

# The `xint` source code

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This is 1.2n of 2017/08/06.

- Release 1.2n of 2017/08/06 modified `xintbinhex` to depend only on `xintkernel`: it does not load `xintcore` anymore. Also, macros were rewritten and in particular conversion from decimal allows bigger arguments (up to around 6000 rather than 4000 digits as in 1.2m).
- Release 1.2m of 2017/07/31 has rewritten entirely the `xintbinhex` module. The new routines (in the style of the 1.2 from `xintcore`) are faster (depending on the macro 1.5x--2.5x faster at 1000 digits, 5x--9x times faster at 1000 digits) but they limit the maximal size of the inputs to a few thousand characters, from 4000 to about 19900 depending on the macro. The 1.08 routines could handle (slowly) tens of thousands of digits.
- Release 1.2l of 2017/07/26 refactored the subtraction and also `\xintiiCmp` got a rewrite. It should certainly use `\pdfstrcmp` for dramatic speed-up but I do not want to have to worry about multi-engine usage.

Some utility routines in `xintcore` manipulating blocks of eight digits and still in  $O(N^2)$  style have been re-written analogously to the 1.2i version of macros such as `\xintInc`. Also `\xintiNum` was revisited.

The arithmetic macros of `xintcore` and all macros of `xintfrac` using `\XINT_infrac` were made compatible with arguments using non-delimited `\the\numexpr` or `\the\mathcode` etc... But `\xinttiiiAbs` and `\xinttiiiOpp` were not modified (to avoid some overhead) as well as routines such as `\xintInc` which are primarily for internal usage.

## 1 Package `xintkernel` implementation

- Release 1.2i of 2016/12/13 has rewritten some legacy macros like `\xintDSR` or `\xintDecSplit` in the style of the techniques of 1.2. But this means also that they are now limited to about 22480 digits for the former and 19970 digits for the latter (this is with the input stack size at 5000 and the maximal expansion depth at 10000.) This is not really an issue from the point of view of calling macros (such as `\xintTrunc`, `\xintRound`), because they usually had since 1.2 their own limitation at about 19950 digits from other code parts (such as division.) The macro `\xintXTrunc` (which is not f-expandable however) can produce tens of thousands of digits and it escapes these limitations. Old macros such as `\xintLength` are not limited either (incidentally it got a lifting in 1.2i.) The macros from `xinttools` (`\xintKeep`, `\xintTrim`, `\xintNthElt`) also are not limited (but slower.)
- Release 1.2 of 2015/10/10 has entirely rewritten the core arithmetic routines in `xintcore`. Many macros benefit indirectly from the faster core routines. The new model is yet to be extended to other portions of the code: for example the routines of `xintbinhex` could be made faster for very big inputs if they adopted some techniques from the implementation of the basic arithmetic routines. The parser of `xintexpr` is faster and does not have a limit at 5000 digits per number anymore.
- Extensive changes in release 1.1 of 2014/10/28 were located in `xintexpr`. Also with that release, packages `xintkernel` and `xintcore` were extracted from `xinttools` and `xint`, and `\xintAdd` was modified to not multiply denominators blindly.

Some parts of the code still date back to the initial release, and at that time I was learning my trade in expandable TeX macro programming. At some point in the future, I will have to re-examine the older parts of the code.

Warning: pay attention when looking at the code to the catcode configuration as found in `\XINT2_setcatcodes`. Additional temporary configuration is used at some locations. For example `!` is of catcode letter in `xintexpr` and there are locations with funny catcodes e.g. using some letters with the math shift catcode.

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This package provides the common minimal code base for loading management and catcode control and also a few programming utilities. With 1.2 a few more helper macros and all `\chardef`'s have been moved here. The package is loaded by both `xintcore.sty` and `xinttools.sty` hence by all other packages.

First appeared as a separate package with release 1.1.

1.2i adds `\xintreplicate`, `\xintgobble`, `\xintLengthUpTo` and `\xintLastItem`, and improves the efficiency of `\xintLength`.

### 1.1 Catcodes, $\varepsilon$ -TeX and reload detection

The code for reload detection was initially copied from HEIKO OBERDIEK's packages, then modified.

## 1 Package *xintkernel* implementation

The method for catcodes was also initially directly inspired by these packages.

```

1 \begingroup\catcode61\catcode48\catcode32=10\relax%
2 \catcode13=5 % ^^M
3 \endlinechar=13 %
4 \catcode123=1 % {
5 \catcode125=2 % }
6 \catcode35=6 % #
7 \catcode44=12 % ,
8 \catcode45=12 % -
9 \catcode46=12 % .
10 \catcode58=12 % :
11 \catcode95=11 % _
12 \expandafter
13 \ifx\csname PackageInfo\endcsname\relax
14 \def\y#1#2{\immediate\write-1{Package #1 Info: #2.}}%
15 \else
16 \def\y#1#2{\PackageInfo{#1}{#2}}%
17 \fi
18 \let\z\relax
19 \expandafter
20 \ifx\csname numexpr\endcsname\relax
21 \y{xintkernel}{\numexpr not available, aborting input}%
22 \def\z{\endgroup\endinput}%
23 \else
24 \expandafter
25 \ifx\csname XINTsetupcatcodes\endcsname\relax
26 \else
27 \y{xintkernel}{I was already loaded, aborting input}%
28 \def\z{\endgroup\endinput}%
29 \fi
30 \fi
31 \ifx\z\relax\else\expandafter\z\fi%
32 \def\PrepareCatcodes
33 {%
34 \endgroup
35 \def\XINT_restorecatcodes
36 {% takes care of all, to allow more economical code in modules
37 \catcode0=\the\catcode0 %
38 \catcode59=\the\catcode59 % ; xintexpr
39 \catcode126=\the\catcode126 % ~ xintexpr
40 \catcode39=\the\catcode39 % ' xintexpr
41 \catcode34=\the\catcode34 % " xintbinhex, and xintexpr
42 \catcode63=\the\catcode63 % ? xintexpr
43 \catcode124=\the\catcode124 % | xintexpr
44 \catcode38=\the\catcode38 % & xintexpr
45 \catcode64=\the\catcode64 % @ xintexpr
46 \catcode33=\the\catcode33 % ! xintexpr
47 \catcode93=\the\catcode93 % ] -, xintfrac, xintseries, xintcfrac
48 \catcode91=\the\catcode91 % [ -, xintfrac, xintseries, xintcfrac
49 \catcode36=\the\catcode36 % $ xintgcd only
50 \catcode94=\the\catcode94 % ^
51 \catcode96=\the\catcode96 % `

```

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```

52      \catcode47=\the\catcode47    % /
53      \catcode41=\the\catcode41    % )
54      \catcode40=\the\catcode40    % (
55      \catcode42=\the\catcode42    % *
56      \catcode43=\the\catcode43    % +
57      \catcode62=\the\catcode62    % >
58      \catcode60=\the\catcode60    % <
59      \catcode58=\the\catcode58    % :
60      \catcode46=\the\catcode46    % .
61      \catcode45=\the\catcode45    % -
62      \catcode44=\the\catcode44    % ,
63      \catcode35=\the\catcode35    % #
64      \catcode95=\the\catcode95    % _
65      \catcode125=\the\catcode125 % }
66      \catcode123=\the\catcode123 % {
67      \endlinechar=\the\endlinechar
68      \catcode13=\the\catcode13    % ^^M
69      \catcode32=\the\catcode32    %
70      \catcode61=\the\catcode61\relax % =
71  }%
72  \edef\XINT_restorecatcodes_endinput
73  {%
74      \XINT_restorecatcodes\noexpand\endinput %
75  }%
76  \def\XINT_setcatcodes
77  {%
78      \catcode61=12    % =
79      \catcode32=10    % space
80      \catcode13=5     % ^^M
81      \endlinechar=13 %
82      \catcode123=1    % {
83      \catcode125=2    % }
84      \catcode95=11    % _ LETTER
85      \catcode35=6     % #
86      \catcode44=12    % ,
87      \catcode45=12    % -
88      \catcode46=12    % .
89      \catcode58=11    % : LETTER
90      \catcode60=12    % <
91      \catcode62=12    % >
92      \catcode43=12    % +
93      \catcode42=12    % *
94      \catcode40=12    % (
95      \catcode41=12    % )
96      \catcode47=12    % /
97      \catcode96=12    % `
98      \catcode94=11    % ^ LETTER
99      \catcode36=3     % $
100     \catcode91=12    % [
101     \catcode93=12    % ]
102     \catcode33=12    % ! (xintexpr.sty will use catcode 11)
103     \catcode64=11    % @ LETTER

```

## 1 Package *xintkernel* implementation

```
104      \catcode38=7    % & for \romannumeral`&&@ trick.
105      \catcode124=12  % |
106      \catcode63=11   % ? LETTER
107      \catcode34=12   % "
108      \catcode39=12   % '
109      \catcode126=3    % ~ MATH
110      \catcode59=12    % ;
111      \catcode0=12     % for \romannumeral`&&@ trick
112  }%
113  \XINT_setcatcodes
114 }%
115 \PrepareCatcodes

Other modules could possibly be loaded under a different catcode regime.

116 \def\XINTsetupcatcodes {% for use by other modules
117   \edef\XINT_restorecatcodes_endinput
118   {%
119     \XINT_restorecatcodes\noexpand\endinput %
120   }%
121   \XINT_setcatcodes
122 }%
```

### 1.2 Package identification

Inspired from HEIKO OBERDIEK's packages. Modified in 1.09b to allow re-use in the other modules. Also I assume now that if `\ProvidesPackage` exists it then does define `\ver@<pkgname>.sty`, code of HO for some reason escaping me (compatibility with LaTeX 2.09 or other things ??) seems to set extra precautions.

1.09c uses e-TeX `\ifdefined`.

```
123 \ifdefined\ProvidesPackage
124   \let\XINT_providespackage\relax
125 \else
126   \def\XINT_providespackage #1#2[#3]%
127     {\immediate\write-1{Package: #2 #3}%
128     \expandafter\xdef\csname ver@#2.sty\endcsname{#3}}%
129 \fi
130 \XINT_providespackage
131 \ProvidesPackage {xintkernel}%
132 [2017/08/06 1.2n Paraphernalia for the xint packages (JFB)]%
```

### 1.3 Constants

```
133 \chardef\xint_c_    0
134 \chardef\xint_c_i    1
135 \chardef\xint_c_ii   2
136 \chardef\xint_c_iii  3
137 \chardef\xint_c_iv   4
138 \chardef\xint_c_v    5
139 \chardef\xint_c_vi   6
140 \chardef\xint_c_vii  7
141 \chardef\xint_c_viii 8
142 \chardef\xint_c_ix   9
143 \chardef\xint_c_x   10
```

```

144 \chardef\xint_c_xii    12
145 \chardef\xint_c_xiv    14
146 \chardef\xint_c_xvi    16
147 \chardef\xint_c_xviii  18
148 \chardef\xint_c_xxii   22
149 \chardef\xint_c_ii^v    32
150 \chardef\xint_c_ii^vi   64
151 \chardef\xint_c_ii^vii   128
152 \mathchardef\xint_c_ii^viii 256
153 \mathchardef\xint_c_ii^xii 4096
154 \mathchardef\xint_c_x^iv 10000

```

## 1.4 Token management utilities

```

155 \def\xint_tmpa { }%
156 \ifx\xint_tmpa\space\else
157   \immediate\write-1{Package xintkernel Warning: ATTENTION!}%
158   \immediate\write-1{\string\space\xint_tmpa macro does not have its normal
159     meaning.}%
160   \immediate\write-1{\xint_tmpa\xint_tmpa\xint_tmpa\xint_tmpa
161     All kinds of catastrophes will ensue!!!!}%
162 \fi
163 \def\xint_tmppb {}%
164 \ifx\xint_tmppb\empty\else
165   \immediate\write-1{Package xintkernel Warning: ATTENTION!}%
166   \immediate\write-1{\string\empty\xint_tmppb macro does not have its normal
167     meaning.}%
168   \immediate\write-1{\xint_tmpa\xint_tmpa\xint_tmpa\xint_tmpa
169     All kinds of catastrophes will ensue!!!!}%
170 \fi
171 \let\xint_tmpa\relax \let\xint_tmppb\relax
172 \ifdefined\space\else\def\space { }\fi
173 \ifdefined\empty\else\def\empty {} \fi
174 \let\xint_gobble_\empty
175 \long\def\xint_gobble_i    #1{%
176 \long\def\xint_gobble_ii   #1#2{%
177 \long\def\xint_gobble_iii   #1#2#3{%
178 \long\def\xint_gobble_iv    #1#2#3#4{%
179 \long\def\xint_gobble_v     #1#2#3#4#5{%
180 \long\def\xint_gobble_vi    #1#2#3#4#5#6{%
181 \long\def\xint_gobble_vii   #1#2#3#4#5#6#7{%
182 \long\def\xint_gobble_viii  #1#2#3#4#5#6#7#8{%
183 \long\def\xint_firstofone   #1{#1}%
184 \long\def\xint_firstoftwo   #1#2{#1}%
185 \long\def\xint_secondoftwo  #1#2{#2}%
186 \long\def\xint_gobble_thenstop #1{ }%
187 \long\def\xint_firstofone_thenstop #1{ #1}%
188 \long\def\xint_firstoftwo_thenstop #1#2{ #1}%
189 \long\def\xint_secondoftwo_thenstop #1#2{ #2}%
190 \long\def\xint_exchangetwo_keepbraces #1#2{{#2}{#1}}%

```

## 1.5 “gob til” macros and UD style fork

