \cs_new:cpn {prg_replicate_1:n}#1{\cs_end:{#1#1#1#1#1#1#1#1#1#1}#1}
1733 \cs_new:cpn {prg_replicate_2:n}#1{\cs_end:{#1#1#1#1#1#1#1#1#1#1}#1#1}
1734 \cs_new:cpn {prg_replicate_3:n}#1{
1735   \cs_end:{#1#1#1#1#1#1#1#1#1#1}#1#1#1}
1736 \cs_new:cpn {prg_replicate_4:n}#1{
1737   \cs_end:{#1#1#1#1#1#1#1#1#1#1}#1#1#1#1}
1738 \cs_new:cpn {prg_replicate_5:n}#1{
1739   \cs_end:{#1#1#1#1#1#1#1#1#1#1}#1#1#1#1#1}
1740 \cs_new:cpn {prg_replicate_6:n}#1{
1741   \cs_end:{#1#1#1#1#1#1#1#1#1#1}#1#1#1#1#1#1}
1742 \cs_new:cpn {prg_replicate_7:n}#1{
1743   \cs_end:{#1#1#1#1#1#1#1#1#1#1}#1#1#1#1#1#1#1}
1744 \cs_new:cpn {prg_replicate_8:n}#1{
1745   \cs_end:{#1#1#1#1#1#1#1#1#1#1}#1#1#1#1#1#1#1#1}
1746 \cs_new:cpn {prg_replicate_9:n}#1{
1747   \cs_end:{#1#1#1#1#1#1#1#1#1#1}#1#1#1#1#1#1#1#1#1}

```

Users shouldn't ask for something to be replicated once or even not at all but...

```

1748 \cs_new:cpn {prg_replicate_first_0:n}#1{\cs_end: }

```

```

1749 \cs_new:cpn {prg_replicate_first_1:n}#1{\cs_end: #1}
1750 \cs_new:cpn {prg_replicate_first_2:n}#1{\cs_end: #1#1}
1751 \cs_new:cpn {prg_replicate_first_3:n}#1{\cs_end: #1#1#1}
1752 \cs_new:cpn {prg_replicate_first_4:n}#1{\cs_end: #1#1#1#1}
1753 \cs_new:cpn {prg_replicate_first_5:n}#1{\cs_end: #1#1#1#1#1}
1754 \cs_new:cpn {prg_replicate_first_6:n}#1{\cs_end: #1#1#1#1#1#1}
1755 \cs_new:cpn {prg_replicate_first_7:n}#1{\cs_end: #1#1#1#1#1#1#1}
1756 \cs_new:cpn {prg_replicate_first_8:n}#1{\cs_end: #1#1#1#1#1#1#1#1}
1757 \cs_new:cpn {prg_replicate_first_9:n}#1{\cs_end: #1#1#1#1#1#1#1#1#1}

```

\prg_stepwise_function:nnnN
g_stepwise_function_incr:nnnN
g_stepwise_function_decr:nnnN

A stepwise function. Firstly we check the direction of the steps #2 since that will depend on which test we should use. If the step is positive we use a greater than test, otherwise a less than test. If the test comes out true exit, otherwise perform #4, add the step to #1 and try again with this new value of #1.

```

1758 \cs_new:Npn \prg_stepwise_function:nnnN #1#2{
1759   \intexpr_compare:nNnTF{#2}<\c_zero
1760   {\exp_args:Nf\prg_stepwise_function_decr:nnnN }
1761   {\exp_args:Nf\prg_stepwise_function_incr:nnnN }
1762   {\intexpr_eval:n{#1}}{#2}
1763 }
1764 \cs_new:Npn \prg_stepwise_function_incr:nnnN #1#2#3#4{
1765   \intexpr_compare:nNnF {#1}>{#3}
1766   {
1767     #4{#1}
1768     \exp_args:Nf \prg_stepwise_function_incr:nnnN
1769     {\intexpr_eval:n{#1 + #2}}
1770     {#2}{#3}{#4}
1771   }
1772 }
1773 \cs_new:Npn \prg_stepwise_function_decr:nnnN #1#2#3#4{
1774   \intexpr_compare:nNnF {#1}<{#3}
1775   {
1776     #4{#1}
1777     \exp_args:Nf \prg_stepwise_function_decr:nnnN
1778     {\intexpr_eval:n{#1 + #2}}
1779     {#2}{#3}{#4}
1780   }
1781 }

```

\g_prg_inline_level_int
\prg_stepwise_inline:nnnn
prg_stepwise_inline_decr:nnnn
prg_stepwise_inline_incr:nnnn

This function uses the same approach as for instance \clist_map_inline:Nn to allow arbitrary nesting. First construct the special function and then call an auxiliary one which just carries the newly constructed csname. Must make assignments global when we maintain our own stack.

```

1782 \int_new:N\g_prg_inline_level_int
1783 \cs_new:Npn\prg_stepwise_inline:nnnn #1#2#3#4{
1784   \int_gincr:N \g_prg_inline_level_int
1785   \cs_gset_nopar:cpn{prg_stepwise_inline_\int_use:N\g_prg_inline_level_int :n}##1{#4}
1786   \intexpr_compare:nNnTF {#2}<\c_zero
1787   {\exp_args:Ncf \prg_stepwise_inline_decr:Nnnn }
1788   {\exp_args:Ncf \prg_stepwise_inline_incr:Nnnn }
1789   {prg_stepwise_inline_\int_use:N\g_prg_inline_level_int :n}

```



```

1790 {\intexpr_eval:n{#1}} {#2} {#3}
1791 \int_gdecr:N \g_prg_inline_level_int
1792 }
1793 \cs_new:Npn \prg_stepwise_inline_incr:Nnnn #1#2#3#4{
1794 \intexpr_compare:nNnF {#2}>{#4}
1795 {
1796   #1{#2}
1797   \exp_args:Nnf \prg_stepwise_inline_incr:Nnnn #1
1798   {\intexpr_eval:n{#2 + #3}} {#3}{#4}
1799 }
1800 }
1801 \cs_new:Npn \prg_stepwise_inline_decr:Nnnn #1#2#3#4{
1802 \intexpr_compare:nNnF {#2}<{#4}
1803 {
1804   #1{#2}
1805   \exp_args:Nnf \prg_stepwise_inline_decr:Nnnn #1
1806   {\intexpr_eval:n{#2 + #3}} {#3}{#4}
1807 }
1808 }

```

\prg_stepwise_variable:nnnNn
_stepwise_variable_decr:nnnNn
_stepwise_variable_incr:nnnNn

Almost the same as above. Just store the value in #4 and execute #5.

```

1809 \cs_new:Npn \prg_stepwise_variable:nnnNn #1#2 {
1810 \intexpr_compare:nNnTF {#2}<\c_zero
1811 {\exp_args:Nf\prg_stepwise_variable_decr:nnnNn}
1812 {\exp_args:Nf\prg_stepwise_variable_incr:nnnNn}
1813 {\intexpr_eval:n{#1}}{#2}
1814 }
1815 \cs_new:Npn \prg_stepwise_variable_incr:nnnNn #1#2#3#4#5 {
1816 \intexpr_compare:nNnF {#1}>{#3}
1817 {
1818   \cs_set_nopar:Npn #4{#1} #5
1819   \exp_args:Nf \prg_stepwise_variable_incr:nnnNn
1820   {\intexpr_eval:n{#1 + #2}}{#2}{#3}#4{#5}
1821 }
1822 }
1823 \cs_new:Npn \prg_stepwise_variable_decr:nnnNn #1#2#3#4#5 {
1824 \intexpr_compare:nNnF {#1}<{#3}
1825 {
1826   \cs_set_nopar:Npn #4{#1} #5
1827   \exp_args:Nf \prg_stepwise_variable_decr:nnnNn
1828   {\intexpr_eval:n{#1 + #2}}{#2}{#3}#4{#5}
1829 }
1830 }

```

97.5 Booleans

For normal booleans we set them to either `\c_true_bool` or `\c_false_bool` and then use `\if_bool:N` to choose the right branch. The functions return either the TF, T, or F case *after* ending the `\if_bool:N`. We only define the N versions here as the c versions can easily be constructed with the expansion module.

```

\bool_new:N Defining and setting a boolean is easy.
\bool_new:c
\bool_set_true:N
\bool_set_true:c
\bool_set_false:N
\bool_set_false:c
\bool_gset_true:N
\bool_gset_true:c
\bool_gset_false:N
\bool_gset_false:c
1831 \cs_new_nopar:Npn \bool_new:N #1 { \cs_new_eq:NN #1 \c_false_bool }
1832 \cs_new_nopar:Npn \bool_new:c #1 { \cs_new_eq:cN {#1} \c_false_bool }
1833 \cs_new_nopar:Npn \bool_set_true:N #1 { \cs_set_eq:NN #1 \c_true_bool }
1834 \cs_new_nopar:Npn \bool_set_true:c #1 { \cs_set_eq:cN {#1} \c_true_bool }
1835 \cs_new_nopar:Npn \bool_set_false:N #1 { \cs_set_eq:NN #1 \c_false_bool }
1836 \cs_new_nopar:Npn \bool_set_false:c #1 { \cs_set_eq:cN {#1} \c_false_bool }
1837 \cs_new_nopar:Npn \bool_gset_true:N #1 { \cs_gset_eq:NN #1 \c_true_bool }
1838 \cs_new_nopar:Npn \bool_gset_true:c #1 { \cs_gset_eq:cN {#1} \c_true_bool }
1839 \cs_new_nopar:Npn \bool_gset_false:N #1 { \cs_gset_eq:NN #1 \c_false_bool }
1840 \cs_new_nopar:Npn \bool_gset_false:c #1 { \cs_gset_eq:cN {#1} \c_false_bool }

```

```

\bool_set_eq:NN Setting a boolean to another is also pretty easy.
\bool_set_eq:Nc
\bool_set_eq:cN
\bool_set_eq:cc
\bool_gset_eq:NN
\bool_gset_eq:Nc
\bool_gset_eq:cN
\bool_gset_eq:cc
1841 \cs_new_eq:NN \bool_set_eq:NN \cs_set_eq:NN
1842 \cs_new_eq:NN \bool_set_eq:Nc \cs_set_eq:Nc
1843 \cs_new_eq:NN \bool_set_eq:cN \cs_set_eq:cN
1844 \cs_new_eq:NN \bool_set_eq:cc \cs_set_eq:cc
1845 \cs_new_eq:NN \bool_gset_eq:NN \cs_gset_eq:NN
1846 \cs_new_eq:NN \bool_gset_eq:Nc \cs_gset_eq:Nc
1847 \cs_new_eq:NN \bool_gset_eq:cN \cs_gset_eq:cN
1848 \cs_new_eq:NN \bool_gset_eq:cc \cs_gset_eq:cc

```

```

\l_tmpa_bool A few booleans just if you need them.
\g_tmpa_bool
1849 \bool_new:N \l_tmpa_bool
1850 \bool_new:N \g_tmpa_bool

```

```

\bool_if_p:N Straight forward here. We could optimize here if we wanted to as the boolean can just
\bool_if_p:c be input directly.
\bool_if:NTF
\bool_if:cTF
1851 \prg_set_conditional:Npnn \bool_if:N #1 {p,TF,T,F}{
1852   \if_bool:N #1 \prg_return_true: \else: \prg_return_false: \fi:
1853 }
1854 \cs_generate_variant:Nn \bool_if_p:N {c}
1855 \cs_generate_variant:Nn \bool_if:N {NTF}
1856 \cs_generate_variant:Nn \bool_if:NT {c}
1857 \cs_generate_variant:Nn \bool_if:NF {c}

```

```

\bool_while_do:Nn A while loop where the boolean is tested before executing the statement. The ‘while’
\bool_while_do:cn version executes the code as long as the boolean is true; the ‘until’ version executes the
\bool_until_do:Nn code as long as the boolean is false.
\bool_until_do:cn
1858 \cs_new:Npn \bool_while_do:Nn #1 #2 {
1859   \bool_if:NT #1 {#2 \bool_while_do:Nn #1 {#2}}
1860 }
1861 \cs_generate_variant:Nn \bool_while_do:Nn {c}

1862 \cs_new:Npn \bool_until_do:Nn #1 #2 {
1863   \bool_if:NF #1 {#2 \bool_until_do:Nn #1 {#2}}
1864 }
1865 \cs_generate_variant:Nn \bool_until_do:Nn {c}

```

<pre> \bool_do_while:Nn \bool_do_while:cn \bool_do_until:Nn \bool_do_until:cn </pre>	<p>A do-while loop where the body is performed at least once and the boolean is tested after executing the body. Otherwise identical to the above functions.</p> <pre> 1866 \cs_new:Npn \bool_do_while:Nn #1 #2 { 1867 #2 \bool_if:NT #1 {\bool_do_while:Nn #1 {#2}} 1868 } 1869 \cs_generate_variant:Nn \bool_do_while:Nn {c} 1870 \cs_new:Npn \bool_do_until:Nn #1 #2 { 1871 #2 \bool_if:NF #1 {\bool_do_until:Nn #1 {#2}} 1872 } 1873 \cs_generate_variant:Nn \bool_do_until:Nn {c} </pre>
--	---

97.6 Parsing boolean expressions

<pre> \bool_if_p:n \bool_if:nTF \bool_get_next:N \bool_cleanup:N \bool_choose:NN \bool_!:w \bool_(:w \bool_p:w \bool_8_1:w \bool_I_1:w \bool_8_0:w \bool_I_0:w \bool_)_0:w \bool_)_1:w \bool_S_0:w \bool_S_1:w </pre>	<p>Evaluating the truth value of a list of predicates is done using an input syntax somewhat similar to the one found in other programming languages with (and) for grouping, ! for logical ‘Not’, && for logical ‘And’ and || for logical Or. We shall use the terms Not, And, Or, Open and Close for these operations.</p> <p>Any expression is terminated by a Close operation. Evaluation happens from left to right in the following manner using a GetNext function:</p> <ul style="list-style-type: none"> • If an Open is seen, start evaluating a new expression using the Eval function and call GetNext again. • If a Not is seen, insert a negating function (if-even in this case) and call GetNext. • If none of the above, start evaluating a new expression by reinserting the token found (this is supposed to be a predicate function) in front of Eval.
--	---

The Eval function then contains a post-processing operation which grabs the instruction following the predicate. This is either And, Or or Close. In each case the truth value is used to determine where to go next. The following situations can arise:

<true>And Current truth value is true, logical And seen, continue with GetNext to examine truth value of next boolean (sub-)expression.

<false>And Current truth value is false, logical And seen, stop evaluating the predicates within this sub-expression and break to the nearest Close. Then return *<false>*.

<true>Or Current truth value is true, logical Or seen, stop evaluating the predicates within this sub-expression and break to the nearest Close. Then return *<true>*.

<false>Or Current truth value is false, logical Or seen, continue with GetNext to examine truth value of next boolean (sub-)expression.

<true>Close Current truth value is true, Close seen, return *<true>*.

<false>Close Current truth value is false, Close seen, return *<false>*.

We introduce an additional Stop operation with the following semantics:

$\langle true \rangle$ Stop Current truth value is true, return $\langle true \rangle$.

$\langle false \rangle$ Stop Current truth value is false, return $\langle false \rangle$.

The reasons for this follow below.

Now for how these works in practice. The canonical true and false values have numerical values 1 and 0 respectively. We evaluate this using the primitive `\tex_number:D` operation. First we issue a `\group_align_safe_begin:` as we are using `&&` as syntax shorthand for the And operation and we need to hide it for \TeX . We also need to finish this special group before finally returning a `\c_true_bool` or `\c_false_bool` as there might otherwise be something left in front in the input stream. For this we call the Stop operation, denoted simply by a `S` following the last Close operation.

```
1874 \cs_set:Npn \bool_if_p:n #1{
1875   \group_align_safe_begin:
1876   \bool_get_next:N ( #1 )S
1877 }
```

The GetNext operation. We make it a switch: If not a `!` or `(`, we assume it is a predicate.

```
1878 \cs_set:Npn \bool_get_next:N #1{
1879   \use:c {
1880     bool_
1881     \if_meaning:w !#1 ! \else: \if_meaning:w (#1 ( \else: p \fi: \fi:
1882     :w
1883   } #1
1884 }
```

The Not operation. Discard the token read and reverse the truth value of the next expression using `\intexpr_if_even_p:n`.

```
1885 \cs_set:cpn {bool_!:w}#1{
1886   \exp_after:wN \intexpr_if_even_p:n \tex_number:D \bool_get_next:N
1887 }
```

The Open operation. Discard the token read and start a sub-expression.

```
1888 \cs_set:cpn {bool_( :w}#1{
1889   \exp_after:wN \bool_cleanup:N \tex_number:D \bool_get_next:N
1890 }
```

Otherwise just evaluate the predicate and look for And, Or or Close afterward.

```
1891 \cs_set:cpn {bool_p:w}{\exp_after:wN \bool_cleanup:N \tex_number:D }
```

This cleanup function can be omitted once predicates return their true/false booleans outside the conditionals.

```
1892 \cs_new_nopar:Npn \bool_cleanup:N #1{
1893   \exp_after:wN \bool_choose:NN \exp_after:wN #1
1894   \int_to_roman:w-'\q
1895 }
```

Branching the six way switch.

```
1896 \cs_new_nopar:Npn \bool_choose:NN #1#2{ \use:c{bool_#2_#1:w} }
```

Continues scanning. Must remove the second & or |.

```
1897 \cs_new_nopar:cpn{bool_&_1:w}&{\bool_get_next:N}
1898 \cs_new_nopar:cpn{bool_|_0:w}|{\bool_get_next:N}
```

Closing a group is just about returning the result. The Stop operation is similar except it closes the special alignment group before returning the boolean.

```
1899 \cs_new_nopar:cpn{bool_}_0:w}{ \c_false_bool }
1900 \cs_new_nopar:cpn{bool_}_1:w}{ \c_true_bool }
1901 \cs_new_nopar:cpn{bool_S_0:w}{\group_align_safe_end: \c_false_bool }
1902 \cs_new_nopar:cpn{bool_S_1:w}{\group_align_safe_end: \c_true_bool }
```

When the truth value has already been decided, we have to throw away the remainder of the current group as we are doing minimal evaluation. This is slightly tricky as there are no braces so we have to play match the () manually.

```
1903 \cs_set:cpn{bool_&_0:w}&{\bool_eval_skip_to_end:Nw \c_false_bool}
1904 \cs_set:cpn{bool_|_1:w}|{\bool_eval_skip_to_end:Nw \c_true_bool}
```

```
\bool_eval_skip_to_end:Nw
\bool_eval_skip_to_end_aux:Nw
\bool_eval_skip_to_end_auxii:Nw
```

There is always at least one) waiting, namely the outer one. However, we are facing the problem that there may be more than one that need to be finished off and we have to detect the correct number of them. Here is a complicated example showing how this is done. After evaluating the following, we realize we must skip everything after the first And. Note the extra Close at the end.

```
\c_false_bool && ((abc) && xyz) && ((xyz) && (def)))
```

First read up to the first Close. This gives us the list we first read up until the first right parenthesis so we are looking at the token list

```
((abc
```

This contains two Open markers so we must remove two groups. Since no evaluation of the contents is to be carried out, it doesn't matter how we remove the groups as long as we wind up with the correct result. We therefore first remove a () pair and what preceded the Open – but leave the contents as it may contain Open tokens itself – leaving

```
(abc && xyz) && ((xyz) && (def)))
```

Another round of this gives us

```
(abc && xyz
```

which still contains an Open so we remove another () pair, giving us

```
abc && xyz && ((xyz) && (def)))
```

Again we read up to a Close and again find Open tokens:

```
abc && xyz && ((xyz
```

Further reduction gives us

```
(xyz && (def))
```

and then

```
(xyz && (def
```

with reduction to

```
xyz && (def))
```

and ultimately we arrive at no Open tokens being skipped and we can finally close the group nicely.

This whole operation could be made a lot simpler if we were allowed to do simple pattern matching. With a new enough pdfTeX one can do that sort of thing to test for existence of particular tokens.

```
1905 \cs_set:Npn \bool_eval_skip_to_end:Nw #1#2){
1906   \bool_eval_skip_to_end_aux:Nw #1 #2(\q_no_value\q_nil{#2}
1907 }
```

If no right parenthesis, then #3 is no_value and we are done, return the boolean #1. If there is, we need to grab a () pair and then recurse

```
1908 \cs_set:Npn \bool_eval_skip_to_end_aux:Nw #1#2(#3#4\q_nil#5{
1909   \quark_if_no_value:NTF #3
1910   { #1 }
1911   { \bool_eval_skip_to_end_auxii:Nw #1 #5 }
1912 }
```

keep the boolean, throw away anything up to the (as it is irrelevant, remove a () pair but remember to reinsert #3 as it may contain (tokens!

```
1913 \cs_set:Npn \bool_eval_skip_to_end_auxii:Nw #1#2(#3){
1914   \bool_eval_skip_to_end:Nw #1#3 )
1915 }
```

`\bool_set:Nn` This function evaluates a boolean expression and assigns the first argument the meaning
`\bool_set:cn` `\c_true_bool` or `\c_false_bool`.

```
\bool_gset:Nn
\bool_gset:cn
1916 \cs_new:Npn \bool_set:Nn #1#2 {\tex_chardef:D #1 = \bool_if_p:n {#2}}
1917 \cs_new:Npn \bool_gset:Nn #1#2 {
1918   \tex_global:D \tex_chardef:D #1 = \bool_if_p:n {#2}
1919 }
1920 \cs_generate_variant:Nn \bool_set:Nn {c}
1921 \cs_generate_variant:Nn \bool_gset:Nn {c}
```

`\bool_not_p:n` The not variant just reverses the outcome of `\bool_if_p:n`. Can be optimized but this is nice and simple and according to the implementation plan. Not even particularly useful to have it when the infix notation is easier to use.

```
1922 \cs_new:Npn \bool_not_p:n #1{ \bool_if_p:n{!(#1)} }
```

`\bool_xor_p:nn` Exclusive or. If the boolean expressions have same truth value, return false, otherwise return true.

```

1923 \cs_new:Npn \bool_xor_p:nn #1#2 {
1924   \intexpr_compare:nNnTF {\bool_if_p:n { #1 }} = {\bool_if_p:n { #2 }}
1925   {\c_false_bool}{\c_true_bool}
1926 }

1927 \prg_set_conditional:Npnn \bool_if:n #1 {TF,T,F}{
1928   \if_predicate:w \bool_if_p:n{#1}
1929   \prg_return_true: \else: \prg_return_false: \fi:
1930 }
```

`\bool_while_do:nn` #1 : Predicate test

`\bool_until_do:nn` #2 : Code to execute

`\bool_do_while:nn`

`\bool_do_until:nn`

```

1931 \cs_new:Npn \bool_while_do:nn #1#2 {
1932   \bool_if:nT {#1} { #2 \bool_while_do:nn {#1}{#2} }
1933 }
1934 \cs_new:Npn \bool_until_do:nn #1#2 {
1935   \bool_if:nF {#1} { #2 \bool_until_do:nn {#1}{#2} }
1936 }
1937 \cs_new:Npn \bool_do_while:nn #1#2 {
1938   #2 \bool_if:nT {#1} { \bool_do_while:nn {#1}{#2} }
1939 }
1940 \cs_new:Npn \bool_do_until:nn #1#2 {
1941   #2 \bool_if:nF {#1} { \bool_do_until:nn {#1}{#2} }
1942 }
```

97.7 Case switch

`\prg_case_int:nnn` This case switch is in reality quite simple. It takes three arguments:

`\prg_case_int_aux:nnn`

1. An integer expression you wish to find.
2. A list of pairs of $\{\langle integer\ expr \rangle\} \{\langle code \rangle\}$. The list can be as long as is desired and $\langle integer\ expr \rangle$ can be negative.
3. The code to be executed if the value wasn't found.

We don't need the else case here yet, so leave it dangling in the input stream.

```

1943 \cs_new:Npn \prg_case_int:nnn #1 #2 {
```

We will be parsing on #1 for each step so we might as well evaluate it first in case it is complicated.

```

1944   \exp_args:Nf \prg_case_int_aux:nnn { \intexpr_eval:n{#1}} #2
```

The ? below is just so there are enough arguments when we reach the end. And it made you look. ;-))

```

1945   \q_recursion_tail ? \q_recursion_stop
1946 }
1947 \cs_new:Npn \prg_case_int_aux:nnn #1#2#3{
```

If we reach the end, return the else case. We just remove braces.

```
1948 \quark_if_recursion_tail_stop_do:nn{#2}{\use:n}
```

Otherwise we compare (which evaluates #2 for us)

```
1949 \intexpr_compare:nNnTF{#1}={#2}
```

If true, we want to remove the remainder of the list, the else case and then execute the code specified. `\prg_end_case:nw {#3}` does just that in one go. This means `f` style expansion works the way one wants it to work.

```
1950 { \prg_end_case:nw {#3} }
1951 { \prg_case_int_aux:nnn {#1}}
1952 }
```

`\prg_case_dim:nnn` Same as `\prg_case_dim:nnn` except it is for $\langle dim \rangle$ registers.
`\prg_case_dim_aux:nnn`

```
1953 \cs_new:Npn \prg_case_dim:nnn #1 #2 {
1954   \exp_args:No \prg_case_dim_aux:nnn {\dim_use:N \dim_eval:n{#1}} #2
1955   \q_recursion_tail ? \q_recursion_stop
1956 }
1957 \cs_new:Npn \prg_case_dim_aux:nnn #1#2#3{
1958   \quark_if_recursion_tail_stop_do:nn{#2}{\use:n}
1959   \dim_compare:nNnTF{#1}={#2}
1960   { \prg_end_case:nw {#3} }
1961   { \prg_case_dim_aux:nnn {#1}}
1962 }
```

`\prg_case_str:nnn` Same as `\prg_case_dim:nnn` except it is for strings.
`\prg_case_str_aux:nnn`

```
1963 \cs_new:Npn \prg_case_str:nnn #1 #2 {
1964   \prg_case_str_aux:nnn {#1} #2
1965   \q_recursion_tail ? \q_recursion_stop
1966 }
1967 \cs_new:Npn \prg_case_str_aux:nnn #1#2#3{
1968   \quark_if_recursion_tail_stop_do:nn{#2}{\use:n}
1969   \tl_if_eq:xxTF{#1}{#2}
1970   { \prg_end_case:nw {#3} }
1971   { \prg_case_str_aux:nnn {#1}}
1972 }
```

`\prg_case_tl:Nnn` Same as `\prg_case_dim:nnn` except it is for token list variables.
`\prg_case_tl_aux:NNn`

```
1973 \cs_new:Npn \prg_case_tl:Nnn #1 #2 {
1974   \prg_case_tl_aux:NNn #1 #2
1975   \q_recursion_tail ? \q_recursion_stop
1976 }
1977 \cs_new:Npn \prg_case_tl_aux:NNn #1#2#3{
1978   \quark_if_recursion_tail_stop_do:Nn #2{\use:n}
1979   \tl_if_eq:NNTF #1 #2
1980   { \prg_end_case:nw {#3} }
1981   { \prg_case_tl_aux:NNn #1}
1982 }
```


`\prg_end_case:nw` Ending a case switch is always performed the same way so we optimize for this. #1 is the code to execute, #2 the remainder, and #3 the dangling else case.

```
1983 \cs_new:Npn \prg_end_case:nw #1#2\q_recursion_stop#3{#1}
```

97.8 Sorting

`\prg_define_quicksort:nnn` #1 is the name, #2 and #3 are the tokens enclosing the argument. For the somewhat strange *<clist>* type which doesn't enclose the items but uses a separator we define it by hand afterwards. When doing the first pass, the algorithm wraps all elements in braces and then uses a generic quicksort which works on token lists.

As an example

```
\prg_define_quicksort:nnn{seq}{\seq_elt:w}{\seq_elt_end:w}
```

defines the user function `\seq_quicksort:n` and furthermore expects to use the two functions `\seq_quicksort_compare:nnTF` which compares the items and `\seq_quicksort_function:n` which is placed before each sorted item. It is up to the programmer to define these functions when needed. For the `seq` type a sequence is a token list variable, so one additionally has to define

```
\cs_set_nopar:Npn \seq_quicksort:N{\exp_args:No\seq_quicksort:n}
```

For details on the implementation see “Sorting in TeX’s Mouth” by Bernd Raichle. Firstly we define the function for parsing the initial list and then the braced list afterwards.

```
1984 \cs_new_nopar:Npn \prg_define_quicksort:nnn #1#2#3 {
1985   \cs_set:cpx{#1_quicksort:n}##1{
1986     \exp_not:c{#1_quicksort_start_partition:w} ##1
1987     \exp_not:n{#2\q_nil#3\q_stop}
1988   }
1989   \cs_set:cpx{#1_quicksort_braced:n}##1{
1990     \exp_not:c{#1_quicksort_start_partition_braced:n} ##1
1991     \exp_not:N\q_nil\exp_not:N\q_stop
1992   }
1993   \cs_set:cpx {#1_quicksort_start_partition:w} #2 ##1 #3{
1994     \exp_not:N \quark_if_nil:nT {##1}\exp_not:N \use_none_delimit_by_q_stop:w
1995     \exp_not:c{#1_quicksort_do_partition_i:nnnw} {##1}{\{}}
1996   }
1997   \cs_set:cpx {#1_quicksort_start_partition_braced:n} ##1 {
1998     \exp_not:N \quark_if_nil:nT {##1}\exp_not:N \use_none_delimit_by_q_stop:w
1999     \exp_not:c{#1_quicksort_do_partition_i_braced:nnnw} {##1}{\{}}
2000   }
```

Now for doing the partitions.

```
2001 \cs_set:cpx {#1_quicksort_do_partition_i:nnnw} ##1##2##3 #2 ##4 #3 {
2002   \exp_not:N \quark_if_nil:nTF {##4} \exp_not:c {#1_do_quicksort_braced:nnnw}
2003   {
2004     \exp_not:c{#1_quicksort_compare:nnTF}{##1}{##4}
2005     \exp_not:c{#1_quicksort_partition_greater_ii:nnnw}
```

```

2006     \exp_not:c{#1_quicksort_partition_less_ii:nnnn}
2007   }
2008   {##1}{##2}{##3}{##4}
2009 }
2010 \cs_set:cpx {#1_quicksort_do_partition_i_braced:nnnn} ##1##2##3##4 {
2011   \exp_not:N \quark_if_nil:nTF {##4} \exp_not:c {#1_do_quicksort_braced:nnnnw}
2012   {
2013     \exp_not:c{#1_quicksort_compare:nnTF}{##1}{##4}
2014     \exp_not:c{#1_quicksort_partition_greater_ii_braced:nnnn}
2015     \exp_not:c{#1_quicksort_partition_less_ii_braced:nnnn}
2016   }
2017   {##1}{##2}{##3}{##4}
2018 }
2019 \cs_set:cpx {#1_quicksort_do_partition_ii:nnnw} ##1##2##3 #2 ##4 #3 {
2020   \exp_not:N \quark_if_nil:nTF {##4} \exp_not:c {#1_do_quicksort_braced:nnnnw}
2021   {
2022     \exp_not:c{#1_quicksort_compare:nnTF}{##4}{##1}
2023     \exp_not:c{#1_quicksort_partition_less_i:nnnn}
2024     \exp_not:c{#1_quicksort_partition_greater_i:nnnn}
2025   }
2026   {##1}{##2}{##3}{##4}
2027 }
2028 \cs_set:cpx {#1_quicksort_do_partition_ii_braced:nnnn} ##1##2##3##4 {
2029   \exp_not:N \quark_if_nil:nTF {##4} \exp_not:c {#1_do_quicksort_braced:nnnnw}
2030   {
2031     \exp_not:c{#1_quicksort_compare:nnTF}{##4}{##1}
2032     \exp_not:c{#1_quicksort_partition_less_i_braced:nnnn}
2033     \exp_not:c{#1_quicksort_partition_greater_i_braced:nnnn}
2034   }
2035   {##1}{##2}{##3}{##4}
2036 }

```

This part of the code handles the two branches in each sorting. Again we will also have to do it braced.

```

2037 \cs_set:cpx {#1_quicksort_partition_less_i:nnnn} ##1##2##3##4{
2038   \exp_not:c{#1_quicksort_do_partition_i:nnnw}{##1}{##2}{##4}{##3}}
2039 \cs_set:cpx {#1_quicksort_partition_less_ii:nnnn} ##1##2##3##4{
2040   \exp_not:c{#1_quicksort_do_partition_ii:nnnw}{##1}{##2}{##3}{##4}}
2041 \cs_set:cpx {#1_quicksort_partition_greater_i:nnnn} ##1##2##3##4{
2042   \exp_not:c{#1_quicksort_do_partition_i:nnnw}{##1}{##4}{##2}{##3}}
2043 \cs_set:cpx {#1_quicksort_partition_greater_ii:nnnn} ##1##2##3##4{
2044   \exp_not:c{#1_quicksort_do_partition_ii:nnnw}{##1}{##2}{##4}{##3}}
2045 \cs_set:cpx {#1_quicksort_partition_less_i_braced:nnnn} ##1##2##3##4{
2046   \exp_not:c{#1_quicksort_do_partition_i_braced:nnnn}{##1}{##2}{##4}{##3}}
2047 \cs_set:cpx {#1_quicksort_partition_less_ii_braced:nnnn} ##1##2##3##4{
2048   \exp_not:c{#1_quicksort_do_partition_ii_braced:nnnn}{##1}{##2}{##3}{##4}}
2049 \cs_set:cpx {#1_quicksort_partition_greater_i_braced:nnnn} ##1##2##3##4{
2050   \exp_not:c{#1_quicksort_do_partition_i_braced:nnnn}{##1}{##4}{##2}{##3}}
2051 \cs_set:cpx {#1_quicksort_partition_greater_ii_braced:nnnn} ##1##2##3##4{
2052   \exp_not:c{#1_quicksort_do_partition_ii_braced:nnnn}{##1}{##2}{##4}{##3}}

```

Finally, the big kahuna! This is where the sub-lists are sorted.

```

2053 \cs_set:cpx {#1_do_quicksort_braced:nnnnw} ##1##2##3##4\q_stop {

```

```

2054 \exp_not:c{#1_quicksort_braced:n}{##2}
2055 \exp_not:c{#1_quicksort_function:n}{##1}
2056 \exp_not:c{#1_quicksort_braced:n}{##3}
2057 }
2058 }

```

`\prg_quicksort:n` A simple version. Sorts a list of tokens, uses the function `\prg_quicksort_compare:nnTF` to compare items, and places the function `\prg_quicksort_function:n` in front of each of them.

```

2059 \prg_define_quicksort:nnn {prg}{-}{-}

```

`\prg_quicksort_function:n`
`\prg_quicksort_compare:nnTF`

```

2060 \cs_set:Npn \prg_quicksort_function:n {\ERROR}
2061 \cs_set:Npn \prg_quicksort_compare:nnTF {\ERROR}

```

That's it (for now).

```

2062 </initex | package>
2063 <*showmemory>
2064 \showMemUsage
2065 </showmemory>

```

98 l3quark implementation

We start by ensuring that the required packages are loaded. We check for `l3expan` since this a basic package that is essential for use of any higher-level package.

```

2066 <*package>
2067 \ProvidesExplPackage
2068 { \filename } { \filedate } { \fileversion } { \filedescription }
2069 \package_check_loaded_expl:
2070 </package>
2071 <*initex | package>

```

`\quark_new:N` Allocate a new quark.

```

2072 \cs_new_nopar:Npn \quark_new:N #1{\tl_new:Nn #1{#1}}

```

`\q_stop` `\q_stop` is often used as a marker in parameter text, `\q_no_value` is the canonical missing value, and `\q_nil` represents a nil pointer in some data structures.

`\q_nil`

```

2073 \quark_new:N \q_stop
2074 \quark_new:N \q_no_value
2075 \quark_new:N \q_nil

```

`\q_error` We need two additional quarks. `\q_error` delimits the end of the computation for purposes of error recovery. `\q_mark` is used in parameter text when we need a scanning boundary that is distinct from `\q_stop`.

`\q_mark`

```

2076 \quark_new:N\q_error
2077 \quark_new:N\q_mark

```

`\q_recursion_tail` Quarks for ending recursions. Only ever used there! `\q_recursion_tail` is appended to whatever list structure we are doing recursion on, meaning it is added as a proper list item with whatever list separator is in use. `\q_recursion_stop` is placed directly after the list.

```
2078 \quark_new:N\q_recursion_tail
2079 \quark_new:N\q_recursion_stop
```

`\quark_if_recursion_tail_stop:n` When doing recursions it is easy to spend a lot of time testing if we found the end marker.
`\quark_if_recursion_tail_stop:N` To avoid this, we use a recursion end marker every time we do this kind of task. Also, if
`\quark_if_recursion_tail_stop:o` the recursion end marker is found, we wrap things up and finish.

```
2080 \cs_new:Npn \quark_if_recursion_tail_stop:n #1 {
2081   \exp_after:wN\if_meaning:w
2082     \quark_if_recursion_tail_aux:w #1?\q_nil\q_recursion_tail\q_recursion_tail
2083     \exp_after:wN \use_none_delimit_by_q_recursion_stop:w
2084   \fi:
2085 }
2086 \cs_new:Npn \quark_if_recursion_tail_stop:N #1 {
2087   \if_meaning:w#1\q_recursion_tail
2088     \exp_after:wN \use_none_delimit_by_q_recursion_stop:w
2089   \fi:
2090 }
2091 \cs_generate_variant:Nn \quark_if_recursion_tail_stop:n {o}
```

`\quark_if_recursion_tail_stop_do:nn`
`\quark_if_recursion_tail_stop_do:Nn`
`\quark_if_recursion_tail_stop_do:on`

```
2092 \cs_new:Npn \quark_if_recursion_tail_stop_do:nn #1#2 {
2093   \exp_after:wN\if_meaning:w
2094     \quark_if_recursion_tail_aux:w #1?\q_nil\q_recursion_tail\q_recursion_tail
2095     \exp_after:wN \use_i_delimit_by_q_recursion_stop:nw
2096   \else:
2097     \exp_after:wN\use_none:n
2098   \fi:
2099   {#2}
2100 }
2101 \cs_new:Npn \quark_if_recursion_tail_stop_do:Nn #1#2 {
2102   \if_meaning:w #1\q_recursion_tail
2103     \exp_after:wN \use_i_delimit_by_q_recursion_stop:nw
2104   \else:
2105     \exp_after:wN\use_none:n
2106   \fi:
2107   {#2}
2108 }
2109 \cs_generate_variant:Nn \quark_if_recursion_tail_stop_do:nn {on}
```

`\quark_if_recursion_tail_aux:w`

```
2110 \cs_new:Npn \quark_if_recursion_tail_aux:w #1#2 \q_nil \q_recursion_tail {#1}
```

`\quark_if_no_value_p:N` Here we test if we found a special quark as the first argument. We better start with
`\quark_if_no_value_p:n` `\q_no_value` as the first argument since the whole thing may otherwise loop if #1 is
`\quark_if_no_value:NTF` wrongly given a string like aabc instead of a single token.¹²
`\quark_if_no_value:nTF`

¹²It may still loop in special circumstances however!

```

2111 \prg_new_conditional:Nnn \quark_if_no_value:N {p,TF,T,F} {
2112   \if_meaning:w \q_no_value #1
2113   \prg_return_true: \else: \prg_return_false: \fi:
2114 }

```

We also provide an `n` type. If run under a sufficiently new pdf ϵ -TeX, it uses a built-in primitive for string comparisons, otherwise it uses the slower `\str_if_eq_var_p:nf` function. In the latter case it would be faster to use a temporary token list variable but it would render the function non-expandable. Using the pdf ϵ -TeX primitive is the preferred approach. Note that we have to add a manual space token in the first part of the comparison, otherwise it is gobbled by `\str_if_eq_var_p:nf`. The reason for using this function instead of `\str_if_eq_p:nn` is that a sequence like `\q_no_value` will test equal to `\q_no_value` using the latter test function and unfortunately this example turned up in one application.

```

2115 \cs_if_exist:cTF {pdf_strcmp:D}
2116 {
2117   \prg_new_conditional:Nnn \quark_if_no_value:n {p,TF,T,F} {
2118     \if_num:w \pdf_strcmp:D
2119     {\exp_not:N \q_no_value}
2120     {\exp_not:n{#1}} = \c_zero
2121     \prg_return_true: \else: \prg_return_false:
2122     \fi:
2123   }
2124 }
2125 {
2126   \prg_new_conditional:Nnn \quark_if_no_value:n {p,TF,T,F} {
2127     \exp_args:NNo
2128     \if_predicate:w \str_if_eq_var_p:nf
2129     {\token_to_str:N\q_no_value\iow_space:}
2130     {\tl_to_str:n{#1}}
2131     \prg_return_true: \else: \prg_return_false:
2132     \fi:
2133   }
2134 }

```

`\quark_if_nil_p:N` A function to check for the presence of `\q_nil`.

`\quark_if_nil:N \underline{TF}`

```

2135 \prg_new_conditional:Nnn \quark_if_nil:N {p,TF,T,F} {
2136   \if_meaning:w \q_nil #1 \prg_return_true: \else: \prg_return_false: \fi:
2137 }

```

`\quark_if_nil_p:n` A function to check for the presence of `\q_nil`.

`\quark_if_nil_p:V`

`\quark_if_nil_p:o`

`\quark_if_nil:n \underline{TF}`

`\quark_if_nil:V \underline{TF}`

`\quark_if_nil:o \underline{TF}`

```

2138 \cs_if_exist:cTF {pdf_strcmp:D} {
2139   \prg_new_conditional:Nnn \quark_if_nil:n {p,TF,T,F} {
2140     \if_num:w \pdf_strcmp:D
2141     {\exp_not:N \q_nil}
2142     {\exp_not:n{#1}} = \c_zero
2143     \prg_return_true: \else: \prg_return_false:
2144     \fi:
2145   }
2146 }

```

```

2147 {
2148 \prg_new_conditional:Nnn \quark_if_nil:n {p,TF,T,F} {
2149   \exp_args:NNo
2150   \if_predicate:w \str_if_eq_var_p:nf
2151     {\token_to_str:N\q_nil\iow_space:}
2152     {\tl_to_str:n{#1}}
2153   \prg_return_true: \else: \prg_return_false:
2154   \fi:
2155 }
2156 }
2157 \cs_generate_variant:Nn \quark_if_nil_p:n {V}
2158 \cs_generate_variant:Nn \quark_if_nil:nTF {V}
2159 \cs_generate_variant:Nn \quark_if_nil:nT {V}
2160 \cs_generate_variant:Nn \quark_if_nil:nF {V}
2161 \cs_generate_variant:Nn \quark_if_nil_p:n {o}
2162 \cs_generate_variant:Nn \quark_if_nil:nTF {o}
2163 \cs_generate_variant:Nn \quark_if_nil:nT {o}
2164 \cs_generate_variant:Nn \quark_if_nil:nF {o}

```

Show token usage:

```

2165
2166 <*showmemory>
2167 \showMemUsage
2168 </showmemory>

```

99 l3token implementation

99.1 Documentation of internal functions

```

\l_peek_true_tl
\l_peek_false_tl

```

These token list variables are used internally when choosing either the true or false branches of a test.

```

\l_peek_search_tl

```

Used to store `\l_peek_search_token`.

```

\peek_tmp:w

```

Scratch function used to gobble tokens from the input stream.

```

\l_peek_true_aux_tl
\c_peek_true_remove_next_tl

```

These token list variables are used internally when choosing either the true or false branches of a test.

```

\peek_ignore_spaces_execute_branches:
\peek_ignore_spaces_aux:

```

Functions used to ignore space tokens in the input stream.

99.2 Module code

First a few required packages to get this going.

```

2169 \*package>
2170 \ProvidesExplPackage
2171   {\filename}{\filedate}{\fileversion}{\filedescription}
2172 \package_check_loaded_expl:
2173 \</package>
2174 \*initex | package>

```

99.3 Character tokens

```

\char_set_catcode:w
\char_set_catcode:nn
\char_value_catcode:w
\char_value_catcode:n
\char_show_value_catcode:w
\char_show_value_catcode:n
2175 \cs_new_eq:NN \char_set_catcode:w \tex_catcode:D
2176 \cs_new_nopar:Npn \char_set_catcode:nn #1#2 {
2177   \char_set_catcode:w #1 = \intexpr_eval:w #2\intexpr_eval_end:
2178 }
2179 \cs_new_nopar:Npn \char_value_catcode:w { \int_use:N \tex_catcode:D }
2180 \cs_new_nopar:Npn \char_value_catcode:n #1 {
2181   \char_value_catcode:w \intexpr_eval:w #1\intexpr_eval_end:
2182 }
2183 \cs_new_nopar:Npn \char_show_value_catcode:w {
2184   \tex_showthe:D \tex_catcode:D
2185 }
2186 \cs_new_nopar:Npn \char_show_value_catcode:n #1 {
2187   \char_show_value_catcode:w \intexpr_eval:w #1\intexpr_eval_end:
2188 }

\char_make_escape:N
\char_make_begin_group:N
\char_make_end_group:N
\char_make_math_shift:N
\char_make_alignment:N
\char_make_end_line:N
\char_make_parameter:N
\char_make_math_superscript:N
\char_make_math_subscript:N
\char_make_ignore:N
\char_make_space:N
\char_make_letter:N
\char_make_other:N
\char_make_active:N
\char_make_comment:N
\char_make_invalid:N
2189 \cs_new_nopar:Npn \char_make_escape:N #1 { \char_set_catcode:nn {'#1} {\c_zero}
2190 \cs_new_nopar:Npn \char_make_begin_group:N #1 { \char_set_catcode:nn {'#1} {\c_one}
2191 \cs_new_nopar:Npn \char_make_end_group:N #1 { \char_set_catcode:nn {'#1} {\c_two}
2192 \cs_new_nopar:Npn \char_make_math_shift:N #1 { \char_set_catcode:nn {'#1} {\c_three}
2193 \cs_new_nopar:Npn \char_make_alignment:N #1 { \char_set_catcode:nn {'#1} {\c_four}
2194 \cs_new_nopar:Npn \char_make_end_line:N #1 { \char_set_catcode:nn {'#1} {\c_five}
2195 \cs_new_nopar:Npn \char_make_parameter:N #1 { \char_set_catcode:nn {'#1} {\c_six}
2196 \cs_new_nopar:Npn \char_make_math_superscript:N #1 { \char_set_catcode:nn {'#1} {\c_seven}
2197 \cs_new_nopar:Npn \char_make_math_subscript:N #1 { \char_set_catcode:nn {'#1} {\c_eight}
2198 \cs_new_nopar:Npn \char_make_ignore:N #1 { \char_set_catcode:nn {'#1} {\c_nine}
2199 \cs_new_nopar:Npn \char_make_space:N #1 { \char_set_catcode:nn {'#1} {\c_ten}
2200 \cs_new_nopar:Npn \char_make_letter:N #1 { \char_set_catcode:nn {'#1} {\c_eleven}
2201 \cs_new_nopar:Npn \char_make_other:N #1 { \char_set_catcode:nn {'#1} {\c_twelve}
2202 \cs_new_nopar:Npn \char_make_active:N #1 { \char_set_catcode:nn {'#1} {\c_thirteen}
2203 \cs_new_nopar:Npn \char_make_comment:N #1 { \char_set_catcode:nn {'#1} {\c_fourteen}
2204 \cs_new_nopar:Npn \char_make_invalid:N #1 { \char_set_catcode:nn {'#1} {\c_fifteen}

\char_make_escape:n
\char_make_begin_group:n
\char_make_end_group:n
\char_make_math_shift:n
\char_make_alignment:n
\char_make_end_line:n
\char_make_parameter:n
\char_make_math_superscript:n
\char_make_math_subscript:n
\char_make_ignore:n
\char_make_space:n
\char_make_letter:n
\char_make_other:n
2205 \cs_new_nopar:Npn \char_make_escape:n #1 { \char_set_catcode:nn {#1} {\c_zero} }
2206 \cs_new_nopar:Npn \char_make_begin_group:n #1 { \char_set_catcode:nn {#1} {\c_one} }

```

```

2207 \cs_new_nopar:Npn \char_make_end_group:n      #1 { \char_set_catcode:nn {#1} {\c_two} }
2208 \cs_new_nopar:Npn \char_make_math_shift:n     #1 { \char_set_catcode:nn {#1} {\c_three} }
2209 \cs_new_nopar:Npn \char_make_alignment:n      #1 { \char_set_catcode:nn {#1} {\c_four} }
2210 \cs_new_nopar:Npn \char_make_end_line:n       #1 { \char_set_catcode:nn {#1} {\c_five} }
2211 \cs_new_nopar:Npn \char_make_parameter:n     #1 { \char_set_catcode:nn {#1} {\c_six} }
2212 \cs_new_nopar:Npn \char_make_math_superscript:n #1 { \char_set_catcode:nn {#1} {\c_seven} }
2213 \cs_new_nopar:Npn \char_make_math_subscript:n #1 { \char_set_catcode:nn {#1} {\c_eight} }
2214 \cs_new_nopar:Npn \char_make_ignore:n        #1 { \char_set_catcode:nn {#1} {\c_nine} }
2215 \cs_new_nopar:Npn \char_make_space:n         #1 { \char_set_catcode:nn {#1} {\c_ten} }
2216 \cs_new_nopar:Npn \char_make_letter:n       #1 { \char_set_catcode:nn {#1} {\c_eleven} }
2217 \cs_new_nopar:Npn \char_make_other:n        #1 { \char_set_catcode:nn {#1} {\c_twelve} }
2218 \cs_new_nopar:Npn \char_make_active:n        #1 { \char_set_catcode:nn {#1} {\c_thirteen} }
2219 \cs_new_nopar:Npn \char_make_comment:n      #1 { \char_set_catcode:nn {#1} {\c_fourteen} }
2220 \cs_new_nopar:Npn \char_make_invalid:n      #1 { \char_set_catcode:nn {#1} {\c_fifteen} }

```

\char_set_mathcode:w Math codes.

```

\char_set_mathcode:nn
\char_gset_mathcode:w
\char_gset_mathcode:nn
\char_value_mathcode:w
\char_value_mathcode:n
\char_show_value_mathcode:w
\char_show_value_mathcode:n
2221 \cs_new_eq:NN \char_set_mathcode:w \tex_mathcode:D
2222 \cs_new_nopar:Npn \char_set_mathcode:nn #1#2 {
2223   \char_set_mathcode:w #1 = \intexpr_eval:w #2\intexpr_eval_end:
2224 }
2225 \cs_new_protected_nopar:Npn \char_gset_mathcode:w { \pref_global:D \tex_mathcode:D }
2226 \cs_new_nopar:Npn \char_gset_mathcode:nn #1#2 {
2227   \char_gset_mathcode:w #1 = \intexpr_eval:w #2\intexpr_eval_end:
2228 }
2229 \cs_new_nopar:Npn \char_value_mathcode:w { \int_use:N \tex_mathcode:D }
2230 \cs_new_nopar:Npn \char_value_mathcode:n #1 {
2231   \char_value_mathcode:w \intexpr_eval:w #1\intexpr_eval_end:
2232 }
2233 \cs_new_nopar:Npn \char_show_value_mathcode:w { \tex_showthe:D \tex_mathcode:D }
2234 \cs_new_nopar:Npn \char_show_value_mathcode:n #1 {
2235   \char_show_value_mathcode:w \intexpr_eval:w #1\intexpr_eval_end:
2236 }

```

```

\char_set_lccode:w
\char_set_lccode:nn
\char_value_lccode:w
\char_value_lccode:n
\char_show_value_lccode:w
\char_show_value_lccode:n
2237 \cs_new_eq:NN \char_set_lccode:w \tex_lccode:D
2238 \cs_new_nopar:Npn \char_set_lccode:nn #1#2{
2239   \char_set_lccode:w #1 = \intexpr_eval:w #2\intexpr_eval_end:
2240 }
2241 \cs_new_nopar:Npn \char_value_lccode:w {\int_use:N\tex_lccode:D}
2242 \cs_new_nopar:Npn \char_value_lccode:n #1{\char_value_lccode:w
2243   \intexpr_eval:w #1\intexpr_eval_end:}
2244 \cs_new_nopar:Npn \char_show_value_lccode:w {\tex_showthe:D\tex_lccode:D}
2245 \cs_new_nopar:Npn \char_show_value_lccode:n #1{
2246   \char_show_value_lccode:w \intexpr_eval:w #1\intexpr_eval_end:}

```

```

\char_set_uccode:w
\char_set_uccode:nn
\char_value_uccode:w
\char_value_uccode:n
\char_show_value_uccode:w
\char_show_value_uccode:n
2247 \cs_new_eq:NN \char_set_uccode:w \tex_uccode:D
2248 \cs_new_nopar:Npn \char_set_uccode:nn #1#2{
2249   \char_set_uccode:w #1 = \intexpr_eval:w #2\intexpr_eval_end:
2250 }
2251 \cs_new_nopar:Npn \char_value_uccode:w {\int_use:N\tex_uccode:D}

```



```

2252 \cs_new_nopar:Npn \char_value_uccode:n #1{\char_value_uccode:w
2253   \intexpr_eval:w #1\intexpr_eval_end:}
2254 \cs_new_nopar:Npn \char_show_value_uccode:w {\tex_showthe:D\tex_uccode:D}
2255 \cs_new_nopar:Npn \char_show_value_uccode:n #1{
2256   \char_show_value_uccode:w \intexpr_eval:w #1\intexpr_eval_end:}

```

```

\char_set_sfcode:w
\char_set_sfcode:nn
\char_value_sfcode:w
\char_value_sfcode:n
\char_show_value_sfcode:w
\char_show_value_sfcode:n
2257 \cs_new_eq:NN \char_set_sfcode:w \tex_sfcode:D
2258 \cs_new_nopar:Npn \char_set_sfcode:nn #1#2 {
2259   \char_set_sfcode:w #1 = \intexpr_eval:w #2\intexpr_eval_end:
2260 }
2261 \cs_new_nopar:Npn \char_value_sfcode:w { \int_use:N \tex_sfcode:D }
2262 \cs_new_nopar:Npn \char_value_sfcode:n #1 {
2263   \char_value_sfcode:w \intexpr_eval:w #1\intexpr_eval_end:
2264 }
2265 \cs_new_nopar:Npn \char_show_value_sfcode:w { \tex_showthe:D \tex_sfcode:D }
2266 \cs_new_nopar:Npn \char_show_value_sfcode:n #1 {
2267   \char_show_value_sfcode:w \intexpr_eval:w #1\intexpr_eval_end:
2268 }

```

99.4 Generic tokens

`\token_new:Nn` Creates a new token. (Will: why can't this just be `\cs_new_eq:NN \token_new:Nn \cs_gnew_eq:NN`? Seriously, that doesn't work!)

```

2269 \cs_new_nopar:Npn \token_new:Nn #1#2 {\cs_gnew_eq:NN #1#2}

```

`\c_group_begin_token` `\c_group_end_token` `\c_math_shift_token` `\c_alignment_tab_token` `\c_parameter_token` `\c_math_superscript_token` `\c_math_subscript_token` `\c_space_token` `\c_letter_token` `\c_other_char_token` `\c_active_char_token` We define these useful tokens. We have to do it by hand with the brace tokens for obvious reasons.

```

2270 \cs_new_eq:NN \c_group_begin_token {
2271 \cs_new_eq:NN \c_group_end_token }
2272 \group_begin:
2273 \char_set_catcode:nn{'\*}{3}
2274 \token_new:Nn \c_math_shift_token {*}
2275 \char_set_catcode:nn{'\*}{4}
2276 \token_new:Nn \c_alignment_tab_token {#}
2277 \token_new:Nn \c_parameter_token {#}
2278 \token_new:Nn \c_math_superscript_token {^}
2279 \char_set_catcode:nn{'\*}{8}
2280 \token_new:Nn \c_math_subscript_token {*}
2281 \token_new:Nn \c_space_token {~}
2282 \token_new:Nn \c_letter_token {a}
2283 \token_new:Nn \c_other_char_token {1}
2284 \char_set_catcode:nn{'\*}{13}
2285 \cs_gset_nopar:Npn \c_active_char_token {\exp_not:N*}
2286 \group_end:

```

`\token_if_group_begin_p:N` `\token_if_group_begin:NTF` Check if token is a begin group token. We use the constant `\c_group_begin_token` for this.

```

2287 \prg_new_conditional:Nnn \token_if_group_begin:N {p,TF,T,F} {
2288   \if_catcode:w \exp_not:N #1\c_group_begin_token
2289   \prg_return_true: \else: \prg_return_false: \fi:
2290 }

```

`\token_if_group_end_p:N` Check if token is a end group token. We use the constant `\c_group_end_token` for this.

`\token_if_group_end:NTF`

```

2291 \prg_new_conditional:Nnn \token_if_group_end:N {p,TF,T,F} {
2292   \if_catcode:w \exp_not:N #1\c_group_end_token
2293   \prg_return_true: \else: \prg_return_false: \fi:
2294 }

```

`\token_if_math_shift_p:N` Check if token is a math shift token. We use the constant `\c_math_shift_token` for this.

`\token_if_math_shift:NTF`

```

2295 \prg_new_conditional:Nnn \token_if_math_shift:N {p,TF,T,F} {
2296   \if_catcode:w \exp_not:N #1\c_math_shift_token
2297   \prg_return_true: \else: \prg_return_false: \fi:
2298 }

```

`\token_if_alignment_tab_p:N` Check if token is an alignment tab token. We use the constant `\c_alignment_tab_token` for this.

`\token_if_alignment_tab:NTF`

```

2299 \prg_new_conditional:Nnn \token_if_alignment_tab:N {p,TF,T,F} {
2300   \if_catcode:w \exp_not:N #1\c_alignment_tab_token
2301   \prg_return_true: \else: \prg_return_false: \fi:
2302 }

```

`\token_if_parameter_p:N` Check if token is a parameter token. We use the constant `\c_parameter_token` for this.

`\token_if_parameter:NTF` We have to trick T_EX a bit to avoid an error message.

```

2303 \prg_new_conditional:Nnn \token_if_parameter:N {p,TF,T,F} {
2304   \exp_after:wN\if_catcode:w \cs:w c_parameter_token\cs_end:\exp_not:N #1
2305   \prg_return_true: \else: \prg_return_false: \fi:
2306 }

```

`\token_if_math_superscript_p:N` Check if token is a math superscript token. We use the constant `\c_math_superscript_token` for this.

`\token_if_math_superscript:NTF`

```

2307 \prg_new_conditional:Nnn \token_if_math_superscript:N {p,TF,T,F} {
2308   \if_catcode:w \exp_not:N #1\c_math_superscript_token
2309   \prg_return_true: \else: \prg_return_false: \fi:
2310 }

```

`\token_if_math_subscript_p:N` Check if token is a math subscript token. We use the constant `\c_math_subscript_token` for this.

`\token_if_math_subscript:NTF`

```

2311 \prg_new_conditional:Nnn \token_if_math_subscript:N {p,TF,T,F} {
2312   \if_catcode:w \exp_not:N #1\c_math_subscript_token
2313   \prg_return_true: \else: \prg_return_false: \fi:
2314 }

```

`\token_if_space_p:N` Check if token is a space token. We use the constant `\c_space_token` for this.
`\token_if_space:N \underline{TF}`

```
2315 \prg_new_conditional:Nnn \token_if_space:N {p,TF,T,F} {
2316   \if_catcode:w \exp_not:N #1\c_space_token
2317   \prg_return_true: \else: \prg_return_false: \fi:
2318 }
```

`\token_if_letter_p:N` Check if token is a letter token. We use the constant `\c_letter_token` for this.
`\token_if_letter:N \underline{TF}`

```
2319 \prg_new_conditional:Nnn \token_if_letter:N {p,TF,T,F} {
2320   \if_catcode:w \exp_not:N #1\c_letter_token
2321   \prg_return_true: \else: \prg_return_false: \fi:
2322 }
```

`\token_if_other_char_p:N` Check if token is an other char token. We use the constant `\c_other_char_token` for this.
`\token_if_other_char:N \underline{TF}`

```
2323 \prg_new_conditional:Nnn \token_if_other_char:N {p,TF,T,F} {
2324   \if_catcode:w \exp_not:N #1\c_other_char_token
2325   \prg_return_true: \else: \prg_return_false: \fi:
2326 }
```

`\token_if_active_char_p:N` Check if token is an active char token. We use the constant `\c_active_char_token` for this.
`\token_if_active_char:N \underline{TF}`

```
2327 \prg_new_conditional:Nnn \token_if_active_char:N {p,TF,T,F} {
2328   \if_catcode:w \exp_not:N #1\c_active_char_token
2329   \prg_return_true: \else: \prg_return_false: \fi:
2330 }
```

`\token_if_eq_meaning_p:NN` Check if the tokens #1 and #2 have same meaning.
`\token_if_eq_meaning:NN \underline{TF}`

```
2331 \prg_new_conditional:Nnn \token_if_eq_meaning:NN {p,TF,T,F} {
2332   \if_meaning:w #1 #2
2333   \prg_return_true: \else: \prg_return_false: \fi:
2334 }
```

`\token_if_eq_catcode_p:NN` Check if the tokens #1 and #2 have same category code.
`\token_if_eq_catcode:NN \underline{TF}`

```
2335 \prg_new_conditional:Nnn \token_if_eq_catcode:NN {p,TF,T,F} {
2336   \if_catcode:w \exp_not:N #1 \exp_not:N #2
2337   \prg_return_true: \else: \prg_return_false: \fi:
2338 }
```

`\token_if_eq_charcode_p:NN` Check if the tokens #1 and #2 have same character code.
`\token_if_eq_charcode:NN \underline{TF}`

```
2339 \prg_new_conditional:Nnn \token_if_eq_charcode:NN {p,TF,T,F} {
2340   \if_charcode:w \exp_not:N #1 \exp_not:N #2
2341   \prg_return_true: \else: \prg_return_false: \fi:
2342 }
```

`\token_if_macro_p:N` When a token is a macro, `\token_to_meaning:N` will always output something like
`\token_if_macro:NTF` `\long macro:#1->#1` so we simply check to see if the meaning contains `->`. Argument
`\token_if_macro_p_aux:w` #2 in the code below will be empty if the string `->` isn't present, proof that the token was
not a macro (which is why we reverse the emptiness test). However this function will fail
on its own auxiliary function (and a few other private functions as well) but that should
certainly never be a problem!

```

2343 \prg_new_conditional:Nnn \token_if_macro:N {p,TF,T,F} {
2344   \exp_after:wN \token_if_macro_p_aux:w \token_to_meaning:N #1 -> \q_nil
2345 }
2346 \cs_new_nopar:Npn \token_if_macro_p_aux:w #1 -> #2 \q_nil{
2347   \if_predicate:w \tl_if_empty_p:n{#2}
2348     \prg_return_false: \else: \prg_return_true: \fi:
2349 }

```

`\token_if_cs_p:N` Check if token has same catcode as a control sequence. We use `\scan_stop:` for this.
`\token_if_cs:NTF`

```

2350 \prg_new_conditional:Nnn \token_if_cs:N {p,TF,T,F} {
2351   \if_predicate:w \token_if_eq_catcode_p:NN \scan_stop: #1
2352     \prg_return_true: \else: \prg_return_false: \fi:

```

`\token_if_expandable_p:N` Check if token is expandable. We use the fact that \TeX will temporarily convert
`\token_if_expandable:NTF` `\exp_not:N` $\langle token \rangle$ into `\scan_stop:` if $\langle token \rangle$ is expandable.

```

2353 \prg_new_conditional:Nnn \token_if_expandable:N {p,TF,T,F} {
2354   \cs_if_exist:NTF #1 {
2355     \exp_after:wN \if_meaning:w \exp_not:N #1 #1
2356     \prg_return_false: \else: \prg_return_true: \fi:
2357   } {
2358     \prg_return_false:
2359   }
2360 }

```

`\token_if_chardef_p:N` Most of these functions have to check the meaning of the token in question so we need to
`\token_if_mathchardef_p:N` do some checkups on which characters are output by `\token_to_meaning:N`. As usual,
`\token_if_int_register_p:N` these characters have catcode 12 so we must do some serious substitutions in the code
`\token_if_skip_register_p:N` below...

```

2361 \group_begin:
2362   \char_set_lccode:nn {'\T}{'\T}
2363   \char_set_lccode:nn {'\F}{'\F}
2364   \char_set_lccode:nn {'\X}{'\n}
2365   \char_set_lccode:nn {'\Y}{'\t}
2366   \char_set_lccode:nn {'\Z}{'\d}
2367   \char_set_lccode:nn {'\?}{'\}
2368   \tl_map_inline:nn{\X\Y\Z\M\C\H\A\R\O\U\S\K\I\P\L\G\P\E}
2369     {\char_set_catcode:nn {'#1}{12}}

```

`\token_if_protected_macro_p:N` We convert the token list to lowercase and restore the catcode and lowercase code changes.
`\token_if_protected_long_macro_p:N`

```

2370 \tl_to_lowercase:n{
2371   \group_end:

```

`\token_if_dim_register_p:N`
`\token_if_skip_register_p:N`
`\token_if_int_register_p:N`
`\token_if_toks_register_p:N`
`\token_if_chardef_p_aux:w`
`\token_if_mathchardef_p_aux:w`
`\token_if_int_register_p_aux:w`
`\token_if_skip_register_p_aux:w`
`\token_if_dim_register_p_aux:w`
`\token_if_toks_register_p_aux:w`
`\token_if_protected_macro_p_aux:w`
`\token_if_long_macro_p_aux:w`
`\token_if_protected_long_macro_p_aux:w`

First up is checking if something has been defined with `\tex_chardef:D` or `\tex_mathchardef:D`. This is easy since T_EX thinks of such tokens as hexadecimal so it stores them as `\char"<hex number>` or `\mathchar"<hex number>`.

```

2372 \prg_new_conditional:Nnn \token_if_chardef:N {p,TF,T,F} {
2373   \exp_after:wN \token_if_chardef_aux:w
2374   \token_to_meaning:N #1?CHAR"\q_nil
2375 }
2376 \cs_new_nopar:Npn \token_if_chardef_aux:w #1?CHAR"#2\q_nil{
2377   \tl_if_empty:nTF {#1} {\prg_return_true:} {\prg_return_false:}
2378 }

2379 \prg_new_conditional:Nnn \token_if_mathchardef:N {p,TF,T,F} {
2380   \exp_after:wN \token_if_mathchardef_aux:w
2381   \token_to_meaning:N #1?MAYHCHAR"\q_nil
2382 }
2383 \cs_new_nopar:Npn \token_if_mathchardef_aux:w #1?MAYHCHAR"#2\q_nil{
2384   \tl_if_empty:nTF {#1} {\prg_return_true:} {\prg_return_false:}
2385 }

```

Integer registers are a little more difficult since they expand to `\count<number>` and there is also a primitive `\countdef`. So we have to check for that primitive as well.

```

2386 \prg_new_conditional:Nnn \token_if_int_register:N {p,TF,T,F} {
2387   \if_meaning:w \tex_countdef:D #1
2388   \prg_return_false:
2389   \else:
2390     \exp_after:wN \token_if_int_register_aux:w
2391     \token_to_meaning:N #1?COUXY\q_nil
2392   \fi:
2393 }
2394 \cs_new_nopar:Npn \token_if_int_register_aux:w #1?COUXY#2\q_nil{
2395   \tl_if_empty:nTF {#1} {\prg_return_true:} {\prg_return_false:}
2396 }

```

Skip registers are done the same way as the integer registers.

```

2397 \prg_new_conditional:Nnn \token_if_skip_register:N {p,TF,T,F} {
2398   \if_meaning:w \tex_skipdef:D #1
2399   \prg_return_false:
2400   \else:
2401     \exp_after:wN \token_if_skip_register_aux:w
2402     \token_to_meaning:N #1?SKIP\q_nil
2403   \fi:
2404 }
2405 \cs_new_nopar:Npn \token_if_skip_register_aux:w #1?SKIP#2\q_nil{
2406   \tl_if_empty:nTF {#1} {\prg_return_true:} {\prg_return_false:}
2407 }

```

Dim registers. No news here

```

2408 \prg_new_conditional:Nnn \token_if_dim_register:N {p,TF,T,F} {
2409   \if_meaning:w \tex_dimendef:D #1
2410   \c_false_bool
2411   \else:

```

```

2412 \exp_after:wN \token_if_dim_register_aux:w
2413 \token_to_meaning:N #1?ZIMEX\q_nil
2414 \fi:
2415 }
2416 \cs_new_nopar:Npn \token_if_dim_register_aux:w #1?ZIMEX#2\q_nil{
2417 \tl_if_empty:nTF {#1} {\prg_return_true:} {\prg_return_false:}
2418 }

```

Toks registers.

```

2419 \prg_new_conditional:Nnn \token_if_toks_register:N {p,TF,T,F} {
2420 \if_meaning:w \tex_toksdef:D #1
2421 \prg_return_false:
2422 \else:
2423 \exp_after:wN \token_if_toks_register_aux:w
2424 \token_to_meaning:N #1?YOKS\q_nil
2425 \fi:
2426 }
2427 \cs_new_nopar:Npn \token_if_toks_register_aux:w #1?YOKS#2\q_nil{
2428 \tl_if_empty:nTF {#1} {\prg_return_true:} {\prg_return_false:}
2429 }

```

Protected macros.

```

2430 \prg_new_conditional:Nnn \token_if_protected_macro:N {p,TF,T,F} {
2431 \exp_after:wN \token_if_protected_macro_aux:w
2432 \token_to_meaning:N #1?PROYECYEEZ~MACRO\q_nil
2433 }
2434 \cs_new_nopar:Npn \token_if_protected_macro_aux:w #1?PROYECYEEZ~MACRO#2\q_nil{
2435 \tl_if_empty:nTF {#1} {\prg_return_true:} {\prg_return_false:}
2436 }

```

Long macros.

```

2437 \prg_new_conditional:Nnn \token_if_long_macro:N {p,TF,T,F} {
2438 \exp_after:wN \token_if_long_macro_aux:w
2439 \token_to_meaning:N #1?LOXG~MACRO\q_nil
2440 }
2441 \cs_new_nopar:Npn \token_if_long_macro_aux:w #1?LOXG~MACRO#2\q_nil{
2442 \tl_if_empty:nTF {#1} {\prg_return_true:} {\prg_return_false:}
2443 }

```

Finally protected long macros where we for once don't have to add an extra test since there is no primitive for the combined prefixes.

```

2444 \prg_new_conditional:Nnn \token_if_protected_long_macro:N {p,TF,T,F} {
2445 \exp_after:wN \token_if_protected_long_macro_aux:w
2446 \token_to_meaning:N #1?PROYECYEEZ?LOXG~MACRO\q_nil
2447 }
2448 \cs_new_nopar:Npn \token_if_protected_long_macro_aux:w #1
2449 ?PROYECYEEZ?LOXG~MACRO#2\q_nil{
2450 \tl_if_empty:nTF {#1} {\prg_return_true:} {\prg_return_false:}
2451 }

```

Finally the \tl_to_lowercase:n ends!

```

2452 }

```

We do not provide a function for testing if a control sequence is “outer” since we don’t use that in L^AT_EX3.

`\prefix_arg_replacement_aux:w` In the `xparse` package we sometimes want to test if a control sequence can be expanded to reveal a hidden value. However, we cannot just expand the macro blindly as it may have arguments and none might be present. Therefore we define these functions to pick either the prefix(es), the argument specification, or the replacement text from a macro. All of this information is returned as characters with catcode 12. If the token in question isn’t a macro, the token `\scan_stop:` is returned instead.

```

2453 \group_begin:
2454 \char_set_lccode:nn {'\?}{'\:}
2455 \char_set_catcode:nn{'\M}{12}
2456 \char_set_catcode:nn{'\A}{12}
2457 \char_set_catcode:nn{'\C}{12}
2458 \char_set_catcode:nn{'\R}{12}
2459 \char_set_catcode:nn{'\O}{12}
2460 \tl_to_lowercase:n{
2461   \group_end:
2462   \cs_new_nopar:Npn \token_get_prefix_arg_replacement_aux:w #1MACRO?#2->#3\q_nil#4{
2463     #4{#1}{#2}{#3}
2464   }
2465   \cs_new_nopar:Npn\token_get_prefix_spec:N #1{
2466     \token_if_macro:NTF #1{
2467       \exp_after:wN \token_get_prefix_arg_replacement_aux:w
2468       \token_to_meaning:N #1\q_nil\use_i:nnn
2469     }{\scan_stop:}
2470   }
2471   \cs_new_nopar:Npn\token_get_arg_spec:N #1{
2472     \token_if_macro:NTF #1{
2473       \exp_after:wN \token_get_prefix_arg_replacement_aux:w
2474       \token_to_meaning:N #1\q_nil\use_ii:nnn
2475     }{\scan_stop:}
2476   }
2477   \cs_new_nopar:Npn\token_get_replacement_spec:N #1{
2478     \token_if_macro:NTF #1{
2479       \exp_after:wN \token_get_prefix_arg_replacement_aux:w
2480       \token_to_meaning:N #1\q_nil\use_iii:nnn
2481     }{\scan_stop:}
2482   }
2483 }

```

Useless code: because we can!

`\token_if_primitive_p:N` It is rather hard to determine if a token is a primitive. First we can check if it is a control sequence or active character. If either, we check if it is a macro. Then we can go through a tedious process of testing for different register types... I don’t actually think this function is useful but you never know.

```

2484 \prg_new_conditional:Nnn \token_if_primitive:N {p,TF,T,F} {
2485   \if_predicate:w \token_if_cs_p:N #1
2486   \if_predicate:w \token_if_macro_p:N #1

```

```

2487     \prg_return_false:
2488   \else:
2489     \token_if_primitive_p_aux:N #1
2490   \fi:
2491 \else:
2492   \if_predicate:w \token_if_active_char_p:N #1
2493   \if_predicate:w \token_if_macro_p:N #1
2494     \prg_return_false:
2495   \else:
2496     \token_if_primitive_p_aux:N #1
2497   \fi:
2498   \else:
2499     \prg_return_false:
2500   \fi:
2501 \fi:
2502 }
2503 \cs_new_nopar:Npn \token_if_primitive_p_aux:N #1{
2504   \if_predicate:w \token_if_chardef_p:N #1 \c_false_bool
2505 \else:
2506   \if_predicate:w \token_if_mathchardef_p:N #1 \prg_return_false:
2507 \else:
2508   \if_predicate:w \token_if_int_register_p:N #1 \prg_return_false:
2509 \else:
2510   \if_predicate:w \token_if_skip_register_p:N #1 \prg_return_false:
2511 \else:
2512   \if_predicate:w \token_if_dim_register_p:N #1 \prg_return_false:
2513 \else:
2514   \if_predicate:w \token_if_toks_register_p:N #1 \prg_return_false:
2515 \else:

```

We made it!

```

2516     \prg_return_true:
2517   \fi:
2518 \fi:
2519 \fi:
2520 \fi:
2521 \fi:
2522 \fi:
2523 }

```

99.5 Peeking ahead at the next token

```

\l_peek_token  We define some other tokens which will initially be the character ?.
\g_peek_token
\l_peek_search_token
2524 \token_new:Nn \l_peek_token {?}
2525 \token_new:Nn \g_peek_token {?}
2526 \token_new:Nn \l_peek_search_token {?}

```

`\peek_after:NN` `\peek_after:NN` takes two argument where the first is a function acting on `\l_peek_token` and the second is the next token in the input stream which `\l_peek_token` is set equal to. `\peek_gafter:NN` does the same globally to `\g_peek_token`.


```

2527 \cs_new_nopar:Npn \peek_after:NN {\tex_futurelet:D \l_peek_token }
2528 \cs_new_nopar:Npn \peek_gafter:NN {
2529   \pref_global:D \tex_futurelet:D \g_peek_token
2530 }

```

For normal purposes there are four main cases:

1. peek at the next token.
2. peek at the next non-space token.
3. peek at the next token and remove it.
4. peek at the next non-space token and remove it.

The generic functions will take four arguments: The token to search for, the test function to run on it and the true/false cases. The general algorithm is this:

1. Store the token to search for in `\l_peek_search_token`.
2. In order to avoid doubling of hash marks where it seems unnatural we put the `\langle true \rangle` and `\langle false \rangle` cases through an `x` type expansion but using `\exp_not:n` to avoid any expansion. This has the same effect as putting it through a `\langle toks \rangle` register but is faster. Also put in a special alignment safe group end.
3. Put in an alignment safe group begin.
4. Peek ahead and call the function which will act on the next token in the input stream.

`\l_peek_true_tl` `\l_peek_false_tl` Two dedicated token list variables that store the true and false cases.

```

2531 \tl_new:Nn \l_peek_true_tl {}
2532 \tl_new:Nn \l_peek_false_tl {}

```

`\peek_tmp:w` Scratch function used for storing the token to be removed if found.

```

2533 \cs_new_nopar:Npn \peek_tmp:w {}

```

`\l_peek_search_tl` We also use this token list variable for storing the token we want to compare. This turns out to be useful.

```

2534 \tl_new:Nn \l_peek_search_tl {}

```

`\peek_token_generic:NNTF` **#1** : the function to execute (obey or ignore spaces, etc.),
#2 : the special token we're looking for.

```

2535 \cs_new:Npn \peek_token_generic:NNTF #1#2#3#4 {
2536   \cs_set_eq:NN \l_peek_search_token #2
2537   \tl_set:Nn \l_peek_search_tl {#2}
2538   \tl_set:Nx \l_peek_true_tl {\exp_not:n{\group_align_safe_end: #3}}
2539   \tl_set:Nx \l_peek_false_tl {\exp_not:n{\group_align_safe_end: #4}}
2540   \group_align_safe_begin:

```

```

2541 \peek_after:NN #1
2542 }
2543 \cs_new:Npn \peek_token_generic:NNT #1#2#3 {
2544 \peek_token_generic:NNTF #1#2 {#3} {}
2545 }
2546 \cs_new:Npn \peek_token_generic:NNF #1#2#3 {
2547 \peek_token_generic:NNTF #1#2 {} {#3}
2548 }

```

`\peek_token_remove_generic:NNTF` If we want to be able to remove any character from the input stream we might as well do it the same way for all characters so we define this as little differently from above.

```

2549 \cs_new:Npn \peek_token_remove_generic:NNTF #1#2#3#4 {
2550 \cs_set_eq:NN \l_peek_search_token #2
2551 \tl_set:Nn \l_peek_search_tl {#2}
2552 \tl_set:Nx \l_peek_true_aux_tl { \exp_not:n{ #3 } }
2553 \tl_set_eq:NN \l_peek_true_tl \c_peek_true_remove_next_tl
2554 \tl_set:Nx \l_peek_false_tl { \exp_not:n{ \group_align_safe_end: #4 } }
2555 \group_align_safe_begin:
2556 \peek_after:NN #1
2557 }
2558 \cs_new:Npn \peek_token_remove_generic:NNT #1#2#3 {
2559 \peek_token_remove_generic:NNTF #1#2 {#3} {}
2560 }
2561 \cs_new:Npn \peek_token_remove_generic:NNF #1#2#3 {
2562 \peek_token_remove_generic:NNTF #1#2 {} {#3}
2563 }

```

`\l_peek_true_aux_tl` Two token list variables to help with removing the character from the input stream.
`\c_peek_true_remove_next_tl`

```

2564 \tl_new:Nn \l_peek_true_aux_tl {}
2565 \tl_new:Nn \c_peek_true_remove_next_tl { \group_align_safe_end:
2566 \tex_afterassignment:D \l_peek_true_aux_tl \cs_set_eq:NN \peek_tmp:w
2567 }

```

`\peek_execute_branches_meaning:` There are three major tests between tokens in TeX: meaning, catcode and charcode.
`\peek_execute_branches_catcode:` Hence we define three basic test functions that set in after the ignoring phase is over and
`\peek_execute_branches_charcode:` done with.

`\peek_execute_branches_charcode_aux:NN`

```

2568 \cs_new_nopar:Npn \peek_execute_branches_meaning: {
2569 \if_meaning:w \l_peek_token \l_peek_search_token
2570 \exp_after:wN \l_peek_true_tl
2571 \else:
2572 \exp_after:wN \l_peek_false_tl
2573 \fi:
2574 }
2575 \cs_new_nopar:Npn \peek_execute_branches_catcode: {
2576 \if_catcode:w \exp_not:N \l_peek_token \exp_not:N \l_peek_search_token
2577 \exp_after:wN \l_peek_true_tl
2578 \else:
2579 \exp_after:wN \l_peek_false_tl
2580 \fi:
2581 }

```

For the charcode version we do things a little differently. We want to check the token directly but if we do this we face problems if the next thing in the input stream is a braced group or a space token. The braced group would be read as a complete argument and the space would be gobbled by T_EX's argument reading routines. Hence we test for both of these and if one of them is found we just execute the false result directly since no one should ever try to use the `charcode` function for searching for `\c_group_begin_token` or `\c_space_token`.

```

2582 \cs_new_nopar:Npn \peek_execute_branches_charcode: {
2583   \bool_if:nTF {
2584     \token_if_eq_catcode_p:NN \l_peek_token \c_group_begin_token ||
2585     \token_if_eq_meaning_p:NN \l_peek_token \c_space_token
2586   }
2587   { \l_peek_false_tl }

```

Otherwise we call a small auxiliary function that just grabs the next token. We can do that because it really is a single token; we just have insert it again afterwards. Also we stored the token we were looking for in the token list variable `\l_peek_search_tl` so we unpack it again for this function.

```

2588   { \exp_after:wN \peek_execute_branches_charcode_aux:NN \l_peek_search_tl }
2589 }

```

Then we just do the usual `\if_charcode:w` comparison. We also remember to insert `#2` again after executing the true or false branches.

```

2590 \cs_new:Npn \peek_execute_branches_charcode_aux:NN #1#2{
2591   \if_charcode:w \exp_not:N #1\exp_not:N#2
2592     \exp_after:wN \l_peek_true_tl
2593   \else:
2594     \exp_after:wN \l_peek_false_tl
2595   \fi:
2596   #2
2597 }

```

```

\peek_def_aux:nnnn
\peek_def_aux_ii:nnnnn

```

This function aids defining conditional variants without too much repeated code. I hope that it doesn't detract too much from the readability.

```

2598 \cs_new_nopar:Npn \peek_def_aux:nnnn #1#2#3#4 {
2599   \peek_def_aux_ii:nnnnn {#1} {#2} {#3} {#4} { TF }
2600   \peek_def_aux_ii:nnnnn {#1} {#2} {#3} {#4} { T }
2601   \peek_def_aux_ii:nnnnn {#1} {#2} {#3} {#4} { F }
2602 }
2603 \cs_new_nopar:Npn \peek_def_aux_ii:nnnnn #1#2#3#4#5 {
2604   \cs_new_nopar:cpx { #1 #5 } {
2605     \tl_if_empty:nF {#2} {
2606       \exp_not:n { \cs_set_eq:NN \peek_execute_branches: #2 }
2607     }
2608     \exp_not:c { #3 #5 }
2609     \exp_not:n { #4 }
2610   }
2611 }

```

`\peek_meaning:NTF` Here we use meaning comparison with `\if_meaning:w`.

```
2612 \peek_def_aux:nnnn
2613 { peek_meaning:N }
2614 {}
2615 { peek_token_generic:NN }
2616 { \peek_execute_branches_meaning: }
```

`peek_meaning_ignore_spaces:NTF`

```
2617 \peek_def_aux:nnnn
2618 { peek_meaning_ignore_spaces:N }
2619 { \peek_execute_branches_meaning: }
2620 { peek_token_generic:NN }
2621 { \peek_ignore_spaces_execute_branches: }
```

`\peek_meaning_remove:NTF`

```
2622 \peek_def_aux:nnnn
2623 { peek_meaning_remove:N }
2624 {}
2625 { peek_token_remove_generic:NN }
2626 { \peek_execute_branches_meaning: }
```

`meaning_remove_ignore_spaces:NTF`

```
2627 \peek_def_aux:nnnn
2628 { peek_meaning_remove_ignore_spaces:N }
2629 { \peek_execute_branches_meaning: }
2630 { peek_token_remove_generic:NN }
2631 { \peek_ignore_spaces_execute_branches: }
```

`\peek_catcode:NTF` Here we use catcode comparison with `\if_catcode:w`.

