The erw-l3 package *

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Abstract

Utilities like expl3[1].

Résumé

Utilitaires de type expl3[1].

Contents

*This file describes version v2.4, last revised 2020/05/21.

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Part I
Usage

\usepackage `\usepackage{erw-l3}`

Requirement

1. `erw-l3.sty` and its dependencies are in the path of the LaTeX engine. See Part III, section 3.
2. Goes in the *preamble*

2 basics

\erw_cs_apply:Nn `\erw_cs_apply:Nn {⟨cs⟩}{⟨token list$_1$⟩}`
\erw_cs_apply:(No|Nf|Nx|cn)
\erw_cs_apply:Nnn
\erw_cs_apply:Nnnn
\erw_cs_apply:Nnnnn

\erw_cs_identity:n `\erw_cs_identity:n{⟨arg⟩}`

\erw_cs_set_inline:Nn `\erw_cs_set_inline:Nn{⟨cs⟩}{⟨code⟩}`
\erw_cs_set_inline:cn

3 csint

\erw_csint:nn `\erw_csint:nn{⟨integer⟩}{⟨arg⟩}`

\erw_csint_name:n `\erw_csint_name:n{⟨integer⟩}`

\erw_csint_names:nnn `\erw_csint_names:nnn{⟨integer⟩}{⟨integer⟩}{⟨integer⟩}`

\erw_csint_names_braced:
\erw_csint_names_braced:n
\erw_csint_names_braced:nnn

\erw_csint_new:n \erw_csint_new:n{⟨*integer*⟩}

\erw_csint_reset: \erw_csint_reset:

4 int

\erw_int_range:n \erw_int_range:n{⟨*integer*⟩}
\erw_int_range:nn

5 lambda

\erw_lambda:nnn \erw_lambda:nnn⟨*token*⟩{⟨*arg spec*⟩}{⟨*code*⟩}

6 option

\erw_option:n \erw_option:n{⟨*keyval list*⟩}

oper / fold_set_par
oper / fold_apply_par
sys / timestamp_delim

7 prop

All functions that modify a ⟨*prop*⟩ check it exists, if not make sure it does.

\erw_prop_put:NN \erw_prop_put:NN⟨*prop*$_1$⟩⟨*prop*$_2$⟩

\erw_prop_put:Nnn \erw_prop_put:Nnn⟨*prop*⟩{⟨*key*⟩}{⟨*val*⟩}

\erw_prop_to_clist:Nn \erw_prop_to_clist:Nn⟨*prop*⟩{⟨*key*$_1$⟩,...}

8 seq

All functions that modify a ⟨*seq*⟩ check it exists, if not make sure it does.

\erw_seq_compose:nN \erw_seq_compose:nN{{⟨*cs*$_1$⟩}...}⟨*seq*⟩

\erw_seq_compose_c:nN \erw_seq_compose_c:nN{{⟨*cs name*$_1$⟩}...}⟨*seq*⟩

\erw_seq_compose_vers:nN \erw_seq_compose:nN{{⟨*cs or code*$_1$⟩}...}⟨*seq*⟩

\erw_seq_from_clist:Nn
\erw_seq_from_clist:cn \erw_seq_from_clist:Nn⟨*seq*⟩{⟨*clist*⟩}

\erw_seq_from_prop:NNn \erw_seq_from_prop:NNn⟨*seq*⟩⟨*prop*⟩{⟨*keyval list*⟩}

\erw_seq_put_right:Nn \erw_seq_put_right:Nn⟨*seq*⟩{⟨*token list*⟩}

\erw_seq_use:Nn \erw_seq_use:Nn⟨*seq*⟩{⟨*items*⟩}

Also see [1, Section 8 of l3seq]

Semantics \seq_use:Nnnn⟨*seq*⟩\erw_tl_separators:n{⟨*items*⟩}

9 sys

\erw_sys_jobnametimestamp:nn
\erw_sys_jobnametimestamp: \erw_sys_jobnametimestamp:nn{date|time|datetime}{10|16}

\erw_sys_timestamp:nn
\erw_sys_timestamp: \erw_sys_timestamp:nn{date|time|datetime}{10|16}

Semantics Timestamp in base 10 or 16

\erw_sys_timestamp_delimiter: \erw_sys_timestamp_delimiter:

10 tl

All functions that modify a ⟨*token list*⟩ check it exists, if not make sure it does.

\erw_tl_append_item:nn \erw_tl_append_item:nn{⟨*arg list*⟩}{⟨*arg*⟩}

\erw_tl_compose:nN
\erw_tl_compose:nn \erw_tl_compose:nn{{cs_1}...}{⟨*token list*⟩}

\erw_tl_compose_c:nN
\erw_tl_compose_c:nn \erw_tl_compose_c:nn{{cs name_1}...}{⟨*token list*⟩}

\erw_tl_compose_vers:nN
\erw_tl_compose_vers:nn \erw_tl_compose_vers:nn{{cs or code_1}...}{⟨*token list*⟩}

\erw_tl_fold:NN
\erw_tl_fold:cN

\erw_tl_fold:NN⟨*cs*⟩⟨*tl var*⟩

\erw_tl_gset_function:N
\erw_tl_gset_function:n

\erw_tl_gset_function:n{⟨*code*⟩}

\erw_tl_join:nn
\erw_tl_join:nnn
\erw_tl_join:nnnn
\erw_tl_join:nnnnn

\erw_tl_join:nn{⟨*token list*$_1$⟩}{⟨*token list*$_2$⟩}

\erw_tl_last_item:n

\erw_tl_last_item:n{⟨*token list*⟩}

\erw_tl_map:n
\erw_tl_map:Nn

\erw_tl_map:n{⟨*items*⟩}

Semantics Maps over ⟨*items*⟩ using the internal function set by \erw_tl_gset_function:n