```

191 \long\def\xint_gob_til_R #1\R {}%
192 \long\def\xint_gob_til_W #1\W {}%
193 \long\def\xint_gob_til_Z #1\Z {}%
194 \long\def\xint_gob_til_zero #10{}%
195 \long\def\xint_gob_til_one #11{}%
196 \long\def\xint_gob_til_zeros_iii #1000{}%
197 \long\def\xint_gob_til_zeros_iv #10000{}%
198 \long\def\xint_gob_til_eightzeroes #100000000{}%
199 \long\def\xint_gob_til_dot #1.{}%
200 \long\def\xint_gob_til_G #1G{}%
201 \long\def\xint_gob_til_minus #1-{}%
202 \long\def\xint_UDzerominusfork #10-#2#3\krof {#2}%
203 \long\def\xint_UDzerofork #10#2#3\krof {#2}%
204 \long\def\xint_UDsignfork #1-#2#3\krof {#2}%
205 \long\def\xint_UDwfork #1\W#2#3\krof {#2}%
206 \long\def\xint_UDXINTWfork #1\XINT_W#2#3\krof {#2}%
207 \long\def\xint_UDzerosfork #100#2#3\krof {#2}%
208 \long\def\xint_UDonezerofork #110#2#3\krof {#2}%
209 \long\def\xint_UDsignsfork #1--#2#3\krof {#2}%
210 \let\xint:\char
211 \long\def\xint_gob_til_xint:#1\xint:{}%
212 \def\xint_bracedstopper{\xint:}%
213 \long\def\xint_gob_til_exclam #1!{}%
214 \long\def\xint_gob_til_sc #1;{}%

```

## 1.6 `\xint_afterfi`

```

215 \long\def\xint_afterfi #1#2\fi {\fi #1}%

```

## 1.7 `\xint_bye`, `\xint_Bye`

`\xint_Bye` is new with 1.2i for `\xintDSRr` and `\xintRound`. Also `\xint_bye_thenstop`.

```

216 \long\def\xint_bye #1\xint_bye {}%
217 \long\def\xint_Bye #1\xint_bye {}%
218 \long\def\xint_bye_thenstop #1\xint_bye { }%

```

## 1.8 `\xintdothis`, `\xintorthat`

New with 1.1. Public names without underscores with 1.2. Used as `\if..\xint_dothis{..}\fi` <multiple times> followed by `\xint_orthat{...}`. To be used with less probable things first.

```

219 \long\def\xint_dothis #1#2\xint_orthat #3{\fi #1}% 1.1
220 \let\xint_orthat \xint_firstofone
221 \long\def\xintdothis #1#2\xintorthat #3{\fi #1}%
222 \let\xintorthat \xint_firstofone

```

## 1.9 `\xint_zapspaces`

1.1. This little utility zaps leading, intermediate, trailing, spaces in completely expanding context (`\edef`, `\csname . . . \endcsname`).

`\xint_zapspaces foo<space>\xint_gobble_i`

Will remove some brace pairs (but not spaces inside them). By the way the `\zap@spaces` of LaTeX2e handles unexpectedly things such as `\zap@spaces 1 {22} 3 4 \@empty` (spaces are not all removed). This does not happen with `\xint_zapspaces`.

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Explanation: if there are leading spaces, then the first #1 will be empty, and the first #2 being undelimited will be stripped from all the remaining leading spaces, if there was more than one to start with. Of course brace-stripping may occur. And this iterates: each time a #2 is removed, either we then have spaces and next #1 will be empty, or we have no spaces and #1 will end at the first space. Ultimately #2 will be `\xint_gobble_i`.

This is not really robust as it may switch the expansion order of macros, and the `\xint_zapspaces` token might end up being fetched up by a macro. But it is enough for our purposes, for example:

`\the\numexpr \xint_zapspaces 1 2 \xint_gobble_i\relax`  
expands to 12, and not 12\relax.

1.2e adds `\xint_zapspaces_o`. Expansion of #1 should not gobble a space!

Made long with 1.2i.

```
223 \long\def\xint_zapspaces #1 #2{#1#2\xint_zapspaces }% 1.1
224 \long\def\xint_zapspaces_o #1{\expandafter\xint_zapspaces#1 \xint_gobble_i}%
```

### 1.10 `\odef`, `\oodef`, `\fdef`

May be prefixed with `\global`. No parameter text.

```
225 \def\xintodef #1{\expandafter\def\expandafter#1\expandafter }%
226 \def\xintoodef #1{\expandafter\expandafter\expandafter\def
227     \expandafter\expandafter\expandafter#1%
228     \expandafter\expandafter\expandafter }%
229 \def\xintfdef #1#2%
230     {\expandafter\def\expandafter#1\expandafter{\romannumeral`&&@#2}}%
231 \ifdefined\odef\else\let\odef\xintodef\fi
232 \ifdefined\oodef\else\let\oodef\xintoodef\fi
233 \ifdefined\fdef\else\let\fdef\xintfdef\fi
```

### 1.11 `\xintReverseOrder`

`\xintReverseOrder`: does NOT expand its argument.

Attention: removes brace pairs.

For digit tokens only a faster reverse macro is provided as `\xintReverseDigits` from 1.2 `xint-core.sty`.

For comma separated items, 1.2g has (not user documented) `\xintCSVReverse` in `xinttools.sty`.

```
234 \def\xintReverseOrder {\romannumeral0\xintreverseorder }%
235 \long\def\xintreverseorder #1%
236 {%
237     \XINT_rord_main {}#1%
238     \xint:
239     \xint_bye\xint_bye\xint_bye\xint_bye
240     \xint_bye\xint_bye\xint_bye\xint_bye
241     \xint:
242 }%
243 \long\def\XINT_rord_main #1#2#3#4#5#6#7#8#9%
244 {%
245     \xint_bye #9\XINT_rord_cleanup\xint_bye
246     \XINT_rord_main {#9#8#7#6#5#4#3#2#1}%
247 }%
248 \def\XINT_rord_cleanup #1{%
249 \long\def\XINT_rord_cleanup\xint_bye\XINT_rord_main ##1#2\xint:
```



`\xintLength` does NOT expand its argument. See `\xintNthElt{0}` from `xinttools.sty` which f-expands its argument.

1.2i has rewritten this venerable macro. New code is about 40% faster across all lengths. Was again slightly changed for 1.2j (cosmetic).

```

253 \def\xintLength {\romannumeral0\xintlength}%
254 \def\xintlength #1{\long\def\xintlength ##1%
255 {%
256     \expandafter#1\the\numexpr\xintlength_loop
257     ##1\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:
258     \xint_c_viii\xint_c_vii\xint_c_vi\xint_c_v
259     \xint_c_iv\xint_c_iii\xint_c_ii\xint_c_i\xint_c_\xint_bye
260     \relax
261 }}\xintlength{ }%
262 \long\def\xintlength_loop #1#2#3#4#5#6#7#8#9%
263 {%
264     \xint_gob_til_xint: #9\xintlength_finish_a\xint:
265     \xint_c_ix+\xintlength_loop
266 }%
267 \def\xintlength_finish_a\xint:\xint_c_ix+\xintlength_loop
268     #1#2#3#4#5#6#7#8#9%
269 {%
270     #9\xint_bye
271 }%

```

New with 1.2i (2016/12/10). Output empty if input empty. One level of braces removed in output. Does NOT expand its argument.

9

```

288 \long\def\XINT_last_loop_endb #1#2#3\xint_bye{ #2}%
289 \long\def\XINT_last_loop_endc #1#2#3#4\xint_bye{ #3}%
290 \long\def\XINT_last_loop_endd #1#2#3#4#5\xint_bye{ #4}%
291 \long\def\XINT_last_loop_ende #1#2#3#4#5#6\xint_bye{ #5}%
292 \long\def\XINT_last_loop_endf #1#2#3#4#5#6#7\xint_bye{ #6}%
293 \long\def\XINT_last_loop_endg #1#2#3#4#5#6#7#8\xint_bye{ #7}%
294 \long\def\XINT_last_loop_endh #1#2#3#4#5#6#7#8#9\xint_bye{ #8}%

```

## 1.14 \xintLengthUpTo

1.2i for use by \xintKeep and \xintTrim.

\xintLengthUpTo{N}{List} produces -0 if length(List)>N, else it returns N-length(List). Hence subtracting it from N always computes min(N,length(List)).

Does not expand its second argument (it is used by \xintKeep and \xintTrim with already expanded argument). Not a user macro. 1.2j rewrote the ending and changed the loop interface. The argument N *must be non-negative*.

```

295 \def\xintLengthUpTo {\romannumeral0\xintlengthupto}%
296 \long\def\xintlengthupto #1#2%
297 {%
298   \expandafter\XINT_lengthupto_loop
299   \the\numexpr#1.#2\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:
300   \xint_c_vii\xint_c_vi\xint_c_v\xint_c_iv
301   \xint_c_iii\xint_c_ii\xint_c_i\xint_c_\xint_bye.%
302 }%
303 \def\XINT_lengthupto_loop_a #1%
304 {%
305   \xint_UDsignfork
306   #1\XINT_lengthupto_gt
307   -\XINT_lengthupto_loop
308   \krof #1%
309 }%
310 \long\def\XINT_lengthupto_gt #1\xint_bye.{-0}%
311 \long\def\XINT_lengthupto_loop #1.#2#3#4#5#6#7#8#9%
312 {%
313   \xint_gob_til_xint: #9\XINT_lengthupto_finish_a\xint:%
314   \expandafter\XINT_lengthupto_loop_a\the\numexpr #1-\xint_c_viii.%
315 }%
316 \def\XINT_lengthupto_finish_a\xint:\expandafter\XINT_lengthupto_loop_a
317 \the\numexpr #1-\xint_c_viii.#2#3#4#5#6#7#8#9%
318 {%
319   \expandafter\XINT_lengthupto_finish_b\the\numexpr #1-#9\xint_bye
320 }%
321 \def\XINT_lengthupto_finish_b #1#2.%
322 {%
323   \xint_UDsignfork
324   #1{-0}%
325   -{ #1#2}%
326   \krof
327 }%

```



```

369   {\xint_c_ #1#1#1#1}%
370 \long\expandafter\def\csname XINT_rep_f6\endcsname #1%
371   {\xint_c_ #1#1#1#1#1}%
372 \long\expandafter\def\csname XINT_rep_f7\endcsname #1%
373   {\xint_c_ #1#1#1#1#1#1}%
374 \long\expandafter\def\csname XINT_rep_f8\endcsname #1%
375   {\xint_c_ #1#1#1#1#1#1#1}%
376 \long\expandafter\def\csname XINT_rep_f9\endcsname #1%
377   {\xint_c_ #1#1#1#1#1#1#1#1}%

```

## 1.16 *\xintgobble*

Added with 1.2i. I hesitated about allowing as many as  $9^6-1=531440$  tokens to gobble, but  $9^5-1=59058$  is too low for playing with long decimal expansions.

Like for *\xintreplicate*, a *\romannumeral* is needed to trigger expansion.

I wrote in a similar spirit an *\xintcount*. But it proved slower than the upgraded 1.2i *\xintLength* in all the range up to thousands of tokens.