```
2632 \peek_def_aux:nnnn
2633 { peek_catcode:N }
2634 {}
2635 { peek_token_generic:NN }
2636 { \peek_execute_branches_catcode: }
```

`peek_catcode_ignore_spaces:NTF`

```
2637 \peek_def_aux:nnnn
2638 { peek_catcode_ignore_spaces:N }
2639 { \peek_execute_branches_catcode: }
2640 { peek_token_generic:NN }
2641 { \peek_ignore_spaces_execute_branches: }
```

`\peek_catcode_remove:NTF`

```
2642 \peek_def_aux:nnnn
2643 { peek_catcode_remove:N }
2644 {}
2645 { peek_token_remove_generic:NN }
2646 { \peek_execute_branches_catcode: }
```

code_remove_ignore_spaces:NTF

```

2647 \peek_def_aux:nnnn
2648 { peek_catcode_remove_ignore_spaces:N }
2649 { \peek_execute_branches_catcode: }
2650 { peek_token_remove_generic:NN }
2651 { \peek_ignore_spaces_execute_branches: }

```

\peek_charcode:NTF Here we use charcode comparison with \if_charcode:w.

```

2652 \peek_def_aux:nnnn
2653 { peek_charcode:N }
2654 {}
2655 { peek_token_generic:NN }
2656 { \peek_execute_branches_charcode: }

```

ek_charcode_ignore_spaces:NTF

```

2657 \peek_def_aux:nnnn
2658 { peek_charcode_ignore_spaces:N }
2659 { \peek_execute_branches_charcode: }
2660 { peek_token_generic:NN }
2661 { \peek_ignore_spaces_execute_branches: }

```

\peek_charcode_remove:NTF

```

2662 \peek_def_aux:nnnn
2663 { peek_charcode_remove:N }
2664 {}
2665 { peek_token_remove_generic:NN }
2666 { \peek_execute_branches_charcode: }

```

code_remove_ignore_spaces:NTF

```

2667 \peek_def_aux:nnnn
2668 { peek_charcode_remove_ignore_spaces:N }
2669 { \peek_execute_branches_charcode: }
2670 { peek_token_remove_generic:NN }
2671 { \peek_ignore_spaces_execute_branches:}

```

\peek_ignore_spaces_aux: Throw away a space token and search again. We could define this in a more devious way where the auxiliary function gobbles the space token but then what do we do if we decide that a certain function should ignore more than one specific token? For example someone might find it interesting to define a \peek_ function that ignores a’s and b’s! Or maybe different kinds of “funny spaces”... Therefore I have decided to use this version which uses \tex_afterassignment:D to call the auxiliary function after the next token has been removed by \cs_set_eq:NN. That way it is easily extensible.

```

2672 \cs_new_nopar:Npn \peek_ignore_spaces_aux: {
2673   \peek_after:NN \peek_ignore_spaces_execute_branches:
2674 }
2675 \cs_new_nopar:Npn \peek_ignore_spaces_execute_branches: {
2676   \token_if_eq_meaning:NNTF \l_peek_token \c_space_token

```

```

2677 { \tex_afterassignment:D \peek_ignore_spaces_aux:
2678 \cs_set_eq:NN \peek_tmp:w
2679 }
2680 \peek_execute_branches:
2681 }

2682 </initex | package>

2683 <*showmemory>
2684 \showMemUsage
2685 </showmemory>

```

100 l3int implementation

100.1 Internal functions and variables

`\int_advance:w` `\int_advance:w <int register> <optional ‘by’> <number> <space>`
 Increments the count register by the specified amount.

T_EXhackers note: This is T_EX’s `\advance`.

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

Internal function for turning a number for a different base into a letter or digit.

<code>\int_pre_eval_one_arg:Nn</code> <code>\int_pre_eval_two_args:Nnn</code>	<code>\int_pre_eval_one_arg:Nn <function> {<integer expression>}</code> <code>\int_pre_eval_one_arg:Nnn <function> {<int expr₁>}</code> <code>{<int expr₂>}</code>
--	--

These are expansion helpers; they evaluate their integer expressions before handing them off to the specified *<function>*.

<code>\int_get_sign_and_digits:n *</code> <code>\int_get_sign:n *</code> <code>\int_get_digits:n *</code>	<code>\int_get_sign_and_digits:n {<number>}</code>
---	--

From an argument that may or may not include a + or – sign, these functions expand to the respective components of the number.

100.2 Module loading and primitives definitions

We start by ensuring that the required packages are loaded.

```

2686 <*package>
2687 \ProvidesExplPackage

```

```

2688   {\filename}{\filedate}{\fileversion}{\filedescription}
2689   \package_check_loaded_expl:
2690   </package>
2691   <*initex | package>

```

`\int_to_roman:w` A new name for the primitives.

```

\int_to_number:w
\int_advance:w
2692   \cs_new_eq:NN \int_to_roman:w \tex_romannumeral:D
2693   \cs_new_eq:NN \int_to_number:w \tex_number:D
2694   \cs_new_eq:NN \int_advance:w \tex_advance:D

```

Functions that support L^AT_EX's user accessible counters should be added here, too. But first the internal counters.

100.3 Allocation and setting

`\int_new:N` Allocation of a new internal counter is already done above. Here we define the next likely variant.

`\int_new:c`

For the L^AT_EX3 format:

```

2695   <*initex>
2696   \alloc_setup_type:nnn {int} {11} \c_max_register_num
2697   \cs_new_nopar:Npn \int_new:N #1 {\alloc_reg:NnNN g {int} \tex_countdef:D#1}
2698   \cs_new_nopar:Npn \int_new_l:N #1 {\alloc_reg:NnNN l {int} \tex_countdef:D#1}
2699   </initex>

```

For 'l3in2e':

```

2700   <*package>
2701   \cs_new_nopar:Npn \int_new:N #1 {
2702     \chk_if_free_cs:N #1
2703     \newcount #1
2704   }
2705   </package>

2706   \cs_generate_variant:Nn \int_new:N {c}

```

`\int_set:Nn` Setting counters is again something that I would like to make uniform at the moment to get a better overview.

`\int_set:cn`

```

\int_gset:Nn
\int_gset:cn
2707   \cs_new_nopar:Npn \int_set:Nn #1#2{#1 \intexpr_eval:w #2\intexpr_eval_end:
2708   <*check>
2709   \chk_local_or_pref_global:N #1
2710   </check>
2711   }
2712   \cs_new_nopar:Npn \int_gset:Nn {
2713   <*check>
2714     \pref_global_chk:
2715   </check>
2716   <-check> \pref_global:D
2717     \int_set:Nn }
2718   \cs_generate_variant:Nn\int_set:Nn {cn}
2719   \cs_generate_variant:Nn\int_gset:Nn {cn}

```

\int_incr:N Incrementing and decrementing of integer registers is done with the following functions.

```

\int_decr:N
\int_gincr:N
\int_gdecr:N
\int_incr:c
\int_decr:c
\int_gincr:c
\int_gdecr:c
2720 \cs_new_nopar:Npn \int_incr:N #1{\int_advance:w#1\c_one
2721 <*check>
2722 \chk_local_or_pref_global:N #1
2723 </check>
2724 }
2725 \cs_new_nopar:Npn \int_decr:N #1{\int_advance:w#1\c_minus_one
2726 <*check>
2727 \chk_local_or_pref_global:N #1
2728 </check>
2729 }
2730 \cs_new_nopar:Npn \int_gincr:N {

```

We make sure that a local variable is not updated globally by changing the internal test (i.e. \chk_local_or_pref_global:N) before making the assignment. This is done by \pref_global_chk: which also issues the necessary \pref_global:D. This is not very efficient, but this code will be only included for debugging purposes. Using \pref_global:D in front of the local function is better in the production versions.

```

2731 <*check>
2732 \pref_global_chk:
2733 </check>
2734 <-check> \pref_global:D
2735 \int_incr:N}
2736 \cs_new_nopar:Npn \int_gdecr:N {
2737 <*check>
2738 \pref_global_chk:
2739 </check>
2740 <-check> \pref_global:D
2741 \int_decr:N}

```

With the \int_add:Nn functions we can shorten the above code. If this makes it too slow ...

```

2742 \cs_set_nopar:Npn \int_incr:N #1{\int_add:Nn#1\c_one}
2743 \cs_set_nopar:Npn \int_decr:N #1{\int_add:Nn#1\c_minus_one}
2744 \cs_set_nopar:Npn \int_gincr:N #1{\int_gadd:Nn#1\c_one}
2745 \cs_set_nopar:Npn \int_gdecr:N #1{\int_gadd:Nn#1\c_minus_one}

2746 \cs_generate_variant:Nn \int_incr:N {c}
2747 \cs_generate_variant:Nn \int_decr:N {c}
2748 \cs_generate_variant:Nn \int_gincr:N {c}
2749 \cs_generate_variant:Nn \int_gdecr:N {c}

```

\int_zero:N Functions that reset an <int> register to zero.

```

\int_zero:c
\int_gzero:N
\int_gzero:c
2750 \cs_new_nopar:Npn \int_zero:N #1 {#1=\c_zero}
2751 \cs_generate_variant:Nn \int_zero:N {c}

2752 \cs_new_nopar:Npn \int_gzero:N #1 {\pref_global:D #1=\c_zero}
2753 \cs_generate_variant:Nn \int_gzero:N {c}

```

\int_add:Nn Adding and subtracting to and from a counter ... We should think of using these functions

```

\int_add:cn
\int_gadd:Nn
\int_gadd:cn
\int_sub:Nn
\int_sub:cn
\int_gsub:Nn
\int_gsub:cn
2754 \cs_new_nopar:Npn \int_add:Nn #1#2{

```


We need to say `by` in case the first argument is a register accessed by its number, e.g., `\count23`. Not that it should ever happen but...

```

2755     \int_advance:w #1 by \intexpr_eval:w #2\intexpr_eval_end:
2756 <*check>
2757     \chk_local_or_pref_global:N #1
2758 </check>
2759 }
2760 \cs_new_nopar:Npn \int_sub:Nn #1#2{
2761     \int_advance:w #1-\intexpr_eval:w #2\intexpr_eval_end:
2762 <*check>
2763     \chk_local_or_pref_global:N #1
2764 </check>
2765 }
2766 \cs_new_nopar:Npn \int_gadd:Nn {
2767 <*check>
2768     \pref_global_chk:
2769 </check>
2770 <-check> \pref_global:D
2771     \int_add:Nn }
2772 \cs_new_nopar:Npn \int_gsub:Nn {
2773 <*check>
2774     \pref_global_chk:
2775 </check>
2776 <-check> \pref_global:D
2777     \int_sub:Nn }
2778 \cs_generate_variant:Nn \int_add:Nn {cn}
2779 \cs_generate_variant:Nn \int_gadd:Nn {cn}
2780 \cs_generate_variant:Nn \int_sub:Nn {cn}
2781 \cs_generate_variant:Nn \int_gsub:Nn {cn}

```

`\int_use:N` Here is how counters are accessed:

```

\int_use:c
2782 \cs_new_eq:NN \int_use:N \tex_the:D
2783 \cs_new_nopar:Npn \int_use:c #1{\int_use:N \cs:w#1\cs_end:}

```

`\int_show:N` Diagnostics.

```

\int_show:c
2784 \cs_new_eq:NN \int_show:N \tex_showthe:D
2785 \cs_new_nopar:Npn \int_show:c {\exp_args:Nc \int_show:N }

```

`\int_to_arabic:n` Nothing exciting here.

```

2786 \cs_new_nopar:Npn \int_to_arabic:n #1{ \intexpr_eval:n{#1}}

```

`\int_roman_lcuc_mapping:Nnn` Using TeX's built-in feature for producing roman numerals has some surprising features. One is the the characters resulting from `\int_to_roman:w` have category code 12 so they may fail in certain comparison tests. Therefore we use a mapping from the character TeX produces to the character we actually want which will give us letters with category code 11.

```

2787 \cs_new_nopar:Npn \int_roman_lcuc_mapping:Nnn #1#2#3{
2788     \cs_set_nopar:cpn {int_to_lc_roman_#1:}{#2}
2789     \cs_set_nopar:cpn {int_to_uc_roman_#1:}{#3}
2790 }

```

Here are the default mappings. I haven't found any examples of say Turkish doing the mapping `i \i I` but at least there is a possibility for it if needed. Note: I have now asked a Turkish person and he tells me they do the `i I` mapping.

```
2791 \int_roman_lcuc_mapping:Nnn i i I
2792 \int_roman_lcuc_mapping:Nnn v v V
2793 \int_roman_lcuc_mapping:Nnn x x X
2794 \int_roman_lcuc_mapping:Nnn l l L
2795 \int_roman_lcuc_mapping:Nnn c c C
2796 \int_roman_lcuc_mapping:Nnn d d D
2797 \int_roman_lcuc_mapping:Nnn m m M
```

For the delimiter we cheat and let it gobble its arguments instead.

```
2798 \int_roman_lcuc_mapping:Nnn Q \use_none:nn \use_none:nn
```

`\int_to_roman:n` The commands for producing the lower and upper case roman numerals run a loop on one character at a time and also carries some information for upper or lower case with `\int_to_Roman:n` it. We put it through `\intexpr_eval:n` first which is safer and more flexible.

```
2799 \cs_new_nopar:Npn \int_to_roman:n #1 {
2800   \exp_after:wN \int_to_roman_lcuc:NN \exp_after:wN l
2801   \int_to_roman:w \intexpr_eval:n {#1} Q
2802 }
2803 \cs_new_nopar:Npn \int_to_Roman:n #1 {
2804   \exp_after:wN \int_to_roman_lcuc:NN \exp_after:wN u
2805   \int_to_roman:w \intexpr_eval:n {#1} Q
2806 }
2807 \cs_new_nopar:Npn \int_to_roman_lcuc:NN #1#2{
2808   \use:c {int_to_#1c_roman_#2:}
2809   \int_to_roman_lcuc:NN #1
2810 }
```

`\convert_number_with_rule:nnN` This is our major workhorse for conversions. `#1` is the number we want converted, `#2` is the base number, and `#3` is the function converting the number. This function expects to receive a non-negative integer and as such is ideal for something using `\if_case:w` internally.

The basic example is this: We want to convert the number 50 (`#1`) into an alphabetic equivalent `ax`. For the English language our list contains 26 elements so this is our argument `#2` while the function `#3` just turns 1 into `a`, 2 into `b`, etc. Hence our goal is to turn 50 into the sequence `#3{1}#1{24}` so what we do is to first divide 50 by 26 and truncating the result returning 1. Then before we execute this we call the function again but this time on the result of the remainder of the division. This goes on until the remainder is less than or equal to the base number where we just call the function `#3` directly on the number.

We do a little pre-expansion of the arguments below as they otherwise have a tendency to grow quite large.

```
2811 \cs_set_nopar:Npn \int_convert_number_with_rule:nnN #1#2#3{
2812   \intexpr_compare:nNnTF {#1}>{#2}
2813   {
2814     \exp_args:Nf \int_convert_number_with_rule:nnN
```

```

2815 { \intexpr_div_truncate:nn {#1-1}{#2} }{#2}
2816 #3

```

Note that we have to nudge our modulus function so it won't return 0 as that wouldn't work with `\if_case:w` when that expects a positive number to produce a letter.

```

2817 \exp_args:Nf #3 { \intexpr_eval:n{1+\intexpr_mod:nn {#1-1}{#2}} }
2818 }
2819 { \exp_args:Nf #3{ \intexpr_eval:n{#1} } }
2820 }

```

As can be seen it is even simpler to convert to number systems that contain 0, since then we don't have to add or subtract 1 here and there.

`\alph_default_conversion_rule:n` Now we just set up a default conversion rule. Ideally every language should have one such rule, as say in Danish there are 29 letters in the alphabet.

```

2821 \cs_new_nopar:Npn \int_alph_default_conversion_rule:n #1{
2822   \if_case:w #1
2823     \or: a\or: b\or: c\or: d\or: e\or: f
2824     \or: g\or: h\or: i\or: j\or: k\or: l
2825     \or: m\or: n\or: o\or: p\or: q\or: r
2826     \or: s\or: t\or: u\or: v\or: w\or: x
2827     \or: y\or: z
2828   \fi:
2829 }
2830 \cs_new_nopar:Npn \int_Alph_default_conversion_rule:n #1{
2831   \if_case:w #1
2832     \or: A\or: B\or: C\or: D\or: E\or: F
2833     \or: G\or: H\or: I\or: J\or: K\or: L
2834     \or: M\or: N\or: O\or: P\or: Q\or: R
2835     \or: S\or: T\or: U\or: V\or: W\or: X
2836     \or: Y\or: Z
2837   \fi:
2838 }

```

`\int_to_alph:n` The actual functions are just instances of the generic function. The second argument of `\int_convert_number_with_rule:nnN` should of course match the number of `\or:s` in the conversion rule.

```

2839 \cs_new_nopar:Npn \int_to_alph:n #1{
2840   \int_convert_number_with_rule:nnN {#1}{26}
2841   \int_alph_default_conversion_rule:n
2842 }
2843 \cs_new_nopar:Npn \int_to_Alph:n #1{
2844   \int_convert_number_with_rule:nnN {#1}{26}
2845   \int_Alph_default_conversion_rule:n
2846 }

```

`\int_to_symbol:n` Turning a number into a symbol is also easy enough.

```

2847 \cs_new_nopar:Npn \int_to_symbol:n #1{
2848   \mode_if_math:TF
2849   {

```

```

2850 \int_convert_number_with_rule:nnN {#1}{9}
2851 \int_symbol_math_conversion_rule:n
2852 }
2853 {
2854 \int_convert_number_with_rule:nnN {#1}{9}
2855 \int_symbol_text_conversion_rule:n
2856 }
2857 }

```

symbol_math_conversion_rule:n Nothing spectacular here.

symbol_text_conversion_rule:n

```

2858 \cs_new_nopar:Npn \int_symbol_math_conversion_rule:n #1 {
2859 \if_case:w #1
2860 \or: *
2861 \or: \dagger
2862 \or: \ddagger
2863 \or: \mathsection
2864 \or: \mathparagraph
2865 \or: \l
2866 \or: **
2867 \or: \dagger\dagger
2868 \or: \ddagger\ddagger
2869 \fi:
2870 }
2871 \cs_new_nopar:Npn \int_symbol_text_conversion_rule:n #1 {
2872 \if_case:w #1
2873 \or: \textasteriskcentered
2874 \or: \textdagger
2875 \or: \textdaggerdbl
2876 \or: \textsection
2877 \or: \textparagraph
2878 \or: \textbardbl
2879 \or: \textasteriskcentered\textasteriskcentered
2880 \or: \textdagger\textdagger
2881 \or: \textdaggerdbl\textdaggerdbl
2882 \fi:
2883 }

```

\l_tmpa_int We provide four local and two global scratch counters, maybe we need more or less.

\l_tmpb_int
\l_tmpc_int
\g_tmpa_int
\g_tmpb_int

```

2884 \int_new:N \l_tmpa_int
2885 \int_new:N \l_tmpb_int
2886 \int_new:N \l_tmpc_int
2887 \int_new:N \g_tmpa_int
2888 \int_new:N \g_tmpb_int

```

\int_pre_eval_one_arg:Nn These are handy when handing down values to other functions. All they do is evaluate the number in advance.

\int_pre_eval_two_args:Nnn

```

2889 \cs_set_nopar:Npn \int_pre_eval_one_arg:Nn #1#2{
2890 \exp_args:Nf#1{\intexpr_eval:n{#2}}
2891 \cs_set_nopar:Npn \int_pre_eval_two_args:Nnn #1#2#3{
2892 \exp_args:Nff#1{\intexpr_eval:n{#2}}{\intexpr_eval:n{#3}}
2893 }

```

100.4 Defining constants

`\int_const:Nn` As stated, most constants can be defined as `\tex_chardef:D` or `\tex_mathchardef:D` but that's engine dependent.

```

2894 \cs_new_nopar:Npn \int_const:Nn #1#2 {
2895   \intexpr_compare:nNnTF {#2} > \c_minus_one {
2896     \intexpr_compare:nNnTF {#2} > \c_max_register_num {
2897       \int_new:N #1 \int_set:Nn #1{#2}
2898     } {
2899       \chk_if_free_cs:N #1 \tex_mathchardef:D #1 = \intexpr_eval:n{#2}
2900     }
2901   } {
2902     \int_new:N #1 \int_set:Nn #1{#2}
2903   }
2904 }

```

`\c_minus_one` And the usual constants, others are still missing. Please, make every constant a real constant at least for the moment. We can easily convert things in the end when we have found what constants are used in critical places and what not.

```

\c_zero
\c_one
\c_two
\c_three 2905 %% \tex_countdef:D \c_minus_one = 10 \scan_stop:
\c_four   2906 %% \c_minus_one = -1 \scan_stop:          %% in l3basics
\c_five   2907 %\int_const:Nn \c_zero {0}
\c_six     2908 \int_const:Nn \c_one {1}
\c_seven   2909 \int_const:Nn \c_two {2}
\c_eight   2910 \int_const:Nn \c_three {3}
\c_nine    2911 \int_const:Nn \c_four {4}
\c_ten     2912 \int_const:Nn \c_five {5}
\c_eleven  2913 \int_const:Nn \c_six {6}
\c_twelve  2914 \int_const:Nn \c_seven {7}
\c_thirteen 2915 \int_const:Nn \c_eight {8}
\c_fourteen 2916 \int_const:Nn \c_nine {9}
\c_fifteen  2917 \int_const:Nn \c_ten {10}
\c_sixteen  2918 \int_const:Nn \c_eleven {11}
\c_seventeen 2919 \int_const:Nn \c_twelve {12}
\c_eighteen 2920 \int_const:Nn \c_thirteen {13}
\c_nineteen 2921 \int_const:Nn \c_fourteen {14}
\c_twenty   2922 \int_const:Nn \c_fifteen {15}
\c_hundred_one 2923 %% \tex_chardef:D \c_sixteen = 16\scan_stop: %% in l3basics
\c_twohundred_fifty_five 2924 \int_const:Nn \c_thirty_two {32}
\c_twohundred_fifty_six
\c_thousand
\c_ten_thousand
\c_ten_thousand_one
\c_ten_thousand_two
\c_ten_thousand_three
\c_ten_thousand_four
\c_twenty_thousand

```

The next one may seem a little odd (obviously!) but is useful when dealing with logical operators.

```

2925 \int_const:Nn \c_hundred_one {101}
2926 \int_const:Nn \c_twohundred_fifty_five{255}
2927 \int_const:Nn \c_twohundred_fifty_six {256}
2928 \int_const:Nn \c_thousand {1000}
2929 \int_const:Nn \c_ten_thousand {10000}
2930 \int_const:Nn \c_ten_thousand_one {10001}
2931 \int_const:Nn \c_ten_thousand_two {10002}
2932 \int_const:Nn \c_ten_thousand_three {10003}
2933 \int_const:Nn \c_ten_thousand_four {10004}
2934 \int_const:Nn \c_twenty_thousand {20000}

```

`\c_max_int` The largest number allowed is $2^{31} - 1$

2935 `\int_const:Nn \c_max_int {2147483647}`

100.5 Scanning and conversion

Conversion between different numbering schemes requires meticulous work. A number can be preceded by any number of + and/or -. We define a generic function which will return the sign and/or the remainder.

```

\int_get_sign_and_digits:n A number may be preceded by any number of +s and -s. Start out by assuming we have
    \int_get_sign:n a positive number.
    \int_get_digits:n
get_sign_and_digits_aux:nNNN 2936 \cs_new_nopar:Npn \int_get_sign_and_digits:n #1{
get_sign_and_digits_aux:oNNN 2937   \int_get_sign_and_digits_aux:nNNN {#1} \c_true_bool \c_true_bool \c_true_bool
2938 }
2939 \cs_new_nopar:Npn \int_get_sign:n #1{
2940   \int_get_sign_and_digits_aux:nNNN {#1} \c_true_bool \c_true_bool \c_false_bool
2941 }
2942 \cs_new_nopar:Npn \int_get_digits:n #1{
2943   \int_get_sign_and_digits_aux:nNNN {#1} \c_true_bool \c_false_bool \c_true_bool
2944 }

```

Now check the first character in the string. Only a - can change if a number is positive or negative, hence we reverse the boolean governing this. Then gobble the - and start over.

```

2945 \cs_new_nopar:Npn \int_get_sign_and_digits_aux:nNNN #1#2#3#4{
2946   \tl_if_head_eq_charcode:fNTF {#1} -
2947   {
2948     \bool_if:NTF #2
2949     { \int_get_sign_and_digits_aux:oNNN {\use_none:n #1} \c_false_bool #3#4 }
2950     { \int_get_sign_and_digits_aux:oNNN {\use_none:n #1} \c_true_bool #3#4 }
2951   }

```

The other cases are much simpler since we either just have to gobble the + or exit immediately and insert the correct sign.

```

2952 {
2953   \tl_if_head_eq_charcode:fNTF {#1} +
2954   { \int_get_sign_and_digits_aux:oNNN {\use_none:n #1} #2#3#4}
2955   {

```

The boolean #3 is for printing the sign while #4 is for printing the digits.

```

2956     \bool_if:NT #3 { \bool_if:NF #2 - }
2957     \bool_if:NT #4 {#1}
2958   }
2959 }
2960 }
2961 \cs_generate_variant:Nn \int_get_sign_and_digits_aux:nNNN {oNNN}

```

`\int_convert_from_base_ten:nn` #1 is the base 10 number to be converted to base #2. We split off the sign first, print if there and then convert only the number. Since this is supposedly a base 10 number we can let T_EX do the reading of + and -.

```

2962 \cs_set_nopar:Npn \int_convert_from_base_ten:nn#1#2{
2963   \intexpr_compare:nNnTF {#1}<\c_zero
2964   {
2965     - \int_convert_from_base_ten_aux:nfn {}
2966     { \intexpr_eval:n {-#1} }
2967   }
2968   {
2969     \int_convert_from_base_ten_aux:nfn {}
2970     { \intexpr_eval:n {#1} }
2971   }
2972   {#2}
2973 }

```

The algorithm runs like this:

1. If the number $\langle num \rangle$ is greater than $\langle base \rangle$, calculate modulus of $\langle num \rangle$ and $\langle base \rangle$ and carry that over for next round. The remainder is calculated as a truncated division of $\langle num \rangle$ and $\langle base \rangle$. Start over with these new values.
2. If $\langle num \rangle$ is less than or equal to $\langle base \rangle$ convert it to the correct symbol, print the previously calculated digits and exit.

#1 is the carried over result, #2 the remainder and #3 the base number.

```

2974 \cs_new_nopar:Npn \int_convert_from_base_ten_aux:nnn#1#2#3{
2975   \intexpr_compare:nNnTF {#2}<{#3}
2976   { \int_convert_number_to_letter:n{#2} #1 }
2977   {
2978     \int_convert_from_base_ten_aux:ffn
2979     {
2980       \int_convert_number_to_letter:n {\intexpr_mod:nn {#2}{#3}}
2981       #1
2982     }
2983     { \intexpr_div_truncate:nn{#2}{#3}}
2984     {#3}
2985   }
2986 }
2987 \cs_generate_variant:Nn \int_convert_from_base_ten_aux:nnn {nfn}
2988 \cs_generate_variant:Nn \int_convert_from_base_ten_aux:nnn {ffn}

```

`\int_convert_number_to_letter:n` Turning a number for a different base into a letter or digit.

```

2989 \cs_set_nopar:Npn \int_convert_number_to_letter:n #1{
2990   \if_case:w \intexpr_eval:w #1-10\intexpr_eval_end:
2991   \exp_after:wN A \or: \exp_after:wN B \or:
2992   \exp_after:wN C \or: \exp_after:wN D \or: \exp_after:wN E \or:
2993   \exp_after:wN F \or: \exp_after:wN G \or: \exp_after:wN H \or:
2994   \exp_after:wN I \or: \exp_after:wN J \or: \exp_after:wN K \or:
2995   \exp_after:wN L \or: \exp_after:wN M \or: \exp_after:wN N \or:
2996   \exp_after:wN O \or: \exp_after:wN P \or: \exp_after:wN Q \or:

```

```

2997 \exp_after:wN R \or: \exp_after:wN S \or: \exp_after:wN T \or:
2998 \exp_after:wN U \or: \exp_after:wN V \or: \exp_after:wN W \or:
2999 \exp_after:wN X \or: \exp_after:wN Y \or: \exp_after:wN Z \else:
3000 \use_i_after_fi:nw{ #1 }\fi: }

```

`\int_convert_to_base_ten:nn` #1 is the number, #2 is its base. First we get the sign, then use only the digits/letters from it and pass that onto a new function.

```

3001 \cs_set_nopar:Npn \int_convert_to_base_ten:nn #1#2 {
3002   \intexpr_eval:n{
3003     \int_get_sign:n{#1}
3004     \exp_args:Nf\int_convert_to_base_ten_aux:nn {\int_get_digits:n{#1}}{#2}
3005   }
3006 }

```

This is an intermediate function to get things started.

```

3007 \cs_new_nopar:Npn \int_convert_to_base_ten_aux:nn #1#2{
3008   \int_convert_to_base_ten_auxi:nnN {0}{#2} #1 \q_nil
3009 }

```

Here we check each letter/digit and calculate the next number. #1 is the previously calculated result (to be multiplied by the base), #2 is the base and #3 is the next letter/digit to be added.

```

3010 \cs_new_nopar:Npn \int_convert_to_base_ten_auxi:nnN#1#2#3{
3011   \quark_if_nil:NTF #3
3012   {#1}
3013   {\exp_args:Nf\int_convert_to_base_ten_auxi:nnN
3014     {\intexpr_eval:n{ #1*#2+\int_convert_letter_to_number:N #3} }
3015     {#2}
3016   }
3017 }

```

This is for turning a letter or digit into a number. This function also takes care of handling lowercase and uppercase letters. Hence a is turned into 11 and so is A.

```

3018 \cs_set_nopar:Npn \int_convert_letter_to_number:N #1{
3019   \intexpr_compare:nNnTF{‘#1}<{58}{#1}
3020   {
3021     \intexpr_eval:n{ ‘#1 -
3022       \intexpr_compare:nNnTF{‘#1}<{91}{ 55 }{ 87 }
3023     }
3024   }
3025 }

```

```

3026 </initex | package>

```

Show token usage:

```

3027 <*showmemory>
3028 \showMemUsage
3029 </showmemory>

```


101 l3num implementation

We start by ensuring that the required packages are loaded.

```

3030 <*package>
3031 \ProvidesExplPackage
3032   {\filename}{\filedate}{\fileversion}{\filedescription}
3033 \package_check_loaded_expl:
3034 </package>
3035 <*initex | package>

```

`\if_num:w` Here are the remaining primitives for number comparisons and expressions.

```

\if_case:w
3036 \cs_new_eq:NN \if_num:w \tex_ifnum:D
3037 \cs_new_eq:NN \if_case:w \tex_ifcase:D

```

Functions that support L^AT_EX's user accessible counters should be added here, too. But first the internal counters.

`\num_incr:N` Incrementing and decrementing of integer registers is done with the following functions.

```

\num_decr:N
\num_gincr:N
\num_gdecr:N
3038 \cs_set_nopar:Npn \num_incr:N #1{\num_add:Nn#1 1}
3039 \cs_set_nopar:Npn \num_decr:N #1{\num_add:Nn#1 \c_minus_one}
3040 \cs_set_nopar:Npn \num_gincr:N #1{\num_gadd:Nn#1 1}
3041 \cs_set_nopar:Npn \num_gdecr:N #1{\num_gadd:Nn#1 \c_minus_one}

```

`\num_incr:c` We also need ...

```

\num_decr:c
\num_gincr:c
\num_gdecr:c
3042 \cs_generate_variant:Nn \num_incr:N {c}
3043 \cs_generate_variant:Nn \num_decr:N {c}
3044 \cs_generate_variant:Nn \num_gincr:N {c}
3045 \cs_generate_variant:Nn \num_gdecr:N {c}

```

`\num_zero:N` We also need ...

```

\num_zero:c
\num_gzero:N
\num_gzero:c
3046 \cs_new_nopar:Npn \num_zero:N #1 {\num_set:Nn #1 0}
3047 \cs_new_nopar:Npn \num_gzero:N #1 {\num_gset:Nn #1 0}

3048 \cs_generate_variant:Nn \num_zero:N {c}
3049 \cs_generate_variant:Nn \num_gzero:N {c}

```

`\num_new:N` Allocate a new `<num>` variable and initialize it with zero.

```

\num_new:c
3050 \cs_new_nopar:Npn \num_new:N #1{\tl_new:Nn #1{0}}
3051 \cs_generate_variant:Nn \num_new:N {c}

```

`\num_set:Nn` Assigning values to `<num>` registers.

```

\num_set:cn
\num_gset:Nn
\num_gset:cn
3052 \cs_new_nopar:Npn \num_set:Nn #1#2{
3053   \tl_set:Nn #1{\tex_number:D \intexpr_eval:n {#2}}
3054 }
3055 \cs_generate_variant:Nn \num_set:Nn {c}

```

```

3056 \cs_new_nopar:Npn \num_gset:Nn {\pref_global:D \num_set:Nn}
3057 \cs_generate_variant:Nn\num_gset:Nn {c}

```

`\num_set_eq:NN` Setting $\langle num \rangle$ registers equal to each other.

```

\num_set_eq:cN
\num_set_eq:Nc
\num_set_eq:cc
3058 \cs_new_eq:NN \num_set_eq:NN \tl_set_eq:NN
3059 \cs_generate_variant:Nn\num_set_eq:NN {c,Nc,cc}

```

`\num_gset_eq:NN` Setting $\langle num \rangle$ registers equal to each other.

```

\num_gset_eq:cN
\num_gset_eq:Nc
\num_gset_eq:cc
3060 \cs_new_eq:NN \num_gset_eq:NN \tl_gset_eq:NN
3061 \cs_generate_variant:Nn\num_gset_eq:NN {c,Nc,cc}

```

`\num_add:Nn` Adding is easily done as the second argument goes through `\intexpr_eval:n`.

```

\num_add:cn
\num_gadd:Nn
\num_gadd:cn
3062 \cs_new_nopar:Npn \num_add:Nn #1#2 {\num_set:Nn #1{#1+#2}}
3063 \cs_generate_variant:Nn\num_add:Nn {c}

3064 \cs_new_nopar:Npn \num_gadd:Nn {\pref_global:D \num_add:Nn}
3065 \cs_generate_variant:Nn\num_gadd:Nn {c}

```

`\num_use:N` Here is how num macros are accessed:

```

\num_use:c
3066 \cs_new_eq:NN\num_use:N \use:n
3067 \cs_new_eq:NN\num_use:c \use:c

```

`\num_show:N` Here is how num macros are diagnosed:

```

\num_show:c
3068 \cs_new_eq:NN\num_show:N \cs_show:N
3069 \cs_new_eq:NN\num_show:c \cs_show:c

```

`\num_elt_count:n` Helper function for counting elements in a list.

```

\num_elt_count_prop:Nn
3070 \cs_new:Npn \num_elt_count:n #1 { + 1 }
3071 \cs_new:Npn \num_elt_count_prop:Nn #1#2 { + 1 }

```

`\l_tmpa_num` We provide an number local and two global $\langle num \rangle$ s, maybe we need more or less.

```

\l_tmpb_num
\l_tmpc_num
3072 \num_new:N \l_tmpa_num
3073 \num_new:N \l_tmpb_num
3074 \num_new:N \l_tmpc_num
\g_tmpa_num
3075 \num_new:N \g_tmpa_num
3076 \num_new:N \g_tmpb_num

```

`\c_max_register_num`

```

3077 \tex_mathchardef:D \c_max_register_num = 32767 \scan_stop:

3078 </initex | package>

```

102 l3intexpr implementation

We start by ensuring that the required packages are loaded.

```

3079 <*package>
3080 \ProvidesExplPackage
3081   {\filename}{\filedate}{\fileversion}{\filedescription}
3082   \package_check_loaded_expl:
3083 </package>
3084 <*initex | package>

```

```

\intexpr_value:w Here are the remaining primitives for number comparisons and expressions.
\intexpr_eval:n
\intexpr_eval:w
\intexpr_eval_end:
\if_intexpr_compare:w
\if_intexpr_odd:w
\if_intexpr_case:w
3085 \cs_set_eq:NN \intexpr_value:w \tex_number:D
3086 \cs_set_eq:NN \intexpr_eval:w \etex_numexpr:D
3087 \cs_set_protected:Npn \intexpr_eval_end: {\tex_relax:D}
3088 \cs_set_eq:NN \if_intexpr_compare:w \tex_ifnum:D
3089 \cs_set_eq:NN \if_intexpr_odd:w \tex_ifodd:D
3090 \cs_set_eq:NN \if_intexpr_case:w \tex_ifcase:D
3091 \cs_set:Npn \intexpr_eval:n #1{
3092   \intexpr_value:w \intexpr_eval:w #1\intexpr_eval_end:
3093 }

```

```

\intexpr_compare_p:n Comparison tests using a simple syntax where only one set of braces is required and
\intexpr_compare:nTF additional operators such as != and >= are supported. First some notes on the idea
                        behind this. We wish to support writing code like

```

```

\intexpr_compare_p:n { 5 + \l_tmpa_int != 4 - \l_tmpb_int }

```

In other words, we want to somehow add the missing `\intexpr_eval:w` where required. We can start evaluating from the left using `\intexpr:w`, and we know that since the relation symbols `<`, `>`, `=` and `!` are not allowed in such expressions, they will terminate the expression. Therefore, we first let T_EX evaluate this left hand side of the (in)equality.

```

3094 \prg_set_conditional:Npnn \intexpr_compare:n #1{p,TF,T,F}{
3095   \exp_after:wN \intexpr_compare_auxi:w \intexpr_value:w
3096   \intexpr_eval:w #1\q_stop
3097 }

```

Then the next step is to figure out which relation we should use, so we have to somehow get rid of the first evaluation so that we can see what stopped it. `\tex_romannumeral:D` is handy here since its expansion given a non-positive number is `<null>`. We therefore simply check if the first token of the left hand side evaluation is a minus. If not, we insert it and issue `\tex_romannumeral:D`, thereby ridding us of the left hand side evaluation. We do however save it for later.

```

3098 \cs_set:Npn \intexpr_compare_auxi:w #1#2\q_stop{
3099   \exp_after:wN \intexpr_compare_auxii:w \tex_romannumeral:D
3100   \if:w #1- \else: -\fi: #1#2 \q_stop #1#2 \q_nil
3101 }

```

This leaves the first relation symbol in front and assuming the right hand side has been input, at least one other token as well. We support the following forms: =, <, > and the extended !=, ==, <= and >=. All the extended forms have an extra = so we check if that is present as well. Then use specific function to perform the test.

```

3102 \cs_set:Npn \intexpr_compare_auxii:w #1#2#3\q_stop{
3103   \use:c{
3104     intexpr_compare_
3105     #1 \if_meaning:w =#2 = \fi:
3106     :w}
3107 }

```

The actual comparisons are then simple function calls, using the relation as delimiter for a delimited argument. Equality is easy:

```

3112 \cs_set:cpn {intexpr_compare_=:w} #1=#2\q_nil{
3113   \if_intexpr_compare:w #1=\intexpr_eval:w #2 \intexpr_eval_end:
3114   \prg_return_true: \else: \prg_return_false: \fi:
3115 }

```

So is the one using == – we just have to use == in the parameter text.

```

3116 \cs_set:cpn {intexpr_compare_==:w} #1==#2\q_nil{
3117   \if_intexpr_compare:w #1=\intexpr_eval:w #2 \intexpr_eval_end:
3118   \prg_return_true: \else: \prg_return_false: \fi:
3119 }

```

Not equal is just about reversing the truth value.

```

3120 \cs_set:cpn {intexpr_compare_!=:w} #1!=#2\q_nil{
3121   \if_intexpr_compare:w #1=\intexpr_eval:w #2 \intexpr_eval_end:
3122   \prg_return_false: \else: \prg_return_true: \fi:
3123 }

```

Less than and greater than are also straight forward.

```

3124 \cs_set:cpn {intexpr_compare_<:w} #1<#2\q_nil{
3125   \if_intexpr_compare:w #1<\intexpr_eval:w #2 \intexpr_eval_end:
3126   \prg_return_true: \else: \prg_return_false: \fi:
3127 }
3128 \cs_set:cpn {intexpr_compare_>:w} #1>#2\q_nil{
3129   \if_intexpr_compare:w #1>\intexpr_eval:w #2 \intexpr_eval_end:
3130   \prg_return_true: \else: \prg_return_false: \fi:
3131 }

```

The less than or equal operation is just the opposite of the greater than operation. Vice versa for less than or equal.

```

3132 \cs_set:cpn {intexpr_compare_<=:w} #1<=#2\q_nil{
3133   \if_intexpr_compare:w #1>\intexpr_eval:w #2 \intexpr_eval_end:
3134   \prg_return_false: \else: \prg_return_true: \fi:
3135 }
3136 \cs_set:cpn {intexpr_compare_>=:w} #1>=#2\q_nil{
3137   \if_intexpr_compare:w #1<\intexpr_eval:w #2 \intexpr_eval_end:
3138   \prg_return_false: \else: \prg_return_true: \fi:
3139 }

```

`\intexpr_compare_p:nNn` More efficient but less natural in typing.

`\intexpr_compare:nNnTF`

```

3136 \prg_set_conditional:Npnn \intexpr_compare:nNn #1#2#3{p,TF,T,F}{
3137   \if_intexpr_compare:w \intexpr_eval:w #1 #2 \intexpr_eval:w #3
3138   \intexpr_eval_end:
3139   \prg_return_true: \else: \prg_return_false: \fi:
3140 }

```

`\intexpr_max:nn` Functions for min, max, and absolute value.

`\intexpr_min:nn`

`\intexpr_abs:n`

```

3141 \cs_set:Npn \intexpr_abs:n #1{
3142   \intexpr_value:w
3143   \if_intexpr_compare:w \intexpr_eval:w #1<\c_zero
3144   -
3145   \fi:
3146   \intexpr_eval:w #1\intexpr_eval_end:
3147 }
3148 \cs_set:Npn \intexpr_max:nn #1#2{
3149   \intexpr_value:w \intexpr_eval:w
3150   \if_intexpr_compare:w
3151     \intexpr_eval:w #1>\intexpr_eval:w #2\intexpr_eval_end:
3152     #1
3153   \else:
3154     #2
3155   \fi:
3156   \intexpr_eval_end:
3157 }
3158 \cs_set:Npn \intexpr_min:nn #1#2{
3159   \intexpr_value:w \intexpr_eval:w
3160   \if_intexpr_compare:w
3161     \intexpr_eval:w #1<\intexpr_eval:w #2\intexpr_eval_end:
3162     #1
3163   \else:
3164     #2
3165   \fi:
3166   \intexpr_eval_end:
3167 }

```

`\intexpr_div_truncate:nn` As `\intexpr_eval:w` rounds the result of a division we also provide a version that truncates the result.

`\intexpr_div_round:nn`

`\intexpr_mod:nn`

Initial version didn't work correctly with eTeX's implementation.

```

3168 %\cs_set:Npn \intexpr_div_truncate_raw:nn #1#2 {
3169 %  \intexpr_eval:n{ (2*#1 - #2) / (2* #2) }
3170 %}

```

New version by Heiko:

```

3171 \cs_set:Npn \intexpr_div_truncate:nn #1#2 {
3172   \intexpr_value:w \intexpr_eval:w
3173   \if_intexpr_compare:w \intexpr_eval:w #1 = \c_zero
3174   0
3175   \else:

```

```

3176      (#1
3177      \if_intexpr_compare:w \intexpr_eval:w #1 < \c_zero
3178      \if_intexpr_compare:w \intexpr_eval:w #2 < \c_zero
3179      -( #2 +
3180      \else:
3181      +( #2 -
3182      \fi:
3183      \else:
3184      \if_intexpr_compare:w \intexpr_eval:w #2 < \c_zero
3185      +( #2 +
3186      \else:
3187      -( #2 -
3188      \fi:
3189      \fi:
3190      1)/2)
3191      \fi:
3192      /(#2)
3193      \intexpr_eval_end:
3194  }

```

For the sake of completeness:

```

3195  \cs_set:Npn \intexpr_div_round:nn #1#2 {\intexpr_eval:n{(#1)/(#2)}}

```

Finally there's the modulus operation.

```

3196  \cs_set:Npn \intexpr_mod:nn #1#2 {
3197    \intexpr_value:w
3198    \intexpr_eval:w
3199    #1 - \intexpr_div_truncate:nn {#1}{#2} * (#2)
3200    \intexpr_eval_end:
3201  }

```

`\intexpr_if_odd_p:n` A predicate function.

```

\intexpr_if_odd:nTF
\intexpr_if_even_p:n
\intexpr_if_even:nTF
3202  \prg_set_conditional:Npnn \intexpr_if_odd:n #1 {p,TF,T,F} {
3203    \if_intexpr_odd:w \intexpr_eval:w #1\intexpr_eval_end:
3204    \prg_return_true: \else: \prg_return_false: \fi:
3205  }
3206  \prg_set_conditional:Npnn \intexpr_if_even:n #1 {p,TF,T,F} {
3207    \if_intexpr_odd:w \intexpr_eval:w #1\intexpr_eval_end:
3208    \prg_return_false: \else: \prg_return_true: \fi:
3209  }

```

`\intexpr_while_do:nn` These are quite easy given the above functions. The `while` versions test first and then execute the body. The `do_while` does it the other way round.

```

\intexpr_until_do:nn
\intexpr_do_while:nn
\intexpr_do_until:nn
3210  \cs_set:Npn \intexpr_while_do:nn #1#2{
3211    \intexpr_compare:nT {#1}{#2 \intexpr_while_do:nn {#1}{#2}}
3212  }
3213  \cs_set:Npn \intexpr_until_do:nn #1#2{
3214    \intexpr_compare:nF {#1}{#2 \intexpr_until_do:nn {#1}{#2}}
3215  }
3216  \cs_set:Npn \intexpr_do_while:nn #1#2{

```

```

3217   #2 \intexpr_compare:nT {#1}{\intexpr_do_while:nNnn {#1}{#2}}
3218 }
3219 \cs_set:Npn \intexpr_do_until:nn #1#2{
3220   #2 \intexpr_compare:nF {#1}{\intexpr_do_until:nn {#1}{#2}}
3221 }

```

\intexpr_while_do:nNnn As above but not using the more natural syntax.

```

\intexpr_until_do:nNnn
\intexpr_do_while:nNnn
\intexpr_do_until:nNnn
3222 \cs_set:Npn \intexpr_while_do:nNnn #1#2#3#4{
3223   \intexpr_compare:nNnT {#1}#2{#3}{#4 \intexpr_while_do:nNnn {#1}#2{#3}{#4}}
3224 }
3225 \cs_set:Npn \intexpr_until_do:nNnn #1#2#3#4{
3226   \intexpr_compare:nNnF {#1}#2{#3}{#4 \intexpr_until_do:nNnn {#1}#2{#3}{#4}}
3227 }
3228 \cs_set:Npn \intexpr_do_while:nNnn #1#2#3#4{
3229   #4 \intexpr_compare:nNnT {#1}#2{#3}{\intexpr_do_while:nNnn {#1}#2{#3}{#4}}
3230 }
3231 \cs_set:Npn \intexpr_do_until:nNnn #1#2#3#4{
3232   #4 \intexpr_compare:nNnF {#1}#2{#3}{\intexpr_do_until:nNnn {#1}#2{#3}{#4}}
3233 }
3234 \</initex | package>

```

103 l3skip implementation

We start by ensuring that the required packages are loaded.

```

3235 \<*package>
3236 \ProvidesExplPackage
3237   {\filename}{\filedate}{\fileversion}{\filedescription}
3238 \package_check_loaded_expl:
3239 \</package>
3240 \<*initex | package>

```

103.1 Skip registers

\skip_new:N Allocation of a new internal registers.

```

\skip_new:c
3241 \<*initex>
3242 \alloc_setup_type:nnn {skip} \c_zero \c_max_register_num
3243 \cs_new_nopar:Npn \skip_new:N #1 { \alloc_reg:NnNN g {skip} \tex_skipdef:D #1 }
3244 \cs_new_nopar:Npn \skip_new_l:N #1 { \alloc_reg:NnNN l {skip} \tex_skipdef:D #1 }
3245 \</initex>
3246 \<*package>
3247 \cs_new_nopar:Npn \skip_new:N #1 {
3248   \chk_if_free_cs:N #1
3249   \newskip #1
3250 }
3251 \</package>
3252 \cs_generate_variant:Nn \skip_new:N {c}

```

`\skip_set:Nn` Setting skips is again something that I would like to make uniform at the moment to get a better overview.

`\skip_set:cn`

`\skip_gset:Nn`

`\skip_gset:cn`

```

3253 \cs_new_nopar:Npn \skip_set:Nn #1#2 {
3254   #1\skip_eval:n{#2}
3255 }
3256 \chk_local_or_pref_global:N #1
3257 /check
3258 }
3259 \cs_new_nopar:Npn \skip_gset:Nn {
3260 }
3261 \pref_global_chk:
3262 /check
3263 -check \pref_global:D
3264 \skip_set:Nn
3265 }
3266 \cs_generate_variant:Nn \skip_set:Nn {cn}
3267 \cs_generate_variant:Nn \skip_gset:Nn {cn}

```

`\skip_zero:N` Reset the register to zero.

`\skip_gzero:N`

`\skip_zero:c`

`\skip_gzero:c`

```

3268 \cs_new_nopar:Npn \skip_zero:N #1{
3269   #1\c_zero_skip \scan_stop:
3270 }
3271 \chk_local_or_pref_global:N #1
3272 /check
3273 }
3274 \cs_new_nopar:Npn \skip_gzero:N {

```

We make sure that a local variable is not updated globally by changing the internal test (i.e. `\chk_local_or_pref_global:N`) before making the assignment. This is done by `\pref_global_chk:` which also issues the necessary `\pref_global:D`. This is not very efficient, but this code will be only included for debugging purposes. Using `\pref_global:D` in front of the local function is better in the production versions.

```

3275 }
3276 \pref_global_chk:
3277 /check
3278 -check \pref_global:D
3279 \skip_zero:N
3280 }
3281 \cs_generate_variant:Nn \skip_zero:N {c}
3282 \cs_generate_variant:Nn \skip_gzero:N {c}

```

`\skip_add:Nn` Adding and subtracting to and from `<skip>s`

`\skip_add:cn`

`\skip_gadd:Nn`

`\skip_gadd:cn`

`\skip_sub:Nn`

`\skip_gsub:Nn`

```

3283 \cs_new_nopar:Npn \skip_add:Nn #1#2 {

```

We need to say by in case the first argument is a register accessed by its number, e.g., `\skip23`.

```

3284 \tex_advance:D#1 by \skip_eval:n{#2}
3285 }
3286 \chk_local_or_pref_global:N #1

```



```

3287 </check>
3288 }
3289 \cs_generate_variant:Nn \skip_add:Nn {cn}

3290 \cs_new_nopar:Npn \skip_sub:Nn #1#2{
3291   \tex_advance:D#1-\skip_eval:n{#2}
3292 <*check>
3293   \chk_local_or_pref_global:N #1
3294 </check>
3295 }

3296 \cs_new_nopar:Npn \skip_gadd:Nn {
3297 <*check>
3298   \pref_global_chk:
3299 </check>
3300 <-check> \pref_global:D
3301   \skip_add:Nn
3302 }
3303 \cs_generate_variant:Nn \skip_gadd:Nn {cn}

3304 \cs_new_nopar:Npn \skip_gsub:Nn {
3305 <*check>
3306   \pref_global_chk:
3307 </check>
3308 <-check> \pref_global:D
3309   \skip_sub:Nn
3310 }

```

\skip_horizontal:N Inserting skips.

```

\skip_horizontal:c
\skip_horizontal:n
\skip_vertical:N
\skip_vertical:c
\skip_vertical:n
3311 \cs_new_eq:NN \skip_horizontal:N \tex_hskip:D
3312 \cs_generate_variant:Nn \skip_horizontal:N {c}

3313 \cs_new_nopar:Npn \skip_horizontal:n #1 { \skip_horizontal:N \skip_eval:n{#1} }
3314 \cs_new_eq:NN \skip_vertical:N \tex_vskip:D
3315 \cs_generate_variant:Nn \skip_vertical:N {c}
3316 \cs_new_nopar:Npn \skip_vertical:n #1 { \skip_vertical:N \skip_eval:n{#1} }

```

\skip_use:N Here is how skip registers are accessed:

```

\skip_use:c
3317 \cs_new_eq:NN \skip_use:N \tex_the:D
3318 \cs_generate_variant:Nn \skip_use:N {c}

```

\skip_show:N Diagnostics.

```

\skip_show:c
3319 \cs_new_eq:NN \skip_show:N \tex_showthe:D
3320 \cs_new_nopar:Npn \skip_show:c #1 { \skip_show:N \cs:w #1 \cs_end: }

```

\skip_eval:n Evaluating a calc expression.

```

3321 \cs_new_nopar:Npn \skip_eval:n #1 { \etex_glueexpr:D #1 \scan_stop: }

```

`\l_tmpa_skip` We provide three local and two global scratch registers, maybe we need more or less.

```

\l_tmpb_skip
\l_tmpc_skip
\g_tmpa_skip
\g_tmpb_skip
3322 %%\chk_if_free_cs:N \l_tmpa_skip
3323 %%\tex_skipdef:D\l_tmpa_skip 255 %currently taken up by \skip@
3324 \skip_new:N \l_tmpa_skip
3325 \skip_new:N \l_tmpb_skip
3326 \skip_new:N \l_tmpc_skip
3327 \skip_new:N \g_tmpa_skip
3328 \skip_new:N \g_tmpb_skip

```

```

\c_zero_skip
\c_max_skip
3329 <*\package>
3330 \skip_new:N \c_zero_skip
3331 \skip_set:Nn \c_zero_skip {0pt}
3332 \skip_new:N \c_max_skip
3333 \skip_set:Nn \c_max_skip {16383.99999pt}
3334 </!\package>
3335 <*\linitex>
3336 \cs_set_eq:NN \c_zero_skip \z@
3337 \cs_set_eq:NN \c_max_skip \maxdimen
3338 </!\linitex>

```

`\skip_if_infinite_glue_p:n` With ε -TEX we all of a sudden get access to a lot information we should otherwise consider ourselves lucky to get. One is the stretch and shrink components of a skip register and the order of those components. `\skip_if_infinite_glue:nTF` tests it directly by looking at the stretch and shrink order. If either of the predicate functions return $\langle true \rangle$ `\bool_if:nTF` will return $\langle true \rangle$ and the logic test will take the true branch.

```

3339 \prg_new_conditional:Nnn \skip_if_infinite_glue:n {p,TF,T,F} {
3340   \bool_if:nTF {
3341     \intexpr_compare_p:nNn {\etex_gluestretchorder:D #1 } > \c_zero ||
3342     \intexpr_compare_p:nNn {\etex_glueshrinkorder:D #1 } > \c_zero
3343   } {\prg_return_true:} {\prg_return_false:}
3344 }

```

`\split_finite_else_action:nnNN` This macro is useful when performing error checking in certain circumstances. If the $\langle skip \rangle$ register holds finite glue it sets #3 and #4 to the stretch and shrink component resp. If it holds infinite glue set #3 and #4 to zero and issue the special action #2 which is probably an error message. Assignments are global.

```

3345 \cs_new_nopar:Npn \skip_split_finite_else_action:nnNN #1#2#3#4{
3346   \skip_if_infinite_glue:nTF {#1}
3347   {
3348     #3 = \c_zero_skip
3349     #4 = \c_zero_skip
3350     #2
3351   }
3352   {
3353     #3 = \etex_gluestretch:D #1 \scan_stop:
3354     #4 = \etex_glueshrink:D #1 \scan_stop:
3355   }
3356 }

```

103.2 Dimen registers

`\dim_new:N` Allocating $\langle dim \rangle$ registers...

`\dim_new:c`

```

3357 \*initex
3358 \alloc_setup_type:nnn {dimen} \c_zero \c_max_register_num
3359 \cs_new_nopar:Npn \dim_new:N #1 {\alloc_reg:NnNN g {dimen} \tex_dimendef:D #1 }
3360 \cs_new_nopar:Npn \dim_new_l:N #1 {\alloc_reg:NnNN l {dimen} \tex_dimendef:D #1 }
3361 \*initex
3362 \*package
3363 \cs_new_nopar:Npn \dim_new:N #1 {
3364   \chk_if_free_cs:N #1
3365   \newdimen #1
3366 }
3367 \*package
3368 \cs_generate_variant:Nn \dim_new:N {c}

```

`\dim_set:Nn` We add `\dim_eval:n` in order to allow simple arithmetic and a space just for those using
`\dim_set:cn` `\dimen1` or alike. See OR!

`\dim_set:Nc`

```

3369 \cs_new_nopar:Npn \dim_set:Nn #1#2 { #1~ \dim_eval:n{#2} }
3370 \cs_generate_variant:Nn \dim_set:Nn {cn,Nc}

3371 \cs_new_nopar:Npn \dim_gset:Nn { \pref_global:D \dim_set:Nn }
3372 \cs_generate_variant:Nn \dim_gset:Nn {cn,Nc,cc}

```

`\dim_zero:N` Resetting.

`\dim_gzero:N`

`\dim_zero:c`

`\dim_gzero:c`

```

3373 \cs_new_nopar:Npn \dim_zero:N #1 { #1\c_zero_skip }
3374 \cs_generate_variant:Nn \dim_zero:N {c}

3375 \cs_new_nopar:Npn \dim_gzero:N { \pref_global:D \dim_zero:N }
3376 \cs_generate_variant:Nn \dim_gzero:N {c}

```

`\dim_add:Nn` Addition.

`\dim_add:cn`

`\dim_add:Nc`

`\dim_gadd:Nn`

`\dim_gadd:cn`

```

3377 \cs_new_nopar:Npn \dim_add:Nn #1#2{

```

We need to say by in case the first argument is a register accessed by its number, e.g.,
`\dimen23`.

```

3378   \tex_advance:D#1 by \dim_eval:n{#2}\scan_stop:
3379 }
3380 \cs_generate_variant:Nn \dim_add:Nn {cn,Nc}

3381 \cs_new_nopar:Npn \dim_gadd:Nn { \pref_global:D \dim_add:Nn }
3382 \cs_generate_variant:Nn \dim_gadd:Nn {cn}

```

`\dim_sub:Nn` Subtracting.

`\dim_sub:cn`

`\dim_sub:Nc`

`\dim_gsub:Nn`

`\dim_gsub:cn`

```

3383 \cs_new_nopar:Npn \dim_sub:Nn #1#2 { \tex_advance:D#1-#2\scan_stop: }
3384 \cs_generate_variant:Nn \dim_sub:Nn {cn,Nc}

```

```

3385 \cs_new_nopar:Npn \dim_gsub:Nn { \pref_global:D \dim_sub:Nn }
3386 \cs_generate_variant:Nn \dim_gsub:Nn {cn}

\dim_use:N Accessing a  $\langle dim \rangle$ .
\dim_use:c
3387 \cs_new_eq:NN \dim_use:N \tex_the:D
3388 \cs_generate_variant:Nn \dim_use:N {c}

\dim_show:N Diagnostics.
\dim_show:c
3389 \cs_new_eq:NN \dim_show:N \tex_showthe:D
3390 \cs_new_nopar:Npn \dim_show:c #1 { \dim_show:N \cs:w #1 \cs_end: }

\l_tmpa_dim Some scratch registers.
\l_tmpb_dim
\l_tmpc_dim
\l_tmpd_dim
\g_tmpa_dim
\g_tmpb_dim
3391 \dim_new:N \l_tmpa_dim
3392 \dim_new:N \l_tmpb_dim
3393 \dim_new:N \l_tmpc_dim
3394 \dim_new:N \l_tmpd_dim
3395 \dim_new:N \g_tmpa_dim
3396 \dim_new:N \g_tmpb_dim

\c_zero_dim Just aliases.
\c_max_dim
3397 \cs_new_eq:NN \c_zero_dim \c_zero_skip
3398 \cs_new_eq:NN \c_max_dim \c_max_skip

\dim_eval:n Evaluating a calc expression.
3399 \cs_new_nopar:Npn \dim_eval:n #1 { \etex_dimexpr:D #1 \scan_stop: }

\if_dim:w The comparison primitive.
3400 \cs_new_eq:NN \if_dim:w \tex_ifdim:D

\dim_compare_p:nNn
\dim_compare:nNnTF
3401 \prg_new_conditional:Nnn \dim_compare:nNn {p,TF,T,F} {
3402   \if_dim:w \dim_eval:n {#1} #2 \dim_eval:n {#3}
3403   \prg_return_true: \else: \prg_return_false: \fi:
3404 }

\dim_while_do:nNnn while_do and do_while functions for dimensions. Same as for the int type only the
\dim_until_do:nNnn names have changed.
\dim_do_while:nNnn
\dim_do_until:nNnn
3405 \cs_new_nopar:Npn \dim_while_do:nNnn #1#2#3#4{
3406   \dim_compare:nNnT {#1}#2{#3}{#4} \dim_while_do:nNnn {#1}#2{#3}{#4}}
3407 }
3408 \cs_new_nopar:Npn \dim_until_do:nNnn #1#2#3#4{
3409   \dim_compare:nNnF {#1}#2{#3}{#4} \dim_until_do:nNnn {#1}#2{#3}{#4}}
3410 }
3411 \cs_new_nopar:Npn \dim_do_while:nNnn #1#2#3#4{
3412   #4 \dim_compare:nNnT {#1}#2{#3}{\dim_do_while:nNnn {#1}#2{#3}{#4}}
3413 }
3414 \cs_new_nopar:Npn \dim_do_until:nNnn #1#2#3#4{
3415   #4 \dim_compare:nNnF {#1}#2{#3}{\dim_do_until:nNnn {#1}#2{#3}{#4}}
3416 }

```

103.3 Muskips

`\muskip_new:N` And then we add muskips.

```

3417 <*initex>
3418 \alloc_setup_type:nnn {muskip} \c_zero \c_max_register_num
3419 \cs_new_nopar:Npn \muskip_new:N #1{\alloc_reg:NnNN g {muskip} \tex_muskipdef:D #1}
3420 \cs_new_nopar:Npn \muskip_new_l:N #1{\alloc_reg:NnNN l {muskip} \tex_muskipdef:D #1}
3421 </initex>
3422 <*package>
3423 \cs_new_nopar:Npn \muskip_new:N #1 {
3424   \chk_if_free_cs:N #1
3425   \newmuskip #1
3426 }
3427 </package>

```

`\muskip_set:Nn` Simple functions for muskips.

```

\muskip_gset:Nn
\muskip_add:Nn
\muskip_gadd:Nn
\muskip_sub:Nn
\muskip_gsub:Nn
3428 \cs_new_nopar:Npn \muskip_set:Nn#1#2{#1\etex_muexpr:D#2\scan_stop:}
3429 \cs_new_nopar:Npn \muskip_gset:Nn{\pref_global:D\muskip_set:Nn}
3430 \cs_new_nopar:Npn \muskip_add:Nn#1#2{\tex_advance:D#1\etex_muexpr:D#2\scan_stop:}
3431 \cs_new_nopar:Npn \muskip_gadd:Nn{\pref_global:D\muskip_add:Nn}
3432 \cs_new_nopar:Npn \muskip_sub:Nn#1#2{\tex_advance:D#1-\etex_muexpr:D#2\scan_stop:}
3433 \cs_new_nopar:Npn \muskip_gsub:Nn{\pref_global:D\muskip_sub:Nn}

```

`\muskip_use:N` Accessing a `<muskip>`.

```

3434 \cs_new_eq:NN \muskip_use:N \tex_the:D
3435 </initex | package>

```

104 l3tl implementation

We start by ensuring that the required packages are loaded.

```

3436 <*package>
3437 \ProvidesExplPackage
3438   {\filename}{\filedate}{\fileversion}{\filedescription}
3439   \package_check_loaded_expl:
3440 </package>
3441 <*initex | package>

```

A token list variable is a control sequence that holds tokens. The interface is similar to that for token registers, but beware that the behavior vis á vis `\cs_set_nopar:Npx` etc. ... is different. (You see this comes from Denys' implementation.)

104.1 Functions

`\tl_new:N` We provide one allocation function (which checks that the name is not used) and two clear functions that locally or globally clear the token list. The allocation function has two arguments to specify an initial value. This is the only way to give values to constants.

`\tl_new:c`
`\tl_new:Nn`
`\tl_new:cn`
`\tl_new:Nx`

```

3442 \cs_new:Npn \tl_new:Nn #1#2{
3443   \chk_if_free_cs:N #1

```

If checking we don't allow constants to be defined.

```

3444 <*check>
3445   \chk_var_or_const:N #1
3446 </check>

```

Otherwise any variable type is allowed.

```

3447   \cs_gset_nopar:Npn #1{#2}
3448 }
3449 \cs_generate_variant:Nn \tl_new:Nn {cn}
3450 \cs_new:Npn \tl_new:Nx #1#2{
3451   \chk_if_free_cs:N #1
3452 <check> \chk_var_or_const:N #1
3453   \cs_gset_nopar:Npx #1{#2}
3454 }
3455 \cs_new_nopar:Npn \tl_new:N #1{\tl_new:Nn #1{}}
3456 \cs_new_nopar:Npn \tl_new:c #1{\tl_new:cn {#1}{}}

```

`\tl_use:N` Perhaps this should just be enabled when checking?
`\tl_use:c`

```

3457 \cs_new_nopar:Npn \tl_use:N #1 {
3458   \if_meaning:w #1 \tex_relax:D

```

If `<tl var.>` equals `\tex_relax:D` it is probably stemming from a `\cs:w... \cs_end:` that was created by mistake somewhere.

```

3459   \msg_kernel_bug:x {Token-list-variable~ '\token_to_str:N #1'~
3460                     has~ an~ erroneous~ structure!}
3461   \else:
3462     \exp_after:wN #1
3463   \fi:
3464 }
3465 \cs_generate_variant:Nn \tl_use:N {c}

```

`\tl_show:N` Showing a `<tl var.>` is just `\show`ing it and I don't really care about checking that it's malformed at this stage.
`\tl_show:c`
`\tl_show:n`

```

3466 \cs_new_nopar:Npn \tl_show:N #1 { \cs_show:N #1 }
3467 \cs_generate_variant:Nn \tl_show:N {c}
3468 \cs_set_eq:NN \tl_show:n \etex_showtokens:D

```

`\tl_set:Nn` To set token lists to a specific value to type of functions are available: `\tl_set_eq:NN` takes two token-lists as its arguments assign the first the contents of the second;
`\tl_set:Nv` `\tl_set:Nn` has as its second argument a 'real' list of tokens. One can view

`\tl_set:Nv`
`\tl_set:Nf`
`\tl_set:Nx`
`\tl_set:cn`
`\tl_set:cV`
`\tl_set:co`
`\tl_set:cx`
`\tl_gset:Nn`
`\tl_gset:Nv`
`\tl_gset:Nn`

\tl_set_eq:NN as a special form of \tl_set:No. Both functions have global counterparts.

During development we check if the token list that is being assigned to exists. If not, a warning will be issued.

```

3469 <*check>
3470 \cs_new:Npn \tl_set:Nn #1#2{
3471   \chk_exist_cs:N #1 \cs_set_nopar:Npn #1{#2}

```

We use \chk_local_or_pref_global:N after the assignment to allow constructs with \pref_global_chk:. But one should note that this is less efficient then using the real global variant since they are built-in.

```

3472   \chk_local_or_pref_global:N #1
3473 }
3474 \cs_new:Npn \tl_set:Nx #1#2{
3475   \chk_exist_cs:N #1 \cs_set_nopar:Npx #1{#2} \chk_local:N #1
3476 }

```

The the global versions.

```

3477 \cs_new:Npn \tl_gset:Nn #1#2{
3478   \chk_exist_cs:N #1 \cs_gset_nopar:Npn #1{#2} \chk_global:N #1
3479 }
3480 \cs_new:Npn \tl_gset:Nx #1#2{
3481   \chk_exist_cs:N #1 \cs_gset_nopar:Npx #1{#2} \chk_global:N #1
3482 }
3483 </check>

```

For some functions like \tl_set:Nn we need to define the ‘non-check’ version with arguments since we want to allow constructions like \tl_set:Nn\l_tmpa_tl\foo and so we can’t use the primitive \TeX command.

```

3484 <!*check>
3485 \cs_new:Npn \tl_set:Nn#1#2{\cs_set_nopar:Npn#1{#2}}
3486 \cs_new:Npn \tl_set:Nx#1#2{\cs_set_nopar:Npx#1{#2}}
3487 \cs_new:Npn \tl_gset:Nn#1#2{\cs_gset_nopar:Npn#1{#2}}
3488 \cs_new:Npn \tl_gset:Nx#1#2{\cs_gset_nopar:Npx#1{#2}}
3489 </!check>

```

The remaining functions can just be defined with help from the expansion module.

```

3490 \cs_generate_variant:Nn \tl_set:Nn {NV,No,Nv,Nf,cn,cV,co,cx}
3491 \cs_generate_variant:Nn \tl_gset:Nn {NV,No,Nv,cn,cx}

```

\ tl _ set _ eq : NN \ tl _ set _ eq : Nc \ tl _ set _ eq : cN \ tl _ set _ eq : cc \ tl _ gset _ eq : NN \ tl _ gset _ eq : Nc \ tl _ gset _ eq : cN \ tl _ gset _ eq : cc	For setting token list variables equal to each other. First checking: <pre> 3492 <*check> 3493 \cs_new_nopar:Npn \tl_set_eq:NN #1#2{ 3494 \chk_exist_cs:N #1 \cs_set_eq:NN #1#2 3495 \chk_local_or_pref_global:N #1 \chk_var_or_const:N #2 3496 } 3497 \cs_new_nopar:Npn \tl_gset_eq:NN #1#2{ 3498 \chk_exist_cs:N #1 \cs_gset_eq:NN #1#2 </pre>
--	---

```

3499 \chk_global:N #1 \chk_var_or_const:N #2
3500 }
3501 </check>

```

Non-checking versions are easy.

```

3502 <!*check>
3503 \cs_new_eq:NN \tl_set_eq:NN \cs_set_eq:NN
3504 \cs_new_eq:NN \tl_gset_eq:NN \cs_gset_eq:NN
3505 </!check>

```

The rest again with the expansion module.

```

3506 \cs_generate_variant:Nn \tl_set_eq:NN {Nc,c,cc}
3507 \cs_generate_variant:Nn \tl_gset_eq:NN {Nc,c,cc}

```

\tl_clear:N Clearing a token list variable.

```

\tl_clear:c
\tl_gclear:N
\tl_gclear:c
3508 \cs_new_nopar:Npn \tl_clear:N #1{\tl_set_eq:NN #1\c_empty_tl}
3509 \cs_generate_variant:Nn \tl_clear:N {c}
3510 \cs_new_nopar:Npn \tl_gclear:N #1{\tl_gset_eq:NN #1\c_empty_tl}
3511 \cs_generate_variant:Nn \tl_gclear:N {c}

```

\tl_clear_new:N These macros check whether a token list exists. If it does it is cleared, if it doesn't it is allocated.

```

\tl_clear_new:c
3512 <*check>
3513 \cs_new_nopar:Npn \tl_clear_new:N #1{
3514 \chk_var_or_const:N #1
3515 \if_predicate:w \cs_if_exist_p:N #1
3516 \tl_clear:N #1
3517 \else:
3518 \tl_new:Nn #1{}
3519 \fi:
3520 }
3521 </check>
3522 <-check>\cs_new_eq:NN \tl_clear_new:N \tl_clear:N
3523 \cs_generate_variant:Nn \tl_clear_new:N {c}

```

\tl_gclear_new:N These are the global versions of the above.

```

\tl_gclear_new:c
3524 <*check>
3525 \cs_new_nopar:Npn \tl_gclear_new:N #1{
3526 \chk_var_or_const:N #1
3527 \if_predicate:w \cs_if_exist_p:N #1
3528 \tl_gclear:N #1
3529 \else:
3530 \tl_new:Nn #1{}
3531 \fi:}
3532 </check>
3533 <-check>\cs_new_eq:NN \tl_gclear_new:N \tl_gclear:N
3534 \cs_generate_variant:Nn \tl_gclear_new:N {c}

```


\backslash tl_put_left:Nn \backslash tl_put_left:NV \backslash tl_put_left:No \backslash tl_put_left:Nx \backslash tl_put_left:cn \backslash tl_put_left:cV \backslash tl_put_left:co \backslash tl_gput_left:Nn \backslash tl_gput_left:NV \backslash tl_gput_left:No \backslash tl_gput_left:Nx \backslash tl_gput_left:cn \backslash tl_gput_left:cV \backslash tl_gput_left:co	<p>We can add tokens to the left (either globally or locally). It is not quite as easy as we would like because we have to ensure the assignments</p> <pre> \l_tpa_tl{##1abc##2def} \l_tpb_tl{##1abc} \l_tpb_tl{##2def} </pre> <p>cause \backslashl_tpa_tl and \backslashl_tpb_tl to be identical. The old code did not succeed in doing this (it gave an error) and so we use a different technique where the item(s) to be added are first stored in a temporary variable and then added using an x type expansion combined with the appropriate level of non-expansion. Putting the tokens directly into one assignment does not work unless we want full expansion. Note (according to the warning earlier) T_EX does not allow us to treat #s the same in all cases. Tough.</p>
---	--

```

3535 \cs_new:Npn \tl_put_left:Nn #1#2 {
3536   \tl_set:Nn \l_exp_tl {#2}
3537   \tl_set:Nx #1 { \exp_not:V \l_exp_tl \exp_not:V #1 }
3538   <check> \chk_local_or_pref_global:N #1
3539 }
3540 \cs_new:Npn \tl_put_left:NV #1#2 {
3541   \tl_set:Nx #1 { \exp_not:V #2 \exp_not:V #1 }
3542 }
3543 \cs_new:Npn \tl_put_left:No #1#2{
3544   \tl_set:No \l_exp_tl {#2}
3545   \tl_set:Nx #1 { \exp_not:V \l_exp_tl \exp_not:V #1 }
3546   <check> \chk_local_or_pref_global:N #1
3547 }
3548 \cs_new:Npn \tl_put_left:Nx #1#2{
3549   \tl_set:Nx #1 { #2 \exp_not:V #1 }
3550   <check> \chk_local_or_pref_global:N #1
3551 }
3552 \cs_new:Npn \tl_gput_left:Nn #1#2{
3553   \tl_set:Nn \l_exp_tl{#2}
3554   \tl_gset:Nx #1 { \exp_not:V \l_exp_tl \exp_not:V #1 }
3555   <check> \chk_local_or_pref_global:N #1
3556 }
3557 \cs_new:Npn \tl_gput_left:NV #1#2 {
3558   \tl_gset:Nx #1 { \exp_not:V #2 \exp_not:V #1 }
3559 }
3560 \cs_new:Npn \tl_gput_left:No #1#2{
3561   \tl_set:No \l_exp_tl {#2}
3562   \tl_gset:Nx #1 { \exp_not:V \l_exp_tl \exp_not:V #1 }
3563   <check> \chk_local_or_pref_global:N #1
3564 }
3565 \cs_new:Npn \tl_gput_left:Nx #1#2{
3566   \tl_gset:Nx #1 { #2 \exp_not:V #1 }
3567   <check> \chk_local_or_pref_global:N #1
3568 }
3569 \cs_generate_variant:Nn \tl_put_left:Nn {cn,co,cV}

3570 \cs_generate_variant:Nn \tl_gput_left:Nn {cn,co}
3571 \cs_generate_variant:Nn \tl_gput_left:NV {cV}

```

\tl_put_right:Nn These are variants of the functions above, but for adding tokens to the right.

```

\tl_put_right:NV
\tl_put_right:No
\tl_put_right:Nx
\tl_put_right:cn
\tl_put_right:cV
\tl_put_right:co
\tl_gput_right:Nn
\tl_gput_right:NV
\tl_gput_right:No
\tl_gput_right:Nx
\tl_gput_right:cn
\tl_gput_right:cV
\tl_gput_right:co
3572 \cs_new:Npn \tl_put_right:Nn #1#2 {
3573   \tl_set:Nn \l_exp_tl {#2}
3574   \tl_set:Nx #1 { \exp_not:V #1 \exp_not:V \l_exp_tl }
3575   <check> \chk_local_or_pref_global:N #1
3576 }
3577 \cs_new:Npn \tl_gput_right:Nn #1#2{
3578   \tl_set:Nn \l_exp_tl {#2}
3579   \tl_gset:Nx #1 { \exp_not:V #1 \exp_not:V \l_exp_tl }
3580   <check> \chk_local_or_pref_global:N #1
3581 }
3582 \cs_new:Npn \tl_put_right:NV #1#2 {
3583   \tl_set:Nx #1 { \exp_not:V #1 \exp_not:V #2 }
3584 }
3585 \cs_new:Npn \tl_put_right:No #1#2 {
3586   \tl_set:No \l_exp_tl {#2}
3587   \tl_set:Nx #1 { \exp_not:V #1 \exp_not:V \l_exp_tl }
3588   <check> \chk_local_or_pref_global:N #1
3589 }
3590 \cs_new:Npn \tl_gput_right:NV #1#2 {
3591   \tl_gset:Nx #1 { \exp_not:V #1 \exp_not:V #2 }
3592 }
3593 \cs_new:Npn \tl_gput_right:No #1#2 {
3594   \tl_set:No \l_exp_tl {#2}
3595   \tl_gset:Nx #1 { \exp_not:V #1 \exp_not:V \l_exp_tl }
3596   <check> \chk_local_or_pref_global:N #1
3597 }
3598 \cs_set:Npn \tl_put_right:Nx #1#2 {
3599   \tl_set:Nx #1 { \exp_not:V #1 #2 }
3600   <check> \chk_local_or_pref_global:N #1
3601 }
3602 \cs_set:Npn \tl_gput_right:Nx #1#2 {
3603   \tl_gset:Nx #1 { \exp_not:V #1 #2 }
3604   <check> \chk_local_or_pref_global:N #1
3605 }
3606 \cs_generate_variant:Nn \tl_put_right:Nn {cn,co}
3607 \cs_generate_variant:Nn \tl_put_right:NV {cV}
3608 \cs_generate_variant:Nn \tl_gput_right:Nn {cn,co,cV}

```

\tl_gset:Nc These two functions are included because they are necessary in Denys' implementations.
\tl_set:Nc The :Nc convention (see the expansion module) is very unusual at first sight, but it works nicely over all modules, so we would like to keep it.

Construct a control sequence on the fly from #2 and save it in #1.

```

3609 \cs_new_nopar:Npn \tl_gset:Nc {
3610   <*check>
3611   \pref_global_chk:
3612   </check>
3613   <-check> \pref_global:D
3614   \tl_set:Nc}

```

\pref_global_chk: will turn the variable check in \tl_set:No into a global check.

```
3615 \cs_new_nopar:Npn \tl_set:Nc #1#2{\tl_set:No #1{\cs:w#2\cs_end:}}
```

104.2 Variables and constants

`\c_job_name_tl` Inherited from the `expl3` name for the primitive.

```
3616 \tl_new:Nn \c_job_name_tl {\tex_jobname:D}
```

`\c_empty_tl` Two constants which are often used.

```
3617 \tl_new:Nn \c_empty_tl {}
```

`\g_tmpa_tl` Global temporary token list variables. They are supposed to be set and used immediately, with no delay between the definition and the use because you can't count on other macros not to redefine them from under you.

```
3618 \tl_new:Nn \g_tmpa_tl {}
```

```
3619 \tl_new:Nn \g_tmpb_tl {}
```

`\l_testa_tl` Global and local temporaries. These are the ones for test routines. This means that one can safely use other temporaries when calling test routines.

`\l_testb_tl`

`\g_testa_tl`

`\g_testb_tl`

```
3620 \tl_new:Nn \l_testa_tl {}
```

```
3621 \tl_new:Nn \l_testb_tl {}
```

```
3622 \tl_new:Nn \g_testa_tl {}
```

```
3623 \tl_new:Nn \g_testb_tl {}
```

`\l_tmpa_tl` These are local temporary token list variables.

`\l_tmpb_tl`

```
3624 \tl_new:Nn \l_tmpa_tl {}
```

```
3625 \tl_new:Nn \l_tmpb_tl {}
```

104.3 Predicates and conditionals

We also provide a few conditionals, both in expandable form (with `\c_true_bool`) and in 'brace-form', the latter are denoted by `TF` at the end, as explained elsewhere.

`\tl_if_empty_p:N` These functions check whether the token list in the argument is empty and execute the proper code from their argument(s).

`\tl_if_empty_p:c`

`\tl_if_empty:NTF`

`\tl_if_empty:cTF`

```
3626 \prg_set_conditional:Npnn \tl_if_empty:N #1 {p,TF,T,F} {
```

```
3627   \if_meaning:w #1 \c_empty_tl
```

```
3628   \prg_return_true: \else: \prg_return_false: \fi:
```

```
3629 }
```

```
3630 \cs_generate_variant:Nn \tl_if_empty_p:N {c}
```

```
3631 \cs_generate_variant:Nn \tl_if_empty:N {NTF}
```

```
3632 \cs_generate_variant:Nn \tl_if_empty:NT {c}
```

```
3633 \cs_generate_variant:Nn \tl_if_empty:NF {c}
```

`\tl_if_eq_p:N` Returns `\c_true_bool` iff the two token list variables are equal.

```

3634 \prg_new_conditional:Npnn \tl_if_eq:N #1#2 {p,TF,T,F} {
3635   \if_meaning:w #1 #2 \prg_return_true: \else: \prg_return_false: \fi:
3636 }
3637 \cs_generate_variant:Nn \tl_if_eq_p:N {Nc,c,cc}
3638 \cs_generate_variant:Nn \tl_if_eq:NNTF {Nc,c,cc}
3639 \cs_generate_variant:Nn \tl_if_eq:NNT {Nc,c,cc}
3640 \cs_generate_variant:Nn \tl_if_eq:NNF {Nc,c,cc}

```

`\tl_if_empty_p:n` It would be tempting to just use `\if_meaning:w\q_nil#1\q_nil` as a test since this works really well. However it fails on a token list starting with `\q_nil` of course but more troubling is the case where argument is a complete conditional such as `\if_true: a \else: b \fi:` because then `\if_true:` is used by `\if_meaning:w`, the test turns out false, the `\else:` executes the false branch, the `\fi:` ends it and the `\q_nil` at the end starts executing... A safer route is to convert the entire token list into harmless characters first and then compare that. This way the test will even accept `\q_nil` as the first token.

```

3641 \prg_new_conditional:Npnn \tl_if_empty:n #1 {p,TF,T,F} {
3642   \exp_after:wN \if_meaning:w \exp_after:wN \q_nil \tl_to_str:n {#1} \q_nil
3643   \prg_return_true: \else: \prg_return_false: \fi:
3644 }
3645 \cs_generate_variant:Nn \tl_if_empty_p:n {V}
3646 \cs_generate_variant:Nn \tl_if_empty:nTF {V}
3647 \cs_generate_variant:Nn \tl_if_empty:nT {V}
3648 \cs_generate_variant:Nn \tl_if_empty:nF {V}
3649 \cs_generate_variant:Nn \tl_if_empty_p:n {o}
3650 \cs_generate_variant:Nn \tl_if_empty:nTF {o}
3651 \cs_generate_variant:Nn \tl_if_empty:nT {o}
3652 \cs_generate_variant:Nn \tl_if_empty:nF {o}

```

`\tl_if_blank_p:n` This is based on the answers in “Around the Bend No 2” but is safer as the tests listed there all have one small flaw: If the input in the test is two tokens with the same meaning as the internal delimiter, they will fail since one of them is mistaken for the actual delimiter. In our version below we make sure to pass the input through `\tl_to_str:n` which ensures that all the tokens are converted to catcode 12. However we use an `a` with catcode 11 as delimiter so we can *never* get into the same problem as the solutions in “Around the Bend No 2”.