\erw_tl_map_inline:nn

\erw_tl_map_inline:nn{⟨*code*⟩}{⟨*items*⟩}

\erw_tl_map_thread:Nn

\erw_tl_math_thread:Nn⟨*cs*⟩{⟨*items*⟩}

\erw_tl_map_thread_at:Nnn

\erw_tl_math_thread_at:Nnn{⟨*integer*⟩}{⟨*token list*⟩}

\erw_tl_repeat:nn

\erw_tl_repeat:nn{⟨*integer*⟩}{⟨*token list*⟩}

\erw_tl_split:nnn
\erw_tl_split:nn

\erw_tl_split:nn{⟨*items*⟩}{⟨*delimiter*⟩}

\erw_tl_separators:n

\erw_tl_separators:n{⟨*items*⟩}

Semantics According to the count of ⟨*items*⟩:

1) {⟨*token list*$_1$⟩}{⟨*token list*$_1$⟩}{⟨*token list*$_1$⟩}

2) {⟨*token list*$_1$⟩}{⟨*token list*$_2$⟩}{⟨*token list*$_1$ *token list*$_2$⟩}

3) {⟨*token list*$_1$⟩}{⟨*token list*$_2$⟩}{⟨*token list*$_3$⟩}

Part II
Listing

1 constants

Listing 1.

```
\ExplSyntaxOn
\seq_const_from_clist:Nn \foo_seq{ A, B, C }
\prop_const_from_keyval:Nn \foo_prop{ A = a, B = b, C = c }
\ExplSyntaxOff
```

2 basics

Listing 2.

```
\ExplSyntaxOn
\cs_set:Nn \__foo:n { f(#1) }
\erw_cs_apply:Nn \__foo:n{X}
\ExplSyntaxOff
```

f(X)

3 csint

Listing 3.

```
\ExplSyntaxOn
\cs_set:Nn\__foo:n{f(#1)}
\cs_set:Nn\__baz:n{h\{#1\}}
\tl_map_function:nN {{\__baz:n}{g[#1]}{\__foo:n}}\erw_csint_new:n
\exp_last_unbraced:Nx
\erw_tl_compose_c:nn
{{\erw_csint_names_braced:nnn{1}{1}{3}}
  {X}}
\ExplSyntaxOff
```

h{g[f(X)]}

4 int

Listing 4.

```
\ExplSyntaxOn
\erw_int_range:nn{2}{5}\\
\erw_int_range:n{5}
\ExplSyntaxOff
```

2345
12345

5 lambda

Listing 5.

```
\ExplSyntaxOn
\tl_set:Nn \l_tmpa_tl
{
  \erw_lambda:nnn \DeclareDocumentCommand{m}{Hello,~#1!}
}
\l_tmpa_tl{world}
\ExplSyntaxOff
```

Hello, world!

6 prop

Listing 6.

```
\ExplSyntaxOn
\erw_prop_put:Nnn \baz_prop { D } { d }
\erw_prop_put:NN \baz_prop \foo_prop
\prop_item:Nn \baz_prop{A}
,\prop_item:Nn \baz_prop{B}
,\prop_item:Nn \baz_prop{C}
,\prop_item:Nn \baz_prop{D}
\ExplSyntaxOff
```

a,b,c,d

Listing 7.

```
\ExplSyntaxOn
\erw_prop_to_clist:Nn \foo_prop{ A, B, C }
\ExplSyntaxOff
```

a,b,c

7 seq

Listing 8.

```
\ExplSyntaxOn
\cs_set:Nn \__foo:n {f(#1)}
\cs_set:Nn \__bar:n {g[#1]}
\cs_set:Nn \__baz:n {h\{#1\}}
\seq_new:N \l_tmp_seq
\seq_put_right:Nn \l_tmp_seq{X}
\erw_seq_compose:nnN{{\__baz:n}{\__bar:n}{\__foo:n}}\l_tmp_seq
\seq_item:Nn \l_tmp_seq{1}\\
\seq_item:Nn \l_tmp_seq{2}\\
\seq_item:Nn \l_tmp_seq{3}\\
\seq_item:Nn \l_tmp_seq{4}
\ExplSyntaxOff
```

X
f(X)
g[f(X)]
h{g[f(X)]}

Listing 9.

```
\ExplSyntaxOn
\cs_set:Nn \__foo:n {f(#1)}
\cs_set:Nn \__bar:n {g[#1]}
\cs_set:Nn \__baz:n {h\{#1\}}
\erw_seq_put_right:Nn \l_tmp_seq{X}
\erw_seq_compose_c:nnN{{__baz:n}{__bar:n}{__foo:n}}\l_tmp_seq
\seq_item:Nn \l_tmp_seq{1}\\
\seq_item:Nn \l_tmp_seq{2}\\
\seq_item:Nn \l_tmp_seq{3}\\
\seq_item:Nn \l_tmp_seq{4}
\ExplSyntaxOff
```