```

378 \def\xintgobble #1%
379   {\csname xint_c_\expandafter\XINT_gobble_a\the\numexpr#1.0}%
380 \def\XINT_gobble #1.{\csname xint_c_\XINT_gobble_a #1.0}%
381 \def\XINT_gobble_a #1{\xint_gob_til_zero#1\XINT_gobble_d0\XINT_gobble_b#1}%
382 \def\XINT_gobble_b #1.#2%
383   {\expandafter\XINT_gobble_c
384     \the\numexpr (#1+\xint_c_v)/\xint_c_ix-\xint_c_i\expandafter.%
385     \the\numexpr #2+\xint_c_i.#1.}%
386 \def\XINT_gobble_c #1.#2.#3.%
387   {\csname XINT_g#2\the\numexpr#3-\xint_c_ix*#1\relax\XINT_gobble_a #1.#2}%
388 \def\XINT_gobble_d0\XINT_gobble_b0.#1{\endcsname}%
389 \expandafter\let\csname XINT_g10\endcsname\endcsname
390 \long\expandafter\def\csname XINT_g11\endcsname#1{\endcsname}%
391 \long\expandafter\def\csname XINT_g12\endcsname#1#2{\endcsname}%
392 \long\expandafter\def\csname XINT_g13\endcsname#1#2#3{\endcsname}%
393 \long\expandafter\def\csname XINT_g14\endcsname#1#2#3#4{\endcsname}%
394 \long\expandafter\def\csname XINT_g15\endcsname#1#2#3#4#5{\endcsname}%
395 \long\expandafter\def\csname XINT_g16\endcsname#1#2#3#4#5#6{\endcsname}%
396 \long\expandafter\def\csname XINT_g17\endcsname#1#2#3#4#5#6#7{\endcsname}%
397 \long\expandafter\def\csname XINT_g18\endcsname#1#2#3#4#5#6#7#8{\endcsname}%
398 \expandafter\let\csname XINT_g20\endcsname\endcsname
399 \long\expandafter\def\csname XINT_g21\endcsname #1#2#3#4#5#6#7#8#9%
400   {\endcsname}%
401 \long\expandafter\edef\csname XINT_g22\endcsname #1#2#3#4#5#6#7#8#9%
402   {\expandafter\noexpand\csname XINT_g21\endcsname}%
403 \long\expandafter\edef\csname XINT_g23\endcsname #1#2#3#4#5#6#7#8#9%
404   {\expandafter\noexpand\csname XINT_g22\endcsname}%
405 \long\expandafter\edef\csname XINT_g24\endcsname #1#2#3#4#5#6#7#8#9%
406   {\expandafter\noexpand\csname XINT_g23\endcsname}%
407 \long\expandafter\edef\csname XINT_g25\endcsname #1#2#3#4#5#6#7#8#9%
408   {\expandafter\noexpand\csname XINT_g24\endcsname}%
409 \long\expandafter\edef\csname XINT_g26\endcsname #1#2#3#4#5#6#7#8#9%
410   {\expandafter\noexpand\csname XINT_g25\endcsname}%
411 \long\expandafter\edef\csname XINT_g27\endcsname #1#2#3#4#5#6#7#8#9%
412   {\expandafter\noexpand\csname XINT_g26\endcsname}%

```

## 1 Package *xintkernel* implementation

```
413 \long\expandafter\edef\csname XINT_g28\endcsname #1#2#3#4#5#6#7#8#9%
414 {\expandafter\noexpand\csname XINT_g27\endcsname}%
415 \expandafter\let\csname XINT_g30\endcsname\endcsname
416 \long\expandafter\edef\csname XINT_g31\endcsname #1#2#3#4#5#6#7#8#9%
417 {\expandafter\noexpand\csname XINT_g28\endcsname}%
418 \long\expandafter\edef\csname XINT_g32\endcsname #1#2#3#4#5#6#7#8#9%
419 {\noexpand\csname XINT_g31\expandafter\noexpand\csname XINT_g28\endcsname}%
420 \long\expandafter\edef\csname XINT_g33\endcsname #1#2#3#4#5#6#7#8#9%
421 {\noexpand\csname XINT_g32\expandafter\noexpand\csname XINT_g28\endcsname}%
422 \long\expandafter\edef\csname XINT_g34\endcsname #1#2#3#4#5#6#7#8#9%
423 {\noexpand\csname XINT_g33\expandafter\noexpand\csname XINT_g28\endcsname}%
424 \long\expandafter\edef\csname XINT_g35\endcsname #1#2#3#4#5#6#7#8#9%
425 {\noexpand\csname XINT_g34\expandafter\noexpand\csname XINT_g28\endcsname}%
426 \long\expandafter\edef\csname XINT_g36\endcsname #1#2#3#4#5#6#7#8#9%
427 {\noexpand\csname XINT_g35\expandafter\noexpand\csname XINT_g28\endcsname}%
428 \long\expandafter\edef\csname XINT_g37\endcsname #1#2#3#4#5#6#7#8#9%
429 {\noexpand\csname XINT_g36\expandafter\noexpand\csname XINT_g28\endcsname}%
430 \long\expandafter\edef\csname XINT_g38\endcsname #1#2#3#4#5#6#7#8#9%
431 {\noexpand\csname XINT_g37\expandafter\noexpand\csname XINT_g28\endcsname}%
432 \expandafter\let\csname XINT_g40\endcsname\endcsname
433 \expandafter\edef\csname XINT_g41\endcsname
434 {\noexpand\csname XINT_g38\expandafter\noexpand\csname XINT_g31\endcsname}%
435 \expandafter\edef\csname XINT_g42\endcsname
436 {\noexpand\csname XINT_g41\expandafter\noexpand\csname XINT_g41\endcsname}%
437 \expandafter\edef\csname XINT_g43\endcsname
438 {\noexpand\csname XINT_g42\expandafter\noexpand\csname XINT_g41\endcsname}%
439 \expandafter\edef\csname XINT_g44\endcsname
440 {\noexpand\csname XINT_g43\expandafter\noexpand\csname XINT_g41\endcsname}%
441 \expandafter\edef\csname XINT_g45\endcsname
442 {\noexpand\csname XINT_g44\expandafter\noexpand\csname XINT_g41\endcsname}%
443 \expandafter\edef\csname XINT_g46\endcsname
444 {\noexpand\csname XINT_g45\expandafter\noexpand\csname XINT_g41\endcsname}%
445 \expandafter\edef\csname XINT_g47\endcsname
446 {\noexpand\csname XINT_g46\expandafter\noexpand\csname XINT_g41\endcsname}%
447 \expandafter\edef\csname XINT_g48\endcsname
448 {\noexpand\csname XINT_g47\expandafter\noexpand\csname XINT_g41\endcsname}%
449 \expandafter\let\csname XINT_g50\endcsname\endcsname
450 \expandafter\edef\csname XINT_g51\endcsname
451 {\noexpand\csname XINT_g48\expandafter\noexpand\csname XINT_g41\endcsname}%
452 \expandafter\edef\csname XINT_g52\endcsname
453 {\noexpand\csname XINT_g51\expandafter\noexpand\csname XINT_g51\endcsname}%
454 \expandafter\edef\csname XINT_g53\endcsname
455 {\noexpand\csname XINT_g52\expandafter\noexpand\csname XINT_g51\endcsname}%
456 \expandafter\edef\csname XINT_g54\endcsname
457 {\noexpand\csname XINT_g53\expandafter\noexpand\csname XINT_g51\endcsname}%
458 \expandafter\edef\csname XINT_g55\endcsname
459 {\noexpand\csname XINT_g54\expandafter\noexpand\csname XINT_g51\endcsname}%
460 \expandafter\edef\csname XINT_g56\endcsname
461 {\noexpand\csname XINT_g55\expandafter\noexpand\csname XINT_g51\endcsname}%
462 \expandafter\edef\csname XINT_g57\endcsname
463 {\noexpand\csname XINT_g56\expandafter\noexpand\csname XINT_g51\endcsname}%
464 \expandafter\edef\csname XINT_g58\endcsname
```

## 1 Package *xintkernel* implementation

```
465 {\noexpand\csname XINT_g57\expandafter\noexpand\csname XINT_g51\endcsname}%
466 \expandafter\let\csname XINT_g60\endcsname\endcsname
467 \expandafter\edef\csname XINT_g61\endcsname
468 {\noexpand\csname XINT_g58\expandafter\noexpand\csname XINT_g51\endcsname}%
469 \expandafter\edef\csname XINT_g62\endcsname
470 {\noexpand\csname XINT_g61\expandafter\noexpand\csname XINT_g61\endcsname}%
471 \expandafter\edef\csname XINT_g63\endcsname
472 {\noexpand\csname XINT_g62\expandafter\noexpand\csname XINT_g61\endcsname}%
473 \expandafter\edef\csname XINT_g64\endcsname
474 {\noexpand\csname XINT_g63\expandafter\noexpand\csname XINT_g61\endcsname}%
475 \expandafter\edef\csname XINT_g65\endcsname
476 {\noexpand\csname XINT_g64\expandafter\noexpand\csname XINT_g61\endcsname}%
477 \expandafter\edef\csname XINT_g66\endcsname
478 {\noexpand\csname XINT_g65\expandafter\noexpand\csname XINT_g61\endcsname}%
479 \expandafter\edef\csname XINT_g67\endcsname
480 {\noexpand\csname XINT_g66\expandafter\noexpand\csname XINT_g61\endcsname}%
481 \expandafter\edef\csname XINT_g68\endcsname
482 {\noexpand\csname XINT_g67\expandafter\noexpand\csname XINT_g61\endcsname}%
```

### 1.17 `\xintMessage`, `\ifxintverbose`

1.2c added it for use by `\xintdefvar` and `\xintdeffunc` of `xintexpr`. 1.2e uses `\write128` rather than `\write16` for compatibility with future extended range of output streams, in LuaTeX in particular.

```
483 \def\xintMessage #1#2#3{%
484   \immediate\write128{Package #1 #2: (on line \the\inputlineno)}%
485   \immediate\write128{\space\space\space\space#3}%
486 }%
487 \newif\ifxintverbose
```

### 1.18 (WIP) Expandable error message

Incorporated in 1.2l release, but really belongs to next major release.

This is copied over from `l3kernel` code. I am using `\ ! /` control sequence though, which must be left undefined. `\xintError`: would be 6 letters more already. Utiliser `\FPE: ?` (mais ce n'est pas uniquement du « floating point »)

Always used in context where expansion was launched by a `\romannumeral0` or `\romannumeral`^^@`.

```
488 \def\XINT_expandableerror #1#2{%
489   \def\XINT_expandableerror ##1{%
490     \expandafter\expandafter\expandafter
491     \XINT_expandableerror_continue\xint_firstofone{#2#1##1#1}}%
492   \def\XINT_expandableerror_continue ##1#1##2#1{##1}%
493 }%
494 \begingroup\lccode`$ 32 \catcode`/ 11 \catcode`! 11 \catcode32 11 %
495 \lowercase{\endgroup\XINT_expandableerror$ \ ! /}%
496 \XINT_restorecatcodes_endinput%
```

## 2 Package `xinttools` implementation

.1	Catcodes, $\varepsilon$ - $\text{\TeX}$ and reload detection . .	15	<code>breakloopanddo</code> , <code>\xintloopskiptonext</code> ,	
.2	Package identification . . . . .	16	<code>\xintloopskipandredo</code> . . . . .	31
.3	<code>\xintgodef</code> , <code>\xintgoodef</code> , <code>\xintgfdef</code> .	16	.21 <code>\XINT_xflet</code> . . . . .	31
.4	<code>\xintRevWithBraces</code> . . . . .	16	.22 <code>\xintApplyInline</code> . . . . .	32
.5	<code>\xintZapFirstSpaces</code> . . . . .	17	.23 <code>\xintFor</code> , <code>\xintFor*</code> , <code>\xintBreakFor</code> ,	
.6	<code>\xintZapLastSpaces</code> . . . . .	18	<code>\xintBreakForAndDo</code> . . . . .	33
.7	<code>\xintZapSpaces</code> . . . . .	19	.24 <code>\XINT_forever</code> , <code>\xintintegers</code> , <code>\xintdi-</code>	
.8	<code>\xintZapSpacesB</code> . . . . .	19	<code>mensions</code> , <code>\xintrationals</code> . . . . .	35
.9	<code>\xintCSVtoList</code> , <code>\xintCSVtoListNon-</code>		.25 <code>\xintForpair</code> , <code>\xintForthree</code> , <code>\xintFor-</code>	
	<code>Stripped</code> . . . . .	19	<code>four</code> . . . . .	37
.10	<code>\xintListWithSep</code> . . . . .	21	.26 <code>\xintAssign</code> , <code>\xintAssignArray</code> , <code>\xint-</code>	
.11	<code>\xintNthElt</code> . . . . .	21	<code>DigitsOf</code> . . . . .	38
.12	<code>\xintKeep</code> . . . . .	22	.27 CSV (non user documented) variants of	
.13	<code>\xintKeepUnbraced</code> . . . . .	24	Length, Keep, Trim, NthElt, Reverse . .	41
.14	<code>\xintTrim</code> . . . . .	25	.27.1 <code>\xintLength:f:csv</code> . . . . .	42
.15	<code>\xintTrimUnbraced</code> . . . . .	26	.27.2 <code>\xintLengthUpTo:f:csv</code> . . . . .	42
.16	<code>\xintApply</code> . . . . .	27	.27.3 <code>\xintKeep:f:csv</code> . . . . .	43
.17	<code>\xintApplyUnbraced</code> . . . . .	28	.27.4 <code>\xintTrim:f:csv</code> . . . . .	45
.18	<code>\xintSeq</code> . . . . .	28	.27.5 <code>\xintNthEltPy:f:csv</code> . . . . .	47
.19	<code>\xintloop</code> , <code>\xintbreakloop</code> , <code>\xintbreak-</code>		.27.6 <code>\xintReverse:f:csv</code> . . . . .	48
	<code>loopanddo</code> , <code>\xintloopskiptonext</code> . . .	30	.27.7 <code>\xintFirstItem:f:csv</code> . . . . .	48
.20	<code>\xintiloop</code> , <code>\xintiloopindex</code> , <code>\xintouter-</code>		.27.8 <code>\xintLastItem:f:csv</code> . . . . .	49
	<code>iloopindex</code> , <code>\xintbreakiloop</code> , <code>\xint-</code>		.27.9 Public names for the undocumented csv macros	49

Release 1.09g of 2013/11/22 splits off `xinttools.sty` from `xint.sty`. Starting with 1.1, `xinttools` ceases being loaded automatically by `xint`.

### 2.1 Catcodes, $\varepsilon$ - $\text{\TeX}$ and reload detection

The code for reload detection was initially copied from HEIKO OBERDIEK's packages, then modified. The method for catcodes was also initially directly inspired by these packages.