```

3653 \prg_new_conditional:Npnn \tl_if_blank:n #1 {p,TF,T,F} {
3654   \exp_after:wN \tl_if_blank_p_aux:w \tl_to_str:n {#1} aa..\q_nil
3655 }
3656 \cs_new:Npn \tl_if_blank_p_aux:w #1#2 a #3#4 \q_nil {
3657   \if_meaning:w #3 #4 \prg_return_true: \else: \prg_return_false: \fi:
3658 }
3659 \cs_generate_variant:Nn \tl_if_blank_p:n {V}
3660 \cs_generate_variant:Nn \tl_if_blank:nTF {V}
3661 \cs_generate_variant:Nn \tl_if_blank:nT {V}
3662 \cs_generate_variant:Nn \tl_if_blank:nF {V}
3663 \cs_generate_variant:Nn \tl_if_blank_p:n {o}
3664 \cs_generate_variant:Nn \tl_if_blank:nTF {o}
3665 \cs_generate_variant:Nn \tl_if_blank:nT {o}
3666 \cs_generate_variant:Nn \tl_if_blank:nF {o}

```

`\tl_if_eq:xxTF` Test if two token lists are identical. pdfTeX contains a most interesting primitive for expandable string comparison so we make use of it if available. Presumably it will be in the final version.

`\tl_if_eq:nnTF` Firstly we give it an appropriate name. Note that this primitive actually performs an x type expansion but it is still expandable! Hence we must program these functions backwards to add `\exp_not:n`. We provide the combinations for the types n, o and x.

```

\tl_if_eq:ooTF
\tl_if_eq:xnTF
\tl_if_eq:nxTF
\tl_if_eq:onTF
\tl_if_eq:noTF
3667 \cs_new_eq:NN \tl_compare:xx \pdf_strcmp:D
\tl_if_eq:VnTF
3668 \cs_new:Npn \tl_compare:nn #1#2{
3669   \tl_compare:xx{\exp_not:n{#1}}{\exp_not:n{#2}}
\tl_if_eq:nVTF
3670 }
\tl_if_eq:xVTF
3671 \cs_new:Npn \tl_compare:nx #1{
\tl_if_eq:xoTF
3672   \tl_compare:xx{\exp_not:n{#1}}
\tl_if_eq:VxTF
3673 }
\tl_if_eq:oxTF
3674 \cs_new:Npn \tl_compare:xn #1#2{
\tl_if_eq_p:xx
3675   \tl_compare:xx{#1}{\exp_not:n{#2}}
\tl_if_eq_p:nn
3676 }
\tl_if_eq_p:VV
3677 \cs_new:Npn \tl_compare:nV #1#2 {
\tl_if_eq_p:oo
3678   \tl_compare:xx { \exp_not:n {#1} } { \exp_not:V #2 }
\tl_if_eq_p:xn
3679 }
\tl_if_eq_p:nx
3680 \cs_new:Npn \tl_compare:no #1#2{
\tl_if_eq_p:Vn
3681   \tl_compare:xx{\exp_not:n{#1}}{\exp_not:n\exp_after:wN{#2}}
\tl_if_eq_p:on
3682 }
\tl_if_eq_p:nV
3683 \cs_new:Npn \tl_compare:Vn #1#2 {
\tl_if_eq_p:no
3684   \tl_compare:xx { \exp_not:V #1 } { \exp_not:n {#2} }
\tl_if_eq_p:xV
3685 }
\tl_if_eq_p:Vx
3686 \cs_new:Npn \tl_compare:on #1#2{
\tl_if_eq_p:Vo
3687   \tl_compare:xx{\exp_not:n\exp_after:wN{#1}}{\exp_not:n{#2}}
\tl_if_eq_p:ox
3688 }
3689 \cs_new:Npn \tl_compare:VV #1#2 {
3690   \tl_compare:xx { \exp_not:V #1 } { \exp_not:V #2 }
3691 }
3692 \cs_new:Npn \tl_compare:oo #1#2{
3693   \tl_compare:xx{\exp_not:n\exp_after:wN{#1}}{\exp_not:n\exp_after:wN{#2}}
3694 }
3695 \cs_new:Npn \tl_compare:xV #1#2 {
3696   \tl_compare:xx {#1} { \exp_not:V #2 }
3697 }
3698 \cs_new:Npn \tl_compare:xo #1#2{
3699   \tl_compare:xx{#1}{\exp_not:n\exp_after:wN{#2}}
3700 }
3701 \cs_new:Npn \tl_compare:Vx #1#2 {
3702   \tl_compare:xx { \exp_not:V #1 } {#2}
3703 }
3704 \cs_new:Npn \tl_compare:ox #1#2{
3705   \tl_compare:xx{\exp_not:n\exp_after:wN{#1}}{#2}
3706 }

```

Since we have a lot of basically identical functions to define we define one to define the rest. Unfortunately we aren't quite set up to use the new `\tl_map_inline:nn` function yet.

```

3707 \cs_set_nopar:Npn \tl_tmp:w #1 {
3708   \tl_set:Nx \l_tmpa_tl {

```

```

3709 \exp_not:N \prg_new_conditional:Npnn \exp_not:c {tl_if_eq:#1}
3710 #####1 #####2 {p,TF,T,F} {
3711   \exp_not:N \tex_ifnum:D
3712   \exp_not:c {tl_compare:#1} {#####1}{#####2}
3713   \exp_not:n{=\c_zero \prg_return_true: \else: \prg_return_false: \fi: }
3714 }
3715 }
3716 \l_tmpa_tl
3717 }
3718 \tl_tmp:w{xx} \tl_tmp:w{nx} \tl_tmp:w{ox} \tl_tmp:w{Vx}
3719 \tl_tmp:w{xn} \tl_tmp:w{nn} \tl_tmp:w{on} \tl_tmp:w{Vn}
3720 \tl_tmp:w{xo} \tl_tmp:w{no} \tl_tmp:w{oo}
3721 \tl_tmp:w{xV} \tl_tmp:w{nV} \tl_tmp:w{VV}

```

However all of this only makes sense if we actually have that primitive. Therefore we disable it again if it is not there and define `\tl_if_eq:nn` the old fashioned (and unexpandable) way.

In some cases below, since arbitrary token lists could be being used in this function, you can't assume (as token list variables usually do) that there won't be any `#` tokens. Therefore, `\tl_set:Nx` and `\exp_not:n` is used instead of plain `\tl_set:Nn`.

```

3722 \cs_if_exist:cF{pdf_strcmp:D}{
3723   \prg_set_protected_conditional:Npnn \tl_if_eq:nn #1#2 {TF,T,F} {
3724     \tl_set:Nx \l_testa_tl {\exp_not:n{#1}}
3725     \tl_set:Nx \l_testb_tl {\exp_not:n{#2}}
3726     \if_meaning:w\l_testa_tl \l_testb_tl
3727     \prg_return_true: \else: \prg_return_false:
3728     \fi:
3729   }
3730   \prg_set_protected_conditional:Npnn \tl_if_eq:nV #1#2 {TF,T,F} {
3731     \tl_set:Nx \l_testa_tl { \exp_not:n {#1} }
3732     \tl_set:Nx \l_testb_tl { \exp_not:V #2 }
3733     \if_meaning:w \l_testa_tl \l_testb_tl
3734     \prg_return_true: \else: \prg_return_false:
3735     \fi:
3736   }
3737   \prg_set_protected_conditional:Npnn \tl_if_eq:no #1#2 {TF,T,F} {
3738     \tl_set:Nx \l_testa_tl {\exp_not:n{#1}}
3739     \tl_set:Nx \l_testb_tl {\exp_not:o{#2}}
3740     \if_meaning:w\l_testa_tl \l_testb_tl
3741     \prg_return_true: \else: \prg_return_false:
3742     \fi:
3743   }
3744   \prg_set_protected_conditional:Npnn \tl_if_eq:nx #1#2 {TF,T,F} {
3745     \tl_set:Nx \l_testa_tl {\exp_not:n{#1}}
3746     \tl_set:Nx \l_testb_tl {#2}
3747     \if_meaning:w\l_testa_tl \l_testb_tl
3748     \prg_return_true: \else: \prg_return_false:
3749     \fi:
3750   }
3751   \prg_set_protected_conditional:Npnn \tl_if_eq:Vn #1#2 {TF,T,F} {
3752     \tl_set:Nx \l_testa_tl { \exp_not:V #1 }
3753     \tl_set:Nx \l_testb_tl { \exp_not:n{#2} }
3754     \if_meaning:w \l_testa_tl \l_testb_tl

```

```

3755     \prg_return_true: \else: \prg_return_false:
3756     \fi:
3757 }
3758 \prg_set_protected_conditional:Npnn \tl_if_eq:on #1#2 {TF,T,F} {
3759     \tl_set:Nx \l_testa_tl {\exp_not:o{#1}}
3760     \tl_set:Nx \l_testb_tl {\exp_not:n{#2}}
3761     \if_meaning:w\l_testa_tl \l_testb_tl
3762     \prg_return_true: \else: \prg_return_false:
3763     \fi:
3764 }
3765 \prg_set_protected_conditional:Npnn \tl_if_eq:VV #1#2 {TF,T,F} {
3766     \tl_set:Nx \l_testa_tl { \exp_not:V #1 }
3767     \tl_set:Nx \l_testb_tl { \exp_not:V #2 }
3768     \if_meaning:w \l_testa_tl \l_testb_tl
3769     \prg_return_true: \else: \prg_return_false:
3770     \fi:
3771 }
3772 \prg_set_protected_conditional:Npnn \tl_if_eq:oo #1#2 {TF,T,F} {
3773     \tl_set:Nx \l_testa_tl {\exp_not:o{#1}}
3774     \tl_set:Nx \l_testb_tl {\exp_not:o{#2}}
3775     \if_meaning:w\l_testa_tl \l_testb_tl
3776     \prg_return_true: \else: \prg_return_false:
3777     \fi:
3778 }
3779 \prg_set_protected_conditional:Npnn \tl_if_eq:Vx #1#2 {TF,T,F} {
3780     \tl_set:Nx \l_testa_tl { \exp_not:V #1 }
3781     \tl_set:Nx \l_testb_tl {#2}
3782     \if_meaning:w \l_testa_tl \l_testb_tl
3783     \prg_return_true: \else: \prg_return_false:
3784     \fi:
3785 }
3786 \prg_set_protected_conditional:Npnn \tl_if_eq:ox #1#2 {TF,T,F} {
3787     \tl_set:Nx \l_testa_tl {\exp_not:o{#1}}
3788     \tl_set:Nx \l_testb_tl {#2}
3789     \if_meaning:w\l_testa_tl \l_testb_tl
3790     \prg_return_true: \else: \prg_return_false:
3791     \fi:
3792 }
3793 \prg_set_protected_conditional:Npnn \tl_if_eq:xn #1#2 {TF,T,F} {
3794     \tl_set:Nx \l_testa_tl {#1}
3795     \tl_set:Nx \l_testb_tl {\exp_not:n{#2}}
3796     \if_meaning:w\l_testa_tl \l_testb_tl
3797     \prg_return_true: \else: \prg_return_false:
3798     \fi:
3799 }
3800 \prg_set_protected_conditional:Npnn \tl_if_eq:xV #1#2 {TF,T,F} {
3801     \tl_set:Nx \l_testa_tl {#1}
3802     \tl_set:Nx \l_testb_tl { \exp_not:V #2 }
3803     \if_meaning:w \l_testa_tl \l_testb_tl
3804     \prg_return_true: \else: \prg_return_false:
3805     \fi:
3806 }
3807 \prg_set_protected_conditional:Npnn \tl_if_eq:xo #1#2 {TF,T,F} {
3808     \tl_set:Nx \l_testa_tl {#1}

```

```

3809 \tl_set:Nx \l_testb_tl {\exp_not:o{#2}}
3810 \if_meaning:w\l_testa_tl \l_testb_tl
3811 \prg_return_true: \else: \prg_return_false:
3812 \fi:
3813 }
3814 \prg_set_protected_conditional:Npnn \tl_if_eq:xx #1#2 {TF,T,F} {
3815 \tl_set:Nx \l_testa_tl {#1}
3816 \tl_set:Nx \l_testb_tl {#2}
3817 \if_meaning:w\l_testa_tl \l_testb_tl
3818 \prg_return_true: \else: \prg_return_false:
3819 \fi:
3820 }
3821 }

```

104.4 Working with the contents of token lists

`\tl_to_lowercase:n` Just some names for a few primitives.

```

\tl_to_uppercase:n
3822 \cs_new_eq:NN \tl_to_lowercase:n \tex_lowercase:D
3823 \cs_new_eq:NN \tl_to_uppercase:n \tex_uppercase:D

```

`\tl_to_str:n` Another name for a primitive.

```

3824 \cs_new_eq:NN \tl_to_str:n \etex_detokenize:D

```

`\tl_to_str:N` These functions return the replacement text of a token list as a string list with all characters catcoded to ‘other’.

```

\tl_to_str:c
\tl_to_str_aux:w
3825 \cs_new_nopar:Npn \tl_to_str:N {\exp_after:wN\tl_to_str_aux:w
3826 \token_to_meaning:N}
3827 \cs_new_nopar:Npn \tl_to_str_aux:w #1>{\
3828 \cs_generate_variant:Nn \tl_to_str:N {c}

```

`\tl_map_function:nN` Expandable loop macro for token lists. These have the advantage of not needing to test if the argument is empty, because if it is, the stop marker will be read immediately and the loop terminated.

```

\tl_map_function:NN
\tl_map_function:cN
\tl_map_function_aux:NN
3829 \cs_new:Npn \tl_map_function:nN #1#2{
3830 \tl_map_function_aux:Nn #2 #1 \q_recursion_tail \q_recursion_stop
3831 }
3832 \cs_new_nopar:Npn \tl_map_function:NN #1#2{
3833 \exp_after:wN \tl_map_function_aux:Nn
3834 \exp_after:wN #2 #1 \q_recursion_tail \q_recursion_stop
3835 }
3836 \cs_new:Npn \tl_map_function_aux:Nn #1#2{
3837 \quark_if_recursion_tail_stop:n{#2}
3838 #1{#2} \tl_map_function_aux:Nn #1
3839 }
3840 \cs_generate_variant:Nn \tl_map_function:NN {cN}

```


`\tl_map_inline:nn` The inline functions are straight forward by now. We use a little trick with the fake
`\tl_map_inline:Nn` counter `\g_tl_inline_level_num` to make them nestable.¹³ We can also make use of
`\tl_map_inline:cn` `\tl_map_function:Nn` from before.

```

\g_tl_inline_level_num
3841 \cs_new:Npn \tl_map_inline:nn #1#2{
3842   \num_gincr:N \g_tl_inline_level_num
3843   \cs_gset:cpn {tl_map_inline_ \num_use:N \g_tl_inline_level_num :n}
3844   ##1{#2}
3845   \exp_args:Nc \tl_map_function_aux:Nn
3846   {tl_map_inline_ \num_use:N \g_tl_inline_level_num :n}
3847   #1 \q_recursion_tail\q_recursion_stop
3848   \num_gdecr:N \g_tl_inline_level_num
3849 }
3850 \cs_new:Npn \tl_map_inline:Nn #1#2{
3851   \num_gincr:N \g_tl_inline_level_num
3852   \cs_gset:cpn {tl_map_inline_ \num_use:N \g_tl_inline_level_num :n}
3853   ##1{#2}
3854   \exp_last_unbraced:NcV \tl_map_function_aux:Nn
3855   {tl_map_inline_ \num_use:N \g_tl_inline_level_num :n}
3856   #1 \q_recursion_tail\q_recursion_stop
3857   \num_gdecr:N \g_tl_inline_level_num
3858 }
3859 \cs_generate_variant:Nn \tl_map_inline:Nn {c}
3860 \tl_new:Nn \g_tl_inline_level_num{0}

```

`\tl_map_variable:nNn` `\tl_map_variable:nNn` $\langle token\ list \rangle$ $\langle temp \rangle$ $\langle action \rangle$ assigns $\langle temp \rangle$ to each element and
`\tl_map_variable:NNn` executes $\langle action \rangle$.
`\tl_map_variable:cNn`

```

3861 \cs_new:Npn \tl_map_variable:nNn #1#2#3{
3862   \tl_map_variable_aux:Nnn #2 {#3} #1 \q_recursion_tail \q_recursion_stop
3863 }

```

Next really has to be v/V args

```

3864 \cs_new_nopar:Npn \tl_map_variable:NNn {\exp_args:No \tl_map_variable:nNn}
3865 \cs_generate_variant:Nn \tl_map_variable:NNn {c}

```

`\tl_map_variable_aux:Nnn` The general loop. Assign the temp variable #1 to the current item #3 and then check if
that's the stop marker. If it is, break the loop. If not, execute the action #2 and continue.

```

3866 \cs_new:Npn \tl_map_variable_aux:Nnn #1#2#3{
3867   \tl_set:Nn #1{#3}
3868   \quark_if_recursion_tail_stop:N #1
3869   #2 \tl_map_variable_aux:Nnn #1{#2}
3870 }

```

`\tl_map_break:` The break statement.

```

3871 \cs_new_eq:NN \tl_map_break: \use_none_delimit_by_q_recursion_stop:w

```

`\tl_reverse:n` Reversal of a token list is done by taking one token at a time and putting it in front of
`\tl_reverse:V` the ones before it.
`\tl_reverse:o`

`\tl_reverse_aux:nN` ¹³This should be a proper integer, but I don't want to mess with the dependencies right now...

```

3872 \cs_new:Npn \tl_reverse:n #1{
3873   \tl_reverse_aux:nN {} #1 \q_recursion_tail\q_recursion_stop
3874 }
3875 \cs_new:Npn \tl_reverse_aux:nN #1#2{
3876   \quark_if_recursion_tail_stop_do:nn {#2}{#1 }
3877   \tl_reverse_aux:nN {#2#1}
3878 }
3879 \cs_generate_variant:Nn \tl_reverse:n {V,o}

```

`\tl_reverse:N` This reverses the list, leaving `\exp_stop_f:` in front, which in turn is removed by the `f` expansion which comes to a halt.

```

3880 \cs_new_nopar:Npn \tl_reverse:N #1 {
3881   \tl_set:Nf #1 { \tl_reverse:o { #1 \exp_stop_f: } }
3882 }

```

`\tl_elt_count:n` Count number of elements within a token list or token list variable. Brace groups within the list are read as a single element. `\num_elt_count:n` grabs the element and replaces it by +1. The 0 to ensure it works on an empty list.

`\tl_elt_count:V`

`\tl_elt_count:o`

`\tl_elt_count:N`

```

3883 \cs_new:Npn \tl_elt_count:n #1{
3884   \intexpr_eval:n {
3885     \tl_map_function:nN {#1}\num_elt_count:n
3886   }
3887 }
3888 \cs_generate_variant:Nn \tl_elt_count:n {V,o}
3889 \cs_new_nopar:Npn \tl_elt_count:N #1{
3890   \intexpr_eval:n {
3891     \tl_map_function:NN #1 \num_elt_count:n
3892   }
3893 }

```

`\tl_set_rescan:Nnn` These functions store the `{\langle token list \rangle}` in `\langle tl var. \rangle` after redefining catcodes, etc., in argument #2.

`\tl_gset_rescan:Nnn`

```

#1 : \langle tl var. \rangle
#2 : {\langle catcode setup, etc. \rangle}
#3 : {\langle token list \rangle}

```

```

3894 \cs_new:Npn \tl_set_rescan:Nnn { \tl_set_rescan_aux:NNnn \tl_set:Nn }
3895 \cs_new:Npn \tl_gset_rescan:Nnn { \tl_set_rescan_aux:NNnn \tl_gset:Nn }

```

`\tl_set_rescan_aux:NNnn` This macro uses a trick to extract an unexpanded token list after it's rescanned with `\etex_scantokens:D`. This technique was first used (as far as I know) by Heiko Oberdiek in his `catchfile` package, albeit for real files rather than the 'fake' `\scantokens` one.

The basic problem arises because `\etex_scantokens:D` emulates a file read, which inserts an EOF marker into the expansion; the simplistic

```
\exp_args:NNo \cs_set:Npn \tmp:w { \etex_scantokens:D {some text} }
```

unfortunately doesn't work, calling the error:

```
! File ended while scanning definition of \tmp:w.
```

(LuaTeX works around this problem with its `\scantextokens` primitive.)

Usually, we'd define `\etex_everyeof:D` to be `\exp_not:N` to gobble the EOF marker, but since we're not expanding the token list, it gets left in there and we have the same basic problem.

Instead, we define `\etex_everyeof:D` to contain a marker that's impossible to occur within the scanned text; that is, the same char twice with different catcodes. (For some reason, we *don't* need to insert a `\exp_not:N` token after it to prevent the EOF marker to expand. Anyone know why?)

A helper function is can be used to save the token list delimited by the special marker, keeping the catcode redefinitions hidden away in a group.

`_two_ats_with_two_catcodes_tl`

A tl with two @ characters with two different catcodes. Used as a special marker for delimited text.

```

3896 \group_begin:
3897 \tex_lccode:D '\A = '\@ \scan_stop:
3898 \tex_lccode:D '\B = '\@ \scan_stop:
3899 \tex_catcode:D '\A = 8 \scan_stop:
3900 \tex_catcode:D '\B = 3 \scan_stop:
3901 \tl_to_lowercase:n {
3902   \group_end:
3903   \tl_new:Nn \c_two_ats_with_two_catcodes_tl {AB}
3904 }

```

#1 : `\tl_set` function
 #2 : `\tl var.`
 #3 : `{\catcode setup, etc.}`
 #4 : `{\token list}`

Note that if you change `\etex_everyeof:D` in #3 then you'd better do it correctly!

```

3905 \cs_new:Npn \tl_set_rescan_aux:NNnn #1#2#3#4 {
3906   \group_begin:
3907     \toks_set:NV \etex_everyeof:D \c_two_ats_with_two_catcodes_tl
3908     \tex_endlinechar:D = \c_minus_one
3909     #3
3910     \exp_after:wN \tl_rescan_aux:w \etex_scantokens:D {#4}
3911     \exp_args:NNNV
3912   \group_end:
3913   #1 #2 \l_tmpa_toks
3914 }

```

`\tl_rescan_aux:w`

```

3915 \exp_after:wN \cs_set:Npn
3916 \exp_after:wN \tl_rescan_aux:w
3917 \exp_after:wN #
3918 \exp_after:wN 1 \c_two_ats_with_two_catcodes_tl {
3919   \tl_set:Nn \l_tmpa_toks {#1}
3920 }

```

`\tl_set_rescan:Nnx` These functions store the full expansion of `{\token list}` in `\tl var.` after redefining
`\tl_gset_rescan:Nnx` catcodes, etc., in argument #2.

```
#1 : <tl var.>
#2 : {\catcode setup, etc.}
#3 : {\token list}
```

The expanded versions are much simpler because the `\etex_scantokens:D` can occur within the expansion.

```
3921 \cs_new:Npn \tl_set_rescan:Nnx #1#2#3 {
3922   \group_begin:
3923     \etex_everyeof:D { \exp_not:N }
3924     \tex_endlinechar:D = \c_minus_one
3925     #2
3926     \tl_set:Nx \l_tmpa_tl { \etex_scantokens:D {#3} }
3927     \exp_args:NNNV
3928   \group_end:
3929   \tl_set:Nn #1 \l_tmpa_tl
3930 }
```

Globally is easier again:

```
3931 \cs_new:Npn \tl_gset_rescan:Nnx #1#2#3 {
3932   \group_begin:
3933     \etex_everyeof:D { \exp_not:N }
3934     \tex_endlinechar:D = \c_minus_one
3935     #2
3936     \tl_gset:Nx #1 { \etex_scantokens:D {#3} }
3937   \group_end:
3938 }
```

`\tl_rescan:nn` The inline wrapper for `\etex_scantokens:D`.

```
#1 : Catcode changes (etc.)
#2 : Token list to re-tokenise
```

```
3939 \cs_new:Npn \tl_rescan:nn #1#2 {
3940   \group_begin:
3941     \toks_set:NV \etex_everyeof:D \c_two_at_with_two_catcodes_tl
3942     \tex_endlinechar:D = \c_minus_one
3943     #1
3944     \exp_after:wN \tl_rescan_aux:w \etex_scantokens:D {#2}
3945   \exp_args:NV \group_end:
3946   \l_tmpa_toks
3947 }
```

104.5 Checking for and replacing tokens

`\tl_if_in:NnTF` See the replace functions for further comments. In this part we don't care too much about brace stripping since we are not interested in passing on the tokens which are split off in the process.

```
3948 \prg_new_protected_conditional:Npnn \tl_if_in:Nn #1#2 {TF,T,F} {
3949   \cs_set:Npn \tl_tmp:w ##1 #2 ##2 \q_stop {
3950     \quark_if_no_value:nTF {##2} {\prg_return_false:} {\prg_return_true:}
```

```

3951 }
3952 \exp_after:wN \tl_tmp:w #1 #2 \q_no_value \q_stop
3953 }
3954 \cs_generate_variant:Nn \tl_if_in:NnTF {c}
3955 \cs_generate_variant:Nn \tl_if_in:NnT {c}
3956 \cs_generate_variant:Nn \tl_if_in:NnF {c}

\tl_if_in:nnTF
\tl_if_in:VnTF
\tl_if_in:onTF 3957 \prg_new_protected_conditional:Npnn \tl_if_in:nn #1#2 {TF,T,F} {
3958   \cs_set:Npn \tl_tmp:w ##1 #2 ##2 \q_stop {
3959     \quark_if_no_value:nTF {##2} {\prg_return_false:} {\prg_return_true:}
3960   }
3961   \tl_tmp:w #1 #2 \q_no_value \q_stop
3962 }
3963 \cs_generate_variant:Nn \tl_if_in:nnTF {V}
3964 \cs_generate_variant:Nn \tl_if_in:nnT {V}
3965 \cs_generate_variant:Nn \tl_if_in:nnF {V}
3966 \cs_generate_variant:Nn \tl_if_in:nnTF {o}
3967 \cs_generate_variant:Nn \tl_if_in:nnT {o}
3968 \cs_generate_variant:Nn \tl_if_in:nnF {o}

```

`\l_tl_replace_toks` A temp variable for the replace operations.

```

3969 %%\l_tl_replace_toks % moved to l3token as alloc not set up yet.

```

`\tl_replace_in:Nnn` Replacing the first item in a token list variable goes like this: Define a temporary function with delimited arguments containing the search term and take a closer look at what is left. We append the expansion of the token list with the search term plus the quark `\q_no_value`. If the search term isn't present this last one is found and the following token is the quark, so we test for that. If the search term is present we will have to split off the `#3\q_no_value` we had, so we define yet another function with delimited arguments to do this. The advantage here is that now we have a special end sequence so there is no problem if the search term appears more than once. Only problem left is to prevent brace stripping in both ends, so we prepend the expansion of the token list with `\prg_do_nothing:` later to be expanded and also prepend the remainder of the first split operation with `\prg_do_nothing:` also to be expanded again later on.

```

\tl_replace_in_aux:NNnn #1 : \tl_set:Nx or \tl_gset:Nx
#2 : <tl var.>
#3 : item to find
#4 : replacement text

3970 \cs_new:Npn \tl_replace_in_aux:NNnn #1#2#3#4{
3971   \cs_set:Npn \tl_tmp:w ##1#3##2\q_stop{
3972     \quark_if_no_value:nF{##2}
3973     {

```

At this point `##1` starts with a `\prg_do_nothing:` so we expand it to remove it.

```

3974   \toks_set:No\l_tl_replace_toks{##1#4}
3975   \cs_set:Npn \tl_tmp:w ####1#3\q_no_value{

```

```

3976         \toks_put_right:No \l_tl_replace_toks { ###1 }
3977     }
3978     \tl_tmp:w \prg_do_nothing: ##2

```

Now all that is done is setting the token list variable equal to the expansion of the token register.

```

3979         #1#2{\toks_use:N\l_tl_replace_toks}
3980     }
3981 }

```

Here is where we start the process. Note that the token list might start with a space token so we use this little trick with \use:n to prevent it from being removed.

```

3982     \use:n{\exp_after:wN \tl_tmp:w\exp_after:wN\prg_do_nothing:}
3983     #2#3 \q_no_value\q_stop
3984 }

```

Now the various versions doing the replacement either globally or locally.

```

3985 \cs_new_nopar:Npn \tl_replace_in:Nnn {\tl_replace_in_aux:NNnn \tl_set:Nx}
3986 \cs_generate_variant:Nn\tl_replace_in:Nnn {cnn}

3987 \cs_new_nopar:Npn \tl_greplace_in:Nnn {\tl_replace_in_aux:NNnn \tl_gset:Nx}
3988 \cs_generate_variant:Nn\tl_greplace_in:Nnn {cnn}

```

```

\tl_replace_all_in:Nnn
\tl_replace_all_in:cnn
\tl_greplace_all_in:Nnn
\tl_greplace_all_in:cnn
\tl_replace_all_in_aux:NNnn

```

The version for replacing *all* occurrences of the search term is fairly easy since we just have to keep doing the replacement on the split-off part until all are replaced. Otherwise it is pretty much the same as above.

```

3989 \cs_set:Npn \tl_replace_all_in_aux:NNnn #1#2#3#4{
3990     \toks_clear:N \l_tl_replace_toks
3991     \cs_set:Npn \tl_tmp:w ##1#3##2\q_stop{
3992         \quark_if_no_value:nTF{##2}
3993         {
3994             \toks_put_right:No \l_tl_replace_toks {##1}
3995         }
3996         {
3997             \toks_put_right:No \l_tl_replace_toks {##1 #4}
3998             \tl_tmp:w \prg_do_nothing: ##2 \q_stop
3999         }
4000     }
4001     \use:n{\exp_after:wN \tl_tmp:w \exp_after:wN \prg_do_nothing:}
4002     #2#3 \q_no_value\q_stop
4003     #1#2{\toks_use:N\l_tl_replace_toks}
4004 }

```

Now the various forms.

```

4005 \cs_new_nopar:Npn \tl_replace_all_in:Nnn {
4006     \tl_replace_all_in_aux:NNnn \tl_set:Nx}
4007 \cs_generate_variant:Nn \tl_replace_all_in:Nnn {cnn}

4008 \cs_new_nopar:Npn \tl_greplace_all_in:Nnn {
4009     \tl_replace_all_in_aux:NNnn \tl_gset:Nx}
4010 \cs_generate_variant:Nn \tl_greplace_all_in:Nnn {cnn}

```

`\tl_remove_in:Nn` Next comes a series of removal functions. I have just implemented them as subcases of
`\tl_remove_in:cn` the replace functions for now (I'm lazy).
`\tl_gremove_in:Nn`
`\tl_gremove_in:cn`

```

4011 \cs_new:Npn \tl_remove_in:Nn #1#2{\tl_replace_in:Nnn #1{#2}{}}
4012 \cs_new:Npn \tl_gremove_in:Nn #1#2{\tl_greplace_in:Nnn #1{#2}{}}
4013 \cs_generate_variant:Nn \tl_remove_in:Nn {cn}
4014 \cs_generate_variant:Nn \tl_gremove_in:Nn {cn}

```

`\tl_remove_all_in:Nn` Same old, same old.
`\tl_remove_all_in:cn`
`\tl_gremove_all_in:Nn`
`\tl_gremove_all_in:cn`

```

4015 \cs_new:Npn \tl_remove_all_in:Nn #1#2{
4016   \tl_replace_all_in:Nnn #1{#2}{}}
4017 }
4018 \cs_new:Npn \tl_gremove_all_in:Nn #1#2{
4019   \tl_greplace_all_in:Nnn #1{#2}{}}
4020 }
4021 \cs_generate_variant:Nn \tl_remove_all_in:Nn {cn}
4022 \cs_generate_variant:Nn \tl_gremove_all_in:Nn {cn}

```

104.6 Heads or tails?

`\tl_head:n` These functions pick up either the head or the tail of a list. `\tl_head_iii:n` returns the
`\tl_head:V` first three items on a list.
`\tl_head_i:n`
`\tl_tail:n`
`\tl_tail:V`
`\tl_tail:f`
`\tl_head_iii:n`
`\tl_head_iii:f`
`\tl_head:w`
`\tl_head_i:w`
`\tl_tail:w`
`\tl_head_iii:w`

```

4023 \cs_new:Npn \tl_head:n #1{\tl_head:w #1\q_nil}
4024 \cs_new_eq:NN \tl_head_i:n \tl_head:n
4025 \cs_new:Npn \tl_tail:n #1{\tl_tail:w #1\q_nil}
4026 \cs_generate_variant:Nn \tl_tail:n {f}
4027 \cs_new:Npn \tl_head_iii:n #1{\tl_head_iii:w #1\q_nil}
4028 \cs_generate_variant:Nn \tl_head_iii:n {f}
4029 \cs_new_eq:NN \tl_head:w \use_i_delimit_by_q_nil:nw
4030 \cs_new_eq:NN \tl_head_i:w \tl_head:w
4031 \cs_new:Npn \tl_tail:w #1#2\q_nil{#2}
4032 \cs_new:Npn \tl_head_iii:w #1#2#3#4\q_nil{#1#2#3}
4033 \cs_generate_variant:Nn \tl_head:n { V }
4034 \cs_generate_variant:Nn \tl_tail:n { V }

```

`\tl_if_head_eq_meaning_p:nN` When we want to check if the first token of a list equals something specific it is usually ei-
`\tl_if_head_eq_meaning:nNTF` ther to see if it is a control sequence or a character. Hence we make two different functions
`\tl_if_head_eq_charcode_p:nN` as the internal test is different. `\tl_if_head_meaning_eq:nNTF` uses `\if_meaning:w` and
`\tl_if_head_eq_charcode_p:fN` will consider the tokens `b11` and `b12` different. `\tl_if_head_char_eq:nNTF` on the other
`\tl_if_head_eq_charcode:nNTF` hand only compares character codes so would regard `b11` and `b12` as equal but would also
`\tl_if_head_eq_charcode:fNTF` regard two primitives as equal.
`\tl_if_head_eq_catcode_p:nN`
`\tl_if_head_eq_catcode:nNTF`

```

4035 \prg_new_conditional:Npnn \tl_if_head_eq_meaning:nN #1#2 {p,TF,T,F} {
4036   \exp_after:wN \if_meaning:w \tl_head:w #1 \q_nil #2
4037   \prg_return_true: \else: \prg_return_false: \fi:
4038 }

```

For the charcode and catcode versions we insert `\exp_not:N` in front of both tokens. If you need them to expand fully as TeX does itself with these you can use an `f` type expansion.

```

4039 \prg_new_conditional:Npnn \tl_if_head_eq_charcode:nN #1#2 {p,TF,T,F} {
4040   \exp_after:wN \if:w \exp_after:wN \exp_not:N
4041     \tl_head:w #1 \q_nil \exp_not:N #2
4042   \prg_return_true: \else: \prg_return_false: \fi:
4043 }

```

Actually the default is already an f type expansion.

```

4044 %% \cs_new:Npn \tl_if_head_eq_charcode_p:fN #1#2{
4045   %%   \exp_after:wN \if_charcode:w \tl_head:w #1 \q_nil \exp_not:N#2
4046   %%   \c_true_bool
4047   %%   \else:
4048   %%   \c_false_bool
4049   %%   \fi:
4050 %% }
4051 %% \def_long_test_function_new:npn {tl_if_head_eq_charcode:fN}#1#2{
4052 %%   \if_predicate:w \tl_if_head_eq_charcode_p:fN {#1}#2}

```

These :fN variants are broken; temporary patch:

```

4053 \cs_generate_variant:Nn \tl_if_head_eq_charcode_p:nN {f}
4054 \cs_generate_variant:Nn \tl_if_head_eq_charcode:nNTF {f}
4055 \cs_generate_variant:Nn \tl_if_head_eq_charcode:nNT {f}
4056 \cs_generate_variant:Nn \tl_if_head_eq_charcode:nNF {f}

```

And now catcodes:

```

4057 \prg_new_conditional:Npnn \tl_if_head_eq_catcode:nN #1#2 {p,TF,T,F} {
4058   \exp_after:wN \if_catcode:w \exp_after:wN \exp_not:N
4059     \tl_head:w #1 \q_nil \exp_not:N #2
4060   \prg_return_true: \else: \prg_return_false: \fi:
4061 }

```

Show token usage:

```

4062 <*showmemory>
4063 \showMemUsage
4064 </showmemory>

```

105 l3toks implementation

We start by ensuring that the required packages are loaded.

```

4065 <*package>
4066 \ProvidesExplPackage
4067   {\filename}{\filedate}{\fileversion}{\filedescription}
4068 \package_check_loaded_expl:
4069 </package>
4070 <*initex | package>

```


105.1 Allocation and use

`\toks_new:N` Allocates a new token register.

```
\toks_new:c
4071 \<initex>
4072 \alloc_setup_type:nnn {toks} \c_zero \c_max_register_num
4073 \cs_new_nopar:Npn \toks_new:N #1 { \alloc_reg:NnNN g {toks} \tex_toksdef:D #1 }
4074 \cs_new_nopar:Npn \toks_new_l:N #1 { \alloc_reg:NnNN l {toks} \tex_toksdef:D #1 }
4075 \</initex>
4076 \<package>\cs_set_eq:NN \toks_new:N \newtoks % nick from LaTeX for the moment
4077 \cs_generate_variant:Nn \toks_new:N {c}
```

`\toks_use:N` This function returns the contents of a token register.

```
\toks_use:c
4078 \cs_new_eq:NN \toks_use:N \tex_the:D
4079 \cs_generate_variant:Nn \toks_use:N {c}
```

`\toks_set:Nn` `\toks_set:Nn<toks><stuff>` stores `<stuff>` without expansion in `<toks>`. `\toks_set:No` and `\toks_set:Nv` `\toks_set:Nx` expand `<stuff>` once and fully.

```
\toks_set:Nv
4080 \<check>
4081 \cs_new_nopar:Npn \toks_set:Nn #1 { \chk_local:N #1 #1 }
4082 \cs_generate_variant:Nn \toks_set:Nn {No,Nf}
4083 \</check>
\toks_set:Nf
\toks_set:cn
```

`\toks_set:co` If we don't check if `<toks>` is a local register then the `\toks_set:Nn` function has nothing to do. We implement `\toks_set:No/d/f` by hand when not checking because this is going to be used *extensively* in keyval processing! TODO: (Will) Can we get some numbers published on how necessary this is? On the other hand I'm happy to believe Morten :)

```
\toks_set:cV
\toks_set:cv
\toks_set:cx
\toks_set:cf
4084 \<!check>
4085 \cs_new_eq:NN \toks_set:Nn \prg_do_nothing:
4086 \cs_new:Npn \toks_set:Nv #1#2 {
4087 #1 \exp_after:wN { \int_to_roman:w -'0 \exp_eval_register:N #2 }
4088 }
4089 \cs_new:Npn \toks_set:Nv #1#2 {
4090 #1 \exp_after:wN { \int_to_roman:w -'0 \exp_eval_register:c {#2} }
4091 }
4092 \cs_new:Npn \toks_set:No #1#2 { #1 \exp_after:wN {#2} }
4093 \cs_new:Npn \toks_set:Nf #1#2 {
4094 #1 \exp_after:wN { \int_to_roman:w -'0#2 }
4095 }
4096 \</!check>
4097 \cs_generate_variant:Nn \toks_set:Nn {Nx,cn,cV,cv,co,cx,cf}
```

`\toks_gset:Nn` These functions are the global variants of the above.

```
\toks_gset:Nv
4098 \<check>\cs_new_nopar:Npn \toks_gset:Nn #1 { \chk_global:N #1 \pref_global:D #1 }
4099 \<!check>\cs_new_eq:NN \toks_gset:Nn \pref_global:D
4100 \cs_generate_variant:Nn \toks_gset:Nn {NV,No,Nx,cn,cV,co,cx}
\toks_gset:Nx
\toks_gset:cn
\toks_gset:cV
\toks_gset:co
\toks_gset:cx
```

\toks_set_eq:NN \toks_set_eq:NN<toks1><toks2> copies the contents of <toks2> in <toks1>.

```

\toks_set_eq:Nc
\toks_set_eq:cN
\toks_set_eq:cc
\toks_gset_eq:NN
\toks_gset_eq:Nc
\toks_gset_eq:cN
\toks_gset_eq:cc
4101 <*check>
4102 \cs_new_nopar:Npn\toks_set_eq:NN #1#2 {
4103   \chk_local:N #1
4104   \chk_var_or_const:N #2
4105   #1 #2
4106 }
4107 \cs_new_nopar:Npn\toks_gset_eq:NN #1#2 {
4108   \chk_global:N #1
4109   \chk_var_or_const:N #2
4110   \pref_global:D #1 #2
4111 }
4112 </check>
4113 <!*check>
4114 \cs_new_eq:NN \toks_set_eq:NN \prg_do_nothing:
4115 \cs_new_eq:NN \toks_gset_eq:NN \pref_global:D
4116 </!check>
4117 \cs_generate_variant:Nn \toks_set_eq:NN {Nc,cN,cc}
4118 \cs_generate_variant:Nn \toks_gset_eq:NN {Nc,cN,cc}

```

\toks_clear:N These functions clear a token register, either locally or globally.

```

\toks_gclear:N
\toks_clear:c
\toks_gclear:c
4119 \cs_new_nopar:Npn \toks_clear:N #1 {
4120   #1\c_empty_toks
4121   <check>\chk_local_or_pref_global:N #1
4122 }
4123 \cs_new_nopar:Npn \toks_gclear:N {
4124   <check> \pref_global_chk:
4125   <!check> \pref_global:D
4126   \toks_clear:N
4127 }
4128 \cs_generate_variant:Nn \toks_clear:N {c}
4129 \cs_generate_variant:Nn \toks_gclear:N {c}

```

\toks_use_clear:N These functions clear a token register (locally or globally) after returning the contents.

\toks_use_clear:c They make sure that clearing the register does not interfere with following tokens. In
\toks_use_gclear:N other words, the contents of the register might operate on what follows in the input
\toks_use_gclear:c stream.

```

4130 \cs_new_nopar:Npn \toks_use_clear:N #1 {
4131   \exp_last_unbraced:NNV \toks_clear:N #1 #1
4132 }
4133 \cs_new_nopar:Npn \toks_use_gclear:N {
4134   <check> \pref_global_chk:
4135   <!check> \pref_global:D
4136   \toks_use_clear:N
4137 }
4138 \cs_generate_variant:Nn \toks_use_clear:N {c}
4139 \cs_generate_variant:Nn \toks_use_gclear:N {c}

```

`\toks_show:N` This function shows the contents of a token register on the terminal. TODO: this is not pretty when the argument is a control sequence that doesn't exist!

```

4140 \cs_new_eq:NN \toks_show:N \tex_showthe:D
4141 \cs_generate_variant:Nn \toks_show:N {c}

```

105.2 Adding to token registers' contents

`\toks_put_left:Nn` `\toks_put_left:Nn <toks><stuff>` adds the tokens of *stuff* on the 'left-side' of the token register *<toks>*. `\toks_put_left:No` does the same, but expands the tokens once. We need to look out for brace stripping so we add a token, which is then later removed.

```

\toks_put_left:Nn 4142 \cs_new_nopar:Npn \toks_put_left:Nn #1 {
\toks_put_left:Nv 4143 \exp_after:wN \toks_put_left_aux:w \exp_after:wN \q_mark
\toks_put_left:No 4144 \toks_use:N #1 \q_stop #1
\toks_put_left:Nx 4145 }
\toks_put_left:cn 4146 \cs_generate_variant:Nn \toks_put_left:Nn {NV,No,Nx,cn,co,cV}
\toks_put_left:cV 4147 \cs_new_nopar:Npn \toks_gput_left:Nn {
\toks_put_left:co 4148 <check> \pref_global_chk:
\toks_gput_left:Nn 4149 <!check> \pref_global:D
\toks_gput_left:Nv 4150 \toks_put_left:Nn
\toks_gput_left:No 4151 }
\toks_gput_left:Nx 4152 \cs_generate_variant:Nn \toks_gput_left:Nn {NV,No,Nx,cn,cV,co}
\toks_gput_left:cn
\toks_gput_left:cV
\toks_gput_left:co
\toks_gput_left_aux:w

```

A helper function for `\toks_put_left:Nn`. Its arguments are subsequently the tokens of *<stuff>*, the token register *<toks>* and the current contents of *<toks>*. We make sure to remove the token we inserted earlier.

```

4153 \cs_new:Npn \toks_put_left_aux:w #1\q_stop #2#3 {
4154 #2 \exp_after:wN { \use_i:nn {#3} #1 }
4155 <check> \chk_local_or_pref_global:N #2
4156 }

```

`\toks_put_right:Nn` These macros add a list of tokens to the right of a token register.

```

\toks_put_right:Nn 4157 \cs_new:Npn \toks_put_right:Nn #1#2 {
\toks_put_right:Nv 4158 #1 \exp_after:wN { \toks_use:N #1 #2 }
\toks_put_right:No 4159 <check> \chk_local_or_pref_global:N #1
\toks_put_right:Nx 4160 }
\toks_put_right:cn 4161 \cs_new_nopar:Npn \toks_gput_right:Nn {
\toks_put_right:cV 4162 <check> \pref_global_chk:
\toks_gput_right:co 4163 <!check> \pref_global:D
\toks_gput_right:Nn 4164 \toks_put_right:Nn
\toks_gput_right:Nv 4165 }
\toks_gput_right:No
\toks_gput_right:Nx
\toks_gput_right:cn
\toks_gput_right:cV
\toks_gput_right:co 4166 <check>\cs_generate_variant:Nn \toks_put_right:Nn {No}
4167 <!*check>

```

A couple done by hand for speed.

```

4168 \cs_new:Npn \toks_put_right:NV #1#2 {
4169   #1 \exp_after:wN \exp_after:wN \exp_after:wN {
4170     \exp_after:wN \toks_use:N \exp_after:wN #1
4171     \int_to_roman:w -'0 \exp_eval_register:N #2
4172   }
4173 }
4174 \cs_new:Npn \toks_put_right:No #1#2 {
4175   #1 \exp_after:wN \exp_after:wN \exp_after:wN {
4176     \exp_after:wN \toks_use:N \exp_after:wN #1 #2
4177   }
4178 }
4179 </!check>
4180 \cs_generate_variant:Nn \toks_put_right:Nn {Nx,cn,cV,co}
4181 \cs_generate_variant:Nn \toks_gput_right:Nn {NV,No,Nx,cn,cV,co}

```

`\toks_put_right:Nf` We implement `\toks_put_right:Nf` by hand because I think I might use it in the `l3keyval` module in which case it is going to be used a lot.

```

4182 <check>\cs_generate_variant:Nn \toks_put_right:Nn {Nf}
4183 <!*check>
4184 \cs_new:Npn \toks_put_right:Nf #1#2 {
4185   #1 \exp_after:wN \exp_after:wN \exp_after:wN {
4186     \exp_after:wN \toks_use:N \exp_after:wN #1 \int_to_roman:w -'0#2
4187   }
4188 }
4189 </!check>

```

105.3 Predicates and conditionals

`\toks_if_empty_p:N` `\toks_if_empty:NTF``<toks>``<true code>``<false code>` tests if a token register is empty and executes either `<true code>` or `<false code>`. This test had the advantage of being expandable. Otherwise one has to do an x type expansion in order to prevent problems with parameter tokens.

```

4190 \prg_new_conditional:Nnn \toks_if_empty:N {p,TF,T,F} {
4191   \tl_if_empty:VTF #1 {\prg_return_true:} {\prg_return_false:}
4192 }
4193 \cs_generate_variant:Nn \toks_if_empty_p:N {c}
4194 \cs_generate_variant:Nn \toks_if_empty:NTF {c}
4195 \cs_generate_variant:Nn \toks_if_empty:NT {c}
4196 \cs_generate_variant:Nn \toks_if_empty:NF {c}

```

`\toks_if_eq_p:NN` This function test whether two token registers have the same contents.

```

\toks_if_eq_p:cN
\toks_if_eq_p:Nc
\toks_if_eq_p:cc
\toks_if_eq:NNTF
\toks_if_eq:NcTF
\toks_if_eq:cNTF
\toks_if_eq:ccTF
4197 \prg_new_conditional:Nnn \toks_if_eq:NN {p,TF,T,F} {
4198   \tl_if_eq:xxTF {\toks_use:N #1} {\toks_use:N #2}
4199   {\prg_return_true:} {\prg_return_false:}
4200 }
4201 \cs_generate_variant:Nn \toks_if_eq_p:NN {Nc,c,cc}
4202 \cs_generate_variant:Nn \toks_if_eq:NNTF {Nc,c,cc}
4203 \cs_generate_variant:Nn \toks_if_eq:NNTF {Nc,c,cc}
4204 \cs_generate_variant:Nn \toks_if_eq:NNF {Nc,c,cc}

```

105.4 Variables and constants

`\l_tmpa_toks` Some scratch registers ...

```

\l_tmpb_toks
\l_tmpc_toks
\g_tmpa_toks
\g_tmpb_toks
\g_tmpc_toks
4205 \tex_toksdef:D \l_tmpa_toks = 255\scan_stop:
4206 \<initex>\seq_put_right:Nn \g_toks_allocation_seq {255}
4207 \toks_new:N \l_tmpb_toks
4208 \toks_new:N \l_tmpc_toks
4209 \toks_new:N \g_tmpa_toks
4210 \toks_new:N \g_tmpb_toks
4211 \toks_new:N \g_tmpc_toks

```

`\c_empty_toks` And here is a constant, which is a (permanently) empty token register.

```
4212 \toks_new:N \c_empty_toks
```

`\l_tl_replace_toks` And here is one for tl vars. Can't define it there as the allocation isn't set up at that point.

```

4213 \toks_new:N \l_tl_replace_toks

4214 \</initex | package>

```

Show token usage:

```

4215 \<*showmemory>
4216 \showMemUsage
4217 \</showmemory>

```

106 l3seq implementation

```

4218 \<*package>
4219 \ProvidesExplPackage
4220 { \filename } { \filedate } { \fileversion } { \filedescription }
4221 \package_check_loaded_expl:
4222 \</package>

```

A sequence is a control sequence whose top-level expansion is of the form ‘`\seq_elt:w` $\langle text_1 \rangle$ `\seq_elt_end: ... \seq_elt:w` $\langle text_n \rangle$...’. We use explicit delimiters instead of braces around $\langle text \rangle$ to allow efficient searching for an item in the sequence.

`\seq_elt:w` We allocate the delimiters and make them errors if executed.
`\seq_elt_end:`

```

4223 \<*initex | package>
4224 \cs_new:Npn \seq_elt:w { \ERROR }
4225 \cs_new:Npn \seq_elt_end: { \ERROR }

```

106.1 Allocating and initialisation

`\seq_new:N` Sequences are implemented using token lists.

```

\seq_new:c
4226 \cs_new_eq:NN \seq_new:N \tl_new:N
4227 \cs_new_eq:NN \seq_new:c \tl_new:c

```

`\seq_clear:N` Clearing a sequence is the same as clearing a token list.
`\seq_clear:c`
`\seq_gclear:N` 4228 `\cs_new_eq:NN \seq_clear:N \tl_clear:N`
`\seq_gclear:c` 4229 `\cs_new_eq:NN \seq_clear:c \tl_clear:c`
4230 `\cs_new_eq:NN \seq_gclear:N \tl_gclear:N`
4231 `\cs_new_eq:NN \seq_gclear:c \tl_gclear:c`

`\seq_clear_new:N` Clearing a sequence is the same as clearing a token list.
`\seq_clear_new:c`
`\seq_gclear_new:N` 4232 `\cs_new_eq:NN \seq_clear_new:N \tl_clear_new:N`
`\seq_gclear_new:c` 4233 `\cs_new_eq:NN \seq_clear_new:c \tl_clear_new:c`
4234 `\cs_new_eq:NN \seq_gclear_new:N \tl_gclear_new:N`
4235 `\cs_new_eq:NN \seq_gclear_new:c \tl_gclear_new:c`

`\seq_set_eq:NN` We can set one seq equal to another.
`\seq_set_eq:Nc`
`\seq_set_eq:cN` 4236 `\cs_new_eq:NN \seq_set_eq:NN \cs_set_eq:NN`
`\seq_set_eq:cc` 4237 `\cs_new_eq:NN \seq_set_eq:cN \cs_set_eq:cN`
4238 `\cs_new_eq:NN \seq_set_eq:Nc \cs_set_eq:Nc`
4239 `\cs_new_eq:NN \seq_set_eq:cc \cs_set_eq:cc`

`\seq_gset_eq:NN` And of course globally which seems to be needed far more often.¹⁴
`\seq_gset_eq:cN` 4240 `\cs_new_eq:NN \seq_gset_eq:NN \cs_gset_eq:NN`
`\seq_gset_eq:Nc` 4241 `\cs_new_eq:NN \seq_gset_eq:cN \cs_gset_eq:cN`
`\seq_gset_eq:cc` 4242 `\cs_new_eq:NN \seq_gset_eq:Nc \cs_gset_eq:Nc`
4243 `\cs_new_eq:NN \seq_gset_eq:cc \cs_gset_eq:cc`

`\seq_gconcat:NNN` `\seq_gconcat:NNN` $\langle seq\ 1 \rangle \langle seq\ 2 \rangle \langle seq\ 3 \rangle$ will globally assign $\langle seq\ 1 \rangle$ the concatenation
`\seq_gconcat:ccc` of $\langle seq\ 2 \rangle$ and $\langle seq\ 3 \rangle$.
4244 `\cs_new_nopar:Npn \seq_gconcat:NNN #1#2#3 {`
4245 `\tl_gset:Nx #1 { \exp_not:V #2 \exp_not:V #3 }`
4246 `}`
4247 `\cs_generate_variant:Nn \seq_gconcat:NNN {ccc}`

106.2 Predicates and conditionals

`\seq_if_empty_p:N` A predicate which evaluates to `\c_true_bool` iff the sequence is empty.
`\seq_if_empty_p:c`
`\seq_if_empty:N \underline{TF}` 4248 `\prg_new_eq_conditional:NNn \seq_if_empty:N \tl_if_empty:N {p,TF,T,F}`
`\seq_if_empty:c \underline{TF}` 4249 `\prg_new_eq_conditional:NNn \seq_if_empty:c \tl_if_empty:c {p,TF,T,F}`
`\seq_if_empty_err:N` Signals an error if the sequence is empty.

4250 `\cs_new_nopar:Npn \seq_if_empty_err:N #1 {`
4251 `\if_meaning:w #1 \c_empty_tl`

¹⁴To save a bit of space these functions could be made identical to those from the `tl` or `clist` module.

As I said before, I don't think we need to provide checks for this kind of error, since it is a severe internal macro package error that can not be produced by the user directly. Can it? So the next line of code should be probably removed. (Will: I have no idea what this comment means.)

```

4252      \tl_clear:N \l_testa_tl % catch prefixes
4253      \msg_kernel_bug:x {Empty~sequence~'\token_to_str:N#1'}
4254      \fi:
4255    }

```

`\seq_if_in:NnTF` `\seq_if_in:NnTF` $\langle seq \rangle \langle item \rangle \langle true\ case \rangle \langle false\ case \rangle$ will check whether $\langle item \rangle$ is in $\langle seq \rangle$ and then either execute the $\langle true\ case \rangle$ or the $\langle false\ case \rangle$. $\langle true\ case \rangle$ and $\langle false\ case \rangle$ may contain incomplete `\if_charcode:w` statements.

`\seq_if_in:cVTF` `\seq_if_in:coTF` `\seq_if_in:cxTF` Note that ##2 in the definition below for `\seq_tmp:w` contains exactly one token which we can compare with `\q_no_value`.

```

4256 \prg_new_conditional:Nnn \seq_if_in:Nn {TF,T,F} {
4257   \cs_set:Npn \seq_tmp:w ##1 \seq_elt:w #2 \seq_elt_end: ##2##3 \q_stop {
4258     \if_meaning:w \q_no_value ##2
4259     \prg_return_false: \else: \prg_return_true: \fi:
4260   }
4261   \exp_after:wN \seq_tmp:w #1 \seq_elt:w #2 \seq_elt_end: \q_no_value \q_stop
4262 }

4263 \cs_generate_variant:Nn \seq_if_in:NnTF {cV,co,c,cx}
4264 \cs_generate_variant:Nn \seq_if_in:NnT {cV,co,c,cx}
4265 \cs_generate_variant:Nn \seq_if_in:NnF {cV,co,c,cx}

```

106.3 Getting data out

`\seq_get:NN` `\seq_get:NN` $\langle sequence \rangle \langle cmd \rangle$ defines $\langle cmd \rangle$ to be the left-most element of $\langle sequence \rangle$.

`\seq_get:cN` `\seq_get_aux:w`

```

4266 \cs_new_nopar:Npn \seq_get:NN #1 {
4267   \seq_if_empty_err:N #1
4268   \exp_after:wN \seq_get_aux:w #1 \q_stop
4269 }
4270 \cs_new:Npn \seq_get_aux:w \seq_elt:w #1 \seq_elt_end: #2 \q_stop #3 {
4271   \tl_set:Nn #3 {#1}
4272 }
4273 \cs_generate_variant:Nn \seq_get:NN {c}

```

`\seq_pop_aux:nnNN` `\seq_pop_aux:nnNN` $\langle def_1 \rangle \langle def_2 \rangle \langle sequence \rangle \langle cmd \rangle$ assigns the left-most element of $\langle sequence \rangle$ to $\langle cmd \rangle$ using $\langle def_2 \rangle$, and assigns the tail of $\langle sequence \rangle$ to $\langle sequence \rangle$ using $\langle def_1 \rangle$.

```

4274 \cs_new:Npn \seq_pop_aux:nnNN #1#2#3 {
4275   \seq_if_empty_err:N #3
4276   \exp_after:wN \seq_pop_aux:w #3 \q_stop #1#2#3
4277 }
4278 \cs_new:Npn \seq_pop_aux:w
4279   \seq_elt:w #1 \seq_elt_end: #2 \q_stop #3#4#5#6 {
4280   #3 #5 {#2}

```

```

4281   #4 #6 {#1}
4282 }

\seq_show:N
\seq_show:c
4283 \cs_new_eq:NN \seq_show:N \tl_show:N
4284 \cs_new_eq:NN \seq_show:c \tl_show:c

\seq_display:N
\seq_display:c
4285 \cs_new_nopar:Npn \seq_display:N #1 {
4286   \iow_term:x { Sequence~\token_to_str:N #1~contains~
4287     the~elements~(without~outer~braces): }
4288   \toks_clear:N \l_tmpa_toks
4289   \seq_map_inline:Nn #1 {
4290     \toks_if_empty:NF \l_tmpa_toks {
4291       \toks_put_right:Nx \l_tmpa_toks {^^J>~}
4292     }
4293     \toks_put_right:Nx \l_tmpa_toks {
4294       \iow_space: \iow_char:N \{ \exp_not:n {##1} \iow_char:N \}
4295     }
4296   }
4297   \toks_show:N \l_tmpa_toks
4298 }
4299 \cs_generate_variant:Nn \seq_display:N {c}

```

106.4 Putting data in

`\seq_put_aux:Nnn` `\seq_put_aux:Nnn` $\langle sequence \rangle$ $\langle left \rangle$ $\langle right \rangle$ adds the elements specified by $\langle left \rangle$ to the left of $\langle sequence \rangle$, and those specified by $\langle right \rangle$ to the right.

```

4300 \cs_new:Npn \seq_put_aux:Nnn #1 {
4301   \exp_after:wN \seq_put_aux:w #1 \q_stop #1
4302 }
4303 \cs_new:Npn \seq_put_aux:w #1\q_stop #2#3#4 { \tl_set:Nn #2 {#3#1#4} }

```

`\seq_put_left:Nn` Here are the usual operations for adding to the left and right.

```

\seq_put_left:Nv
\seq_put_left:Nv
\seq_put_left:No
4304 \cs_new:Npn \seq_put_left:Nn #1#2 {
4305   \seq_put_aux:Nnn #1 {\seq_elt:w #2\seq_elt_end:} {}
\seq_put_left:Nx
4306 }
\seq_put_left:cn
\seq_put_left:cV
\seq_put_left:co
\seq_put_right:Nn
\seq_put_right:No
\seq_put_right:Nv
\seq_put_right:Nx
\seq_put_right:cn
\seq_put_right:cV
\seq_put_right:co

```

We can't put in a `\prg_do_nothing:` instead of `{}` above since this argument is passed literally (and we would end up with many `\prg_do_nothing:s` inside the sequences).

```

4307 \cs_generate_variant:Nn \seq_put_left:Nn {NV,No,Nx,c,cV,co}

4308 \cs_new:Npn \seq_put_right:Nn #1#2{
4309   \seq_put_aux:Nnn #1{\seq_elt:w #2\seq_elt_end:}}

4310 \cs_generate_variant:Nn \seq_put_right:Nn {NV,No,Nx,c,cV,co}

```



```

\seq_gput_left:Nn
\seq_gput_left:NV
\seq_gput_left:No
\seq_gput_left:Nx
\seq_gput_left:cn
\seq_gput_left:cV
\seq_gput_left:co
\seq_gput_right:Nn
\seq_gput_right:NV
\seq_gput_right:No
\seq_gput_right:Nx
\seq_gput_right:cn
\seq_gput_right:cV
\seq_gput_right:co

4311 \cs_new:Npn \seq_gput_left:Nn {
4312   \*check
4313   \pref_global_chk:
4314   \</check>
4315   \*!check
4316   \pref_global:D
4317   \</!check>
4318   \seq_put_left:Nn
4319 }

4320 \cs_new:Npn \seq_gput_right:Nn {
4321   \*check
4322   \pref_global_chk:
4323   \</check>
4324   \*!check
4325   \pref_global:D
4326   \</!check>
4327   \seq_put_right:Nn
4328 }

4329 \cs_generate_variant:Nn \seq_gput_left:Nn {NV,No,Nx,c,cV,co}
4330 \cs_generate_variant:Nn \seq_gput_right:Nn {NV,No,Nx,c,cV,co}

\seq_gput_right:Nc TODO: move to xor (Sep 2008)

4331 \cs_generate_variant:Nn \seq_gput_right:Nn {Nc}

```

106.5 Mapping

```

\seq_map_variable:NNn Nothing spectacular here.
\seq_map_variable:cNn
\seq_map_variable_aux:Nnw
  \seq_map_break:
  \seq_map_break:n

4332 \cs_new:Npn \seq_map_variable_aux:Nnw #1#2 \seq_elt:w #3 \seq_elt_end: {
4333   \tl_set:Nx #1{\exp_not:n{#3}}
4334   \quark_if_nil:NT #1 \seq_map_break:
4335   #2
4336   \seq_map_variable_aux:Nnw #1{#2}
4337 }
4338 \cs_new:Npn \seq_map_variable:NNn #1#2#3 {
4339   \tl_set:Nx #2 {\exp_not:n{\seq_map_variable_aux:Nnw #2{#3}}}
4340   \exp_after:wN #2 #1 \seq_elt:w \q_nil\seq_elt_end: \q_stop
4341 }
4342 \cs_generate_variant:Nn \seq_map_variable:NNn {c}
4343
4344 \cs_new_eq:NN \seq_map_break: \use_none_delimit_by_q_stop:w
4345 \cs_new_eq:NN \seq_map_break:n \use_i_delimit_by_q_stop:nw

\seq_map_function:NN \seq_map_function:NN <sequence> <cmd> applies <cmd> to each element of <sequence>,
\seq_map_function:cN from left to right. Since we don't have braces, this implementation is not very efficient. It
might be better to say that <cmd> must be a function with one argument that is delimited
by \seq_elt_end:.

```

```

4346 \cs_new_nopar:Npn \seq_map_function:NN #1#2 {
4347   \cs_set:Npn \seq_elt:w ##1 \seq_elt_end: {#2{##1}}
4348   #1
4349   \cs_set_eq:NN \seq_elt:w \ERROR
4350 }
4351 \cs_generate_variant:Nn \seq_map_function:NN {c}

```

\seq_map_inline:Nn When no braces are used, this version of mapping seems more natural.
\seq_map_inline:cn

```

4352 \cs_new_nopar:Npn \seq_map_inline:Nn #1#2 {
4353   \cs_set:Npn \seq_elt:w ##1 \seq_elt_end: {#2}
4354   #1
4355   \cs_set_eq:NN \seq_elt:w \ERROR
4356 }
4357 \cs_generate_variant:Nn \seq_map_inline:Nn {c}

```

106.6 Manipulation

\l_clist_remove_clist A common scratch space for the removal routines.

```

4358 \seq_new:N \l_seq_remove_seq

```

\seq_remove_duplicates_aux:NN Copied from \clist_remove_duplicates.

```

\seq_remove_duplicates_aux:n
\seq_remove_duplicates:N
\seq_gremove_duplicates:N
4359 \cs_new:Nn \seq_remove_duplicates_aux:NN {
4360   \seq_clear:N \l_seq_remove_seq
4361   \seq_map_function:NN #2 \seq_remove_duplicates_aux:n
4362   #1 #2 \l_seq_remove_seq
4363 }
4364 \cs_new:Nn \seq_remove_duplicates_aux:n {
4365   \seq_if_in:NnF \l_seq_remove_seq {#1} {
4366     \seq_put_right:Nn \l_seq_remove_seq {#1}
4367   }
4368 }
4369 \cs_new_nopar:Npn \seq_remove_duplicates:N {
4370   \seq_remove_duplicates_aux:NN \seq_set_eq:NN
4371 }
4372 \cs_new_nopar:Npn \seq_gremove_duplicates:N {
4373   \seq_remove_duplicates_aux:NN \seq_gset_eq:NN
4374 }

```

106.7 Sequence stacks

\seq_push:Nn Since sequences can be used as stacks, we ought to have both ‘push’ and ‘pop’. In most cases they are nothing more than new names for old functions.

```

\seq_push:NV
\seq_push:No
\seq_push:cn
\seq_pop:NN
\seq_pop:cn
4375 \cs_new_eq:NN \seq_push:Nn \seq_put_left:Nn
4376 \cs_new_eq:NN \seq_push:NV \seq_put_left:NV
4377 \cs_new_eq:NN \seq_push:No \seq_put_left:No
4378 \cs_new_eq:NN \seq_push:cn \seq_put_left:cn
4379 \cs_new_nopar:Npn \seq_pop:NN { \seq_pop_aux:nnNN \tl_set:Nn \tl_set:Nn }
4380 \cs_generate_variant:Nn \seq_pop:NN {c}

```

`\seq_gpush:Nn` I don't agree with Denys that one needs only local stacks, actually I believe that one will probably need the functions here more often. In case of `\seq_gpop:NN` the value is nevertheless returned locally.

`\seq_gpush:Nv`
`\seq_gpop:NN`
`\seq_gpop:cN`

```

4381 \cs_new_eq:NN \seq_gpush:Nn \seq_gput_left:Nn
4382 \cs_new_nopar:Npn \seq_gpop:NN { \seq_pop_aux:nnNN \tl_gset:Nn \tl_set:Nn }
4383 \cs_generate_variant:Nn \seq_gpush:Nn {NV,No,c,Nv}
4384 \cs_generate_variant:Nn \seq_gpop:NN {c}

```

`\seq_top:NN` Looking at the top element of the stack without removing it is done with this operation.

`\seq_top:cN`

```

4385 \cs_new_eq:NN \seq_top:NN \seq_get:NN
4386 \cs_new_eq:NN \seq_top:cN \seq_get:cN

```

```

4387 </initex | package>

```

Show token usage:

```

4388 <*showmemory>
4389 %\showMemUsage
4390 </showmemory>

```

107 l3clist implementation

We start by ensuring that the required packages are loaded.

```

4391 <*package>
4392 \ProvidesExplPackage
4393 { \filename } { \filedate } { \fileversion } { \filedescription }
4394 \package_check_loaded_expl:
4395 </package>
4396 <*initex | package>

```

107.1 Allocation and initialisation

`\clist_new:N` Comma-Lists are implemented using token lists.

`\clist_new:c`

```

4397 \cs_new_eq:NN \clist_new:N \tl_new:N
4398 \cs_generate_variant:Nn \clist_new:N {c}

```

`\clist_clear:N` Clearing a comma-list is the same as clearing a token list.

`\clist_clear:c`
`\clist_gclear:N`
`\clist_gclear:c`

```

4399 \cs_new_eq:NN \clist_clear:N \tl_clear:N
4400 \cs_generate_variant:Nn \clist_clear:N {c}
4401 \cs_new_eq:NN \clist_gclear:N \tl_gclear:N
4402 \cs_generate_variant:Nn \clist_gclear:N {c}

```

`\clist_clear_new:N` Clearing a comma-list is the same as clearing a token list.

`\clist_clear_new:c`
`\clist_gclear_new:N`
`\clist_gclear_new:c`

```

4403 \cs_new_eq:NN \clist_clear_new:N \tl_clear_new:N
4404 \cs_generate_variant:Nn \clist_clear_new:N {c}
4405 \cs_new_eq:NN \clist_gclear_new:N \tl_gclear_new:N
4406 \cs_generate_variant:Nn \clist_gclear_new:N {c}

```

```

\clist_set_eq:NN We can set one  $\langle clist \rangle$  equal to another.
\clist_set_eq:cN
\clist_set_eq:Nc
\clist_set_eq:cc
4407 \cs_new_eq:NN \clist_set_eq:NN \cs_set_eq:NN
4408 \cs_new_eq:NN \clist_set_eq:cN \cs_set_eq:cN
4409 \cs_new_eq:NN \clist_set_eq:Nc \cs_set_eq:Nc
4410 \cs_new_eq:NN \clist_set_eq:cc \cs_set_eq:cc

\clist_gset_eq:NN An of course globally which seems to be needed far more often.
\clist_gset_eq:cN
\clist_gset_eq:Nc
\clist_gset_eq:cc
4411 \cs_new_eq:NN \clist_gset_eq:NN \cs_gset_eq:NN
4412 \cs_new_eq:NN \clist_gset_eq:cN \cs_gset_eq:cN
4413 \cs_new_eq:NN \clist_gset_eq:Nc \cs_gset_eq:Nc
4414 \cs_new_eq:NN \clist_gset_eq:cc \cs_gset_eq:cc

\clist_set_from_seq:NN I hope this technique is more efficient than looping through each element and using
\clist_gset_from_seq:NN \clist_put_right:Nn (Will).

4415 \cs_new:Npn \clist_set_from_seq_aux:NNN #1#2#3 {
4416   \cs_set:Npn \seq_elt:w ##1 \seq_elt_end: ##2 {
4417     \exp_not:n {##1}
4418     \quark_if_nil:NF ##2 { , ##2 }
4419   }
4420   #1 #2 { #3 \q_nil }
4421 }
4422 \cs_new:Npn \clist_set_from_seq:NN { \clist_set_from_seq_aux:NNN \tl_set:Nx }
4423 \cs_new:Npn \clist_gset_from_seq:NN { \clist_set_from_seq_aux:NNN \tl_gset:Nx }

```

107.2 Predicates and conditionals

```

\clist_if_empty_p:N
\clist_if_empty_p:c
\clist_if_empty:N $\underline{TF}$ 
\clist_if_empty:c $\underline{TF}$ 
4424 \prg_new_eq_conditional:NNn \clist_if_empty:N \tl_if_empty:N {p,TF,T,F}
4425 \prg_new_eq_conditional:NNn \clist_if_empty:c \tl_if_empty:c {p,TF,T,F}

\clist_if_empty_err:N Signals an error if the comma-list is empty.

4426 \cs_new_nopar:Npn \clist_if_empty_err:N #1 {
4427   \if_meaning:w #1 \c_empty_tl
4428   \tl_clear:N \l_testa_tl % catch prefixes
4429   \msg_kernel_bug:x {Empty~comma-list~'\token_to_str:N #1'}
4430   \fi:
4431 }

\clist_if_eq_p:NN Returns \c_true iff the two comma-lists are equal.
\clist_if_eq_p:Nc
\clist_if_eq_p:cN
\clist_if_eq_p:cc
\clist_if_eq:NN $\underline{TF}$ 
\clist_if_eq:cN $\underline{TF}$ 
\clist_if_eq:Nc $\underline{TF}$ 
\clist_if_eq:cc $\underline{TF}$ 
4432 \prg_new_eq_conditional:NNn \clist_if_eq:NN \tl_if_eq:NN {p,TF,T,F}
4433 \prg_new_eq_conditional:NNn \clist_if_eq:cN \tl_if_eq:cN {p,TF,T,F}
4434 \prg_new_eq_conditional:NNn \clist_if_eq:Nc \tl_if_eq:Nc {p,TF,T,F}
4435 \prg_new_eq_conditional:NNn \clist_if_eq:cc \tl_if_eq:cc {p,TF,T,F}

```

`\clist_if_in:NnTF` `\clist_if_in:NnTF` $\langle clist \rangle \langle item \rangle \langle true\ case \rangle \langle false\ case \rangle$ will check whether $\langle item \rangle$ is
`\clist_if_in:NVTF` in $\langle clist \rangle$ and then either execute the $\langle true\ case \rangle$ or the $\langle false\ case \rangle$. $\langle true\ case \rangle$ and
`\clist_if_in:NoTF` $\langle false\ case \rangle$ may contain incomplete `\if_charcode:w` statements.
`\clist_if_in:cnTF`
`\clist_if_in:cVTF`
`\clist_if_in:coTF`

```

4436 \prg_new_conditional:Nnn \clist_if_in:Nn {TF,T,F} {
4437   \cs_set:Npn \clist_tmp:w ##1,##2,##3 \q_stop {
4438     \if_meaning:w \q_no_value ##2
4439     \prg_return_false: \else: \prg_return_true: \fi:
4440   }
4441   \exp_last_unbraced:NNo \clist_tmp:w , #1 , #2 , \q_no_value \q_stop
4442 }

4443 \cs_generate_variant:Nn \clist_if_in:NnTF {NV,No,cn,cV,co}
4444 \cs_generate_variant:Nn \clist_if_in:NnT {NV,No,cn,cV,co}
4445 \cs_generate_variant:Nn \clist_if_in:NnF {NV,No,cn,cV,co}

```

107.3 Retrieving data

`\clist_use:N` Using a $\langle clist \rangle$ is just executing it but if $\langle clist \rangle$ equals `\scan_stop:` it is probably stem-
`\clist_use:c` ming from a `\cs:w ... \cs_end:` that was created by mistake somewhere.

```

4446 \cs_new_nopar:Npn \clist_use:N #1 {
4447   \if_meaning:w #1 \scan_stop:
4448   \msg_kernel_bug:x {
4449     Comma~list~ '\token_to_str:N #1'~ has~ an~ erroneous~ structure!}
4450   \else:
4451     \exp_after:wN #1
4452   \fi:
4453 }
4454 \cs_generate_variant:Nn \clist_use:N {c}

```

`\clist_get:NN` `\clist_get:NN` $\langle comma\ list \rangle \langle cmd \rangle$ defines $\langle cmd \rangle$ to be the left-most element of $\langle comma\ list \rangle$.
`\clist_get:cN`
`\clist_get_aux:w`

```

4455 \cs_new_nopar:Npn \clist_get:NN #1 {
4456   \clist_if_empty_err:N #1
4457   \exp_after:wN \clist_get_aux:w #1,\q_stop
4458 }

4459 \cs_new:Npn \clist_get_aux:w #1,##2\q_stop #3 { \tl_set:Nn #3{#1} }

4460 \cs_generate_variant:Nn \clist_get:NN {cN}

```

`\clist_pop_aux:nnNN` `\clist_pop_aux:nnNN` $\langle def_1 \rangle \langle def_2 \rangle \langle comma\ list \rangle \langle cmd \rangle$ assigns the left-most element of
`\clist_pop_aux:w` $\langle comma\ list \rangle$ to $\langle cmd \rangle$ using $\langle def_2 \rangle$, and assigns the tail of $\langle comma\ list \rangle$ to $\langle comma\ list \rangle$
`\clist_pop_auxi:w` using $\langle def_1 \rangle$.

```

4461 \cs_new:Npn \clist_pop_aux:nnNN #1#2#3 {
4462   \clist_if_empty_err:N #3
4463   \exp_after:wN \clist_pop_aux:w #3,\q_nil\q_stop #1#2#3
4464 }

```

After the assignments below, if there was only one element in the original *clist*, it now contains only `\q_nil`.

```

4465 \cs_new:Npn \clist_pop_aux:w #1,#2\q_stop #3#4#5#6 {
4466     #4 #6 {#1}
4467     #3 #5 {#2}
4468     \quark_if_nil:NTF #5 { #3 #5 {} }{ \clist_pop_auxi:w #2 #3#5 }
4469 }

4470 \cs_new:Npn \clist_pop_auxi:w #1,\q_nil #2#3 { #2#3{#1} }

```

`\clist_show:N`
`\clist_show:c`

```

4471 \cs_new_eq:NN \clist_show:N \tl_show:N
4472 \cs_new_eq:NN \clist_show:c \tl_show:c

```

`\clist_display:N`
`\clist_display:c`

```

4473 \cs_new_nopar:Npn \clist_display:N #1 {
4474     \iow_term:x { Comma-list~\token_to_str:N #1~contains~
4475         the~elements~(without~outer~braces): }
4476     \toks_clear:N \l_tmpa_toks
4477     \clist_map_inline:Nn #1 {
4478         \toks_if_empty:NF \l_tmpa_toks {
4479             \toks_put_right:Nx \l_tmpa_toks {^^J>~}
4480         }
4481         \toks_put_right:Nx \l_tmpa_toks {
4482             \iow_space: \iow_char:N \{ \exp_not:n {##1} \iow_char:N \}
4483         }
4484     }
4485     \toks_show:N \l_tmpa_toks
4486 }
4487 \cs_generate_variant:Nn \clist_display:N {c}

```

107.4 Storing data

`\clist_put_aux:NNnnNn`

The generic put function. When adding we have to distinguish between an empty *clist* and one that contains at least one item (otherwise we accumulate commas).

MH says: Perhaps we should make sure that empty arguments don't get on the stack as that is probably a mistake. That's what I've implemented here. Since `\tl_if_empty:nF` is expandable prefixes are still allowed.

```

4488 \cs_new:Npn \clist_put_aux:NNnnNn #1#2#3#4#5#6 {
4489     \clist_if_empty:NTF #5 { #1 #5 {#6} } {
4490         \tl_if_empty:nF {#6} { #2 #5{#3#6#4} }
4491     }
4492 }

```

`\clist_put_left:Nn`
`\clist_put_left:NV`
`\clist_put_left:No`
`\clist_put_left:Nx`
`\clist_put_left:cn`
`\clist_put_left:cV`
`\clist_put_left:co`

The operations for adding to the left.

```

4493 \cs_new_nopar:Npn \clist_put_left:Nn {
4494     \clist_put_aux:NNnnNn \tl_set:Nn \tl_put_left:Nn {} ,
4495 }
4496 \cs_generate_variant:Nn \clist_put_left:Nn {NV,No,Nx,cn,cV,co}

```

```

\clist_gput_left:Nn Global versions.
\clist_gput_left:NV
\clist_gput_left:No
\clist_gput_left:Nx
\clist_gput_left:cn
\clist_gput_left:cV
\clist_gput_left:co
\clist_put_right:Nn
\clist_put_right:NV
\clist_put_right:No
\clist_put_right:Nx
\clist_put_right:cn
\clist_put_right:cV
\clist_put_right:co
\clist_gput_right:Nn
\clist_gput_right:NV
\clist_gput_right:No
\clist_gput_right:Nx
\clist_gput_right:cn
\clist_gput_right:cV
\clist_gput_right:co

```

4497 \cs_new_nopar:Npn \clist_gput_left:Nn {
4498 \clist_put_aux:NNnnNn \tl_gset:Nn \tl_gput_left:Nn {} ,
4499 }
4500 \cs_generate_variant:Nn \clist_gput_left:Nn {NV,No,Nx,cn,cV,co}

Adding something to the right side is almost the same.

4501 \cs_new_nopar:Npn \clist_put_right:Nn {
4502 \clist_put_aux:NNnnNn \tl_set:Nn \tl_put_right:Nn , {}
4503 }
4504 \cs_generate_variant:Nn \clist_put_right:Nn {NV,No,Nx,cn,cV,co}

And here the global variants.

4505 \cs_new_nopar:Npn \clist_gput_right:Nn {
4506 \clist_put_aux:NNnnNn \tl_gset:Nn \tl_gput_right:Nn , {}
4507 }
4508 \cs_generate_variant:Nn \clist_gput_right:Nn {NV,No,Nx,cn,cV,co}

107.5 Mapping

```

\clist_map_function:NN \clist_map_function:NN <comma-list> <cmd> applies <cmd> to each element of <comma-list>,
\clist_map_function:cN from left to right.
\clist_map_function:nN

```

4509 \cs_new_nopar:Npn \clist_map_function:NN #1#2 {
4510 \clist_if_empty:NF #1 {
4511 \exp_after:wN \clist_map_function_aux:Nw
4512 \exp_after:wN #2 #1 , \q_recursion_tail , \q_recursion_stop
4513 }
4514 }
4515 \cs_generate_variant:Nn \clist_map_function:NN {cN}

4516 \cs_new:Npn \clist_map_function:nN #1#2 {
4517 \tl_if_blank:nF {#1} {
4518 \clist_map_function_aux:Nw #2 #1 , \q_recursion_tail , \q_recursion_stop
4519 }
4520 }

\clist_map_function_aux:Nw The general loop. Tests if we hit the first stop marker and exits if we did. If we didn't, place the function #1 in front of the element #2, which is surrounded by braces.

```

4521 \cs_new:Npn \clist_map_function_aux:Nw #1#2,{
4522 \quark_if_recursion_tail_stop:n{#2}
4523 #1{#2}
4524 \clist_map_function_aux:Nw #1
4525 }

```

\clist_map_break: The break statement is easy. Same as in other modules, gobble everything up to the special recursion stop marker.

```

4526 \cs_new_eq:NN \clist_map_break: \use_none_delimit_by_q_recursion_stop:w

```

`\clist_map_inline:Nn` The inline type is faster but not expandable. In order to make it nestable, we use a counter to keep track of the nesting level so that all of the functions called have distinct names. A simpler approach would of course be to use grouping and thus the save stack but then you lose the ability to do things locally.

A funny little thing occurred in one document: The command setting up the first call of `\clist_map_inline:Nn` was used in a tabular cell and the inline code used `\` so the loop broke as soon as this happened. Lesson to be learned from this: If you wish to have group like structure but not using the groupings of \TeX , then do every operation globally.

```

4527 \int_new:N \g_clist_inline_level_int
4528 \cs_new:Npn \clist_map_inline:Nn #1#2 {
4529   \clist_if_empty:NF #1 {
4530     \int_gincr:N \g_clist_inline_level_int
4531     \cs_gset:cpn {clist_map_inline_ \int_use:N \g_clist_inline_level_int :n}
4532     ##1{#2}

```

It is a lot more efficient to carry over the special function rather than constructing the same csname over and over again, so we just do it once. We reuse `\clist_map_function_aux:Nw` for the actual loop.

```

4533   \exp_last_unbraced:NcV \clist_map_function_aux:Nw
4534   {clist_map_inline_ \int_use:N \g_clist_inline_level_int :n}
4535   #1 , \q_recursion_tail , \q_recursion_stop
4536   \int_gdecr:N \g_clist_inline_level_int
4537 }
4538 }
4539 \cs_generate_variant:Nn \clist_map_inline:Nn {c}
4540 \cs_new:Npn \clist_map_inline:nn #1#2 {
4541   \tl_if_empty:NF {#1} {
4542     \int_gincr:N \g_clist_inline_level_int
4543     \cs_gset:cpn {clist_map_inline_ \int_use:N \g_clist_inline_level_int :n}
4544     ##1{#2}
4545     \exp_args:Nc \clist_map_function_aux:Nw
4546     {clist_map_inline_ \int_use:N \g_clist_inline_level_int :n}
4547     #1 , \q_recursion_tail , \q_recursion_stop
4548     \int_gdecr:N \g_clist_inline_level_int
4549   }
4550 }

```

`\clist_map_variable:nNn` `\clist_map_variable:NNn` $\langle comma-list \rangle$ $\langle temp \rangle$ $\langle action \rangle$ assigns $\langle temp \rangle$ to each element and executes $\langle action \rangle$.

`\clist_map_variable:cNn`

```

4551 \cs_new:Npn \clist_map_variable:nNn #1#2#3 {
4552   \tl_if_empty:NF {#1} {
4553     \clist_map_variable_aux:Nnw #2 {#3} #1
4554     , \q_recursion_tail , \q_recursion_stop
4555   }
4556 }

```

Something for v/V

```

4557 \cs_new_nopar:Npn \clist_map_variable:NNn {\exp_args:No \clist_map_variable:nNn}
4558 \cs_generate_variant:Nn \clist_map_variable:NNn {cNn}

```


\clist_map_variable_aux:Nnw	The general loop. Assign the temp variable #1 to the current item #3 and then check if that's the stop marker. If it is, break the loop. If not, execute the action #2 and continue.
-----------------------------	--

```

4559 \cs_new:Npn \clist_map_variable_aux:Nnw #1#2#3,{
4560   \cs_set_nopar:Npn #1{#3}
4561   \quark_if_recursion_tail_stop:N #1
4562   #2 \clist_map_variable_aux:Nnw #1{#2}
4563 }

```

107.6 Higher level functions

$\backslash\text{clist_concat_aux:NNN}$ $\backslash\text{clist_concat:NNN}$	$\backslash\text{clist_gconcat:NNN}$ $\langle\text{clist } 1\rangle$ $\langle\text{clist } 2\rangle$ $\langle\text{clist } 3\rangle$ will globally assign $\langle\text{clist } 1\rangle$ the concatenation of $\langle\text{clist } 2\rangle$ and $\langle\text{clist } 3\rangle$.
---	---

Again the situation is a bit more complicated because of the use of commas between items, so if either list is empty we have to avoid adding a comma.