X
f(X)
g[f(X)]
h{g[f(X)]}

Listing 10.

```
\ExplSyntaxOn
\erw_seq_from_prop:NNn \bar_seq\foo_prop{ A, B, C }
\seq_use:Nn\bar_seq{,}
\ExplSyntaxOff
```

a,b,c

Listing 11.

```
\ExplSyntaxOn
\seq_put_right:Nn\l_tmpa_seq{ A }
\seq_put_right:Nn\l_tmpa_seq{ B }
\erw_seq_use:Nn \l_tmpa_seq{{~and~}}\\
\erw_seq_use:Nn \l_tmpa_seq{{,\ }{~and~}}\\
\erw_seq_use:Nn \l_tmpa_seq{{~and~}{,\ }{,~and~}}\\[1em]
\seq_put_right:Nn\l_tmpa_seq{ C }
\erw_seq_use:Nn \l_tmpa_seq{{~and~}}\\
\erw_seq_use:Nn \l_tmpa_seq{{,\ }{and~}}\\
\erw_seq_use:Nn \l_tmpa_seq{{~and~}{,\ }{,~and~}}\\
\ExplSyntaxOff
```

A and B
A and B
A and B

A and B and C
A, B, and C
A, B, and C

8 sys

Listing 12.

```
\ExplSyntaxOn
\noindent\erw_sys_timestamp:nn{date}{10}{-}
\noindent\erw_sys_timestamp:nn{time}{10}\\
\noindent\erw_sys_timestamp:nn{datetime}{10}\\
\erw_sys_timestamp:nn{date}{16}{\%}
\erw_sys_timestamp:nn{time}{16}\\
\erw_option:n{ sys / timestamp_delim = {\%} }
\erw_sys_timestamp:nn{datetime}{16}\\
\erw_sys_jobnametimestamp:
\ExplSyntaxOff
```

```
20200522-150
20200522-150
1343c4a%96
1343c4a%96
erw-l3%1343c4a%96
```

Listing 13.

```
\ExplSyntaxOn
\erw_option:n{ sys / timestamp_delim = \c_empty_tl }
\iow_new:N \foo_iow
\tl_set:Nx \foo_dec { \erw_sys_timestamp:nn{datetime}{10} }
\tl_set:Nx \foo_hex { \erw_sys_timestamp: }
\iow_open:Nn \foo_iow{\foo_hex}
\iow_now:Nn\foo_iow{Hello,\ world!}
\iow_close:N \foo_iow
D:\foo_dec\\
\file_timestamp:n{\foo_hex}\\
\file_input:n{\foo_hex}
\ExplSyntaxOff
```

```
D:20200522150
D:20200522015023-04'00'
Hello, world!
```

9 tl

Listing 14.

```
\ExplSyntaxOn
\cs_set:Nn \__foo:n {f(#1)}
\cs_set:Nn \__bar:n {g[#1]}
\cs_set:Nn \__baz:n {h\{#1\}}
\tl_set:Nn \l_tmpa_tl{X}
\erw_tl_compose:nN{{\__baz:n}{\__bar:n}{\__foo:n}}\l_tmpa_tl
\l_tmpa_tl\\
\tl_set:Nn \l_tmpa_tl{X}
\erw_tl_compose:nn{{\__baz:n}{\__bar:n}{\__foo:n}}{X}\\
\ExplSyntaxOff
```

```
h{g[f(X)]}
h{g[f(X)]}
```

Listing 15.

```
\ExplSyntaxOn
\cs_set:Nn \__foo:n  {f(#1)}
\cs_set:Nn \__bar:n  {g[#1]}
\cs_set:Nn \__baz:n  {h\{#1\}}
\tl_set:Nn \l_tmpa_tl{X}
\erw_tl_compose_c:nN{{__baz:n}{__bar:n}{__foo:n}}\l_tmpa_tl
\l_tmpa_tl\\
\erw_tl_compose_c:nn{{__baz:n}{__bar:n}{__foo:n}}{X}
\ExplSyntaxOff
```

---

h{g[f(X)]}
h{g[f(X)]}

Listing 16.

```
\ExplSyntaxOn
\cs_set:Npn \__foo #1 {f(#1)}
\cs_set:Npn \__bar #1 {g[#1]}
\cs_set:Npn \__baz #1 {h\{#1\}}
\erw_tl_compose_vers:nn{{\__baz}{g[#1]}{\__foo}}{X}
\ExplSyntaxOff
```

---

h{g[f(X)]}

Listing 17.

```
\ExplSyntaxOn
\cs_set:Nn \__foo:n {f(#1)}
\tl_set:Nn \l_tmpa_tl{X}
\erw_tl_fold:NN\__foo:n\l_tmpa_tl
\l_tmpa_tl\\
\cs_set:Nn \__bar:n {g[#1]}
\erw_tl_fold:cN {__bar:n}\l_tmpa_tl
\l_tmpa_tl
\ExplSyntaxOff
```

---

f(X)
g[f(X)]

Listing 18.

```
\ExplSyntaxOn
\erw_tl_repeat:nn{3}{x}
\ExplSyntaxOff
```

---

xxx

Listing 19.

```
\ExplSyntaxOn
\erw_tl_split:nn{{a}{b}{c}}{==}
\ExplSyntaxOff
```

a==b==c

Listing 20.

```
\ExplSyntaxOn
\cs_set:Nn \__foo:n {(#1)}
\erw_tl_map:Nn \__foo:n{{a}{b}{c}}
\ExplSyntaxOff
```

(a)(b)(c)