```

1 \begingroup\catcode61\catcode48\catcode32=10\relax%
2  \catcode13=5      % ^^M
3  \endlinechar=13 %
4  \catcode123=1     % {
5  \catcode125=2     % }
6  \catcode64=11     % @
7  \catcode35=6      % #
8  \catcode44=12     % ,
9  \catcode45=12     % -
10 \catcode46=12     % .
11 \catcode58=12     % :
12 \let\z\endgroup
13 \expandafter\let\expandafter\x\csname ver@xinttools.sty\endcsname
14 \expandafter\let\expandafter\w\csname ver@xintkernel.sty\endcsname
15 \expandafter
16  \ifx\csname PackageInfo\endcsname\relax
17    \def\y#1#2{\immediate\write-1{Package #1 Info: #2.}}%
18  \else
19    \def\y#1#2{\PackageInfo{#1}{#2}}%

```



```

20   \fi
21   \expandafter
22   \ifx\csname numexpr\endcsname\relax
23     \y{xinttools}{\numexpr not available, aborting input}%
24     \aftergroup\endinput
25   \else
26     \ifx\x\relax    % plain-TeX, first loading of xinttools.sty
27       \ifx\w\relax % but xintkernel.sty not yet loaded.
28         \def\z{\endgroup\input xintkernel.sty\relax}%
29       \fi
30     \else
31       \def\empty {}%
32       \ifx\x\empty % LaTeX, first loading,
33       % variable is initialized, but \ProvidesPackage not yet seen
34       \ifx\w\relax % xintkernel.sty not yet loaded.
35         \def\z{\endgroup\RequirePackage{xintkernel}}}%
36       \fi
37     \else
38       \aftergroup\endinput % xinttools already loaded.
39     \fi
40   \fi
41 \fi
42 \z%
43 \XINTsetupcatcodes% defined in xintkernel.sty

```

## 2.2 Package identification

```

44 \XINT_providespackage
45 \ProvidesPackage{xinttools}%
46 [2017/08/06 1.2n Expandable and non-expandable utilities (JFB)]%

```

*\XINT\_toks* is used in macros such as *\xintFor*. It is not used elsewhere in the xint bundle.

```

47 \newtoks\XINT_toks
48 \xint_firstofone{\let\XINT_sptoken= } %<- space here!

```

## 2.3 *\xintgodef*, *\xintgoodef*, *\xintgfdef*

1.09i. For use in *\xintAssign*.

```

49 \def\xintgodef {\global\xintodef }%
50 \def\xintgoodef {\global\xintoodef }%
51 \def\xintgfdef {\global\xintfdef }%

```

## 2.4 *\xintRevWithBraces*

New with 1.06. Makes the expansion of its argument and then reverses the resulting tokens or braced tokens, adding a pair of braces to each (thus, maintaining it when it was already there.) The reason for *\xint:*, here and in other locations, is in case #1 expands to nothing, the *\romannumeral-`0* must be stopped

```

52 \def\xintRevWithBraces      {\romannumeral0\xintrevwithbraces }%
53 \def\xintRevWithBracesNoExpand {\romannumeral0\xintrevwithbracesnoexpand }%
54 \long\def\xintrevwithbraces #1%

```



```

55 {%
56   \expandafter\XINT_revwbr_loop\expandafter{\expandafter}%
57   \romannumeral`&&@#1\xint:\xint:\xint:\xint:%
58           \xint:\xint:\xint:\xint:\xint_bye
59 }%
60 \long\def\xintrevwithbracesnoexpand #1%
61 {%
62   \XINT_revwbr_loop {%
63   #1\xint:\xint:\xint:\xint:%
64   \xint:\xint:\xint:\xint:\xint_bye
65 }%
66 \long\def\XINT_revwbr_loop #1#2#3#4#5#6#7#8#9%
67 {%
68   \xint_gob_til_xint: #9\XINT_revwbr_finish_a\xint:%
69   \XINT_revwbr_loop {{#9}{#8}{#7}{#6}{#5}{#4}{#3}{#2}{#1}%
70 }%
71 \long\def\XINT_revwbr_finish_a\xint:\XINT_revwbr_loop #1#2\xint_bye
72 {%
73   \XINT_revwbr_finish_b #2\R\R\R\R\R\R\R\Z #1%
74 }%
75 \def\XINT_revwbr_finish_b #1#2#3#4#5#6#7#8\Z
76 {%
77   \xint_gob_til_R
78       #1\XINT_revwbr_finish_c \xint_gobble_viii
79       #2\XINT_revwbr_finish_c \xint_gobble_vii
80       #3\XINT_revwbr_finish_c \xint_gobble_vi
81       #4\XINT_revwbr_finish_c \xint_gobble_v
82       #5\XINT_revwbr_finish_c \xint_gobble_iv
83       #6\XINT_revwbr_finish_c \xint_gobble_iii
84       #7\XINT_revwbr_finish_c \xint_gobble_ii
85       \R\XINT_revwbr_finish_c \xint_gobble_i\Z
86 }%

```

1.1c revisited this old code and improved upon the earlier endings.

```

87 \def\XINT_revwbr_finish_c#1{%
88 \def\XINT_revwbr_finish_c##1##2\Z{\expandafter#1##1}%
89 }\XINT_revwbr_finish_c{ }%

```

## 2.5 \xintZapFirstSpaces

1.09f, written [2013/11/01]. Modified (2014/10/21) for release 1.1 to correct the bug in case of an empty argument, or argument containing only spaces, which had been forgotten in first version. New version is simpler than the initial one. This macro does NOT expand its argument.

```

90 \def\xintZapFirstSpaces {\romannumeral0\xintzapfirstspaces }%
91 \def\xintzapfirstspaces#1{\long
92 \def\xintzapfirstspaces ##1{\XINT_zapbsp_a #1##1\xint:#1#1\xint:}%
93 }\xintzapfirstspaces{ }%

```

If the original #1 started with a space, the grabbed #1 is empty. Thus `_again?` will see `#1=\xint_bye`, and hand over control to `_again` which will loop back into `\XINT_zapbsp_a`, with one initial space less. If the original #1 did not start with a space, or was empty, then the #1 below will be a

<sptoken>, then an extract of the original #1, not empty and not starting with a space, which contains what was up to the first <sp><sp> present in original #1, or, if none preexisted, <sptoken> and all of #1 (possibly empty) plus an ending \xint:. The added initial space will stop later the \romannumeral0. No brace stripping is possible. Control is handed over to \XINT\_zapbsp\_b which strips out the ending \xint:<sp><sp>\xint:

```

94 \def\XINT_zapbsp_a#1{\long\def\XINT_zapbsp_a ##1#1#1{%
95   \XINT_zapbsp_again?##1\xint_bye\XINT_zapbsp_b ##1#1#1}%
96 }\XINT_zapbsp_a{ }%
97 \long\def\XINT_zapbsp_again? #1{\xint_bye #1\XINT_zapbsp_again }%
98 \xint_firstofone{\def\XINT_zapbsp_again\XINT_zapbsp_b} {\XINT_zapbsp_a }%
99 \long\def\XINT_zapbsp_b #1\xint:#2\xint:{#1}%

```

## 2.6 \xintZapLastSpaces

1.09f, written [2013/11/01].

```

100 \def\xintZapLastSpaces {\romannumeral0\xintzaplastspaces }%
101 \def\xintzaplastspaces#1{\long
102 \def\xintzaplastspaces ##1{\XINT_zapbsp_a {} \empty##1#1#1\xint_bye\xint:}%
103 }\xintzaplastspaces{ }%

```

The \empty from \xintzaplastspaces is to prevent brace removal in the #2 below. The \expandafter chain removes it.

```

104 \xint_firstofone {\long\def\XINT_zapbsp_a #1#2 } %<- second space here
105   {\expandafter\XINT_zapbsp_b\expandafter{#2}{#1}}%

```

Notice again an \empty added here. This is in preparation for possibly looping back to \XINT\_zapbsp\_a. If the initial #1 had no <sp><sp>, the stuff however will not loop, because #3 will already be <some spaces>\xint\_bye. Notice that this macro fetches all way to the ending \xint:. This looks not very efficient, but how often do we have to strip ending spaces from something which also has inner stretches of \_multiple\_ space tokens ?;-).

```

106 \long\def\XINT_zapbsp_b #1#2#3\xint:%
107   {\XINT_zapbsp_end? #3\XINT_zapbsp_e {#2#1}\empty #3\xint:}%

```

When we have been over all possible <sp><sp> things, we reach the ending space tokens, and #3 will be a bunch of spaces (possibly none) followed by \xint\_bye. So the #1 in \_end? will be \xint\_bye. In all other cases #1 can not be \xint\_bye (assuming naturally this token does not arise in original input), hence control falls back to \XINT\_zapbsp\_e which will loop back to \XINT\_zapbsp\_a.

```

108 \long\def\XINT_zapbsp_end? #1{\xint_bye #1\XINT_zapbsp_end }%

```

We are done. The #1 here has accumulated all the previous material, and is stripped of its ending spaces, if any.

```

109 \long\def\XINT_zapbsp_end\XINT_zapbsp_e #1#2\xint:{ #1}%

```

We haven't yet reached the end, so we need to re-inject two space tokens after what we have gotten so far. Then we loop.

```

110 \def\XINT_zapbsp_e#1{%
111 \long\def\XINT_zapbsp_e ##1{\XINT_zapbsp_a {##1#1#1}}%
112 }\XINT_zapbsp_e{ }%

```

## 2.7 \xintZapSpaces

1.09f, written [2013/11/01]. Modified for 1.1, 2014/10/21 as it has the same bug as \xintZapFirstSpaces. We in effect do first \xintZapFirstSpaces, then \xintZapLastSpaces.

```

113 \def\xintZapSpaces {\romannumeral0\xintzapspace }%
114 \def\xintzapspace#1{%
115 \long\def\xintzapspace ##1% like \xintZapFirstSpaces.
116     {\XINT_zapsp_a #1##1\xint:#1#1\xint:}%
117 }\xintzapspace{ }%
118 \def\XINT_zapsp_a#1{%
119 \long\def\XINT_zapsp_a ##1#1#1%
120     {\XINT_zapsp_again?##1\xint_bye\XINT_zapsp_b##1#1#1}%
121 }\XINT_zapsp_a{ }%
122 \long\def\XINT_zapsp_again? #1{\xint_bye #1\XINT_zapsp_again }%
123 \xint_firstofone{\def\XINT_zapsp_again\XINT_zapsp_b} {\XINT_zapsp_a }%
124 \xint_firstofone{\def\XINT_zapsp_b} {\XINT_zapsp_c }%
125 \def\XINT_zapsp_c#1{%
126 \long\def\XINT_zapsp_c ##1\xint:##2\xint:%
127     {\XINT_zapsp_a{ }\empty ##1#1#1\xint_bye\xint:}%
128 }\XINT_zapsp_c{ }%

```

## 2.8 \xintZapSpacesB

1.09f, written [2013/11/01]. Strips up to one pair of braces (but then does not strip spaces inside).