```

4564 \cs_new_nopar:Npn \clist_concat_aux:NNNN #1#2#3#4 {
4565   \toks_set:No \l_tmpa_toks {#3}
4566   \toks_set:No \l_tmpb_toks {#4}
4567   #1 #2 {
4568     \toks_use:N \l_tmpa_toks
4569     \toks_if_empty:NF \l_tmpa_toks { \toks_if_empty:NF \l_tmpb_toks , }
4570     \toks_use:N \l_tmpb_toks
4571   }
4572 }
4573 \cs_new_nopar:Npn \clist_concat:NNN { \clist_concat_aux:NNNN \tl_set:Nx }
4574 \cs_new_nopar:Npn \clist_gconcat:NNN { \clist_concat_aux:NNNN \tl_gset:Nx }
4575 \cs_generate_variant:Nn \clist_concat:NNN {ccc}
4576 \cs_generate_variant:Nn \clist_gconcat:NNN {ccc}

```

```
\l clist_remove_clist  A common scratch space for the removal routines.
```

```
4577 \clist new:N \l clist remove clist
```

<pre>list_remove_duplicates_aux:NN clist_remove_duplicates_aux:n \clist_remove_duplicates:N</pre>	<p>Removing duplicate entries in a $\langle \textit{clist} \rangle$ is fairly straight forward. We use a temporary variable and then go through the list from left to right. For each element check if the element is already present in the list.</p>
---	---

```
\clist_remove_duplicates:N
\clist_gremove_duplicates:N
```

The high level functions are just for telling if it should be a local or global setting.

```
4588 \cs new nopar:Npn \clist remove duplicates:N {
```

```

4589 \clist_remove_duplicates_aux:NN \clist_set_eq:NN
4590 }
4591 \cs_new_nopar:Npn \clist_gremove_duplicates:N {
4592 \clist_remove_duplicates_aux:NN \clist_gset_eq:NN
4593 }

```

```

\clist_remove_element:Nn
\clist_gremove_element:Nn
\clist_remove_element_aux:NNn
\clist_remove_element_aux:n

```

The same general idea is used for removing elements: the parent functions just set things up for the internal ones.

```

4594 \cs_new_nopar:Npn \clist_remove_element:Nn {
4595 \clist_remove_element_aux:NNn \clist_set_eq:NN
4596 }
4597 \cs_new_nopar:Npn \clist_gremove_element:Nn {
4598 \clist_remove_element_aux:NNn \clist_gset_eq:NN
4599 }
4600 \cs_new:Nn \clist_remove_element_aux:NNn {
4601 \clist_clear:N \l_clist_remove_clist
4602 \cs_set:Nn \clist_remove_element_aux:n {
4603 \tl_if_eq:nnF {#3} {##1} {
4604 \clist_put_right:Nn \l_clist_remove_clist {##1}
4605 }
4606 }
4607 \clist_map_function:NN #2 \clist_remove_element_aux:n
4608 #1 #2 \l_clist_remove_clist
4609 }
4610 \cs_new:Nn \clist_remove_element_aux:n { }

```

107.7 Stack operations

We build stacks from comma-lists, but here we put the specific functions together.

```

\clist_push:Nn
\clist_push:No
\clist_push:NV
\clist_push:cn
\clist_pop:NN
\clist_pop:cn

```

Since comma-lists can be used as stacks, we ought to have both ‘push’ and ‘pop’. In most cases they are nothing more than new names for old functions.

```

4611 \cs_new_eq:NN \clist_push:Nn \clist_put_left:Nn
4612 \cs_new_eq:NN \clist_push:NV \clist_put_left:NV
4613 \cs_new_eq:NN \clist_push:No \clist_put_left:No
4614 \cs_new_eq:NN \clist_push:cn \clist_put_left:cn
4615 \cs_new_nopar:Npn \clist_pop:NN {\clist_pop_aux:nnNN \tl_set:Nn \tl_set:Nn}
4616 \cs_generate_variant:Nn \clist_pop:NN {cN}

```

```

\clist_gpush:Nn
\clist_gpush:No
\clist_gpush:NV
\clist_gpush:cn
\clist_gpop:NN
\clist_gpop:cn

```

I don’t agree with Denys that one needs only local stacks, actually I believe that one will probably need the functions here more often. In case of `\clist_gpop:NN` the value is nevertheless returned locally.

```

4617 \cs_new_eq:NN \clist_gpush:Nn \clist_gput_left:Nn
4618 \cs_new_eq:NN \clist_gpush:NV \clist_gput_left:NV
4619 \cs_new_eq:NN \clist_gpush:No \clist_gput_left:No
4620 \cs_generate_variant:Nn \clist_gpush:Nn {cn}

4621 \cs_new_nopar:Npn \clist_gpop:NN {\clist_pop_aux:nnNN \tl_gset:Nn \tl_set:Nn}
4622 \cs_generate_variant:Nn \clist_gpop:NN {cN}

```

`\clist_top:NN` Looking at the top element of the stack without removing it is done with this operation.
`\clist_top:cN`

```
4623 \cs_new_eq:NN \clist_top:NN \clist_get:NN
4624 \cs_new_eq:NN \clist_top:cN \clist_get:cN

4625 </initex | package>
```

Show token usage:

```
4626 <*showmemory>
4627 %\showMemUsage
4628 </showmemory>
```

108 l3prop implementation

A property list is a token register whose contents is of the form

$$\backslash\mathbf{q_prop} \langle key_1 \rangle \backslash\mathbf{q_prop} \{ \langle info_1 \rangle \} \dots \backslash\mathbf{q_prop} \langle key_n \rangle \backslash\mathbf{q_prop} \{ \langle info_n \rangle \}$$

The property $\langle key \rangle$ s and $\langle info \rangle$ s might be arbitrary token lists; each $\langle info \rangle$ is surrounded by braces.

We start by ensuring that the required packages are loaded.

```
4629 <*package>
4630 \ProvidesExplPackage
4631   {\filename}{\filedate}{\fileversion}{\filedescription}
4632 \package_check_loaded_expl:
4633 </package>
4634 <*initex | package>
```

`\q_prop` The separator between $\langle key \rangle$ s and $\langle info \rangle$ s and $\langle key \rangle$ s.

```
4635 \quark_new:N\q_prop
```

To get values from property-lists, token lists should be passed to the appropriate functions.

108.1 Functions

`\prop_new:N` Property lists are implemented as token registers.

`\prop_new:c`

```
4636 \cs_new_eq:NN \prop_new:N \toks_new:N
4637 \cs_new_eq:NN \prop_new:c \toks_new:c
```

`\prop_clear:N` The same goes for clearing a property list, either locally or globally.

`\prop_clear:c`

`\prop_gclear:N`

`\prop_gclear:c`

```
4638 \cs_new_eq:NN \prop_clear:N \toks_clear:N
4639 \cs_new_eq:NN \prop_clear:c \toks_clear:c
4640 \cs_new_eq:NN \prop_gclear:N \toks_gclear:N
4641 \cs_new_eq:NN \prop_gclear:c \toks_gclear:c
```

```

\prop_set_eq:NN This makes two  $\langle prop \rangle$ s have the same contents.
\prop_set_eq:Nc
\prop_set_eq:cN
\prop_set_eq:cc
\prop_gset_eq:NN
\prop_gset_eq:Nc
\prop_gset_eq:cN
\prop_gset_eq:cc
4642 \cs_new_eq:NN \prop_set_eq:NN \toks_set_eq:NN
4643 \cs_new_eq:NN \prop_set_eq:Nc \toks_set_eq:Nc
4644 \cs_new_eq:NN \prop_set_eq:cN \toks_set_eq:cN
4645 \cs_new_eq:NN \prop_set_eq:cc \toks_set_eq:cc
4646 \cs_new_eq:NN \prop_gset_eq:NN \toks_gset_eq:NN
4647 \cs_new_eq:NN \prop_gset_eq:Nc \toks_gset_eq:Nc
4648 \cs_new_eq:NN \prop_gset_eq:cN \toks_gset_eq:cN
4649 \cs_new_eq:NN \prop_gset_eq:cc \toks_gset_eq:cc

```

```

\prop_show:N Show on the console the raw contents of a property list's token register.
\prop_show:c
4650 \cs_new_eq:NN \prop_show:N \toks_show:N
4651 \cs_new_eq:NN \prop_show:c \toks_show:c

```

```

\prop_display:N Pretty print the contents of a property list on the console.
\prop_display:c
4652 \cs_new_nopar:Npn \prop_display:N #1 {
4653   \iow_term:x { Property-list~\token_to_str:N #1~contains~
4654     the~pairs~(without-outer~braces): }
4655   \toks_clear:N \l_tmpa_toks
4656   \prop_map_inline:Nn #1 {
4657     \toks_if_empty:NF \l_tmpa_toks {
4658       \toks_put_right:Nx \l_tmpa_toks {^^J>~}
4659     }
4660     \toks_put_right:Nx \l_tmpa_toks {
4661       \iow_space: \iow_char:N \{ \exp_not:n {##1} \iow_char:N \} \iow_space:
4662       \iow_space: => \iow_space:
4663       \iow_space: \iow_char:N \{ \exp_not:n {##2} \iow_char:N \}
4664     }
4665   }
4666   \toks_show:N \l_tmpa_toks
4667 }
4668 \cs_generate_variant:Nn \prop_display:N {c}

```

```

\prop_split_aux:Nnn \prop_split_aux:Nnn $\langle prop \rangle$  $\langle key \rangle$  $\langle cmd \rangle$  invokes  $\langle cmd \rangle$  with 3 arguments: 1st is the be-
ginning of  $\langle prop \rangle$  before  $\langle key \rangle$ , 2nd is the value associated with  $\langle key \rangle$ , 3rd is the rest of
 $\langle prop \rangle$  after  $\langle key \rangle$ . If there is no property  $\langle key \rangle$  in  $\langle prop \rangle$ , then the 2nd argument will be
 $\backslash q\_no\_value$  and the 3rd argument is empty; otherwise the 3rd argument has the extra
tokens  $\backslash q\_prop \langle key \rangle \backslash q\_prop \backslash q\_no\_value$  at the end.
4669 \cs_new:Npn \prop_split_aux:Nnn #1#2#3{
4670   \cs_set:Npn \prop_tmp:w ##1 \q_prop #2 \q_prop ##2##3 \q_stop {
4671     #3 {##1}{##2}{##3}
4672   }
4673   \exp_after:wN \prop_tmp:w \toks_use:N #1 \q_prop #2 \q_prop \q_no_value \q_stop
4674 }

```

```

\prop_get:NnN \prop_get:NnN  $\langle prop \rangle$  $\langle key \rangle$  $\langle tl var. \rangle$  defines  $\langle tl var. \rangle$  to be the value associated with  $\langle key \rangle$ 
\prop_get:cnN in  $\langle prop \rangle$ ,  $\backslash q\_no\_value$  if not found.
\prop_get_aux:w
4675 \cs_new:Npn \prop_get:NnN #1#2 {

```

```

4676 \prop_split_aux:Nnn #1{#2}\prop_get_aux:w
4677 }
4678 \cs_new:Npn \prop_get_aux:w #1#2#3#4 { \tl_set:Nx #4 {\exp_not:n{#2}} }
4679 \cs_generate_variant:Nn \prop_get:NnN {cnN}

```

\prop_gget:NnN The global version of the previous function.
\prop_gget:cnN
\prop_gget_aux:w

```

4680 \cs_new:Npn \prop_gget:NnN #1#2{
4681 \prop_split_aux:Nnn #1{#2}\prop_gget_aux:w}
4682 \cs_new:Npn \prop_gget_aux:w #1#2#3#4{\tl_gset:Nx#4{\exp_not:n{#2}}}
4683 \cs_generate_variant:Nn \prop_gget:NnN {cnN}

```

\prop_get_gdel:NnN \prop_get_gdel:NnN is the same as \prop_get:NnN but the $\langle key \rangle$ and its value are afterwards globally removed from $\langle property_list \rangle$. One probably also needs the local variants or only the local one, or... We decide this later.
\prop_get_del_aux:w

```

4684 \cs_new:Npn \prop_get_gdel:NnN #1#2#3{
4685 \prop_split_aux:Nnn #1{#2}{\prop_get_del_aux:w #3{\toks_gset:Nn #1{#2}}}}
4686 \cs_new:Npn \prop_get_del_aux:w #1#2#3#4#5#6{
4687 \tl_set:Nx #1{\exp_not:n{#5}}
4688 \quark_if_no_value:NF #1 {
4689 \cs_set_nopar:Npn \prop_tmp:w ##1\q_prop#3\q_prop\q_no_value {#2{#4##1}}
4690 \prop_tmp:w #6}
4691 }

```

\prop_put:Nnn \prop_put:Nnn { $\langle prop \rangle$ } { $\langle key \rangle$ } { $\langle info \rangle$ } adds/changes the value associated with $\langle key \rangle$ in $\langle prop \rangle$ to $\langle info \rangle$.
\prop_put:NnV
\prop_put:NVn
\prop_put:NVV
\prop_put:cnn
\prop_gput:Nnn
\prop_gput:NnV
\prop_gput:Nno
\prop_gput:Nnx
\prop_gput:cnn
\prop_gput:ccx
\prop_put_aux:w

```

4692 \cs_new:Npn \prop_put:Nnn #1#2{
4693 \prop_split_aux:Nnn #1{#2}{
4694 \prop_clear:N #1
4695 \prop_put_aux:w {\toks_put_right:Nn #1}{#2}
4696 }
4697 }
4698 \cs_new:Npn \prop_gput:Nnn #1#2{
4699 \prop_split_aux:Nnn #1{#2}{
4700 \prop_gclear:N #1
4701 \prop_put_aux:w {\toks_gput_right:Nn #1}{#2}
4702 }
4703 }
4704 \cs_new:Npn \prop_put_aux:w #1#2#3#4#5#6{
4705 #1{\q_prop#2\q_prop{#6}#3}
4706 \tl_if_empty:nF{#5}
4707 {
4708 \cs_set_nopar:Npn \prop_tmp:w ##1\q_prop#2\q_prop\q_no_value {#1{##1}}
4709 \prop_tmp:w #5
4710 }
4711 }
4712 \cs_generate_variant:Nn \prop_put:Nnn { NnV, NVn, NVV, cnn }

```

4713 \cs_generate_variant:Nn \prop_gput:Nnn {NnV,Nno,Nnx,Nox,cnn,ccx}

\prop_del:Nn \prop_del:Nn <prop><key> deletes the entry for <key> in <prop>, if any.
 \prop_gdel:Nn
 \prop_del_aux:w 4714 \cs_new:Npn \prop_del:Nn #1#2{
 4715 \prop_split_aux:Nnn #1{#2}{\prop_del_aux:w {\toks_set:Nn #1}{#2}}}
 4716 \cs_new:Npn \prop_gdel:Nn #1#2{
 4717 \prop_split_aux:Nnn #1{#2}{\prop_del_aux:w {\toks_gset:Nn #1}{#2}}}
 4718 \cs_new:Npn \prop_del_aux:w #1#2#3#4#5{
 4719 \cs_set_nopar:Npn \prop_tmp:w {#4}
 4720 \quark_if_no_value:NF \prop_tmp:w {
 4721 \cs_set_nopar:Npn \prop_tmp:w ##1\q_prop#2\q_prop\q_no_value {#1{#3##1}}
 4722 \prop_tmp:w #5
 4723 }
 4724 }

\prop_gput_if_new:Nnn \prop_gput_if_new:Nnn <prop> <key> <info> is equivalent to
 \prop_put_if_new_aux:w
 \prop_if_in:NnTF <prop><key>
 {}%
 {\prop_gput:Nnn
 <property_list>
 <key>
 <info>}

Here we go (listening to Porgy & Bess in a recording with Ella F. and Louis A. which makes writing macros sometimes difficult; I find myself humming instead of working):

4725 \cs_new:Npn \prop_gput_if_new:Nnn #1#2{
 4726 \prop_split_aux:Nnn #1{#2}{\prop_put_if_new_aux:w #1{#2}}}
 4727 \cs_new:Npn \prop_put_if_new_aux:w #1#2#3#4#5#6{
 4728 \tl_if_empty:nT {#5}{#1{\q_prop#2\q_prop{#6}#3}}}

108.2 Predicates and conditionals

\prop_if_empty_p:N This conditional takes a <prop> as its argument and evaluates either the true or the false case, depending on whether or not <prop> contains any properties.

\prop_if_empty_p:c
 \prop_if_empty:NTF 4729 \prg_new_eq_conditional:Nnn \prop_if_empty:N \toks_if_empty:N {p,TF,T,F}
 \prop_if_empty:cTF 4730 \prg_new_eq_conditional:Nnn \prop_if_empty:c \toks_if_empty:c {p,TF,T,F}

\prop_if_eq_p:NN These functions test whether two property lists are equal.

\prop_if_eq_p:cN 4731 \prg_new_eq_conditional:Nnn \prop_if_eq:NN \toks_if_eq:NN {p,TF,T,F}
 \prop_if_eq_p:Nc 4732 \prg_new_eq_conditional:Nnn \prop_if_eq:cN \toks_if_eq:cN {p,TF,T,F}
 \prop_if_eq_p:cc 4733 \prg_new_eq_conditional:Nnn \prop_if_eq:Nc \toks_if_eq:Nc {p,TF,T,F}
 \prop_if_eq:NTTF 4734 \prg_new_eq_conditional:Nnn \prop_if_eq:cc \toks_if_eq:cc {p,TF,T,F}

\prop_if_eq:NcTF
 \prop_if_eq:cNTF
 \prop_if_eq:ccTF
 \prop_if_in:NVTF \prop_if_in:NnTF <property_list> <key> <true_case> <false_case> will check whether or not <key> is on the <property_list> and then select either the true or false case.

\prop_if_in:NcTF
 \prop_if_in:cnTF
 \prop_if_in:ccTF
 \prop_if_in_aux:w

```

4735 \prg_new_conditional:Nnn \prop_if_in:Nn {TF,T,F} {
4736   \prop_split_aux:Nnn #1 {#2} {\prop_if_in_aux:w}
4737 }
4738 \cs_new_nopar:Npn \prop_if_in_aux:w #1#2#3 {
4739   \quark_if_no_value:nTF {#2} {\prg_return_false:} {\prg_return_true:}
4740 }

4741 \cs_generate_variant:Nn \prop_if_in:NnTF {NV,No,cn,cc}
4742 \cs_generate_variant:Nn \prop_if_in:NnT {NV,No,cn,cc}
4743 \cs_generate_variant:Nn \prop_if_in:NnF {NV,No,cn,cc}

```

108.3 Mapping functions

`\prop_map_function:NN` Maps a function on every entry in the property list. The function must take 2 arguments: a key and a value.
`\prop_map_function:cN`
`\prop_map_function:Nc`
`\prop_map_function:cc`
`\prop_map_function_aux:w`

First, some failed attempts:

```

\cs_new_nopar:Npn \prop_map_function:NN #1#2{
  \exp_after:wN \prop_map_function_aux:w
  \exp_after:wN #2 \toks_use:N #1 \q_prop{\q_prop \q_no_value \q_stop
}
\cs_new_nopar:Npn \prop_map_function_aux:w #1\q_prop#2\q_prop#3{
  \if_predicate:w \tl_if_empty_p:n{#2}
  \exp_after:wN \prop_map_break:
  \fi:
  #1{#2}{#3}
  \prop_map_function_aux:w #1
}

```

problem with the above implementation is that an empty key stops the mapping but all other functions in the module allow the use of empty keys (as one value)

```

\cs_set_nopar:Npn \prop_map_function:NN #1#2{
  \exp_after:wN \prop_map_function_aux:w
  \exp_after:wN #2 \toks_use:N #1 \q_prop \q_no_value \q_prop \q_no_value
}
\cs_set_nopar:Npn \prop_map_function_aux:w #1\q_prop#2\q_prop#3{
  \quark_if_no_value:nF{#2}
  {
    #1{#2}{#3}
    \prop_map_function_aux:w #1
  }
}

```

problem with the above implementation is that `\quark_if_no_value:nF` is fairly slow and if `\quark_if_no_value:NF` is used instead we have to do an assignment thus making the mapping not expandable (is that important?)

Here's the current version of the code:

```

4744 \cs_set_nopar:Npn \prop_map_function:NN #1#2 {
4745     \exp_after:wN \prop_map_function_aux:w
4746     \exp_after:wN #2 \toks_use:N #1 \q_prop \q_nil \q_prop \q_no_value \q_stop
4747 }
4748 \cs_set:Npn \prop_map_function_aux:w #1 \q_prop #2 \q_prop #3 {
4749     \if_meaning:w \q_nil #2
4750     \exp_after:wN \prop_map_break:
4751     \fi:
4752     #1{#2}{#3}
4753     \prop_map_function_aux:w #1
4754 }

```

(potential) problem with the above implementation is that it will return true if #2 contains more than just \q_nil thus executing whatever follows. Claim: this can't happen :-)

so we should be ok

```

4755 \cs_generate_variant:Nn \prop_map_function:NN {c,Nc,cc}

```

\prop_map_inline:Nn
\prop_map_inline:cn
\g_prop_inline_level_num

The inline functions are straight forward. It takes longer to test if the list is empty than to run it on an empty list so we don't waste time doing that.

```

4756 \num_new:N \g_prop_inline_level_num
4757 \cs_new_nopar:Npn \prop_map_inline:Nn #1#2 {
4758     \num_gincr:N \g_prop_inline_level_num
4759     \cs_gset:cpn {prop_map_inline_ \num_use:N \g_prop_inline_level_num :n}
4760     ##1##2{#2}
4761     \prop_map_function:Nc #1
4762     {prop_map_inline_ \num_use:N \g_prop_inline_level_num :n}
4763     \num_gdecr:N \g_prop_inline_level_num
4764 }
4765 \cs_generate_variant:Nn\prop_map_inline:Nn {cn}

```

\prop_map_break: The break statement.

```

4766 \cs_new_eq:NN \prop_map_break: \use_none_delimit_by_q_stop:w
4767 </initex | package>

```

Show token usage:

```

4768 <*showmemory>
4769 %\showMemUsage
4770 </showmemory>

```

109 l3io implementation

We start by ensuring that the required packages are loaded.

```

4771 <*package>
4772 \ProvidesExplPackage
4773 { \filename } { \filedate } { \fileversion } { \filedescription }
4774 \package_check_loaded_expl:
4775 </package>
4776 <*initex | package>

```


This section is primarily concerned with input and output streams. The naming conventions for i/o streams is `ior` (for read) and `iow` (for write) as module names. e.g. `\c_ior_test_stream` is an input stream variable called ‘test’.

109.1 Output streams

`\iow_new:N` Allocation of new output streams is done by these functions. As we currently do not
`\iow_new:c` distribute a new allocation module we nick the `\newwrite` function.

```

4777 \*initex>
4778 \alloc_setup_type:nnn {iow} \c_zero \c_sixteen
4779 \cs_new_nopar:Npn \iow_new:N #1 {\alloc_reg:NnNN g {iow} \tex_chardef:D #1}
4780 \*initex>
4781 \*package>
4782 \cs_set_eq:NN \iow_new:N \newwrite
4783 \*package>
4784 \cs_generate_variant:Nn \iow_new:N {c}

```

`\iow_open:Nn` To open streams for reading or writing the following two functions are provided. The
`\iow_open:cn` streams are opened immediately.

From some bad experiences on the mainframe, I learned that it is better to force the close before opening a dataset for writing. We have to check whether this is also necessary in case of `\tex_openin:D`.

```

4785 \cs_new_nopar:Npn \iow_open:Nn #1#2 {
4786   \iow_close:N #1
4787   \tex_immediate:D \tex_openout:D #1#2 \scan_stop:
4788 }
4789 \cs_generate_variant:Nn \iow_open:Nn {c}

```

`\iow_close:N` Since we close output streams prior to opening, a separate closing operation is probably not necessary. But here it is, just in case.... Actually you will need this if you intend to write and then read in the same pass from a stream.

```

4790 \cs_new_nopar:Npn \iow_close:N { \tex_immediate:D \tex_closeout:D }

```

`\c_iow_term_stream` Here we allocate two output streams for writing to the transcript file only (`\c_iow_log_stream`)
`\c_ior_term_stream` and to both the terminal and transcript file (`\c_iow_term_stream`). Both can be used
`\c_iow_log_stream` to read from and have equivalent `\c_ior` versions.
`\c_ior_log_stream`

```

4791 \cs_new_eq:NN \c_iow_term_stream \c_sixteen
4792 \cs_new_eq:NN \c_ior_term_stream \c_sixteen
4793 \cs_new_eq:NN \c_iow_log_stream \c_minus_one
4794 \cs_new_eq:NN \c_ior_log_stream \c_minus_one

```

Immediate writing

`\iow_now:Nx` An abbreviation for an often used operation, which immediately writes its second argument expanded to the output stream.

```

4795 \cs_new_nopar:Npn \iow_now:Nx { \tex_immediate:D \iow_shipout_x:Nn }

```

`\iow_now:Nn` This routine writes the second argument onto the output stream without expansion. If this stream isn't open, the output goes to the terminal instead. If the first argument is no output stream at all, we get an internal error.

```
4796 \cs_new_nopar:Npn \iow_now:Nn #1#2 {
4797   \iow_now:Nx #1 { \exp_not:n {#2} }
4798 }
```

`\iow_log:n` Now we redefine two functions for which we needed a definition very early on.

```
\iow_log:x
\iow_term:n
\iow_term:x
4799 \cs_set_nopar:Npn \iow_log:x { \iow_now:Nx \c_iow_log_stream }
4800 \cs_set_nopar:Npn \iow_log:n { \iow_now:Nn \c_iow_log_stream }
4801 \cs_set_nopar:Npn \iow_term:x { \iow_now:Nx \c_iow_term_stream }
4802 \cs_set_nopar:Npn \iow_term:n { \iow_now:Nn \c_iow_term_stream }
```

`\iow_term:x` isn't exactly equivalent to the old `\typeout` since we need to control expansion in the function we provide for the user.

`\iow_now_when_avail:Nn` `\iow_now_when_avail:Nn` $\langle stream \rangle$ $\langle code \rangle$. This routine writes its second argument unexpanded to the stream given by the first argument, provided that this stream was opened for writing. Note, that # characters get doubled within $\langle code \rangle$.

In this routine we have to check whether or not the output stream that was requested is defined at all. So we check if the name is still free.

```
4803 \cs_new_nopar:Npn \iow_now_when_avail:Nn #1 {
4804   \cs_if_free:NTF #1 {\use_none:n} {\iow_now:Nn #1}
4805 }
4806 \cs_generate_variant:Nn \iow_now_when_avail:Nn {c}
```

`\iow_now_buffer_safe:Nn` Another type of writing onto an output stream is used for potentially long token sequences. We break the output lines at every blank in the second argument. This avoids the problem of buffer overflow when reading back, or badly broken lines on systems with limited file records. The only thing we have to take care of, is the danger of two blanks in succession since these get converted into a `\par` when we read the stuff back. But this can happen only if things like two spaces find their way into the second argument. Usually, multiple spaces are removed by T_EX's scanner.

```
4807 \cs_new_nopar:Npn \iow_now_buffer_safe_aux:w #1#2#3 {
4808   \group_begin: \tex_newlinechar:D'\ #1#2{#3} \group_end:
4809 }
4810 \cs_new_nopar:Npn \iow_now_buffer_safe:Nx {
4811   \iow_now_buffer_safe_aux:w \iow_now:Nx
4812 }
4813 \cs_new_nopar:Npn \iow_now_buffer_safe:Nn {
4814   \iow_now_buffer_safe_aux:w \iow_now:Nn
4815 }
```

Deferred writing

`\iow_shipout_x:Nn` First the easy part, this is the primitive.

```
\iow_shipout_x:Nx
4816 \cs_set_eq:NN \iow_shipout_x:Nn \tex_write:D
4817 \cs_generate_variant:Nn \iow_shipout_x:Nn {Nx}
```

`\iow_shipout:Nn` With ε -TeX available deferred writing is easy.

`\iow_shipout:Nx`

```

4818 \cs_new_nopar:Npn \iow_shipout:Nn #1#2{
4819   \iow_shipout_x:Nn #1 { \exp_not:n {#2} }
4820 }
4821 \cs_generate_variant:Nn \iow_shipout:Nn {Nx}
```

‘Buffer safe’ forms of these functions are not possible since the deferred writing will restore the value of `\tex_newlinechar:D` before it will have a chance to act. But on the other hand it is nevertheless possible to make all deferred writes long by setting the `\tex_newlinechar:D` inside the output routine just before the `\tex_shipout:D`. The only disadvantage of this method is the fact that messages to the terminal during this time will also then break at spaces. But we should consider this.

Special characters for writing

`\iow_newline:` Global variable holding the character that forces a new line when something is written to an output stream.

```
4822 \cs_new_nopar:Npn \iow_newline: {^^J}
```

`\iow_space:` Global variable holding the character that inserts a space char when writing to an output stream.

```
4823 \cs_new_nopar:Npn \iow_space: {~}
```

`\iow_char:N` Function to write any escaped char to an output stream.

```
4824 \cs_new:Nn \iow_char:N { \cs_to_str:N #1 }
```

`\c_iow_comment_char` TODO: remove these in favour of `\iow_char:N` (Will, Apr 2009)

`\c_iow_lbrace_char` We also need to be able to write braces and the comment character. We achieve this by defining global constants to expand into a version of these characters with `\tex_catcode:D = 12`.

`\c_iow_rbrace_char`

```
4825 \tl_new:Nx \c_iow_comment_char { \cs_to_str:N \% }
```

To avoid another allocation function which is probably only necessary here we use the `\cs_set_nopar:Npx` command directly.

```
4826 \tl_new:Nx \c_iow_lbrace_char { \cs_to_str:N \{ }
4827 \tl_new:Nx \c_iow_rbrace_char { \cs_to_str:N \} }
```

109.2 Input streams

`\ior_new:N` Allocation of new input streams is done by this function. As we currently do not distribute a new allocation module we nick the `\newwread` function.

```

4828 <*initex>
4829 \alloc_setup_type:nnn {ior} \c_zero \c_sixteen
4830 \cs_new_nopar:Npn \ior_new:N #1 { \alloc_reg:NnNN g {ior} \tex_chardef:D #1 }
4831 </initex>
4832 <package> \cs_set_eq:NN \ior_new:N \newwread
```

`\ior_open:Nn` Processing of input-streams (via `\tex_openin:D` and `closein`) is always ‘immediate’ as far as T_EX is concerned. An extra `\tex_immediate:D` is silently ignored.

```
4833 \cs_set_eq:NN \ior_close:N \tex_closein:D
4834 \cs_new_nopar:Npn \ior_open:Nn #1#2 {
4835   \ior_close:N #1 \scan_stop:
4836   \tex_openin:D #1#2 \scan_stop:
4837 }
```

`\if_eof:w`

```
4838 \cs_new_eq:NN \if_eof:w \tex_ifeof:D
```

`\ior_if_eof_p:N` `\ior_if_eof:NTF` *<stream>* *<true case>* *<false case>*. To test if some particular input stream is exhausted the following conditional is provided:

```
4839 \prg_new_conditional:Nnn \ior_if_eof:N {p,TF,T,F} {
4840   \tex_ifeof:D #1 \prg_return_true: \else: \prg_return_false: \fi:
4841 }
```

`\ior_to:NN` And here we read from files.

```
\ior_gto:NN
4842 \cs_new_nopar:Npn \ior_to:NN #1#2 {
4843   \tex_read:D #1 to #2
4844   <check> \chk_local_or_pref_global:N #2
4845 }
4846 \cs_new_nopar:Npn \ior_gto:NN {
4847   <+check> \pref_global_chk:
4848   <-check> \pref_global:D
4849   \ior_to:NN
4850 }
4851 </initex | package>
```

Show token usage:

```
4852 <*showmemory>
4853 \showMemUsage
4854 </showmemory>
```

110 l3msg implementation

The usual lead-off.

```
4855 <*package>
4856 \ProvidesExplPackage
4857   {\filename}{\filedate}{\fileversion}{\filedescription}
4858   \package_check_loaded_expl:
4859 </package>
4860 <*initex | package>
```

L^AT_EX is handling context, so the T_EX “noise” is turned down.

```
4861 \int_set:Nn \tex_errorcontextlines:D { \c_minus_one }
```

110.1 Variables and constants

<code>\c_msg_fatal_tl</code>	Header information.
<code>\c_msg_error_tl</code>	
<code>\c_msg_warning_tl</code>	4862 <code>\tl_new:Nn \c_msg_fatal_tl { Fatal~Error }</code>
<code>\c_msg_info_tl</code>	4863 <code>\tl_new:Nn \c_msg_error_tl { Error }</code>
	4864 <code>\tl_new:Nn \c_msg_warning_tl { Warning }</code>
	4865 <code>\tl_new:Nn \c_msg_info_tl { Info }</code>
<code>\c_msg_fatal_text_tl</code>	Simple pieces of text for messages.
<code>\c_msg_help_text_tl</code>	
<code>\c_msg_kernel_bug_text_tl</code>	4866 <code>\tl_new:Nn \c_msg_fatal_text_tl {</code>
<code>\c_msg_kernel_bug_more_text_tl</code>	4867 <code> This~is~a~fatal~error:~LaTeX~will~abort</code>
<code>\c_msg_no_info_text_tl</code>	4868 <code>}</code>
<code>\c_msg_return_text_tl</code>	4869 <code>\tl_new:Nn \c_msg_help_text_tl {</code>
	4870 <code> For~immediate~help~type~H~<return></code>
	4871 <code>}</code>
	4872 <code>\tl_new:Nn \c_msg_kernel_bug_text_tl {</code>
	4873 <code> This~is~a~LaTeX~bug:~check~coding!</code>
	4874 <code>}</code>
	4875 <code>\tl_new:Nn \c_msg_kernel_bug_more_text_tl {</code>
	4876 <code> There~is~a~coding~bug~somewhere~around~here.</code>
	4877 <code> \msg_newline:</code>
	4878 <code> This~probably~needs~examining~by~an~expert.</code>
	4879 <code> \c_msg_return_text_tl</code>
	4880 <code>}</code>
	4881 <code>\tl_new:Nn \c_msg_no_info_text_tl {</code>
	4882 <code> LaTeX~does~not~know~anything~more~about~this~error,~sorry.</code>
	4883 <code> \c_msg_return_text_tl</code>
	4884 <code>}</code>
	4885 <code>\tl_new:Nn \c_msg_return_text_tl {</code>
	4886 <code> \msg_two_newlines:</code>
	4887 <code> Try~typing~<return>~to~proceed.</code>
	4888 <code> \msg_newline:</code>
	4889 <code> If~that~doesn't~work,~type~X~<return>~to~quit</code>
	4890 <code>}</code>
<code>\c_msg_hide_tl<spaces></code>	An empty variable with a number of (category code 11) spaces at the end of its name. This is used to push the \TeX part of an error message “off the screen”.
	No indentation here as <code>_</code> is a letter!
	4891 <code>\group_begin:</code>
	4892 <code>\char_make_letter:N\ %</code>
	4893 <code>\tl_to_lowercase:n{%</code>
	4894 <code>\group_end:%</code>
	4895 <code>\tl_new:Nn%</code>
	4896 <code>\c_msg_hide_tl</code>
	4897 <code>{}%</code>
	4898 <code>}%</code>
<code>\c_msg_on_line_tl</code>	“On line”.
	4899 <code>\tl_new:Nn \c_msg_on_line_tl { on~line }</code>

<code>\c_msg_text_prefix_tl</code>	Prefixes for storage areas.
<code>\c_msg_more_text_prefix_tl</code>	
<code>\c_msg_code_prefix_tl</code>	<pre> 4900 \tl_new:Nn \c_msg_text_prefix_tl { msg_text ~>~ } 4901 \tl_new:Nn \c_msg_more_text_prefix_tl { msg_text_more ~>~ } 4902 \tl_new:Nn \c_msg_code_prefix_tl { msg_code ~>~ } </pre>
<code>\l_msg_class_tl</code>	For holding the current message method and that for redirection.
<code>\l_msg_current_class_tl</code>	<pre> 4903 \tl_new:N \l_msg_class_tl 4904 \tl_new:N \l_msg_current_class_tl </pre>
<code>\l_msg_names_clist</code>	Lists used for filtering.
	<pre> 4905 \clist_new:N \l_msg_names_clist </pre>
<code>\l_msg_redirect_classes_prop</code>	For filtering messages, a list of all messages and of those which have to be modified is required.
<code>\l_msg_redirect_names_prop</code>	<pre> 4906 \prop_new:N \l_msg_redirect_classes_prop 4907 \prop_new:N \l_msg_redirect_names_prop </pre>
<code>\l_msg_redirect_classes_clist</code>	To prevent an infinite loop.
	<pre> 4908 \clist_new:N \l_msg_redirect_classes_clist </pre>

110.2 Output helper functions

<code>\msg_line_number:</code>	For writing the line number nicely.
<code>\msg_line_context:</code>	<pre> 4909 \cs_new_nopar:Nn { \msg_line_number: } { 4910 \toks_use:N \tex_inputlineno:D 4911 } 4912 \cs_new_nopar:Nn { \msg_line_context: } { 4913 \msg_space: 4914 \c_msg_on_line_tl 4915 \msg_space: 4916 \msg_line_number: 4917 } </pre>
<code>\msg_newline:</code>	Always forces a new line.
<code>\msg_two_newlines:</code>	<pre> 4918 \cs_new_nopar:Nn \msg_newline: { ^^J } 4919 \cs_new_nopar:Nn \msg_two_newlines: { ^^J ^^J } </pre>
<code>\msg_space:</code>	For printing spaces, some very simple functions.
<code>\msg_two_spaces:</code>	
<code>\msg_four_spaces:</code>	<pre> 4920 \cs_new_nopar:Nn \msg_space: { ~ } 4921 \cs_new_nopar:Nn \msg_two_spaces: { \msg_space: \msg_space: } 4922 \cs_new_nopar:Nn \msg_four_spaces: { \msg_two_spaces: \msg_two_spaces: } </pre>

110.3 Generic functions

The lowest level functions make no assumptions about modules, *etc.*

`\msg_generic_new:nnnn` Creating a new message is basically the same as the non-checking version, and so after a
`\msg_generic_new:nnn` check everything hands over.
`\msg_generic_new:nn`

```
4923 \cs_new_nopar:Npn \msg_generic_new:nnnn #1 {  
4924   \exp_args:Nc \chk_if_free_cs:N { \c_msg_text_prefix_tl #1 :nn }  
4925   \msg_generic_set:nnnn {#1}  
4926 }  
4927 \cs_new_nopar:Npn \msg_generic_new:nnn #1 {  
4928   \exp_args:Nc \chk_if_free_cs:N { \c_msg_text_prefix_tl #1 :nn }  
4929   \msg_generic_set:nnn {#1}  
4930 }  
4931 \cs_new_nopar:Npn \msg_generic_new:nn #1 {  
4932   \exp_args:Nc \chk_if_free_cs:N { \c_msg_text_prefix_tl #1 :nn }  
4933   \msg_generic_set:nn {#1}  
4934 }
```

`\msg_generic_set:nnnn` Creating a message is quite simple. There must be a short text part, while the other parts
`\msg_generic_set:nnn` may not exist. To avoid filling up the hash table with empty functions, only non-empty
`\msg_generic_set:nn` arguments are stored. The various auxiliary functions are used to allow spaces in the
`\msg_generic_set_clist:n` text arguments.
`\msg_generic_set_text:n`
`\msg_generic_set_more_text:n`
`\msg_generic_set_code:n`

```
4935 \cs_new_nopar:Npn \msg_generic_set:nnnn #1 {  
4936   \msg_generic_set_clist:n {#1}  
4937   \char_make_space:N \ %  
4938   \msg_generic_set_code:nnnn{#1}%  
4939 }  
4940 \cs_new_nopar:Npn \msg_generic_set:nnn #1 {  
4941   \msg_generic_set_clist:n {#1}  
4942   \char_make_space:N \ %  
4943   \msg_generic_set_more_text:nnn{#1}%  
4944 }  
4945 \cs_new_nopar:Npn \msg_generic_set:nn #1 {  
4946   \msg_generic_set_clist:n {#1}  
4947   \char_make_space:N \ %  
4948   \msg_generic_set_text:nn{#1}%  
4949 }  
4950 \cs_new_nopar:Npn \msg_generic_set_clist:n #1 {  
4951   \clist_if_in:NnF \l_msg_names_clist { // #1 / } {  
4952     \clist_put_right:Nn \l_msg_names_clist { // #1 / }  
4953   }  
4954 }  
4955 \cs_new:Nn \msg_generic_set_text:nn {  
4956   \cs_set:cn { \c_msg_text_prefix_tl #1 :nn } {#2}  
4957   \char_make_ignore:N \  
4958 }  
4959 \cs_new:Nn \msg_generic_set_more_text:nnn {  
4960   \cs_set:cn { \c_msg_text_prefix_tl #1 :nn } {#2}  
4961   \tl_if_empty:nTF {#3} {  
4962     \cs_set_eq:cN { \c_msg_more_text_prefix_tl #1 } \c_undefined
```

```

4963 }{
4964   \cs_set:cn { \c_msg_more_text_prefix_tl #1 :nn } {#3}
4965 }
4966 \char_make_ignore:N \
4967 }
4968 \cs_new:Npn \msg_generic_set_code:nnnn #1#2#3 {
4969   \cs_set:cn { \c_msg_text_prefix_tl #1 :nn } {#2}
4970   \tl_if_empty:nTF {#3} {
4971     \cs_set_eq:cN { \c_msg_more_text_prefix_tl #1 } \c_undefined
4972   }{
4973     \cs_set:cn { \c_msg_more_text_prefix_tl #1 :nn } {#3}
4974   }
4975   \char_make_ignore:N \
4976   \msg_generic_set_code:nn {#1}
4977 }
4978 \cs_new:Nn \msg_generic_set_code:nn {
4979   \tl_if_empty:nTF {#2} {
4980     \cs_set_eq:cN { \c_msg_code_prefix_tl #1 : } \c_undefined
4981   }{
4982     \cs_set:cn { \c_msg_code_prefix_tl #1 : } {#2}
4983   }
4984 }

```

```

\msg_direct_interrupt:xxxxn
\msg_direct_interrupt:n

```

The low-level interruption macro is rather opaque, unfortunately. The idea here is to create a message which hides all of T_EX's own information by filling the output up with spaces. To achieve this, spaces have to be letters: hence no indentation. The odd `\c_msg_hide_tl` actually does the hiding: it is the large run of spaces in the name that is important here. The meaning of `\` is altered so that the explanation text is a simple run whilst the initial error has line-continuation shown.

```

4985 \group_begin:
4986 \char_set_lccode:nn {'\&} {'\ } % {
4987 \char_set_lccode:w '\} = '\ \scan_stop:
4988 \char_make_active:N \&
4989 \char_make_letter:N\ %
4990 \tl_to_lowercase:n{%
4991 \group_end:%
4992 \cs_new_protected:Nn\msg_direct_interrupt:xxxxn{%
4993 \group_begin:%
4994 \cs_set_eq:NN\ \msg_newline:%
4995 \cs_set_eq:NN\ \msg_space:%
4996 \msg_direct_interrupt_aux:n{#4}%
4997 \cs_set_nopar:Npn\ \{ \msg_newline:#3}%
4998 \tex_errhelp:D\l_msg_tmp_tl%
4999 \cs_set:Npn&{%
5000 \tex_errmessage:D{%
5001 #1\msg_newline:%
5002 #2\msg_two_newlines:%
5003 \c_msg_help_text_tl%
5004 \c_msg_hide_tl %
5005 }%
5006 }%
5007 &%
5008 \group_end:%

```



```

5009 #5%
5010 }%
5011 }%
5012 \cs_new:Nn \msg_direct_interrupt_aux:n {
5013   \tl_if_empty:nTF {#1} {
5014     \tl_set:Nx \l_msg_tmp_tl { { \c_msg_no_info_text_tl } }
5015   }{
5016     \tl_set:Nx \l_msg_tmp_tl { {#1} }
5017   }
5018 }

```

\msg_direct_log:xx Printing to the log or terminal without a stop is rather easier.
\msg_direct_term:xx

```

5019 \cs_new_protected:Nn \msg_direct_log:xx {
5020   \group_begin:
5021     \cs_set:Npn \ { \msg_newline: #2 }
5022     \cs_set_eq:NN \ \msg_space:
5023     \iow_log:x { #1 \msg_newline: }
5024   \group_end:
5025 }
5026 \cs_new_protected:Nn \msg_direct_term:xx {
5027   \group_begin:
5028     \cs_set:Npn \ { \msg_newline: #2 }
5029     \cs_set_eq:NN \ \msg_space:
5030     \iow_term:x { #1 \msg_newline: }
5031   \group_end:
5032 }

```

110.4 General functions

The main functions for messaging are built around the separation of module from the message name. These have short names as they will be widely used.

\msg_new:nnnnn For making messages.

```

\msg_new:nnnn
\msg_new:nnn
\msg_set:nnnnn
\msg_set:nnnn
\msg_set:nnn
5033 \cs_new_nopar:Npn \msg_new:nnnnn #1#2 {
5034   \msg_generic_new:nnnn { #1 / #2 }
5035 }
5036 \cs_new_nopar:Npn \msg_new:nnnn #1#2 {
5037   \msg_generic_new:nnn { #1 / #2 }
5038 }
5039 \cs_new_nopar:Npn \msg_new:nnn #1#2 {
5040   \msg_generic_new:nn { #1 / #2 }
5041 }
5042 \cs_new_nopar:Npn \msg_set:nnnnn #1#2 {
5043   \msg_generic_set:nnnn { #1 / #2 }
5044 }
5045 \cs_new_nopar:Npn \msg_set:nnnn #1#2 {
5046   \msg_generic_set:nnn { #1 / #2 }
5047 }
5048 \cs_new_nopar:Npn \msg_set:nnn #1#2 {
5049   \msg_generic_set:nn { #1 / #2 }
5050 }

```

`\msg_class_new:nn` Creating a new class produces three new functions, with varying numbers of arguments.
`\msg_class_set:nn` The `\msg_class_loop:n` function is set up so that redirection will work as desired.

```

5051 \cs_new_nopar:Npn \msg_class_new:nn #1 {
5052   \exp_args:Nc \chk_if_free_cs:N { msg_ #1 :nnxx }
5053   \prop_new:c { l_msg_redirect_ #1 _prop }
5054   \msg_class_set:nn {#1}
5055 }
5056 \cs_new_nopar:Nn \msg_class_set:nn {
5057   \prop_clear:c { l_msg_redirect_ #1 _prop }
5058   \cs_set_protected:cn { msg_ #1 :nnxx } {
5059     \msg_use:nnnnxx {#1} {#2} {##1} {##2} {##3} {##4}
5060   }
5061   \cs_set_protected:cn { msg_ #1 :nnx } {
5062     \use:c { msg_ #1 :nnxx } {##1} {##2} {##3} { }
5063   }
5064   \cs_set_protected:cn { msg_ #1 :nn } {
5065     \use:c { msg_ #1 :nnxx } {##1} {##2} { } { }
5066   }
5067 }

```

`\msg_use:nnnnxx` The main message-using macro creates two auxiliary functions: one containing the code for the message, and the second a loop function. There is then a hand-off to the system for checking if redirection is needed.

```

5068 \cs_new:Nn \msg_use:nnnnxx {
5069   \cs_set:Nn \msg_use_code: {
5070     \clist_clear:N \l_msg_redirect_classes_clist
5071     #2
5072   }
5073   \cs_set:Nn \msg_use_loop:n {
5074     \clist_if_in:NnTF \l_msg_redirect_classes_clist {#1} {
5075       \msg_kernel_error:n { message-loop }
5076     }{
5077       \clist_put_right:Nn \l_msg_redirect_classes_clist {#1}
5078       \cs_if_exist:cTF { msg_ ##1 :nnxx } {
5079         \use:c { msg_ ##1 :nnxx } {#3} {#4} {#5} {#6}
5080       }{
5081         \msg_kernel_error:nx { message-class-unknown } { ##1 }
5082       }
5083     }
5084   }
5085   \cs_if_exist:cTF { \c_msg_text_prefix_tl #3 / #4 :nn } {
5086     \msg_use_aux:nnn {#1} {#3} {#4}
5087   }{
5088     \msg_kernel_error:nxx { message-unknown } { #3 } { #4 }
5089   }
5090 }

```

`\msg_use_code:` Blank definitions are initially created for these functions.
`\msg_use_loop:`

```

5091 \cs_new_nopar:Nn \msg_use_code: { }
5092 \cs_new_nopar:Nn \msg_use_loop:n { }

```

`\msg_use_aux:nnn` The first auxiliary macro looks for a match by name: the most restrictive check.

```

5093 \cs_new_nopar:Nn \msg_use_aux:nnn {
5094   \tl_set:Nn \l_msg_current_class_tl {#1}
5095   \tl_set:Nn \l_msg_current_module_tl {#2}
5096   \prop_if_in:NnTF \l_msg_redirect_names_prop { // #2 / #3 / } {
5097     \msg_use_loop_check:nn { names } { // #2 / #3 / }
5098   }{
5099     \msg_use_aux:nn {#1} {#2}
5100   }
5101 }

```

`\msg_use_aux:nn` The second function checks for general matches by module or for all modules.

```

5102 \cs_new_nopar:Nn \msg_use_aux:nn {
5103   \prop_if_in:cnTF { l_msg_redirect_ #1 _prop } {#2} {
5104     \msg_use_loop_check:nn {#1} {#2}
5105   }{
5106     \prop_if_in:cnTF { l_msg_redirect_ #1 _prop } {*} {
5107       \msg_use_loop_check:nn {#1} {*}
5108     }{
5109       \msg_use_code:
5110     }
5111   }
5112 }

```

`\msg_use_loop_check:nn` When checking whether to loop, the same code is needed in a few places.

```

5113 \cs_new:Nn \msg_use_loop_check:nn {
5114   \prop_get:cnN { l_msg_redirect_ #1 _prop } {#2} \l_msg_class_tl
5115   \tl_if_eq:NNTF \l_msg_current_class_tl \l_msg_class_tl {
5116     \msg_use_code:
5117   }{
5118     \msg_use_loop:n { \l_msg_class_tl }
5119   }
5120 }

```

`\msg_fatal:nxxx` For fatal errors, after the error message TeX bails out.

`\msg_fatal:nnx`
`\msg_fatal:nn`

```

5121 \msg_class_new:nn { fatal } {
5122   \msg_direct_interrupt:xxxxn
5123   { \c_msg_fatal_tl \msg_two_newlines: }
5124   {
5125     ( \c_msg_fatal_tl ) \msg_space:
5126     \use:c { \c_msg_text_prefix_tl #1 / #2 :nn } {#3} {#4}
5127   }
5128   { ( \c_msg_fatal_tl ) \msg_space: }
5129   { \c_msg_fatal_text_tl }
5130   { \tex_end:D }
5131 }

```

`\msg_error:nxxx` For an error, the interrupt routine is called, then any recovery code is tried.

`\msg_error:nnx`
`\msg_error:nn`

```

5132 \msg_class_new:nn { error } {

```

```

5133 \msg_direct_interrupt:xxxxn
5134 { #1~\c_msg_error_tl \msg_newline: }
5135 {
5136   ( #1 ) \msg_space:
5137   \use:c { \c_msg_text_prefix_tl #1 / #2 :nn } {#3} {#4}
5138 }
5139 { ( #1 ) \msg_space: }
5140 {
5141   \cs_if_exist:cTF { \c_msg_more_text_prefix_tl #1 / #2 :nn } {
5142     \use:c { \c_msg_more_text_prefix_tl #1 / #2 :nn } {#3} {#4}
5143   }{
5144     \c_msg_no_info_text_tl
5145   }
5146 }
5147 {
5148   \cs_if_exist:cT { \c_msg_code_prefix_tl #1 / #2 :nn } {
5149     \use:c { \c_msg_code_prefix_tl #1 / #2 :nn } {#3} {#4}
5150   }
5151 }
5152 }

```

\msg_warning:nnxx Warnings are printed to the terminal.

```

\msg_warning:nnx
\msg_warning:nn
5153 \msg_class_new:nn { warning } {
5154   \msg_direct_term:xx {
5155     \msg_space: #1~\c_msg_warning_tl :~
5156     \use:c { \c_msg_text_prefix_tl #1 / #2 :nn } {#3} {#4}
5157   }
5158   { ( #1 ) \msg_two_spaces: }
5159 }

```

\msg_info:nnxx Information only goes into the log.

```

\msg_info:nnx
\msg_info:nn
5160 \msg_class_new:nn { info } {
5161   \msg_direct_log:xx {
5162     \msg_space: #1~\c_msg_info_tl :~
5163     \use:c { \c_msg_text_prefix_tl #1 / #2 :nn } {#3} {#4}
5164   }
5165   { ( #1 ) \msg_two_spaces: }
5166 }

```

\msg_log:nnxx “Log” data is very similar to information, but with no extras added.

```

\msg_log:nnx
\msg_log:nn
5167 \msg_class_new:nn { log } {
5168   \msg_direct_log:xx {
5169     \use:c { \c_msg_text_prefix_tl #1 / #2 :nn } {#3} {#4}
5170   }
5171   { }
5172 }

```

\msg_trace:nnxx Trace data is the same as log data, more or less

```

\msg_trace:nnx
\msg_trace:nn
5173 \msg_class_new:nn { trace } {

```

```

5174 \msg_direct_log:xx {
5175   \use:c { \c_msg_text_prefix_tl #1 / #2 :nn } {#3} {#4}
5176 }
5177 { }
5178 }

```

`\msg_none:nxxx` The none message type is needed so that input can be gobbled.

```

\msg_none:nnx
\msg_none:nn
5179 \msg_class_new:nn { none } { }

```

110.5 Redirection functions

`\msg_redirect_class:nn` Converts class one into class two.

```

5180 \cs_new_nopar:Nn \msg_redirect_class:nn {
5181   \prop_put:cnn { l_msg_redirect_ #1 _prop } {*} {#2}
5182 }

```

`\msg_redirect_module:nnn` For when all messages of a class should be altered for a given module.

```

5183 \cs_new_nopar:Nn \msg_redirect_module:nnn {
5184   \prop_put:cnn { l_msg_redirect_ #2 _prop } {#1} {#3}
5185 }

```

`\msg_redirect_name:nnn` Named message will always use the given class.

```

5186 \cs_new_nopar:Nn \msg_redirect_name:nnn {
5187   \prop_put:Nnn \l_msg_redirect_names_prop { // #1 / #2 / } {#3}
5188 }

```

110.6 Kernel-specific functions

`\msg_kernel_new:nnnn` The kernel needs some messages of its own. These are created using pre-built functions.
`\msg_kernel_new:nnn` Two functions are provided: one more general and one which only has the short text
`\msg_kernel_new:nn` part.

```

\msg_kernel_set:nnnn
\msg_kernel_set:nnn
\msg_kernel_set:nn
5189 \cs_new_nopar:Npn \msg_kernel_new:nnnn #1 {
5190   \msg_new:nnnnn { LaTeX } {#1}
5191 }
5192 \cs_new_nopar:Npn \msg_kernel_new:nnn #1 {
5193   \msg_new:nnnn { LaTeX } {#1}
5194 }
5195 \cs_new_nopar:Npn \msg_kernel_new:nn #1 {
5196   \msg_new:nnn { LaTeX } {#1}
5197 }
5198 \cs_new_nopar:Npn \msg_kernel_set:nnnn #1 {
5199   \msg_set:nnnnn { LaTeX } {#1}
5200 }
5201 \cs_new_nopar:Npn \msg_kernel_set:nnn #1 {
5202   \msg_set:nnnn { LaTeX } {#1}
5203 }
5204 \cs_new_nopar:Npn \msg_kernel_set:nn #1 {
5205   \msg_set:nnn { LaTeX } {#1}
5206 }

```

`\msg_kernel_classes_new:n` Quickly make the fewer-arguments versions.

```

5207 \cs_new_nopar:Nn \msg_kernel_classes_new:n {
5208   \cs_new_protected:cn { msg_kernel_ #1 :nx } {
5209     \use:c { msg_kernel_ #1 :nxx } {##1} {##2} { }
5210   }
5211   \cs_new_protected:cn { msg_kernel_ #1 :n } {
5212     \use:c { msg_kernel_ #1 :nxx } {##1} { } { }
5213   }
5214 }

```

`\msg_kernel_fatal:nxx` Fatal kernel errors cannot be re-defined.

`\msg_kernel_fatal:nx`
`\msg_kernel_fatal:n`

```

5215 \cs_new_protected:Nn \msg_kernel_fatal:nxx {
5216   \msg_direct_interrupt:xxxxn
5217   { \c_msg_fatal_tl \msg_two_newlines: }
5218   {
5219     ( LaTeX ) \msg_space:
5220     \use:c { \c_msg_text_prefix_tl LaTeX / #1 :nn } {#2} {#3}
5221   }
5222   { ( LaTeX ) \msg_space: }
5223   { \c_msg_fatal_text_tl }
5224   { \tex_end:D }
5225 }
5226 \msg_kernel_classes_new:n { fatal }

```

`\msg_kernel_error:nxx` Neither can kernel errors.

`\msg_kernel_error:nx`
`\msg_kernel_error:n`

```

5227 \cs_new_protected:Nn \msg_kernel_error:nxx {
5228   \msg_direct_interrupt:xxxxn
5229   { LaTeX~\c_msg_error_tl \msg_newline: }
5230   {
5231     ( LaTeX ) \msg_space:
5232     \use:c { \c_msg_text_prefix_tl LaTeX / #1 :nn } {#2} {#3}
5233   }
5234   { ( LaTeX ) \msg_space: }
5235   {
5236     \cs_if_exist:cTF { \c_msg_more_text_prefix_tl LaTeX / #1 :nn } {
5237       \use:c { \c_msg_more_text_prefix_tl LaTeX / #1 :nn } {#2} {#3}
5238     }{
5239       \c_msg_no_info_text_tl
5240     }
5241   }
5242   {
5243     \cs_if_exist:cT { \c_msg_code_prefix_tl LaTeX / #1 :nn } {
5244       \use:c { \c_msg_code_prefix_tl LaTeX / #1 :nn } {#2} {#3}
5245     }
5246   }
5247 }
5248 \msg_kernel_classes_new:n { error }

```

`\msg_kernel_warning:nxx`

Life is much more simple for warnings and information messages, as these are just short-cuts to the standard classes.

`\msg_kernel_warning:nx`

`\msg_kernel_warning:n`

`\msg_kernel_info:nxx`

`\msg_kernel_info:nx`

`\msg_kernel_info:n`

```

5249 \cs_new_protected_nopar:Npn \msg_kernel_warning:nxx {
5250   \msg_warning:nxxx { LaTeX }
5251 }
5252 \msg_kernel_classes_new:n { warning }
5253 \cs_new_protected_nopar:Npn \msg_kernel_info:nxx {
5254   \msg_info:nxxx { LaTeX }
5255 }
5256 \msg_kernel_classes_new:n { info }

```

Some very basic error messages.

```

5257 \msg_kernel_new:nnn { coding-bug } {%
5258   This is a LaTeX bug: check coding!\%
5259   #1%
5260 }{%
5261   #2%
5262 }
5263 \msg_kernel_new:nnn { message-unknown } {%
5264   Unknown message ‘#2’ for module ‘#1’.%
5265 }{%
5266   LaTeX was asked to display a message by the ‘#1’ module.\%
5267   The message was supposed to be called ‘#2’, but I can’t\%
5268   find a message with that name.
5269   \c_msg_return_text_tl
5270 }
5271 \msg_kernel_new:nnn { message-class-unknown } {%
5272   Unknown message class ‘#1’.%
5273 }{%
5274   You have asked for a message to be redirected to class ‘#1’\%
5275   but this class is unknown.
5276   \c_msg_return_text_tl
5277 }
5278 \msg_kernel_new:nnn { message-loop } {%
5279   Message redirection loop.%
5280 }{%
5281   You have asked for a message to be redirected,\%
5282   but the redirection instructions form a loop:\%
5283   you’ve lost the message.
5284   \c_msg_return_text_tl
5285 }

```

`\msg_kernel_bug:x` The L^AT_EX coding bug error gets re-visited here.

```

5286 \cs_set_protected:Nn \msg_kernel_bug:x {
5287   \msg_direct_interrupt:xxxxn
5288   { \c_msg_kernel_bug_text_tl }
5289   { !~#1 }
5290   { ! }
5291   { \c_msg_kernel_bug_more_text_tl }
5292   { }
5293 }
5294 </initex | package>

```

111 l3box implementation

Announce and ensure that the required packages are loaded.

```

5295 <*package>
5296 \ProvidesExplPackage
5297   {\filename}{\filedate}{\fileversion}{\filedescription}
5298   \package_check_loaded_expl:
5299 </package>
5300 <*initex | package>

```

The code in this module is very straight forward so I'm not going to comment it very extensively.

111.1 Generic boxes

`\box_new:N` Defining a new $\langle box \rangle$ register.

`\box_new:c`

```

5301 <*initex>
5302 \alloc_setup_type:nnn {box} \c_zero \c_max_register_num

```

Now, remember that `\box255` has a special role in T_EX, it shouldn't be allocated...

```

5303 \seq_put_right:Nn \g_box_allocation_seq {255}
5304 \cs_new_nopar:Npn \box_new:N #1 {\alloc_reg:NnNN g {box} \tex_mathchardef:D #1}
5305 \cs_new_nopar:Npn \box_new_l:N #1 {\alloc_reg:NnNN l {box} \tex_mathchardef:D #1}
5306 </initex>

```

When we run on top of L^AT_EX, we just use its allocation mechanism.

```

5307 <*package>
5308 \cs_new:Npn \box_new:N #1 {
5309   \chk_if_free_cs:N #1
5310   \newbox #1
5311 }
5312 </package>

5313 \cs_generate_variant:Nn \box_new:N {c}

```

`\if_hbox:N` The primitives for testing if a $\langle box \rangle$ is empty/void or which type of box it is.

`\if_vbox:N`

`\if_box_empty:N`

```

5314 \cs_new_eq:NN \if_hbox:N \tex_ifhbox:D
5315 \cs_new_eq:NN \if_vbox:N \tex_ifvbox:D
5316 \cs_new_eq:NN \if_box_empty:N \tex_ifvoid:D

```

`\box_if_horizontal_p:N`

`\box_if_horizontal_p:c`

`\box_if_vertical_p:N`

`\box_if_vertical_p:c`

`\box_if_horizontal:NTF`

`\box_if_horizontal:cTF`

`\box_if_vertical:NTF`

`\box_if_vertical:cTF`

```

5317 \prg_new_conditional:Nnn \box_if_horizontal:N {p,TF,T,F} {
5318   \tex_ifhbox:D #1 \prg_return_true: \else: \prg_return_false: \fi:
5319 }
5320 \prg_new_conditional:Nnn \box_if_vertical:N {p,TF,T,F} {
5321   \tex_ifvbox:D #1 \prg_return_true: \else: \prg_return_false: \fi:
5322 }

```



```

5323 \cs_generate_variant:Nn \box_if_horizontal_p:N {c}
5324 \cs_generate_variant:Nn \box_if_horizontal:NTF {c}
5325 \cs_generate_variant:Nn \box_if_horizontal:NT {c}
5326 \cs_generate_variant:Nn \box_if_horizontal:NF {c}
5327 \cs_generate_variant:Nn \box_if_vertical_p:N {c}
5328 \cs_generate_variant:Nn \box_if_vertical:NTF {c}
5329 \cs_generate_variant:Nn \box_if_vertical:NT {c}
5330 \cs_generate_variant:Nn \box_if_vertical:NF {c}

```

`\box_if_empty_p:N` Testing if a $\langle box \rangle$ is empty/void.

```

\box_if_empty_p:c
\box_if_empty:NTF
\box_if_empty:cTF
5331 \prg_new_conditional:Nnn \box_if_empty:N {p,TF,T,F} {
5332   \tex_ifvoid:D #1 \prg_return_true: \else: \prg_return_false: \fi:
5333 }
5334 \cs_generate_variant:Nn \box_if_empty_p:N {c}
5335 \cs_generate_variant:Nn \box_if_empty:NTF {c}
5336 \cs_generate_variant:Nn \box_if_empty:NT {c}
5337 \cs_generate_variant:Nn \box_if_empty:NF {c}

```

`\box_set_eq:NN` Assigning the contents of a box to be another box. This clears the second box globally (that's how \TeX does it).

```

\box_set_eq:cN
\box_set_eq:Nc
\box_set_eq:cc
5338 \cs_new_nopar:Npn \box_set_eq:NN #1#2 {\tex_setbox:D #1 \tex_box:D #2}
5339 \cs_generate_variant:Nn \box_set_eq:NN {cN,Nc,cc}

```

`\box_gset_eq:NN` Global version of the above.

```

\box_gset_eq:cN
\box_gset_eq:Nc
\box_gset_eq:cc
5340 \cs_new_nopar:Npn \box_gset_eq:NN {\pref_global:D\box_set_eq:NN}
5341 \cs_generate_variant:Nn \box_gset_eq:NN {cN,Nc,cc}

```

`\l_last_box` A different name for this read-only primitive.

```

5342 \cs_new_eq:NN \l_last_box \tex_lastbox:D

```

`\box_set_to_last:N` Set a box to the previous box.

```

\box_set_to_last:c
\box_gset_to_last:N
\box_gset_to_last:c
5343 \cs_new_nopar:Npn \box_set_to_last:N #1{\tex_setbox:D#1\l_last_box}
5344 \cs_generate_variant:Nn \box_set_to_last:N {c}
5345 \cs_new_nopar:Npn \box_gset_to_last:N {\pref_global:D \box_set_to_last:N}
5346 \cs_generate_variant:Nn \box_gset_to_last:N {c}

```

`\box_move_left:nn` Move box material in different directions.

```

\box_move_right:nn
\box_move_up:nn
\box_move_down:nn
5347 \cs_new:Npn \box_move_left:nn #1#2{\tex_moveleft:D\dim_eval:n{#1}{#2}}
5348 \cs_new:Npn \box_move_right:nn #1#2{\tex_moveright:D\dim_eval:n{#1}{#2}}
5349 \cs_new:Npn \box_move_up:nn #1#2{\tex_raise:D\dim_eval:n{#1}{#2}}
5350 \cs_new:Npn \box_move_down:nn #1#2{\tex_lower:D\dim_eval:n{#1}{#2}}

```

`\box_clear:N` Clear a $\langle box \rangle$ register.

```

\box_clear:c
\box_gclear:N
\box_gclear:c
5351 \cs_new_nopar:Npn \box_clear:N #1{\box_set_eq:NN #1 \c_empty_box }
5352 \cs_generate_variant:Nn \box_clear:N {c}
5353 \cs_new_nopar:Npn \box_gclear:N {\pref_global:D\box_clear:N}
5354 \cs_generate_variant:Nn \box_gclear:N {c}

```

`\box_ht:N` Accessing the height, depth, and width of a $\langle box \rangle$ register.

```

\box_ht:c
\box_dp:N
\box_dp:c
\box_wd:N
\box_wd:c
5355 \cs_new_eq:NN \box_ht:N \tex_ht:D
5356 \cs_new_eq:NN \box_dp:N \tex_dp:D
5357 \cs_new_eq:NN \box_wd:N \tex_wd:D
5358 \cs_generate_variant:Nn \box_ht:N {c}
5359 \cs_generate_variant:Nn \box_dp:N {c}
5360 \cs_generate_variant:Nn \box_wd:N {c}

```

`\box_use_clear:N` Using a $\langle box \rangle$. These are just T_EX primitives with meaningful names.

```

\box_use_clear:c
\box_use:N
\box_use:c
5361 \cs_new_eq:NN \box_use_clear:N \tex_box:D
5362 \cs_generate_variant:Nn \box_use_clear:N {c}
5363 \cs_new_eq:NN \box_use:N \tex_copy:D
5364 \cs_generate_variant:Nn \box_use:N {c}

```

`\box_show:N` Show the contents of a box and write it into the log file.

```

\box_show:c
5365 \cs_set_eq:NN \box_show:N \tex_showbox:D
5366 \cs_generate_variant:Nn \box_show:N {c}

```

`\c_empty_box` We allocate some $\langle box \rangle$ registers here (and borrow a few from L^AT_EX).

```

\l_tmpa_box
\l_tmpb_box
5367 \<package>\cs_set_eq:NN \c_empty_box \voidb@x
5368 \<package>\cs_new_eq:NN \l_tmpa_box \@tempboxa
5369 \<initex>\box_new:N \c_empty_box
5370 \<initex>\box_new:N \l_tmpa_box
5371 \box_new:N \l_tmpb_box

```

111.2 Vertical boxes

`\vbox:n` Put a vertical box directly into the input stream.

```

5372 \cs_new_nopar:Npn \vbox:n {\tex_vbox:D \scan_stop:}

```

`\vbox_set:Nn` Storing material in a vertical box with a natural height.

```

\vbox_set:cn
\vbox_gset:Nn
\vbox_gset:cn
5373 \cs_new:Npn \vbox_set:Nn #1#2 {\tex_setbox:D #1 \tex_vbox:D {#2}}
5374 \cs_generate_variant:Nn \vbox_set:Nn {cn}
5375 \cs_new_nopar:Npn \vbox_gset:Nn {\pref_global:D \vbox_set:Nn}
5376 \cs_generate_variant:Nn \vbox_gset:Nn {cn}

```

`\vbox_set_to_ht:Nnn` Storing material in a vertical box with a specified height.

```

\vbox_set_to_ht:cnn
\vbox_gset_to_ht:Nnn
\vbox_gset_to_ht:cnn
\vbox_gset_to_ht:ccn
5377 \cs_new:Npn \vbox_set_to_ht:Nnn #1#2#3 {
5378   \tex_setbox:D #1 \tex_vbox:D to #2 {#3}
5379 }
5380 \cs_generate_variant:Nn \vbox_set_to_ht:Nnn {cnn}
5381 \cs_new_nopar:Npn \vbox_gset_to_ht:Nnn {\pref_global:D \vbox_set_to_ht:Nnn }
5382 \cs_generate_variant:Nn \vbox_gset_to_ht:Nnn {cnn,ccn}

```

`\vbox_set_inline_begin:N` Storing material in a vertical box. This type is useful in environment definitions.

```

\ vbox_set_inline_end:
\ vbox_gset_inline_begin:N
\ vbox_gset_inline_end:
5383 \cs_new_nopar:Npn \vbox_set_inline_begin:N #1 {
5384   \tex_setbox:D #1 \tex_vbox:D \c_group_begin_token }
5385 \cs_new_eq:NN \vbox_set_inline_end: \c_group_end_token
5386 \cs_new_nopar:Npn \vbox_gset_inline_begin:N {
5387   \pref_global:D \vbox_set_inline_begin:N }
5388 \cs_new_eq:NN \vbox_gset_inline_end: \c_group_end_token

```

`\vbox_to_ht:nn` Put a vertical box directly into the input stream.

```

\ vbox_to_zero:n
5389 \cs_new:Npn \vbox_to_ht:nn #1#2{\tex_vbox:D to \dim_eval:n{#1}{#2}}
5390 \cs_new:Npn \vbox_to_zero:n #1 {\tex_vbox:D to \c_zero_dim {#1}}

```

`\vbox_set_split_to_ht:NNn` Splitting a vertical box in two.

```

5391 \cs_new_nopar:Npn \vbox_set_split_to_ht:NNn #1#2#3{
5392   \tex_setbox:D #1 \tex_vsplit:D #2 to #3
5393 }

```

`\vbox_unpack:N` Unpacking a box and if requested also clear it.

```

\ vbox_unpack:c
5394 \cs_new_eq:NN \vbox_unpack:N \tex_unvcopy:D
5395 \cs_generate_variant:Nn \vbox_unpack:N {c}
5396 \cs_new_eq:NN \vbox_unpack_clear:N \tex_unvbox:D
5397 \cs_generate_variant:Nn \vbox_unpack_clear:N {c}

```

111.3 Horizontal boxes

`\hbox:n` Put a horizontal box directly into the input stream.

```

5398 \cs_new_nopar:Npn \hbox:n {\tex_hbox:D \scan_stop:}

```

`\hbox_set:Nn` Assigning the contents of a box to be another box. This clears the second box globally (that's how T_EX does it).

```

\ hbox_set:cn
\ hbox_gset:Nn
\ hbox_gset:cn
5399 \cs_new:Npn \hbox_set:Nn #1#2 {\tex_setbox:D #1 \tex_hbox:D {#2}}
5400 \cs_generate_variant:Nn \hbox_set:Nn {cn}
5401 \cs_new_nopar:Npn \hbox_gset:Nn {\pref_global:D \hbox_set:Nn}
5402 \cs_generate_variant:Nn \hbox_gset:Nn {cn}

```

`\hbox_set_to_wd:Nnn` Storing material in a horizontal box with a specified width.

```

\ hbox_set_to_wd:cnn
\ hbox_gset_to_wd:Nnn
\ hbox_gset_to_wd:cnn
5403 \cs_new:Npn \hbox_set_to_wd:Nnn #1#2#3 {
5404   \tex_setbox:D #1 \tex_hbox:D to \dim_eval:n{#2} {#3}
5405 }
5406 \cs_generate_variant:Nn \hbox_set_to_wd:Nnn {cnn}
5407 \cs_new_nopar:Npn \hbox_gset_to_wd:Nnn {\pref_global:D \hbox_set_to_wd:Nnn }
5408 \cs_generate_variant:Nn \hbox_gset_to_wd:Nnn {cnn}

```

`\hbox_set_inline_begin:N` Storing material in a horizontal box. This type is useful in environment definitions.

```

\hbox_set_inline_begin:c
\hbox_set_inline_end:
\hbox_gset_inline_begin:N
\hbox_gset_inline_begin:c
\hbox_gset_inline_end:
5409 \cs_new_nopar:Npn \hbox_set_inline_begin:N #1 {
5410   \tex_setbox:D #1 \tex_hbox:D \c_group_begin_token
5411 }
5412 \cs_generate_variant:Nn \hbox_set_inline_begin:N {c}
5413 \cs_new_eq:NN \hbox_set_inline_end: \c_group_end_token
5414 \cs_new_nopar:Npn \hbox_gset_inline_begin:N {
5415   \pref_global:D \hbox_set_inline_begin:N
5416 }
5417 \cs_generate_variant:Nn \hbox_gset_inline_begin:N {c}
5418 \cs_new_eq:NN \hbox_gset_inline_end: \c_group_end_token

```

`\hbox_to_wd:nn` Put a horizontal box directly into the input stream.

```

\hbox_to_zero:n
5419 \cs_new:Npn \hbox_to_wd:nn #1#2 {\tex_hbox:D to #1 {#2}}
5420 \cs_new:Npn \hbox_to_zero:n #1 {\tex_hbox:D to \c_zero_skip {#1}}

```

`\hbox_unpack:N` Unpacking a box and if requested also clear it.

```

\hbox_unpack:c
\hbox_unpack_clear:N
\hbox_unpack_clear:c
5421 \cs_new_eq:NN \hbox_unpack:N \tex_unhcopy:D
5422 \cs_generate_variant:Nn \hbox_unpack:N {c}
5423 \cs_new_eq:NN \hbox_unpack_clear:N \tex_unhbox:D
5424 \cs_generate_variant:Nn \hbox_unpack_clear:N {c}

5425 </initex | package>

5426 <*showmemory>
5427 \showMemUsage
5428 </showmemory>

```

112 l3xref implementation

112.1 Internal functions and variables

```

\g_xref_all_curr_immediate_fields_prop
\g_xref_all_curr_deferred_fields_prop

```

What they say they are :)

```
\xref_write
```

A stream for writing cross references, although they are not required to be in a separate file.

```
\xref_define_label:nn
```

```
\xref_define_label:nn {\name} {\plist contents}}
```

Define the property list for each label; used internally by `\xref_set_label:n`.

112.2 Module code

We start by ensuring that the required packages are loaded.

```

5429 <*package>
5430 \ProvidesExplPackage
5431   {\filename}{\filedate}{\fileversion}{\filedescription}
5432 \package_check_loaded_expl:
5433 </package>
5434 <*initex | package>

```

There are two kinds of information, namely information which is *immediate* like a section title and then there's *deferred* information like page numbers. Each reference type belong to one of these categories, which we save internally as the property lists `\g_xref_all_curr_immediate_fields_prop` and `\g_xref_all_curr_deferred_fields_prop` and the reference type `<xyz>` exists as the key-info pair `\xref_<xyz>_key {\l_xref_curr_<xyz>_tl}` on one of these lists. This way each new entry type is just added as another key-info pair.

When the cross references are generated at the beginning of the document each will turn into a control sequence. Thus `\label{mylab}` will internally refer to the property list `\g_xref_mylab_prop`.

The extraction of values from this property list can be done in several different ways but we want to keep the operation expandable. Therefore we use a dedicated function for each type of cross reference, which looks like this:

```
\xref_get_value_xyz_aux:w -> #1 \xref_xyz_key #2#3\q_nil{#2}
```

This will throw away all the bits we don't need. In case `xyz` is the first on the `mylab` property list `#1` is empty, if it's the last key-info pair `#3` is empty. The value of the field can be extracted with the function `\xref_get_value:nn` where the first argument is the type and the second the label name so here it would be `\xref_get_value:nn {xyz}{mylab}`.

`\l_curr_immediate_fields_prop` The two main property lists for storing information. They contain key-info pairs for all
`\all_curr_deferred_fields_prop` known types.

```

5435 \prop_new:N \g_xref_all_curr_immediate_fields_prop
5436 \prop_new:N \g_xref_all_curr_deferred_fields_prop

```

`\xref_new:nn` Setting up a new cross reference type is fairly straight forward when we follow the game
`\xref_deferred_new:nn` plan mentioned earlier.

`\xref_new_aux:nnn`

```

5437 \cs_new_nopar:Npn \xref_new:nn {\xref_new_aux:nnn{immediate}}
5438 \cs_new_nopar:Npn \xref_deferred_new:nn {\xref_new_aux:nnn{deferred}}
5439 \cs_new_nopar:Npn \xref_new_aux:nnn #1#2#3{

```

First put the new type in the relevant property list.

```

5440 \prop_gput:ccx {g_xref_all_curr_ #1 _fields_prop}
5441 { xref_ #2 _key }
5442 { \exp_not:c {l_xref_curr_#2_tl } }

```

Then define the key to be a protected macro.¹⁵

```
5443 \cs_set_protected_nopar:cpn { xref_#2_key }{}
5444 \tl_new:cn{l_xref_curr_#2_tl}{#3}
```

Now for the function extracting the value of a reference. We could do this with a simple `\prop_if_in` thing put since we want to do things in an expandable way we make a separate grabber for each type—this is also faster. The grabber function can be defined by using an intricate construction of `\exp_after:wN` and other goodies but I prefer readable code. The end result for the input `xyz` is

```
\cs_set_nopar:Npn\xref_get_value_xyz_aux:w #1\xref_xyz_key #2#3\q_nil{#2}
```

```
5445 \toks_set:Nx \l_tmpa_toks {
5446   \exp_not:n { \cs_set_nopar:cpn {xref_get_value_#2_aux:w} ##1 }
5447   \exp_not:N \q_prop
5448   \exp_not:c { xref_#2_key }
5449   \exp_not:N \q_prop
5450 }
5451 \toks_use:N \l_tmpa_toks ##2 ##3\q_nil {##2}
5452 }
```

`\xref_get_value:nn` Getting the correct value for a given label-type pair is a matter of connecting the correct grabber functions and property list.

```
5453 \cs_new_nopar:Npn \xref_get_value:nn #1#2 {
5454   \cs_if_exist:cTF{g_xref_#2_prop}
5455   {
```

This next expansion may look a little weird but it isn't if you think about it!

```
5456   \exp_args:NcNc \exp_after:wN {xref_get_value_#1_aux:w}
5457   \toks_use:N {g_xref_#2_prop}
```

Better put in the stop marker.

```
5458   \q_nil
5459 }
5460 {??}
5461 }
```

Temporary! We expand the property list and so we can't have the `\q_prop` marker just expand!

```
5462 \cs_set_nopar:Npn \exp_after:cc #1#2 {
5463   \exp_after:wN \exp_after:wN
5464   \cs:w #1\exp_after:wN\cs_end: \cs:w #2\cs_end:
5465 }
5466 \cs_set_protected:Npn \q_prop {\q_prop}
```

¹⁵We could also set it equal to `\scan_stop:` but this just feels “cleaner”.

`\xref_define_label:nn` Define the property list for each label. We better do this in two steps because the special catcode regime is in effect and since some of the info fields are very likely to contain actual text, we better make sure spaces aren't ignored! As for the meaning of other characters then it is a possibility to also have a field containing catcode instructions which can then be activated with `\etex_scantokens:D`.

`\xref_define_label_aux:nn`

```

5467 \cs_new_protected_nopar:Npn \xref_define_label:nn {
5468   \group_begin:
5469     \char_set_catcode:nn {'\ }c_ten
5470     \xref_define_label_aux:nn
5471 }

```

If the label is already taken we have a multiply defined label and we should do something about it. For now we don't do anything spectacular.

```

5472 \cs_new_nopar:Npn \xref_define_label_aux:nn #1#2 {
5473   \cs_if_free:cTF{g_xref_#1_prop}
5474   {\prop_new:c{g_xref_#1_prop}}{\WARNING}
5475   \toks_gset:cn{g_xref_#1_prop}{#2}
5476   \group_end:
5477 }

```

`\xref_set_label:n` Then the generic command for setting a label. We expand the immediate labels fully before calling the write function but make sure the deferred fields aren't expanded just yet. Due to property lists being implemented as token list registers we must expand the 'immediate' fields twice.

```

5478 \cs_set_nopar:Npn \xref_set_label:n #1{
5479   \cs_set_nopar:Npx \xref_tmp:w{\toks_use:N\g_xref_all_curr_immediate_fields_prop}
5480   \exp_args:NNx\iow_shipout_x:Nn \xref_write{
5481     \xref_define_label:nn {#1} {
5482       \xref_tmp:w
5483       \toks_use:N \g_xref_all_curr_deferred_fields_prop
5484     }
5485   }
5486 }

```

`\xref_write` A stream for writing cross references although they do not require to be in a separate file.

```

5487 \iow_new:N \xref_write

```

That's it (for now).