Listing 21.

```
\ExplSyntaxOn
\cs_set:Nn \__foo:n {(#1)}
\erw_tl_map_thread:Nn \__foo:n
{
  {{a}{b}{c}{d}{e}{f}}
}\\
\cs_set:Nn\__foo:nn {(#1+#2)}
\erw_tl_map_thread:Nn \__foo:nn
{
  {{a}{b}{c}{d}{e}{f}}
  {{A}{B}{C}{D}{E}{F}}
}\\
\cs_set:Nn \__foo:nnn {(#1+#2+#3)}
\erw_tl_map_thread:Nn \__foo:nnn
{
  {{a}{b}{c}{d}{e}{f}}
  {{A}{B}{C}{D}{E}{F}}
  {{k}{l}{m}{n}{o}{p}}
}\\
\cs_set:Nn \__foo:nnnn {(#1+#2+#3+#4)}
\erw_tl_map_thread:Nn \__foo:nnnn
{
  {{a}{b}{c}{d}{e}{f}}
  {{A}{B}{C}{D}{E}{F}}
  {{k}{l}{m}{n}{o}{p}}
  {{K}{L}{M}{N}{O}{P}}
}
\ExplSyntaxOff
```

(a)(b)(c)(d)(e)(f)
(a+A)(b+B)(c+C)(d+D)(e+E)(f+F)

(a+A+k)(b+B+l)(c+C+m)(d+D+n)(e+E+o)(f+F+p)
(a+A+k+K)(b+B+l+L)(c+C+m+M)(d+D+n+N)(e+E+o+O)(f+F+p+P)

Listing 22.

```
\ExplSyntaxOn
\cs_set:Nn\__foo:nn {(#1+#2)}
\erw_tl_map_thread_at:Nnn \__foo:nn{2}
{
  {{a}{b}{c}{d}{e}{f}}
  {{A}{B}{C}{D}{E}{F}}
}
\ExplSyntaxOff
```

(b+B)

Part III
Other

1 Acknowledgment

This work has benefited from Q&A's from the LaTeXcommunity[3]. lambda originally appeared in [2].

2 Install

1) Compile `erw-l3.dtx` (under Unix, `$tex timestamp.dtx`)

2) Put the generated `erw-l3.sty` in the search path of the LaTeXengine

3 Support

This package is available from https://www.ctan.org/pkg/erw-l3 and https://github.com/rogard/erw-l3.

3.1 Platform

i)
```
Linux laptop 4.15.0-20-generic #21-Ubuntu SMP Tue Apr 24
↪  06:16:15 UTC 2018 x86_64 x86_64 x86_64 GNU/Linux
```

3.2 Engine

a)
```
pdfTeX 3.14159265-2.6-1.40.20 (TeX Live 2019)
```

b)
```
pdfTeX 3.14159265-2.6-1.40.21 (TeX Live 2020)
```

c)
```
LuaHBTeX, Version 1.12.0 (TeX Live 2020)
```

d)
```
XeTeX 3.14159265-2.6-0.999992 (TeX Live 2020)
```

3.3 Results

1) erw-l3 v2.0 compiles satisfactorily on platform *i)* and engines *b)*, *c)*, and *d)*

References

[1] The LaTeX3 Project Team *The LaTeX3 interfaces*, 2019, http://ftp.math.purdue.edu/mirrors/ctan.org/macros/latex/contrib/l3kernel/interface3.pdf

[2] @sean-allred's answer to "How to create lambda expressions?", https://tex.stackexchange.com/a/188053/112708

[3] https://tex.stackexchange.com/users/112708/erwann?tab=questions

Change History

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The italic numbers denote the pages where the corresponding entry is described, numbers underlined point to the definition, all others indicate the places where it is used.

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Part IV
Implementation

1 Opening

```
⟨*package⟩
⟨@@=erw⟩
%       \ExplSyntaxOn
```

2 basics

2.1 backend

```
\cs_new:Nn \__erw_cs_name:N
{
  \exp_last_unbraced:Nf \use_i:nnn {\cs_split_function:N #1}
}
```

2.2 frontend

```
\cs_new:Nn \erw_cs_apply:Nn
{
  #1{#2}
}
\cs_generate_variant:Nn \erw_cs_apply:Nn {No, Nf, Nx, c}
\cs_new:Nn \erw_cs_apply:Nnn
{
  #1{#2}{#3}
}
\cs_new:Nn \erw_cs_apply:Nnnn
{
  #1{#2}{#3}{#4}
}
\cs_new:Nn \erw_cs_apply:Nnnnn
{
  #1{#2}{#3}{#4}{#5}
}
\cs_set:Npn \erw_cs_identity:n #1{#1}
\cs_new:Nn \erw_cs_set_inline:Nn
{
  \cs_set:Npn #1 ##1{#2}
}
\cs_generate_variant:Nn \erw_cs_set_inline:Nn {cn}
\cs_new:Nn \erw_cs_gset_inline:Nn
{
  \cs_gset:Npn #1 ##1{#2}
}
\cs_generate_variant:Nn \erw_cs_gset_inline:Nn {cn}
\cs_new:Nn \erw_tl_join:nn{#1#2}
\cs_new:Nn \erw_tl_join:nnn{#1#2#3}
\cs_new:Nn \erw_tl_join:nnnn{#1#2#3#4}
\cs_new:Nn \erw_tl_join:nnnnn{#1#2#3#4#5}
```

3 clist

3.1 backend

3.2 frontend

4 csint

4.1 backend

```
\int_new:N \g__erw_csint_int
\tl_set:Nn \g__erw_csint_name_tl {\erw_csint_name:n{\g__erw_csint_int}}
```