```

129 \def\xintZapSpacesB {\romannumeral0\xintzapspaceb }%
130 \long\def\xintzapspaceb #1{\XINT_zapspb_one? #1\xint:\xint:%
131     \xint_bye\xintzapspace {#1}}%
132 \long\def\XINT_zapspb_one? #1#2%
133     {\xint_gob_til_xint: #1\XINT_zapspb_onlyspace\xint:%
134     \xint_gob_til_xint: #2\XINT_zapspb_bracedorone\xint:%
135     \xint_bye {#1}}%
136 \def\XINT_zapspb_onlyspace\xint:%
137     \xint_gob_til_xint:\xint:\XINT_zapspb_bracedorone\xint:%
138     \xint_bye #1\xint_bye\xintzapspace #2{ }%
139 \long\def\XINT_zapspb_bracedorone\xint:%
140     \xint_bye #1\xint:\xint_bye\xintzapspace #2{ #1}%

```

## 2.9 \xintCSVtoList, \xintCSVtoListNonStripped

\xintCSVtoList transforms a,b,...,z into {a}{b}...{z}. The comma separated list may be a macro which is first f-expanded. First included in release 1.06. Here, use of \Z (and \R) perfectly safe.

[2013/11/02]: Starting with 1.09f, automatically filters items with \xintZapSpacesB to strip away all spaces around commas, and spaces at the start and end of the list. The original is kept as \xintCSVtoListNonStripped, and is faster. But ... it doesn't strip spaces.

```

141 \def\xintCSVtoList {\romannumeral0\xintcsvtolist }%
142 \long\def\xintcsvtolist #1{\expandafter\xintApply
143     \expandafter\xintzapspaceb
144     \expandafter{\romannumeral0\xintcsvtolistnonstripped{#1}}}%

```

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```

145 \def\xintCSVtoListNoExpand {\romannumeral0\xintcsvtolistnoexpand }%
146 \long\def\xintcsvtolistnoexpand #1{\expandafter\xintApply
147     \expandafter\xintzapspacesb
148     \expandafter{\romannumeral0\xintcsvtolistnonstrippednoexpand{#1}}}%
149 \def\xintCSVtoListNonStripped {\romannumeral0\xintcsvtolistnonstripped }%
150 \def\xintCSVtoListNonStrippedNoExpand
151     {\romannumeral0\xintcsvtolistnonstrippednoexpand }%
152 \long\def\xintcsvtolistnonstripped #1%
153 {%
154     \expandafter\XINT_csvtol_loop_a\expandafter
155     {\expandafter}\romannumeral`&&@#1%
156     ,\xint_bye,\xint_bye,\xint_bye,\xint_bye
157     ,\xint_bye,\xint_bye,\xint_bye,\xint_bye,\Z
158 }%
159 \long\def\xintcsvtolistnonstrippednoexpand #1%
160 {%
161     \XINT_csvtol_loop_a
162     {#1,\xint_bye,\xint_bye,\xint_bye,\xint_bye
163     ,\xint_bye,\xint_bye,\xint_bye,\xint_bye,\Z
164 }%
165 \long\def\XINT_csvtol_loop_a #1#2,#3,#4,#5,#6,#7,#8,#9,%
166 {%
167     \xint_bye #9\XINT_csvtol_finish_a\xint_bye
168     \XINT_csvtol_loop_b {#1}{#2}{#3}{#4}{#5}{#6}{#7}{#8}{#9}}%
169 }%
170 \long\def\XINT_csvtol_loop_b #1#2{\XINT_csvtol_loop_a {#1#2}}%
171 \long\def\XINT_csvtol_finish_a\xint_bye\XINT_csvtol_loop_b #1#2#3\Z
172 {%
173     \XINT_csvtol_finish_b #3\R,\R,\R,\R,\R,\R,\R,\Z #2{#1}%
174 }%

```

1.1c revisits this old code and improves upon the earlier endings. But as the `_d..` macros have already nine parameters, I needed the `\expandafter` and `\xint_gob_til_Z` in `finish_b` (compare `\XINT_keep_endb`, or also `\XINT_RQ_endb`).

```

175 \def\XINT_csvtol_finish_b #1,#2,#3,#4,#5,#6,#7,#8\Z
176 {%
177     \xint_gob_til_R
178     #1\expandafter\XINT_csvtol_finish_dviii\xint_gob_til_Z
179     #2\expandafter\XINT_csvtol_finish_dvii \xint_gob_til_Z
180     #3\expandafter\XINT_csvtol_finish_dvi \xint_gob_til_Z
181     #4\expandafter\XINT_csvtol_finish_dv \xint_gob_til_Z
182     #5\expandafter\XINT_csvtol_finish_div \xint_gob_til_Z
183     #6\expandafter\XINT_csvtol_finish_diii \xint_gob_til_Z
184     #7\expandafter\XINT_csvtol_finish_dii \xint_gob_til_Z
185     \R\XINT_csvtol_finish_di \Z
186 }%
187 \long\def\XINT_csvtol_finish_dviii #1#2#3#4#5#6#7#8#9{ #9}%
188 \long\def\XINT_csvtol_finish_dvii #1#2#3#4#5#6#7#8#9{ #9{#1}}%
189 \long\def\XINT_csvtol_finish_dvi #1#2#3#4#5#6#7#8#9{ #9{#1}{#2}}%
190 \long\def\XINT_csvtol_finish_dv #1#2#3#4#5#6#7#8#9{ #9{#1}{#2}{#3}}%
191 \long\def\XINT_csvtol_finish_div #1#2#3#4#5#6#7#8#9{ #9{#1}{#2}{#3}{#4}}%
192 \long\def\XINT_csvtol_finish_diii #1#2#3#4#5#6#7#8#9{ #9{#1}{#2}{#3}{#4}{#5}}%

```

```

193 \long\def\XINT_csvtol_finish_dii #1#2#3#4#5#6#7#8#9%
194 { #9{#1}{#2}{#3}{#4}{#5}{#6}}%
195 \long\def\XINT_csvtol_finish_di\Z #1#2#3#4#5#6#7#8#9%
196 { #9{#1}{#2}{#3}{#4}{#5}{#6}{#7}}%

```

## 2.10 \xintListWithSep

1.04. `\xintListWithSep {sep}{a}{b}...{z}` returns a `\sep b \sep ... \sep z`. It f-expands its second argument. The 'sep' may be `\par`'s: the macro `\xintlistwithsep` etc... are all declared long. 'sep' does not have to be a single token. It is not expanded.

```

197 \def\xintListWithSep {\romannumeral0\xintlistwithsep }%
198 \def\xintListWithSepNoExpand {\romannumeral0\xintlistwithsepnoexpand }%
199 \long\def\xintlistwithsep #1#2%
200 { \expandafter\XINT_lws\expandafter {\romannumeral`&&@#2}{#1}}%
201 \long\def\XINT_lws #1#2{\XINT_lws_start {#2}#1\xint_bye }%
202 \long\def\xintlistwithsepnoexpand #1#2{\XINT_lws_start {#1}#2\xint_bye }%
203 \long\def\XINT_lws_start #1#2%
204 {%
205   \xint_bye #2\XINT_lws_dont\xint_bye
206   \XINT_lws_loop_a {#2}{#1}%
207 }%
208 \long\def\XINT_lws_dont\xint_bye\XINT_lws_loop_a #1#2{ }%
209 \long\def\XINT_lws_loop_a #1#2#3%
210 {%
211   \xint_bye #3\XINT_lws_end\xint_bye
212   \XINT_lws_loop_b {#1}{#2#3}{#2}%
213 }%
214 \long\def\XINT_lws_loop_b #1#2{\XINT_lws_loop_a {#1#2}}%
215 \long\def\XINT_lws_end\xint_bye\XINT_lws_loop_b #1#2#3{ #1}%

```

## 2.11 \xintNthElt

First included in release 1.06. Last refactored in 1.2j.

`\xintNthElt {i}{List}` returns the *i* th item from List (one pair of braces removed). The list is first f-expanded. The `\xintNthEltNoExpand` does no expansion of its second argument. Both variants expand *i* inside `\numexpr`.

With *i* = 0, the number of items is returned using `\xintLength` but with the List argument f-expanded first.

Negative values return the *|i|*th element from the end.

When *i* is out of range, an empty value is returned.

```

216 \def\xintNthElt {\romannumeral0\xintnthelt }%
217 \def\xintNthEltNoExpand {\romannumeral0\xintntheltnoexpand }%
218 \long\def\xintnthelt #1#2{\expandafter\XINT_nthelt_a\the\numexpr #1\expandafter.%
219   \expandafter{\romannumeral`&&@#2}}%
220 \def\xintntheltnoexpand #1{\expandafter\XINT_nthelt_a\the\numexpr #1.}%
221 \def\XINT_nthelt_a #1%
222 {%
223   \xint_UDzerominusfork
224   #1-\XINT_nthelt_zero
225   0#1\XINT_nthelt_neg
226   0-{\XINT_nthelt_pos #1}%

```

```

227 \krof
228 }%
229 \def\XINT_nthelt_zero #1.{\xintlength }%
230 \long\def\XINT_nthelt_neg #1.#2%
231 {%
232 \expandafter\XINT_nthelt_neg_a\the\numexpr\xint_c_i+\XINT_length_loop
233 #2\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:
234 \xint_c_viii\xint_c_vii\xint_c_vi\xint_c_v
235 \xint_c_iv\xint_c_iii\xint_c_ii\xint_c_i\xint_c_\xint_bye
236 -#1.#2\xint_bye
237 }%
238 \def\XINT_nthelt_neg_a #1%
239 {%
240 \xint_UDzerominusfork
241 #1-\xint_bye_thenstop
242 0#1\xint_bye_thenstop
243 0-{}%
244 \krof
245 \expandafter\XINT_nthelt_neg_b
246 \romannumeral\expandafter\XINT_gobble\the\numexpr-\xint_c_i+#1%
247 }%
248 \long\def\XINT_nthelt_neg_b #1#2\xint_bye{ #1}%
249 \long\def\XINT_nthelt_pos #1.#2%
250 {%
251 \expandafter\XINT_nthelt_pos_done
252 \romannumeral0\expandafter\XINT_trim_loop\the\numexpr#1-\xint_c_x.%
253 #2\xint:\xint:\xint:\xint:\xint:%
254 \xint:\xint:\xint:\xint:\xint:%
255 \xint_bye
256 }%
257 \def\XINT_nthelt_pos_done #1{%
258 \long\def\XINT_nthelt_pos_done ##1##2\xint_bye{%
259 \xint_gob_til_xint:##1\expandafter#1\xint_gobble_ii\xint:#1##1}%
260 }\XINT_nthelt_pos_done{ }%

```

## 2.12 \xintKeep

First included in release 1.09m.

`\xintKeep{i}{L}` f-expands its second argument L. It then grabs the first i items from L and discards the rest.

ATTENTION: \*\*each such kept item is returned inside a brace pair\*\* Use `\xintKeepUnbraced` to avoid that.

For i equal or larger to the number N of items in (expanded) L, the full L is returned (with braced items). For i=0, the macro returns an empty output. For i<0, the macro discards the first N-|i| items. No brace pairs added to the remaining items. For i is less or equal to -N, the full L is returned (with no braces added.)

`\xintKeepNoExpand` does not expand the L argument.

Prior to 1.2i the code proceeded along a loop with no pre-computation of the length of L, for the i>0 case. The faster 1.2i version takes advantage of novel `\xintLengthUpTo` from `xintkernel.sty`.

```

261 \def\xintKeep          {\romannumeral0\xintkeep }%
262 \def\xintKeepNoExpand {\romannumeral0\xintkeepnoexpand }%

```

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```

263 \long\def\xintkeep #1#2{\expandafter\XINT_keep_a\the\numexpr #1\expandafter.%
264 \expandafter{\romannumeral`&&@#2}}%
265 \def\xintkeepnoexpand #1{\expandafter\XINT_keep_a\the\numexpr #1.}%
266 \def\XINT_keep_a #1%
267 {%
268 \xint_UDzerominusfork
269 #1-\XINT_keep_keeptime
270 0#1\XINT_keep_neg
271 0-{\XINT_keep_pos #1}%
272 \krof
273 }%
274 \long\def\XINT_keep_keeptime .#1{ }%
275 \long\def\XINT_keep_neg #1.#2%
276 {%
277 \expandafter\XINT_keep_neg_a\the\numexpr
278 #1-\numexpr\XINT_length_loop
279 #2\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:
280 \xint_c_viii\xint_c_vii\xint_c_vi\xint_c_v
281 \xint_c_iv\xint_c_iii\xint_c_ii\xint_c_i\xint_c_\xint_bye.#2%
282 }%
283 \def\XINT_keep_neg_a #1%
284 {%
285 \xint_UDsignfork
286 #1{\expandafter\space\romannumeral\XINT_gobble}%
287 -\XINT_keep_keeptime
288 \krof
289 }%
290 \def\XINT_keep_keeptime #1.{ }%
291 \long\def\XINT_keep_pos #1.#2%
292 {%
293 \expandafter\XINT_keep_loop
294 \the\numexpr#1-\XINT_lengthupto_loop
295 #1.#2\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:
296 \xint_c_vii\xint_c_vi\xint_c_v\xint_c_iv
297 \xint_c_iii\xint_c_ii\xint_c_i\xint_c_\xint_bye.%
298 -\xint_c_viii.{ }#2\xint_bye%
299 }%
300 \def\XINT_keep_loop #1#2.%
301 {%
302 \xint_gob_til_minus#1\XINT_keep_loop_end-%
303 \expandafter\XINT_keep_loop
304 \the\numexpr#1#2-\xint_c_viii\expandafter.\XINT_keep_loop_pickeight
305 }%
306 \long\def\XINT_keep_loop_pickeight
307 #1#2#3#4#5#6#7#8#9{{#1}{#2}{#3}{#4}{#5}{#6}{#7}{#8}{#9}}}%
308 \def\XINT_keep_loop_end-\expandafter\XINT_keep_loop
309 \the\numexpr-#1-\xint_c_viii\expandafter.\XINT_keep_loop_pickeight
310 {\csname XINT_keep_end#1\endcsname}%
311 \long\expandafter\def\csname XINT_keep_end1\endcsname
312 #1#2#3#4#5#6#7#8#9\xint_bye { #1{#2}{#3}{#4}{#5}{#6}{#7}{#8}}}%
313 \long\expandafter\def\csname XINT_keep_end2\endcsname
314 #1#2#3#4#5#6#7#8\xint_bye { #1{#2}{#3}{#4}{#5}{#6}{#7}}}%

```