```

5488 </initex | package>

5489 <*showmemory>
5490 \showMemUsage
5491 </showmemory>

```

113 l3xref test file

```
5492 <*testfile>
5493 \documentclass{article}
5494 \usepackage{l3xref}
5495 \ExplSyntaxOn
5496 \cs_set_nopar:Npn \startrecording {\iow_open:Nn \xref_write {\jobname.xref}}
5497 \cs_set_nopar:Npn \DefineCrossReferences {
5498   \group_begin:
5499     \ExplSyntaxNamesOn
5500     \InputIfFileExists{\jobname.xref}{\}{}
5501   \group_end:
5502 }
5503 \AtBeginDocument{\DefineCrossReferences\startrecording}
5504
5505 \xref_new:nn {name}{}
5506 \cs_set_nopar:Npn \setname{\tl_set:Nn\l_xref_curr_name_tl}
5507 \cs_set_nopar:Npn \getname{\xref_get_value:nn{name}}
5508
5509 \xref_deferred_new:nn {page}{\thepage}
5510 \cs_set_nopar:Npn \getpage{\xref_get_value:nn{page}}
5511
5512 \xref_deferred_new:nn {valuepage}{\number\value{page}}
5513 \cs_set_nopar:Npn \getvaluepage{\xref_get_value:nn{valuepage}}
5514
5515 \cs_set_eq:NN \setlabel \xref_set_label:n
5516
5517 \ExplSyntaxOff
5518 \begin{document}
5519 \pagenumbering{roman}
5520
5521 Text\setname{This is a name}\setlabel{testlabel1}. More
5522 text\setname{This is another name}\setlabel{testlabel2}. \clearpage
5523
5524 Text\setname{This is a third name}\setlabel{testlabel3}. More
5525 text\setname{Hello World!}\setlabel{testlabel4}. \clearpage
5526
5527 \pagenumbering{arabic}
5528
5529 Text\setname{Name 5}\setlabel{testlabel5}. More text\setname{Name
5530 6}\setlabel{testlabel6}. \clearpage
5531
5532 Text\setname{Name 7}\setlabel{testlabel 7}. More text\setname{Name
5533 8}\setlabel{testlabel8}. \clearpage
5534
5535 Now let's extract some values. \getname{testlabel1} on page
5536 \getpage{testlabel1} with value \getvaluepage{testlabel1}.
5537
5538 Now let's extract some values. \getname{testlabel 7} on page
5539 \getpage{testlabel 7} with value \getvaluepage{testlabel 7}.
5540 \end{document}
5541 </testfile>
```


114 l3keyval implementation

114.1 Internal functions and variables

```
\l_KV_tmpa_tl
\l_KV_tmpb_tl
\c_KV_single_equal_sign_tl
\l_KV_parse_toks
\l_KV_currkey_toks
\l_KV_currval_toks
```

Token list variables and token registers used internally.

```
\KV_sanitize_outerlevel_active_equals:N
\KV_sanitize_outerlevel_active_commas:N
```

```
\KV_sanitize_outerlevel_active_equals:N <tl var.>
```

Replaces catcode other = and , within a *<tl var.>* with active characters.

```
\KV_remove_surrounding_spaces:nw
\KV_remove_surrounding_spaces_auxi:w *
```

```
\KV_remove_surrounding_spaces:nw <toks> <token list> \
\KV_remove_surrounding_spaces_auxi:w <token list> \Q3
```

Removes a possible leading space plus a possible ending space from a *<token list>*. The first version (which is not used in the code) stores it in *<toks>*.

```
\KV_add_value_element:w
\KV_set_key_element:w
```

```
\KV_set_key_element:w <token list> \q_nil
\KV_add_value_element:w \q_stop <token list> \q_nil
```

Specialised functions to strip spaces from their input and set the token registers *\l_KV_currkey_toks* or *\l_KV_currval_toks* respectively.

```
\KV_split_key_value_current:w
\KV_split_key_value_space_removal:w
\KV_split_key_value_space_removal_detect_error:wTF
\KV_split_key_value_no_space_removal:w
```

```
\KV_split_key_value_current:w ...
```

These functions split keyval lists into chunks depending which sanitising method is being used. *\KV_split_key_value_current:w* is *\cs_set_eq:NN* to whichever is appropriate.

114.2 Module code

We start by ensuring that the required packages are loaded.

```
5542 <*package>
5543 \ProvidesExplPackage
5544   {\filename}{\filedate}{\fileversion}{\filedescription}
5545 \package_check_loaded_expl:
5546 </package>
5547 <*initex | package>
```

\backslash l_KV_tmpa_tl \backslash l_KV_tmppb_tl \backslash c_KV_single_equal_sign_tl	<p>Various useful things.</p> <pre> 5548 \tl_new:N \l_KV_tmpa_tl 5549 \tl_new:N \l_KV_tmppb_tl 5550 \tl_new:Nn \c_KV_single_equal_sign_tl{=} </pre>
\backslash l_KV_parse_toks \backslash l_KV_currkey_toks \backslash l_KV_currval_toks	<p>Some more useful things.</p> <pre> 5551 \toks_new:N \l_KV_parse_toks 5552 \toks_new:N \l_KV_currkey_toks 5553 \toks_new:N \l_KV_currval_toks </pre>
\backslash move_one_level_of_braces_bool	<p>A boolean to control</p> <pre> 5554 \bool_new:N \l_KV_remove_one_level_of_braces_bool 5555 \bool_set_true:N \l_KV_remove_one_level_of_braces_bool </pre>
\backslash ze_outerlevel_active_equals:N \backslash ze_outerlevel_active_commas:N	<p>Some functions for sanitizing top level equals and commas. Replace =₁₃ and ,₁₃ with =₁₂ and ,₁₂ resp.</p> <pre> 5556 \group_begin: 5557 \char_set_catcode:nn{'\={}{13} 5558 \char_set_catcode:nn{'\,}{13} 5559 \char_set_lccode:nn{'\8}{\={} 5560 \char_set_lccode:nn{'\9}{'\,} 5561 \tl_to_lowercase:n{\group_end: 5562 \cs_new_nopar:Npn \KV_sanitize_outerlevel_active_equals:N #1{ 5563 \tl_replace_all_in:Nnn #1 = 8 5564 } 5565 \cs_new_nopar:Npn \KV_sanitize_outerlevel_active_commas:N #1{ 5566 \tl_replace_all_in:Nnn #1 , 9 5567 } 5568 } </pre>
\backslash remove_surrounding_spaces:nw \backslash ove_surrounding_spaces_auxi:w \backslash ve_surrounding_spaces_auxii:w \backslash KV_set_key_element:w \backslash KV_add_value_element:w	<p>The macro \backslashKV_remove_surrounding_spaces:nw removes a possible leading space plus a possible ending space from its second argument and stores it in the token register #1.</p> <p>Based on Around the Bend No. 15 but with some enhancements. For instance, this definition is purely expandable.</p> <p>We use a funny token Q₃ as a delimiter.</p> <pre> 5569 \group_begin: 5570 \char_set_catcode:nn{'Q}{3} 5571 \cs_gnew:Npn \KV_remove_surrounding_spaces:nw#1#2\q_nil{ </pre>

The idea in this processing is to use a Q with strange catcode to remove a trailing space. But first, how to get this expansion going?

If you have read the fine print in the l3expan module, you'll know that the f type expansion will expand until the first non-expandable token is seen and if this token is a space, it will be gobbled. Sounds useful for removing a leading space but we also need to make sure that it does nothing but removing that space! Therefore we prepend the argument to be

trimmed with an `\exp_not:N`. Now why is that? `\exp_not:N` in itself is an expandable command so will allow the `f` expansion to continue. If the first token in the argument to be trimmed is a space, it will be gobbled and the expansion stop. If the first token isn't a space, the `\exp_not:N` turns it temporarily into `\scan_stop:` which is unexpandable. The processing stops but the token following directly after `\exp_not:N` is now back to normal.

The function here allows you to insert arbitrary functions in the first argument but they should all be with an `f` type expansion. For the application in this module, we use `\toks_set:Nf`.

Once the expansion has been kick-started, we apply `\KV_remove_surrounding_spaces_auxi:w` to the replacement text of `#2`, adding a leading `\exp_not:N`. Note that no braces are stripped off of the original argument.

```
5572   #1{\KV_remove_surrounding_spaces_auxi:w \exp_not:N#2Q~Q}
5573 }
```

`\KV_remove_surrounding_spaces_auxi:w` removes a trailing space if present, then calls `\KV_remove_surrounding_spaces_auxii:w` to clean up any leftover bizarre Qs. In order for `\KV_remove_surrounding_spaces_auxii:w` to work properly we need to put back a `Q` first.

```
5574 \cs_gnew:Npn\KV_remove_surrounding_spaces_auxi:w#1~Q{
5575   \KV_remove_surrounding_spaces_auxii:w #1 Q
5576 }
```

Now all that is left to do is remove a leading space which should be taken care of by the function used to initiate the expansion. Simply return the argument before the funny `Q`.

```
5577 \cs_gnew:Npn\KV_remove_surrounding_spaces_auxii:w#1Q#2{#1}
```

Here are some specialized versions of the above. They do exactly what we want in one go. First trim spaces from the value and then put the result surrounded in braces onto `\l_KV_parse_toks`.

```
5578 \cs_gnew:Npn\KV_add_value_element:w\q_stop#1\q_nil{
5579   \toks_set:Nf\l_KV_currval_toks {
5580     \KV_remove_surrounding_spaces_auxi:w \exp_not:N#1Q~Q
5581   }
5582   \toks_put_right:No\l_KV_parse_toks{
5583     \exp_after:wN {\toks_use:N \l_KV_currval_toks}
5584   }
5585 }
```

When storing the key we firstly remove spaces plus the prepended `\q_no_value`.

```
5586 \cs_gnew:Npn\KV_set_key_element:w#1\q_nil{
5587   \toks_set:Nf\l_KV_currkey_toks
5588   {
5589     \exp_last_unbraced:NNo \KV_remove_surrounding_spaces_auxi:w
5590     \exp_not:N \use_none:n #1Q~Q
5591   }
```

Afterwards we gobble an extra level of braces if that's what we are asked to do.

```

5592 \bool_if:NT \l_KV_remove_one_level_of_braces_bool
5593 {
5594   \exp_args:NNo \toks_set:No \l_KV_currkey_toks {
5595     \exp_after:wN \KV_add_element_aux:w
5596     \toks_use:N \l_KV_currkey_toks \q_nil
5597   }
5598 }
5599 }
5600 \group_end:

```

\KV_add_element_aux:w A helper function for fixing braces around keys and values.

```

5601 \cs_new:Npn \KV_add_element_aux:w#1\q_nil{#1}

```

Parse a list of keyvals, put them into list form with entries like \KV_key_no_value_elt:n{key1} and \KV_key_value_elt:nn{key2}{val2}.

\KV_parse_sanitizе_aux:n The slow parsing algorithm sanitizes active commas and equal signs at the top level first. Then uses #1 as inspector of each element in the comma list.

```

5602 \cs_new:Npn \KV_parse_sanitizе_aux:n #1 {
5603   \group_begin:
5604   \toks_clear:N \l_KV_parse_toks
5605   \tl_set:Nx \l_KV_tmpa_tl { \exp_not:n {#1} }
5606   \KV_sanitizе_outerlevel_active_equals:N \l_KV_tmpa_tl
5607   \KV_sanitizе_outerlevel_active_commas:N \l_KV_tmpa_tl
5608   \exp_last_unbraced:NNV \KV_parse_elt:w \q_no_value
5609   \l_KV_tmpa_tl , \q_nil ,

```

We evaluate the parsed keys and values outside the group so the token register is restored to its previous value.

```

5610   \exp_last_unbraced:NV \group_end:
5611   \l_KV_parse_toks
5612 }

```

\KV_parse_no_sanitizе_aux:n Like above but we don't waste time sanitizing. This is probably the one we will use for preamble parsing where catcodes of = and , are as expected!

```

5613 \cs_new:Npn \KV_parse_no_sanitizе_aux:n #1{
5614   \group_begin:
5615   \toks_clear:N \l_KV_parse_toks
5616   \KV_parse_elt:w \q_no_value #1 , \q_nil ,
5617   \exp_last_unbraced:NV \group_end:
5618   \l_KV_parse_toks
5619 }

```

\KV_parse_elt:w This function will always have a \q_no_value stuffed in as the rightmost token in #1. In case there was a blank entry in the comma separated list we just run it again. The \use_none:n makes sure to gobble the quark \q_no_value. A similar test is made to check if we hit the end of the recursion.

```

5620 \cs_set:Npn \KV_parse_elt:w #1,{
5621   \tl_if_blank:oTF{\use_none:n #1}
5622   { \KV_parse_elt:w \q_no_value }
5623   {
5624     \quark_if_nil:oF {\use_ii:nn #1 }

```

If we made it to here we can start parsing the key and value. When done try, try again.

```

5625   {
5626     \KV_split_key_value_current:w #1==\q_nil
5627     \KV_parse_elt:w \q_no_value
5628   }
5629 }
5630 }

```

`\KV_split_key_value_current:w` The function called to split the keys and values.

```

5631 \cs_new:Npn \KV_split_key_value_current:w {\ERROR}

```

We provide two functions for splitting keys and values. The reason being that most of the time, we should probably be in the special coding regime where spaces are ignored. Hence it makes no sense to spend time searching for extra space tokens and we can do the settings directly. When comparing these two versions (neither doing any sanitizing) the `no_space_removal` version is more than 40% faster than `space_removal`.

It is up to functions like `\DeclareTemplate` to check which catcode regime is active and then pick up the version best suited for it.

`\KV_split_key_value_space_removal:w`
`space_removal_detect_error:wTF`
`key_value_space_removal_aux:w`

The code below removes extraneous spaces around the keys and values plus one set of braces around the entire value.

Unlike the version to be used when spaces are ignored, this one only grabs the key which is everything up to the first = and save the rest for closer inspection. Reason is that if a user has entered `mykey={{myval}}`, then the outer braces have already been removed before we even look at what might come after the key. So this is slightly more tedious (but only slightly) but at least it always removes only one level of braces.

```

5632 \cs_new:Npn \KV_split_key_value_space_removal:w #1 = #2\q_nil{

```

First grab the key.

```

5633   \KV_set_key_element:w#1\q_nil

```

Then we start checking. If only a key was entered, #2 contains = and nothing else, so we test for that first.

```

5634   \tl_set:Nx\l_KV_tmpa_tl{\exp_not:n{#2}}
5635   \tl_if_eq:NNTF\l_KV_tmpa_tl\c_KV_single_equal_sign_tl

```

Then we just insert the default key.

```

5636   {
5637     \toks_put_right:No\l_KV_parse_toks{
5638       \exp_after:wN \KV_key_no_value_elt:n
5639       \exp_after:wN {\toks_use:N\l_KV_currkey_toks}
5640     }
5641   }

```

Otherwise we must take a closer look at what is left. The remainder of the original list up to the comma is now stored in #2 plus an additional ==, which wasn't gobbled during the initial reading of arguments. If there is an error then we can see at least one more = so we call an auxiliary function to check for this.

```

5642 {
5643   \KV_split_key_value_space_removal_detect_error:wTF#2\q_no_value\q_nil
5644   {\KV_split_key_value_space_removal_aux:w \q_stop #2}
5645   {\ERROR}
5646 }
5647 }

```

The error test.

```

5648 \cs_new:Npn
5649   \KV_split_key_value_space_removal_detect_error:wTF#1=#2#3\q_nil{
5650   \tl_if_head_eq_meaning:nNTF{#3}\q_no_value
5651 }

```

Now we can start extracting the value. Recall that #1 here starts with \q_stop so all braces are still there! First we try to see how much is left if we gobble three brace groups from #1. If #1 is empty or blank, all three quarks are gobbled. If #1 consists of exactly one token or brace group, only the latter quark is left.

```

5652 \cs_new:Npn \KV_val_preserve_braces:NnN #1#2#3{{#2}}
5653 \cs_new:Npn \KV_split_key_value_space_removal_aux:w #1=={
5654   \tl_set:Nx\l_KV_tmpa_tl{\exp_not:o{\use_none:nnn#1\q_nil\q_nil}}
5655   \toks_put_right:No\l_KV_parse_toks{
5656     \exp_after:wN \KV_key_value_elt:nn
5657     \exp_after:wN {\toks_use:N\l_KV_currkey_toks}
5658   }

```

If there a blank space or nothing at all, \l_KV_tmpa_tl is now completely empty.

```

5659   \tl_if_empty:NNTF\l_KV_tmpa_tl

```

We just put an empty value on the stack.

```

5660 { \toks_put_right:Nn\l_KV_parse_toks{}} }
5661 {

```

If there was exactly one brace group or token in #1, \l_KV_tmpa_tl is now equal to \q_nil. Then we can just pick it up as the second argument of #1. This will also take care of any spaces which might surround it.

```

5662   \quark_if_nil:NNTF\l_KV_tmpa_tl
5663   {
5664     \bool_if:NNTF \l_KV_remove_one_level_of_braces_bool
5665     {
5666       \toks_put_right:No\l_KV_parse_toks{
5667         \exp_after:wN{\use_ii:nnn #1\q_nil}
5668       }
5669     }
5670     {
5671       \toks_put_right:No\l_KV_parse_toks{

```

```

5672         \exp_after:wN{\KV_val_preserve_braces:NnN #1\q_nil}
5673     }
5674 }
5675 }

```

Otherwise we grab the value.

```

5676     { \KV_add_value_element:w #1\q_nil }
5677 }
5678 }

```

`\key_value_no_space_removal:w`

This version is for when in the special coding regime where spaces are ignored so there is no need to do any fancy space hacks, however fun they may be. Since there are no spaces, a set of braces around a value is automatically stripped by TeX.

```

5679 \cs_new:Npn \KV_split_key_value_no_space_removal:w #1#2=#3=#4\q_nil{
5680   \tl_set:Nn\l_KV_tmpa_tl{#4}
5681   \tl_if_empty:NTF \l_KV_tmpa_tl
5682   {
5683     \toks_put_right:Nn\l_KV_parse_toks{\KV_key_no_value_elt:n{#2}}
5684   }
5685   {
5686     \tl_if_eq:NNTF\c_KV_single_equal_sign_tl\l_KV_tmpa_tl
5687     {
5688       \toks_put_right:Nn\l_KV_parse_toks{\KV_key_value_elt:nn{#2}{#3}}
5689     }
5690     {\ERROR}
5691   }
5692 }

```

```

\KV_key_no_value_elt:n
\KV_key_value_elt:nn

```

```

5693 \cs_new:Npn \KV_key_no_value_elt:n #1{\ERROR}
5694 \cs_new:Npn \KV_key_value_elt:nn #1#2{\ERROR}

```

`\key_value_no_space_removal_no_sanitize:w`

Finally we can put all the things together. `\KV_parse_no_space_removal_no_sanitize:n` is the version that disallows unmatched conditional and does no space removal.

```

5695 \cs_new_nopar:Npn \KV_parse_no_space_removal_no_sanitize:n {
5696   \cs_set_eq:NN \KV_split_key_value_current:w \KV_split_key_value_no_space_removal:w
5697   \KV_parse_no_sanitize_aux:n
5698 }

```

`\key_value_space_removal_sanitize:n`
`\key_value_no_space_removal_no_sanitize:n`

The other varieties can be defined in a similar manner. For the version needed at the document level, we can use this one.

```

5699 \cs_new_nopar:Npn \KV_parse_space_removal_sanitize:n {
5700   \cs_set_eq:NN \KV_split_key_value_current:w \KV_split_key_value_space_removal:w
5701   \KV_parse_sanitize_aux:n
5702 }

```

For preamble use by the non-programmer this is probably best.

```

5703 \cs_new_nopar:Npn \KV_parse_space_removal_no_sanitize:n {

```

```

5704 \cs_set_eq:NN \KV_split_key_value_current:w \KV_split_key_value_space_removal:w
5705 \KV_parse_no_sanitise_aux:n
5706 }

5707 </initex | package>

5708 <*showmemory>
5709 \showMemUsage
5710 </showmemory>

```

The usual preliminaries.

```

5711 <*package>
5712 \ProvidesExplPackage
5713   {\filename}{\filedate}{\fileversion}{\filedescription}
5714 \package_check_loaded_expl:
5715 </package>
5716 <*initex | package>

```

114.2.1 Variables and constants

`\c_keys_root_tl` Where the keys are really stored.

```

\c_keys_properties_root_tl
5717 \tl_new:Nn \c_keys_root_tl { keys~>~ }
5718 \tl_new:Nn \c_keys_properties_root_tl { keys_properties }

```

`\c_keys_value_forbidden_tl` Two marker token lists.

```

\c_keys_value_required_tl
5719 \tl_new:Nn \c_keys_value_forbidden_tl { forbidden }
5720 \tl_new:Nn \c_keys_value_required_tl { required }

```

`\l_keys_choice_int` Used for the multiple choice system.

```

\l_keys_choice_tl
5721 \int_new:N \l_keys_choice_int
5722 \tl_new:N \l_keys_choice_tl

```

`\l_keys_key_tl` Storage for the current key name and the path of the key (key name plus module name).

```

\l_keys_path_tl
\l_keys_property_tl
5723 \tl_new:N \l_keys_key_tl
5724 \tl_new:N \l_keys_path_tl
5725 \tl_new:N \l_keys_property_tl

```

`\l_keys_module_tl` The module for an entire set of keys.

```

5726 \tl_new:N \l_keys_module_tl

```

`\l_keys_nesting_seq` For nesting.

```

\l_keys_nesting_tl
5727 \seq_new:N \l_keys_nesting_seq
5728 \tl_new:Nn \l_keys_nesting_tl { none }

```

`\l_keys_no_value_bool` To indicate that no value has been given.

```

5729 \bool_new:N \l_keys_no_value_bool

```


`\l_keys_value_toks` A token register for the given value.

```
5730 \toks_new:N \l_keys_value_toks
```

`\q_keys_stop` A quark for delimiting keys: no one else should use it!

```
5731 \quark_new:N \q_keys_stop
```

114.2.2 Internal functions

`\keys_arguments_tidy:w` So that nothing runs away, a safety precaution is taken in the code.

```
5732 \cs_new:Npn \keys_arguments_tidy:w #1 \q_keys_stop { }
```

`\keys_bool_set:N` Boolean keys are really just choices, but all done by hand.

`\keys_bool_set_inverse:N`
`\keys_bool_set_aux:N`

```
5733 \cs_new_nopar:Nn \keys_bool_set:N {  
5734   \keys_cmd_set:nNx { \l_keys_path_tl / true } 1 {  
5735     \exp_not:c { bool_ \keys_variable_get_scope:N #1 set_true:N }  
5736     \exp_not:N #1  
5737   }  
5738   \keys_cmd_set:nNx { \l_keys_path_tl / false } 1 {  
5739     \exp_not:N \use:c  
5740     { bool_ \keys_variable_get_scope:N #1 set_false:N }  
5741     \exp_not:N #1  
5742   }  
5743   \keys_bool_set_aux:N #1  
5744 }  
5745 \cs_new_nopar:Nn \keys_bool_set_inverse:N {  
5746   \keys_cmd_set:nNx { \l_keys_path_tl / true } 1 {  
5747     \exp_not:c { bool_ \keys_variable_get_scope:N #1 set_false:N }  
5748     \exp_not:N #1  
5749   }  
5750   \keys_cmd_set:nNx { \l_keys_path_tl / false } 1 {  
5751     \exp_not:c { bool_ \keys_variable_get_scope:N #1 set_true:N }  
5752     \exp_not:N #1  
5753   }  
5754   \keys_bool_set_aux:N #1  
5755 }  
5756 \cs_new_nopar:Nn \keys_bool_set_aux:N {  
5757   \keys_choice_make:  
5758   \cs_if_exist:NF #1 {  
5759     \bool_new:N #1  
5760   }  
5761   \keys_default_set:n { true }  
5762 }
```

`\keys_choice_find:n` Executing a choice has two parts. First, try the choice given, then if that fails call the unknown key. That will exist, as it is created when a choice is first made. So there is no need for any escape code.

```
5763 \cs_new_nopar:Nn \keys_choice_find:n {  
5764   \keys_execute_aux:nn { \l_keys_path_tl / #1 } { }
```

```

5765     \keys_execute_aux:nn { \l_keys_path_tl / unknown } { }
5766   }
5767 }

```

\keys_choice_make: To make a choice from a key, two steps: set the code, and set the unknown key.

```

5768 \cs_new_nopar:Nn \keys_choice_make: {
5769   \keys_cmd_set:nNn { \l_keys_path_tl } 1 {
5770     \keys_choice_find:n {##1}
5771   }
5772   \keys_cmd_set:nNn { \l_keys_path_tl / unknown } 1 {
5773     \msg_kernel_error:nxx { key-choice-unknown } { \l_keys_path_tl }
5774     {##1}
5775   }
5776 }

```

\keys_choices_generate:nx Creating multiple-choices means setting up the “indicator” code, then applying whatever the user wanted.

```

5777 \cs_new:Nn \keys_choices_generate:nx {
5778   \keys_choice_make:
5779   \int_zero:N \l_keys_choice_int
5780   \cs_set_nopar:Nn \keys_choices_generate_aux:n {
5781     \int_incr:N \l_keys_choice_int
5782     \keys_cmd_set:nNx { \l_keys_path_tl / ##1 } 1 {
5783       \exp_not:n { \tl_set:Nn \l_keys_choice_tl } {##1}
5784       \exp_not:n { \int_set:Nn \l_keys_choice_int }
5785       { \int_use:N \l_keys_choice_int }
5786     } #2
5787   }
5788 }
5789 \clist_map_function:nN {##1} \keys_choices_generate_aux:n
5790 }
5791 \cs_new_nopar:Nn \keys_choices_generate_aux:n { }

```

\keys_cmd_set:nNn Creating a new command means setting properties and then creating a function with the correct number of arguments.
\keys_cmd_set:nNx
\keys_cmd_set_aux:nN

```

5792 \cs_new:Nn \keys_cmd_set:nNn {
5793   \keys_cmd_set_aux:nN {##1} #2
5794   \cs_generate_from_arg_count:cNnn { \c_keys_root_tl #1 .cmd:w }
5795   \cs_set:Npn #2 { #3 \keys_arguments_tidy:w }
5796 }
5797 \cs_new:Nn \keys_cmd_set:nNx {
5798   \keys_cmd_set_aux:nN {##1} #2
5799   \cs_generate_from_arg_count:cNnn { \c_keys_root_tl #1 .cmd:w }
5800   \cs_set:Npx #2 { #3 \exp_not:N \keys_arguments_tidy:w }
5801 }
5802 \cs_new_nopar:Nn \keys_cmd_set_aux:nN {
5803   \keys_property_undefine:n { #1 .default_tl }
5804   \num_set:cn { \c_keys_root_tl #1 .args_num } {##2}
5805   \tl_set:cn { \c_keys_root_tl #1 .req_tl } { }
5806 }

```

`\keys_default_set:n` Setting a default value is easy.

```
\keys_default_set:V
5807 \cs_new:Nn \keys_default_set:n {
5808   \tl_set:cn { \c_keys_root_tl \l_keys_path_tl .default_tl } {#1}
5809 }
5810 \cs_generate_variant:Nn \keys_default_set:n { V }
```

`\keys_define:nn` The main key-defining function mainly sets up things for `l3keyval` to use.

```
5811 \cs_new:Nn \keys_define:nn {
5812   \tl_set:Nn \l_keys_module_tl {#1}
5813   \cs_set_eq:NN \KV_key_no_value_elt:n \keys_define_elt:n
5814   \cs_set_eq:NN \KV_key_value_elt:nn \keys_define_elt:nn
5815   \seq_push:NV \l_keys_nesting_seq \l_keys_nesting_tl
5816   \tl_set:Nn \l_keys_nesting_tl { define }
5817   \KV_parse_no_space_removal_no_sanitization {#2}
5818   \seq_pop:NN \l_keys_nesting_seq \l_keys_nesting_tl
5819   \cs_set_eq:Nc \KV_key_no_value_elt:n
5820     { keys_ \l_keys_nesting_tl _elt:n }
5821   \cs_set_eq:Nc \KV_key_value_elt:nn
5822     { keys_ \l_keys_nesting_tl _elt:nn }
5823 }
```

`\keys_define_elt:n` The element processors for defining keys.

```
\keys_define_elt:nn
5824 \cs_new_nopar:Nn \keys_define_elt:n {
5825   \bool_set_true:N \l_keys_no_value_bool
5826   \keys_define_elt_aux:nn {#1} { }
5827 }
5828 \cs_new:Nn \keys_define_elt:nn {
5829   \bool_set_false:N \l_keys_no_value_bool
5830   \keys_define_elt_aux:nn {#1} {#2}
5831 }
```

`\keys_define_elt_aux:nn` The auxiliary function does most of the work.

```
5832 \cs_new:Nn \keys_define_elt_aux:nn {
5833   \keys_property_find:n {#1}
5834   \cs_set_eq:Nc \keys_tmp:w
5835     { \c_keys_properties_root_tl \l_keys_property_tl }
5836   \cs_if_exist:NTF \keys_tmp:w {
5837     \keys_define_key:n {#2}
5838   }{
5839     \msg_kernel_error:nx { key-property-unknown }
5840     { \l_keys_property_tl }
5841   }
5842 }
```

`\keys_define_key:n` Defining a new key means finding the code for the appropriate property then running it. As properties have signatures, a check can be made for required values without needing anything set explicitly.

```
5843 \cs_new:Nn \keys_define_key:n {
```

```

5844 \bool_if:NTF \l_keys_no_value_bool {
5845   \intexpr_compare:nTF {
5846     \exp_args:Nc \cs_get_arg_count_from_signature:N
5847       { \l_keys_property_tl } = \c_zero
5848   } {
5849     \keys_tmp:w \q_keys_stop
5850   }{
5851     \msg_kernel_error:nx { key-property-value-required }
5852     { \l_keys_property_tl }
5853   }
5854 }{
5855   \intexpr_compare:nTF {
5856     \exp_args:Nc \cs_get_arg_count_from_signature:N
5857       { \l_keys_property_tl } = \c_one
5858   } {
5859     \keys_tmp:w {#1} \q_keys_stop
5860   }{
5861     \keys_tmp:w #1 { } { } { } { } { } { } { } { } { } \q_keys_stop
5862   }
5863 }
5864 }

```

\keys_execute: Actually executing a key is done in two parts. First, look for the key itself, then look for
 \keys_execute_unknown: the unknown key with the same path. If both of these fail, complain!
 \keys_execute_aux:nn

```

5865 \cs_new_nopar:Nn \keys_execute: {
5866   \keys_execute_aux:nn { \l_keys_path_tl } {
5867     \keys_execute_unknown:
5868   }
5869 }
5870 \cs_new_nopar:Nn \keys_execute_unknown: {
5871   \keys_execute_aux:nn { \l_keys_module_tl / unknown } {
5872     \msg_kernel_error:nx { key-unknown } { \l_keys_path_tl }
5873   }
5874 }

```

If there is only one argument required, it is wrapped in braces so that everything is passed through properly. On the other hand, if more than one is needed it is down to the user to have put things in correctly! The use of \q_keys_stop here means that arguments do not run away (hence the nine empty groups), but that the module can clean up the spare groups at the end of executing the key.

```

5875 \cs_new_nopar:Nn \keys_execute_aux:nn {
5876   \cs_set_eq:Nc \keys_tmp:w { \c_keys_root_tl #1 .cmd:w }
5877   \cs_if_exist:NTF \keys_tmp:w {
5878     \intexpr_compare:nTF {
5879       \num_use:c { \c_keys_root_tl #1 .args_num } = \c_one
5880     } {
5881       \exp_args:NV \keys_tmp:w \l_keys_value_toks \q_keys_stop
5882     }{
5883       \exp_after:wN \keys_tmp:w \toks_use:N \l_keys_value_toks
5884       { } { } { } { } { } { } { } { } { } \q_keys_stop
5885     }
5886   }{

```

```

5887     #2
5888 }
5889 }

```

\keys_if_exist:nnTF A check for the existence of a key. This works by looking for the command function for the key (which ends `.cmd:w`).

```

5890 \prg_set_conditional:Nnn \keys_if_exist:nn {TF,T,F} {
5891   \cs_if_exist:cTF { \c_keys_root_tl #1 / #2 .cmd:w } {
5892     \prg_return_true:
5893   }{
5894     \prg_return_false:
5895   }
5896 }

```

keys_if_value_requirement:nTF To test if a value is required or forbidden. Only one version is needed, so done by hand.

```

5897 \cs_new_nopar:Npn \keys_if_value_requirement:nTF #1 {
5898   \tl_if_eq:ccTF { c_keys_value_ #1 _tl } {
5899     \c_keys_root_tl \l_keys_path_tl .req_tl
5900   }
5901 }

```

\keys_initial_value:n Pretty easy to set initial values.

```

\keys_initial_value:V
5902 \cs_new:Nn \keys_initial_value:n {
5903   \toks_set:Nn \l_keys_value_toks {#1}
5904   \keys_execute_aux:nn { \l_keys_path_tl } {
5905     \msg_kernel_error:nx { key-initial-without-code }
5906     { \l_keys_path_tl }
5907   }
5908 }
5909 \cs_generate_variant:Nn \keys_initial_value:n { V }

```

\keys_meta_make:n To create a met-key, simply set up to pass data through.

```

\keys_meta_make:x
5910 \cs_new_nopar:Nn \keys_meta_make:n {
5911   \keys_cmd_set:nNx { \l_keys_path_tl } 1 {
5912     \exp_not:N \keys_set:nn { \l_keys_module_tl } {#1}
5913   }
5914 }
5915 \cs_generate_variant:Nn \keys_meta_make:n { x }

```

\keys_property_find:n Searching for a property means finding the last “.” in the input, and storing the text before and after it.

```

\keys_property_find_aux:n
\keys_property_find_aux:w
5916 \cs_new_nopar:Nn \keys_property_find:n {
5917   \tl_set:Nx \l_keys_path_tl { \l_keys_module_tl / }
5918   \tl_if_in:nnTF {#1} {.} {
5919     \keys_property_find_aux:n {#1}
5920   }{
5921     \msg_kernel_error:nx { key-no-property } { #1 }
5922   }

```

```

5923 }
5924 \cs_new_nopar:Nn \keys_property_find_aux:n {
5925   \keys_property_find_aux:w #1 \q_stop
5926 }
5927 \cs_new_nopar:Npn \keys_property_find_aux:w #1 . #2 \q_stop {
5928   \tl_if_in:nnTF {#2} {.} {
5929     \tl_set:Nx \l_keys_path_tl {
5930       \l_keys_path_tl \tl_to_str:n {#1} .
5931     }
5932     \keys_property_find_aux:w #2 \q_stop
5933   }{
5934     \tl_set:Nx \l_keys_path_tl { \l_keys_path_tl \tl_to_str:n {#1} }
5935     \tl_set:Nn \l_keys_property_tl { . #2 }
5936   }
5937 }

```

`\keys_property_new:nn` Creating a new property is simply a case of making the correctly-named function.

```

5938 \cs_new_nopar:Nn \keys_property_new:nn {
5939   \cs_new:cn { \c_keys_properties_root_tl #1 }
5940   { #2 \keys_arguments_tidy:w }
5941 }

```

`\keys_property_undefine:n` Removing a property means undefining it.

```

5942 \cs_new_nopar:Nn \keys_property_undefine:n {
5943   \cs_set_eq:cN { \c_keys_root_tl #1 } \c_undefined
5944 }

```

`\keys_set:nn` The main setting function just does the set up to get `l3keyval` to do the hard work.

`\keys_set:nV`
`\keys_set:nv`

```

5945 \cs_new:Nn \keys_set:nn {
5946   \tl_set:Nn \l_keys_module_tl {#1}
5947   \cs_set_eq:NN \KV_key_no_value_elt:n \keys_set_elt:n
5948   \cs_set_eq:NN \KV_key_value_elt:nn \keys_set_elt:nn
5949   \seq_push:NV \l_keys_nesting_seq \l_keys_nesting_tl
5950   \tl_set:Nn \l_keys_nesting_tl { set }
5951   \KV_parse_space_removal_sanitize:n {#2}
5952   \seq_pop:NN \l_keys_nesting_seq \l_keys_nesting_tl
5953   \cs_set_eq:Nc \KV_key_no_value_elt:n
5954   { keys_ \l_keys_nesting_tl _elt:n }
5955   \cs_set_eq:Nc \KV_key_value_elt:nn
5956   { keys_ \l_keys_nesting_tl _elt:nn }
5957 }
5958 \cs_generate_variant:Nn \keys_set:nn { nV, nv }

```

`\keys_set_elt:n` The two element processors are almost identical, and pass the data through to the underlying auxiliary, which does the work.
`\keys_set_elt:nn`

```

5959 \cs_new_nopar:Nn \keys_set_elt:n {
5960   \bool_set_true:N \l_keys_no_value_bool
5961   \keys_set_elt_aux:nn {#1} { }
5962 }

```

```

5963 \cs_new:Nn \keys_set_elt:nn {
5964   \bool_set_false:N \l_keys_no_value_bool
5965   \keys_set_elt_aux:nn {#1} {#2}
5966 }

```

`\keys_set_elt_aux:nn` First, set the current path and add a default if needed. There are then checks to see if the a value is required or forbidden. If everything passes, move on to execute the code.

```

5967 \cs_new:Nn \keys_set_elt_aux:nn {
5968   \tl_set:Nx \l_keys_key_tl { \tl_to_str:n {#1} }
5969   \tl_set:Nx \l_keys_path_tl { \l_keys_module_tl / \l_keys_key_tl }
5970   \keys_value_or_default:n {#2}
5971   \keys_if_value_requirement:nTF { required } {
5972     \bool_if:NTF \l_keys_no_value_bool {
5973       \msg_kernel_error:nx { key-value-required } { \l_keys_path_tl }
5974     }{
5975       \keys_set_elt_aux:
5976     }
5977   }{
5978     \keys_set_elt_aux:
5979   }
5980 }
5981 \cs_new_nopar:Nn \keys_set_elt_aux: {
5982   \keys_if_value_requirement:nTF { forbidden } {
5983     \bool_if:NTF \l_keys_no_value_bool {
5984       \keys_execute:
5985     }{
5986       \msg_kernel_error:nxx { key-value-forbidden } { \l_keys_path_tl }
5987       { \toks_use:N \l_keys_value_toks }
5988     }
5989   }{
5990     \keys_execute:
5991   }
5992 }

```

`\keys_show:nn` Showing a key is just a question of using the correct name.

```

5993 \cs_new_nopar:Nn \keys_show:nn {
5994   \cs_show:c { \c_keys_root_tl #1 / \tl_to_str:n {#2} .cmd:w }
5995 }

```

`\keys_tmp:w` This scratch function is used to actually execute keys.

```

5996 \cs_new:Npn \keys_tmp:w {}

```

`\keys_value_or_default:n` If a value is given, return it as #1, otherwise send a default if available.

```

5997 \cs_new:Nn \keys_value_or_default:n {
5998   \toks_set:Nn \l_keys_value_toks {#1}
5999   \bool_if:NT \l_keys_no_value_bool {
6000     \cs_if_exist:cT { \c_keys_root_tl \l_keys_path_tl .default_tl } {
6001       \toks_set:Nv \l_keys_value_toks {
6002         \c_keys_root_tl \l_keys_path_tl .default_tl

```

```

6003     }
6004   }
6005 }
6006 }

```

`\keys_value_requirement:n` Values can be required or forbidden by having the appropriate marker set.

```

6007 \cs_new_nopar:Nn \keys_value_requirement:n {
6008   \tl_set_eq:cc { \c_keys_root_tl \l_keys_path_tl .req_tl }
6009   { c_keys_value_ #1 _tl }
6010 }

```

`\keys_variable_get_scope:N` Expandable functions to find the type of a variable, and to return `g` if the variable is global. The trick for `\keys_variable_get_scope:N` is the same as that in `\cs_split_function:NN`, but it can be simplified as the requirements here are less complex.

`\keys_variable_get_scope_aux:w`

`\keys_variable_get_type:N`

`\keys_variable_get_type:w`

```

6011 \group_begin:
6012   \char_set_lccode:nn {'\&} {'\g}
6013   \char_make_other:N \&
6014   \tl_to_lowercase:n {
6015     \group_end:
6016     \cs_new_nopar:Nn \keys_variable_get_scope:N {
6017       \exp_last_unbraced:Nf \keys_variable_get_scope_aux:w
6018       { \cs_to_str:N #1 \exp_stop_f: \q_nil }
6019     }
6020     \cs_new_nopar:Npn \keys_variable_get_scope_aux:w #1#2 \q_nil {
6021       \token_if_eq_meaning:NNT & #1 {g}
6022     }
6023   }
6024   \group_begin:
6025     \char_set_lccode:nn {'\&} {'\_}
6026     \char_make_other:N \&
6027     \tl_to_lowercase:n {
6028       \group_end:
6029       \cs_new_nopar:Nn \keys_variable_get_type:N {
6030         \exp_after:wN \keys_variable_get_type_aux:w
6031         \token_to_str:N #1 & a \q_nil
6032       }
6033       \cs_new_nopar:Npn \keys_variable_get_type_aux:w #1 & #2#3 \q_nil {
6034         \token_if_eq_meaning:NNTF a #2 {
6035           #1
6036         }{
6037           \keys_variable_get_type_aux:w #2#3 \q_nil
6038         }
6039       }
6040     }

```

`\keys_variable_set:NN` To set a variable, there is first a check so that it must exist. The setting function is then created by recovering the type and scope from the variable name.

```

6041 \cs_new_nopar:Nn \keys_variable_set:NN {
6042   \cs_if_exist:cF {
6043     \keys_variable_get_type:N #2 _

```



```

6044     \keys_variable_get_scope:N #2 set:N #1
6045   } {
6046     \msg_kernel_error:nxx { key-no-set-function } {
6047       \exp_not:c {
6048         \keys_variable_get_type:N #2 _
6049         \keys_variable_get_scope:N #2 set:N #1
6050       }
6051     } {#2}
6052   }
6053   \cs_if_exist:NF #2 {
6054     \use:c { \keys_variable_get_type:N #2 _new:N } #2
6055   }
6056   \keys_cmd_set:nNx { \l_keys_path_tl } 1 {
6057     \exp_not:c {
6058       \keys_variable_get_type:N #2 _
6059       \keys_variable_get_scope:N #2 set:N #1
6060     } \exp_not:N #2 {##1}
6061   }
6062 }

```

114.2.3 Properties

.bool:N One function for this.

```

6063 \keys_property_new:nn { .bool:N } {
6064   \keys_bool_set:N #1
6065 }

```

.choice: Making a choice is handled internally, as it is also needed by **.generate_choices:nn**.

```

6066 \keys_property_new:nn { .choice: } {
6067   \keys_choice_make:
6068 }

```

.code:n Creating code is simply a case of passing through to the underlying **set** function.

```

        .code:x
        .code:Nn
        .code:Nx
6069 \keys_property_new:nn { .code:n } {
6070   \keys_cmd_set:nNn { \l_keys_path_tl } 1 {#1}
6071 }
6072 \keys_property_new:nn { .code:Nn } {
6073   \keys_cmd_set:nNn { \l_keys_path_tl } #1 {#2}
6074 }
6075 \keys_property_new:nn { .code:x } {
6076   \keys_cmd_set:nNx { \l_keys_path_tl } 1 {#1}
6077 }
6078 \keys_property_new:nn { .code:Nx } {
6079   \keys_cmd_set:nNx { \l_keys_path_tl } #1 {#2}
6080 }

```

.default:n Expansion is left to the internal functions.

```

        .default:V
6081 \keys_property_new:nn { .default:n } {
6082   \keys_default_set:n {#1}

```

```

6083 }
6084 \keys_property_new:nn { .default:V } {
6085   \keys_default_set:V #1
6086 }

```

.function:N Creating functions is pretty easy, so is done without an extra internal function. There is a check to ensure that the function is defined.

```

6087 \keys_property_new:nn { .function:N } {
6088   \keys_cmd_set:nNn { \l_keys_path_tl } 1 {
6089     \cs_set:Nn #1 {##1}
6090   }
6091   \cs_if_free:NT #1 {
6092     \cs_set:Nn #1 { }
6093   }
6094 }

```

.generate_choices:nn Making choices is expansion-dependent.

```

6095 \keys_property_new:nn { .generate_choices:nn } {
6096   \keys_choices_generate:nx {#1} { \exp_not:n {#2} }
6097 }
6098 \keys_property_new:nn { .generate_choices:nx } {
6099   \keys_choices_generate:nx {#1} {#2}
6100 }

```

.initial:n Sending things off as usual.

```

6101 \keys_property_new:nn { .initial:n } {
6102   \keys_initial_value:n {#1}
6103 }
6104 \keys_property_new:nn { .initial:V } {
6105   \keys_initial_value:V #1
6106 }

```

.meta:n Making a meta is handled internally.

```

6107 \keys_property_new:nn { .meta:n } {
6108   \keys_meta_make:n {#1}
6109 }
6110 \keys_property_new:nn { .meta:x } {
6111   \keys_meta_make:x {#1}
6112 }

```

.set:N Setting a variable is very easy: just pass the data along.

```

6113 \keys_property_new:nn { .set:N } {
6114   \keys_variable_set:NN n #1
6115 }
6116 \keys_property_new:nn { .set_x:N } {
6117   \keys_variable_set:NN x #1
6118 }

```

.value_forbidden: These are very similar, so both call the same function.

```
.value_required:
6119 \keys_property_new:nn { .value_forbidden: } {
6120   \keys_value_requirement:n { forbidden }
6121 }
6122 \keys_property_new:nn { .value_required: } {
6123   \keys_value_requirement:n { required }
6124 }
```

114.2.4 Messages

For when there is a need to complain.

```
6125 \msg_kernel_new:nn { key-choice-unknown } {%
6126   Choice ‘#2’ unknown for key ‘#1’:\\%
6127   the key is being ignored.%
6128 }
6129 \msg_kernel_new:nn { key-initial-without-code } {%
6130   An initial value cannot be set for key ‘#1’:
6131   the key has not yet been created.%
6132 }
6133 \msg_kernel_new:nn { key-unknown } {%
6134   The key ‘#1’ is unknown and is being ignored.%
6135 }
6136 \msg_kernel_new:nn { key-value-forbidden } {%
6137   The key ‘#1’ cannot taken a value:\\%
6138   the given input ‘#2’ is being ignored.%
6139 }
6140 \msg_kernel_new:nn { key-value-required } {%
6141   The key ‘#1’ requires a value\\%
6142   and is being ignored.%
6143 }
6144 \msg_kernel_new:nn { key-no-property } {%
6145   No property given in definition of key ‘#1’.%
6146 }
6147 \msg_kernel_new:nnn { key-no-set-function } {%
6148   There is no function #1\\%
6149   for setting variable \exp_not:N #2.%
6150 }{%
6151   LaTeX can only ‘set’ variables which have a function\\%
6152   \exp_not:N \<var>_(g)set:Nn, or in some cases
6153   \exp_not:N \<var>_(g)set:Nx.\\%
6154   You have asked to ‘set’ some other kind of variable.%
6155 }
6156 }
6157 \msg_kernel_new:nn { key-property-unknown } {%
6158   The key property ‘#1’ is unknown.%
6159 }
6160 \msg_kernel_new:nn { key-property-value-required } {%
6161   The property ‘#1’ requires a value\\%
6162   and is being ignored.%
6163 }
6164 </initex | package>
```

115 l3calc implementation

115.1 Variables

```
\l_calc_expression_tl  
\g_calc_A_register  
\l_calc_B_register  
\l_calc_current_type_int  
\g_calc_A_int  
\l_calc_B_int  
\l_calc_C_int  
\g_calc_A_dim  
\l_calc_B_dim  
\l_calc_C_dim  
\g_calc_A_skip  
\l_calc_B_skip  
\l_calc_C_skip  
\g_calc_A_muskip  
\l_calc_B_muskip  
\l_calc_C_muskip
```

Internal registers.

115.2 Internal functions

```
\calc_assign_generic:NNNNnn
\calc_pre_scan:N
\calc_open:w
\calc_init_B:
\calc_numeric:
\calc_close:
\calc_post_scan:N
\calc_multiply:N
\calc_divide:N
\calc_generic_add_or_subtract:N
\calc_add:
\calc_subtract:
\calc_add_A_to_B:
\calc_subtract_A_from_B:
\calc_generic_multiply_or_divide:N
\calc_multiply_B_by_A:
\calc_divide_B_by_A:
\calc_multiply:
\calc_divide:
\calc_textsize:Nn
\calc_ratio_multiply:nn
\calc_ratio_divide:nn
\calc_real_evaluate:nn
\calc_real_multiply:n
\calc_real_divide:n
\calc_maxmin_operation:Nnn
\calc_maxmin_generic:Nnn
\calc_maxmin_div_or_mul:NNnn
\calc_maxmin_multiply:
\calc_maxmin_multiply:
\calc_error:N
\calc_chk_document_counter:nn
```

Awaiting better documentation :)

115.3 Module code

Since this is basically a re-worked version of the `calc` package, I haven't bothered with too many comments except for in the places where this package differs. This may (and should) change at some point.

We start by ensuring that the required packages are loaded.

```
6165 <*package>
6166 \ProvidesExplPackage
6167   {\filename}{\filedate}{\fileversion}{\filedescription}
6168   \package_check_loaded_expl:
6169 </package>
6170 <*initex | package>
```

```

\l_calc_expression_tl Here we define some registers and pointers we will need.
\g_calc_A_register
\l_calc_B_register
\l_calc_current_type_int
6171 \tl_new:Nn\l_calc_expression_tl{}
6172 \cs_new_nopar:Npn \g_calc_A_register{}
6173 \cs_new_nopar:Npn \l_calc_B_register{}
6174 \int_new:N \l_calc_current_type_int

```

```

\g_calc_A_int For each type of register we will need three registers to do our manipulations.
\l_calc_B_int
\l_calc_C_int
\g_calc_A_dim
\l_calc_B_dim
\l_calc_C_dim
\g_calc_A_skip
\l_calc_B_skip
\l_calc_C_skip
\g_calc_A_muskip
\l_calc_B_muskip
\l_calc_C_muskip
6175 \int_new:N \g_calc_A_int
6176 \int_new:N \l_calc_B_int
6177 \int_new:N \l_calc_C_int
6178 \dim_new:N \g_calc_A_dim
6179 \dim_new:N \l_calc_B_dim
6180 \dim_new:N \l_calc_C_dim
6181 \skip_new:N \g_calc_A_skip
6182 \skip_new:N \l_calc_B_skip
6183 \skip_new:N \l_calc_C_skip
6184 \muskip_new:N \g_calc_A_muskip
6185 \muskip_new:N \l_calc_B_muskip
6186 \muskip_new:N \l_calc_C_muskip

```

```

\calc_assign_generic:NNNNnn The generic function. #1 is a number denoting which type we are doing. (0=int, 1=dim,
2=skip, 3=muskip), #2 = temp register A, #3 = temp register B, #4 is a function acting
on #5 which is the register to be set. #6 is the calc expression. We do a little extra work
so that \real and \ratio can still be used by the user.

```

```

6187 \cs_new:Npn \calc_assign_generic:NNNNnn#1#2#3#4#5#6{
6188   \cs_set_eq:NN\g_calc_A_register#2
6189   \cs_set_eq:NN\l_calc_B_register#3
6190   \int_set:Nn \l_calc_current_type_int {#1}
6191   \group_begin:
6192     \cs_set_eq:NN \real \calc_real:n
6193     \cs_set_eq:NN \ratio\calc_ratio:nn
6194     \tl_set:Nx\l_calc_expression_tl{#6}
6195     \exp_after:wN
6196   \group_end:
6197   \exp_after:wN\calc_open:w\exp_after:wN(\l_calc_expression_tl !
6198   \pref_global:D\g_calc_A_register\l_calc_B_register
6199   \group_end:
6200   #4{#5}\l_calc_B_register
6201 }

```

A simpler version relying on \real and \ratio having our definition is

```

\cs_new:Npn \calc_assign_generic:NNNNnn#1#2#3#4#5#6{
  \cs_set_eq:NN\g_calc_A_register#2\cs_set_eq:NN\l_calc_B_register#3
  \int_set:Nn \l_calc_current_type_int {#1}
  \tl_set:Nx\l_calc_expression_tl{#6}
  \exp_after:wN\calc_open:w\exp_after:wN(\l_calc_expression_tl !
  \pref_global:D\g_calc_A_register\l_calc_B_register
  \group_end:
  #4{#5}\l_calc_B_register
}

```

\calc_int_set:Nn Here are the individual versions for the different register types. First integer registers.
\calc_int_gset:Nn
\calc_int_add:Nn
\calc_int_gadd:Nn
\calc_int_sub:Nn
\calc_int_gsub:Nn

```

6202 \cs_new_nopar:Npn\calc_int_set:Nn{
6203   \calc_assign_generic:NNNNnn\c_zero\g_calc_A_int\l_calc_B_int\int_set:Nn
6204 }
6205 \cs_new_nopar:Npn\calc_int_gset:Nn{
6206   \calc_assign_generic:NNNNnn\c_zero\g_calc_A_int\l_calc_B_int\int_gset:Nn
6207 }
6208 \cs_new_nopar:Npn\calc_int_add:Nn{
6209   \calc_assign_generic:NNNNnn\c_zero\g_calc_A_int\l_calc_B_int\int_add:Nn
6210 }
6211 \cs_new_nopar:Npn\calc_int_gadd:Nn{
6212   \calc_assign_generic:NNNNnn\c_zero\g_calc_A_int\l_calc_B_int\int_gadd:Nn
6213 }
6214 \cs_new_nopar:Npn\calc_int_sub:Nn{
6215   \calc_assign_generic:NNNNnn\c_zero\g_calc_A_int\l_calc_B_int\int_sub:Nn
6216 }
6217 \cs_new_nopar:Npn\calc_int_gsub:Nn{
6218   \calc_assign_generic:NNNNnn\c_zero\g_calc_A_int\l_calc_B_int\int_gsub:Nn
6219 }

```

\calc_dim_set:Nn Dimens.

```

\calc_dim_gset:Nn
\calc_dim_add:Nn
\calc_dim_gadd:Nn
\calc_dim_sub:Nn
\calc_dim_gsub:Nn
6220 \cs_new_nopar:Npn\calc_dim_set:Nn{
6221   \calc_assign_generic:NNNNnn\c_one\g_calc_A_dim\l_calc_B_dim\dim_set:Nn
6222 }
6223 \cs_new_nopar:Npn\calc_dim_gset:Nn{
6224   \calc_assign_generic:NNNNnn\c_one\g_calc_A_dim\l_calc_B_dim\dim_gset:Nn
6225 }
6226 \cs_new_nopar:Npn\calc_dim_add:Nn{
6227   \calc_assign_generic:NNNNnn\c_one\g_calc_A_dim\l_calc_B_dim\dim_add:Nn
6228 }
6229 \cs_new_nopar:Npn\calc_dim_gadd:Nn{
6230   \calc_assign_generic:NNNNnn\c_one\g_calc_A_dim\l_calc_B_dim\dim_gadd:Nn
6231 }
6232 \cs_new_nopar:Npn\calc_dim_sub:Nn{
6233   \calc_assign_generic:NNNNnn\c_one\g_calc_A_int\l_calc_B_int\dim_sub:Nn
6234 }
6235 \cs_new_nopar:Npn\calc_dim_gsub:Nn{
6236   \calc_assign_generic:NNNNnn\c_one\g_calc_A_int\l_calc_B_int\dim_gsub:Nn
6237 }

```

\calc_skip_set:Nn Skips.

```

\calc_skip_gset:Nn
\calc_skip_add:Nn
\calc_skip_gadd:Nn
\calc_skip_sub:Nn
\calc_skip_gsub:Nn
6238 \cs_new_nopar:Npn\calc_skip_set:Nn{
6239   \calc_assign_generic:NNNNnn\c_two\g_calc_A_skip\l_calc_B_skip\skip_set:Nn
6240 }
6241 \cs_new_nopar:Npn\calc_skip_gset:Nn{
6242   \calc_assign_generic:NNNNnn\c_two\g_calc_A_skip\l_calc_B_skip\skip_gset:Nn
6243 }
6244 \cs_new_nopar:Npn\calc_skip_add:Nn{
6245   \calc_assign_generic:NNNNnn\c_two\g_calc_A_skip\l_calc_B_skip\skip_add:Nn
6246 }
6247 \cs_new_nopar:Npn\calc_skip_gadd:Nn{

```

```

6248 \calc_assign_generic:NNNNnn\c_two\g_calc_A_skip\l_calc_B_skip\skip_gadd:Nn
6249 }
6250 \cs_new_nopar:Npn\calc_skip_sub:Nn{
6251 \calc_assign_generic:NNNNnn\c_two\g_calc_A_skip\l_calc_B_skip\skip_sub:Nn
6252 }
6253 \cs_new_nopar:Npn\calc_skip_gsub:Nn{
6254 \calc_assign_generic:NNNNnn\c_two\g_calc_A_skip\l_calc_B_skip\skip_gsub:Nn
6255 }

```

\calc_muskip_set:Nn Muskip_s.

```

\calc_muskip_gset:Nn
\calc_muskip_add:Nn
\calc_muskip_gadd:Nn
\calc_muskip_sub:Nn
\calc_muskip_gsub:Nn
6256 \cs_new_nopar:Npn\calc_muskip_set:Nn{
6257 \calc_assign_generic:NNNNnn\c_three\g_calc_A_muskip\l_calc_B_muskip
6258 \muskip_set:Nn
6259 }
6260 \cs_new_nopar:Npn\calc_muskip_gset:Nn{
6261 \calc_assign_generic:NNNNnn\c_three\g_calc_A_muskip\l_calc_B_muskip
6262 \muskip_gset:Nn
6263 }
6264 \cs_new_nopar:Npn\calc_muskip_add:Nn{
6265 \calc_assign_generic:NNNNnn\c_three\g_calc_A_muskip\l_calc_B_muskip
6266 \muskip_add:Nn
6267 }
6268 \cs_new_nopar:Npn\calc_muskip_gadd:Nn{
6269 \calc_assign_generic:NNNNnn\c_three\g_calc_A_muskip\l_calc_B_muskip
6270 \muskip_gadd:Nn
6271 }
6272 \cs_new_nopar:Npn\calc_muskip_sub:Nn{
6273 \calc_assign_generic:NNNNnn\c_three\g_calc_A_muskip\l_calc_B_muskip
6274 \muskip_add:Nn
6275 }
6276 \cs_new_nopar:Npn\calc_muskip_gsub:Nn{
6277 \calc_assign_generic:NNNNnn\c_three\g_calc_A_muskip\l_calc_B_muskip
6278 \muskip_gadd:Nn
6279 }

```

\calc_pre_scan:N In case we found one of the special operations, this should just be executed.

```

6280 \cs_new_nopar:Npn \calc_pre_scan:N #1{
6281 \if_meaning:w(#1
6282 \exp_after:wN\calc_open:w
6283 \else:
6284 \if_meaning:w \calc_textsize:Nn #1
6285 \else:
6286 \if_meaning:w \calc_maxmin_operation:Nnn #1
6287 \else:

```

\calc_numeric: uses a primitive assignment so doesn't care about these dangling \fi:s.

```

6288 \calc_numeric:
6289 \fi:
6290 \fi:
6291 \fi:
6292 #1}

```


\calc_open:w

```

6293 \cs_new_nopar:Npn \calc_open:w({
6294   \group_begin:\group_execute_after:N\calc_init_B:
6295   \group_begin:\group_execute_after:N\calc_init_B:
6296   \calc_pre_scan:N
6297 }

```

\calc_init_B:

\calc_numeric:

\calc_close:

```

6298 \cs_new_nopar:Npn\calc_init_B:{\l_calc_B_register\g_calc_A_register}
6299 \cs_new_nopar:Npn\calc_numeric:{
6300   \tex_afterassignment:D\calc_post_scan:N
6301   \pref_global:D\g_calc_A_register
6302 }
6303 \cs_new_nopar:Npn\calc_close:{
6304   \group_end:\pref_global:D\g_calc_A_register\l_calc_B_register
6305   \group_end:\pref_global:D\g_calc_A_register\l_calc_B_register
6306   \calc_post_scan:N}

```

\calc_post_scan:N Look at what token we have and decide where to go.

```

6307 \cs_new_nopar:Npn\calc_post_scan:N#1{
6308   \if_meaning:w#1!\cs_set_eq:NN\calc_next:w\group_end: \else:
6309     \if_meaning:w#1+\cs_set_eq:NN\calc_next:w\calc_add: \else:
6310       \if_meaning:w#1-\cs_set_eq:NN\calc_next:w\calc_subtract: \else:
6311         \if_meaning:w#1*\cs_set_eq:NN\calc_next:w\calc_multiply:N \else:
6312         \if_meaning:w#1/\cs_set_eq:NN\calc_next:w\calc_divide:N \else:
6313         \if_meaning:w#1)\cs_set_eq:NN\calc_next:w\calc_close: \else:
6314         \if_meaning:w#1\scan_stop:\cs_set_eq:NN\calc_next:w\calc_post_scan:N
6315         \else:

```

If we get here, there is an error but let's also disable \calc_next:w since it is otherwise undefined. No need to give extra errors just for that.

```

6316           \cs_set_eq:NN \calc_next:w \prg_do_nothing:
6317           \calc_error:N#1
6318         \fi:
6319       \fi:
6320     \fi:
6321   \fi:
6322 \fi:
6323 \fi:
6324 \fi:
6325 \calc_next:w}

```

\calc_multiply:N The switches for multiplication and division.

\calc_divide:N

```

6326 \cs_new_nopar:Npn \calc_multiply:N #1{
6327   \if_meaning:w \calc_maxmin_operation:Nnn #1
6328   \cs_set_eq:NN \calc_next:w \calc_maxmin_multiply:
6329   \else:
6330     \if_meaning:w \calc_ratio_multiply:nn #1
6331     \cs_set_eq:NN \calc_next:w \calc_ratio_multiply:nn

```

```

6332     \else:
6333         \if_meaning:w \calc_real_evaluate:nn #1
6334         \cs_set_eq:NN \calc_next:w \calc_real_multiply:n
6335         \else:
6336             \cs_set_nopar:Npn \calc_next:w{\calc_multiply: #1}
6337         \fi:
6338     \fi:
6339 \fi:
6340 \calc_next:w
6341 }
6342 \cs_new_nopar:Npn \calc_divide:N #1{
6343     \if_meaning:w \calc_maxmin_operation:Nnn #1
6344     \cs_set_eq:NN \calc_next:w \calc_maxmin_divide:
6345     \else:
6346         \if_meaning:w \calc_ratio_multiply:nn #1
6347         \cs_set_eq:NN \calc_next:w \calc_ratio_divide:nn
6348     \else:
6349         \if_meaning:w \calc_real_evaluate:nn #1
6350         \cs_set_eq:NN \calc_next:w \calc_real_divide:n
6351     \else:
6352         \cs_set_nopar:Npn \calc_next:w{\calc_divide: #1}
6353     \fi:
6354 \fi:
6355 \fi:
6356 \calc_next:w
6357 }

```

\calc_generic_add_or_subtract:N Here is how we add and subtract.

```

\calc_add:
\calc_subtract:
\calc_add_A_to_B:
\calc_subtract_A_from_B:
6358 \cs_new_nopar:Npn \calc_generic_add_or_subtract:N#1{
6359     \group_end:
6360     \pref_global:D\g_calc_A_register\l_calc_B_register\group_end:
6361     \group_begin:\group_execute_after:N#1\group_begin:
6362     \group_execute_after:N\calc_init_B:
6363     \calc_pre_scan:N}
6364 \cs_new_nopar:Npn \calc_add:{\calc_generic_add_or_subtract:N\calc_add_A_to_B:}
6365 \cs_new_nopar:Npn \calc_subtract:{
6366     \calc_generic_add_or_subtract:N\calc_subtract_A_from_B:}

```

Don't use \tex_advance:D since it allows overflows.

```

6367 \cs_new_nopar:Npn \calc_add_A_to_B:{
6368     \l_calc_B_register
6369     \if_case:w\l_calc_current_type_int
6370     \etex_numexpr:D\or:
6371     \etex_dimexpr:D\or:
6372     \etex_glueexpr:D\or:
6373     \etex_muexpr:D\fi:
6374     \l_calc_B_register + \g_calc_A_register\scan_stop:
6375 }
6376 \cs_new_nopar:Npn \calc_subtract_A_from_B:{
6377     \l_calc_B_register
6378     \if_case:w\l_calc_current_type_int
6379     \etex_numexpr:D\or:

```

```

6380 \etex_dimexpr:D\or:
6381 \etex_glueexpr:D\or:
6382 \etex_muexpr:D\fi:
6383 \l_calc_B_register - \g_calc_A_register\scan_stop:
6384 }

```

`\generic_multiply_or_divide:N` And here is how we multiply and divide. Note that we do not use the primitive TeX operations but the expandable operations provided by ϵ -TeX. This means that all results are rounded not truncated!

```

\calc_multiply_B_by_A:
\calc_divide_B_by_A:
\calc_multiply:
\calc_divide:
6385 \cs_new_nopar:Npn\calc_generic_multiply_or_divide:N#1{
6386 \group_end:
6387 \group_begin:
6388 \cs_set_eq:NN\g_calc_A_register\g_calc_A_int
6389 \cs_set_eq:NN\l_calc_B_register\l_calc_B_int
6390 \int_zero:N \l_calc_current_type_int
6391 \group_execute_after:N#1\calc_pre_scan:N
6392 }
6393 \cs_new_nopar:Npn\calc_multiply_B_by_A:{
6394 \l_calc_B_register
6395 \if_case:w\l_calc_current_type_int
6396 \etex_numexpr:D\or:
6397 \etex_dimexpr:D\or:
6398 \etex_glueexpr:D\or:
6399 \etex_muexpr:D\fi:
6400 \l_calc_B_register*\g_calc_A_int\scan_stop:
6401 }
6402 \cs_new_nopar:Npn\calc_divide_B_by_A:{
6403 \l_calc_B_register
6404 \if_case:w\l_calc_current_type_int
6405 \etex_numexpr:D\or:
6406 \etex_dimexpr:D\or:
6407 \etex_glueexpr:D\or:
6408 \etex_muexpr:D\fi:
6409 \l_calc_B_register/\g_calc_A_int\scan_stop:
6410 }
6411 \cs_new_nopar:Npn\calc_multiply:{
6412 \calc_generic_multiply_or_divide:N\calc_multiply_B_by_A:}
6413 \cs_new_nopar:Npn\calc_divide:{
6414 \calc_generic_multiply_or_divide:N\calc_divide_B_by_A:}

```

`\calc_calculate_box_size:nnn` Put something in a box and measure it. #1 is a list of `\box_ht:N` etc., #2 should be `\dim_set:Nn<dim register>` or `\dim_gset:Nn<dim register>` and #3 is the contents.

```

\calc_calculate_box_size_aux:n
6415 \cs_new:Npn \calc_calculate_box_size:nnn #1#2#3{
6416 \hbox_set:Nn \l_tmpa_box {{#3}}
6417 #2{\c_zero_dim \tl_map_function:nN{#1}\calc_calculate_box_size_aux:n}
6418 }

```

Helper for calculating the final dimension.

```

6419 \cs_set_nopar:Npn \calc_calculate_box_size_aux:n#1{ + #1\l_tmpa_box}

```

`\calc_textsize:Nn` Now we can define `\calc_textsize:Nn`.

```

6420 \cs_set_protected:Npn \calc_textsize:Nn#1#2{
6421   \group_begin:
6422   \cs_set_eq:NN\calc_widthof_aux:n\box_wd:N
6423   \cs_set_eq:NN\calc_heightof_aux:n\box_ht:N
6424   \cs_set_eq:NN\calc_depthof_aux:n\box_dp:N
6425   \cs_set_nopar:Npn\calc_totalheightof_aux:n{\box_ht:N\box_dp:N}
6426   \exp_args:No\calc_calculate_box_size:nnn{#1}
6427   {\dim_gset:Nn\g_calc_A_register}

```

Restore the four user commands here since there might be a recursive call.

```

6428 {
6429   \cs_set_eq:NN \calc_depthof_aux:n \calc_depthof_auxi:n
6430   \cs_set_eq:NN \calc_widthof_aux:n \calc_widthof_auxi:n
6431   \cs_set_eq:NN \calc_heightof_aux:n \calc_heightof_auxi:n
6432   \cs_set_eq:NN \calc_totalheightof_aux:n \calc_totalheightof_auxi:n
6433   #2
6434 }
6435 \group_end:
6436 \calc_post_scan:N
6437 }

```

`\calc_ratio_multiply:nn` Evaluate a ratio. If we were already evaluation a *muskip* register, the ratio is probably also done with this type and we'll have to convert them to regular points.

`\calc_ratio_divide:nn`

```

6438 \cs_set_protected:Npn\calc_ratio_multiply:nn#1#2{
6439   \group_end:\group_begin:
6440   \if_num:w\l_calc_current_type_int < \c_three
6441     \calc_dim_set:Nn\l_calc_B_int{#1}
6442     \calc_dim_set:Nn\l_calc_C_int{#2}
6443   \else:
6444     \calc_dim_muskip:Nn{\l_calc_B_int\etex_mutogluue:D}{#1}
6445     \calc_dim_muskip:Nn{\l_calc_C_int\etex_mutogluue:D}{#2}
6446   \fi:

```

Then store the ratio as a fraction, which we just pass on.

```

6447   \cs_gset_nopar:Npx\calc_calculated_ratio:{
6448     \int_use:N\l_calc_B_int/\int_use:N\l_calc_C_int
6449   }
6450   \group_end:

```

Here we set the new value of `\l_calc_B_register` and remember to evaluate it as the correct type. Note that the intermediate calculation is a scaled operation (meaning the intermediate value is 64-bit) so we don't get into trouble when first multiplying by a large number and then dividing.

```

6451   \l_calc_B_register
6452   \if_case:w\l_calc_current_type_int
6453     \etex_numexpr:D\or:
6454     \etex_dimexpr:D\or:
6455     \etex_glueexpr:D\or:
6456     \etex_muexpr:D\fi:
6457   \l_calc_B_register*\calc_calculated_ratio:\scan_stop:
6458   \group_begin:
6459   \calc_post_scan:N}

```

Division is just flipping the arguments around.

```
6460 \cs_new:Npn \calc_ratio_divide:nn#1#2{\calc_ratio_multiply:nn{#2}{#1}}
```

\calc_real_evaluate:nn Although we could define the \real function as a subcase of \ratio, this is horribly inefficient since we just want to convert the decimal to a fraction.
\calc_real_multiply:n
\calc_real_divide:n

```
6461 \cs_new_protected_nopar:Npn\calc_real_evaluate:nn #1#2{
6462   \group_end:
6463   \l_calc_B_register
6464   \if_case:w\l_calc_current_type_int
6465   \etex_numexpr:D\or:
6466   \etex_dimexpr:D\or:
6467   \etex_glueexpr:D\or:
6468   \etex_muexpr:D\fi:
6469   \l_calc_B_register *
6470   \tex_number:D \dim_eval:n{#1pt}/
6471   \tex_number:D\dim_eval:n{#2pt}
6472   \scan_stop:
6473   \group_begin:
6474   \calc_post_scan:N}
6475 \cs_new_nopar:Npn \calc_real_multiply:n #1{\calc_real_evaluate:nn{#1}{1}}
6476 \cs_new_nopar:Npn \calc_real_divide:n {\calc_real_evaluate:nn{1}}
```

\calc_maxmin_operation:Nnn The max and min functions.

```
\calc_maxmin_generic:Nnn
\calc_maxmin_div_or_mul:NNnn
\calc_maxmin_multiply:
\calc_maxmin_multiply:
6477 \cs_set_protected:Npn\calc_maxmin_operation:Nnn#1#2#3{
6478   \group_begin:
6479   \calc_maxmin_generic:Nnn#1{#2}{#3}
6480   \group_end:
6481   \calc_post_scan:N
6482 }
```

#1 is either > or < and was expanded into this initially.

```
6483 \cs_new_protected:Npn \calc_maxmin_generic:Nnn#1#2#3{
6484   \group_begin:
6485   \if_case:w\l_calc_current_type_int
6486   \calc_int_set:Nn\l_calc_C_int{#2}%
6487   \calc_int_set:Nn\l_calc_B_int{#3}%
6488   \pref_global:D\g_calc_A_register
6489   \if_num:w\l_calc_C_int#1\l_calc_B_int
6490   \l_calc_C_int\else:\l_calc_B_int\fi:
6491   \or:
6492   \calc_dim_set:Nn\l_calc_C_dim{#2}%
6493   \calc_dim_set:Nn\l_calc_B_dim{#3}%
6494   \pref_global:D\g_calc_A_register
6495   \if_dim:w\l_calc_C_dim#1\l_calc_B_dim
6496   \l_calc_C_dim\else:\l_calc_B_dim\fi:
6497   \or:
6498   \calc_skip_set:Nn\l_calc_C_skip{#2}%
6499   \calc_skip_set:Nn\l_calc_B_skip{#3}%
6500   \pref_global:D\g_calc_A_register
6501   \if_dim:w\l_calc_C_skip#1\l_calc_B_skip
```

```

6502     \l_calc_C_skip\else:\l_calc_B_skip\fi:
6503 \else:
6504     \calc_muskip_set:Nn\l_calc_C_muskip{#2}%
6505     \calc_muskip_set:Nn\l_calc_B_muskip{#3}%
6506     \pref_global:D\g_calc_A_register
6507     \if_dim:w\l_calc_C_muskip#1\l_calc_B_muskip
6508     \l_calc_C_muskip\else:\l_calc_B_muskip\fi:
6509 \fi:
6510 \group_end:
6511 }
6512 \cs_new:Npn\calc_maxmin_div_or_mul:NNnn#1#2#3#4{
6513 \group_end:
6514 \group_begin:
6515 \int_zero:N\l_calc_current_type_int
6516 \group_execute_after:N#1
6517 \calc_maxmin_generic:Nnn#2{#3}{#4}
6518 \group_end:
6519 \group_begin:
6520 \calc_post_scan:N
6521 }
6522 \cs_new_nopar:Npn\calc_maxmin_multiply:{
6523 \calc_maxmin_div_or_mul:NNnn\calc_multiply_B_by_A:}
6524 \cs_new_nopar:Npn\calc_maxmin_divide: {
6525 \calc_maxmin_div_or_mul:NNnn\calc_divide_B_by_A:}

```

`\calc_error:N` The error message.

```

6526 \cs_new_nopar:Npn\calc_error:N#1{
6527 \PackageError{calc}
6528 {'\token_to_str:N#1'~ invalid~ at~ this~ point}
6529 {I~ expected~ to~ see~ one~ of:~ +- -- *~ /~ )}
6530 }

```

115.4 Higher level commands

The various operations allowed.

`\calc_maxof:nn` Max and min operations

`\calc_minof:nn`

`\maxof`

`\minof`

```

6531 \cs_new:Npn \calc_maxof:nn#1#2{
6532 \calc_maxmin_operation:Nnn > \exp_not:n{{#1}{#2}}
6533 }
6534 \cs_new:Npn \calc_minof:nn#1#2{
6535 \calc_maxmin_operation:Nnn < \exp_not:n{{#1}{#2}}
6536 }
6537 \cs_set_eq:NN \maxof \calc_maxof:nn
6538 \cs_set_eq:NN \minof \calc_minof:nn

```

`\calc_widthof:n` Text dimension commands.

`\calc_widthof_aux:n`

`\calc_widthof_auxi:n`

`\calc_heightof:n`

`\calc_heightof_aux:n`

`\calc_heightof_auxi:n`

`\calc_depthof:n`

`\calc_depthof_aux:n`

`\calc_depthof_auxi:n`

`\calc_totalheightof:n`

`\calc_totalheightof_aux:n`

`\calc_totalheightof_auxi:n`

```

6539 \cs_new:Npn \calc_widthof:n#1{
6540 \calc_textsize:Nn \exp_not:N\calc_widthof_aux:n\exp_not:n{{#1}}

```

```

6541 }
6542 \cs_new:Npn \calc_heightof:n#1{
6543   \calc_textsize:Nn \exp_not:N\calc_heightof_aux:n\exp_not:n{{#1}}
6544 }
6545 \cs_new:Npn \calc_depthof:n#1{
6546   \calc_textsize:Nn \exp_not:N\calc_depthof_aux:n\exp_not:n{{#1}}
6547 }
6548 \cs_new:Npn \calc_totalheightof:n#1{
6549   \calc_textsize:Nn \exp_not:N\calc_totalheightof_aux:n \exp_not:n{{#1}}
6550 }
6551 \cs_new:Npn \calc_widthof_aux:n #1{
6552   \exp_not:N\calc_widthof_aux:n\exp_not:n{{#1}}
6553 }
6554 \cs_new_eq:NN \calc_widthof_auxi:n \calc_widthof_aux:n
6555 \cs_new:Npn \calc_depthof_aux:n #1{
6556   \exp_not:N\calc_depthof_aux:n\exp_not:n{{#1}}
6557 }
6558 \cs_new_eq:NN \calc_depthof_auxi:n \calc_depthof_aux:n
6559 \cs_new:Npn \calc_heightof_aux:n #1{
6560   \exp_not:N\calc_heightof_aux:n\exp_not:n{{#1}}
6561 }
6562 \cs_new_eq:NN \calc_heightof_auxi:n \calc_heightof_aux:n
6563 \cs_new:Npn \calc_totalheightof_aux:n #1{
6564   \exp_not:N\calc_totalheightof_aux:n\exp_not:n{{#1}}
6565 }
6566 \cs_new_eq:NN \calc_totalheightof_auxi:n \calc_totalheightof_aux:n

```

\calc_ratio:nn Ratio and real.

```

\calc_real:n
6567 \cs_new:Npn \calc_ratio:nn#1#2{
6568   \calc_ratio_multiply:nn\exp_not:n{{#1}}{#2}}
6569 \cs_new_nopar:Npn \calc_real:n {\calc_real_evaluate:nn}

```

We can implement real and ratio without actually using these names. We'll see.

\widthof \heightof \depthof \totalheightof \ratio \real User commands.

```

6570 \cs_set_eq:NN \depthof\calc_depthof:n
6571 \cs_set_eq:NN \widthof\calc_widthof:n
6572 \cs_set_eq:NN \heightof\calc_heightof:n
6573 \cs_set_eq:NN \totalheightof\calc_totalheightof:n
6574 %%\cs_set_eq:NN \ratio\calc_ratio:nn
6575 %%\cs_set_eq:NN \real\calc_real:n

\setlength
\gsetlength
\addtolength
\gaddtolength
6576 \cs_set_protected_nopar:Npn \setlength{\calc_skip_set:Nn}
6577 \cs_set_protected_nopar:Npn \gsetlength{\calc_skip_gset:Nn}
6578 \cs_set_protected_nopar:Npn \addtolength{\calc_skip_add:Nn}
6579 \cs_set_protected_nopar:Npn \gaddtolength{\calc_skip_gadd:Nn}

```

\calc_setcounter:nn Document commands for L^AT_EX 2_ε counters. Also add support for amstext. Note that when l3breqn is used, \mathchoice will no longer need this switch as the argument is only executed once.

```

\setcounter
\addtocounter
\stepcounter

```

\calc_chk_document_counter:nn

```

6580 </initex | package>
6581 <*package>
6582 \newif\iffirstchoice@ \firstchoice@true
6583 </package>
6584 <*initex | package>
6585 \cs_set_protected_nopar:Npn \calc_setcounter:nn#1#2{
6586   \calc_chk_document_counter:nn{#1}{
6587     \exp_args:Nc\calc_int_gset:Nn {c@#1}{#2}
6588   }
6589 }
6590 \cs_set_protected_nopar:Npn \calc_addtocounter:nn#1#2{
6591 </initex | package>
6592 <*package>
6593   \iffirstchoice@
6594 </package>
6595 <*initex | package>
6596   \calc_chk_document_counter:nn{#1}{
6597     \exp_args:Nc\calc_int_gadd:Nn {c@#1}{#2}
6598   }
6599 </initex | package>
6600 <*package>
6601   \fi:
6602 </package>
6603 <*initex | package>
6604 }
6605 \cs_set_protected_nopar:Npn \calc_stepcounter:n#1{
6606 </initex | package>
6607 <*package>
6608   \iffirstchoice@
6609 </package>
6610 <*initex | package>
6611   \calc_chk_document_counter:nn{#1}{
6612     \int_gincr:c {c@#1}
6613     \group_begin:
6614       \cs_set_eq:NN \@elt\@stpelt \use:c{cl@#1}
6615     \group_end:
6616   }
6617 </initex | package>
6618 <*package>
6619   \fi:
6620 </package>
6621 <*initex | package>
6622 }
6623 \cs_new_nopar:Npn \calc_chk_document_counter:nn#1{
6624   \cs_if_free:cTF{c@#1}{\@nocounterr {#1}}
6625 }
6626 \cs_set_eq:NN \setcounter \calc_setcounter:nn
6627 \cs_set_eq:NN \addtocounter \calc_addtocounter:nn
6628 \cs_set_eq:NN \stepcounter \calc_stepcounter:n
6629 </initex | package>
6630 <*package>
6631 \AtBeginDocument{
6632   \cs_set_eq:NN \setcounter \calc_setcounter:nn
6633   \cs_set_eq:NN \addtocounter \calc_addtocounter:nn

```



```

6634 \cs_set_eq:NN \stepcounter \calc_stepcounter:n
6635 }

```

Prevent the usual calc from loading.

```

6636 \cs_set_nopar:cpn{ver@calc.sty}{2005/08/06}
6637 \</package>

6638 \<*showmemory>
6639 \showMemUsage
6640 \</showmemory>

```

116 l3file implementation

The usual lead-off.

```

6641 \<*package>
6642 \ProvidesExplPackage
6643   {\filename}{\filedate}{\fileversion}{\filedescription}
6644   \package_check_loaded_expl:
6645 \</package>
6646 \<*initex | package>

```

`\g_file_record_clist` When files are read with logging, the names are added here. There are two lists, one for everything and one for only those items which might later be listed (as in L^AT_EX 2_ε's `\listfiles`).

```

6647 \clist_new:N \g_file_record_clist
6648 \clist_new:N \g_file_record_full_clist

```

`\l_file_search_path_clist` Checking input needs a stream to work with

```

6649 \clist_new:N \l_file_search_path_clist

```

`\l_file_test_read_stream` Checking input needs a stream to work with

```

6650 \ior_new:N \l_file_test_read_stream

```

`\l_file_tmp_bool` A flag is needed for internal purposes.

```

6651 \bool_new:N \l_file_tmp_bool

```

`\l_file_tmp_tl` A scratch token list variable.

```

6652 \tl_new:N \l_file_tmp_tl

```

`\file_if_exist_p:n` Checking if a file exists takes place in two parts. First, there is a simple check “here”. If
`\file_if_exist:nTF` that fails, then there is a loop over the current search path.

```

\file_if_exist_path:n
\file_if_exist_aux:n
6653 \prg_new_conditional:Nnn \file_if_exist:n {p,TF,T,F} {
6654   \ior_open:Nn \l_file_test_read_stream {#1}

```

```

6655 \ior_if_eof:NTF \l_file_test_read_stream {
6656   \file_if_exist_path:n {#1}
6657 }{
6658   \ior_close:N \l_file_test_read_stream
6659   \prg_return_true:
6660 }
6661 }
6662 \cs_new_nopar:Nn \file_if_exist_path:n {
6663   \bool_set_false:N \l_file_tmp_bool
6664   \cs_set_nopar:Nn \file_if_exist_aux:n {
6665     \ior_open:Nn \l_file_test_read_stream { #1 ##1 }
6666     \ior_if_eof:NF \l_file_test_read_stream {
6667       \bool_set_true:N \l_file_tmp_bool
6668       \clist_map_break:
6669     }
6670   }
6671 }
6672 \package
6673 \cs_if_exist:NT \input@path {
6674   \cs_set_eq:NN \l_file_search_path_clist \input@path
6675 }
6676 \package
6677 \initex \package
6678 \clist_map_function:NN \l_file_search_path_clist \file_if_exist_aux:n
6679 \ior_close:N \l_file_test_read_stream
6680 \bool_if:NTF \l_file_tmp_bool {
6681   \prg_return_true:
6682 }{
6683   \prg_return_false:
6684 }
6685 }
6686 \cs_new_nopar:Nn \file_if_exist_aux:n { }

```

\file_add_path:nN
 \file_add_path_search:n
 \file_add_path_aux:n

Checking if a file exists takes place in two parts. First, there is a simple check “here”. If that fails, then there is a loop over the current search path.