4.2 frontend

```
\cs_new:Nn \erw_csint:nn
{
  \erw_cs_apply:cn{__erw_csint_\int_to_alph:n{#1}:n}{#2}
}
\cs_new:Nn \erw_csint_name:n {__erw_csint_\int_to_alph:n{#1}:n}
\cs_new:Nn \erw_csint_names:nnn
{
  \int_step_function:nnnN { #1 }{ #2 }{ #3 } \erw_csint_name:n
}
\cs_new_protected:Nn \erw_csint_new:n
{
  \int_incr:N \g__erw_csint_int
  \erw_cs_set_inline:cn{\g__erw_csint_name_tl}
  {
    \token_if_cs:NTF
    {#1}
    {#1{##1}}
    {#1}
  }
}
\cs_new:Nn \erw_csint_names_braced:nnn
{
  \int_step_function:nnnN { #1 }{ #2 }{ #3 } \erw_csint_names_braced:n
  % TODO \tl_range_braced:nnn?
}
\cs_new:Nn \erw_csint_names_braced:n {{\erw_csint_name:n{#1}}}
\cs_new:Nn \erw_csint_names_braced:
{
  \erw_csint_names_braced:nnn{1}{1}{\g__erw_csint_int}
}
\cs_new_protected:Nn \erw_csint_reset:
{
  \int_zero:N \g__erw_csint_int
  \tl_set:Nn \__erw_csint_ext_tl{}%^^A TODO remove?
}
```

5 int

5.1 backend

```
\cs_set:Npn \__erw_int_range:nnn #1 #2 #3
{
  \int_compare:nNnTF
  {
    \int_eval:n{#2+1}
  }>{#3}
  {
    {#1}
  }
  {
    \__erw_int_range:nnn
    {
      \exp_args:Nx\erw_tl_append_item:nn{#1}
      {
        \int_eval:n{#2+1}
      }
    }
    {\int_eval:n{#2+1}}
    {#3}
  }
}
```

5.2 frontend

```
\cs_new:Nn \erw_int_range:nn
{
  \__erw_int_range:nnn {{#1}}{#1}{#2}
}
\cs_new:Nn \erw_int_range:n
{
  \__erw_int_range:nnn {}{0}{#1}
% ^^A Alt to:
% ^^A    \int_step_inline:nn {#1}{##1}
}
```

6 keyval

```
\cs_new:Nn \erw_keyval_keyonly:nn
{
  \msg_error:nnn{erw}{keyval/keyonly}{#1}{#2}
}
```

7 lambda

\erw_lambda:nnn

```
\cs_new_protected:Npn \erw_lambda:nnn #1 #2 #3
{
  \exp_args:NNx
  #1 \__erw_lambda_expression
  {#2}
  {#3}
  \__erw_lambda_expression
}
```

(*End definition for* `\erw_lambda:nnn`. *This function is documented on page* 5.)

8 msg

8.1 backend

```
\msg_new:nnn{__erw}{generic}{#1}
\msg_new:nnn{__erw}{separ}{#1~expects~1~to~3~items,~#2}
\msg_new:nnn{__erw}{timestamp / base}{Calling~#1,~arg~must~be~'dec|hex'}
\msg_new:nnn{__erw}{timestamp / period}{Calling~#1,~arg~must~be~'date|time|datetime'}
```

8.2 frontend

```
\msg_new:nnn{erw}{csnset}{#1~not~set}
\msg_new:nnn{erw}{keyval/keyonly}{passed~key~#1~val~#2~where~keyonly}
\msg_new:nnn{erw}{keyval/mandatval}{key~#1~has~no~matching~val}
```

9 prop

9.1 backend

9.2 frontend

```
\cs_new_protected:Nn \erw_prop_to_clist:Nn
{
  \cs_set:Nn \__erw_keyval_function:n {,\prop_item:Nn#1{##1}}
  \exp_args:Nf
  \tl_tail:n
  {
    \keyval_parse:NNn
    \__erw_keyval_function:n
    \erw_keyval_keyonly:nn
    {#2}
  }
}
\cs_generate_variant:Nn \erw_prop_to_clist:Nn { c }

\cs_new_protected:Nn \erw_prop_put:NN
{
  \cs_set:Nn \__erw_prop_append:nn
  {
    \prop_gput:Nnx #1 {##1}{ \prop_item:Nn #2{##1} }
  }
  \prop_map_function:NN #2 \__erw_prop_append:nn
}
\cs_generate_variant:Nn \erw_prop_put:NN { cc }
\cs_new_protected:Nn\erw_prop_put:Nnn
{
  \prop_if_exist:NTF#1
  {
    \prop_put:Nnn #1 {#2}{#3}
  }
  {
    \prop_new:N #1
    \erw_prop_put:Nnn #1{#2}{#3}
  }
}
```

```
\cs_generate_variant:Nn \erw_prop_put:Nnn { c }
```

10 oper

10.1 backend

```
\cs_new:Nn \__erw_oper_compose:NnN
{
  \erw_cs_set_inline:Nn \g__erw_tl_function:n
  {
    #1{##1}#3
  }
  \exp_args:Nf\erw_tl_map:n
  {
    \tl_reverse:n{#2}
  }
}
```