```

315 \long\expandafter\def\csname XINT_keep_end3\endcsname
316   #1#2#3#4#5#6#7\xint_bye { #1{#2}{#3}{#4}{#5}{#6}}%
317 \long\expandafter\def\csname XINT_keep_end4\endcsname
318   #1#2#3#4#5#6\xint_bye { #1{#2}{#3}{#4}{#5}}%
319 \long\expandafter\def\csname XINT_keep_end5\endcsname
320   #1#2#3#4#5\xint_bye { #1{#2}{#3}{#4}}%
321 \long\expandafter\def\csname XINT_keep_end6\endcsname
322   #1#2#3#4\xint_bye { #1{#2}{#3}}%
323 \long\expandafter\def\csname XINT_keep_end7\endcsname
324   #1#2#3\xint_bye { #1{#2}}%
325 \long\expandafter\def\csname XINT_keep_end8\endcsname
326   #1#2\xint_bye { #1}%

```

## 2.13 \xintKeepUnbraced

1.2a. Same as \xintKeep but will *not* add (or maintain) brace pairs around the kept items when  $\text{length}(L) > i > 0$ .

The name may cause a mis-understanding: for  $i < 0$ , (i.e. keeping only trailing items), there is no brace removal at all happening.

Modified for 1.2i like \xintKeep.

```

327 \def\xintKeepUnbraced          {\romannumeral0\xintkeepunbraced}%
328 \def\xintKeepUnbracedNoExpand {\romannumeral0\xintkeepunbracednoexpand}%
329 \long\def\xintkeepunbraced #1#2%
330   {\expandafter\xint_keepunbr_a\the\numexpr #1\expandafter.%
331     \expandafter{\romannumeral`&&@#2}}%
332 \def\xintkeepunbracednoexpand #1%
333   {\expandafter\xint_keepunbr_a\the\numexpr #1.}%
334 \def\xint_keepunbr_a #1%
335 {%
336   \xint_UDzerominusfork
337   #1-\XINT_keep_keeptime
338   0#1\XINT_keep_neg
339   0-{\XINT_keepunbr_pos #1}%
340   \krof
341 }%
342 \long\def\xint_keepunbr_pos #1.#2%
343 {%
344   \expandafter\xint_keepunbr_loop
345   \the\numexpr#1-\XINT_lengthupto_loop
346   #1.#2\xint:\xint:\xint:\xint:\xint:\xint:\xint:
347   \xint_c_vii\xint_c_vi\xint_c_v\xint_c_iv
348   \xint_c_iii\xint_c_ii\xint_c_i\xint_c_\xint_bye.%
349   -\xint_c_viii.{}#2\xint_bye%
350 }%
351 \def\xint_keepunbr_loop #1#2.%
352 {%
353   \xint_gob_til_minus#1\XINT_keepunbr_loop_end-%
354   \expandafter\xint_keepunbr_loop
355   \the\numexpr#1#2-\xint_c_viii\expandafter.\XINT_keepunbr_loop_pickeight
356 }%
357 \long\def\xint_keepunbr_loop_pickeight
358   #1#2#3#4#5#6#7#8#9{{#1#2#3#4#5#6#7#8#9}}%

```



```

359 \def\XINT_keepunbr_loop_end-\expandafter\XINT_keepunbr_loop
360   \the\numexpr-#1-\xint_c_viii\expandafter.\XINT_keepunbr_loop_pickeight
361   {\csname XINT_keepunbr_end#1\endcsname}%
362 \long\expandafter\def\csname XINT_keepunbr_end1\endcsname
363   #1#2#3#4#5#6#7#8#9\xint_bye { #1#2#3#4#5#6#7#8}%
364 \long\expandafter\def\csname XINT_keepunbr_end2\endcsname
365   #1#2#3#4#5#6#7#8\xint_bye { #1#2#3#4#5#6#7}%
366 \long\expandafter\def\csname XINT_keepunbr_end3\endcsname
367   #1#2#3#4#5#6#7\xint_bye { #1#2#3#4#5#6}%
368 \long\expandafter\def\csname XINT_keepunbr_end4\endcsname
369   #1#2#3#4#5#6\xint_bye { #1#2#3#4#5}%
370 \long\expandafter\def\csname XINT_keepunbr_end5\endcsname
371   #1#2#3#4#5\xint_bye { #1#2#3#4}%
372 \long\expandafter\def\csname XINT_keepunbr_end6\endcsname
373   #1#2#3#4\xint_bye { #1#2#3}%
374 \long\expandafter\def\csname XINT_keepunbr_end7\endcsname
375   #1#2#3\xint_bye { #1#2}%
376 \long\expandafter\def\csname XINT_keepunbr_end8\endcsname
377   #1#2\xint_bye { #1}%

```

## 2.14 `\xintTrim`

First included in release 1.09m.

`\xintTrim{i}{L}` f-expands its second argument *L*. It then removes the first *i* items from *L* and keeps the rest. For *i* equal or larger to the number *N* of items in (expanded) *L*, the macro returns an empty output. For *i*=0, the original (expanded) *L* is returned. For *i*<0, the macro proceeds from the tail. It thus removes the last  $|i|$  items, i.e. it keeps the first  $N-|i|$  items. For  $|i| \geq N$ , the empty list is returned.

`\xintTrimNoExpand` does not expand the *L* argument.

Speed improvements with 1.2i for *i*<0 branch (which hands over to `\xintKeep`). Speed improvements with 1.2j for *i*>0 branch which gobbles items nine by nine despite not knowing in advance if it will go too far.

```

378 \def\xintTrim          {\romannumeral0\xinttrim }%
379 \def\xintTrimNoExpand {\romannumeral0\xinttrimnoexpand }%
380 \long\def\xinttrim #1#2{\expandafter\XINT_trim_a\the\numexpr #1\expandafter.%
381   \expandafter{\romannumeral`&&@#2}}%
382 \def\xinttrimnoexpand #1{\expandafter\XINT_trim_a\the\numexpr #1.}%
383 \def\XINT_trim_a #1%
384 {%
385   \xint_UDzerominusfork
386   #1-\XINT_trim_trimnone
387   0#1\XINT_trim_neg
388   0-{\XINT_trim_pos #1}%
389   \krof
390 }%
391 \long\def\XINT_trim_trimnone .#1{ #1}%
392 \long\def\XINT_trim_neg #1.#2%
393 {%
394   \expandafter\XINT_trim_neg_a\the\numexpr
395   #1-\numexpr\XINT_length_loop
396   #2\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:

```

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```
397 \xint_c_viii\xint_c_vii\xint_c_vi\xint_c_v
398 \xint_c_iv\xint_c_iii\xint_c_ii\xint_c_i\xint_c_\xint_bye
399 .{ }#2\xint_bye
400 }%
401 \def\xint_trim_neg_a #1%
402 {%
403 \xint_UDsignfork
404 #1{\expandafter\xint_keep_loop\the\numexpr-\xint_c_viii+}%
405 -\xint_trim_trimall
406 \krof
407 }%
408 \def\xint_trim_trimall#1{%
409 \def\xint_trim_trimall {\expandafter#1\xint_bye}%
410 }\xint_trim_trimall{ }%
```

This branch doesn't pre-evaluate the length of the list argument. Redone again for 1.2j, manages to trim nine by nine. Some non optimal looking aspect of the code is for allowing sharing with `\xintNthElt`.

```
411 \long\def\xint_trim_pos #1.#2%
412 {%
413 \expandafter\xint_trim_pos_done\expandafter\space
414 \romannumeral0\expandafter\xint_trim_loop\the\numexpr#1-\xint_c_ix.%
415 #2\xint:\xint:\xint:\xint:\xint:%
416 \xint:\xint:\xint:\xint:\xint:%
417 \xint_bye
418 }%
419 \def\xint_trim_loop #1#2.%
420 {%
421 \xint_gob_til_minus#1\xint_trim_finish-%
422 \expandafter\xint_trim_loop\the\numexpr#1#2\xint_trim_loop_trimnine
423 }%
424 \long\def\xint_trim_loop_trimnine #1#2#3#4#5#6#7#8#9%
425 {%
426 \xint_gob_til_xint: #9\xint_trim_toofew\xint:-\xint_c_ix.%
427 }%
428 \def\xint_trim_toofew\xint:{*\xint_c_}%
429 \def\xint_trim_finish#1{%
430 \def\xint_trim_finish-%
431 \expandafter\xint_trim_loop\the\numexpr-##1\xint_trim_loop_trimnine
432 }%
433 \expandafter\expandafter\expandafter#1%
434 \csname xint_gobble_\romannumeral\numexpr\xint_c_ix-##1\endcsname
435 }}\xint_trim_finish{ }%
436 \long\def\xint_trim_pos_done #1\xint:#2\xint_bye {#1}%

```

### 2.15 `\xintTrimUnbraced`

#### 1.2a. Modified in 1.2i like `\xintTrim`

```
437 \def\xintTrimUnbraced {\romannumeral0\xinttrimunbraced }%
438 \def\xintTrimUnbracedNoExpand {\romannumeral0\xinttrimunbracednoexpand }%
439 \long\def\xinttrimunbraced #1#2%
```

```

440   {\expandafter\XINT_trimunbr_a\the\numexpr #1\expandafter.%
441   \expandafter{\romannumeral`&&@#2}}}%
442 \def\xinttrimunbracednoexpand #1%
443   {\expandafter\XINT_trimunbr_a\the\numexpr #1.}%
444 \def\XINT_trimunbr_a #1%
445 {%
446   \xint_UDzerominusfork
447     #1-\XINT_trim_trimnone
448     0#1\XINT_trimunbr_neg
449     0-{\XINT_trim_pos #1}%
450   \krof
451 }%
452 \long\def\XINT_trimunbr_neg #1.#2%
453 {%
454   \expandafter\XINT_trimunbr_neg_a\the\numexpr
455   #1-\numexpr\XINT_length_loop
456   #2\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:
457   \xint_c_viii\xint_c_vii\xint_c_vi\xint_c_v
458   \xint_c_iv\xint_c_iii\xint_c_ii\xint_c_i\xint_c_\xint_bye
459   .}{#2\xint_bye
460 }%
461 \def\XINT_trimunbr_neg_a #1%
462 {%
463   \xint_UDsignfork
464     #1{\expandafter\XINT_keepunbr_loop\the\numexpr-\xint_c_viii+}%
465     -\XINT_trim_trimall
466   \krof
467 }%

```

## 2.16 \xintApply

`\xintApply {\macro}{a}{b}...{z}` returns `{\macro{a}}...{\macro{b}}` where each instance of `\macro` is *f-expanded*. The list itself is first *f-expanded* and may thus be a macro. Introduced with release 1.04.

```

468 \def\xintApply      {\romannumeral0\xintapply }%
469 \def\xintApplyNoExpand {\romannumeral0\xintapplynoexpand }%
470 \long\def\xintapply #1#2%
471 {%
472   \expandafter\XINT_apply\expandafter {\romannumeral`&&@#2}%
473   {#1}%
474 }%
475 \long\def\XINT_apply #1#2{\XINT_apply_loop_a {}{#2}#1\xint_bye }%
476 \long\def\xintapplynoexpand #1#2{\XINT_apply_loop_a {}{#1}#2\xint_bye }%
477 \long\def\XINT_apply_loop_a #1#2#3%
478 {%
479   \xint_bye #3\XINT_apply_end\xint_bye
480   \expandafter
481   \XINT_apply_loop_b
482   \expandafter {\romannumeral`&&@#2{#3}}{#1}{#2}%
483 }%
484 \long\def\XINT_apply_loop_b #1#2{\XINT_apply_loop_a {#2{#1}}}%
485 \long\def\XINT_apply_end\xint_bye\expandafter\XINT_apply_loop_b