```

6687 \cs_new_nopar:Nn \file_add_path:nN {
6688   \tl_clear:N #2
6689   \ior_open:Nn \l_file_test_read_stream {#1}
6690   \ior_if_eof:NTF \l_file_test_read_stream {
6691     \file_add_path_search:nN {#1} #2
6692   }{
6693     \tl_set:Nn #2 {#1}
6694   }
6695   \ior_close:N \l_file_test_read_stream
6696 }
6697 \cs_new_nopar:Nn \file_add_path_search:nN {
6698   \cs_set_nopar:Nn \file_add_path_aux:n {
6699     \ior_open:Nn \l_file_test_read_stream { ##1 #1 }
6700     \ior_if_eof:NF \l_file_test_read_stream {
6701       \tl_set:Nn #2 { ##1 #1 }
6702       \clist_map_break:
6703     }
6704   }
6705 }

```

```

6705 </initex | package>
6706 <*package>
6707   \cs_if_exist:NT \input@path {
6708     \cs_set_eq:NN \l_file_search_path_clist \input@path
6709   }
6710 </package>
6711 <*initex | package>
6712   \clist_map_function:NN \l_file_search_path_clist \file_add_path_aux:n
6713 }
6714 \cs_new_nopar:Nn \file_add_path_aux:n { }

```

`\file_input:n` `\file_add_path:n` will return an empty token list variable if the file is not found. This is used rather than `\file_if_exist:nT` here as it saves running the same loop twice.

```

6715 \cs_new:Nn \file_input:n {
6716   \file_add_path:nN {#1} \l_file_tmp_tl
6717   \tl_if_empty:NF \l_file_tmp_tl {
6718     \file_input_no_check:n \l_file_tmp_tl
6719   }
6720 }
6721 \cs_new:Nn \file_input_no_record:n {
6722   \file_add_path:nN {#1} \l_file_tmp_tl
6723   \tl_if_empty:NF \l_file_tmp_tl {
6724     \file_input_no_check_no_record:n \l_file_tmp_tl
6725   }
6726 }

```

`\file_input_no_check:n` File input records what is going on before setting to work.

```

6727 \cs_new_nopar:Nn \file_input_no_check:n {
6728   \clist_gput_right:Nx \g_file_record_clist {#1}
6729   \wlog{ADDING: #1}
6730 </initex | package>
6731 <*package>
6732   \@addtofilelist {#1}
6733 </package>
6734 <*initex | package>
6735   \clist_gput_right:Nx \g_file_record_full_clist {#1}
6736   \tex_input:D #1 ~
6737 }

```

`\file_input_no_check_no_record:n` Inputting a file without adding to the main record is basically the same: even in this case the file goes on the full log.

```

6738 \cs_new_nopar:Nn \file_input_no_check_no_record:n {
6739   \clist_gput_right:Nx \g_file_record_full_clist {#1}
6740   \tex_input:D #1 ~
6741 }

```

`\file_list:` Two functions to list all files used to the log: the full version includes everything whereas `\file_list_full:` the standard version uses the shorter record.

```

\file_list:N
6742 \cs_new_nopar:Nn \file_list: {

```

```

6743 \file_list:N \g_file_record_clist
6744 }
6745 \cs_new_nopar:Nn \file_list_full: {
6746 \file_list:N \g_file_record_full_clist
6747 }
6748 \cs_new_nopar:Nn \file_list:N {
6749 \clist_remove_duplicates:N #1
6750 \iow_log:x { *~File~List~* }
6751 \clist_map_function:NN #1 \file_list_aux:n
6752 \iow_log:x { ***** }
6753 }
6754 \cs_new_nopar:Nn \file_list_aux:n {
6755 \iow_log:x { #1 }
6756 }

```

When used as a package, there is a need to hold onto the standard file list as well as the new one here.