10.2 frontend

```
\keys_define:nn{__erw}
{
  oper/fold_set_par.tl_gset:N = \g__erw_oper_fold_set_par_tl,
  oper/fold_set_par.value_required:n = true,
  oper/fold_set_par.default:n = {Nf},
  oper/fold_set_par.initial:n = {Nf},
  oper/fold_apply_par.tl_gset:N = \g__erw_oper_fold_apply_par_tl,
  oper/fold_apply_par.value_required:n = true,
  oper/fold_apply_par.default:n = {Nf},
  oper/fold_apply_par.initial:n = {Nf}
}
```

11 seq

11.1 backend

```
\tl_new:N \g__erw_seq_fold_item_tl
\cs_new_protected:Nn\__erw_seq_set_from_clist:Nn
{
  \cs_set_protected:Nn \__erw_function:n
  {
    \seq_put_right:Nn #1{##1}
  }
  \keyval_parse:NNn
  \__erw_function:n
  \erw_keyval_keyonly:nn
  {#2}
}
\cs_generate_variant:Nn \__erw_seq_set_from_clist:Nn { c }
\cs_new_protected:Nn\__erw_seq_set_from_prop:NNn
{
  \__erw_seq_set_from_clist:Nn #1
  {\erw_prop_to_clist:Nn #2 {#3}}
}
\cs_generate_variant:Nn \__erw_seq_set_from_prop:NNn { cc }
```

11.2 frontend

```
\cs_new:Nn \erw_seq_compose:nN
{
  \__erw_oper_compose:NnN \__erw_seq_fold:NN {#1} #2
}
\cs_new:Nn \erw_seq_compose_c:nN
{
  \__erw_oper_compose:NnN \__erw_seq_fold:cN {#1} #2
}
\cs_new:Nn \erw_seq_compose_vers:nN
{
  \msg_error:nnn{__erw}{csnset}{\erw_seq_compose_vers:nN}
}
\cs_new_protected:Nn\erw_seq_from_clist:Nn
{
  \seq_if_exist:NTF#1
  {\__erw_seq_set_from_clist:Nn#1{#2}}
  {\seq_new:N#1\erw_seq_from_clist:Nn#1{#2}}
}
\cs_generate_variant:Nn \erw_seq_from_clist:Nn { c }
\cs_new_protected:Nn\erw_seq_from_prop:NNn
{
  \seq_if_exist:NTF#1
  {\__erw_seq_set_from_prop:NNn#1#2{#3}}
  {\seq_new:N#1\erw_seq_from_prop:NNn#1#2{#3}}
}
\cs_generate_variant:Nn \erw_seq_from_prop:NNn { cc }
\cs_new_protected:Nn\erw_seq_put_right:Nn
{
  \seq_if_exist:NTF#1
  {\seq_put_right:Nn#1{#2}}
  {\seq_new:N#1\erw_seq_put_right:Nn #1{#2}}
}
\cs_generate_variant:Nn\erw_seq_put_right:Nn { c }
\cs_new:Nn \__erw_seq_fold:NN
{
  \seq_get_right:NN #2 \g__erw_seq_fold_item_tl
  \erw_tl_fold:NN #1 \g__erw_seq_fold_item_tl
  \seq_put_right:No #2 {\g__erw_seq_fold_item_tl}
}
\cs_generate_variant:Nn \__erw_seq_fold:NN {cN}
\cs_new:Nn \erw_seq_use:Nn
{
  \exp_last_unbraced:NNf
  \seq_use:Nnnn #1
  \erw_tl_separators:n{#2}
}
```

12 sys

12.1 backend

__erw_sys_date:N
__erw_sys_date_dec:
__erw_sys_date_hex:

```
\cs_new:Nn \__erw_sys_date_dec:
{
  \int_eval:n
  {
    \c_sys_year_int * 10000
    +\c_sys_month_int * 100
    +\c_sys_day_int *  1
  }
}
\cs_new:Nn \__erw_sys_date:N{\int_to_hex:n{\__erw_sys_date_dec:}}
\cs_new:Nn \__erw_sys_date_hex:{\int_to_hex:n{\__erw_sys_date_dec:}}
```

(*End definition for* `\__erw_sys_date:N`, `\__erw_sys_date_dec:`, *and* `\__erw_sys_date_hex:`.)

`\__erw_sys_time_dec:`
`\__erw_sys_time_hex`

```
\cs_new:Nn \__erw_sys_time_dec:
{
  \int_eval:n
  {
    \c_sys_hour_int * 100
    +\c_sys_minute_int * 1
  }
}
\cs_new:Nn\__erw_sys_time_hex:{\int_to_hex:n{\__erw_sys_time_dec:}}
```

(*End definition for* `\__erw_sys_time_dec:` *and* `\__erw_sys_time_hex`.)

`\__erw_sys_datetime_base:n`
`\__erw_sys_datetime_dec:n`
`\__erw_sys_datetime_join:nn`
`\__erw_sys_datetime_hex:n`
`\__erw_sys_datetime_period:n`

```
\cs_new:Nn\__erw_sys_datetime_base:n
{
  \int_case:nnTF{#1}
  {
    {10}{dec}
    {16}{hex}
  }
  {\c_empty_tl}
  {\msg_error:nnn{__erw}{timestamp / base}{\__erw_sys_datetime_base:n{#1}}}
}
\cs_new:Nn\__erw_sys_datetime_join:nn{\erw_tl_join:nnn{#1}{\g__erw_sys_timestamp_delim_str}{#
\cs_new:Nn\__erw_sys_datetime_period:n
{
  \str_case:nnTF{#1}
  {
    {date}{date}
    {time}{time}
    {datetime}{datetime}
  }
  {\c_empty_tl}
  {\msg_error:nnn{__erw}{ timestamp / period }{\__erw_sys_datetime_period:n{#1}}}
}
\cs_new:Nn\__erw_sys_datetime_dec: {\__erw_sys_datetime_join:nn{\__erw_sys_date_dec:}{\__erw_
\cs_new:Nn\__erw_sys_datetime_hex: {\__erw_sys_datetime_join:nn{\__erw_sys_date_hex:}{\__erw_
```