```

```
486 \expandafter #1#2#3{ #2}%
```

## 2.17 \xintApplyUnbraced

`\xintApplyUnbraced {\macro}{a}{b}...{z}` returns `\macro{a}...\macro{z}` where each instance of `\macro` is f-expanded using `\romannumeral-`0`. The second argument may be a macro as it is itself also f-expanded. No braces are added: this allows for example a non-expandable `\def` in `\macro`, without having to do `\gdef`. Introduced with release 1.06b.

```
487 \def\xintApplyUnbraced {\romannumeral0\xintapplyunbraced }%
488 \def\xintApplyUnbracedNoExpand {\romannumeral0\xintapplyunbracednoexpand }%
489 \long\def\xintapplyunbraced #1#2%
490 {%
491   \expandafter\XINT_applyunbr\expandafter {\romannumeral`&&@#2}%
492   {#1}%
493 }%
494 \long\def\XINT_applyunbr #1#2{\XINT_applyunbr_loop_a {}{#2}#1\xint_bye }%
495 \long\def\xintapplyunbracednoexpand #1#2%
496   {\XINT_applyunbr_loop_a {}{#1}#2\xint_bye }%
497 \long\def\XINT_applyunbr_loop_a #1#2#3%
498 {%
499   \xint_bye #3\XINT_applyunbr_end\xint_bye
500   \expandafter\XINT_applyunbr_loop_b
501   \expandafter {\romannumeral`&&@#2{#3}}{#1}{#2}%
502 }%
503 \long\def\XINT_applyunbr_loop_b #1#2{\XINT_applyunbr_loop_a {#2}#1}%
504 \long\def\XINT_applyunbr_end\xint_bye\expandafter\XINT_applyunbr_loop_b
505   \expandafter #1#2#3{ #2}%
```

## 2.18 \xintSeq

1.09c. Without the optional argument puts stress on the input stack, should not be used to generated thousands of terms then.

```
506 \def\xintSeq {\romannumeral0\xintseq }%
507 \def\xintseq #1{\XINT_seq_chkopt #1\xint_bye }%
508 \def\XINT_seq_chkopt #1%
509 {%
510   \ifx [#1\expandafter\XINT_seq_opt
511     \else\expandafter\XINT_seq_noopt
512   \fi #1%
513 }%
514 \def\XINT_seq_noopt #1\xint_bye #2%
515 {%
516   \expandafter\XINT_seq\expandafter
517     {\the\numexpr#1\expandafter}\expandafter{\the\numexpr #2}%
518 }%
519 \def\XINT_seq #1#2%
520 {%
521   \ifcase\ifnum #1=#2 0\else\ifnum #2>#1 1\else -1\fi\fi\space
522     \expandafter\xint_firstoftwo_thenstop
523   \or
524     \expandafter\XINT_seq_p
```

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```

525 \else
526   \expandafter\XINT_seq_n
527 \fi
528 {#2}{#1}%
529 }%
530 \def\XINT_seq_p #1#2%
531 {%
532   \ifnum #1>#2
533     \expandafter\expandafter\expandafter\XINT_seq_p
534   \else
535     \expandafter\XINT_seq_e
536   \fi
537   \expandafter{\the\numexpr #1-\xint_c_i}{#2}{#1}%
538 }%
539 \def\XINT_seq_n #1#2%
540 {%
541   \ifnum #1<#2
542     \expandafter\expandafter\expandafter\XINT_seq_n
543   \else
544     \expandafter\XINT_seq_e
545   \fi
546   \expandafter{\the\numexpr #1+\xint_c_i}{#2}{#1}%
547 }%
548 \def\XINT_seq_e #1#2#3{ }%
549 \def\XINT_seq_opt [\xint_bye #1]#2#3%
550 {%
551   \expandafter\XINT_seqo\expandafter
552   {\the\numexpr #2\expandafter}\expandafter
553   {\the\numexpr #3\expandafter}\expandafter
554   {\the\numexpr #1}%
555 }%
556 \def\XINT_seqo #1#2%
557 {%
558   \ifcase\ifnum #1=#2 0\else\ifnum #2>#1 1\else -1\fi\fi\space
559   \expandafter\XINT_seqo_a
560   \or
561   \expandafter\XINT_seqo_pa
562   \else
563   \expandafter\XINT_seqo_na
564   \fi
565   {#1}{#2}%
566 }%
567 \def\XINT_seqo_a #1#2#3{ {#1}}%
568 \def\XINT_seqo_o #1#2#3#4{ #4}%
569 \def\XINT_seqo_pa #1#2#3%
570 {%
571   \ifcase\ifnum #3=\xint_c_ 0\else\ifnum #3>\xint_c_ 1\else -1\fi\fi\space
572   \expandafter\XINT_seqo_o
573   \or
574   \expandafter\XINT_seqo_pb
575   \else
576   \xint_afterfi{\expandafter\space\xint_gobble_iv}%

```

```

577 \fi
578 {#1}{#2}{#3}{{#1}}%
579 }%
580 \def\XINT_seqo_pb #1#2#3%
581 {%
582 \expandafter\XINT_seqo_pc\expandafter{\the\numexpr #1+#3}{#2}{#3}%
583 }%
584 \def\XINT_seqo_pc #1#2%
585 {%
586 \ifnum #1>#2
587 \expandafter\XINT_seqo_o
588 \else
589 \expandafter\XINT_seqo_pd
590 \fi
591 {#1}{#2}%
592 }%
593 \def\XINT_seqo_pd #1#2#3#4{\XINT_seqo_pb {#1}{#2}{#3}{#4{#1}}}%
594 \def\XINT_seqo_na #1#2#3%
595 {%
596 \ifcase\ifnum #3=\xint_c_ 0\else\ifnum #3>\xint_c_ 1\else -1\fi\fi\space
597 \expandafter\XINT_seqo_o
598 \or
599 \xint_afterfi{\expandafter\space\xint_gobble_iv}%
600 \else
601 \expandafter\XINT_seqo_nb
602 \fi
603 {#1}{#2}{#3}{{#1}}%
604 }%
605 \def\XINT_seqo_nb #1#2#3%
606 {%
607 \expandafter\XINT_seqo_nc\expandafter{\the\numexpr #1+#3}{#2}{#3}%
608 }%
609 \def\XINT_seqo_nc #1#2%
610 {%
611 \ifnum #1<#2
612 \expandafter\XINT_seqo_o
613 \else
614 \expandafter\XINT_seqo_nd
615 \fi
616 {#1}{#2}%
617 }%
618 \def\XINT_seqo_nd #1#2#3#4{\XINT_seqo_nb {#1}{#2}{#3}{#4{#1}}}%

```

## 2.19 \xintloop, \xintbreakloop, \xintbreakloopaddo, \xintloopskiptonext

1.09g [2013/11/22]. Made long with 1.09h.

```

619 \long\def\xintloop #1#2\repeat {#1#2\xintloop_again\fi\xint_gobble_i {#1#2}}%
620 \long\def\xintloop_again\fi\xint_gobble_i #1{\fi
621 #1\xintloop_again\fi\xint_gobble_i {#1}}%
622 \long\def\xintbreakloop #1\xintloop_again\fi\xint_gobble_i #2{}%
623 \long\def\xintbreakloopaddo #1#2\xintloop_again\fi\xint_gobble_i #3{#1}%
624 \long\def\xintloopskiptonext #1\xintloop_again\fi\xint_gobble_i #2{}%

```

625 #2\xintloop\_again\fi\xint\_gobble\_i {#2}}%

## 2.20 \xintloop, \xintloopindex, \xintouterloopindex, \xintbreakiloop, \xintbreakiloopanddo, \xintloopskiptonext, \xintloopskipandredo

1.09g [2013/11/22]. Made long with 1.09h.

```

626 \def\xintloop [#1+#2]{%
627   \expandafter\xintloop_a\the\numexpr #1\expandafter.\the\numexpr #2.%
628 \long\def\xintloop_a #1.#2.#3#4\repeat{%
629   #3#4\xintloop_again\fi\xint_gobble_iii {#1}{#2}{#3#4}}%
630 \def\xintloop_again\fi\xint_gobble_iii #1#2{%
631   \fi\expandafter\xintloop_again_b\the\numexpr#1+#2.#2.%
632 \long\def\xintloop_again_b #1.#2.#3{%
633   #3\xintloop_again\fi\xint_gobble_iii {#1}{#2}{#3}}%
634 \long\def\xintbreakiloop #1\xintloop_again\fi\xint_gobble_iii #2#3#4{%
635 \long\def\xintbreakiloopanddo
636   #1.#2\xintloop_again\fi\xint_gobble_iii #3#4#5{#1}%
637 \long\def\xintloopindex #1\xintloop_again\fi\xint_gobble_iii #2%
638   {#2#1\xintloop_again\fi\xint_gobble_iii {#2}}%
639 \long\def\xintouterloopindex #1\xintloop_again
640   #2\xintloop_again\fi\xint_gobble_iii #3%
641   {#3#1\xintloop_again #2\xintloop_again\fi\xint_gobble_iii {#3}}%
642 \long\def\xintloopskiptonext #1\xintloop_again\fi\xint_gobble_iii #2#3{%
643   \expandafter\xintloop_again_b \the\numexpr#2+#3.#3.%
644 \long\def\xintloopskipandredo #1\xintloop_again\fi\xint_gobble_iii #2#3#4{%
645   #4\xintloop_again\fi\xint_gobble_iii {#2}{#3}{#4}}%
```

## 2.21 \XINT\_xflet

1.09e [2013/10/29]: we f-expand unbraced tokens and swallow arising space tokens until the dust settles.

```

646 \def\XINT_xflet #1%
647 {%
648   \def\XINT_xflet_macro {#1}\XINT_xflet_zapsp
649 }%
650 \def\XINT_xflet_zapsp
651 {%
652   \expandafter\futurelet\expandafter\XINT_token
653   \expandafter\XINT_xflet_sp?\romannumeral`&&@%
654 }%
655 \def\XINT_xflet_sp?
656 {%
657   \ifx\XINT_token\XINT_sptoken
658     \expandafter\XINT_xflet_zapsp
659   \else\expandafter\XINT_xflet_zapspB
660   \fi
661 }%
662 \def\XINT_xflet_zapspB
663 {%
664   \expandafter\futurelet\expandafter\XINT_tokenB
665   \expandafter\XINT_xflet_spB?\romannumeral`&&@%
```

```

666 }%
667 \def\XINT_xflet_spB?
668 {%
669   \ifx\XINT_tokenB\XINT_sptoken
670     \expandafter\XINT_xflet_zapspB
671   \else\expandafter\XINT_xflet_eq?
672   \fi
673 }%
674 \def\XINT_xflet_eq?
675 {%
676   \ifx\XINT_token\XINT_tokenB
677     \expandafter\XINT_xflet_macro
678   \else\expandafter\XINT_xflet_zapsp
679   \fi
680 }%

```

## 2.22 \xintApplyInline

1.09a: `\xintApplyInline\macro{a}{b}...{z}` has the same effect as executing `\macro{a}` and then applying again `\xintApplyInline` to the shortened list `{b}...{z}` until nothing is left. This is a non-expandable command which will result in quicker code than using `\xintApplyUnbraced`. It f-expands its second (list) argument first, which may thus be encapsulated in a macro.

Rewritten in 1.09c. Nota bene: uses catcode 3 Z as privated list terminator.