```

6757 </initex | package>
6758 <*package>
6759 % \begin{macrocode}
6760 \AtBeginDocument{
6761 \clist_put_right:NV \g_file_record_clist \@filelist
6762 \clist_put_right:NV \g_file_record_full_clist \@filelist
6763 }
6764 </package>

```

Index

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.

Symbols		
\!	.....	1515
\%	.....	4825
\&	.....	4986, 4988, 6012, 6013, 6025, 6026
\*	.....	2273, 2275, 2279, 2284
\,	.....	5558, 5560
\-	.....	63
\.bool:N	.....	6063
\.choice:	.....	6066
\.code:Nn	.....	6069
\.code:Nx	.....	6069
\.code:n	.....	6069
\.code:x	.....	6069
\.default:V	.....	6081
\.default:n	.....	6081
\.function:N	.....	6087
\.generate_choices:nn	.....	6095
\.generate_choices:nx	.....	6095
\.initial:V	.....	6101
\.initial:n	.....	6101
\.meta:n	.....	6107
\.meta:x	.....	6107
\.set:N	.....	6113
\.set_x:N	.....	6113
\.value_forbidden:	.....	6119
\.value_required:	.....	6119
\/	.....	62
\:	.....	588, 592, 1010, 2454
\::	.....	166, 1449, 1452, 1454, 1454–1456, 1458, 1459, 1461, 1464, 1467, 1475, 1480, 1485, 1493, 1536– 1543, 1545–1552, 1554–1556, 1558, 1560–1562, 1564–1567, 1569–1572, 1574–1579, 1581, 1582, 1647, 1651, 1654, 1658, 1664–1666, 1668, 1674
\::N	.....	166, 1458, 1458, 1540–1543, 1562, 1564–1567, 1574, 1575, 1674
\::V	.....	166, 1485, 1485, 1538, 1542, 1551, 1558, 1562
\::V_unbraced	.....	1646, 1654, 1665, 1668, 1674
\::c	.....	166, 1461, 1461, 1545, 1548, 1554, 1569, 1574–1579, 1668
\::f	.....	166, 1467, 1467, 1536, 1540, 1546–1549
\::f_unbraced	.....	1646, 1647, 1664
\::n	.....	166, 1455, 1455, 1549– 1552, 1564, 1565, 1569–1572, 1579
\::o	.....	166, 1464, 1464, 1546, 1550, 1554–1556, 1560, 1564, 1566, 1567, 1570, 1572, 1575–1577, 1581, 1582
\::o_unbraced	.....	1646, 1651
\::v	.....	166, 1485, 1493, 1537, 1541
\::v_unbraced	.....	1646, 1658, 1666
\::x	.....	166, 1473, 1475, 1480, 1539, 1543, 1545, 1552, 1556, 1560, 1561, 1565, 1567, 1571, 1572, 1578, 1579, 1581
\<	.....	6152, 6153
\=	.....	5557, 5559
\?	.....	2367, 2454
\@	.....	714, 1010, 1011, 3897, 3898
\@@end	.....	687
\@@hyph	.....	691
\@@input	.....	685
\@@italiccorr	.....	690
\@@underline	.....	686
\@addtofilelist	.....	6732
\@currentx	.....	713
\@currname	.....	712
\@currnamestack	.....	707, 715
\@declaredoptions	.....	710
\@elt	.....	6614
\@empty	.....	709, 710
\@filelist	.....	6761, 6762
\@gobble	.....	693
\@ifpackageloaded	.....	727
\@nil	.....	707, 711
\@nocounterr	.....	6624
\@p@pfilename	.....	707, 711
\@popfilename	.....	124, 660, 667, 668
\@pushfilename	.....	124, 660, 660, 665
\@stpelt	.....	6614
\@tempboxa	.....	5368
\@unknownoptionerror	.....	708
\@	.....	1134, 1136, 1140, 1148, 1149, 2367, 4994, 4997, 5021, 5028, 5258, 5266, 5267, 5274, 5281, 5282, 6126, 6137, 6141, 6148, 6151, 6153, 6161
\{	.....	4294, 4482, 4661, 4663, 4826
\}	.....	4294, 4482, 4661, 4663, 4827, 4987
\_	.....	587, 591, 6025
\|	.....	2865
Numbers		
\8	.....	5559
\9	.....	5560

- _ 61, 1516, 4808, 4892, 4937,
4942, 4947, 4957, 4966, 4975, 4986,
4987, 4989, 4995, 5022, 5029, 5469
- A**
- \A 2368, 2456, 3897, 3899
- \a 1002
- \above 182
- \abovedisplaysshortskip 195
- \abovedisplayskip 196
- \abovewithdelims 183
- \accent 233
- \addtocounter 120, 6580, 6627, 6633
- \addtolength 120, 6576, 6578
- \adjdemerits 270
- \advance 77
- \afterassignment 87
- \aftergroup 88
- \alloc_reg:NnNN 2697, 2698,
3243, 3244, 3359, 3360, 3419, 3420,
4073, 4074, 4779, 4830, 5304, 5305
- \alloc_setup_type:nnn ... 2696, 3242,
3358, 3418, 4072, 4778, 4829, 5302
- \AtBeginDocument 5503, 6631, 6760
- \atop 184
- \atopwithdelims 185
- B**
- \B 3898, 3900
- \badness 332
- \baselineskip 260
- \batchmode 153
- \begin 5518, 6759
- \begingroup 2, 91
- \beginL 445
- \beginR 447
- \belowdisplaysshortskip 197
- \belowdisplayskip 198
- \binoppenalty 221
- .bool:N 113
- \bool(:w 1874
- \bool_)_0:w 1874
- \bool_)_1:w 1874
- \bool_8_0:w 1874
- \bool_8_1:w 1874
- \bool_:w 1874
- \bool_choose:NN 1874, 1893, 1896
- \bool_cleanup:N .. 1874, 1889, 1891, 1892
- \bool_do_until:cn 33, 1866
- \bool_do_until:Nn 33, 1866, 1870, 1871, 1873
- \bool_do_until:nn .. 36, 1931, 1940, 1941
- \bool_do_while:cn 33, 1866
- \bool_do_while:Nn 33, 1866, 1866, 1867, 1869
- \bool_do_while:nn .. 36, 1931, 1937, 1938
- \bool_eval_skip_to_end:Nw
..... 1903, 1904, 1905, 1905, 1914
- \bool_eval_skip_to_end_aux:Nw
..... 1905, 1906, 1908
- \bool_eval_skip_to_end_auxii:Nw
..... 1905, 1911, 1913
- \bool_get_next:N 1874,
1876, 1878, 1886, 1889, 1897, 1898
- \bool_gset:cn 34, 1916
- \bool_gset:Nn 34, 1916, 1917, 1921
- \bool_gset_eq:cc 33, 1841, 1848
- \bool_gset_eq:cN 33, 1841, 1847
- \bool_gset_eq:Nc 33, 1841, 1846
- \bool_gset_eq:NN 33, 1841, 1845
- \bool_gset_false:c 32, 1831, 1840
- \bool_gset_false:N 32, 1831, 1839
- \bool_gset_true:c 32, 1831, 1838
- \bool_gset_true:N 32, 1831, 1837
- \bool_I_0:w 1874
- \bool_I_1:w 1874
- \bool_if:cTF 33, 1851
- \bool_if:N 1851
- \bool_if:n 1927
- \bool_if:NF 1857, 1863, 1871, 2956
- \bool_if:nF 1935, 1941
- \bool_if:NT 1856,
1859, 1867, 2956, 2957, 5592, 5999
- \bool_if:nT 1932, 1938
- \bool_if:NTF 33, 1282, 1851, 1855,
2948, 5664, 5844, 5972, 5983, 6680
- \bool_if:nTF 34, 1874, 2583, 3340
- \bool_if_p:c 33, 1851
- \bool_if_p:N 33, 1851, 1854
- \bool_if_p:n 34, 1874,
1874, 1916, 1918, 1922, 1924, 1928
- \bool_new:c 32, 1831, 1832
- \bool_new:N 32, 1831, 1831,
1849, 1850, 5554, 5729, 5759, 6651
- \bool_not_p:n 34, 1922, 1922
- \bool_p:w 1874
- \bool_S_0:w 1874
- \bool_S_1:w 1874
- \bool_set:cn 34, 1916
- \bool_set:Nn 34, 1916, 1916, 1920
- \bool_set_eq:cc 33, 1841, 1844
- \bool_set_eq:cN 33, 1841, 1843
- \bool_set_eq:Nc 33, 1841, 1842
- \bool_set_eq:NN 33, 1841, 1841
- \bool_set_false:c 32, 1831, 1836
- \bool_set_false:N
..... 32, 1831, 1835, 5829, 5964, 6663
- \bool_set_true:c 32, 1831, 1834

- \bool_set_true:N 32, [1831](#), [1833](#), [5555](#), [5825](#), [5960](#), [6667](#)
 - \bool_until_do:cn [33](#), [1858](#)
 - \bool_until_do:Nn [33](#), [1858](#), [1862](#), [1863](#), [1865](#)
 - \bool_until_do:nn .. [36](#), [1931](#), [1934](#), [1935](#)
 - \bool_while_do:cn [33](#), [1858](#)
 - \bool_while_do:Nn [33](#), [1858](#), [1858](#), [1859](#), [1861](#)
 - \bool_while_do:nn .. [36](#), [1931](#), [1931](#), [1932](#)
 - \bool_xor_p:nn [34](#), [1923](#), [1923](#)
 - \botmark [168](#)
 - \botmarks [394](#)
 - \box [376](#)
 - \box_clear:c [105](#), [5351](#)
 - \box_clear:N [105](#), [5351](#), [5351](#)–[5353](#)
 - \box_dp:c [106](#), [5355](#)
 - \box_dp:N [106](#), [5355](#), [5356](#), [5359](#), [6424](#), [6425](#)
 - \box_gclear:c [105](#), [5351](#)
 - \box_gclear:N [105](#), [5351](#), [5353](#), [5354](#)
 - \box_gset_eq:cc [105](#), [5340](#)
 - \box_gset_eq:cN [105](#), [5340](#)
 - \box_gset_eq:Nc [105](#), [5340](#)
 - \box_gset_eq:NN ... [105](#), [5340](#), [5340](#), [5341](#)
 - \box_gset_to_last:c [105](#), [5343](#)
 - \box_gset_to_last:N [105](#), [5343](#), [5345](#), [5346](#)
 - \box_ht:c [106](#), [5355](#)
 - \box_ht:N [106](#), [5355](#), [5355](#), [5358](#), [6423](#), [6425](#)
 - \box_if_empty:cTF [105](#), [5331](#)
 - \box_if_empty:N [5331](#)
 - \box_if_empty:Nf [5337](#)
 - \box_if_empty:NT [5336](#)
 - \box_if_empty:NTF [105](#), [5331](#), [5335](#)
 - \box_if_empty_p:c [105](#), [5331](#)
 - \box_if_empty_p:N [105](#), [5331](#), [5334](#)
 - \box_if_horizontal:cTF [104](#), [5317](#)
 - \box_if_horizontal:N [5317](#)
 - \box_if_horizontal:Nf [5326](#)
 - \box_if_horizontal:NT [5325](#)
 - \box_if_horizontal:NTF . [104](#), [5317](#), [5324](#)
 - \box_if_horizontal_p:c [104](#), [5317](#)
 - \box_if_horizontal_p:N . [104](#), [5317](#), [5323](#)
 - \box_if_vertical:cTF [104](#), [5317](#)
 - \box_if_vertical:N [5320](#)
 - \box_if_vertical:Nf [5330](#)
 - \box_if_vertical:NT [5329](#)
 - \box_if_vertical:NTF ... [104](#), [5317](#), [5328](#)
 - \box_if_vertical_p:c [104](#), [5317](#)
 - \box_if_vertical_p:N ... [104](#), [5317](#), [5327](#)
 - \box_move_down:nn [105](#), [5347](#), [5350](#)
 - \box_move_left:nn [105](#), [5347](#), [5347](#)
 - \box_move_right:nn [105](#), [5347](#), [5348](#)
 - \box_move_up:nn [105](#), [5347](#), [5349](#)
 - \box_new:c [104](#), [5301](#)
 - \box_new:N [104](#), [5301](#), [5304](#), [5308](#), [5313](#), [5369](#)–[5371](#)
 - \box_new_l:N [5305](#)
 - \box_set_eq:cc [105](#), [5338](#)
 - \box_set_eq:cN [105](#), [5338](#)
 - \box_set_eq:Nc [105](#), [5338](#)
 - \box_set_eq:NN [105](#), [5338](#), [5338](#)–[5340](#), [5351](#)
 - \box_set_to_last:c [105](#), [5343](#)
 - \box_set_to_last:N . [105](#), [5343](#), [5343](#)–[5345](#)
 - \box_show:c [106](#), [5365](#)
 - \box_show:N [106](#), [5365](#), [5365](#), [5366](#)
 - \box_use:c [105](#), [5361](#)
 - \box_use:N [105](#), [5361](#), [5363](#), [5364](#)
 - \box_use_clear:c [105](#), [5361](#)
 - \box_use_clear:N .. [105](#), [5361](#), [5361](#), [5362](#)
 - \box_wd:c [106](#), [5355](#)
 - \box_wd:N [106](#), [5355](#), [5357](#), [5360](#), [6422](#)
 - \boxmaxdepth [338](#)
 - \brokenpenalty [295](#)
- C**
- \C [2368](#), [2457](#)
 - \c_active_char_token [44](#), [2270](#), [2285](#), [2328](#)
 - \c_alignment_tab_token [44](#), [2270](#), [2276](#), [2300](#)
 - \c_eight [53](#), [2197](#), [2213](#), [2905](#), [2915](#)
 - \c_eleven [53](#), [2200](#), [2216](#), [2905](#), [2918](#)
 - \c_empty_box .. [106](#), [5351](#), [5367](#), [5367](#), [5369](#)
 - \c_empty_tl [72](#), [3508](#), [3510](#), [3617](#), [3617](#), [3627](#), [4251](#), [4427](#)
 - \c_empty_toks [79](#), [4120](#), [4212](#), [4212](#)
 - \c_false_bool [10](#), [943](#), [963](#), [999](#), [1000](#), [1024](#), [1258](#), [1267](#), [1831](#), [1832](#), [1835](#), [1836](#), [1839](#), [1840](#), [1899](#), [1901](#), [1903](#), [1925](#), [2410](#), [2504](#), [2940](#), [2943](#), [2949](#), [4048](#)
 - \c_fifteen [53](#), [2204](#), [2220](#), [2905](#), [2922](#)
 - \c_five [53](#), [2194](#), [2210](#), [2905](#), [2912](#)
 - \c_four [53](#), [2193](#), [2209](#), [2905](#), [2911](#)
 - \c_fourteen [53](#), [2203](#), [2219](#), [2905](#), [2921](#)
 - \c_group_begin_token [44](#), [2270](#), [2270](#), [2288](#), [2584](#), [5384](#), [5410](#)
 - \c_group_end_token [44](#), [2270](#), [2271](#), [2292](#), [5385](#), [5388](#), [5413](#), [5418](#)
 - \c_hundred_one [53](#), [2905](#), [2925](#)
 - \c_ior_log_stream [98](#), [4791](#), [4794](#)
 - \c_ior_term_stream [98](#), [4791](#), [4792](#)
 - \c_iow_comment_char [98](#), [4825](#), [4825](#)
 - \c_iow_lbrace_char [98](#), [4825](#), [4826](#)
 - \c_iow_log_stream [98](#), [4791](#), [4793](#), [4799](#), [4800](#)
 - \c_iow_rbrace_char [98](#), [4825](#), [4827](#)
 - \c_iow_term_stream [98](#), [4791](#), [4791](#), [4801](#), [4802](#)
 - \c_job_name_tl [72](#), [3616](#), [3616](#)
 - \c_keys_properties_root_tl [119](#), [5717](#), [5718](#), [5835](#), [5939](#)

- \c_keys_root_tl
 [119](#), [5717](#), [5717](#), [5794](#), [5799](#),
 [5804](#), [5805](#), [5808](#), [5876](#), [5879](#), [5891](#),
 [5899](#), [5943](#), [5994](#), [6000](#), [6002](#), [6008](#)
- \c_keys_value_forbidden_tl
 [119](#), [5719](#), [5719](#)
- \c_keys_value_required_tl [119](#), [5719](#), [5720](#)
- \c_KV_single_equal_sign_tl
 [300](#), [5548](#), [5550](#), [5635](#), [5686](#)
- \c_letter_token [44](#), [2270](#), [2282](#), [2320](#)
- \c_luatex_is_engine_bool
 [24](#), [1255](#), [1265](#), [1267](#), [1274](#)
- \c_math_shift_token . [44](#), [2270](#), [2274](#), [2296](#)
- \c_math_subscript_token
 [44](#), [2270](#), [2280](#), [2312](#)
- \c_math_superscript_token
 [44](#), [2270](#), [2278](#), [2308](#)
- \c_max_dim [64](#), [3397](#), [3398](#)
- \c_max_int [53](#), [2935](#), [2935](#)
- \c_max_register_num
 [56](#), [2696](#), [2896](#), [3077](#),
 [3077](#), [3242](#), [3358](#), [3418](#), [4072](#), [5302](#)
- \c_max_skip [62](#), [3329](#), [3332](#), [3333](#), [3337](#), [3398](#)
- \c_minus_one . [14](#), [53](#), [1088](#), [1089](#), [1092](#),
 [1093](#), [1098](#), [2725](#), [2743](#), [2745](#), [2895](#),
 [2905](#), [2905](#), [2906](#), [3039](#), [3041](#), [3908](#),
 [3924](#), [3934](#), [3942](#), [4793](#), [4794](#), [4861](#)
- \c_msg_code_prefix_tl [103](#), [4900](#), [4902](#),
 [4980](#), [4982](#), [5148](#), [5149](#), [5243](#), [5244](#)
- \c_msg_error_tl [103](#), [4862](#), [4863](#), [5134](#), [5229](#)
- \c_msg_fatal_text_tl
 [103](#), [4866](#), [4866](#), [5129](#), [5223](#)
- \c_msg_fatal_tl
 [103](#), [4862](#), [4862](#), [5123](#), [5125](#), [5128](#), [5217](#)
- \c_msg_help_text_tl [103](#), [4866](#), [4869](#), [5003](#)
- \c_msg_hide_tl [4896](#), [5004](#)
- \c_msg_info_tl [103](#), [4862](#), [4865](#), [5162](#)
- \c_msg_kernel_bug_more_text_tl
 [103](#), [4866](#), [4875](#), [5291](#)
- \c_msg_kernel_bug_text_tl
 [103](#), [4866](#), [4872](#), [5288](#)
- \c_msg_more_text_prefix_tl
 [103](#), [4900](#), [4901](#), [4962](#), [4964](#),
 [4971](#), [4973](#), [5141](#), [5142](#), [5236](#), [5237](#)
- \c_msg_no_info_text_tl
 ... [103](#), [4866](#), [4881](#), [5014](#), [5144](#), [5239](#)
- \c_msg_on_line_tl . [103](#), [4899](#), [4899](#), [4914](#)
- \c_msg_return_text_tl [103](#), [4866](#),
 [4879](#), [4883](#), [4885](#), [5269](#), [5276](#), [5284](#)
- \c_msg_text_prefix_tl
 [103](#), [4900](#), [4900](#), [4924](#), [4928](#), [4932](#),
 [4956](#), [4960](#), [4969](#), [5085](#), [5126](#), [5137](#),
 [5156](#), [5163](#), [5169](#), [5175](#), [5220](#), [5232](#)
- \c_msg_warning_tl . [103](#), [4862](#), [4864](#), [5155](#)
- \c_nine [53](#), [2198](#), [2214](#), [2905](#), [2916](#)
- \c_one [53](#), [2190](#), [2206](#), [2720](#),
 [2742](#), [2744](#), [2905](#), [2908](#), [5857](#), [5879](#),
 [6221](#), [6224](#), [6227](#), [6230](#), [6233](#), [6236](#)
- \c_other_char_token . [44](#), [2270](#), [2283](#), [2324](#)
- \c_parameter_token [44](#), [2270](#), [2277](#)
- \c_peek_true_remove_next_tl
 [193](#), [2553](#), [2564](#), [2565](#)
- \c_seven . [53](#), [1713](#), [2196](#), [2212](#), [2905](#), [2914](#)
- \c_six ... [53](#), [1709](#), [2195](#), [2211](#), [2905](#), [2913](#)
- \c_sixteen .. [14](#), [53](#), [1088](#), [1095](#), [1101](#),
 [2905](#), [2923](#), [4778](#), [4791](#), [4792](#), [4829](#)
- \c_space_token
 [44](#), [2270](#), [2281](#), [2316](#), [2585](#), [2676](#)
- \c_ten ... [53](#), [2199](#), [2215](#), [2905](#), [2917](#), [5469](#)
- \c_ten_thousand [53](#), [2905](#), [2929](#)
- \c_ten_thousand_four [53](#), [2905](#), [2933](#)
- \c_ten_thousand_one [53](#), [2905](#), [2930](#)
- \c_ten_thousand_three ... [53](#), [2905](#), [2932](#)
- \c_ten_thousand_two [53](#), [2905](#), [2931](#)
- \c_thirteen [53](#), [2202](#), [2218](#), [2905](#), [2920](#)
- \c_thirty_two [53](#), [2905](#), [2924](#)
- \c_thousand [53](#), [2905](#), [2928](#)
- \c_three [53](#), [2192](#), [2208](#), [2905](#), [2910](#), [6257](#),
 [6261](#), [6265](#), [6269](#), [6273](#), [6277](#), [6440](#)
- \c_true_bool [10](#), [943](#), [963](#),
 [999](#), [999](#), [1028](#), [1256](#), [1265](#), [1833](#),
 [1834](#), [1837](#), [1838](#), [1900](#), [1902](#), [1904](#),
 [1925](#), [2937](#), [2940](#), [2943](#), [2950](#), [4046](#)
- \c_twelve [53](#), [2201](#), [2217](#), [2905](#), [2919](#)
- \c_twenty_thousand [53](#), [2905](#), [2934](#)
- \c_two [53](#), [2191](#), [2207](#), [2905](#), [2909](#),
 [6239](#), [6242](#), [6245](#), [6248](#), [6251](#), [6254](#)
- \c_two_ats_with_two_catcodes_tl
 [3896](#), [3903](#), [3907](#), [3918](#), [3941](#)
- \c_twohundred_fifty_five . [53](#), [2905](#), [2926](#)
- \c_twohundred_fifty_six . [53](#), [2905](#), [2927](#)
- \c_undefined [44](#), [50](#), [4962](#), [4971](#), [4980](#), [5943](#)
- \c_undefined:D [1251](#), [1253](#)
- \c_xetex_is_engine_bool
 [24](#), [1255](#), [1256](#), [1258](#), [1261](#), [1270](#)
- \c_zero [14](#), [53](#),
 [942](#), [947](#), [952](#), [957](#), [962](#), [967](#), [972](#),
 [977](#), [1070](#), [1076](#), [1088](#), [1096](#), [1706](#),
 [1707](#), [1711](#), [1759](#), [1786](#), [1810](#), [2120](#),
 [2142](#), [2189](#), [2205](#), [2750](#), [2752](#), [2905](#),
 [2907](#), [2963](#), [3143](#), [3173](#), [3177](#), [3178](#),
 [3184](#), [3242](#), [3341](#), [3342](#), [3358](#), [3418](#),
 [3713](#), [4072](#), [4778](#), [4829](#), [5302](#), [5847](#),
 [6203](#), [6206](#), [6209](#), [6212](#), [6215](#), [6218](#)
- \c_zero_dim [64](#), [3397](#), [3397](#), [5390](#), [6417](#)
- \c_zero_skip [62](#), [3269](#), [3329](#), [3330](#), [3331](#),
 [3336](#), [3348](#), [3349](#), [3373](#), [3397](#), [5420](#)
- \calc_add: [320](#), [6309](#), [6358](#), [6364](#)

\calc_add_A_to_B: . 320, 6358, 6364, 6367
\calc_addtocounter:nn
..... 120, 6580, 6590, 6627, 6633
\calc_assign_generic:NNNNnn
..... 320, 6187, 6187,
6203, 6206, 6209, 6212, 6215, 6218,
6221, 6224, 6227, 6230, 6233, 6236,
6239, 6242, 6245, 6248, 6251, 6254,
6257, 6261, 6265, 6269, 6273, 6277
\calc_calculate_box_size:nnn
..... 121, 6415, 6415, 6426
\calc_calculate_box_size_aux:n
..... 6415, 6417, 6419
\calc_calculated_ratio: 6447, 6457
\calc_chk_document_counter:nn
... 320, 6580, 6586, 6596, 6611, 6623
\calc_close: 320, 6298, 6303, 6313
\calc_depthof:n ... 120, 6539, 6545, 6570
\calc_depthof_aux:n 6424,
6429, 6539, 6546, 6555, 6556, 6558
\calc_depthof_auxi:n ... 6429, 6539, 6558
\calc_dim_add:Nn 121, 6220, 6226
\calc_dim_gadd:Nn 121, 6220, 6229
\calc_dim_gset:Nn 121, 6220, 6223
\calc_dim_gsub:Nn 121, 6220, 6235
\calc_dim_muskip:Nn 6444, 6445
\calc_dim_set:Nn
121, 6220, 6220, 6441, 6442, 6492, 6493
\calc_dim_sub:Nn 121, 6220, 6232
\calc_divide: 320, 6352, 6385, 6413
\calc_divide:N 320, 6312, 6326, 6342
\calc_divide_B_by_A:
..... 320, 6385, 6402, 6414, 6525
\calc_error:N 320, 6317, 6526, 6526
\calc_generic_add_or_subtract:N
..... 320, 6358, 6358, 6364, 6366
\calc_generic_multiply_or_divide:N .
..... 320, 6385, 6385, 6412, 6414
\calc_heightof:n .. 120, 6539, 6542, 6572
\calc_heightof_aux:n 6423,
6431, 6539, 6543, 6559, 6560, 6562
\calc_heightof_auxi:n .. 6431, 6539, 6562
\calc_init_B:
... 320, 6294, 6295, 6298, 6298, 6362
\calc_int_add:Nn 121, 6202, 6208
\calc_int_gadd:Nn . 121, 6202, 6211, 6597
\calc_int_gset:Nn . 121, 6202, 6205, 6587
\calc_int_gsub:Nn 121, 6202, 6217
\calc_int_set:Nn 121, 6202, 6202, 6486, 6487
\calc_int_sub:Nn 121, 6202, 6214
\calc_maxmin_div_or_mul:NNnn
..... 320, 6477, 6512, 6523, 6525
\calc_maxmin_divide: 6344, 6524
\calc_maxmin_generic:Nnn
..... 320, 6477, 6479, 6483, 6517
\calc_maxmin_multiply:
..... 320, 6328, 6477, 6522
\calc_maxmin_operation:Nnn 320, 6286,
6327, 6343, 6477, 6477, 6532, 6535
\calc_maxof:nn 120, 6531, 6531, 6537
\calc_minof:nn 120, 6531, 6534, 6538
\calc_multiply: ... 320, 6336, 6385, 6411
\calc_multiply:N .. 320, 6311, 6326, 6326
\calc_multiply_B_by_A:
..... 320, 6385, 6393, 6412, 6523
\calc_muskip_add:Nn 121, 6256, 6264
\calc_muskip_gadd:Nn ... 121, 6256, 6268
\calc_muskip_gset:Nn ... 121, 6256, 6260
\calc_muskip_gsub:Nn ... 121, 6256, 6276
\calc_muskip_set:Nn
..... 121, 6256, 6256, 6504, 6505
\calc_muskip_sub:Nn 121, 6256, 6272
\calc_next:w 6308–6314,
6316, 6325, 6328, 6331, 6334, 6336,
6340, 6344, 6347, 6350, 6352, 6356
\calc_numeric: 320, 6288, 6298, 6299
\calc_open:w .. 320, 6197, 6282, 6293, 6293
\calc_post_scan:N
..... 320, 6300, 6306, 6307, 6307,
6314, 6436, 6459, 6474, 6481, 6520
\calc_pre_scan:N
... 320, 6280, 6280, 6296, 6363, 6391
\calc_ratio:nn 120, 6193, 6567, 6567, 6574
\calc_ratio_divide:nn 320, 6347, 6438, 6460
\calc_ratio_multiply:nn .. 320, 6330,
6331, 6346, 6438, 6438, 6460, 6568
\calc_real:n .. 120, 6192, 6567, 6569, 6575
\calc_real_divide:n 320, 6350, 6461, 6476
\calc_real_evaluate:nn ... 320, 6333,
6349, 6461, 6461, 6475, 6476, 6569
\calc_real_multiply:n 320, 6334, 6461, 6475
\calc_setcounter:nn
..... 120, 6580, 6585, 6626, 6632
\calc_skip_add:Nn . 121, 6238, 6244, 6578
\calc_skip_gadd:Nn . 121, 6238, 6247, 6579
\calc_skip_gset:Nn . 121, 6238, 6241, 6577
\calc_skip_gsub:Nn 121, 6238, 6253
\calc_skip_set:Nn
... 121, 6238, 6238, 6498, 6499, 6576
\calc_skip_sub:Nn 121, 6238, 6250
\calc_stepcounter:n
..... 120, 6580, 6605, 6628, 6634
\calc_subtract: ... 320, 6310, 6358, 6365
\calc_subtract_A_from_B:
..... 320, 6358, 6366, 6376
\calc_textsize:Nn 320, 6284,
6420, 6420, 6540, 6543, 6546, 6549

`\calc_totalheightof:n` [120](#), [6539](#), [6548](#), [6573](#)
`\calc_totalheightof_aux:n` [6425](#),
[6432](#), [6539](#), [6549](#), [6563](#), [6564](#), [6566](#)
`\calc_totalheightof_auxi:n`
. [6432](#), [6539](#), [6566](#)
`\calc_widthof:n` [120](#), [6539](#), [6539](#), [6571](#)
`\calc_widthof_aux:n` [6422](#),
[6430](#), [6539](#), [6540](#), [6551](#), [6552](#), [6554](#)
`\calc_widthof_auxi:n` [6430](#), [6539](#), [6554](#)
`\catcode` [26–28](#), [30](#), [31](#), [34–36](#), [38](#), [39](#), [380](#)
`\char` [234](#)
`\char_gset_mathcode:nn` [43](#), [2221](#), [2226](#)
`\char_gset_mathcode:w` [43](#), [2221](#), [2225](#), [2227](#)
`\char_make_active:N` [42](#), [2189](#), [2202](#), [4988](#)
`\char_make_active:n` [42](#), [2205](#), [2218](#)
`\char_make_alignment:N` [42](#), [2189](#), [2193](#)
`\char_make_alignment:n` [42](#), [2205](#), [2209](#)
`\char_make_begin_group:N` [42](#), [2189](#), [2190](#)
`\char_make_begin_group:n` [42](#), [2205](#), [2206](#)
`\char_make_comment:N` [42](#), [2189](#), [2203](#)
`\char_make_comment:n` [42](#), [2205](#), [2219](#)
`\char_make_end_group:N` [42](#), [2189](#), [2191](#)
`\char_make_end_group:n` [42](#), [2205](#), [2207](#)
`\char_make_end_line:N` [42](#), [2189](#), [2194](#)
`\char_make_end_line:n` [42](#), [2205](#), [2210](#)
`\char_make_escape:N` [42](#), [2189](#), [2189](#)
`\char_make_escape:n` [42](#), [2205](#), [2205](#)
`\char_make_ignore:N`
. [42](#), [2189](#), [2198](#), [4957](#), [4966](#), [4975](#)
`\char_make_ignore:n` [42](#), [2205](#), [2214](#)
`\char_make_invalid:N` [42](#), [2189](#), [2204](#)
`\char_make_invalid:n` [42](#), [2205](#), [2220](#)
`\char_make_letter:N`
. [42](#), [2189](#), [2200](#), [4892](#), [4989](#)
`\char_make_letter:n` [42](#), [2205](#), [2216](#)
`\char_make_math_shift:N` [42](#), [2189](#), [2192](#)
`\char_make_math_shift:n` [42](#), [2205](#), [2208](#)
`\char_make_math_subscript:N`
. [42](#), [2189](#), [2197](#)
`\char_make_math_subscript:n`
. [42](#), [2205](#), [2213](#)
`\char_make_math_superscript:N`
. [42](#), [2189](#), [2196](#)
`\char_make_math_superscript:n`
. [42](#), [2205](#), [2212](#)
`\char_make_other:N`
. [42](#), [2189](#), [2201](#), [6013](#), [6026](#)
`\char_make_other:n` [42](#), [2205](#), [2217](#)
`\char_make_parameter:N` [42](#), [2189](#), [2195](#)
`\char_make_parameter:n` [42](#), [2205](#), [2211](#)
`\char_make_space:N`
. [42](#), [2189](#), [2199](#), [4937](#), [4942](#), [4947](#)
`\char_make_space:n` [42](#), [2205](#), [2215](#)

`\char_set_catcode:nn`
. [41](#), [2175](#), [2176](#), [2189–](#)
[2220](#), [2273](#), [2275](#), [2279](#), [2284](#), [2369](#),
[2455–2459](#), [5469](#), [5557](#), [5558](#), [5570](#)
`\char_set_catcode:w` [41](#), [2175](#), [2175](#), [2177](#)
`\char_set_lccode:nn`
. [42](#), [2237](#), [2238](#), [2362–2367](#),
[2454](#), [4986](#), [5559](#), [5560](#), [6012](#), [6025](#)
`\char_set_lccode:w`
. [42](#), [2237](#), [2237](#), [2239](#), [4987](#)
`\char_set_mathcode:nn` [43](#), [2221](#), [2222](#)
`\char_set_mathcode:w` [43](#), [2221](#), [2221](#), [2223](#)
`\char_set_sfcode:nn` [43](#), [2257](#), [2258](#)
`\char_set_sfcode:w` [43](#), [2257](#), [2257](#), [2259](#)
`\char_set_uccode:nn` [43](#), [2247](#), [2248](#)
`\char_set_uccode:w` [43](#), [2247](#), [2247](#), [2249](#)
`\char_show_value_catcode:n` [41](#), [2175](#), [2186](#)
`\char_show_value_catcode:w`
. [41](#), [2175](#), [2183](#), [2187](#)
`\char_show_value_lccode:n` [42](#), [2237](#), [2245](#)
`\char_show_value_lccode:w`
. [42](#), [2237](#), [2244](#), [2246](#)
`\char_show_value_mathcode:n`
. [43](#), [2221](#), [2234](#)
`\char_show_value_mathcode:w`
. [43](#), [2221](#), [2233](#), [2235](#)
`\char_show_value_sfcode:n` [43](#), [2257](#), [2266](#)
`\char_show_value_sfcode:w`
. [43](#), [2257](#), [2265](#), [2267](#)
`\char_show_value_uccode:n` [43](#), [2247](#), [2255](#)
`\char_show_value_uccode:w`
. [43](#), [2247](#), [2254](#), [2256](#)
`\char_value_catcode:n` [41](#), [2175](#), [2180](#)
`\char_value_catcode:w` [41](#), [2175](#), [2179](#), [2181](#)
`\char_value_lccode:n` [42](#), [2237](#), [2242](#)
`\char_value_lccode:w` [42](#), [2237](#), [2241](#), [2242](#)
`\char_value_mathcode:n` [43](#), [2221](#), [2230](#)
`\char_value_mathcode:w` [43](#), [2221](#), [2229](#), [2231](#)
`\char_value_sfcode:n` [43](#), [2257](#), [2262](#)
`\char_value_sfcode:w` [43](#), [2257](#), [2261](#), [2263](#)
`\char_value_uccode:n` [43](#), [2247](#), [2252](#)
`\char_value_uccode:w` [43](#), [2247](#), [2251](#), [2252](#)
`\chardef` [69](#)
`\chk_exist_cs:N`
. [3471](#), [3475](#), [3478](#), [3481](#), [3494](#), [3498](#)
`\chk_global:N` [3478](#), [3481](#), [3499](#), [4098](#), [4108](#)
`\chk_if_exist_cs:c` [10](#), [1125](#), [1132](#)
`\chk_if_exist_cs:N`
. [10](#), [1125](#), [1125](#), [1132](#), [1598](#)
`\chk_if_free_cs:N` [10](#),
[1110](#), [1110](#), [1162](#), [1234](#), [1245](#), [2702](#),
[2899](#), [3248](#), [3322](#), [3364](#), [3424](#), [3443](#),
[3451](#), [4924](#), [4928](#), [4932](#), [5052](#), [5309](#)
`\chk_local:N` [3475](#), [4081](#), [4103](#)

- \chk_local_or_pref_global:N 2709, 2722, 2727,
2757, 2763, 3256, 3271, 3286, 3293,
3472, 3495, 3538, 3546, 3550, 3555,
3563, 3567, 3575, 3580, 3588, 3596,
3600, 3604, 4121, 4155, 4159, 4844
- \chk_var_or_const:N 3445, 3452,
3495, 3499, 3514, 3526, 4104, 4109
- .choice: 113
- \cleaders 252
- \clearpage 5522, 5525, 5530, 5533
- \clist_clear:c 85, [4399](#)
- \clist_clear:N
85, [4399](#), [4399](#), [4400](#), [4579](#), [4601](#), [5070](#)
- \clist_clear_new:c 85, [4403](#)
- \clist_clear_new:N .. 85, [4403](#), [4403](#), [4404](#)
- \clist_concat:ccc 89, [4564](#)
- \clist_concat:NNN .. 89, [4564](#), [4573](#), [4575](#)
- \clist_concat_aux:NNNN
..... [4564](#), [4564](#), [4573](#), [4574](#)
- \clist_display:c 87, [4473](#)
- \clist_display:N ... 87, [4473](#), [4473](#), [4487](#)
- \clist_gclear:c 85, [4399](#)
- \clist_gclear:N 85, [4399](#), [4401](#), [4402](#)
- \clist_gclear_new:c 85, [4403](#)
- \clist_gclear_new:N . 85, [4403](#), [4405](#), [4406](#)
- \clist_gconcat:ccc 89, [4564](#)
- \clist_gconcat:NNN .. 89, [4564](#), [4574](#), [4576](#)
- \clist_get:cN 87, [4455](#), [4624](#)
- \clist_get:NN .. 87, [4455](#), [4455](#), [4460](#), [4623](#)
- \clist_get_aux:w ... 90, [4455](#), [4457](#), [4459](#)
- \clist_gpop:cN 90, [4617](#)
- \clist_gpop:NN 90, [4617](#), [4621](#), [4622](#)
- \clist_gpush:cn 90, [4617](#)
- \clist_gpush:Nn 90, [4617](#), [4617](#), [4620](#)
- \clist_gpush:No 90, [4617](#), [4619](#)
- \clist_gpush:NV 90, [4617](#), [4618](#)
- \clist_gput_left:cn 86, [4497](#)
- \clist_gput_left:co 86, [4497](#)
- \clist_gput_left:cV 86, [4497](#)
- \clist_gput_left:Nn
..... 86, [4497](#), [4497](#), [4500](#), [4617](#)
- \clist_gput_left:No 86, [4497](#), [4619](#)
- \clist_gput_left:NV 86, [4497](#), [4618](#)
- \clist_gput_left:Nx 86, [4497](#)
- \clist_gput_right:cn 86, [4505](#)
- \clist_gput_right:co 86, [4505](#)
- \clist_gput_right:cV 86, [4505](#)
- \clist_gput_right:Nn 86, [4505](#), [4505](#), [4508](#)
- \clist_gput_right:No 86, [4505](#)
- \clist_gput_right:NV 86, [4505](#)
- \clist_gput_right:Nx
..... 86, [4505](#), [6728](#), [6735](#), [6739](#)
- \clist_gremove_duplicates:N
..... 89, [4578](#), [4591](#)
- \clist_gremove_element:Nn 89, [4594](#), [4597](#)
- \clist_gset_eq:cc 85, [4411](#), [4414](#)
- \clist_gset_eq:cN 85, [4411](#), [4412](#)
- \clist_gset_eq:Nc 85, [4411](#), [4413](#)
- \clist_gset_eq:NN 85, [4411](#), [4411](#), [4592](#), [4598](#)
- \clist_gset_from_seq:NN . 85, [4415](#), [4423](#)
- \clist_if_empty:c 4425
- \clist_if_empty:cTF 88, [4424](#)
- \clist_if_empty:N 4424
- \clist_if_empty:NF 4510, [4529](#)
- \clist_if_empty:NTF 88, [4424](#), [4489](#)
- \clist_if_empty_err:N
..... 90, [4426](#), [4426](#), [4456](#), [4462](#)
- \clist_if_empty_p:c 88, [4424](#)
- \clist_if_empty_p:N 88, [4424](#)
- \clist_if_eq:cc 4435
- \clist_if_eq:ccTF 89, [4432](#)
- \clist_if_eq:cN 4433
- \clist_if_eq:cNTF 89, [4432](#)
- \clist_if_eq:Nc 4434
- \clist_if_eq:NcTF 89, [4432](#)
- \clist_if_eq:NN 4432
- \clist_if_eq:NNTF 89, [4432](#)
- \clist_if_eq_p:cc 88, [4432](#)
- \clist_if_eq_p:cN 88, [4432](#)
- \clist_if_eq_p:Nc 88, [4432](#)
- \clist_if_eq_p:NN 88, [4432](#)
- \clist_if_in:cnTF 89, [4436](#)
- \clist_if_in:coTF 89, [4436](#)
- \clist_if_in:cVTF 89, [4436](#)
- \clist_if_in:Nn 4436
- \clist_if_in:NnF 4445, [4584](#), [4951](#)
- \clist_if_in:NnT 4444
- \clist_if_in:NnTF .. 89, [4436](#), [4443](#), [5074](#)
- \clist_if_in:NoTF 89, [4436](#)
- \clist_if_in:NVTF 89, [4436](#)
- \clist_map_break: 88, [4526](#), [4526](#), [6668](#), [6702](#)
- \clist_map_function:cN 87, [4509](#)
- \clist_map_function:NN 87, [4509](#), [4509](#),
4515, 4580, 4607, 6678, 6712, 6751
- \clist_map_function:nN 87, [4509](#), [4516](#), [5789](#)
- \clist_map_function_aux:Nw ... 4511,
4518, [4521](#), [4521](#), [4524](#), [4533](#), [4545](#)
- \clist_map_inline:cn 87, [4527](#)
- \clist_map_inline:Nn
..... 87, [4477](#), [4527](#), [4528](#), [4539](#)
- \clist_map_inline:nn 87, [4527](#), [4540](#)
- \clist_map_variable:cNn 88, [4551](#)
- \clist_map_variable:NNn
..... 88, [4551](#), [4557](#), [4558](#)
- \clist_map_variable:nNn
..... 88, [4551](#), [4551](#), [4557](#)

- \clist_map_variable_aux:Nnw 4553, 4559, 4559, 4562
- \clist_new:c 85, 4397
- \clist_new:N 85, 4397, 4397, 4398, 4577, 4905, 4908, 6647–6649
- \clist_pop:cn 90, 4611
- \clist_pop:NN 90, 4611, 4615, 4616
- \clist_pop_aux:nnNN 90, 4461, 4461, 4615, 4621
- \clist_pop_aux:w 90, 4461, 4463, 4465
- \clist_pop_auxi:w 90, 4461, 4468, 4470
- \clist_push:cn 90, 4611, 4614
- \clist_push:Nn 90, 4611, 4611
- \clist_push:No 90, 4611, 4613
- \clist_push:NV 90, 4611, 4612
- \clist_put_aux:NNnnNn 90, 4488, 4488, 4494, 4498, 4502, 4506
- \clist_put_left:cn 86, 4493, 4614
- \clist_put_left:co 86, 4493
- \clist_put_left:cV 86, 4493
- \clist_put_left:Nn 86, 4493, 4493, 4496, 4611
- \clist_put_left:No 86, 4493, 4613
- \clist_put_left:NV 86, 4493, 4612
- \clist_put_left:Nx 86, 4493
- \clist_put_right:cn 86, 4501
- \clist_put_right:co 86, 4501
- \clist_put_right:cV 86, 4501
- \clist_put_right:Nn 86, 4501, 4501, 4504, 4585, 4604, 4952, 5077
- \clist_put_right:No 86, 4501
- \clist_put_right:NV 86, 4501, 6761, 6762
- \clist_put_right:Nx 86, 4501
- \clist_remove_duplicates:N 89, 4578, 4588, 6749
- \clist_remove_duplicates_aux:n 4578, 4580, 4583
- \clist_remove_duplicates_aux:NN 4578, 4578, 4589, 4592
- \clist_remove_element_aux:n 4594, 4602, 4607, 4610
- \clist_remove_element_aux:NNn 4594, 4595, 4598, 4600
- \clist_set_eq:cc 85, 4407, 4410
- \clist_set_eq:cn 85, 4407, 4408
- \clist_set_eq:Nc 85, 4407, 4409
- \clist_set_eq:NN 85, 4407, 4407, 4589, 4595
- \clist_set_from_seq:NN 85, 4415, 4422
- \clist_set_from_seq_aux:NNN 4415, 4422, 4423
- \clist_show:c 87, 4471, 4472
- \clist_show:N 87, 4471, 4471
- \clist_tmp:w 4437, 4441
- \clist_top:cn 90, 4623, 4624
- \clist_top:NN 90, 4623, 4623
- \clist_use:c 86, 4446
- \clist_use:N 86, 4446, 4446, 4454
- \closein 128
- \closeout 123
- \clubpenalties 436
- \clubpenalty 263
- .code:n 113
- .code:Nn 113
- .code:Nx 113
- .code:x 113
- \copy 320
- \count 371
- \countdef 70
- \cr 95
- \crr 96
- \cs:w 10, 777, 780, 834, 868, 1055, 1341, 1380, 1462, 1512, 1525, 1526, 1528, 1530, 1532–1534, 1596, 1719, 1725, 1728, 2304, 2783, 3320, 3390, 3615, 5464
- \cs_end: 10, 777, 781, 834, 868, 1049, 1055, 1341, 1380, 1462, 1512, 1525, 1526, 1528, 1530, 1532, 1533, 1535, 1596, 1721, 1722, 1731–1733, 1735, 1737, 1739, 1741, 1743, 1745, 1747–1757, 2304, 2783, 3320, 3390, 3615, 5464
- \cs_generate_from_arg_count:cnNn 962, 967, 972, 977, 1326, 1379, 5794, 5799
- \cs_generate_from_arg_count:NNnn 1297, 1297, 1327, 1340
- \cs_generate_from_arg_count_error_msg:Nn 1297, 1320, 1329
- \cs_generate_internal_variant:n 25, 1618, 1633, 1633
- \cs_generate_internal_variant_aux:n 1636, 1639, 1639, 1644
- \cs_generate_variant:Nn 25, 1597, 1597, 1854–1857, 1861, 1865, 1869, 1873, 1920, 1921, 2091, 2109, 2157–2164, 2706, 2718, 2719, 2746–2749, 2751, 2753, 2778–2781, 2961, 2987, 2988, 3042–3045, 3048, 3049, 3051, 3055, 3057, 3059, 3061, 3063, 3065, 3252, 3266, 3267, 3281, 3282, 3289, 3303, 3312, 3315, 3318, 3368, 3370, 3372, 3374, 3376, 3380, 3382, 3384, 3386, 3388, 3449, 3465, 3467, 3490, 3491, 3506, 3507, 3509, 3511, 3523, 3534, 3569–3571, 3606–3608, 3630–3633, 3637–3640, 3645–3652, 3659–3666, 3828, 3840, 3859, 3865,

- 3879, 3888, 3954–3956, 3963–3968,
 3986, 3988, 4007, 4010, 4013, 4014,
 4021, 4022, 4026, 4028, 4033, 4034,
 4053–4056, 4077, 4079, 4082, 4097,
 4100, 4117, 4118, 4128, 4129, 4138,
 4139, 4141, 4146, 4152, 4166, 4180–
 4182, 4193–4196, 4201–4204, 4247,
 4263–4265, 4273, 4299, 4307, 4310,
 4329–4331, 4342, 4351, 4357, 4380,
 4383, 4384, 4398, 4400, 4402, 4404,
 4406, 4443–4445, 4454, 4460, 4487,
 4496, 4500, 4504, 4508, 4515, 4539,
 4558, 4575, 4576, 4616, 4620, 4622,
 4668, 4679, 4683, 4712, 4713, 4741–
 4743, 4755, 4765, 4784, 4789, 4806,
 4817, 4821, 5313, 5323–5330, 5334–
 5337, 5339, 5341, 5344, 5346, 5352,
 5354, 5358–5360, 5362, 5364, 5366,
 5374, 5376, 5380, 5382, 5395, 5397,
 5400, 5402, 5406, 5408, 5412, 5417,
 5422, 5424, 5810, 5909, 5915, 5958
 \cs_generate_variant_aux:N
 1597, 1609, 1613, 1623, 1630, 1631
 \cs_generate_variant_aux:nnNn
 1597, 1599, 1601
 \cs_generate_variant_aux:nnw
 1597, 1602, 1604, 1628
 \cs_get_arg_count_from_signature:c
 1294, 1381
 \cs_get_arg_count_from_signature:N
 23, 899, 905, 912,
 919, 1278, 1278, 1295, 1342, 5846, 5856
 \cs_get_arg_count_from_signature_aux:nnN
 1278, 1279, 1281
 \cs_get_arg_count_from_signature_auxii:w
 1278, 1288, 1293
 \cs_get_function_name:N 23, 1031, 1031
 \cs_get_function_signature:N
 23, 1031, 1034
 \cs_gnew:cn 17, 1400
 \cs_gnew:cpn 15, 1193, 1199
 \cs_gnew:cpx 15, 1193, 1200
 \cs_gnew:cx 17, 1400
 \cs_gnew:Nn 17, 1361
 \cs_gnew:Npn 15, 1174, 1176,
 1199, 5571, 5574, 5577, 5578, 5586
 \cs_gnew:Npx 15, 1174, 1177, 1200
 \cs_gnew:Nx 17, 1361
 \cs_gnew_eq:cc 21, 1244, 1250
 \cs_gnew_eq:cN 21, 1244, 1248
 \cs_gnew_eq:Nc 21, 1244, 1249
 \cs_gnew_eq:NN
 21, 1244, 1244, 1248–1250, 2269
 \cs_gnew_nopar:cn 17, 1400
 \cs_gnew_nopar:cpn 16, 1182, 1191
 \cs_gnew_nopar:cpx 16, 1182, 1192
 \cs_gnew_nopar:cx 17, 1400
 \cs_gnew_nopar:Nn 17, 1361
 \cs_gnew_nopar:Npn 16, 1174, 1174, 1191
 \cs_gnew_nopar:Npx 16, 1174, 1175, 1192
 \cs_gnew_nopar:Nx 17, 1361
 \cs_gnew_protected:cn 17, 1400
 \cs_gnew_protected:cpn 16, 1209, 1215
 \cs_gnew_protected:cpx 16, 1209, 1216
 \cs_gnew_protected:cx 17, 1400
 \cs_gnew_protected:Nn 17, 1361
 \cs_gnew_protected:Npn 16, 1174, 1180, 1215
 \cs_gnew_protected:Npx 16, 1174, 1181, 1216
 \cs_gnew_protected:Nx 17, 1361
 \cs_gnew_protected_nopar:cn 18, 1400
 \cs_gnew_protected_nopar:cpn
 16, 1201, 1207
 \cs_gnew_protected_nopar:cpx
 16, 1201, 1208
 \cs_gnew_protected_nopar:cx 18, 1400
 \cs_gnew_protected_nopar:Nn 18, 1361
 \cs_gnew_protected_nopar:Npn
 16, 1174, 1178, 1207
 \cs_gnew_protected_nopar:Npx
 16, 1174, 1179, 1208
 \cs_gnew_protected_nopar:Nx 18, 1361
 \cs_gset:cn 20, 1384
 \cs_gset:cpn 18, 1193,
 1195, 3843, 3852, 4531, 4543, 4759
 \cs_gset:cpx 18, 1193, 1196
 \cs_gset:cx 20, 1384
 \cs_gset:Nn 20, 1338
 \cs_gset:Npn 18, 814, 816, 1176, 1195, 1517
 \cs_gset:Npx 18, 814, 819, 1177, 1196
 \cs_gset:Nx 20, 1338
 \cs_gset_eq:cc
 21, 1240, 1243, 1848, 4243, 4414
 \cs_gset_eq:cN 21, 1240, 1242,
 1253, 1838, 1840, 1847, 4241, 4412
 \cs_gset_eq:Nc
 21, 1240, 1241, 1846, 4242, 4413
 \cs_gset_eq:NN
 21, 1240, 1240–1243, 1251, 1837,
 1839, 1845, 3498, 3504, 4240, 4411
 \cs_gset_nopar:cn 20, 1384
 \cs_gset_nopar:cpn 19, 1182, 1187, 1785
 \cs_gset_nopar:cpx 19, 1182, 1188
 \cs_gset_nopar:cx 20, 1384
 \cs_gset_nopar:Nn 20, 1338
 \cs_gset_nopar:Npn
 19, 814, 814, 817, 823,
 829, 1174, 1187, 2285, 3447, 3478, 3487

- \cs_gset_nopar:Npx 19, [814](#), 815, 820, 826,
832, 1175, 1188, 3453, 3481, 3488, 6447
- \cs_gset_nopar:Nx 20, [1338](#)
- \cs_gset_protected:cn 20, [1384](#)
- \cs_gset_protected:cpn .. 19, [1209](#), 1211
- \cs_gset_protected:cpx .. 19, [1209](#), 1212
- \cs_gset_protected:cx 20, [1384](#)
- \cs_gset_protected:Nn 20, [1338](#)
- \cs_gset_protected:Npn
..... 19, [814](#), 828, 1180, 1211
- \cs_gset_protected:Npx
..... 19, [814](#), 831, 1181, 1212
- \cs_gset_protected:Nx 20, [1338](#)
- \cs_gset_protected_nopar:cn ... 21, [1384](#)
- \cs_gset_protected_nopar:cpn
..... 19, [1201](#), 1203
- \cs_gset_protected_nopar:cpx
..... 19, [1201](#), 1204
- \cs_gset_protected_nopar:cx ... 21, [1384](#)
- \cs_gset_protected_nopar:Nn ... 21, [1338](#)
- \cs_gset_protected_nopar:Npn
..... 19, [814](#), 822, 1178, 1203
- \cs_gset_protected_nopar:Npx
..... 19, [814](#), 825, 1179, 1204
- \cs_gset_protected_nopar:Nx ... 21, [1338](#)
- \cs_gundefine:c 21, [1251](#), 1252
- \cs_gundefine:N 21, [1251](#), 1251
- \cs_if_do_not_use_aux:nnN [1063](#), 1064, 1066
- \cs_if_do_not_use_p:N 10, [1063](#), 1063, 1076
- \cs_if_eq:ccF 1431
- \cs_if_eq:ccT 1430
- \cs_if_eq:ccTF 9, [1416](#), 1429
- \cs_if_eq:cNF 1423
- \cs_if_eq:cNT 1422
- \cs_if_eq:cNTF 9, [1416](#), 1421
- \cs_if_eq:NcF 1427
- \cs_if_eq:NcT 1426
- \cs_if_eq:NcTF 9, [1416](#), 1425
- \cs_if_eq:NN 1416
- \cs_if_eq:NNF 1423, 1427, 1431
- \cs_if_eq:NNT 1422, 1426, 1430
- \cs_if_eq:NNTF . 9, [1416](#), 1421, 1425, 1429
- \cs_if_eq_name:NN 1142
- \cs_if_eq_name_p:NN 9, [1142](#)
- \cs_if_eq_p:cc 9, [1416](#), 1428
- \cs_if_eq_p:cN 9, [1416](#), 1420
- \cs_if_eq_p:Nc 9, [1416](#), 1424
- \cs_if_eq_p:NN . 9, [1416](#), 1420, 1424, 1428
- \cs_if_exist:c 1048
- \cs_if_exist:cF 3722, 6042
- \cs_if_exist:cT 5148, 5243, 6000
- \cs_if_exist:cTF 10, [1037](#), 2115, 2138,
5078, 5085, 5141, 5236, 5454, 5891
- \cs_if_exist:N 1037
- \cs_if_exist:Nf 1126, 5758, 6053
- \cs_if_exist:NT 6673, 6707
- \cs_if_exist:NTF 10, [1037](#), 2354, 5836, 5877
- \cs_if_exist_p:c 10, [1037](#)
- \cs_if_exist_p:N 10, [1037](#), 1070, 3515, 3527
- \cs_if_free:cF 1087
- \cs_if_free:cT 1086, 1634
- \cs_if_free:cTF
..... 9, [1069](#), 1085, 1608, 5473, 6624
- \cs_if_free:N 1069
- \cs_if_free:Nf 1087, 1111
- \cs_if_free:NT 1086, 6091
- \cs_if_free:NTF 9, [1069](#), 1085, 1474, 4804
- \cs_if_free_p:c 9, [1069](#), 1084
- \cs_if_free_p:N 9, [1069](#), 1084
- \cs_meaning:c 11, [777](#), 783
- \cs_meaning:N 11, [777](#), 782, 783
- \cs_new:cn 16, [1400](#), 5939
- \cs_new:cpn 15,
1193, 1197, 1731–1734, 1736, 1738,
1740, 1742, 1744, 1746, 1748–1757
- \cs_new:cpx 15, [1193](#), 1198, 1635
- \cs_new:cx 16, [1400](#)
- \cs_new:Nn
. 16, [1361](#), 4359, 4364, 4578, 4583,
4600, 4610, 4824, 4955, 4959, 4978,
5012, 5068, 5113, 5777, 5792, 5797,
5807, 5811, 5828, 5832, 5843, 5902,
5945, 5963, 5967, 5997, 6715, 6721
- \cs_new:Npn .. 15, 880, 904, [1160](#), 1168,
1197, 1448, 1451, 1454, 1455, 1458,
1461, 1464, 1467, 1475, 1480, 1485,
1493, 1520, 1521, 1523, 1526, 1527,
1529, 1531, 1534, 1583, 1584, 1587,
1590, 1593, 1596, 1597, 1633, 1639,
1646, 1647, 1651, 1654, 1658, 1670,
1676, 1758, 1764, 1773, 1783, 1793,
1801, 1809, 1815, 1823, 1858, 1862,
1866, 1870, 1916, 1917, 1922, 1923,
1931, 1934, 1937, 1940, 1943, 1947,
1953, 1957, 1963, 1967, 1973, 1977,
1983, 2080, 2086, 2092, 2101, 2110,
2535, 2543, 2546, 2549, 2558, 2561,
2590, 3070, 3071, 3442, 3450, 3470,
3474, 3477, 3480, 3485–3488, 3535,
3540, 3543, 3548, 3552, 3557, 3560,
3565, 3572, 3577, 3582, 3585, 3590,
3593, 3656, 3668, 3671, 3674, 3677,
3680, 3683, 3686, 3689, 3692, 3695,
3698, 3701, 3704, 3829, 3836, 3841,
3850, 3861, 3866, 3872, 3875, 3883,
3894, 3895, 3905, 3921, 3931, 3939,
3970, 4011, 4012, 4015, 4018, 4023,

- 4025, 4027, 4031, 4032, 4044, 4086,
 4089, 4092, 4093, 4153, 4157, 4168,
 4174, 4184, 4224, 4225, 4270, 4274,
 4278, 4300, 4303, 4304, 4308, 4311,
 4320, 4332, 4338, 4415, 4422, 4423,
 4459, 4461, 4465, 4470, 4488, 4516,
 4521, 4528, 4540, 4551, 4559, 4669,
 4675, 4678, 4680, 4682, 4684, 4686,
 4692, 4698, 4704, 4714, 4716, 4718,
 4725, 4727, 4968, 5308, 5347–5350,
 5373, 5377, 5389, 5390, 5399, 5403,
 5419, 5420, 5601, 5602, 5613, 5631,
 5632, 5648, 5652, 5653, 5679, 5693,
 5694, 5732, 5996, 6187, 6415, 6460,
 6512, 6531, 6534, 6539, 6542, 6545,
 6548, 6551, 6555, 6559, 6563, 6567
 \cs_new:Npx 15, 1160, 1169, 1198
 \cs_new:Nx 16, 1361
 \cs_new_eq:cc 21, 925, 1233, 1239
 \cs_new_eq:cN 21, 1233, 1237, 1832
 \cs_new_eq:Nc 21, 1233, 1238
 \cs_new_eq:NN 21, 1233,
 1233, 1237–1239, 1256, 1258, 1265,
 1267, 1473, 1831, 1841–1848, 2175,
 2221, 2237, 2247, 2257, 2270, 2271,
 2692–2694, 2782, 2784, 3036, 3037,
 3058, 3060, 3066–3069, 3311, 3314,
 3317, 3319, 3387, 3389, 3397, 3398,
 3400, 3434, 3503, 3504, 3522, 3533,
 3667, 3822–3824, 3871, 4024, 4029,
 4030, 4078, 4085, 4099, 4114, 4115,
 4140, 4226–4243, 4283, 4284, 4344,
 4345, 4375–4378, 4381, 4385, 4386,
 4397, 4399, 4401, 4403, 4405, 4407–
 4414, 4471, 4472, 4526, 4611–4614,
 4617–4619, 4623, 4624, 4636–4651,
 4766, 4791–4794, 4838, 5314–5316,
 5342, 5355–5357, 5361, 5363, 5368,
 5385, 5388, 5394, 5396, 5413, 5418,
 5421, 5423, 6554, 6558, 6562, 6566
 \cs_new_nopar:cn 17, 1400
 \cs_new_nopar:cpn 15, 1182, 1189, 1897–1902
 \cs_new_nopar:cpx 15, 1182, 1190, 1612, 2604
 \cs_new_nopar:cx 17, 1400
 \cs_new_nopar:Nn
 . 17, 1361, 4909, 4912, 4918–4922,
 5056, 5091–5093, 5102, 5180, 5183,
 5186, 5207, 5733, 5745, 5756, 5763,
 5768, 5791, 5802, 5824, 5865, 5870,
 5875, 5910, 5916, 5924, 5938, 5942,
 5959, 5981, 5993, 6007, 6016, 6029,
 6041, 6662, 6686, 6687, 6697, 6714,
 6727, 6738, 6742, 6745, 6748, 6754
 \cs_new_nopar:Npn
 15, 1160, 1166, 1183, 1189, 1237–
 1239, 1241–1243, 1248–1252, 1277,
 1420–1431, 1447, 1472, 1664–1667,
 1673, 1705, 1707, 1708, 1718, 1724,
 1727, 1730, 1831–1840, 1892, 1896,
 1984, 2072, 2176, 2179, 2180, 2183,
 2186, 2189–2220, 2222, 2226, 2229,
 2230, 2233, 2234, 2238, 2241, 2242,
 2244, 2245, 2248, 2251, 2252, 2254,
 2255, 2258, 2261, 2262, 2265, 2266,
 2269, 2346, 2376, 2383, 2394, 2405,
 2416, 2427, 2434, 2441, 2448, 2462,
 2465, 2471, 2477, 2503, 2527, 2528,
 2533, 2568, 2575, 2582, 2598, 2603,
 2672, 2675, 2697, 2698, 2701, 2707,
 2712, 2720, 2725, 2730, 2736, 2750,
 2752, 2754, 2760, 2766, 2772, 2783,
 2785–2787, 2799, 2803, 2807, 2821,
 2830, 2839, 2843, 2847, 2858, 2871,
 2894, 2936, 2939, 2942, 2945, 2974,
 3007, 3010, 3046, 3047, 3050, 3052,
 3056, 3062, 3064, 3243, 3244, 3247,
 3253, 3259, 3268, 3274, 3283, 3290,
 3296, 3304, 3313, 3316, 3320, 3321,
 3345, 3359, 3360, 3363, 3369, 3371,
 3373, 3375, 3377, 3381, 3383, 3385,
 3390, 3399, 3405, 3408, 3411, 3414,
 3419, 3420, 3423, 3428–3433, 3455–
 3457, 3466, 3493, 3497, 3508, 3510,
 3513, 3525, 3609, 3615, 3825, 3827,
 3832, 3864, 3880, 3889, 3985, 3987,
 4005, 4008, 4073, 4074, 4081, 4098,
 4102, 4107, 4119, 4123, 4130, 4133,
 4142, 4147, 4161, 4244, 4250, 4266,
 4285, 4346, 4352, 4369, 4372, 4379,
 4382, 4426, 4446, 4455, 4473, 4493,
 4497, 4501, 4505, 4509, 4557, 4564,
 4573, 4574, 4588, 4591, 4594, 4597,
 4615, 4621, 4652, 4738, 4757, 4779,
 4785, 4790, 4795, 4796, 4800, 4802,
 4803, 4807, 4810, 4813, 4818, 4822,
 4823, 4830, 4834, 4842, 4846, 4923,
 4927, 4931, 4935, 4940, 4945, 4950,
 5033, 5036, 5039, 5042, 5045, 5048,
 5051, 5189, 5192, 5195, 5198, 5201,
 5204, 5304, 5305, 5338, 5340, 5343,
 5345, 5351, 5353, 5372, 5375, 5381,
 5383, 5386, 5391, 5398, 5401, 5407,
 5409, 5414, 5437–5439, 5453, 5472,
 5562, 5565, 5695, 5699, 5703, 5897,
 5927, 6020, 6033, 6172, 6173, 6202,
 6205, 6208, 6211, 6214, 6217, 6220,
 6223, 6226, 6229, 6232, 6235, 6238,
 6241, 6244, 6247, 6250, 6253, 6256,

- 6260, 6264, 6268, 6272, 6276, 6280,
6293, 6298, 6299, 6303, 6307, 6326,
6342, 6358, 6364, 6365, 6367, 6376,
6385, 6393, 6402, 6411, 6413, 6475,
6476, 6522, 6524, 6526, 6569, 6623
\cs_new_nopar:Npx . . . 15, 1160, 1167, 1190
\cs_new_nopar:Nx 17, 1361
\cs_new_protected:cn 17, 1400, 5208, 5211
\cs_new_protected:cpn . . . 16, 1209, 1213
\cs_new_protected:cpx . . . 16, 1209, 1214
\cs_new_protected:cx 17, 1400
\cs_new_protected:Nn
17, 1361, 4992, 5019, 5026, 5215, 5227
\cs_new_protected:Npn
. 16, 892, 918, 1160,
1172, 1213, 1233, 1240, 1244, 6483
\cs_new_protected:Npx 16, 1160, 1173, 1214
\cs_new_protected:Nx 17, 1361
\cs_new_protected_nopar:cn 17, 1400
\cs_new_protected_nopar:cpn
. 16, 1201, 1205
\cs_new_protected_nopar:cpx
. 16, 1201, 1206
\cs_new_protected_nopar:cx 17, 1400
\cs_new_protected_nopar:Nn 17, 1361
\cs_new_protected_nopar:Npn
. 16, 1160, 1170,
1205, 2225, 5249, 5253, 5467, 6461
\cs_new_protected_nopar:Npx
. 16, 1160, 1171, 1206
\cs_new_protected_nopar:Nx 17, 1361
\cs_record_meaning:N 14, 1107, 1108, 1119
\cs_set:cn 20, 1384,
4956, 4960, 4964, 4969, 4973, 4982
\cs_set:cpn 18, 1193, 1193,
1885, 1888, 1891, 1903, 1904, 3108,
3112, 3116, 3120, 3124, 3128, 3132
\cs_set:cpx 18, 1193,
1194, 1985, 1989, 1993, 1997, 2001,
2010, 2019, 2028, 2037, 2039, 2041,
2043, 2045, 2047, 2049, 2051, 2053
\cs_set:cx 20, 1384
\cs_set:Nn
20, 1338, 4602, 5069, 5073, 6089, 6092
\cs_set:Npn 18, 794,
796, 834–871, 874, 877, 883, 889,
895, 898, 901, 908, 915, 921, 924,
927–929, 934, 941, 946, 951, 956,
961, 966, 971, 976, 981, 984, 995–
998, 1008, 1014, 1018, 1027, 1031,
1034, 1063, 1066, 1108, 1157, 1160,
1168, 1182, 1193, 1278, 1281, 1293,
1297, 1329, 1338, 1377, 1525, 1601,
1604, 1630, 1874, 1878, 1905, 1908,
1913, 2060, 2061, 3091, 3098, 3102,
3141, 3148, 3158, 3168, 3171, 3195,
3196, 3210, 3213, 3216, 3219, 3222,
3225, 3228, 3231, 3598, 3602, 3915,
3949, 3958, 3971, 3975, 3989, 3991,
4257, 4347, 4353, 4416, 4437, 4670,
4748, 4999, 5021, 5028, 5620, 5795
\cs_set:Npx . 18, 794, 799, 1169, 1194, 5800
\cs_set:Nx 20, 1338
\cs_set_eq:cc
21, 922, 1229, 1232, 1844, 4239, 4410
\cs_set_eq:cN
. 21, 1229, 1230, 1834, 1836, 1843,
4237, 4408, 4962, 4971, 4980, 5943
\cs_set_eq:Nc
. 21, 1229, 1231, 1842, 4238, 4409,
5819, 5821, 5834, 5876, 5953, 5955
\cs_set_eq:NN 21, 1229, 1229–1232, 1235,
1240, 1246, 1833, 1835, 1841, 2536,
2550, 2566, 2606, 2678, 3085, 3086,
3088–3090, 3336, 3337, 3468, 3494,
3503, 4076, 4236, 4349, 4355, 4407,
4782, 4816, 4832, 4833, 4994, 4995,
5022, 5029, 5365, 5367, 5515, 5696,
5700, 5704, 5813, 5814, 5947, 5948,
6188, 6189, 6192, 6193, 6308–6314,
6316, 6328, 6331, 6334, 6344, 6347,
6350, 6388, 6389, 6422–6424, 6429–
6432, 6537, 6538, 6570–6575, 6614,
6626–6628, 6632–6634, 6674, 6708
\cs_set_eq:NwN
. . . . 21, 749, 755–782, 784, 787–
795, 814, 815, 1089, 1229, 1443–1445
\cs_set_nopar:cn 20, 1384
\cs_set_nopar:cpn 18, 1182, 1185, 1217–
1225, 1227, 2788, 2789, 5446, 6636
\cs_set_nopar:cpx 18, 1182, 1186
\cs_set_nopar:cx 20, 1384
\cs_set_nopar:Nn 20, 1338, 5780, 6664, 6698
\cs_set_nopar:Npn 18, 738, 794, 794, 796,
797, 799, 802, 803, 805, 809, 1001,
1084–1087, 1097, 1100, 1103, 1110,
1125, 1132, 1136, 1153, 1166, 1185,
1230–1232, 1294, 1326, 1501, 1511,
1536–1543, 1545–1552, 1554–1556,
1558, 1560–1562, 1564–1567, 1569–
1572, 1574–1579, 1581, 1582, 1818,
1826, 2742–2745, 2811, 2889, 2891,
2962, 2989, 3001, 3018, 3038–3041,
3471, 3485, 3707, 4560, 4689, 4708,
4719, 4721, 4744, 4799, 4801, 4997,
5462, 5478, 5496, 5497, 5506, 5507,
5510, 5513, 6336, 6352, 6419, 6425

- \cs_set_nopar:Npx [18](#), [794](#), [795](#), [800](#), [806](#),
[812](#), [1167](#), [1186](#), [1476](#), [3475](#), [3486](#), [5479](#)
 - \cs_set_nopar:Nx [20](#), [1338](#)
 - \cs_set_protected:cn
..... [20](#), [1384](#), [5058](#), [5061](#), [5064](#)
 - \cs_set_protected:cpn ... [19](#), [1209](#), [1209](#)
 - \cs_set_protected:cpx
..... [19](#), [1209](#), [1210](#), [1339](#), [1378](#)
 - \cs_set_protected:cx [20](#), [1384](#)
 - \cs_set_protected:Nn [20](#), [1338](#), [5286](#)
 - \cs_set_protected:Npn
[19](#), [794](#), [808](#), [886](#), [911](#), [1172](#), [1209](#),
[1229](#), [3087](#), [5466](#), [6420](#), [6438](#), [6477](#)
 - \cs_set_protected:Npx
..... [19](#), [794](#), [811](#), [1173](#), [1210](#)
 - \cs_set_protected:Nx [20](#), [1338](#)
 - \cs_set_protected_nopar:cn [20](#), [1384](#)
 - \cs_set_protected_nopar:cpn
..... [19](#), [1201](#), [1201](#), [5443](#)
 - \cs_set_protected_nopar:cpx
..... [19](#), [1201](#), [1202](#)
 - \cs_set_protected_nopar:cx [20](#), [1384](#)
 - \cs_set_protected_nopar:Nn [20](#), [1338](#)
 - \cs_set_protected_nopar:Npn
..... [19](#), [794](#), [802](#), [808](#), [811](#), [816](#),
[819](#), [822](#), [825](#), [828](#), [831](#), [1161](#), [1170](#),
[1201](#), [6576–6579](#), [6585](#), [6590](#), [6605](#)
 - \cs_set_protected_nopar:Npx
..... [19](#), [794](#), [805](#), [1171](#), [1202](#)
 - \cs_set_protected_nopar:Nx [20](#), [1338](#)
 - \cs_show:c [11](#), [777](#), [785](#), [3069](#), [5994](#)
 - \cs_show:N .. [11](#), [777](#), [784](#), [785](#), [3068](#), [3466](#)
 - \cs_split_function:NN
..... [23](#), [873](#), [879](#), [885](#), [891](#),
[897](#), [903](#), [910](#), [917](#), [989](#), [991](#), [1009](#),
[1014](#), [1032](#), [1035](#), [1064](#), [1279](#), [1599](#)
 - \cs_split_function_aux:w [1009](#), [1015](#), [1018](#)
 - \cs_split_function_auxii:w
..... [1009](#), [1025](#), [1027](#)
 - \cs_str_aux:w [1002](#), [1008](#)
 - \cs_tmp:w [1160](#), [1166–1182](#), [1185–](#)
[1216](#), [1338](#), [1345–1377](#), [1384–1415](#)
 - \cs_to_str:N [4](#),
[22](#), [1001](#), [1001](#), [1016](#), [4824–4827](#), [6018](#)
 - \cs_to_str_aux:w [1001](#)
 - \csname [11](#), [158](#)
 - \currentgrouplevel [410](#)
 - \currentgrouptype [411](#)
 - \currentifbranch [407](#)
 - \currentiflevel [406](#)
 - \currentifttype [408](#)
- D**
- \d [2366](#)
 - \dagger [2861](#), [2867](#)
 - \day [366](#)
 - \ddagger [2862](#), [2868](#)
 - \deadcycles [300](#)
 - \DeclareOption [48](#), [51](#)
 - \def [3–6](#), [24](#), [43](#), [49](#), [52](#), [57](#), [65](#)
 - \def_long_test_function_new:nnpn .. [4051](#)
 - .default:n [113](#)
 - .default:V [113](#)
 - \default@ds [708](#)
 - \defaultthyphenchar [350](#)
 - \defaultskewchar [351](#)
 - \DefineCrossReferences [5497](#), [5503](#)
 - \delcode [381](#)
 - \delimiter [175](#)
 - \delimiterfactor [224](#)
 - \delimitershortfall [223](#)
 - \depthof [120](#), [6570](#), [6570](#)
 - \detokenize [398](#)
 - \dim_add:cn [63](#), [3377](#)
 - \dim_add:Nc [63](#), [3377](#)
 - \dim_add:Nn [63](#), [3377](#), [3377](#), [3380](#), [3381](#), [6227](#)
 - \dim_compare:nNn [3401](#)
 - \dim_compare:nNnF [3409](#), [3415](#)
 - \dim_compare:nNnTF [3406](#), [3412](#)
 - \dim_compare_p:nNn [64](#), [3401](#)
 - \dim_do_until:nNnn .. [64](#), [3405](#), [3414](#), [3415](#)
 - \dim_do_while:nNnn .. [64](#), [3405](#), [3411](#), [3412](#)
 - \dim_eval:n [63](#),
[1954](#), [3369](#), [3378](#), [3399](#), [3399](#), [3402](#),
[5347–5350](#), [5389](#), [5404](#), [6470](#), [6471](#)
 - \dim_gadd:cn [63](#), [3377](#)
 - \dim_gadd:Nn ... [63](#), [3377](#), [3381](#), [3382](#), [6230](#)
 - \dim_gset:cc [62](#), [3369](#)
 - \dim_gset:cn [62](#), [3369](#)
 - \dim_gset:Nc [62](#), [3369](#)
 - \dim_gset:Nn [62](#), [3369](#), [3371](#), [3372](#), [6224](#), [6427](#)
 - \dim_gsub:cn [63](#), [3383](#)
 - \dim_gsub:Nn ... [63](#), [3383](#), [3385](#), [3386](#), [6236](#)
 - \dim_gzero:c [62](#), [3373](#)
 - \dim_gzero:N [62](#), [3373](#), [3375](#), [3376](#)
 - \dim_new:c [62](#), [3357](#)
 - \dim_new:N [62](#), [3357](#), [3359](#),
[3363](#), [3368](#), [3391–3396](#), [6178–6180](#)
 - \dim_new_l:N [3360](#)
 - \dim_set:cn [62](#), [3369](#)
 - \dim_set:Nc [62](#), [3369](#)
 - \dim_set:Nn ... [62](#), [3369](#), [3369–3371](#), [6221](#)
 - \dim_show:c [63](#), [3389](#), [3390](#)
 - \dim_show:N [63](#), [3389](#), [3389](#), [3390](#)
 - \dim_sub:cn [63](#), [3383](#)
 - \dim_sub:Nc [63](#), [3383](#)
 - \dim_sub:Nn [63](#), [3383](#), [3383–3385](#), [6233](#)

- `\dim_until_do:nNnn` .. 64, 3405, 3408, 3409
- `\dim_use:c` 63, 3387
- `\dim_use:N` 63, 1954, 3387, 3387, 3388
- `\dim_while_do:nNnn` .. 64, 3405, 3405, 3406
- `\dim_zero:c` 62, 3373
- `\dim_zero:N` 62, 3373, 3373–3375
- `\dimen` 372
- `\dimendef` 71
- `\dimexpr` 425
- `\directlua` 554
- `\discretionary` 235
- `\displayindent` 200
- `\displaylimits` 210
- `\displaystyle` 188
- `\displaywidowpenalties` 438
- `\displaywidowpenalty` 199
- `\displaywidth` 201
- `\divide` 78
- `\documentclass` 5493
- `\doublehyphendemerits` 268
- `\dp` 379
- `\ds@` 709
- `\dump` 362
-
- E**
- `\E` 2368
- `\edef` 22, 66
- `\efcode` 463
- `\else` 12, 119
- `\else:` 8, 742, 756, 759, 856, 943,
948, 953, 963, 968, 973, 1003, 1021,
1040, 1043, 1051, 1057, 1072, 1078,
1138, 1139, 1141, 1158, 1257, 1262,
1266, 1271, 1275, 1284, 1318, 1418,
1506, 1691, 1695, 1699, 1703, 1852,
1881, 1929, 2096, 2104, 2113, 2121,
2131, 2136, 2143, 2153, 2289, 2293,
2297, 2301, 2305, 2309, 2313, 2317,
2321, 2325, 2329, 2333, 2337, 2341,
2348, 2352, 2356, 2389, 2400, 2411,
2422, 2488, 2491, 2495, 2498, 2505,
2507, 2509, 2511, 2513, 2515, 2571,
2578, 2593, 2999, 3100, 3110, 3114,
3118, 3122, 3126, 3130, 3134, 3139,
3153, 3163, 3175, 3180, 3183, 3186,
3204, 3208, 3403, 3461, 3517, 3529,
3628, 3635, 3643, 3657, 3713, 3727,
3734, 3741, 3748, 3755, 3762, 3769,
3776, 3783, 3790, 3797, 3804, 3811,
3818, 4037, 4042, 4047, 4060, 4259,
4439, 4450, 4840, 5318, 5321, 5332,
6283, 6285, 6287, 6308–6313, 6315,
6329, 6332, 6335, 6345, 6348, 6351,
6443, 6490, 6496, 6502, 6503, 6508
- `\emergencystretch` 283
- `\end` 157, 5540
- `\endcsname` 11, 159
- `\endgroup` 13, 17, 92
- `\endinput` 18, 131
- `\endL` 446
- `\endlinechar` 29, 37, 173
- `\endR` 448
- `\eqno` 193
- `\errhelp` 14, 139
- `\errmessage` 15, 133
- `\erroneous` 1518
- `\ERROR` ... 2060, 2061, 4224, 4225, 4349,
4355, 5631, 5645, 5690, 5693, 5694
- `\errorcontextlines` 140
- `\errorstopmode` 154
- `\escapechar` 172
- `\etex_beginL:D` 445
- `\etex_beginR:D` 447
- `\etex_botmarks:D` 394
- `\etex_clubpenalties:D` 436
- `\etex_currentgrouplevel:D` 410
- `\etex_currentgrouptype:D` 411, 1709
- `\etex_currentifbranch:D` 407
- `\etex_currentiflevel:D` 406
- `\etex_currentiftype:D` 408
- `\etex_detokenize:D` 398, 3824
- `\etex_dimexpr:D` 425, 3399,
6371, 6380, 6397, 6406, 6454, 6466
- `\etex_displaywidowpenalties:D` 438
- `\etex_endL:D` 446
- `\etex_endR:D` 448
- `\etex_eTeXrevision:D` 390
- `\etex_eTeXversion:D` 389
- `\etex_everyeof:D` 450, 3907, 3923, 3933, 3941
- `\etex_firstmarks:D` 393
- `\etex_fontchardp:D` 418
- `\etex_fontcharht:D` 417
- `\etex_fontcharic:D` 420
- `\etex_fontcharwd:D` 419
- `\etex_glueexpr:D` 426, 3321,
6372, 6381, 6398, 6407, 6455, 6467
- `\etex_glueshrink:D` 429, 3354
- `\etex_glueshrinkorder:D` 431, 3342
- `\etex_gluestretch:D` 428, 3353
- `\etex_gluestretchorder:D` 430, 3341
- `\etex_gluetomu:D` 432
- `\etex_ifcsname:D` 387, 773
- `\etex_ifdefined:D` 386, 555, 556, 772
- `\etex_iffontchar:D` 416
- `\etex_interactionmode:D` 414
- `\etex_interlinepenalties:D` 435
- `\etex_lastlinefit:D` 434
- `\etex_lastnodetype:D` 415, 1711, 1713

- `\etex_marks:D` 391
- `\etex_middle:D` 439
- `\etex_muexpr:D` . 427, 3428, 3430, 3432, 6373, 6382, 6399, 6408, 6456, 6468
- `\etex_mutogluue:D` 433, 6444, 6445
- `\etex_numexpr:D` 424, 1298, 1332, 3086, 6370, 6379, 6396, 6405, 6453, 6465
- `\etex_pagediscards:D` 442
- `\etex_parshapedimen:D` 423
- `\etex_parshapeindent:D` 421
- `\etex_parshapelength:D` 422
- `\etex_predisplaydirection:D` 449
- `\etex_protected:D` 451, 793
- `\etex_readline:D` 401
- `\etex_savinghyphcodes:D` 440
- `\etex_savingvdiscards:D` 441
- `\etex_scantokens:D` 399, 3910, 3926, 3936, 3944
- `\etex_showgroups:D` 412
- `\etex_showifs:D` 413
- `\etex_showtokens:D` 400, 3468
- `\etex_splitbotmarks:D` 396
- `\etex_splitdiscards:D` 443
- `\etex_splitfirstmarks:D` 395
- `\etex_TeXETstate:D` 444
- `\etex_topmarks:D` 392
- `\etex_tracingassigns:D` 402
- `\etex_tracinggroups:D` 409
- `\etex_tracingifs:D` 405
- `\etex_tracingnesting:D` 404
- `\etex_tracingscantokens:D` 403
- `\etex_unexpanded:D` 397, 564, 661, 665, 668, 776, 1445
- `\etex_unless:D` 388, 761
- `\etex_widowpenalties:D` 437
- `\etexmissingerror` 5, 15, 16
- `\etexmissinghelp` 6, 14, 16
- `\eTeXrevision` 390
- `\eTeXversion` 389
- `\everycr` 101
- `\everydisplay` 202
- `\everyeof` 450
- `\everyhbox` 341
- `\everyjob` 370
- `\everymath` 226
- `\everypar` 289
- `\everyvbox` 342
- `\ExecuteOptions` 53
- `\exhyphenpenalty` 265
- `\exp_after:cc` 5462
- `\exp_after:wN` 13, 166, 774, 774, 868–870, 936, 943, 948, 953, 958, 963, 968, 973, 978, 986, 1002, 1004, 1006, 1015, 1020, 1022, 1050, 1052, 1055, 1067, 1071, 1073, 1143–1148, 1154, 1283, 1285, 1288, 1341, 1380, 1442, 1443, 1462, 1465, 1468, 1469, 1477, 1481, 1482, 1486, 1487, 1494, 1495, 1502, 1507, 1509, 1512, 1520–1527, 1529–1532, 1534, 1535, 1583, 1585, 1588, 1591, 1594, 1596, 1606, 1631, 1642, 1648, 1649, 1652, 1655, 1656, 1659, 1660, 1671, 1677, 1720, 1886, 1889, 1891, 1893, 2081, 2083, 2088, 2093, 2095, 2097, 2103, 2105, 2304, 2344, 2355, 2373, 2380, 2390, 2401, 2412, 2423, 2431, 2438, 2445, 2467, 2473, 2479, 2570, 2572, 2577, 2579, 2588, 2592, 2594, 2800, 2804, 2991–2999, 3095, 3099, 3462, 3642, 3654, 3681, 3687, 3693, 3699, 3705, 3825, 3833, 3834, 3910, 3915–3918, 3944, 3952, 3982, 4001, 4036, 4040, 4045, 4058, 4087, 4090, 4092, 4094, 4143, 4154, 4158, 4169, 4170, 4175, 4176, 4185, 4186, 4261, 4268, 4276, 4301, 4340, 4451, 4457, 4463, 4511, 4512, 4673, 4745, 4746, 4750, 5456, 5463, 5464, 5583, 5595, 5638, 5639, 5656, 5657, 5667, 5672, 5883, 6030, 6195, 6197, 6282
- `\exp_arg:x` 27, 1473, 1473, 1474, 1482
- `\exp_arg_last_unbraced:nn` 1646, 1646, 1648, 1652, 1655, 1659
- `\exp_arg_next:nnn` 1448, 1448, 1465, 1468, 1477, 1481, 1486, 1494
- `\exp_arg_next_nobrace:nnn` 1448, 1451, 1462
- `\exp_args:cc` 27, 1525, 1526
- `\exp_args:Nc` 27, 783, 785, 786, 868, 868, 942, 947, 952, 957, 1084–1087, 1132, 1183, 1230, 1237, 1242, 1248, 1295, 1327, 1420–1423, 1525, 1525, 2785, 3845, 4545, 4924, 4928, 4932, 5052, 5846, 5856, 6587, 6597
- `\exp_args:Ncc` 28, 1232, 1239, 1243, 1250, 1428–1431, 1525, 1529
- `\exp_args:Nccc` 29, 1525, 1531
- `\exp_args:Ncco` 29, 1562, 1576, 1577
- `\exp_args:Nccx` 29, 1562, 1578
- `\exp_args:Ncf` .. 28, 1540, 1548, 1787, 1788
- `\exp_args:NcNc` 29, 1562, 1574, 5456
- `\exp_args:NcNo` 29, 1562, 1575
- `\exp_args:Ncnx` 29, 1562, 1579
- `\exp_args:Nco` 28, 1534, 1534, 1540
- `\exp_args:Ncx` 28, 1540, 1545
- `\exp_args:Nf` 28, 1536, 1536, 1760, 1761, 1768,

- 1777, 1811, 1812, 1819, 1827, 1944,
2814, 2817, 2819, 2890, 3004, 3013
- \exp_args:Nff 28, 1540, 1547, 2892
- \exp_args:Nfo 28, 1540, 1546
- \exp_args:NNc 28, 989, 991, 1231, 1238,
1241, 1249, 1424–1427, 1525, 1527
- \exp_args:NNf .. 28, 1540, 1540, 1797, 1805
- \exp_args:Nnf
... 28, 896, 902, 909, 916, 1540, 1549
- \exp_args:Nnnc 29, 1562, 1569
- \exp_args:NNNo 29, 1520, 1523
- \exp_args:NNno 29, 1562, 1564
- \exp_args:Nnno 29, 1562, 1570
- \exp_args:NNNV . 29, 1562, 1562, 3911, 3927
- \exp_args:NNnx 29, 1562, 1565
- \exp_args:Nnnx 29, 1562, 1571
- \exp_args:NNo
... 28, 1520, 1521, 2127, 2149, 5594
- \exp_args:Nno 28, 1540, 1550
- \exp_args:NNoo 29, 1562, 1566
- \exp_args:NNox 29, 1562, 1567
- \exp_args:Nnox 29, 1562, 1572
- \exp_args:NNV 28, 1540, 1542
- \exp_args:NNv 28, 1540, 1541
- \exp_args:NnV 28, 1540, 1551
- \exp_args:NNx 28, 1540, 1543, 5480
- \exp_args:Nnx 28, 1540, 1552
- \exp_args:No
27, 1520, 1520, 1954, 3864, 4557, 6426
- \exp_args:Noc 28, 1540, 1554
- \exp_args:Noo 28, 1540, 1555
- \exp_args:Nooo 29, 1562, 1582
- \exp_args:Noox 29, 1562, 1581
- \exp_args:Nox 28, 1540, 1556
- \exp_args:NV ... 27, 1536, 1538, 3945, 5881
- \exp_args:Nv 27, 1536, 1537
- \exp_args:NVV 28, 1540, 1558
- \exp_args:Nx 27, 1536, 1539
- \exp_args:Nxo 28, 1540, 1560
- \exp_args:Nxx 28, 1540, 1561
- \exp_eval_error_msg:w 166, 1501, 1504, 1517
- \exp_eval_register:c
166, 1497, 1501, 1511, 1591, 1661, 4090
- \exp_eval_register:N 166, 1489, 1501,
1501, 1512, 1594, 1656, 4087, 4171
- \exp_last_unbraced:NcV
... 30, 1664, 1667, 3854, 4533
- \exp_last_unbraced:Nf 30, 1664, 1664, 6017
- \exp_last_unbraced:NNNo . 30, 1664, 1676
- \exp_last_unbraced:NNo
... 30, 1664, 1670, 4441, 5589
- \exp_last_unbraced:NNV
... 30, 1664, 1673, 4131, 5608
- \exp_last_unbraced:NV
... 30, 1664, 1665, 5610, 5617
- \exp_last_unbraced:Nv ... 30, 1664, 1666
- \exp_not:c 29, 1596, 1596, 1616, 1640,
1986, 1990, 1995, 1999, 2002, 2004–
2006, 2011, 2013–2015, 2020, 2022–
2024, 2029, 2031–2033, 2038, 2040,
2042, 2044, 2046, 2048, 2050, 2052,
2054–2056, 2608, 3709, 3712, 5442,
5448, 5735, 5747, 5751, 6047, 6057
- \exp_not:d 29, 1583, 1584
- \exp_not:f 29, 1583, 1587
- \exp_not:N ... 13, 29, 774, 775, 1340–
1342, 1379–1381, 1442, 1444, 1502,
1596, 1991, 1994, 1998, 2002, 2011,
2020, 2029, 2119, 2141, 2285, 2288,
2292, 2296, 2300, 2304, 2308, 2312,
2316, 2320, 2324, 2328, 2336, 2340,
2355, 2576, 2591, 3709, 3711, 3923,
3933, 4040, 4041, 4045, 4058, 4059,
5447, 5449, 5572, 5580, 5590, 5736,
5739, 5741, 5748, 5752, 5800, 5912,
6060, 6149, 6152, 6153, 6540, 6543,
6546, 6549, 6552, 6556, 6560, 6564
- \exp_not:n 13, 29,
774, 776, 1442, 1445, 1583, 1585,
1588, 1591, 1594, 1987, 2120, 2142,
2538, 2539, 2552, 2554, 2606, 2609,
3669, 3672, 3675, 3678, 3681, 3684,
3687, 3693, 3699, 3705, 3713, 3724,
3725, 3731, 3738, 3745, 3753, 3760,
3795, 4294, 4333, 4339, 4417, 4482,
4661, 4663, 4678, 4682, 4687, 4797,
4819, 5446, 5605, 5634, 5783, 5784,
6096, 6532, 6535, 6540, 6543, 6546,
6549, 6552, 6556, 6560, 6564, 6568
- \exp_not:o 29, 1583, 1583, 3739,
3759, 3773, 3774, 3787, 3809, 5654
- \exp_not:V 29,
1583, 1593, 3537, 3541, 3545, 3549,
3554, 3558, 3562, 3566, 3574, 3579,
3583, 3587, 3591, 3595, 3599, 3603,
3678, 3684, 3690, 3696, 3702, 3732,
3752, 3766, 3767, 3780, 3802, 4245
- \exp_not:v 29, 1583, 1590
- \exp_stop_f: 30, 1467, 1472, 1509, 3881, 6018
- \expandafter 11, 12, 14, 15, 89
- \expanded 1473
- \ExplSyntaxNamesOff 5, 586, 590
- \ExplSyntaxNamesOn 5, 586, 586, 5499
- \ExplSyntaxOff 3, 5, 22,
560, 563, 663, 670, 681, 698, 706, 5517
- \ExplSyntaxOn 3,
5, 560, 560, 654, 658, 679, 720, 5495

- `\ExplSyntaxPopStack` ... 124, 672, 676, 676
`\ExplSyntaxStack`
 124, 662, 669, 672, 676, 677, 684
`\ExplSyntaxStatus` 23, 24,
 124, 560, 561, 565, 566, 576, 585, 662
- F**
- `\F` 2363
`\fam` 81
`\fi` 12, 32, 120
`\fi:` 8, 744, 756, 760, 855–858,
 937, 943, 948, 953, 958, 963, 968,
 973, 978, 987, 1005, 1023, 1045,
 1046, 1053, 1059, 1074, 1080, 1140,
 1141, 1154, 1155, 1158, 1259, 1262,
 1268, 1271, 1275, 1286, 1323, 1418,
 1505, 1508, 1518, 1607, 1631, 1643,
 1691, 1695, 1699, 1703, 1706, 1707,
 1852, 1881, 1929, 2084, 2089, 2098,
 2106, 2113, 2122, 2132, 2136, 2144,
 2154, 2289, 2293, 2297, 2301, 2305,
 2309, 2313, 2317, 2321, 2325, 2329,
 2333, 2337, 2341, 2348, 2352, 2356,
 2392, 2403, 2414, 2425, 2490, 2497,
 2500, 2501, 2517–2522, 2573, 2580,
 2595, 2828, 2837, 2869, 2882, 3000,
 3100, 3105, 3110, 3114, 3118, 3122,
 3126, 3130, 3134, 3139, 3145, 3155,
 3165, 3182, 3188, 3189, 3191, 3204,
 3208, 3403, 3463, 3519, 3531, 3628,
 3635, 3643, 3657, 3713, 3728, 3735,
 3742, 3749, 3756, 3763, 3770, 3777,
 3784, 3791, 3798, 3805, 3812, 3819,
 4037, 4042, 4049, 4060, 4254, 4259,
 4430, 4439, 4452, 4751, 4840, 5318,
 5321, 5332, 6289–6291, 6318–6324,
 6337–6339, 6353–6355, 6373, 6382,
 6399, 6408, 6446, 6456, 6468, 6490,
 6496, 6502, 6508, 6509, 6601, 6619
`\file_add_path:nN`
 122, 6687, 6687, 6716, 6722
`\file_add_path_aux:n` 6687, 6698, 6712, 6714
`\file_add_path_search:n` 6687
`\file_add_path_search:nN` 6691, 6697
`\file_if_exist:n` 6653
`\file_if_exist:nTF` 122, 6653
`\file_if_exist_aux:n` 6653, 6664, 6678, 6686
`\file_if_exist_p:n` 122, 6653
`\file_if_exist_path:n` .. 6653, 6656, 6662
`\file_input:n` 122, 6715, 6715
`\file_input_no_check:n`
 123, 6718, 6727, 6727
`\file_input_no_check_no_record:n` ...
 123, 6724, 6738, 6738
`\file_input_no_record:n` 122, 6715, 6721
`\file_list:` 123, 6742, 6742
`\file_list:N` 6742, 6743, 6746, 6748
`\file_list_aux:n` 6751, 6754
`\file_list_full:` 123, 6742, 6745
`\fileauthor` 6, 594, 608, 623
`\filedate` 6, 594, 609, 636, 640,
 645, 648, 751, 1438, 1685, 2068,
 2171, 2688, 3032, 3081, 3237, 3438,
 4067, 4220, 4393, 4631, 4773, 4857,
 5297, 5431, 5544, 5713, 6167, 6643
`\filedescription` ... 6, 594, 605, 622,
 640, 648, 751, 1438, 1685, 2068,
 2171, 2688, 3032, 3081, 3237, 3438,
 4067, 4220, 4393, 4631, 4773, 4857,
 5297, 5431, 5544, 5713, 6167, 6643
`\filename` 6, 594, 606, 620,
 640, 648, 751, 1438, 1685, 2068,
 2171, 2688, 3032, 3081, 3237, 3438,
 4067, 4220, 4393, 4631, 4773, 4857,
 5297, 5431, 5544, 5713, 6167, 6643
`\filenameext` 6, 594, 610, 637, 644
`\filetimestamp` 6, 594, 611, 638, 646
`\fileversion` 6, 594, 607, 621,
 640, 648, 751, 1438, 1685, 2068,
 2171, 2688, 3032, 3081, 3237, 3438,
 4067, 4220, 4393, 4631, 4773, 4857,
 5297, 5431, 5544, 5713, 6167, 6643
`\finalhyphendemerits` 269
`\firstchoice@true` 6582
`\firstmark` 167
`\firstmarks` 393
`\firstoftwo` 3, 12
`\floatingpenalty` 314
`\font` 80
`\fontchardp` 418
`\fontcharht` 417
`\fontcharic` 420
`\fontcharwd` 419
`\fontdimen` 347
`\fontname` 171
`\frozen@everydisplay` 689
`\frozen@everymath` 688
`.function:N` 113
`\futurelet` 76
- G**
- `\G` 2368
`\g` 6012
`\g_box_allocation_seq` 5303
`\g_calc_A_dim`
 319, 6175, 6178, 6221, 6224, 6227, 6230

- \g_calc_A_int 319, 6175,
6175, 6203, 6206, 6209, 6212, 6215,
6218, 6233, 6236, 6388, 6400, 6409
 - \g_calc_A_muskip ... 319, 6175, 6184,
6257, 6261, 6265, 6269, 6273, 6277
 - \g_calc_A_register
319, 6171, 6172, 6188, 6198, 6298,
6301, 6304, 6305, 6360, 6374, 6383,
6388, 6427, 6488, 6494, 6500, 6506
 - \g_calc_A_skip 319, 6175, 6181,
6239, 6242, 6245, 6248, 6251, 6254
 - \g_clist_inline_level_int
..... 4527, 4530, 4531,
4534, 4536, 4542, 4543, 4546, 4548
 - \g_file_record_clist
... 123, 6647, 6647, 6728, 6743, 6761
 - \g_file_record_full_clist
123, 6647, 6648, 6735, 6739, 6746, 6762
 - \g_peek_token 48, 2524, 2525, 2529
 - \g_prg_inline_level_int
175, 1782, 1782, 1784, 1785, 1789, 1791
 - \g_prop_inline_level_num
94, 4756, 4756, 4758, 4759, 4762, 4763
 - \g_testa_tl 72, 3620, 3622
 - \g_testb_tl 72, 3620, 3623
 - \g_tl_inline_level_num
..... 72, 3841, 3842, 3843, 3846,
3848, 3851, 3852, 3855, 3857, 3860
 - \g_tmpa_bool 175, 1849, 1850
 - \g_tmpa_dim 64, 3391, 3395
 - \g_tmpa_int 53, 2884, 2887
 - \g_tmpa_num 56, 3072, 3075
 - \g_tmpa_skip 62, 3322, 3327
 - \g_tmpa_tl 72, 3618, 3618
 - \g_tmpa_toks 79, 4205, 4209
 - \g_tmpb_dim 64, 3391, 3396
 - \g_tmpb_int 53, 2884, 2888
 - \g_tmpb_num 56, 3072, 3076
 - \g_tmpb_skip 62, 3322, 3328
 - \g_tmpb_tl 72, 3618, 3619
 - \g_tmpb_toks 79, 4205, 4210
 - \g_tmpe_toks 79, 4205, 4211
 - \g_toks_allocation_seq 4206
 - \g_trace_statistics_status 737
 - \g_xref_all_curr_deferred_fields_prop
..... 295, 5435, 5436, 5483
 - \g_xref_all_curr_immediate_fields_prop
..... 295, 5435, 5435, 5479
 - \gaddtolength 120, 6576, 6579
 - \gdef 67
 - .generate_choices:nn 114
 - .generate_choices:nx 114
 - \GetIdInfo 6, 594, 594
 - \GetIdInfoAuxCVS:w 594, 629, 634
 - \GetIdInfoAux:w 594, 614, 618
 - \GetIdInfoAuxii:w 594, 624, 627
 - \GetIdInfoAuxSVN:w 594, 631, 642
 - \GetIdInfoMaybeMissing:w 597, 599
 - \getname 5507, 5535, 5538
 - \getpage 5510, 5536, 5539
 - \getvaluepage 5513, 5536, 5539
 - \global 82
 - \globaldefs 86
 - \glueexpr 426
 - \glueshrink 429
 - \glueshrinkorder 431
 - \gluestretch 428
 - \gluestretchorder 430
 - \gluetomu 432
 - \group_align_safe_begin:
..... 37, 1705, 1705, 1875, 2540, 2555
 - \group_align_safe_end: 37, 1705, 1707,
1901, 1902, 2538, 2539, 2554, 2565
 - \group_begin: 23, 787, 788, 1009, 1514,
2272, 2361, 2453, 3896, 3906, 3922,
3932, 3940, 4808, 4891, 4985, 4993,
5020, 5027, 5468, 5498, 5556, 5569,
5603, 5614, 6011, 6024, 6191, 6294,
6295, 6361, 6387, 6421, 6439, 6458,
6473, 6478, 6484, 6514, 6519, 6613
 - \group_end: 23, 787,
789, 1013, 1519, 2286, 2371, 2461,
3902, 3912, 3928, 3937, 3945, 4808,
4894, 4991, 5008, 5024, 5031, 5476,
5501, 5561, 5600, 5610, 5617, 6015,
6028, 6196, 6199, 6304, 6305, 6308,
6359, 6360, 6386, 6435, 6439, 6450,
6462, 6480, 6510, 6513, 6518, 6615
 - \group_execute_after:N 23, 790,
790, 6294, 6295, 6361, 6362, 6391, 6516
 - \gsetlength 120, 6576, 6577
- ## H
- \H 2368
 - \halign 93
 - \hangafter 271
 - \hangindent 272
 - \hbadness 333
 - \hbox 328
 - \hbox:n 106, 5398, 5398
 - \hbox:w 745
 - \hbox_gset:cn 106, 5399
 - \hbox_gset:Nn 106, 5399, 5401, 5402
 - \hbox_gset_inline_begin:c 107, 5409
 - \hbox_gset_inline_begin:N
..... 107, 5409, 5414, 5417
 - \hbox_gset_inline_end: . 107, 5409, 5418
 - \hbox_gset_to_wd:cn 107, 5403

- \hbox_gset_to_wd:Nnn 107, 5403, 5407, 5408
 - \hbox_set:cn 106, 5399
 - \hbox_set:Nn .. 106, 5399, 5399–5401, 6416
 - \hbox_set_inline_begin:c 107, 5409
 - \hbox_set_inline_begin:N
..... 107, 5409, 5409, 5412, 5415
 - \hbox_set_inline_end: .. 107, 5409, 5413
 - \hbox_set_to_wd:cnn 107, 5403
 - \hbox_set_to_wd:Nnn
..... 107, 5403, 5403, 5406, 5407
 - \hbox_to_wd:nn 107, 5419, 5419
 - \hbox_to_zero:n 107, 5419, 5420
 - \hbox_unpack:c 107, 5421
 - \hbox_unpack:N 107, 5421, 5421, 5422
 - \hbox_unpack_clear:c 107, 5421
 - \hbox_unpack_clear:N 107, 5421, 5423, 5424
 - \heightof 120, 6570, 6572
 - \hfil 236
 - \hfill 238
 - \hfilneg 237
 - \hfuzz 335
 - \hoffset 310
 - \holdinginserts 313
 - \hrule 249
 - \hsize 274
 - \hskip 239
 - \hss 240
 - \ht 378
 - \hyphenation 364
 - \hyphenchar 348
 - \hyphenpenalty 266
- I**
- \I 2368
 - \if 102
 - \if:w . 8, 756, 762, 935, 985, 1002, 1151,
1154, 1155, 1605, 1631, 3100, 4040
 - \if_bool:N 9, 756, 763, 1261, 1270, 1274, 1852
 - \if_box_empty:N 104, 5314, 5316
 - \if_case:w 56, 2822, 2831,
2859, 2872, 2990, 3036, 3037, 6369,
6378, 6395, 6404, 6452, 6464, 6485
 - \if_catcode:w . 8, 756, 766, 2288, 2292,
2296, 2300, 2304, 2308, 2312, 2316,
2320, 2324, 2328, 2336, 2576, 4058
 - \if_charcode:w 8, 756, 765, 2340, 2591, 4045
 - \if_cs_exist:N 9, 772, 772, 1041, 1255, 1264
 - \if_cs_exist:w 9, 772, 773, 1049
 - \if_dim:w
64, 3400, 3400, 3402, 6495, 6501, 6507
 - \if_eof:w 97, 4838, 4838
 - \if_false: 8, 756, 757, 870, 1706
 - \if_hbox:N 104, 5314, 5314
 - \if_horizontal_mode: 739
 - \if_intexpr_case:w 59, 3085, 3090
 - \if_intexpr_compare:w
. 59, 3085, 3088, 3109, 3113, 3117,
3121, 3125, 3129, 3133, 3137, 3143,
3150, 3160, 3173, 3177, 3178, 3184
 - \if_intexpr_odd:w 59, 3085, 3089, 3203, 3207
 - \if_meaning:w 8, 767, 767, 1019,
1038, 1055, 1137–1139, 1417, 1502,
1503, 1641, 1881, 2081, 2087, 2093,
2102, 2112, 2136, 2332, 2355, 2387,
2398, 2409, 2420, 2569, 3105, 3458,
3627, 3635, 3642, 3657, 3726, 3733,
3740, 3747, 3754, 3761, 3768, 3775,
3782, 3789, 3796, 3803, 3810, 3817,
4036, 4251, 4258, 4427, 4438, 4447,
4749, 6281, 6284, 6286, 6308–6314,
6327, 6330, 6333, 6343, 6346, 6349
 - \if_mode_horizontal: .. 9, 768, 769, 1694
 - \if_mode_inner: 9, 768, 771, 1698
 - \if_mode_math: 9, 768, 768, 1702
 - \if_mode_vertical: 9, 768, 770, 1690
 - \if_num:w 56, 1706, 1707,
2118, 2140, 3036, 3036, 6440, 6489
 - \if_predicate:w ... 8, 756, 764, 1282,
1928, 2128, 2150, 2347, 2351, 2485,
2486, 2492, 2493, 2504, 2506, 2508,
2510, 2512, 2514, 3515, 3527, 4052
 - \if_true: 8, 756, 756, 869
 - \if_vbox:N 104, 5314, 5315
 - \ifcase 103
 - \ifcat 104
 - \ifcsname 387
 - \ifdefined 386
 - \ifdim 107
 - \ifeof 108
 - \iffalse 113
 - \iffirstchoice@ 6582, 6593, 6608
 - \iffontchar 416
 - \ifhbox 109
 - \ifhmode 115
 - \ifinner 118
 - \ifmmode 116
 - \ifnum 105
 - \ifodd 23, 106
 - \iftrue 114
 - \ifvbox 110
 - \ifvmode 117
 - \ifvoid 111
 - \ifx 11, 112
 - \ignorespaces 160
 - \immediate 122
 - \indent 256
 - .initial:n 114
 - .initial:V 114

- \input 130
- \input@path 6673, 6674, 6707, 6708
- \InputIfFileExists 5500
- \inputlineno 132
- \insert 312
- \insertpenalties 315
- \int_add:cn 50, 2754
- \int_add:Nn 50, 2742, 2743, 2754, 2754, 2771, 2778, 6209
- \int_advance:w 209, 2692, 2694, 2720, 2725, 2755, 2761
- \int_Alph_default_conversion_rule:n 52, 2821, 2830, 2845
- \int_alph_default_conversion_rule:n 52, 2821, 2821, 2841
- \int_const:Nn 52, 2894, 2894, 2907–2922, 2924–2935
- \int_convert_from_base_ten:nn 53, 2962, 2962
- \int_convert_from_base_ten_aux:ffn 2978
- \int_convert_from_base_ten_aux:fon 2962
- \int_convert_from_base_ten_aux:nfn 2965, 2969
- \int_convert_from_base_ten_aux:nnn 2962, 2974, 2987, 2988
- \int_convert_from_base_ten_aux:non 2962
- \int_convert_letter_to_number:N 3014, 3018
- \int_convert_number_to_letter:n 209, 2976, 2980, 2989, 2989
- \int_convert_number_with_rule:nnN 52, 2811, 2811, 2814, 2840, 2844, 2850, 2854
- \int_convert_to_base_ten:nn 54, 3001, 3001
- \int_convert_to_base_ten_aux:nn 3004, 3007
- \int_convert_to_base_ten_auxi:nnN 3008, 3010, 3013
- \int_decr:c 50, 2720
- \int_decr:N 50, 2720, 2725, 2741, 2743, 2747
- \int_gadd:cn 50, 2754
- \int_gadd:Nn 50, 2744, 2745, 2754, 2766, 2779, 6212
- \int_gdecr:c 50, 2720
- \int_gdecr:N 50, 1791, 2720, 2736, 2745, 2749, 4536, 4548
- \int_get_digits:n 209, 2936, 2942, 3004
- \int_get_sign:n 209, 2936, 2939, 3003
- \int_get_sign_and_digits:n 209, 2936, 2936
- \int_get_sign_and_digits_aux:nNNN 2936, 2937, 2940, 2943, 2945, 2961
- \int_get_sign_and_digits_aux:oNNN 2936, 2949, 2950, 2954
- \int_gincr:c 50, 2720, 6612
- \int_gincr:N 50, 1784, 2720, 2730, 2744, 2748, 4530, 4542
- \int_gset:cn 50, 2707
- \int_gset:Nn 50, 2707, 2712, 2719, 6206
- \int_gsub:cn 50, 2754
- \int_gsub:Nn 50, 2754, 2772, 2781, 6218
- \int_gzero:c 50, 2750
- \int_gzero:N 50, 2750, 2752, 2753
- \int_incr:c 50, 2720
- \int_incr:N 50, 2720, 2720, 2735, 2742, 2746, 5781
- \int_new:c 49, 2695
- \int_new:N 49, 1782, 2695, 2697, 2701, 2706, 2884–2888, 2897, 2902, 4527, 5721, 6174–6177
- \int_new_l:N 2698
- \int_pre_eval_one_arg:Nn 209, 2889, 2889
- \int_pre_eval_two_args:Nnn 209, 2889, 2891
- \int_roman_lcuc_mapping:Nnn 52, 2787, 2787, 2791–2798
- \int_set:cn 50, 2707
- \int_set:Nn 50, 2707, 2707, 2717, 2718, 2897, 2902, 4861, 5784, 6190, 6203
- \int_show:c 51, 2784, 2785
- \int_show:N 51, 2784, 2784, 2785
- \int_sub:cn 50, 2754
- \int_sub:Nn 50, 2754, 2760, 2777, 2780, 6215
- \int_symbol_math_conversion_rule:n 52, 2851, 2858, 2858
- \int_symbol_text_conversion_rule:n 52, 2855, 2858, 2871
- \int_to_Alph:n 51, 2839, 2843
- \int_to_alph:n 51, 2839, 2839
- \int_to_arabic:n 51, 2786, 2786
- \int_to_number:w 52, 2692, 2693
- \int_to_Roman:n 51, 2799, 2803
- \int_to_roman:n 51, 2799, 2799
- \int_to_roman:w 51, 1894, 2692, 2692, 2801, 2805, 4087, 4090, 4094, 4171, 4186
- \int_to_roman_lcuc:NN 52, 2799, 2800, 2804, 2807, 2809
- \int_to_symbol:n 51, 2847, 2847
- \int_use:c 50, 2782, 2783
- \int_use:N 50, 1785, 1789, 2179, 2229, 2241, 2251, 2261, 2782, 2782, 2783, 4531, 4534, 4543, 4546, 5785, 6448
- \int_zero:c 50, 2750
- \int_zero:N 50, 2750, 2750, 2751, 5779, 6390, 6515

- \interactionmode 414
- \interlinepenalties 435
- \interlinepenalty 294
- \intexpr_abs:n 58, [3141](#), 3141
- \intexpr_compare:n 3094
- \intexpr_compare:nF 3214, 3220
- \intexpr_compare:nNn 3136
- \intexpr_compare:nNnF
..... 1711, 1713, 1765, 1774,
1794, 1802, 1816, 1824, 3226, 3232
- \intexpr_compare:nNnT .. 1709, 3223, 3229
- \intexpr_compare:nNnTF 57, 1759,
1786, 1810, 1924, 1949, 2812, 2895,
2896, 2963, 2975, 3019, 3022, [3136](#)
- \intexpr_compare:nT 3211, 3217
- \intexpr_compare:nTF
..... 57, [3094](#), 5845, 5855, 5878
- \intexpr_compare_auxi:w 3095, 3098
- \intexpr_compare_auxii:w 3099, 3102
- \intexpr_compare_p:n 57, [3094](#)
- \intexpr_compare_p:nNn 57, [3136](#), 3341, 3342
- \intexpr_div_round:nn ... 58, [3168](#), 3195
- \intexpr_div_truncate:nn
.... 58, 2815, 2983, [3168](#), 3171, 3199
- \intexpr_div_truncate_raw:nn 3168
- \intexpr_do_until:nn 59, [3210](#), 3219, 3220
- \intexpr_do_until:nNnn 59, [3222](#), 3231, 3232
- \intexpr_do_while:nn 59, [3210](#), 3216
- \intexpr_do_while:nNnn
..... 59, 3217, [3222](#), 3228, 3229
- \intexpr_eval:n 57, 1721,
1762, 1769, 1778, 1790, 1798, 1806,
1813, 1820, 1828, 1944, 2786, 2801,
2805, 2817, 2819, 2890, 2892, 2899,
2966, 2970, 3002, 3014, 3021, 3053,
[3085](#), 3091, 3169, 3195, 3884, 3890
- \intexpr_eval:w
..... 58, 2177, 2181, 2187, 2223,
2227, 2231, 2235, 2239, 2243, 2246,
2249, 2253, 2256, 2259, 2263, 2267,
2707, 2755, 2761, 2990, [3085](#), 3086,
3092, 3096, 3109, 3113, 3117, 3121,
3125, 3129, 3133, 3137, 3143, 3146,
3149, 3151, 3159, 3161, 3172, 3173,
3177, 3178, 3184, 3198, 3203, 3207
- \intexpr_eval_end:
..... 58, 2177, 2181, 2187, 2223,
2227, 2231, 2235, 2239, 2243, 2246,
2249, 2253, 2256, 2259, 2263, 2267,
2707, 2755, 2761, 2990, [3085](#), 3087,
3092, 3109, 3113, 3117, 3121, 3125,
3129, 3133, 3138, 3146, 3151, 3156,
3161, 3166, 3193, 3200, 3203, 3207
- \intexpr_if_even:n 3206
- \intexpr_if_even:nTF 58, [3202](#)
- \intexpr_if_even_p:n 58, 1886, [3202](#)
- \intexpr_if_odd:n 3202
- \intexpr_if_odd:nTF 58, [3202](#)
- \intexpr_if_odd_p:n 58, [3202](#)
- \intexpr_max:nn 58, [3141](#), 3148
- \intexpr_min:nn 58, [3141](#), 3158
- \intexpr_mod:nn 58, 2817, 2980, [3168](#), 3196
- \intexpr_until_do:nn 59, [3210](#), 3213, 3214
- \intexpr_until_do:nNnn 59, [3222](#), 3225, 3226
- \intexpr_value:w 58, [3085](#), 3085, 3092,
3095, 3142, 3149, 3159, 3172, 3197
- \intexpr_while_do:nn 59, [3210](#), 3210, 3211
- \intexpr_while_do:nNnn 59, [3222](#), 3222, 3223
- \ior_close:N
97, [4833](#), 4833, 4835, 6658, 6679, 6695
- \ior_gto:NN 97, [4842](#), 4846
- \ior_if_eof:N 4839
- \ior_if_eof:Nf 6666, 6700
- \ior_if_eof:Nf 97, [4839](#), 6655, 6690
- \ior_if_eof_p:N 97, [4839](#)
- \ior_new:N 97, [4828](#), 4830, 4832, 6650
- \ior_open:Nn
97, [4833](#), 4834, 6654, 6665, 6689, 6699
- \ior_to:NN 97, [4842](#), 4842, 4849
- \iow_char:N
96, 4294, 4482, 4661, 4663, [4824](#), 4824
- \iow_close:N 95, 4786, [4790](#), 4790
- \iow_log:n 95, [4799](#), 4800
- \iow_log:x 14, 95, [1097](#), 1097, 1121, 1621,
4799, 4799, 5023, 6750, 6752, 6755
- \iow_new:c 95, [4777](#)
- \iow_new:N 95, [4777](#), 4779, 4782, 4784, 5487
- \iow_newline: 96, [4822](#), 4822
- \iow_now:Nn
95, [4796](#), 4796, 4800, 4802, 4804, 4814
- \iow_now:Nx
95, [4795](#), 4795, 4797, 4799, 4801, 4811
- \iow_now_buffer_safe:Nn . 95, [4807](#), 4813
- \iow_now_buffer_safe:Nx . 95, [4807](#), 4810
- \iow_now_buffer_safe_aux:w
..... 4807, 4811, 4814
- \iow_now_buffer_safe_expanded_aux:w
..... 4807
- \iow_now_when_avail:cn 96, [4803](#)
- \iow_now_when_avail:Nn 96, [4803](#), 4803, 4806
- \iow_open:cn 95, [4785](#)
- \iow_open:Nn ... 95, [4785](#), 4785, 4789, 5496
- \iow_shipout:Nn 96, [4818](#), 4818, 4821
- \iow_shipout:Nx 96, [4818](#)
- \iow_shipout_x:Nn
.... 14, 96, [777](#), 777, 1098, 1101,
4795, [4816](#), 4816, 4817, 4819, 5480
- \iow_shipout_x:Nx 96, [4816](#)

- \iow_space: 96, 2129, 2151,
4294, 4482, 4661-4663, 4823, 4823
- \iow_term:n 95, 4799, 4802
- \iow_term:x
.. 14, 95, 1097, 1100, 1104, 1120,
4286, 4474, 4653, 4799, 4801, 5030
- J**
- \jobname 369, 5496, 5500
- K**
- \K 2368
- \kern 247
- \keys_arguments_tidy:w
... 117, 5732, 5732, 5795, 5800, 5940
- \keys_bool_set:N .. 117, 5733, 5733, 6064
- \keys_bool_set_aux:N 5733, 5743, 5754, 5756
- \keys_bool_set_inverse:N 117, 5733, 5745
- \keys_choice_find:n 117, 5763, 5763, 5770
- \keys_choice_make:
... 117, 5757, 5768, 5768, 5778, 6067
- \keys_choices_generate:nx
..... 117, 5777, 5777, 6096, 6099
- \keys_choices_generate_aux:n
..... 5777, 5780, 5789, 5791
- \keys_cmd_set:nNn 117, 5769,
5772, 5792, 5792, 6070, 6073, 6088
- \keys_cmd_set:nNx
117, 5734, 5738, 5746, 5750, 5782,
5792, 5797, 5911, 6056, 6076, 6079
- \keys_cmd_set_aux:nN 5792, 5793, 5798, 5802
- \keys_default_set:n
... 117, 5761, 5807, 5807, 5810, 6082
- \keys_default_set:V 117, 5807, 6085
- \keys_define:nn 112, 5811, 5811
- \keys_define_elt:n . 117, 5813, 5824, 5824
- \keys_define_elt:nn 117, 5814, 5824, 5828
- \keys_define_elt_aux:nn
..... 5826, 5830, 5832, 5832
- \keys_define_key:n . 117, 5837, 5843, 5843
- \keys_execute: 117, 5865, 5865, 5984, 5990
- \keys_execute_aux:nn 5764,
5765, 5865, 5866, 5871, 5875, 5904
- \keys_execute_unknown:
..... 117, 5865, 5867, 5870
- \keys_if_exist:nn 5890
- \keys_if_exist:nnTF 116, 5890
- \keys_if_value_requirement:nTF
..... 118, 5897, 5897, 5971, 5982
- \keys_initial_value:n
..... 118, 5902, 5902, 5909, 6102
- \keys_initial_value:V .. 118, 5902, 6105
- \keys_meta_make:n
..... 118, 5910, 5910, 5915, 6108
- \keys_meta_make:x 118, 5910, 6111
- \keys_property_find:n 118, 5833, 5916, 5916
- \keys_property_find_aux:n 5916, 5919, 5924
- \keys_property_find_aux:w
..... 5916, 5925, 5927, 5932
- \keys_property_new:nn
..... 118, 5938, 5938, 6063,
6066, 6069, 6072, 6075, 6078, 6081,
6084, 6087, 6095, 6098, 6101, 6104,
6107, 6110, 6113, 6116, 6119, 6122
- \keys_property_undefine:n
..... 118, 5803, 5942, 5942
- \keys_set:nn .. 116, 5912, 5945, 5945, 5958
- \keys_set:nV 116, 5945
- \keys_set:nv 116, 5945
- \keys_set_elt:n ... 118, 5947, 5959, 5959
- \keys_set_elt:nn .. 118, 5948, 5959, 5963
- \keys_set_elt_aux: 5967, 5975, 5978, 5981
- \keys_set_elt_aux:nn 5961, 5965, 5967, 5967
- \keys_show:nn 116, 5993, 5993
- \keys_tmp:w
118, 5834, 5836, 5849, 5859, 5861,
5876, 5877, 5881, 5883, 5996, 5996
- \keys_value_or_default:n
..... 118, 5970, 5997, 5997
- \keys_value_requirement:n
..... 118, 6007, 6007, 6120, 6123
- \keys_variable_get_scope:N
..... 119, 5735, 5740, 5747,
5751, 6011, 6016, 6044, 6049, 6059
- \keys_variable_get_scope_aux:w
..... 6011, 6017, 6020
- \keys_variable_get_type:N
119, 6011, 6029, 6043, 6048, 6054, 6058
- \keys_variable_get_type:w 6011
- \keys_variable_get_type_aux:w
..... 6030, 6033, 6037
- \keys_variable_set:NN
..... 119, 6041, 6041, 6114, 6117
- \KV_add_element_aux:w .. 5595, 5601, 5601
- \KV_add_value_element:w
..... 300, 5569, 5578, 5676
- \KV_key_no_value_elt:n 111, 5638, 5683,
5693, 5693, 5813, 5819, 5947, 5953
- \KV_key_value_elt:nn 111, 5656, 5688,
5693, 5694, 5814, 5821, 5948, 5955
- \KV_parse_elt:w
.. 5608, 5616, 5620, 5620, 5622, 5627
- \KV_parse_no_sanitize_aux:n
..... 5613, 5613, 5697, 5705
- \KV_parse_no_space_removal_no_sanitize:n
..... 110, 5695, 5695, 5817
- \KV_parse_sanitize_aux:n 5602, 5602, 5701

- \KV_parse_space_removal_no_sanitizew 110, 5699, 5703
 - \KV_parse_space_removal_sanitizew 110, 5699, 5699, 5951
 - \KV_remove_surrounding_spaces:nw 300, 5569, 5571
 - \KV_remove_surrounding_spaces_auxi:w 300, 5569, 5572, 5574, 5580, 5589
 - \KV_remove_surrounding_spaces_auxii:w 5569, 5575, 5577
 - \KV_sanitizew_outerlevel_active_commas:N 300, 5556, 5565, 5607
 - \KV_sanitizew_outerlevel_active_equals:N 300, 5556, 5562, 5606
 - \KV_set_key_element:w 300, 5569, 5586, 5633
 - \KV_split_key_value_current:w 300, 5626, 5631, 5631, 5696, 5700, 5704
 - \KV_split_key_value_no_space_removal:w 300, 5679, 5679, 5696
 - \KV_split_key_value_space_removal:w 300, 5632, 5632, 5700, 5704
 - \KV_split_key_value_space_removal_aux:w 5632, 5644, 5653
 - \KV_split_key_value_space_removal_detect_error:wTF 300, 5632, 5643, 5649
 - \KV_val_preserve_braces:NnN 5652, 5672
- L**
- \L 2368
 - \l_calc_B_dim 319, 6175, 6179, 6221, 6224, 6227, 6230, 6493, 6495, 6496