(*End definition for* `\__erw_sys_datetime_base:n` *and others.*)

__erw_sys_jobnametimestamp_prefix:

```
\cs_new:Nn\__erw_sys_jobnametimestamp_prefix:
{
  \erw_tl_join:nn
  {\c_sys_jobname_str}
  {\g__erw_sys_timestamp_delim_str}
}
% \begin{macro}{\__erw_sys_jobnametimestamp:n, \__erw_sys_jobnametimestamp:}
%    \begin{macrocode}
\cs_new:Nn\__erw_sys_jobnametimestamp:nn
{
  \erw_tl_join:nn
  {\__erw_sys_jobnametimestamp_prefix:}
  {\erw_sys_timestamp:nn{#1}{#2}}
}
\cs_new:Nn\__erw_sys_jobnametimestamp:
{
  \erw_tl_join:nn
  {\__erw_sys_jobnametimestamp_prefix:}
  {\erw_sys_timestamp:}
}
```

(*End definition for* `\__erw_sys_jobnametimestamp_prefix:`.)

__erw_sys_timestamp:nn

```
\cs_new:Nn\__erw_sys_timestamp:nn
{
  \exp_args:No
  \use:c{__erw_sys_\__erw_sys_datetime_period:n{#1}_\__erw_sys_datetime_base:n{#2}:}
}
\cs_new_protected:Nn \__erw_sys_set_delim:nn
{
  \use:c{tl_gset:N#1}
  \g__erw_sys_timestamp_delim_str{#2}
}
```

(*End definition for* `\__erw_sys_timestamp:nn`.)

```
\keys_define:nn{__erw}
{
  sys / timestamp_delim .code:n =
  {
    \exp_last_unbraced:No
    \__erw_sys_set_delim:nn{n}{#1}
  },
  sys / timestamp_delim  .value_required:n = true,
  sys / timestamp_delim  .default:n = {-},
  sys / timestamp_delim  .initial:n = {-}
}
% \subsection{frontend}
%    \begin{macrocode}
\cs_new:Nn\erw_sys_jobnametimestamp:nn{\__erw_sys_jobnametimestamp:nn{#1}{#2}}
\cs_new:Nn\erw_sys_jobnametimestamp:{\__erw_sys_jobnametimestamp:}
\cs_new:Nn\erw_sys_timestamp_delimiter:
{
```

```
  \use:N \g__erw_sys_timestamp_delim_str
}
\cs_new:Nn\erw_sys_timestamp:nn
{
  \__erw_sys_timestamp:nn{#1}{#2}
}
\cs_new:Nn\erw_sys_timestamp:
{
  \__erw_sys_timestamp:nn{datetime}{16}
}
```

13 tl

13.1 backend

```
\tl_new:N \g__erw_tl_compose_tl
```

\g__erw_tl_function:n

```
\cs_new_protected:Nn \g__erw_tl_function:n
{
  \msg_error:nnn
  {erw}
  {csnset}
  {\g__erw_tl_function:n}
}
```

(*End definition for* \g__erw_tl_function:n.)

__erw_map:nn

```
\cs_set_protected:Nn \__erw_map:nn
{
  \quark_if_recursion_tail_stop:n{#1}
  \g__erw_tl_function:n{#1}  \__erw_map:nn{#2}
}
```

(*End definition for* __erw_map:nn.)

__erw_tl_map_thread_at:Nnn
__erw_tl_map_thread_at:Nnnn
__erw_tl_map_thread_at:Nnnnn
__erw_tl_map_thread_at:Nnnnn

```
\cs_set_protected:Nn \__erw_tl_map_thread_at:Nnn
{
  \erw_cs_apply:Nn #1
  {\exp_args:Nf\tl_item:nn {#3} {#2} }
}
\cs_set_protected:Nn \__erw_tl_map_thread_at:Nnnn
{
  \erw_cs_apply:Nnn #1
  {\exp_args:Nf\tl_item:nn {#3} {#2} }
  {\exp_args:Nf\tl_item:nn {#4} {#2} }
}
\cs_set_protected:Nn \__erw_tl_map_thread_at:Nnnnn
{
  \erw_cs_apply:Nnnn #1
  {\exp_args:Nf\tl_item:nn {#3} {#2} }
  {\exp_args:Nf\tl_item:nn {#4} {#2} }
```

```
  {\exp_args:Nf\tl_item:nn {#5} {#2} }
}
\cs_set_protected:Nn \__erw_tl_map_thread_at:Nnnnnn
{
  \erw_cs_apply:Nnnnn #1
  {\exp_args:Nf\tl_item:nn {#3} {#2} }
  {\exp_args:Nf\tl_item:nn {#4} {#2} }
  {\exp_args:Nf\tl_item:nn {#5} {#2} }
  {\exp_args:Nf\tl_item:nn {#6} {#2} }
}
```

(*End definition for* `\__erw_tl_map_thread_at:Nnn` *and others.*)

`\__erw_tl_separators:nn` #1 : ⟨ *int* ⟩
#2 : ⟨ *items* ⟩

```
\cs_new:Nn \__erw_tl_separators:nn
{
  \int_case:nnTF {#1}
  {
    {1}
    { \prg_replicate:nn{ 3 }{#2} }
    {2}
    {
      { \use_ii:nn #2 }
      { \use_i:nn #2 }
      { \use_i:nn #2 \use_ii:nn #2 }
    }
    {3}{#2}
  }
  { \c_empty_tl }
  {
    \msg_error:nnnn { __erw }
    { separ }
    { \exp_not:N \__erw_tl_separators:nn }
    {#2}
  }
}
\cs_generate_variant:Nn \__erw_tl_separators:nn { e }
```

(*End definition for* `\__erw_tl_separators:nn`.)

13.2 frontend

```
\cs_new:Nn \erw_tl_append_item:nn
{
  {#1{#2}}
}
\cs_new:Nn \erw_tl_compose:nN
{
  \__erw_oper_compose:NnN \erw_tl_fold:NN {#1} #2
}
\cs_new:Nn \erw_tl_compose:nn
{
  \tl_set:Nn \g__erw_tl_compose_tl {#2}
```

```
  \erw_tl_compose:nN{#1}\g__erw_tl_compose_tl
  \g__erw_tl_compose_tl
}
\cs_new:Nn \erw_tl_compose_c:nN
{
  \__erw_oper_compose:NnN \erw_tl_fold:cN {#1} #2
}
\cs_new:Nn \erw_tl_compose_c:nn
{
  \tl_set:Nn \g__erw_tl_compose_tl {#2}
  \erw_tl_compose_c:nN{#1}\g__erw_tl_compose_tl
  \g__erw_tl_compose_tl
}
\cs_new:Nn \erw_tl_compose_vers:nN
{
  \msg_error:nnn{__erw}{csnset}{\erw_tl_compose_vers:nN}
}
\cs_new:Nn \erw_tl_compose_vers:nn
{
  \erw_csint_reset:{}
  \tl_map_function:nN{#1}\erw_csint_new:n
  \exp_last_unbraced:Nx
  \erw_tl_compose_c:nn
  {{\erw_csint_names_braced:{}}}
  {#2}
}
\cs_new:Nn \erw_tl_fold:NN
{
  \use:c{tl_set:\g__erw_oper_fold_set_par_tl}
  #2
  {\use:c{erw_cs_apply:\g__erw_oper_fold_apply_par_tl}{#1}{#2}}
}
\cs_generate_variant:Nn \erw_tl_fold:NN {cN}
\cs_new:Nn \erw_tl_gset_function:N
{
  \erw_cs_gset_eq:NN \g__erw_tl_function:n #1
}
\cs_new:Nn \erw_tl_gset_function:n
{
  \erw_cs_gset_inline:Nn \g__erw_tl_function:n {#1}
}
\cs_new:Nn \erw_tl_last_item:n
{
  \exp_args:Nof \tl_item:nn
  {#1}
  {
    \tl_count:n{#1}
  }
}
\cs_new_protected:Nn \erw_tl_map:n
{
  \__erw_map:nn#1\q_recursion_tail\q_recursion_stop\q_recursion_tail\q_recursion_stop
}
\cs_new_protected:Nn \erw_tl_map:Nn
```

```
{
  \cs_set_eq:NN \g__erw_tl_function:n #1
  \erw_tl_map:n{#2}
}
\cs_new_protected:Nn \erw_tl_map_inline:nn
{
  \erw_cs_set_inline:Nn \g__erw_tl_function:n {#1}
  \erw_tl_map:n{#2}
}
\cs_new:Nn \erw_tl_repeat:nn
{
  \int_step_inline:nnnn{1}{1}{#1}{#2}
}
\cs_new:Nn \erw_tl_split:nnn
{
  \tl_head:n{#1}
  \use:c{exp_args:#3} \tl_map_inline:nn
  {
    \tl_tail:n
    {
      #1
    }
  }{#2##1}
}
\cs_new:Nn \erw_tl_split:nn
{
  \erw_tl_split:nnn{#1}{#2}{Nf}
}
\cs_new_protected:Nn \erw_tl_map_thread_at:Nnn
{
  \exp_args:Nf\int_case:nnTF
  {
    \tl_count:n{#3}
  }
  {
    {1}{ \__erw_tl_map_thread_at:Nnn #1{#2}#3 }
    {2}{ \__erw_tl_map_thread_at:Nnnn #1{#2}#3 }
    {3}{ \__erw_tl_map_thread_at:Nnnnn #1{#2}#3 }
    {4}{ \__erw_tl_map_thread_at:Nnnnnn #1{#2}#3 }
  }
  {
    % Do nothing
  }
  {
    \msg_error:nnn{__erw}
    {generic}
    {erw_tl_map_thread_at:~count~of~#3~not~withing~1~to~4}
  }
}
\cs_new_protected:Nn \erw_tl_map_thread:Nn
{
  \int_step_inline:nn
  {
    \exp_args:Nf \tl_count:n{ \tl_head:n{#2} }
```

```
  }
  {
    \erw_tl_map_thread_at:Nnn #1 {##1} {#2}
  }
}
\cs_new:Nn \erw_tl_separators:n
{
  \__erw_tl_separators:en{ \tl_count:n{#1} }{#1}
}
```

14 option

```
\cs_new_protected:Nn\erw_option:n
{
  \keys_set:nn{__erw}{#1}
}
```

15 Closing

```
\ExplSyntaxOff
```
⟨/package⟩