 - \l_calc_B_int 319, 6175, 6176, 6203, 6206, 6209, 6212, 6215, 6218, 6233, 6236, 6389, 6441, 6444, 6448, 6487, 6489, 6490
 - \l_calc_B_muskip 319, 6175, 6185, 6257, 6261, 6265, 6269, 6273, 6277, 6505, 6507, 6508
 - \l_calc_B_register 319, 6171, 6173, 6189, 6198, 6200, 6298, 6304, 6305, 6360, 6368, 6374, 6377, 6383, 6389, 6394, 6400, 6403, 6409, 6451, 6457, 6463, 6469
 - \l_calc_B_skip 319, 6175, 6182, 6239, 6242, 6245, 6248, 6251, 6254, 6499, 6501, 6502
 - \l_calc_C_dim 319, 6175, 6180, 6492, 6495, 6496
 - \l_calc_C_int 319, 6175, 6177, 6442, 6445, 6448, 6486, 6489, 6490
 - \l_calc_C_muskip 319, 6175, 6186, 6504, 6507, 6508
 - \l_calc_C_skip 319, 6175, 6183, 6498, 6501, 6502
 - \l_calc_current_type_int 319, 6171, 6174, 6190, 6369, 6378, 6390, 6395, 6404, 6440, 6452, 6464, 6485, 6515
 - \l_calc_expression_tl 319, 6171, 6171, 6194, 6197
 - \l_clist_remove_clist 4358, 4577, 4577, 4579, 4581, 4584, 4585, 4601, 4604, 4608
 - \l_exp_tl 166, 1447, 1447, 1476, 1477, 3536, 3537, 3544, 3545, 3553, 3554, 3561, 3562, 3573, 3574, 3578, 3579, 3586, 3587, 3594, 3595
 - \l_file_search_path_clist 123, 6649, 6649, 6674, 6678, 6708, 6712
 - \l_file_test_read_stream 123, 6650, 6650, 6654, 6655, 6658, 6665, 6666, 6679, 6689, 6690, 6695, 6699, 6700
 - \l_file_tmp_bool 123, 6651, 6651, 6663, 6667, 6680
 - \l_file_tmp_tl 123, 6652, 6652, 6716–6718, 6722–6724
 - \l_keys_choice_int 115, 5721, 5721, 5779, 5781, 5784, 5785
 - \l_keys_choice_tl 115, 5721, 5722, 5783
 - \l_keys_key_tl 116, 5723, 5723, 5968, 5969
 - \l_keys_module_tl 119, 5726, 5726, 5812, 5871, 5912, 5917, 5946, 5969
 - \l_keys_nesting_seq 119, 5727, 5727, 5815, 5818, 5949, 5952
 - \l_keys_nesting_tl 119, 5727, 5728, 5815, 5816, 5818, 5820, 5822, 5949, 5950, 5952, 5954, 5956
 - \l_keys_no_value_bool 119, 5729, 5729, 5825, 5829, 5844, 5960, 5964, 5972, 5983, 5999
 - \l_keys_path_tl 119, 5723, 5724, 5734, 5738, 5746, 5750, 5764, 5765, 5769, 5772, 5773, 5782, 5808, 5866, 5872, 5899, 5904, 5906, 5911, 5917, 5929, 5930, 5934, 5969, 5973, 5986, 6000, 6002, 6008, 6056, 6070, 6073, 6076, 6079, 6088
 - \l_keys_property_tl 119, 5723, 5725, 5835, 5840, 5847, 5852, 5857, 5935
 - \l_keys_value_toks 119, 5730, 5730, 5881, 5883, 5903, 5987, 5998, 6001
 - \l_KV_currkey_toks 300, 5551, 5552, 5587, 5594, 5596, 5639, 5657
 - \l_KV_currval_toks 300, 5551, 5553, 5579, 5583
 - \l_KV_parse_toks 300, 5551, 5551, 5582, 5604, 5611, 5615, 5618, 5637, 5655, 5660, 5666, 5671, 5683, 5688

- \l_KV_remove_one_level_of_braces_bool . . . [110](#), [5554](#), [5554](#), [5555](#), [5592](#), [5664](#)
- \l_KV_tmpa_tl [300](#), [5548](#), [5548](#), [5605–5607](#), [5609](#), [5634](#), [5635](#), [5654](#), [5659](#), [5662](#), [5680](#), [5681](#), [5686](#)
- \l_KV_tmpb_tl [300](#), [5548](#), [5549](#)
- \l_last_box [106](#), [5342](#), [5342](#), [5343](#)
- \l_msg_class_tl [103](#), [4903](#), [4903](#), [5114](#), [5115](#), [5118](#)
- \l_msg_current_class_tl [103](#), [4903](#), [4904](#), [5094](#), [5115](#)
- \l_msg_current_module_tl [5095](#)
- \l_msg_names_clist [103](#), [4905](#), [4905](#), [4951](#), [4952](#)
- \l_msg_redirect_classes_clist [103](#), [4908](#), [4908](#), [5070](#), [5074](#), [5077](#)
- \l_msg_redirect_classes_prop [103](#), [4906](#), [4906](#)
- \l_msg_redirect_names_prop [103](#), [4906](#), [4907](#), [5096](#), [5187](#)
- \l_msg_tmp_tl [4998](#), [5014](#), [5016](#)
- \l_peek_false_tl [193](#), [2531](#), [2532](#), [2539](#), [2554](#), [2572](#), [2579](#), [2587](#), [2594](#)
- \l_peek_search_tl [193](#), [2534](#), [2534](#), [2537](#), [2551](#), [2588](#)
- \l_peek_search_token [48](#), [2524](#), [2526](#), [2536](#), [2550](#), [2569](#), [2576](#)
- \l_peek_token [48](#), [2524](#), [2524](#), [2527](#), [2569](#), [2576](#), [2584](#), [2585](#), [2676](#)
- \l_peek_true_aux_tl [193](#), [2552](#), [2564](#), [2564](#), [2566](#)
- \l_peek_true_tl [193](#), [2531](#), [2531](#), [2538](#), [2553](#), [2570](#), [2577](#), [2592](#)
- \l_seq_remove_seq [4358](#), [4360](#), [4362](#), [4365](#), [4366](#)
- \l_testa_tl [72](#), [3620](#), [3620](#), [3724](#), [3726](#), [3731](#), [3733](#), [3738](#), [3740](#), [3745](#), [3747](#), [3752](#), [3754](#), [3759](#), [3761](#), [3766](#), [3768](#), [3773](#), [3775](#), [3780](#), [3782](#), [3787](#), [3789](#), [3794](#), [3796](#), [3801](#), [3803](#), [3808](#), [3810](#), [3815](#), [3817](#), [4252](#), [4428](#)
- \l_testb_tl [72](#), [3620](#), [3621](#), [3725](#), [3726](#), [3732](#), [3733](#), [3739](#), [3740](#), [3746](#), [3747](#), [3753](#), [3754](#), [3760](#), [3761](#), [3767](#), [3768](#), [3774](#), [3775](#), [3781](#), [3782](#), [3788](#), [3789](#), [3795](#), [3796](#), [3802](#), [3803](#), [3809](#), [3810](#), [3816](#), [3817](#)
- \l_tl_replace_toks [72](#), [79](#), [3969](#), [3969](#), [3974](#), [3976](#), [3979](#), [3990](#), [3994](#), [3997](#), [4003](#), [4213](#), [4213](#)
- \l_tmpa_bool [175](#), [1849](#), [1849](#)
- \l_tmpa_box [106](#), [5367](#), [5368](#), [5370](#), [6416](#), [6419](#)
- \l_tmpa_dim [64](#), [3391](#), [3391](#)
- \l_tmpa_int [53](#), [2884](#), [2884](#)
- \l_tmpa_num [56](#), [3072](#), [3072](#)
- \l_tmpa_skip [62](#), [3322](#), [3322–3324](#)
- \l_tmpa_tl [4](#), [72](#), [600](#), [602](#), [603](#), [614](#), [616](#), [3624](#), [3624](#), [3708](#), [3716](#), [3926](#), [3929](#)
- \l_tmpa_toks [79](#), [3913](#), [3919](#), [3946](#), [4205](#), [4205](#), [4288](#), [4290](#), [4291](#), [4293](#), [4297](#), [4476](#), [4478](#), [4479](#), [4481](#), [4485](#), [4565](#), [4568](#), [4569](#), [4655](#), [4657](#), [4658](#), [4660](#), [4666](#), [5445](#), [5451](#)
- \l_tmpb_box [106](#), [5367](#), [5371](#)
- \l_tmpb_dim [64](#), [3391](#), [3392](#)
- \l_tmpb_int [53](#), [2884](#), [2885](#)
- \l_tmpb_num [56](#), [3072](#), [3073](#)
- \l_tmpb_skip [62](#), [3322](#), [3325](#)
- \l_tmpb_tl [72](#), [601](#), [602](#), [3624](#), [3625](#)
- \l_tmpb_toks [79](#), [4205](#), [4207](#), [4566](#), [4569](#), [4570](#)
- \l_tmpe_dim [64](#), [3391](#), [3393](#)
- \l_tmpe_int [53](#), [2884](#), [2886](#)
- \l_tmpe_num [56](#), [3072](#), [3074](#)
- \l_tmpe_skip [62](#), [3322](#), [3326](#)
- \l_tmpe_toks [79](#), [4205](#), [4208](#)
- \l_tmpe_dim [64](#), [3391](#), [3394](#)
- \l_xref_curr_name_tl [5506](#)
- \language [164](#)
- \lastbox [321](#)
- \lastkern [254](#)
- \lastlinefit [434](#)
- \lastnodetype [415](#)
- \lastpenalty [360](#)
- \lastskip [255](#)
- \lccode [383](#)
- \leaders [251](#)
- \left [219](#)
- \lefthyphenmin [275](#)
- \leftmarginkern [497](#)
- \leftskip [277](#)
- \leqno [194](#)
- \let [40](#), [64](#)
- \limits [211](#)
- \linepenalty [267](#)
- \lineskip [261](#)
- \lineskiplimit [262](#)
- \long [43](#), [49](#), [52](#), [57](#), [83](#)
- \looseness [279](#)
- \lower [316](#)
- \lowercase [355](#)
- \lpcode [464](#)
- \luatex_directlua:D [554](#), [1264](#)
- \luatex_if_engine: [1273](#)
- \luatex_if_engine:TF [24](#), [1255](#)

M

- \M [2368](#), [2455](#)
- \m@ne [1089](#)

<code>\mag</code>	163	<code>\msg_direct_log:xx</code>	
<code>\mark</code>	165	... 102 , 5019 , 5019 , 5161 , 5168 , 5174	
<code>\marks</code>	391	<code>\msg_direct_term:xx</code> 102 , 5019 , 5026 , 5154	
<code>\mathaccent</code>	176	<code>\msg_error:nn</code>	99 , 5132
<code>\mathbin</code>	206	<code>\msg_error:nxx</code>	99 , 5132
<code>\mathchar</code>	177	<code>\msg_error:nxxx</code>	99 , 5132
<code>\mathchardef</code>	74	<code>\msg_fatal:nn</code>	99 , 5121
<code>\mathchoice</code>	174	<code>\msg_fatal:nxx</code>	99 , 5121
<code>\mathclose</code>	207	<code>\msg_fatal:nxxx</code>	99 , 5121
<code>\mathcode</code>	385	<code>\msg_four_spaces:</code>	101 , 4920 , 4922
<code>\mathinner</code>	208	<code>\msg_generic_new:nn</code> 101 , 4923 , 4931 , 5040	
<code>\mathop</code>	209	<code>\msg_generic_new:nnn</code> 101 , 4923 , 4927 , 5037	
<code>\mathopen</code>	213	<code>\msg_generic_new:nnnn</code> 101 , 4923 , 4923 , 5034	
<code>\mathord</code>	214	<code>\msg_generic_set:nn</code>	
<code>\mathparagraph</code>	2864	... 101 , 4933 , 4935 , 4945 , 5049	
<code>\mathpunct</code>	215	<code>\msg_generic_set:nnn</code>	
<code>\mathrel</code>	216	... 101 , 4929 , 4935 , 4940 , 5046	
<code>\mathsection</code>	2863	<code>\msg_generic_set:nnnn</code>	
<code>\mathsurround</code>	227	... 101 , 4925 , 4935 , 4935 , 5043	
<code>\maxdeadcycles</code>	297	<code>\msg_generic_set_clist:n</code>	
<code>\maxdepth</code>	298	... 4935 , 4936 , 4941 , 4946 , 4950	
<code>\maxdimen</code>	3337	<code>\msg_generic_set_code:n</code>	4935
<code>\maxof</code>	120 , 6531 , 6537	<code>\msg_generic_set_code:nn</code>	4976 , 4978
<code>\meaning</code>	357	<code>\msg_generic_set_code:nnnn</code>	4938 , 4968
<code>\medmuskip</code>	228	<code>\msg_generic_set_more_text:n</code>	4935
<code>\message</code>	134	<code>\msg_generic_set_more_text:nnn</code>	
<code>\MessageBreak</code>	729	... 4943 , 4959	
<code>.meta:n</code>	114	<code>\msg_generic_set_text:n</code>	4935
<code>.meta:x</code>	114	<code>\msg_generic_set_text:nn</code>	4948 , 4955
<code>\middle</code>	439	<code>\msg_info:nn</code>	100 , 5160
<code>\minof</code>	120 , 6531 , 6538	<code>\msg_info:nxx</code>	100 , 5160
<code>\mkern</code>	181	<code>\msg_info:nxxx</code>	100 , 5160 , 5254
<code>\mode_if_horizontal:</code>	1693	<code>\msg_kernel_bug:x</code>	14 ,
<code>\mode_if_horizontal:TF</code>	36 , 1693	... 103 , 1103 , 1103 , 1113 , 1128 , 1330 ,	
<code>\mode_if_horizontal_p:</code>	36 , 1693	... 3459 , 4253 , 4429 , 4448 , 5286 , 5286	
<code>\mode_if_inner:</code>	1697	<code>\msg_kernel_classes_new:n</code>	
<code>\mode_if_inner:TF</code>	36 , 1697	... 5207 , 5207 , 5226 , 5248 , 5252 , 5256	
<code>\mode_if_inner_p:</code>	36 , 1697	<code>\msg_kernel_error:n</code>	102 , 5075 , 5227
<code>\mode_if_math:</code>	1701	<code>\msg_kernel_error:nx</code> 102 , 5081 , 5227 ,	
<code>\mode_if_math:TF</code>	36 , 1701 , 2848	... 5839 , 5851 , 5872 , 5905 , 5921 , 5973	
<code>\mode_if_math_p:</code>	36 , 1701	<code>\msg_kernel_error:nxx</code>	
<code>\mode_if_vertical:</code>	1689	... 102 , 5088 , 5227 , 5227 , 5773 , 5986 , 6046	
<code>\mode_if_vertical:TF</code>	36 , 1689	<code>\msg_kernel_fatal:n</code>	102 , 5215
<code>\mode_if_vertical_p:</code>	36 , 1689	<code>\msg_kernel_fatal:nx</code>	102 , 5215
<code>\month</code>	367	<code>\msg_kernel_fatal:nxx</code>	102 , 5215 , 5215
<code>\moveleft</code>	317	<code>\msg_kernel_info:n</code>	103 , 5249
<code>\moveright</code>	318	<code>\msg_kernel_info:nx</code>	103 , 5249
<code>\msg_class_new:nn</code> 99 , 5051 , 5051 , 5121 ,		<code>\msg_kernel_info:nxx</code>	103 , 5249 , 5253
... 5132 , 5153 , 5160 , 5167 , 5173 , 5179		<code>\msg_kernel_new:nn</code>	
<code>\msg_class_set:nn</code>	99 , 5051 , 5054 , 5056	... 102 , 5189 , 5195 , 6125 , 6129 ,	
<code>\msg_direct_interrupt:n</code>	4985	... 6133 , 6136 , 6140 , 6144 , 6157 , 6160	
<code>\msg_direct_interrupt:xxxxn</code> 101 , 4985 ,		<code>\msg_kernel_new:nnn</code>	102 , 5189 ,
... 4992 , 5122 , 5133 , 5216 , 5228 , 5287		... 5192 , 5257 , 5263 , 5271 , 5278 , 6147	
<code>\msg_direct_interrupt_aux:n</code>	4996 , 5012	<code>\msg_kernel_new:nnnn</code>	102 , 5189 , 5189

- \msg_kernel_set:nn 102, 5189, 5204
 - \msg_kernel_set:nnn 102, 5189, 5201
 - \msg_kernel_set:nnnn 102, 5189, 5198
 - \msg_kernel_warning:n 102, 5249
 - \msg_kernel_warning:nx 102, 5249
 - \msg_kernel_warning:nxx 102, 5249, 5249
 - \msg_line_context: 101, 4909, 4912
 - \msg_line_number: 101, 4909, 4909, 4916
 - \msg_log:nn 100, 5167
 - \msg_log:nxx 100, 5167
 - \msg_log:nxxx 100, 5167
 - \msg_new:nnn 99, 5033, 5039, 5196
 - \msg_new:nnnn 99, 5033, 5036, 5193
 - \msg_new:nnnnn 99, 5033, 5033, 5190
 - \msg_newline: 101, 4877,
4888, 4918, 4918, 4994, 4997, 5001,
5021, 5023, 5028, 5030, 5134, 5229
 - \msg_none:nn 100, 5179
 - \msg_none:nxx 100, 5179
 - \msg_none:nxxx 100, 5179
 - \msg_redirect_class:nn 100, 5180, 5180
 - \msg_redirect_module:nnn 100, 5183, 5183
 - \msg_redirect_name:nnn 101, 5186, 5186
 - \msg_set:nnn 99, 5033, 5048, 5205
 - \msg_set:nnnn 99, 5033, 5045, 5202
 - \msg_set:nnnnn 99, 5033, 5042, 5199
 - \msg_space: 101,
4913, 4915, 4920, 4920, 4921, 4995,
5022, 5029, 5125, 5128, 5136, 5139,
5155, 5162, 5219, 5222, 5231, 5234
 - \msg_trace:nn 100, 5173
 - \msg_trace:nxx 100, 5173
 - \msg_trace:nxxx 100, 5173
 - \msg_two_newlines:
101, 4886, 4918, 4919, 5002, 5123, 5217
 - \msg_two_spaces:
. . . 101, 4920, 4921, 4922, 5158, 5165
 - \msg_use:nnnxxx 5059, 5068, 5068
 - \msg_use_aux:nn 5099, 5102, 5102
 - \msg_use_aux:nnn 5086, 5093, 5093
 - \msg_use_code: 5069, 5091, 5091, 5109, 5116
 - \msg_use_loop: 5091
 - \msg_use_loop:n 5073, 5092, 5118
 - \msg_use_loop_check:nn
. 5097, 5104, 5107, 5113, 5113
 - \msg_warning:nn 99, 5153
 - \msg_warning:nxx 99, 5153
 - \msg_warning:nxxx 99, 5153, 5250
 - \mskip 178
 - \muexpr 427
 - \multiply 79
 - \muskip 375
 - \muskip_add:Nn
. 65, 3428, 3430, 3431, 6266, 6274
 - \muskip_gadd:Nn 65, 3428, 3431, 6270, 6278
 - \muskip_gset:Nn 65, 3428, 3429, 6262
 - \muskip_gsub:Nn 65, 3428, 3433
 - \muskip_new:N
. 65, 3417, 3419, 3423, 6184–6186
 - \muskip_new_l:N 3420
 - \muskip_set:Nn 65, 3428, 3428, 3429, 6258
 - \muskip_sub:Nn 65, 3428, 3432, 3433
 - \muskip_use:N 65, 3434, 3434
 - \muskipdef 73
 - \mutoglu 433
- N
- \n 2364
 - \name_pop_stack:w 694, 705, 724
 - \name_primitive:NN
57, 61–451, 453–473, 475–481, 483–
486, 488–509, 511–522, 524–554, 557
 - \name_tmp: 724
 - \name_undefine:N 43, 49, 52, 59, 693
 - \NeedsTeXFormat 716
 - \newbox 5310
 - \newcount 2703
 - \newdimen 3365
 - \newif 6582
 - \newlinechar 129
 - \newmuskip 3425
 - \newread 4832
 - \newskip 3249
 - \newtoks 4076
 - \newwrite 4782
 - \noalign 97
 - \noboundary 232
 - \noexpand 32, 90
 - \noindent 258
 - \nolimits 212
 - \nonscript 192
 - \nonstopmode 155
 - \nulldelimiterspace 225
 - \nullfont 343
 - \num_add:cn 55, 3062
 - \num_add:Nn 55, 3038, 3039, 3062, 3062–3064
 - \num_decr:c 54, 3042
 - \num_decr:N 54, 3038, 3039, 3043
 - \num_elt_count:n 56, 3070, 3070, 3885, 3891
 - \num_elt_count_prop:Nn 56, 3070, 3071
 - \num_gadd:cn 55, 3062
 - \num_gadd:Nn 55, 3040, 3041, 3062, 3064, 3065
 - \num_gdecr:c 54, 3042
 - \num_gdecr:N
54, 3038, 3041, 3045, 3848, 3857, 4763
 - \num_gincr:c 54, 3042
 - \num_gincr:N
54, 3038, 3040, 3044, 3842, 3851, 4758

- \num_gset:cn 55, 3052
 - \num_gset:Nn ... 55, 3047, 3052, 3056, 3057
 - \num_gset_eq:cc 55, 3060
 - \num_gset_eq:cN 55, 3060
 - \num_gset_eq:Nc 55, 3060
 - \num_gset_eq:NN 55, 3060, 3060, 3061
 - \num_gzero:c 55, 3046
 - \num_gzero:N 55, 3046, 3047, 3049
 - \num_incr:c 54, 3042
 - \num_incr:N 54, 3038, 3038, 3042
 - \num_new:c 54, 3050
 - \num_new:N 54, 3050, 3050, 3051, 3072–3076, 4756
 - \num_set:cn 55, 3052, 5804
 - \num_set:Nn 55, 3046, 3052, 3052, 3055, 3056, 3062
 - \num_set_eq:cc 55, 3058
 - \num_set_eq:cN 55, 3058
 - \num_set_eq:Nc 55, 3058
 - \num_set_eq:NN 55, 3058, 3058, 3059
 - \num_show:c 55, 3068, 3069
 - \num_show:N 55, 3068, 3068
 - \num_use:c 55, 3066, 3067, 5879
 - \num_use:N 55, 3066, 3066, 3843, 3846, 3852, 3855, 4759, 4762
 - \num_zero:c 55, 3046
 - \num_zero:N 55, 3046, 3046, 3048
 - \number 352, 5512
 - \numexpr 424
- O**
- \O 2368, 2459
 - \omit 98
 - \openin 124
 - \openout 125
 - \or 121
 - \or: 8, 56, 59, 756, 758, 857, 1300, 1302, 1304, 1306, 1308, 1310, 1312, 1314, 1316, 2823–2827, 2832–2836, 2860–2868, 2873–2881, 2991–2999, 6370–6372, 6379–6381, 6396–6398, 6405–6407, 6453–6455, 6465–6467, 6491, 6497
 - \outer 84
 - \output 299
 - \outputpenalty 309
 - \over 186
 - \overfullrule 337
 - \overline 217
 - \overwithdelims 187
- P**
- \P 2368
 - \package_check_loaded_expl: 726, 752, 1439, 1686, 2069, 2172, 2689, 3033, 3082, 3238, 3439, 4068, 4221, 4394, 4632, 4774, 4858, 5298, 5432, 5545, 5714, 6168, 6644
 - \package_provides:w 699, 700
 - \PackageError 16, 728, 6527
 - \pagedepth 301
 - \pagediscards 442
 - \pagefillstretch 305
 - \pagefillstretch 304
 - \pagefilstretch 303
 - \pagegoal 307
 - \pagenumbering 5519, 5527
 - \pageshrink 306
 - \pagestretch 302
 - \pagetotal 308
 - \par 257, 692
 - \parfillskip 288
 - \parindent 281
 - \parshape 273
 - \parshapedimen 423
 - \parshapeindent 421
 - \parshapelength 422
 - \parskip 280
 - \patterns 363
 - \pausing 150
 - \pdf_adjustspacing:D 461
 - \pdf_annot:D 530
 - \pdf_catalog:D 540
 - \pdf_compresslevel:D 455
 - \pdf_creationdate:D 490
 - \pdf_decimaldigits:D 456
 - \pdf_dest:D 534
 - \pdf_destmargin:D 480
 - \pdf_efcode:D 463
 - \pdf_elapsedtime:D 520
 - \pdf_endlink:D 532
 - \pdf_endthread:D 537
 - \pdf_escapehex:D 501
 - \pdf_escapename:D 500
 - \pdf_escapestring:D 499
 - \pdf_dump:D 509
 - \pdf_filemoddate:D 507
 - \pdf_filesize:D 508
 - \pdf_fontattr:D 544
 - \pdf_fontexpand:D 546
 - \pdf_fontname:D 493
 - \pdf_fontobjnum:D 494
 - \pdf_fontsize:D 495
 - \pdf_forcepagebox:D 466
 - \pdf_gamma:D 472
 - \pdf_horigin:D 475
 - \pdf_imageapplygamma:D 471

<code>\pdf_imagegamma:D</code>	473	<code>\pdf_texversion:D</code>	511
<code>\pdf_imagehicolor:D</code>	470	<code>\pdf_thread:D</code>	535
<code>\pdf_imageresolution:D</code>	457	<code>\pdf_threadmargin:D</code>	481
<code>\pdf_includechars:D</code>	496	<code>\pdf_tracingfonts:D</code>	459
<code>\pdf_inclusionerrorlevel:D</code>	468	<code>\pdf_trailer:D</code>	545
<code>\pdf_info:D</code>	539	<code>\pdf_unescapehex:D</code>	502
<code>\pdf_lastannot:D</code>	516	<code>\pdf_uniformdeviate:D</code>	504
<code>\pdf_lastdemerits:D</code>	519	<code>\pdf_uniqueresname:D</code>	460
<code>\pdf_lastobj:D</code>	512	<code>\pdf_vorigin:D</code>	476
<code>\pdf_lastxform:D</code>	513	<code>\pdf_xform:D</code>	526
<code>\pdf_lastximage:D</code>	514	<code>\pdf_xformname:D</code>	492
<code>\pdf_lastximagepages:D</code>	515	<code>\pdf_ximage:D</code>	528
<code>\pdf_lastxpos:D</code>	517	<code>\pdfadjustspacing</code>	461
<code>\pdf_lastypos:D</code>	518	<code>\pdfannot</code>	530
<code>\pdf_leftmarginkern:D</code>	497	<code>\pdfcatalog</code>	540
<code>\pdf_linkmargin:D</code>	479	<code>\pdfcompresslevel</code>	455
<code>\pdf_literal:D</code>	548	<code>\pdfcreationdate</code>	490
<code>\pdf_lpcode:D</code>	464	<code>\pdfdecimaldigits</code>	456
<code>\pdf_mapfile:D</code>	542	<code>\pdfdest</code>	534
<code>\pdf_mapline:D</code>	543	<code>\pdfdestmargin</code>	480
<code>\pdf_mdffivesum:D</code>	506	<code>\pdfelapsedtime</code>	520
<code>\pdf_minorversion:D</code>	454	<code>\pdfendlink</code>	532
<code>\pdf_names:D</code>	541	<code>\pdfendthread</code>	537
<code>\pdf_noligatures:D</code>	552	<code>\pdfescapehex</code>	501
<code>\pdf_normaldeviate:D</code>	505	<code>\pdfescapename</code>	500
<code>\pdf_obj:D</code>	524	<code>\pdfescapestring</code>	499
<code>\pdf_optionalwaysusepdfpagebox:D</code> ..	467	<code>\pdffiledump</code>	509
<code>\pdf_optionpdfinclusionerrorlevel:D</code> ..	469	<code>\pdffilemoddate</code>	507
<code>\pdf_outline:D</code>	533	<code>\pdffilesize</code>	508
<code>\pdf_output:D</code>	453	<code>\pdffontattr</code>	544
<code>\pdf_pageattr:D</code>	484	<code>\pdffontexpand</code>	546
<code>\pdf_pageheight:D</code>	478	<code>\pdffontname</code>	493
<code>\pdf_pageref:D</code>	491	<code>\pdffontobjnum</code>	494
<code>\pdf_pageresources:D</code>	485	<code>\pdffontsize</code>	495
<code>\pdf_pagesattr:D</code>	483	<code>\pdfforcepagebox</code>	466
<code>\pdf_pagewidth:D</code>	477	<code>\pdfgamma</code>	472
<code>\pdf_pkmode:D</code>	486	<code>\pdfhorigin</code>	475
<code>\pdf_pkresolution:D</code>	458	<code>\pdfimageapplygamma</code>	471
<code>\pdf_protrudechars:D</code>	462	<code>\pdfimagegamma</code>	473
<code>\pdf_randomseed:D</code>	521	<code>\pdfimagehicolor</code>	470
<code>\pdf_refobj:D</code>	525	<code>\pdfimageresolution</code>	457
<code>\pdf_refxform:D</code>	527	<code>\pdfincludechars</code>	496
<code>\pdf_refximage:D</code>	529	<code>\pdfinclusionerrorlevel</code>	468
<code>\pdf_resettimer:D</code>	550	<code>\pdfinfo</code>	539
<code>\pdf_rightmarginkern:D</code>	498	<code>\pdflastannot</code>	516
<code>\pdf_rpcode:D</code>	465	<code>\pdflastdemerits</code>	519
<code>\pdf_savepos:D</code>	538	<code>\pdflastobj</code>	512
<code>\pdf_setrandomseed:D</code>	551	<code>\pdflastxform</code>	513
<code>\pdf_shellescape:D</code>	522	<code>\pdflastximage</code>	514
<code>\pdf_startlink:D</code>	531	<code>\pdflastximagepages</code>	515
<code>\pdf_startthread:D</code>	536	<code>\pdflastxpos</code>	517
<code>\pdf_strcmp:D</code> .. 503, 557, 2118, 2140, 3667		<code>\pdflastypos</code>	518
<code>\pdf_textrbanner:D</code>	489	<code>\pdflinkmargin</code>	479
<code>\pdf_textrrevision:D</code>	488	<code>\pdfliteral</code>	548

<code>\pdfmapfile</code>	542	<code>\peek_charcode_ignore_spaces:NTF</code> ...	
<code>\pdfmapline</code>	543	.....	48, 2657
<code>\pdfmdfivesum</code>	506	<code>\peek_charcode_remove:NTF</code>	48, 2662
<code>\pdfminorversion</code>	454	<code>\peek_charcode_remove_ignore_spaces:NTF</code>	
<code>\pdfnames</code>	541	.....	48, 2667
<code>\pdfnoligatures</code>	552	<code>\peek_def_aux:nnnn</code>	2598, 2598,
<code>\pdfnormaldeviate</code>	505	2612, 2617, 2622, 2627, 2632, 2637,	
<code>\pdfobj</code>	524	2642, 2647, 2652, 2657, 2662, 2667	
<code>\pdfoptionalwaysusepdfpagebox</code>	467	<code>\peek_def_aux_ii:nnnnn</code>	
<code>\pdfoptionpdfinclusionerrorlevel</code> ..	469	.....	2598, 2599–2601, 2603
<code>\pdfoutline</code>	533	<code>\peek_execute_branches:</code>	2606, 2680
<code>\pdfoutput</code>	453	<code>\peek_execute_branches_catcode:</code>	
<code>\pdfpageattr</code>	484	49, 2568, 2575, 2636, 2639, 2646, 2649	
<code>\pdfpageheight</code>	478	<code>\peek_execute_branches_charcode:</code> ...	
<code>\pdfpageref</code>	491	49, 2568, 2582, 2656, 2659, 2666, 2669	
<code>\pdfpageresources</code>	485	<code>\peek_execute_branches_charcode_aux:NN</code>	
<code>\pdfpagesattr</code>	483	.....	2568, 2588, 2590
<code>\pdfpagewidth</code>	477	<code>\peek_execute_branches_meaning:</code>	
<code>\pdfpkmode</code>	486	49, 2568, 2568, 2616, 2619, 2626, 2629	
<code>\pdfpkresolution</code>	458	<code>\peek_gafter:NN</code>	48, 2527, 2528
<code>\pdfprotrudechars</code>	462	<code>\peek_ignore_spaces_aux:</code>	
<code>\pdfrandomseed</code>	521	.....	193, 2672, 2672, 2677
<code>\pdfrefobj</code>	525	<code>\peek_ignore_spaces_execute_branches:</code>	
<code>\pdfrefxform</code>	527	.....	193, 2621, 2631, 2641,
<code>\pdfrefximage</code>	529	2651, 2661, 2671, 2672, 2673, 2675	
<code>\pdfresettimer</code>	550	<code>\peek_meaning:NTF</code>	48, 2612
<code>\pdfsavepos</code>	538	<code>\peek_meaning_ignore_spaces:NTF</code> 48, 2617	
<code>\pdfsetrandomseed</code>	551	<code>\peek_meaning_remove:NTF</code>	48, 2622
<code>\pdfshellescape</code>	522	<code>\peek_meaning_remove_ignore_spaces:NTF</code>	
<code>\pdfstartlink</code>	531	.....	48, 2627
<code>\pdfstartthread</code>	536	<code>\peek_tmp:w</code> ... 193, 2533, 2533, 2566, 2678	
<code>\pdfstrcmp</code>	503	<code>\peek_token_generic:NNF</code>	2546
<code>\pdftexbanner</code>	489	<code>\peek_token_generic:NNT</code>	2543
<code>\pdftexrevision</code>	488	<code>\peek_token_generic:NNTF</code>	
<code>\pdftexversion</code>	511	.....	49, 2535, 2535, 2544, 2547
<code>\pdfthread</code>	535	<code>\peek_token_remove_generic:NNF</code> ..	2561
<code>\pdfthreadmargin</code>	481	<code>\peek_token_remove_generic:NNT</code> ..	2558
<code>\pdftracingfonts</code>	459	<code>\peek_token_remove_generic:NNTF</code>	
<code>\pdftrailer</code>	545	.....	49, 2549, 2549, 2559, 2562
<code>\pdfunescapehex</code>	502	<code>\penalty</code>	358
<code>\pdfuniformdeviate</code>	504	<code>\postdisplaypenalty</code>	205
<code>\pdfuniqueresname</code>	460	<code>\predisplaydirection</code>	449
<code>\pdfvorigin</code>	476	<code>\predisdisplaypenalty</code>	204
<code>\pdfxform</code>	526	<code>\predisplaysize</code>	203
<code>\pdfxformname</code>	492	<code>\pref_global:D</code>	22, 791,
<code>\pdfximage</code>	528	791, 1240, 1246, 2225, 2529, 2716,	
<code>\peek_after:NN</code>		2734, 2740, 2752, 2770, 2776, 3056,	
.... 48, 2527, 2527, 2541, 2556, 2673		3064, 3263, 3278, 3300, 3308, 3371,	
<code>\peek_catcode:NTF</code>	48, 2632	3375, 3381, 3385, 3429, 3431, 3433,	
<code>\peek_catcode_ignore_spaces:NTF</code> 48, 2637		3613, 4098, 4099, 4110, 4115, 4125,	
<code>\peek_catcode_remove:NTF</code>	48, 2642	4135, 4149, 4163, 4316, 4325, 4848,	
<code>\peek_catcode_remove_ignore_spaces:NTF</code>		5340, 5345, 5353, 5375, 5381, 5387,	
..... 48, 2647		5401, 5407, 5415, 6198, 6301, 6304,	
<code>\peek_charcode:NTF</code>	48, 2652	6305, 6360, 6488, 6494, 6500, 6506	

- \pref_global_chk:
 ... 2714, 2732, 2738, 2768, 2774,
 3261, 3276, 3298, 3306, 3611, 4124,
 4134, 4148, 4162, 4313, 4322, 4847
- \pref_long:D 22, 791, 792,
 797, 800, 809, 812, 817, 820, 829, 832
- \pref_protected:D
 . 22, 791, 793, 796, 799, 802, 803,
 805, 806, 809, 812, 823, 826, 829, 832
- \pretolerance 284
- \prevdepth 331
- \prevgraf 290
- \prg_case_dim:nnn 35, 1953, 1953
- \prg_case_dim_aux:nnn
 1953, 1954, 1957, 1961
- \prg_case_int:nnn 35, 1943, 1943
- \prg_case_int_aux:nnn
 1943, 1944, 1947, 1951
- \prg_case_str:nnn 35, 1963, 1963
- \prg_case_str_aux:nnn
 1963, 1964, 1967, 1971
- \prg_case_tl:Nnn 35, 1973, 1973
- \prg_case_tl_aux:NNn 1973, 1974, 1977, 1981
- \prg_conditional_form_F:nnn 998
- \prg_conditional_form_p:nnn 995
- \prg_conditional_form_T:nnn 997
- \prg_conditional_form_TF:nnn 996
- \prg_define_quicksort:nnn 1984, 1984, 2059
- \prg_do_nothing: 14, 1277, 1277, 3978,
 3982, 3998, 4001, 4085, 4114, 6316
- \prg_end_case:nw
 .. 1950, 1960, 1970, 1980, 1983, 1983
- \prg_generate_conditional_aux:nnNNnnnn
 873,
 879, 885, 891, 897, 903, 910, 917, 929
- \prg_generate_conditional_aux:nw ..
 930, 934, 939
- \prg_generate_conditional_parm_aux:nnNNnnnn
 929
- \prg_generate_conditional_parm_aux:nw
 929
- \prg_generate_F_form_count:Nnnnn ...
 961, 976
- \prg_generate_F_form_parm:Nnnnn 941, 956
- \prg_generate_p_form_count:Nnnnn ...
 961, 961
- \prg_generate_p_form_parm:Nnnnn 941, 941
- \prg_generate_T_form_count:Nnnnn ...
 961, 971
- \prg_generate_T_form_parm:Nnnnn 941, 951
- \prg_generate_TF_form_count:Nnnnn ..
 961, 966
- \prg_generate_TF_form_parm:Nnnnn ...
 941, 946
- \prg_get_count_aux:nn
 896, 902, 909, 916, 927, 927
- \prg_get_parm_aux:nw
 872, 878, 884, 890, 927, 928
- \prg_new_conditional:Nnn 31,
 895, 901, 1689, 2111, 2117, 2126,
 2135, 2139, 2148, 2287, 2291, 2295,
 2299, 2303, 2307, 2311, 2315, 2319,
 2323, 2327, 2331, 2335, 2339, 2343,
 2350, 2353, 2372, 2379, 2386, 2397,
 2408, 2419, 2430, 2437, 2444, 2484,
 3339, 3401, 4190, 4197, 4256, 4436,
 4735, 4839, 5317, 5320, 5331, 6653
- \prg_new_conditional:Npnn
 .. 31, 871, 877, 1260, 1689, 3634,
 3641, 3653, 3709, 4035, 4039, 4057
- \prg_new_eq_conditional:NNn
 .. 31, 921, 924, 1689, 4248, 4249,
 4424, 4425, 4432-4435, 4729-4734
- \prg_new_protected_conditional:Nnn ..
 31, 895, 915, 1689
- \prg_new_protected_conditional:Npnn
 31, 871, 889, 1689, 3948, 3957
- \prg_quicksort:n 38, 2059
- \prg_quicksort_compare:nnTF
 38, 2060, 2061
- \prg_quicksort_function:n 38, 2060, 2060
- \prg_replicate:nn 37, 1718, 1718
- \prg_replicate_ 1730
- \prg_replicate_aux:N 1718, 1724, 1725, 1728
- \prg_replicate_first_aux:N
 1718, 1720, 1727
- \prg_return_false:
 .. 31, 869, 870, 1039, 1044, 1056,
 1061, 1079, 1082, 1139, 1141, 1158,
 1262, 1271, 1275, 1418, 1689, 1691,
 1695, 1699, 1703, 1852, 1929, 2113,
 2121, 2131, 2136, 2143, 2153, 2289,
 2293, 2297, 2301, 2305, 2309, 2313,
 2317, 2321, 2325, 2329, 2333, 2337,
 2341, 2348, 2352, 2356, 2358, 2377,
 2384, 2388, 2395, 2399, 2406, 2417,
 2421, 2428, 2435, 2442, 2450, 2487,
 2494, 2499, 2506, 2508, 2510, 2512,
 2514, 3110, 3114, 3118, 3122, 3126,
 3130, 3134, 3139, 3204, 3208, 3343,
 3403, 3628, 3635, 3643, 3657, 3713,
 3727, 3734, 3741, 3748, 3755, 3762,
 3769, 3776, 3783, 3790, 3797, 3804,
 3811, 3818, 3950, 3959, 4037, 4042,
 4060, 4191, 4199, 4259, 4439, 4739,
 4840, 5318, 5321, 5332, 5894, 6683
- \prg_return_true: 31, 869, 869, 1042,
 1058, 1077, 1138, 1158, 1262, 1270,

- 1274, 1418, [1689](#), 1691, 1695, 1699,
 1703, 1852, 1929, 2113, 2121, 2131,
 2136, 2143, 2153, 2289, 2293, 2297,
 2301, 2305, 2309, 2313, 2317, 2321,
 2325, 2329, 2333, 2337, 2341, 2348,
 2352, 2356, 2377, 2384, 2395, 2406,
 2417, 2428, 2435, 2442, 2450, 2516,
 3110, 3114, 3118, 3122, 3126, 3130,
 3134, 3139, 3204, 3208, 3343, 3403,
 3628, 3635, 3643, 3657, 3713, 3727,
 3734, 3741, 3748, 3755, 3762, 3769,
 3776, 3783, 3790, 3797, 3804, 3811,
 3818, 3950, 3959, 4037, 4042, 4060,
 4191, 4199, 4259, 4439, 4739, 4840,
 5318, 5321, 5332, 5892, 6659, [6681](#)
 \prg_set_conditional:Nnn
 [31](#), [895](#), [895](#), [1689](#), [5890](#)
 \prg_set_conditional:Npnn
 .. [31](#), [871](#), [871](#), [1037](#), [1048](#), [1069](#),
 [1133](#), [1142](#), [1150](#), [1269](#), [1273](#), [1416](#),
 [1689](#), [1689](#), [1693](#), [1697](#), [1701](#), [1851](#),
 [1927](#), [3094](#), [3136](#), [3202](#), [3206](#), [3626](#)
 \prg_set_eq_conditional:Nnn
 [31](#), [921](#), [921](#), [1689](#)
 \prg_set_eq_conditional_aux:NNNn ...
 [922](#), [925](#), [981](#), [981](#)
 \prg_set_eq_conditional_aux:NNNw ...
 [981](#), [982](#), [984](#), [993](#)
 \prg_set_protected_conditional:Nnn .
 [31](#), [895](#), [908](#), [1689](#)
 \prg_set_protected_conditional:Npnn
 .. [31](#), [871](#), [883](#), [1689](#), [3723](#), [3730](#),
 [3737](#), [3744](#), [3751](#), [3758](#), [3765](#), [3772](#),
 [3779](#), [3786](#), [3793](#), [3800](#), [3807](#), [3814](#)
 \prg_stepwise_function:nnnN
 [37](#), [1758](#), [1758](#)
 \prg_stepwise_function_decr:nnnN ...
 [1758](#), [1760](#), [1773](#), [1777](#)
 \prg_stepwise_function_incr:nnnN ...
 [1758](#), [1761](#), [1764](#), [1768](#)
 \prg_stepwise_inline:nnnn [37](#), [1782](#), [1783](#)
 \prg_stepwise_inline_decr:Nnnn
 [1787](#), [1801](#), [1805](#)
 \prg_stepwise_inline_decr:nnnn .. [1782](#)
 \prg_stepwise_inline_incr:Nnnn
 [1788](#), [1793](#), [1797](#)
 \prg_stepwise_inline_incr:nnnn .. [1782](#)
 \prg_stepwise_variable:nnnN
 [37](#), [1809](#), [1809](#)
 \prg_stepwise_variable_decr:nnnN ..
 [1809](#), [1811](#), [1823](#), [1827](#)
 \prg_stepwise_variable_incr:nnnN ..
 [1809](#), [1812](#), [1815](#), [1819](#)
 \ProcessOptions [54](#)
 \prop_clear:c [91](#), [4638](#), [4639](#), [5057](#)
 \prop_clear:N [91](#), [4638](#), [4638](#), [4694](#)
 \prop_del:Nn [92](#), [4714](#), [4714](#)
 \prop_del_aux:w [94](#), [4714](#), [4715](#), [4717](#), [4718](#)
 \prop_display:c [93](#), [4652](#)
 \prop_display:N [93](#), [4652](#), [4652](#), [4668](#)
 \prop_gclear:c [91](#), [4638](#), [4641](#)
 \prop_gclear:N [91](#), [4638](#), [4640](#), [4700](#)
 \prop_gdel:Nn [92](#), [4714](#), [4716](#)
 \prop_get:cnN [92](#), [4675](#), [5114](#)
 \prop_get:NnN [92](#), [4675](#), [4675](#), [4679](#)
 \prop_get_aux:w [94](#), [4675](#), [4676](#), [4678](#)
 \prop_get_del_aux:w . [94](#), [4684](#), [4685](#), [4686](#)
 \prop_get_gdel:NnN [92](#), [4684](#), [4684](#)
 \prop_gget:cnN [92](#), [4680](#)
 \prop_gget:NnN [92](#), [4680](#), [4680](#), [4683](#)
 \prop_gget_aux:w ... [94](#), [4680](#), [4681](#), [4682](#)
 \prop_gput:ccx [91](#), [4692](#), [5440](#)
 \prop_gput:cnn [91](#), [4692](#)
 \prop_gput:Nnn [91](#), [4692](#), [4698](#), [4713](#)
 \prop_gput:Nno [91](#), [4692](#)
 \prop_gput:NnV [91](#), [4692](#)
 \prop_gput:Nnx [91](#), [4692](#)
 \prop_gput_if_new:Nnn ... [91](#), [4725](#), [4725](#)
 \prop_gset_eq:cc [92](#), [4642](#), [4649](#)
 \prop_gset_eq:cN [92](#), [4642](#), [4648](#)
 \prop_gset_eq:Nc [92](#), [4642](#), [4647](#)
 \prop_gset_eq:NN [92](#), [4642](#), [4646](#)
 \prop_if_empty:c [4730](#)
 \prop_if_empty:cTF [93](#), [4729](#)
 \prop_if_empty:N [4729](#)
 \prop_if_empty:NTF [93](#), [4729](#)
 \prop_if_empty_p:c [93](#), [4729](#)
 \prop_if_empty_p:N [93](#), [4729](#)
 \prop_if_eq:cc [4734](#)
 \prop_if_eq:ccTF [93](#), [4731](#)
 \prop_if_eq:cN [4732](#)
 \prop_if_eq:cNTF [93](#), [4731](#)
 \prop_if_eq:Nc [4733](#)
 \prop_if_eq:NcTF [93](#), [4731](#)
 \prop_if_eq:NN [4731](#)
 \prop_if_eq:NNTF [93](#), [4731](#)
 \prop_if_eq_p:cc [93](#), [4731](#)
 \prop_if_eq_p:cN [93](#), [4731](#)
 \prop_if_eq_p:Nc [93](#), [4731](#)
 \prop_if_eq_p:NN [93](#), [4731](#)
 \prop_if_in:ccTF [93](#), [4735](#)
 \prop_if_in:cnTF ... [93](#), [4735](#), [5103](#), [5106](#)
 \prop_if_in:Nn [4735](#)
 \prop_if_in:NnF [4743](#)
 \prop_if_in:NnT [4742](#)
 \prop_if_in:NnTF ... [93](#), [4735](#), [4741](#), [5096](#)
 \prop_if_in:NoTF [93](#), [4735](#)
 \prop_if_in:NVTF [93](#), [4735](#)

- \prop_if_in_aux:w .. 94, 4735, 4736, 4738
 - \prop_map_break: ... 92, 4750, 4766, 4766
 - \prop_map_function:cc 92, 4744
 - \prop_map_function:cN 92, 4744
 - \prop_map_function:Nc ... 92, 4744, 4761
 - \prop_map_function:NN 92, 4744, 4744, 4755
 - \prop_map_function_aux:w
 - 94, 4744, 4745, 4748, 4753
 - \prop_map_inline:cn 92, 4756
 - \prop_map_inline:Nn
 - 92, 4656, 4756, 4757, 4765
 - \prop_new:c 91, 4636, 4637, 5053, 5474
 - \prop_new:N
 - 91, 4636, 4636, 4906, 4907, 5435, 5436
 - \prop_put:cn 91, 4692, 5181, 5184
 - \prop_put:Nnn .. 91, 4692, 4692, 4712, 5187
 - \prop_put:NnV 91, 4692
 - \prop_put:NVn 91, 4692
 - \prop_put:NVV 91, 4692
 - \prop_put_aux:w 94, 4692, 4695, 4701, 4704
 - \prop_put_if_new_aux:w 94, 4725, 4726, 4727
 - \prop_set_eq:cc 92, 4642, 4645
 - \prop_set_eq:cN 92, 4642, 4644
 - \prop_set_eq:Nc 92, 4642, 4643
 - \prop_set_eq:NN 92, 4642, 4642
 - \prop_show:c 93, 4650, 4651
 - \prop_show:N 93, 4650, 4650
 - \prop_split_aux:Nnn
 - . 94, 4669, 4669, 4676, 4681, 4685,
 - 4693, 4699, 4715, 4717, 4726, 4736
 - \prop_tmp:w 4670, 4673,
 - 4689, 4690, 4708, 4709, 4719–4722
 - \protect 730
 - \protected 451
 - \ProvidesClass 657
 - \ProvidesExplClass 5, 651, 656
 - \ProvidesExplPackage 5,
 - 651, 652, 750, 1437, 1684, 2067,
 - 2170, 2687, 3031, 3080, 3236, 3437,
 - 4066, 4219, 4392, 4630, 4772, 4856,
 - 5296, 5430, 5543, 5712, 6166, 6642
 - \ProvidesPackage 653, 696
- Q**
- \Q 5570
 - \q 1016, 1721, 1894
 - \q_error 40, 2076, 2076
 - \q_keys_stop 119, 5731, 5731,
 - 5732, 5849, 5859, 5861, 5881, 5884
 - \q_mark 40, 2076, 2077, 4143
 - \q_nil 40, 672, 676, 849,
 - 852, 1002, 1008, 1016, 1018, 1025,
 - 1027, 1289, 1293, 1906, 1908, 1987,
 - 1991, 2073, 2075, 2082, 2094, 2110,
 - 2136, 2141, 2151, 2344, 2346, 2374,
 - 2376, 2381, 2383, 2391, 2394, 2402,
 - 2405, 2413, 2416, 2424, 2427, 2432,
 - 2434, 2439, 2441, 2446, 2449, 2462,
 - 2468, 2474, 2480, 3008, 3100, 3108,
 - 3112, 3116, 3120, 3124, 3128, 3132,
 - 3642, 3654, 3656, 4023, 4025, 4027,
 - 4031, 4032, 4036, 4041, 4045, 4059,
 - 4340, 4420, 4463, 4470, 4746, 4749,
 - 5451, 5458, 5571, 5578, 5586, 5596,
 - 5601, 5609, 5616, 5626, 5632, 5633,
 - 5643, 5649, 5654, 5667, 5672, 5676,
 - 5679, 6018, 6020, 6031, 6033, 6037
 - \q_no_value 40, 1906, 2073,
 - 2074, 2112, 2119, 2129, 3952, 3961,
 - 3975, 3983, 4002, 4258, 4261, 4438,
 - 4441, 4673, 4689, 4708, 4721, 4746,
 - 5608, 5616, 5622, 5627, 5643, 5650
 - \q_prop 93, 4635, 4635,
 - 4670, 4673, 4689, 4705, 4708, 4721,
 - 4728, 4746, 4748, 5447, 5449, 5466
 - \q_recursion_stop
 - 40, 851, 854, 932, 982, 1602,
 - 1945, 1955, 1965, 1975, 1983, 2078,
 - 2079, 3830, 3834, 3847, 3856, 3862,
 - 3873, 4512, 4518, 4535, 4547, 4554
 - \q_recursion_tail
 - 40, 1945, 1955, 1965, 1975,
 - 2078, 2078, 2082, 2087, 2094, 2102,
 - 2110, 3830, 3834, 3847, 3856, 3862,
 - 3873, 4512, 4518, 4535, 4547, 4554
 - \q_stop 40, 850, 853, 1987,
 - 1991, 2053, 2073, 2073, 3096, 3098,
 - 3100, 3102, 3949, 3952, 3958, 3961,
 - 3971, 3983, 3991, 3998, 4002, 4144,
 - 4153, 4257, 4261, 4268, 4270, 4276,
 - 4279, 4301, 4303, 4340, 4437, 4441,
 - 4457, 4459, 4463, 4465, 4670, 4673,
 - 4746, 5578, 5644, 5925, 5927, 5932
 - \quark_if_nil:N 2135
 - \quark_if_nil:n 2139, 2148
 - \quark_if_nil:NF 4418
 - \quark_if_nil:nF 2160, 2164
 - \quark_if_nil:NT 4334
 - \quark_if_nil:nT . 1994, 1998, 2159, 2163
 - \quark_if_nil:NTF 39, 2135, 3011, 4468, 5662
 - \quark_if_nil:nTF 39, 2002,
 - 2011, 2020, 2029, 2138, 2158, 2162
 - \quark_if_nil:oF 5624
 - \quark_if_nil:oTF 39, 2138
 - \quark_if_nil:VTF 39, 2138
 - \quark_if_nil_p:N 39, 2135
 - \quark_if_nil_p:n .. 39, 2138, 2157, 2161
 - \quark_if_nil_p:o 39, 2138

- \quark_if_nil_p:V 39, 2138
 \quark_if_no_value:N 2111
 \quark_if_no_value:n 2117, 2126
 \quark_if_no_value:NF 4688, 4720
 \quark_if_no_value:nF 3972
 \quark_if_no_value:NTF .. 39, 1909, 2111
 \quark_if_no_value:nTF
 39, 2111, 3950, 3959, 3992, 4739
 \quark_if_no_value_p:N 39, 2111
 \quark_if_no_value_p:n 39, 2111
 \quark_if_recursion_tail_aux:w
 2082, 2094, 2110, 2110
 \quark_if_recursion_tail_stop:N
 40, 2080, 2086, 3868, 4561
 \quark_if_recursion_tail_stop:n
 40, 2080, 2080, 2091, 3837, 4522
 \quark_if_recursion_tail_stop:o 40, 2080
 \quark_if_recursion_tail_stop_do:Nn
 40, 1978, 2092, 2101
 \quark_if_recursion_tail_stop_do:nn
 40, 1948,
 1958, 1968, 2092, 2092, 2109, 3876
 \quark_if_recursion_tail_stop_do:on
 40, 2092
 \quark_new:N 39, 2072, 2072–2079, 4635, 5731
- R**
- \R 2368, 2458
 \radical 179
 \raise 319
 \ratio 120, 6193, 6570, 6574
 \read 126
 \readline 401
 \real 120, 6192, 6570, 6575
 \relax 11, 23, 26–31, 34–39, 161, 705
 \relpenalty 222
 \RequirePackage 717
 \reverse_if:N 8, 756, 761
 \right 220
 \righthyphenmin 276
 \rightmarginkern 498
 \rightskip 278
 \romannumeral 353
 \rpcode 465
- S**
- \S 2368
 \savinghyphcodes 440
 \savingvdiscards 441
 \scan_align_safe_stop: 37, 1702, 1708, 1708
 \scan_stop: 23, 737,
 787, 787, 985, 1010, 1134, 1138,
 1139, 1147, 1149, 1151, 1154, 1158,
 1714, 2351, 2469, 2475, 2481, 2905,
 2906, 2923, 3077, 3269, 3321, 3353,
 3354, 3378, 3383, 3399, 3428, 3430,
 3432, 3897–3900, 4205, 4447, 4787,
 4835, 4836, 4987, 5372, 5398, 6314,
 6374, 6383, 6400, 6409, 6457, 6472
 \scantokens 399
 \scriptfont 345
 \scriptscriptfont 346
 \scriptscriptstyle 191
 \scriptspace 231
 \scriptstyle 190
 \scrollmode 156
 \secondoftwo 4, 12
 \seq_clear:c 80, 4228, 4229
 \seq_clear:N 80, 4228, 4228, 4360
 \seq_clear_new:c 80, 4232, 4233
 \seq_clear_new:N 80, 4232, 4232
 \seq_display:c 82, 4285
 \seq_display:N 82, 4285, 4285, 4299
 \seq_elt:w 83, 4223, 4224, 4257,
 4261, 4270, 4279, 4305, 4309, 4332,
 4340, 4347, 4349, 4353, 4355, 4416
 \seq_elt_end: 83, 4223,
 4225, 4257, 4261, 4270, 4279, 4305,
 4309, 4332, 4340, 4347, 4353, 4416
 \seq_gclear:c 80, 4228, 4231
 \seq_gclear:N 80, 4228, 4230
 \seq_gclear_new:c 80, 4232, 4235
 \seq_gclear_new:N 80, 4232, 4234
 \seq_gconcat:ccc 80, 4244
 \seq_gconcat:NNN ... 80, 4244, 4244, 4247
 \seq_get:cN 81, 4266, 4386
 \seq_get:NN 81, 4266, 4266, 4273, 4385
 \seq_get_aux:w 83, 4266, 4268, 4270
 \seq_gpop:cN 84, 4381
 \seq_gpop:NN 84, 4381, 4382, 4384
 \seq_gpush:cn 84, 4381
 \seq_gpush:Nn 84, 4381, 4381, 4383
 \seq_gpush:No 84, 4381
 \seq_gpush:Nv 84, 4381
 \seq_gput_left:cn 81, 4311
 \seq_gput_left:co 81, 4311
 \seq_gput_left:cV 81, 4311
 \seq_gput_left:Nn 81, 4311, 4311, 4329, 4381
 \seq_gput_left:No 81, 4311
 \seq_gput_left:Nv 81, 4311
 \seq_gput_left:Nx 81, 4311
 \seq_gput_right:cn 81, 4311
 \seq_gput_right:co 81, 4311
 \seq_gput_right:cV 81, 4311
 \seq_gput_right:Nc 81, 4331
 \seq_gput_right:Nn
 81, 4311, 4320, 4330, 4331

<code>\seq_gput_right:No</code>	81, 4311	<code>\seq_put_left:Nv</code>	80, 4304 , 4376
<code>\seq_gput_right:Nv</code>	81, 4311	<code>\seq_put_left:Nx</code>	80, 4304
<code>\seq_gput_right:Nx</code>	81, 4311	<code>\seq_put_right:cn</code>	81, 4304
<code>\seq_gremove_duplicates:N</code>	82, 4359 , 4372	<code>\seq_put_right:co</code>	81, 4304
<code>\seq_gset_eq:cc</code>	80, 4240 , 4243	<code>\seq_put_right:cV</code>	81, 4304
<code>\seq_gset_eq:cN</code>	80, 4240 , 4241	<code>\seq_put_right:Nn</code>	81, 4206, 4304, 4308, 4310, 4327, 4366, 5303
<code>\seq_gset_eq:Nc</code>	80, 4240 , 4242	<code>\seq_put_right:No</code>	81, 4304
<code>\seq_gset_eq:NN</code>	80, 4240 , 4240, 4373	<code>\seq_put_right:Nv</code>	81, 4304
<code>\seq_if_empty:c</code>	4249	<code>\seq_put_right:Nx</code>	81, 4304
<code>\seq_if_empty:cTF</code>	83, 4248	<code>\seq_remove_duplicates:N</code>	82, 4359 , 4369
<code>\seq_if_empty:N</code>	4248	<code>\seq_remove_duplicates_aux:n</code>	4359, 4361, 4364
<code>\seq_if_empty:NTF</code>	83, 4248	<code>\seq_remove_duplicates_aux:NN</code>	4359, 4359, 4370, 4373
<code>\seq_if_empty_err:N</code>	83, 4250 , 4250, 4267, 4275	<code>\seq_set_eq:cc</code>	80, 4236 , 4239
<code>\seq_if_empty_p:c</code>	82, 4248	<code>\seq_set_eq:cN</code>	80, 4236 , 4237
<code>\seq_if_empty_p:N</code>	82, 4248	<code>\seq_set_eq:Nc</code>	80, 4236 , 4238
<code>\seq_if_in:cnTF</code>	83, 4256	<code>\seq_set_eq:NN</code>	80, 4236 , 4236, 4370
<code>\seq_if_in:coTF</code>	83, 4256	<code>\seq_show:c</code>	82, 4283 , 4284
<code>\seq_if_in:cVTF</code>	83, 4256	<code>\seq_show:N</code>	82, 4283 , 4283
<code>\seq_if_in:cxTF</code>	83, 4256	<code>\seq_tmp:w</code>	4257, 4261
<code>\seq_if_in:Nn</code>	4256	<code>\seq_top:cN</code>	84, 4385 , 4386
<code>\seq_if_in:NnF</code>	4265, 4365	<code>\seq_top:NN</code>	84, 4385 , 4385
<code>\seq_if_in:NnT</code>	4264	<code>.set:N</code>	114
<code>\seq_if_in:NnTF</code>	83, 4256 , 4263	<code>.set_x:N</code>	114
<code>\seq_map_break:</code>	83, 4332 , 4334, 4344	<code>\setbox</code>	327
<code>\seq_map_break:n</code>	83, 4332 , 4345	<code>\setcounter</code>	120, 6580 , 6626, 6632
<code>\seq_map_function:cN</code>	82, 4346	<code>\setlabel</code>	5515, 5521, 5522, 5524, 5525, 5529, 5530, 5532, 5533
<code>\seq_map_function:NN</code>	82, 4346 , 4346, 4351, 4361	<code>\setlanguage</code>	85
<code>\seq_map_inline:cn</code>	82, 4352	<code>\setlength</code>	120, 6576 , 6576
<code>\seq_map_inline:Nn</code>	82, 4289, 4352 , 4352, 4357	<code>\setname</code>	5506, 5521, 5522, 5524, 5525, 5529, 5532
<code>\seq_map_variable:cNn</code>	82, 4332	<code>\sfcode</code>	382
<code>\seq_map_variable:NNn</code>	82, 4332 , 4338, 4342	<code>\shipout</code>	292
<code>\seq_map_variable_aux:Nnw</code>	4332, 4332, 4336, 4339	<code>\show</code>	135
<code>\seq_new:c</code>	3, 79, 4226 , 4227	<code>\showbox</code>	137
<code>\seq_new:N</code> ..	3, 79, 4226 , 4226, 4358, 5727	<code>\showboxbreadth</code>	151
<code>\seq_pop:cN</code>	84, 4375	<code>\showboxdepth</code>	152
<code>\seq_pop:NN</code>	84, 4375 , 4379, 4380, 5818, 5952	<code>\showgroups</code>	412
<code>\seq_pop_aux:nnNN</code>	83, 4274 , 4274, 4379, 4382	<code>\showifs</code>	413
<code>\seq_pop_aux:w</code>	83, 4274 , 4276, 4278	<code>\showlists</code>	138
<code>\seq_push:cn</code>	84, 4375 , 4378	<code>\showMemUsage</code>	738, 747, 1434, 1681, 2064, 2167, 2684, 3028, 4063, 4216, 4389, 4627, 4769, 4853, 5427, 5490, 5709, 6639
<code>\seq_push:Nn</code>	84, 4375 , 4375	<code>\showthe</code>	136
<code>\seq_push:No</code>	84, 4375 , 4377	<code>\showtokens</code>	400
<code>\seq_push:Nv</code> ...	84, 4375 , 4376, 5815, 5949	<code>\skewchar</code>	349
<code>\seq_put_aux:Nnn</code>	83, 4300 , 4300, 4305, 4309	<code>\skip</code>	373
<code>\seq_put_aux:w</code>	83, 4300 , 4301, 4303	<code>\skip@</code>	3323
<code>\seq_put_left:cn</code>	80, 4304 , 4378	<code>\skip_add:cn</code>	60, 3283
<code>\seq_put_left:co</code>	80, 4304	<code>\skip_add:Nn</code>	60, 3283 , 3283, 3289, 3301, 6245
<code>\seq_put_left:cV</code>	80, 4304		
<code>\seq_put_left:Nn</code>	80, 4304 , 4304, 4307, 4318, 4375		
<code>\seq_put_left:No</code>	80, 4304 , 4377		

- `\skip_eval:n` 61, 3254, 3284, 3291, 3313, 3316, 3321, 3321
 - `\skip_gadd:cn` 60, 3283
 - `\skip_gadd:Nn` .. 60, 3283, 3296, 3303, 6248
 - `\skip_gset:cn` 60, 3253
 - `\skip_gset:Nn` .. 60, 3253, 3259, 3267, 6242
 - `\skip_gsub:Nn` 60, 3283, 3304, 6254
 - `\skip_gzero:c` 60, 3268
 - `\skip_gzero:N` 60, 3268, 3274, 3282
 - `\skip_horizontal:c` 61, 3311
 - `\skip_horizontal:N` .. 61, 3311, 3311–3313
 - `\skip_horizontal:n` 61, 3311, 3313
 - `\skip_if_infinite_glue:n` 3339
 - `\skip_if_infinite_glue:nTF` 61, 3339, 3346
 - `\skip_if_infinite_glue_p:n` 61, 3339
 - `\skip_new:c` 60, 3241
 - `\skip_new:N` 60, 3241, 3243, 3247, 3252, 3324–3328, 3330, 3332, 6181–6183
 - `\skip_new_l:N` 3244
 - `\skip_set:cn` 60, 3253
 - `\skip_set:Nn` 60, 3253, 3253, 3264, 3266, 3331, 3333, 6239
 - `\skip_show:c` 61, 3319, 3320
 - `\skip_show:N` 61, 3319, 3319, 3320
 - `\skip_split_finite_else_action:nnNN` 61, 3345, 3345
 - `\skip_sub:Nn` ... 60, 3283, 3290, 3309, 6251
 - `\skip_use:c` 61, 3317
 - `\skip_use:N` 61, 3317, 3317, 3318
 - `\skip_vertical:c` 61, 3311
 - `\skip_vertical:N` ... 61, 3311, 3314–3316
 - `\skip_vertical:n` 61, 3311, 3316
 - `\skip_zero:c` 60, 3268
 - `\skip_zero:N` ... 60, 3268, 3268, 3279, 3281
 - `\skipdef` 72
 - `\spacefactor` 291
 - `\spaceskip` 286
 - `\span` 99
 - `\special` 361, 549
 - `\splitbotmark` 170
 - `\splitbotmarks` 396
 - `\splitdiscards` 443
 - `\splitfirstmark` 169
 - `\splitfirstmarks` 395
 - `\splitmaxdepth` 339
 - `\splittopskip` 340
 - `\startrecording` 5496, 5503
 - `\stepcounter` 120, 6580, 6628, 6634
 - `\str_if_eq:nn` 1133
 - `\str_if_eq_p:nn` 10, 1067, 1133
 - `\str_if_eq_p_aux:w` 1133, 1134, 1136, 1140, 1144
 - `\str_if_eq_var:nf` 1150
 - `\str_if_eq_var_p:nf` . 10, 1150, 2128, 2150
 - `\str_if_eq_var_start:nnN` 1150, 1151, 1153, 1155, 1157
 - `\str_if_eq_var_stop:w` .. 1150, 1154, 1157
 - `\strcmp` 555, 557
 - `\string` 354
- T**
- `\T` 2362
 - `\t` 2365
 - `\tabskip` 100
- TeX and L^AT_EX 2_ε commands:
- `\@Roman` 51
 - `\@alph` 51
 - `\@arabic` 51
 - `\@empty` 72
 - `\@fnsymbol` 51
 - `\@for` 88
 - `\@ifnextchar` 48
 - `\@namedef` 18
 - `\@ne` 53
 - `\@roman` 51
 - `\@tfor` 71
 - `\empty` 14
 - `\advance` 209
 - `\aftergroup` 23
 - `\Alph` 51
 - `\begingroup` 23
 - `\box` 106
 - `\catcode` 41
 - `\closein` 97
 - `\copy` 106
 - `\csname` 11
 - `\def` 18
 - `\detokenize` 68
 - `\dimexpr` 63
 - `\dp` 106
 - `\edef` 18
 - `\empty` 72
 - `\endcsname` 11
 - `\endgroup` 23
 - `\expandafter` 13, 166
 - `\futurelet` 48
 - `\gdef` 19
 - `\global` 22
 - `\glueexpr` 62
 - `\hskip` 61
 - `\ht` 106
 - `\ifcase` 56, 59
 - `\ifdim` 64
 - `\ifeof` 97
 - `\ifhbox` 104
 - `\ifnum` 56, 59
 - `\ifodd` 59
 - `\ifvbox` 104

<code>\ifvoid</code>	104, 105	<code>\tex_atopwithdelims:D</code>	185
<code>\jobname</code>	72	<code>\tex_badness:D</code>	332
<code>\lccode</code>	43	<code>\tex_baselineskip:D</code>	260
<code>\let</code>	22	<code>\tex_batchmode:D</code>	153
<code>\long</code>	22	<code>\tex_begingroup:D</code>	91, 595, 697, 788
<code>\lowercase</code>	71	<code>\tex_belowdisplayshortskip:D</code>	197
<code>\m@ne</code>	53	<code>\tex_belowdisplayskip:D</code>	198
<code>\mathcode</code>	43	<code>\tex_binoppenalty:D</code>	221
<code>\meaning</code>	23	<code>\tex_botmark:D</code>	168
<code>\newbox</code>	104	<code>\tex_box:D</code>	376, 5338, 5361
<code>\newcount</code>	49	<code>\tex_boxmaxdepth:D</code>	338
<code>\newdimen</code>	62	<code>\tex_brokenpenalty:D</code>	295
<code>\newmuskip</code>	65	<code>\tex_catcode:D</code>	380, 568–570, 572, 573, 577–579, 581, 582, 587, 588, 591, 592, 596, 714, 1011, 1515, 1516, 2175, 2179, 2184, 3899, 3900
<code>\newread</code>	97	<code>\tex_char:D</code>	234
<code>\newskip</code>	60	<code>\tex_chardef:D</code> ...	69, 999, 1000, 1095, 1096, 1916, 1918, 2923, 4779, 4830
<code>\newtoks</code>	75	<code>\tex_cleaders:D</code>	252
<code>\newwrite</code>	95	<code>\tex_closein:D</code>	128, 4833
<code>\noexpand</code>	14, 29	<code>\tex_closeout:D</code>	123, 4790
<code>\number</code>	52, 58	<code>\tex_clubpenalty:D</code>	263
<code>\numexpr</code>	58	<code>\tex_copy:D</code>	320, 5363
<code>\or</code>	56, 59	<code>\tex_count:D</code>	371
<code>\outer</code>	22	<code>\tex_countdef:D</code>	70, 1092, 2387, 2697, 2698, 2905
<code>\protected</code>	22	<code>\tex_cr:D</code>	95
<code>\relax</code>	23	<code>\tex_crcr:D</code>	96
<code>\romannumeral</code>	52	<code>\tex_csname:D</code>	158, 704, 719, 780
<code>\sfcode</code>	43	<code>\tex_day:D</code>	366
<code>\showbox</code>	106	<code>\tex_deadcycles:D</code>	300
<code>\string</code>	22	<code>\tex_def:D</code>	65, 560, 566, 576, 585, 586, 590, 594, 599–601, 603, 605– 611, 614, 618, 620–623, 627, 634, 636–638, 642, 644–646, 652, 656, 676, 677, 684, 694, 696, 700, 705, 711, 716, 717, 726, 783, 785, 786, 794
<code>\thr@@</code>	53	<code>\tex_defaultthyphenchar:D</code>	350
<code>\tw@</code>	53	<code>\tex_defaultskewchar:D</code>	351
<code>\uccode</code>	43	<code>\tex_delcode:D</code>	381
<code>\unexpanded</code>	14, 29	<code>\tex_delimiter:D</code>	175
<code>\unhbox</code>	107	<code>\tex_delimiterfactor:D</code>	224
<code>\unhcopy</code>	107	<code>\tex_delimitershortfall:D</code>	223
<code>\unvbox</code>	108	<code>\tex_dimen:D</code>	372
<code>\unvcopy</code>	108	<code>\tex_dimendef:D</code>	71, 2409, 3359, 3360
<code>\uppercase</code>	71	<code>\tex_discretionary:D</code>	235
<code>\vskip</code>	61	<code>\tex_displayindent:D</code>	200
<code>\vsplit</code>	108	<code>\tex_displaylimits:D</code>	210
<code>\wd</code>	106	<code>\tex_displaystyle:D</code>	188
<code>\write</code>	96	<code>\tex_displaywidowpenalty:D</code>	199
<code>\xdef</code>	19	<code>\tex_displaywidth:D</code>	201
<code>\z@</code>	53	<code>\tex_divide:D</code>	78
<code>\tex_above:D</code>	182	<code>\tex_doublehyphendemerits:D</code>	268
<code>\tex_abovedisplayshortskip:D</code>	195		
<code>\tex_abovedisplayskip:D</code>	196		
<code>\tex_abovewithdelims:D</code>	183		
<code>\tex_accent:D</code>	233		
<code>\tex_adjdemerits:D</code>	270		
<code>\tex_advance:D</code>	77, 2694, 3284, 3291, 3378, 3383, 3430, 3432		
<code>\tex_afterassignment:D</code>	87, 2566, 2677, 6300		
<code>\tex_aftergroup:D</code>	88, 790		
<code>\tex_atop:D</code>	184		

- `\tex_dp:D` 379, 5356
- `\tex_dump:D` 362
- `\tex_edef:D` ... 66, 563, 660, 662, 667, 795
- `\tex_else:D`
119, 562, 613, 630, 671, 680, 695, 759
- `\tex_emergencystretch:D` 283
- `\tex_end:D` 157, 687, 5130, 5224
- `\tex_endcsname:D` 159, 704, 719, 781
- `\tex_endgroup:D` ... 92, 604, 619, 701, 789
- `\tex_endinput:D` 131
- `\tex_endlinechar:D`
173, 571, 580, 3908, 3924, 3934, 3942
- `\tex_eqno:D` 193
- `\tex_errhelp:D` 139, 4998
- `\tex_errmessage:D` .. 133, 740, 1105, 5000
- `\tex_errorcontextlines:D` 140, 4861
- `\tex_errorstopmode:D` 154
- `\tex_escapechar:D` 172
- `\tex_everycr:D` 101
- `\tex_everydisplay:D` 202, 689
- `\tex_veryhbox:D` 341
- `\tex_veryjob:D` 370
- `\tex_everymath:D` 226, 688
- `\tex_everypar:D` 289
- `\tex_veryvbox:D` 342
- `\tex_exhyphenpenalty:D` 265
- `\tex_expandafter:D` 89, 629, 631,
665, 668, 672, 703, 707, 718, 774, 1443
- `\tex_fam:D` 81
- `\tex_fi:D` 120, 558, 559, 574,
583, 615, 632, 673, 682, 722, 723, 760
- `\tex_finalhyphendemerits:D` 269
- `\tex_firstmark:D` 167
- `\tex_floatingpenalty:D` 314
- `\tex_font:D` 80
- `\tex_fontdimen:D` 347
- `\tex_fontname:D` 171
- `\tex_futurelet:D` ... 76, 724, 2527, 2529
- `\tex_gdef:D` 67, 712, 713, 715, 814
- `\tex_global:D` ... 82, 709, 710, 791, 1918
- `\tex_globaldefs:D` 86
- `\tex_halign:D` 93
- `\tex_hangafter:D` 271
- `\tex_hangindent:D` 272
- `\tex_hbadness:D` 333
- `\tex_hbox:D`
328, 5398, 5399, 5404, 5410, 5419, 5420
- `\tex_hfil:D` 236
- `\tex_hfill:D` 238
- `\tex_hfilneg:D` 237
- `\tex_hfuzz:D` 335
- `\tex_hoffset:D` 310
- `\tex_holdinginserts:D` 313
- `\tex_hrule:D` 249
- `\tex_hsize:D` 274
- `\tex_hskip:D` 239, 3311
- `\tex_hss:D` 240
- `\tex_ht:D` 378, 5355
- `\tex_hyphen:D` 63, 691
- `\tex_hyphenation:D` 364
- `\tex_hyphenchar:D` 348
- `\tex_hyphenpenalty:D` 266
- `\tex_if:D` 102, 669, 762, 765
- `\tex_ifcase:D` 103, 1298, 3037, 3090
- `\tex_ifcat:D` 104, 766
- `\tex_ifdim:D` 107, 3400
- `\tex_ifeof:D` 108, 4838, 4840
- `\tex_iffalse:D` 113, 757
- `\tex_ifhbox:D` 109, 5314, 5318
- `\tex_ifhmode:D` 115, 769
- `\tex_ifinner:D` 118, 771
- `\tex_ifmmode:D` 116, 768
- `\tex_ifnum:D`
105, 1070, 1076, 3036, 3088, 3711
- `\tex_ifodd:D`
106, 561, 565, 678, 763, 764, 3089
- `\tex_iftrue:D` 114, 756
- `\tex_ifvbox:D` 110, 5315, 5321
- `\tex_ifvmode:D` 117, 770
- `\tex_ifvoid:D` 111, 5316, 5332
- `\tex_ifx:D` ... 112, 602, 628, 693, 718, 767
- `\tex_ignorespaces:D` 160
- `\tex_immediate:D` 122, 639,
647, 702, 1098, 1101, 4787, 4790, 4795
- `\tex_indent:D` 256
- `\tex_input:D` ... 130, 685, 721, 6736, 6740
- `\tex_inputlineno:D` . 132, 1122, 1625, 4910
- `\tex_insert:D` 312
- `\tex_insertpenalties:D` 315
- `\tex_interlinepenalty:D` 294
- `\tex_italiccor:D` 62, 690
- `\tex_jobname:D` 369, 3616
- `\tex_kern:D` 247
- `\tex_language:D` 164
- `\tex_lastbox:D` 321, 5342
- `\tex_lastkern:D` 254
- `\tex_lastpenalty:D` 360
- `\tex_lastskip:D` 255
- `\tex_lccode:D`
383, 1010, 2237, 2241, 2244, 3897, 3898
- `\tex_leaders:D` 251
- `\tex_left:D` 219
- `\tex_lefthyphenmin:D` 275
- `\tex_leftskip:D` 277
- `\tex_leqno:D` 194
- `\tex_let:D` 40,
44, 50, 58, 64, 685–692, 708–710, 755
- `\tex_limits:D` 211

<code>\tex_linepenalty:D</code>	267	<code>\tex_output:D</code>	299
<code>\tex_lineskip:D</code>	261	<code>\tex_outputpenalty:D</code>	309
<code>\tex_lineskiplimit:D</code>	262	<code>\tex_over:D</code>	186
<code>\tex_long:D</code>	83, 792	<code>\tex_overfullrule:D</code>	337
<code>\tex_looseness:D</code>	279	<code>\tex_overline:D</code>	217
<code>\tex_lower:D</code>	316, 5350	<code>\tex_overwithdelims:D</code>	187
<code>\tex_lowercase:D</code>	355, 1012, 3822	<code>\tex_pagedepth:D</code>	301
<code>\tex_mag:D</code>	163	<code>\tex_pagefilllstretch:D</code>	305
<code>\tex_mark:D</code>	165	<code>\tex_pagefillstretch:D</code>	304
<code>\tex_mathaccent:D</code>	176	<code>\tex_pagefilstretch:D</code>	303
<code>\tex_mathbin:D</code>	206	<code>\tex_pagegoal:D</code>	307
<code>\tex_mathchar:D</code>	177	<code>\tex_pageshrink:D</code>	306
<code>\tex_mathchardef:D</code>	74, 2899, 3077, 5304, 5305	<code>\tex_pagestretch:D</code>	302
<code>\tex_mathchoice:D</code>	174	<code>\tex_pagetotal:D</code>	308
<code>\tex_mathclose:D</code>	207	<code>\tex_par:D</code>	257, 692
<code>\tex_mathcode:D</code> 385, 2221, 2225, 2229, 2233		<code>\tex_parfillskip:D</code>	288
<code>\tex_mathinner:D</code>	208	<code>\tex_parindent:D</code>	281
<code>\tex_mathop:D</code>	209	<code>\tex_parshape:D</code>	273
<code>\tex_mathopen:D</code>	213	<code>\tex_parskip:D</code>	280
<code>\tex_mathord:D</code>	214	<code>\tex_patterns:D</code>	363
<code>\tex_mathpunct:D</code>	215	<code>\tex_pausing:D</code>	150
<code>\tex_mathrel:D</code>	216	<code>\tex_penalty:D</code>	358
<code>\tex_mathsurround:D</code>	227	<code>\tex_postdisplaypenalty:D</code>	205
<code>\tex_maxdeadcycles:D</code>	297	<code>\tex_predisplaypenalty:D</code>	204
<code>\tex_maxdepth:D</code>	298	<code>\tex_predisplaysize:D</code>	203
<code>\tex_meaning:D</code>	357, 778, 782	<code>\tex_pretolerance:D</code>	284
<code>\tex_medmuskip:D</code>	228	<code>\tex_prevdepth:D</code>	331
<code>\tex_message:D</code>	134, 743	<code>\tex_prevgraf:D</code>	290
<code>\tex_mkern:D</code>	181	<code>\tex_radical:D</code>	179
<code>\tex_month:D</code>	367	<code>\tex_raise:D</code>	319, 5349
<code>\tex_moveleft:D</code>	317, 5347	<code>\tex_read:D</code>	126, 4843
<code>\tex_moveright:D</code>	318, 5348	<code>\tex_relax:D</code>	
<code>\tex_mskip:D</code>	178	..... 161, 561, 565, 568–573, 577–	
<code>\tex_multiply:D</code>	79	582, 587, 588, 591, 592, 596, 624,	
<code>\tex_muskip:D</code>	375	625, 627, 634, 635, 642, 643, 678,	
<code>\tex_muskipdef:D</code>	73, 3419, 3420	719, 721, 787, 1038, 1055, 1298,	
<code>\tex_newlinechar:D</code>	129, 4808	1332, 1503, 1515, 1516, 3087, 3458	
<code>\tex_noalign:D</code>	97	<code>\tex_relpemalty:D</code>	222
<code>\tex_noboundary:D</code>	232	<code>\tex_right:D</code>	220
<code>\tex_noexpand:D</code>	90, 574, 775, 1444	<code>\tex_righthyphenmin:D</code>	276
<code>\tex_noindent:D</code>	258	<code>\tex_rightskip:D</code>	278
<code>\tex_nolimits:D</code>	212	<code>\tex_romannumeral:D</code> 353, 869, 870, 1016,	
<code>\tex_nonscript:D</code>	192	1469, 1488, 1496, 1588, 1591, 1594,	
<code>\tex_nonstopmode:D</code>	155	1649, 1656, 1661, 1721, 2692, 3099	
<code>\tex_nulldelimiterspace:D</code>	225	<code>\tex_scriptfont:D</code>	345
<code>\tex_nullfont:D</code>	343	<code>\tex_scriptscriptfont:D</code>	346
<code>\tex_number:D</code> .. 352, 1151, 1886, 1889,		<code>\tex_scriptscriptstyle:D</code>	191
1891, 2693, 3053, 3085, 6470, 6471		<code>\tex_scriptspace:D</code>	231
<code>\tex_omit:D</code>	98	<code>\tex_scriptstyle:D</code>	190
<code>\tex_openin:D</code>	124, 4836	<code>\tex_scrollmode:D</code>	156
<code>\tex_openout:D</code>	125, 4787	<code>\tex_setbox:D</code> .. 327, 5338, 5343, 5373,	
<code>\tex_or:D</code>	121, 758	5378, 5384, 5392, 5399, 5404, 5410	
<code>\tex_outer:D</code>	84	<code>\tex_setlanguage:D</code>	85
		<code>\tex_sfcode:D</code>	382, 2257, 2261, 2265

<code>\tex_shipout:D</code>	292, 745	<code>\tex_uppercase:D</code>	356, 3823
<code>\tex_show:D</code>	135, 784	<code>\tex_vadjust:D</code>	259
<code>\tex_showbox:D</code>	137, 5365	<code>\tex_valign:D</code>	94
<code>\tex_showboxbreadth:D</code>	151	<code>\tex_vbadness:D</code>	334
<code>\tex_showboxdepth:D</code>	152	<code>\tex_vbox:D</code>	329, 5372, 5373, 5378, 5384, 5389, 5390
<code>\tex_showlists:D</code>	138	<code>\tex_vcenter:D</code>	180
<code>\tex_showthe:D</code> .	136, 2184, 2233, 2244, 2254, 2265, 2784, 3319, 3389, 4140	<code>\tex_vfil:D</code>	241
<code>\tex_skewchar:D</code>	349	<code>\tex_vfill:D</code>	243
<code>\tex_skip:D</code>	373	<code>\tex_vfilneg:D</code>	242
<code>\tex_skipdef:D</code> .	72, 2398, 3243, 3244, 3323	<code>\tex_vfuzz:D</code>	336
<code>\tex_space:D</code>	61	<code>\tex_voffset:D</code>	311
<code>\tex_spacefactor:D</code>	291	<code>\tex_vrule:D</code>	250
<code>\tex_spaceskip:D</code>	286	<code>\tex_vsize:D</code>	293
<code>\tex_span:D</code>	99	<code>\tex_vskip:D</code>	244, 3314
<code>\tex_special:D</code>	361	<code>\tex_vsplit:D</code>	322, 5392
<code>\tex_splitbotmark:D</code>	170	<code>\tex_vss:D</code>	245
<code>\tex_splitfirstmark:D</code>	169	<code>\tex_vtop:D</code>	330
<code>\tex_splitmaxdepth:D</code>	339	<code>\tex_wd:D</code>	377, 5357
<code>\tex_splittopskip:D</code>	340	<code>\tex_widowpenalty:D</code>	264
<code>\tex_string:D</code>	354, 779	<code>\tex_write:D</code> .	127, 639, 647, 702, 777, 4816
<code>\tex_tabskip:D</code>	100	<code>\tex_xdef:D</code>	68, 703, 815
<code>\tex_textfont:D</code>	344	<code>\tex_xleaders:D</code>	253
<code>\tex_textstyle:D</code>	189	<code>\tex_xspaceskip:D</code>	287
<code>\tex_the:D</code>	162, 568–573, 1122, 1332, 1509, 1517, 1625, 2782, 3317, 3387, 3434, 4078	<code>\tex_year:D</code>	368
<code>\tex_thickmuskip:D</code>	230	<code>\textasteriskcentered</code>	2873, 2879
<code>\tex_thinmuskip:D</code>	229	<code>\textbardbl</code>	2878
<code>\tex_time:D</code>	365	<code>\textdagger</code>	2874, 2880
<code>\tex_toks:D</code>	374	<code>\textdaggerdbl</code>	2875, 2881
<code>\tex_toksdef:D</code> .	75, 2420, 4073, 4074, 4205	<code>\textfont</code>	344
<code>\tex_tolerance:D</code>	285	<code>\textparagraph</code>	2877
<code>\tex_topmark:D</code>	166	<code>\textsection</code>	2876
<code>\tex_topskip:D</code>	296	<code>\textstyle</code>	189
<code>\tex_tracingcommands:D</code>	141	<code>\TeXETstate</code>	444
<code>\tex_tracinglostchars:D</code>	142	<code>\the</code>	26–31, 162
<code>\tex_tracingmacros:D</code>	143	<code>\thepage</code>	5509
<code>\tex_tracingonline:D</code>	144	<code>\thickmuskip</code>	230
<code>\tex_tracingoutput:D</code>	145	<code>\thinmuskip</code>	229
<code>\tex_tracingpages:D</code>	146	<code>\time</code>	365
<code>\tex_tracingparagraphs:D</code>	147	<code>\tl_clear:c</code>	67, 3508, 4229
<code>\tex_tracingrestores:D</code>	148	<code>\tl_clear:N</code> .	67, 3508, 3508, 3509, 3516, 3522, 4228, 4252, 4399, 4428, 6688
<code>\tex_tracingstats:D</code>	149	<code>\tl_clear_new:c</code>	67, 3512, 4233
<code>\tex_uccode:D</code>	384, 2247, 2251, 2254	<code>\tl_clear_new:N</code>	67, 3512, 3513, 3522, 3523, 4232, 4403
<code>\tex_uchyph:D</code>	282	<code>\tl_compare:nn</code>	3668
<code>\tex_underline:D</code>	218, 686	<code>\tl_compare:no</code>	3680
<code>\tex_unhbox:D</code>	323, 5423	<code>\tl_compare:nV</code>	3677
<code>\tex_unhcopy:D</code>	324, 5421	<code>\tl_compare:nx</code>	3671
<code>\tex_unkern:D</code>	248	<code>\tl_compare:on</code>	3686
<code>\tex_unpenalty:D</code>	359	<code>\tl_compare:oo</code>	3692
<code>\tex_unskip:D</code>	246	<code>\tl_compare:ox</code>	3704
<code>\tex_unvbox:D</code>	325, 5396	<code>\tl_compare:Vn</code>	3683
<code>\tex_unvcopy:D</code>	326, 5394	<code>\tl_compare:VV</code>	3689

\tl_compare:Vx	3701	\tl_gset_eq:cN	68, 3492
\tl_compare:xn	3674	\tl_gset_eq:Nc	68, 3492
\tl_compare:xo	3698	\tl_gset_eq:NN	68, 3060, 3492, 3497, 3504, 3507, 3510
\tl_compare:xV	3695	\tl_gset_rescan:Nnn	69, 3894, 3895
\tl_compare:xx	3667, 3669, 3672, 3675, 3678, 3681, 3684, 3687, 3690, 3693, 3696, 3699, 3702, 3705	\tl_gset_rescan:Nnx	69, 3921, 3931
\tl_elt_count:N	72, 3883, 3889	\tl_head:n	74, 4023, 4023, 4024, 4033
\tl_elt_count:n	72, 3883, 3883, 3888	\tl_head:V	74, 4023
\tl_elt_count:o	72, 3883	\tl_head:w	74, 4023, 4023, 4029, 4030, 4036, 4041, 4045, 4059
\tl_elt_count:V	72, 3883	\tl_head_i:n	74, 4023, 4024
\tl_gclear:c	67, 3508, 4231	\tl_head_i:w	74, 4023, 4030
\tl_gclear:N	67, 3508, 3510, 3511, 3528, 3533, 4230, 4401	\tl_head_iii:f	74, 4023
\tl_gclear_new:c	67, 3524, 4235	\tl_head_iii:n	74, 4023, 4027, 4028
\tl_gclear_new:N	67, 3524, 3525, 3533, 3534, 4234, 4405	\tl_head_iii:w	74, 4023, 4027, 4032
\tl_gput_left:cn	67, 3535	\tl_if_blank:n	3653
\tl_gput_left:co	67, 3535	\tl_if_blank:nF	3662, 3666, 4517
\tl_gput_left:cV	67, 3535	\tl_if_blank:nT	3661, 3665
\tl_gput_left:Nn	67, 3535, 3552, 3570, 4498	\tl_if_blank:nTF	70, 3653, 3660, 3664
\tl_gput_left:No	67, 3535, 3560	\tl_if_blank:oTF	70, 3653, 5621
\tl_gput_left:NV	67, 3535, 3557, 3571	\tl_if_blank:VTF	70, 3653
\tl_gput_left:Nx	67, 3535, 3565	\tl_if_blank_p:n	70, 3653, 3659, 3663
\tl_gput_right:cn	68, 3572	\tl_if_blank_p:o	70, 3653
\tl_gput_right:co	68, 3572	\tl_if_blank_p:V	70, 3653
\tl_gput_right:cV	68, 3572	\tl_if_blank_p_aux:w	3653, 3654, 3656
\tl_gput_right:Nn	68, 3572, 3577, 3608, 4506	\tl_if_empty:c	4249, 4425
\tl_gput_right:No	68, 3572, 3593	\tl_if_empty:cTF	69, 3626
\tl_gput_right:NV	68, 3572, 3590	\tl_if_empty:N	3626, 4248, 4424
\tl_gput_right:Nx	68, 3572, 3602	\tl_if_empty:n	3641
\tl_gremove_all_in:cn	73, 4015	\tl_if_empty:NF	3633, 6717, 6723
\tl_gremove_all_in:Nn	73, 4015, 4018, 4022	\tl_if_empty:nF	2605, 3648, 3652, 4490, 4541, 4552, 4706
\tl_gremove_in:cn	73, 4011	\tl_if_empty:NT	3632
\tl_gremove_in:Nn	73, 4011, 4012, 4014	\tl_if_empty:nT	3647, 3651, 4728
\tl_greplace_all_in:cnn	73, 3989	\tl_if_empty:NTF	69, 3626, 3631, 5659, 5681
\tl_greplace_all_in:Nnn	73, 3989, 4008, 4010, 4019	\tl_if_empty:nTF	70, 2377, 2384, 2395, 2406, 2417, 2428, 2435, 2442, 2450, 3641, 3646, 3650, 4961, 4970, 4979, 5013
\tl_greplace_in:cnn	73, 3970	\tl_if_empty:oTF	70, 3641
\tl_greplace_in:Nnn	73, 3970, 3987, 3988, 4012	\tl_if_empty:VTF	70, 3641, 4191
\tl_gset:cn	66, 3469	\tl_if_empty_p:c	69, 3626
\tl_gset:cx	66, 3469	\tl_if_empty_p:N	69, 3626, 3630
\tl_gset:Nc	66, 3609, 3609	\tl_if_empty_p:n	70, 2347, 3641, 3645, 3649
\tl_gset:Nn	66, 3469, 3477, 3487, 3491, 3895, 4382, 4498, 4506, 4621	\tl_if_empty_p:o	70, 3641
\tl_gset:No	66, 3469	\tl_if_empty_p:V	70, 3641
\tl_gset:Nv	66, 3469	\tl_if_eq:cc	4435
\tl_gset:Nx	66, 3469, 3480, 3488, 3554, 3558, 3562, 3566, 3579, 3591, 3595, 3603, 3936, 3987, 4009, 4245, 4423, 4574, 4682	\tl_if_eq:ccTF	69, 3634, 5898
\tl_gset_eq:cc	68, 3492	\tl_if_eq:cN	4433
		\tl_if_eq:cNTF	69, 3634
		\tl_if_eq:Nc	4434
		\tl_if_eq:NcTF	69, 3634
		\tl_if_eq:NN	3634, 4432
		\tl_if_eq:nn	3723

<code>\tl_if_eq:NNF</code>	3640	<code>\tl_if_head_eq_charcode:fNTF</code>	
<code>\tl_if_eq:nnF</code>	4603	.....	74, 2946, 2953, 4035
<code>\tl_if_eq:NNT</code>	3639	<code>\tl_if_head_eq_charcode:nN</code>	4039
<code>\tl_if_eq:NNTF</code>		<code>\tl_if_head_eq_charcode:nNF</code>	4056
69, 1979, 3634, 3638, 5115, 5635, 5686		<code>\tl_if_head_eq_charcode:nNT</code>	4055
<code>\tl_if_eq:nnTF</code>	70, 3667	<code>\tl_if_head_eq_charcode:nNTF</code>	
<code>\tl_if_eq:no</code>	3737	.....	74, 4035, 4054
<code>\tl_if_eq:noTF</code>	70, 3667	<code>\tl_if_head_eq_charcode_p:fN</code>	
<code>\tl_if_eq:nV</code>	3730	.....	74, 4035, 4044, 4052
<code>\tl_if_eq:nVTF</code>	70, 3667	<code>\tl_if_head_eq_charcode_p:nN</code>	
<code>\tl_if_eq:nx</code>	3744	.....	74, 4035, 4053
<code>\tl_if_eq:nxTF</code>	70, 3667	<code>\tl_if_head_eq_meaning:nN</code>	4035
<code>\tl_if_eq:on</code>	3758	<code>\tl_if_head_eq_meaning:nNTF</code>	
<code>\tl_if_eq:onTF</code>	70, 3667	.....	74, 4035, 5650
<code>\tl_if_eq:oo</code>	3772	<code>\tl_if_head_eq_meaning_p:nN</code> ...	74, 4035
<code>\tl_if_eq:ooTF</code>	70, 3667	<code>\tl_if_in:cnTF</code>	73, 3948
<code>\tl_if_eq:ox</code>	3786	<code>\tl_if_in:Nn</code>	3948
<code>\tl_if_eq:oxTF</code>	70, 3667	<code>\tl_if_in:nn</code>	3957
<code>\tl_if_eq:Vn</code>	3751	<code>\tl_if_in:NnF</code>	3956
<code>\tl_if_eq:VnTF</code>	70, 3667	<code>\tl_if_in:nnF</code>	3965, 3968
<code>\tl_if_eq:VV</code>	3765	<code>\tl_if_in:NnT</code>	3955
<code>\tl_if_eq:VVTF</code>	70, 3667	<code>\tl_if_in:nnT</code>	3964, 3967
<code>\tl_if_eq:Vx</code>	3779	<code>\tl_if_in:NnTF</code>	73, 3948, 3954
<code>\tl_if_eq:VxTF</code>	70, 3667	<code>\tl_if_in:nnTF</code>	
<code>\tl_if_eq:xn</code>	3793	....	73, 3957, 3963, 3966, 5918, 5928
<code>\tl_if_eq:xnTF</code>	70, 3667	<code>\tl_if_in:onTF</code>	73, 3957
<code>\tl_if_eq:xo</code>	3807	<code>\tl_if_in:VnTF</code>	73, 3957
<code>\tl_if_eq:xoTF</code>	70, 3667	<code>\tl_map_break:</code>	71, 3871, 3871
<code>\tl_if_eq:xV</code>	3800	<code>\tl_map_function:cN</code>	71, 3829
<code>\tl_if_eq:xVTF</code>	70, 3667	<code>\tl_map_function:NN</code>	
<code>\tl_if_eq:xx</code>	3814	.....	71, 3829, 3832, 3840, 3891
<code>\tl_if_eq:xxTF</code>	70, 1969, 3667, 4198	<code>\tl_map_function:nN</code>	
<code>\tl_if_eq_p:cc</code>	69, 3634	.....	71, 3829, 3829, 3885, 6417
<code>\tl_if_eq_p:cN</code>	69, 3634	<code>\tl_map_function_aux:NN</code>	3829
<code>\tl_if_eq_p:Nc</code>	69, 3634	<code>\tl_map_function_aux:Nn</code>	
<code>\tl_if_eq_p:NN</code>	69, 3634, 3637	..	3830, 3833, 3836, 3838, 3845, 3854
<code>\tl_if_eq_p:nn</code>	70, 3667	<code>\tl_map_inline:cn</code>	71, 3841
<code>\tl_if_eq_p:no</code>	70, 3667	<code>\tl_map_inline:Nn</code> ..	71, 3841, 3850, 3859
<code>\tl_if_eq_p:nV</code>	70, 3667	<code>\tl_map_inline:nn</code> ..	71, 2368, 3841, 3841
<code>\tl_if_eq_p:nx</code>	70, 3667	<code>\tl_map_inline_aux:n</code>	3841
<code>\tl_if_eq_p:on</code>	70, 3667	<code>\tl_map_variable:cNn</code>	71, 3861
<code>\tl_if_eq_p:oo</code>	70, 3667	<code>\tl_map_variable:NNn</code> 71, 3861, 3864, 3865	
<code>\tl_if_eq_p:ox</code>	70, 3667	<code>\tl_map_variable:nNn</code> 71, 3861, 3861, 3864	
<code>\tl_if_eq_p:Vn</code>	70, 3667	<code>\tl_map_variable_aux:NnN</code>	3866
<code>\tl_if_eq_p:VV</code>	70, 3667	<code>\tl_map_variable_aux:Nnn</code> 3862, 3866, 3869	
<code>\tl_if_eq_p:Vx</code>	70, 3667	<code>\tl_new:c</code>	66, 3442, 3456, 4227
<code>\tl_if_eq_p:xn</code>	70, 3667	<code>\tl_new:cn</code>	66, 3442, 3456, 5444
<code>\tl_if_eq_p:xo</code>	70, 3667	<code>\tl_new:N</code>	
<code>\tl_if_eq_p:xV</code>	70, 3667	..	66, 3442, 3455, 4226, 4397, 4903,
<code>\tl_if_eq_p:xx</code>	70, 3667	4904, 5548, 5549, 5722–5726, 6652	
<code>\tl_if_head_eq_catcode:nN</code>	4057	<code>\tl_new:Nn</code>	66, 2072, 2531,
<code>\tl_if_head_eq_catcode:nNTF</code> ...	74, 4035	2532, 2534, 2564, 2565, 3050, 3442,	
<code>\tl_if_head_eq_catcode_p:nN</code> ...	74, 4035	3442, 3449, 3455, 3518, 3530, 3616–	
		3625, 3860, 3903, 4862–4866, 4869,	

- 4872, 4875, 4881, 4885, 4895, 4899–
 4902, 5550, 5717–5720, 5728, 6171
 \tl_new:Nx 66, 3442, 3450, 4825–4827
 \tl_put_left:cn 67, 3535
 \tl_put_left:co 67, 3535
 \tl_put_left:cV 67, 3535
 \tl_put_left:Nn 67, 3535, 3535, 3569, 4494
 \tl_put_left:No 67, 3535, 3543
 \tl_put_left:NV 67, 3535, 3540
 \tl_put_left:Nx 67, 3535, 3548
 \tl_put_right:cn 67, 3572
 \tl_put_right:co 67, 3572
 \tl_put_right:cV 67, 3572
 \tl_put_right:Nn 67, 3572, 3572, 3606, 4502
 \tl_put_right:No 67, 3572, 3585
 \tl_put_right:NV 67, 3572, 3582, 3607
 \tl_put_right:Nx 67, 3572, 3598
 \tl_remove_all_in:cn 73, 4015
 \tl_remove_all_in:Nn 73, 4015, 4015, 4021
 \tl_remove_in:cn 73, 4011
 \tl_remove_in:Nn 73, 4011, 4011, 4013
 \tl_replace_all_in:cnn 73, 3989
 \tl_replace_all_in:Nnn
 73, 3989, 4005, 4007, 4016, 5563, 5566
 \tl_replace_all_in_aux:NNnn
 3989, 3989, 4006, 4009
 \tl_replace_in:cnn 73, 3970
 \tl_replace_in:Nnn
 73, 3970, 3985, 3986, 4011
 \tl_replace_in_aux:NNnn
 3970, 3970, 3985, 3987
 \tl_rescan:nn 68, 3939, 3939
 \tl_rescan_aux:w 3910, 3915, 3916, 3944
 \tl_reverse:N 72, 3880, 3880
 \tl_reverse:n 72, 3872, 3872, 3879
 \tl_reverse:o 72, 3872, 3881
 \tl_reverse:V 72, 3872
 \tl_reverse_aux:nN 3872, 3873, 3875, 3877
 \tl_set:cn 66, 3469, 5805, 5808
 \tl_set:co 66, 3469
 \tl_set:cV 66, 3469
 \tl_set:cx 66, 3469
 \tl_set:Nc 66, 3609, 3614, 3615
 \tl_set:Nf 66, 3469, 3881
 \tl_set:Nn
 . 66, 2537, 2551, 3469, 3470, 3485,
 3490, 3536, 3553, 3573, 3578, 3867,
 3894, 3919, 3929, 4271, 4303, 4379,
 4382, 4459, 4494, 4502, 4615, 4621,
 5094, 5095, 5506, 5680, 5783, 5812,
 5816, 5935, 5946, 5950, 6693, 6701
 \tl_set:No 66, 3053,
3469, 3544, 3561, 3586, 3594, 3615
 \tl_set:NV 66, 3469
 \tl_set:Nv 66, 3469
 \tl_set:Nx 66, 2538, 2539, 2552, 2554,
3469, 3474, 3486, 3537, 3541, 3545,
 3549, 3574, 3583, 3587, 3599, 3708,
 3724, 3725, 3731, 3732, 3738, 3739,
 3745, 3746, 3752, 3753, 3759, 3760,
 3766, 3767, 3773, 3774, 3780, 3781,
 3787, 3788, 3794, 3795, 3801, 3802,
 3808, 3809, 3815, 3816, 3926, 3985,
 4006, 4333, 4339, 4422, 4573, 4678,
 4687, 5014, 5016, 5605, 5634, 5654,
 5917, 5929, 5934, 5968, 5969, 6194
 \tl_set_eq:cc 68, 3492, 6008
 \tl_set_eq:cN 68, 3492
 \tl_set_eq:Nc 68, 3492
 \tl_set_eq:NN 68, 2553,
 3058, 3492, 3493, 3503, 3506, 3508
 \tl_set_rescan:Nnn 69, 3894, 3894
 \tl_set_rescan:Nnx 69, 3921, 3921
 \tl_set_rescan_aux:NNnn
 3894, 3895, 3896, 3905
 \tl_show:c 66, 3466, 4284, 4472
 \tl_show:N 66, 3466, 3466, 3467, 4283, 4471
 \tl_show:n 66, 3466, 3468
 \tl_tail:f 74, 4023
 \tl_tail:n 74, 4023, 4025, 4026, 4034
 \tl_tail:V 74, 4023
 \tl_tail:w 74, 4023, 4025, 4031
 \tl_tmp:w 3707, 3718–
 3721, 3949, 3952, 3958, 3961, 3971,
 3975, 3978, 3982, 3991, 3998, 4001
 \tl_to_lowercase:n
 71, 2370, 2460, 3822, 3822,
 3901, 4893, 4990, 5561, 6014, 6027
 \tl_to_str:c 68, 3825
 \tl_to_str:N 68, 3825, 3825, 3828
 \tl_to_str:n 68, 2130, 2152, 3642, 3654,
3824, 3824, 5930, 5934, 5968, 5994
 \tl_to_str_aux:w 3825, 3825, 3827
 \tl_to_uppercase:n 71, 3822, 3823
 \tl_use:c 66, 3457
 \tl_use:N 66, 3457, 3457, 3465
 \token_get_arg_spec:N 47, 2453, 2471
 \token_get_prefix_arg_replacement_aux:w
 2453, 2462, 2467, 2473, 2479
 \token_get_prefix_spec:N 47, 2453, 2465
 \token_get_replacement_spec:N
 47, 2453, 2477
 \token_if_active_char:N 2327
 \token_if_active_char:NTF 45, 2327
 \token_if_active_char_p:N 45, 2327, 2492
 \token_if_alignment_tab:N 2299
 \token_if_alignment_tab:NTF 44, 2299
 \token_if_alignment_tab_p:N 44, 2299

- \token_if_chardef:N 2372
- \token_if_chardef:NTF 46, 2361
- \token_if_chardef_aux:w 2373, 2376
- \token_if_chardef_p:N ... 46, 2361, 2504
- \token_if_chardef_p_aux:w 2361
- \token_if_cs:N 2350
- \token_if_cs:NTF 46, 2350
- \token_if_cs_p:N 46, 2350, 2485
- \token_if_dim_register:N 2408
- \token_if_dim_register:NTF 47, 2361
- \token_if_dim_register_aux:w 2412, 2416
- \token_if_dim_register_p:N 47, 2361, 2512
- \token_if_dim_register_p_aux:w .. 2361
- \token_if_eq_catcode:NN 2335
- \token_if_eq_catcode:NNTF 45, 2335
- \token_if_eq_catcode_p:NN
..... 45, 2335, 2351, 2584
- \token_if_eq_charcode:NN 2339
- \token_if_eq_charcode:NNTF 45, 2339
- \token_if_eq_charcode_p:NN 45, 2339
- \token_if_eq_meaning:NN 2331
- \token_if_eq_meaning:NNT 6021
- \token_if_eq_meaning:NNTF
..... 45, 2331, 2676, 6034
- \token_if_eq_meaning_p:NN 45, 2331, 2585
- \token_if_expandable:N 2353
- \token_if_expandable:NTF 46, 2353
- \token_if_expandable_p:N 46, 2353
- \token_if_group_begin:N 2287
- \token_if_group_begin:NTF 44, 2287
- \token_if_group_begin_p:N 44, 2287
- \token_if_group_end:N 2291
- \token_if_group_end:NTF 44, 2291
- \token_if_group_end_p:N 44, 2291
- \token_if_int_register:N 2386
- \token_if_int_register:NTF 47, 2361
- \token_if_int_register_aux:w 2390, 2394
- \token_if_int_register_p:N 47, 2361, 2508
- \token_if_int_register_p_aux:w .. 2361
- \token_if_letter:N 2319
- \token_if_letter:NTF 45, 2319
- \token_if_letter_p:N 45, 2319
- \token_if_long_macro:N 2437
- \token_if_long_macro:NTF 46, 2361
- \token_if_long_macro_aux:w .. 2438, 2441
- \token_if_long_macro_p:N 46, 2361
- \token_if_long_macro_p_aux:w 2361
- \token_if_macro:N 2343
- \token_if_macro:NTF
..... 46, 2343, 2466, 2472, 2478
- \token_if_macro_p:N . 46, 2343, 2486, 2493
- \token_if_macro_p_aux:w 2343, 2344, 2346
- \token_if_math_shift:N 2295
- \token_if_math_shift:NTF 44, 2295
- \token_if_math_shift_p:N 44, 2295
- \token_if_math_subscript:N 2311
- \token_if_math_subscript:NTF .. 45, 2311
- \token_if_math_subscript_p:N .. 45, 2311
- \token_if_math_superscript:N 2307
- \token_if_math_superscript:NTF 45, 2307
- \token_if_math_superscript_p:N 45, 2307
- \token_if_mathchardef:N 2379
- \token_if_mathchardef:NTF 47, 2361
- \token_if_mathchardef_aux:w . 2380, 2383
- \token_if_mathchardef_p:N 47, 2361, 2506
- \token_if_mathchardef_p_aux:w ... 2361
- \token_if_other_char:N 2323
- \token_if_other_char:NTF 45, 2323
- \token_if_other_char_p:N 45, 2323
- \token_if_parameter:N 2303
- \token_if_parameter:NTF 44, 2303
- \token_if_parameter_p:N 44, 2303
- \token_if_primitive:N 2484
- \token_if_primitive:NTF 47, 2484
- \token_if_primitive_p:N 47, 2484
- \token_if_primitive_p_aux:N
..... 2484, 2489, 2496, 2503
- \token_if_protected_long_macro:N . 2444
- \token_if_protected_long_macro:NTF .
..... 46, 2361
- \token_if_protected_long_macro_aux:w
..... 2445, 2448
- \token_if_protected_long_macro_p:N .
..... 46, 2361
- \token_if_protected_long_macro_p_aux:w
..... 2361
- \token_if_protected_macro:N 2430
- \token_if_protected_macro:NTF . 46, 2361
- \token_if_protected_macro_aux:w
..... 2431, 2434
- \token_if_protected_macro_p:N . 46, 2361
- \token_if_protected_macro_p_aux:w 2361
- \token_if_skip_register:N 2397
- \token_if_skip_register:NTF 47, 2361
- \token_if_skip_register_aux:w 2401, 2405
- \token_if_skip_register_p:N
..... 47, 2361, 2510
- \token_if_skip_register_p_aux:w .. 2361
- \token_if_space:N 2315
- \token_if_space:NTF 45, 2315
- \token_if_space_p:N 45, 2315
- \token_if_toks_register:N 2419
- \token_if_toks_register:NTF 47, 2361
- \token_if_toks_register_aux:w 2423, 2427
- \token_if_toks_register_p:N
..... 47, 2361, 2514
- \token_if_toks_register_p_aux:w .. 2361

- \token_new:Nn . . . 44, 2269, 2269, 2274,
2276–2278, 2280–2283, 2524–2526
- \token_to_meaning:N
- . . . 22, 777, 778, 1115, 2344, 2374,
2381, 2391, 2402, 2413, 2424, 2432,
2439, 2446, 2468, 2474, 2480, 3826
- \token_to_str:c 22, 777, 786, 1622
- \token_to_str:N 4,
22, 777, 779, 786, 1002, 1006, 1067,
1113, 1120, 1121, 1128, 1145, 1149,
1331, 2129, 2151, 3459, 4253, 4286,
4429, 4449, 4474, 4653, 6031, 6528
- \toks 374
- \toks_clear:c 76, 4119, 4639
- \toks_clear:N 76,
3990, 4119, 4119, 4126, 4128, 4131,
4288, 4476, 4638, 4655, 5604, 5615
- \toks_gclear:c 76, 4119, 4641
- \toks_gclear:N . 76, 4119, 4123, 4129, 4640
- \toks_gput_left:cn 77, 4142
- \toks_gput_left:co 77, 4142
- \toks_gput_left:cV 77, 4142
- \toks_gput_left:Nn . . 77, 4142, 4147, 4152
- \toks_gput_left:No 77, 4142
- \toks_gput_left:Nv 77, 4142
- \toks_gput_left:Nx 77, 4142
- \toks_gput_right:cn 78, 4157
- \toks_gput_right:co 78, 4157
- \toks_gput_right:cV 78, 4157
- \toks_gput_right:Nn
. 78, 4157, 4161, 4181, 4701
- \toks_gput_right:No 78, 4157
- \toks_gput_right:Nv 78, 4157
- \toks_gput_right:Nx 78, 4157
- \toks_gset:cn 76, 4098, 5475
- \toks_gset:co 76, 4098
- \toks_gset:cV 76, 4098
- \toks_gset:cx 76, 4098
- \toks_gset:Nn
. 76, 4098, 4098–4100, 4685, 4717
- \toks_gset:No 76, 4098
- \toks_gset:Nv 76, 4098
- \toks_gset:Nx 76, 4098
- \toks_gset_eq:cc 76, 4101, 4649
- \toks_gset_eq:cN 76, 4101, 4648
- \toks_gset_eq:Nc 76, 4101, 4647
- \toks_gset_eq:NN
. 76, 4101, 4107, 4115, 4118, 4646
- \toks_if_empty:c 4730
- \toks_if_empty:cTF 78, 4190
- \toks_if_empty:N 4190, 4729
- \toks_if_empty:Nf
. 4196, 4290, 4478, 4569, 4657
- \toks_if_empty:NT 4195
- \toks_if_empty:NTF 78, 4190, 4194
- \toks_if_empty_p:c 78, 4190
- \toks_if_empty_p:N 78, 4190, 4193
- \toks_if_eq:cc 4734
- \toks_if_eq:ccTF 78, 4197
- \toks_if_eq:cN 4732
- \toks_if_eq:cNTF 78, 4197
- \toks_if_eq:Nc 4733
- \toks_if_eq:NcTF 78, 4197
- \toks_if_eq:NN 4197, 4731
- \toks_if_eq:NNF 4204
- \toks_if_eq:NNT 4203
- \toks_if_eq:NNTF 78, 4197, 4202
- \toks_if_eq_p:cc 78, 4197
- \toks_if_eq_p:cN 78, 4197
- \toks_if_eq_p:Nc 78, 4197
- \toks_if_eq_p:NN 78, 4197, 4201
- \toks_new:c 75, 4071, 4637
- \toks_new:N 75, 4071, 4073, 4076, 4077,
4207–4213, 4636, 5551–5553, 5730
- \toks_new_l:N 4074
- \toks_put_left:cn 77, 4142
- \toks_put_left:co 77, 4142
- \toks_put_left:cV 77, 4142
- \toks_put_left:Nn 77, 4142, 4142, 4146, 4150
- \toks_put_left:No 77, 4142
- \toks_put_left:Nv 77, 4142
- \toks_put_left:Nx 77, 4142
- \toks_put_left_aux:w . . . 4142, 4143, 4153
- \toks_put_right:cn 78, 4157
- \toks_put_right:co 78, 4157
- \toks_put_right:cV 78, 4157
- \toks_put_right:Nf 78, 4182, 4184
- \toks_put_right:Nn
. 78, 4157, 4157, 4164, 4166,
4180, 4182, 4695, 5660, 5683, 5688
- \toks_put_right:No
. 78, 3976, 3994, 3997, 4157,
4174, 5582, 5637, 5655, 5666, 5671
- \toks_put_right:Nv 78, 4157, 4168
- \toks_put_right:Nx 78, 4157,
4291, 4293, 4479, 4481, 4658, 4660
- \toks_set:cf 76, 4080
- \toks_set:cn 76, 4080
- \toks_set:co 76, 4080
- \toks_set:cV 76, 4080
- \toks_set:cv 76, 4080
- \toks_set:cx 76, 4080
- \toks_set:Nf . . . 76, 4080, 4093, 5579, 5587
- \toks_set:Nn 76, 4080, 4081,
4082, 4085, 4097, 4715, 5903, 5998
- \toks_set:No
76, 3974, 4080, 4092, 4565, 4566, 5594
- \toks_set:Nv . . . 76, 3907, 3941, 4080, 4086

\toks_set:Nv	76, 4080, 4089, 6001	\unvcopy	326
\toks_set:Nx	76, 4080, 5445	\uppercase	356
\toks_set_eq:cc	76, 4101, 4645	\use:c	11, 834, 834, 938, 1609, 1613, 1623, 1879, 1896, 2808, 3067, 3103, 5062, 5065, 5079, 5126, 5137, 5142, 5149, 5156, 5163, 5169, 5175, 5209, 5212, 5220, 5232, 5237, 5244, 5739, 6054, 6614
\toks_set_eq:cN	76, 4101, 4644	\use:n	11, 835, 835, 953, 958, 973, 978, 1332, 1948, 1958, 1968, 1978, 3066, 3982, 4001
\toks_set_eq:Nc	76, 4101, 4643	\use:nn	11, 835, 836
\toks_set_eq:NN	76, 4101, 4102, 4114, 4117, 4642	\use:nnn	11, 835, 837
\toks_show:c	77, 4140, 4651	\use:nnnn	11, 835, 838
\toks_show:N	77, 4140, 4140, 4141, 4297, 4485, 4650, 4666	\use_0_parameter:	1217
\toks_use:c	75, 4078	\use_1_parameter:	1217
\toks_use:N	75, 3979, 4003, 4078, 4078, 4079, 4144, 4158, 4170, 4176, 4186, 4198, 4568, 4570, 4673, 4746, 4910, 5451, 5457, 5479, 5483, 5583, 5596, 5639, 5657, 5883, 5987	\use_2_parameter:	1217
\toks_use_clear:c	77, 4130	\use_3_parameter:	1217
\toks_use_clear:N	77, 4130, 4130, 4136, 4138	\use_4_parameter:	1217
\toks_use_gclear:c	77, 4130	\use_5_parameter:	1217
\toks_use_gclear:N	77, 4130, 4133, 4139	\use_6_parameter:	1217
\toksdef	75	\use_7_parameter:	1217
\tolerance	285	\use_8_parameter:	1217
\topmark	166	\use_9_parameter:	1217
\topmarks	392	\use_i:nn	12, 839, 839, 948, 968, 1020, 1050, 1071, 1283, 4154
\topskip	296	\use_i:nnn	12, 841, 841, 1032, 2468
\totalheightof	120, 6570, 6573	\use_i:nnnn	12, 841, 844
\tracingassigns	402	\use_i_after_else:nw	13, 855, 856
\tracingcommands	141	\use_i_after_fi:nw	13, 855, 855, 1319, 3000
\tracinggroups	409	\use_i_after_or:nw	13, 855, 857
\tracingifs	405	\use_i_after_orelse:nw	13, 855, 858, 1299, 1301, 1303, 1305, 1307, 1309, 1311, 1313, 1315, 1317
\tracinglostchars	142	\use_i_delimit_by_q_nil:nw	13, 852, 852, 4029
\tracingmacros	143	\use_i_delimit_by_q_recursion_stop:nw	13, 852, 854, 2095, 2103
\tracingnesting	404	\use_i_delimit_by_q_stop:nw	13, 852, 853, 4345
\tracingonline	144	\use_i_ii:nnn	12, 841, 848, 1507
\tracingoutput	145	\use_ii:nn	12, 839, 840, 948, 968, 1004, 1022, 1052, 1073, 1285, 5624
\tracingpages	146	\use_ii:nnn	12, 841, 842, 1035, 2474, 5667
\tracingparagraphs	147	\use_ii:nnnn	12, 841, 845
\tracingrestores	148	\use_iii:nnn	12, 841, 843, 2480
\tracingscantokens	403	\use_iii:nnnn	12, 841, 846
\tracingstats	149	\use_iv:nnnn	12, 841, 847
U			
\U	2368	\use_none:n	12, 859, 859, 1006, 1321, 1642, 2097, 2105, 2949, 2950, 2954, 4804, 5590, 5621
\uccode	384	\use_none:nn	12, 859, 860, 953, 958, 973, 978, 1631, 2798
\uchyph	282	\use_none:nnn	12, 859, 861, 5654
\underline	218		
\unexpanded	23, 397		
\unhbox	323		
\unhcopy	324		
\unkern	248		
\unless	388		
\unpenalty	359		
\unskip	246		
\unvbox	325		

- `\use_none:nnnn` 12, 859, 862
`\use_none:nnnnn` 12, 859, 863
`\use_none:nnnnnn` 12, 859, 864
`\use_none:nnnnnnn` 12, 859, 865
`\use_none:nnnnnnnn` 12, 859, 866
`\use_none:nnnnnnnnn` ... 12, 859, 867, 1289
`\use_none_delimit_by_q_nil:w` 13, 849, 849
`\use_none_delimit_by_q_recursion_stop:w`
..... 13, 849, 851,
936, 986, 1606, 2083, 2088, 3871, 4526
`\use_none_delimit_by_q_stop:w`
. 13, 849, 850, 1994, 1998, 4344, 4766
`\usepackage` 730, 5494
- ### V
- `\vadjust` 259, 547
`\valign` 94
`\value` 5512
`.value_forbidden:` 114
`.value_required:` 114
`\vbadness` 334
`\vbox` 329
`\vbox:n` 107, 5372, 5372
`\vbox_gset:cn` 107, 5373
`\vbox_gset:Nn` 107, 5373, 5375, 5376
`\vbox_gset_inline_begin:N` 108, 5383, 5386
`\vbox_gset_inline_end:` . 108, 5383, 5388
`\vbox_gset_to_ht:ccn` 108, 5377
`\vbox_gset_to_ht:cnn` 108, 5377
`\vbox_gset_to_ht:Nnn` 108, 5377, 5381, 5382
`\vbox_set:cn` 107, 5373
`\vbox_set:Nn` 107, 5373, 5373–5375
`\vbox_set_inline_begin:N`
..... 108, 5383, 5383, 5387
`\vbox_set_inline_end:` .. 108, 5383, 5385
`\vbox_set_split_to_ht:Nnn` 108, 5391, 5391
`\vbox_set_to_ht:cnn` 108, 5377
`\vbox_set_to_ht:Nnn`
..... 108, 5377, 5377, 5380, 5381
`\vbox_to_ht:nn` 108, 5389, 5389
`\vbox_to_zero:n` 108, 5389, 5390
`\vbox_unpack:c` 108, 5394
`\vbox_unpack:N` 108, 5394, 5394, 5395
`\vbox_unpack_clear:c` 108, 5394
`\vbox_unpack_clear:N` 108, 5394, 5396, 5397
`\vcenter` 180
`\vfil` 241
`\vfill` 243
- `\vfilneg` 242
`\vfuzz` 336
`\voffset` 311
`\voidb@x` 5367
`\vrule` 250
`\vsize` 293
`\vskip` 244
`\vsplit` 322
`\vss` 245
`\vtop` 330
- ### W
- `\WARNING` 5474
`\wd` 377
`\widowpenalties` 437
`\widowpenalty` 264
`\widthof` 120, 6570, 6571
`\wlog` 6729
`\write` 127
- ### X
- `\X` 2364, 2368
`\xdef` 68
`\xetex_if_engine:` 1260, 1269
`\xetex_if_engine:TF` 4, 24, 1255
`\xetex_version:D` 553, 556, 1255
`\XeTeXversion` 553
`\xleaders` 253
`\xref_deferred_new:nn`
..... 109, 5437, 5438, 5509, 5512
`\xref_define_label:nn` 295, 5467, 5467, 5481
`\xref_define_label_aux:nn` 5467, 5470, 5472
`\xref_get_value:nn`
... 109, 5453, 5453, 5507, 5510, 5513
`\xref_new:nn` 109, 5437, 5437, 5505
`\xref_new_aux:nnn` 5437, 5437–5439
`\xref_set_label:n` . 108, 5478, 5478, 5515
`\xref_tmp:w` 5479, 5482
`\xref_write` ... 295, 5480, 5487, 5487, 5496
`\xspaceskip` 287
- ### Y
- `\Y` 2365, 2368
`\year` 368
- ### Z
- `\Z` 2366, 2368
`\z@` 3336