```

681 \catcode`Z 3
682 \long\def\xintApplyInline #1#2%
683 {%
684   \long\expandafter\def\expandafter\XINT_inline_macro
685   \expandafter ##\expandafter 1\expandafter {#1{##1}}%
686   \XINT_xflet\XINT_inline_b #2Z% this Z has catcode 3
687 }%
688 \def\XINT_inline_b
689 {%
690   \ifx\XINT_token Z\expandafter\xint_gobble_i
691   \else\expandafter\XINT_inline_d\fi
692 }%
693 \long\def\XINT_inline_d #1%
694 {%
695   \long\def\XINT_item{#1}\XINT_xflet\XINT_inline_e
696 }%
697 \def\XINT_inline_e
698 {%
699   \ifx\XINT_token Z\expandafter\XINT_inline_w
700   \else\expandafter\XINT_inline_f\fi
701 }%
702 \def\XINT_inline_f
703 {%
704   \expandafter\XINT_inline_g\expandafter{\XINT_inline_macro {##1}}%
705 }%
706 \long\def\XINT_inline_g #1%
707 {%
708   \expandafter\XINT_inline_macro\XINT_item
709   \long\def\XINT_inline_macro ##1{#1}\XINT_inline_d

```



```

710 }%
711 \def\XINT_inline_w #1%
712 {%
713   \expandafter\XINT_inline_macro\XINT_item
714 }%

```

## 2.23 \xintFor, \xintFor\*, \xintBreakFor, \xintBreakForAndDo

1.09c [2013/10/09]: a new kind of loop which uses macro parameters #1, #2, #3, #4 rather than macros; while not expandable it survives executing code closing groups, like what happens in an alignment with the & character. When inserted in a macro for later use, the # character must be doubled.

The non-star variant works on a csv list, which it expands once, the star variant works on a token list, which it (repeatedly) f-expands.

1.09e adds \XINT\_forever with \xintintegers, \xintdimensions, \xintrationals and \xintBreakFor, \xintBreakForAndDo, \xintifForFirst, \xintifForLast. On this occasion \xint\_firstoftwo and \xint\_secondoftwo are made long.

1.09f: rewrites large parts of \xintFor code in order to filter the comma separated list via \xintCSVtoList which gets rid of spaces. The #1 in \XINT\_for\_forever? has an initial space token which serves two purposes: preventing brace stripping, and stopping the expansion made by \xintcsvtolist. If the \XINT\_forever branch is taken, the added space will not be a problem there.

1.09f rewrites (2013/11/03) the code which now allows all macro parameters from #1 to #9 in \xintFor, \xintFor\*, and \XINT\_forever. 1.2i: slightly more robust \xintifForFirst/Last in case of nesting.

```

715 \def\XINT_tmpa #1#2{\ifnum #2<#1 \xint_afterfi {{#####2}}\fi}%
716 \def\XINT_tmpb #1#2{\ifnum #1<#2 \xint_afterfi {{#####2}}\fi}%
717 \def\XINT_tmpc #1%
718 {%
719   \expandafter\edef \csname XINT_for_left#1\endcsname
720     {\xintApplyUnbraced {\XINT_tmpa #1}{123456789}}%
721   \expandafter\edef \csname XINT_for_right#1\endcsname
722     {\xintApplyUnbraced {\XINT_tmpb #1}{123456789}}%
723 }%
724 \xintApplyInline \XINT_tmpc {123456789}%
725 \long\def\xintBreakFor      #1Z{%}%
726 \long\def\xintBreakForAndDo #1#2Z{#1}%
727 \def\xintFor {\let\xintifForFirst\xint_firstoftwo
728               \let\xintifForLast\xint_secondoftwo
729               \futurelet\XINT_token\XINT_for_ifstar }%
730 \def\XINT_for_ifstar {\ifx\XINT_token*\expandafter\XINT_forx
731                      \else\expandafter\XINT_for \fi }%
732 \catcode`U 3 % with numexpr
733 \catcode`V 3 % with xintfrac.sty (xint.sty not enough)
734 \catcode`D 3 % with dimexpr
735 \def\XINT_flet_zapsp
736 {%
737   \futurelet\XINT_token\XINT_flet_sp?
738 }%
739 \def\XINT_flet_sp?
740 {%
741   \ifx\XINT_token\XINT_sptoken
742     \xint_afterfi{\expandafter\XINT_flet_zapsp\romannumeral0}%

```

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```

743 \else\expandafter\XINT_flet_macro
744 \fi
745 }%
746 \long\def\XINT_for #1#2in#3#4#5%
747 {%
748 \expandafter\XINT_toks\expandafter
749 {\expandafter\XINT_for_d\the\numexpr #2\relax {#5}}%
750 \def\XINT_flet_macro {\expandafter\XINT_for_forever?\space}%
751 \expandafter\XINT_flet_zapsp #3Z%
752 }%
753 \def\XINT_for_forever? #1Z%
754 {%
755 \ifx\XINT_token U\XINT_to_forever\fi
756 \ifx\XINT_token V\XINT_to_forever\fi
757 \ifx\XINT_token D\XINT_to_forever\fi
758 \expandafter\the\expandafter\XINT_toks\romannumeral0\xintcsvtolist {#1}Z%
759 }%
760 \def\XINT_to_forever\fi #1\xintcsvtolist #2{\fi \XINT_forever #2}%
761 \long\def\XINT_forx *#1#2in#3#4#5%
762 {%
763 \expandafter\XINT_toks\expandafter
764 {\expandafter\XINT_forx_d\the\numexpr #2\relax {#5}}%
765 \XINT_xflet\XINT_forx_forever? #3Z%
766 }%
767 \def\XINT_forx_forever?
768 {%
769 \ifx\XINT_token U\XINT_to_forxever\fi
770 \ifx\XINT_token V\XINT_to_forxever\fi
771 \ifx\XINT_token D\XINT_to_forxever\fi
772 \XINT_forx_empty?
773 }%
774 \def\XINT_to_forxever\fi #1\XINT_forx_empty? {\fi \XINT_forever }%
775 \catcode`U 11
776 \catcode`D 11
777 \catcode`V 11
778 \def\XINT_forx_empty?
779 {%
780 \ifx\XINT_token Z\expandafter\xintBreakFor\fi
781 \the\XINT_toks
782 }%
783 \long\def\XINT_for_d #1#2#3%
784 {%
785 \long\def\XINT_y ##1##2##3##4##5##6##7##8##9{#2}%
786 \XINT_toks {{#3}}%
787 \long\edef\XINT_x {\noexpand\XINT_y \csname XINT_for_left#1\endcsname
788 \the\XINT_toks \csname XINT_for_right#1\endcsname }%
789 \XINT_toks {\XINT_x\let\xintifForFirst\xint_secondoftwo
790 \let\xintifForLast\xint_secondoftwo\XINT_for_d #1{#2}}%
791 \futurelet\XINT_token\XINT_for_last?
792 }%
793 \long\def\XINT_forx_d #1#2#3%
794 {%

```

```

795 \long\def\XINT_y ##1##2##3##4##5##6##7##8##9{#2}%
796 \XINT_toks {{#3}}%
797 \long\edef\XINT_x {\noexpand\XINT_y \csname XINT_for_left#1\endcsname
798 \the\XINT_toks \csname XINT_for_right#1\endcsname }%
799 \XINT_toks {\XINT_x\let\xintifForFirst\xint_secondoftwo
800 \let\xintifForLast\xint_secondoftwo\XINT_forx_d #1{#2}}%
801 \XINT_xflet\XINT_for_last?
802 }%
803 \def\XINT_for_last?
804 {%
805 \ifx\XINT_token Z\expandafter\XINT_for_last?yes\fi
806 \the\XINT_toks
807 }%
808 \def\XINT_for_last?yes
809 {%
810 \let\xintifForLast\xint_firstoftwo
811 \xintBreakForAndDo{\XINT_x\xint_gobble_i Z}%
812 }%

```

## 2.24 \XINT\_forever, \xintintegers, \xintdimensions, \xintrationals

New with 1.09e. But this used inadvertently \xintiadd/\xintimul which have the unnecessary \xintnum overhead. Changed in 1.09f to use \xintiiadd/\xintiimul which do not have this overhead. Also 1.09f uses \xintZapSpacesB for the \xintrationals case to get rid of leading and ending spaces in the #4 and #5 delimited parameters of \XINT\_forever\_opt\_a (for \xintintegers and \xintdimensions this is not necessary, due to the use of \numexpr resp. \dimexpr in \XINT\_?expr\_Ua, resp. \XINT\_?expr\_Da).

```

813 \catcode`U 3
814 \catcode`D 3
815 \catcode`V 3
816 \let\xintegers U%
817 \let\xintintegers U%
818 \let\xintdimensions D%
819 \let\xintrationals V%
820 \def\XINT_forever #1%
821 {%
822 \expandafter\XINT_forever_a
823 \csname XINT_?expr_\ifx#1UU\else\ifx#1DD\else V\fi\fi a\expandafter\endcsname
824 \csname XINT_?expr_\ifx#1UU\else\ifx#1DD\else V\fi\fi i\expandafter\endcsname
825 \csname XINT_?expr_\ifx#1UU\else\ifx#1DD\else V\fi\fi \endcsname
826 }%
827 \catcode`U 11
828 \catcode`D 11
829 \catcode`V 11
830 \def\XINT_?expr_Ua #1#2%
831 {\expandafter{\expandafter\numexpr\the\numexpr #1\expandafter\relax
832 \expandafter\relax\expandafter}%
833 \expandafter{\the\numexpr #2}}%
834 \def\XINT_?expr_Da #1#2%
835 {\expandafter{\expandafter\dimexpr\number\dimexpr #1\expandafter\relax
836 \expandafter s\expandafter p\expandafter\relax\expandafter}%
837 \expandafter{\number\dimexpr #2}}%

```

## 2 Package *xinttools* implementation

```

838 \catcode`Z 11
839 \def\XINT_?expr_Va #1#2%
840 {%
841     \expandafter\XINT_?expr_Vb\expandafter
842         {\romannumeral`&&\xintrowwithzeros{\xintZapSpacesB{#2}}}%
843         {\romannumeral`&&\xintrowwithzeros{\xintZapSpacesB{#1}}}%
844 }%
845 \catcode`Z 3
846 \def\XINT_?expr_Vb #1#2{\expandafter\XINT_?expr_Vc #2.#1.}%
847 \def\XINT_?expr_Vc #1/#2.#3/#4.%
848 {%
849     \xintifEq {#2}{#4}%
850         {\XINT_?expr_Vf {#3}{#1}{#2}}%
851         {\expandafter\XINT_?expr_Vd\expandafter
852             {\romannumeral0\xintiimul {#2}{#4}}%
853             {\romannumeral0\xintiimul {#1}{#4}}%
854             {\romannumeral0\xintiimul {#2}{#3}}%
855         }%
856 }%
857 \def\XINT_?expr_Vd #1#2#3{\expandafter\XINT_?expr_Ve\expandafter {#2}{#3}{#1}}%
858 \def\XINT_?expr_Ve #1#2{\expandafter\XINT_?expr_Vf\expandafter {#2}{#1}}%
859 \def\XINT_?expr_Vf #1#2#3{{#2/#3}{0}{#1}{#2}{#3}}%
860 \def\XINT_?expr_Ui {\numexpr 1\relax}{1}%
861 \def\XINT_?expr_Di {\dimexpr 0pt\relax}{65536}}%
862 \def\XINT_?expr_Vi {{1/1}{0111}}%
863 \def\XINT_?expr_U #1#2%
864     {\expandafter{\expandafter\numexpr\the\numexpr #1+#2\relax\relax}{#2}}%
865 \def\XINT_?expr_D #1#2%
866     {\expandafter{\expandafter\dimexpr\the\numexpr #1+#2\relax sp\relax}{#2}}%
867 \def\XINT_?expr_V #1#2{\XINT_?expr_Vx #2}%
868 \def\XINT_?expr_Vx #1#2%
869 {%
870     \expandafter\XINT_?expr_Vy\expandafter
871         {\romannumeral0\xintiiadd {#1}{#2}}{#2}%
872 }%
873 \def\XINT_?expr_Vy #1#2#3#4%
874 {%
875     \expandafter{\romannumeral0\xintiiadd {#3}{#1}/#4}{#1}{#2}{#3}{#4}}%
876 }%
877 \def\XINT_forever_a #1#2#3#4%
878 {%
879     \ifx #4[\expandafter\XINT_forever_opt_a
880         \else\expandafter\XINT_forever_b
881         \fi #1#2#3#4%
882 }%
883 \def\XINT_forever_b #1#2#3Z{\expandafter\XINT_forever_c\the\XINT_toks #2#3}%
884 \long\def\XINT_forever_c #1#2#3#4#5%
885     {\expandafter\XINT_forever_d\expandafter #2#4#5{#3}Z}%
886 \def\XINT_forever_opt_a #1#2#3[#4+#5]#6Z%
887 {%
888     \expandafter\expandafter\expandafter
889     \XINT_forever_opt_c\expandafter\the\expandafter\XINT_toks

```

```

890 \romannumeral`&&@#1{#4}{#5}#3%
891 }%
892 \long\def\XINT_forever_opt_c #1#2#3#4#5#6{\XINT_forever_d #2{#4}{#5}#6{#3}Z}%
893 \long\def\XINT_forever_d #1#2#3#4#5%
894 {%
895 \long\def\XINT_y ##1##2##3##4##5##6##7##8##9{#5}%
896 \XINT_toks {{#2}}%
897 \long\edef\XINT_x {\noexpand\XINT_y \csname XINT_for_left#1\endcsname
898 \the\XINT_toks \csname XINT_for_right#1\endcsname }%
899 \XINT_x
900 \let\xintifForFirst\xint_secondoftwo
901 \let\xintifForLast\xint_secondoftwo
902 \expandafter\XINT_forever_d\expandafter #1\romannumeral`&&@#4{#2}{#3}#4{#5}%
903 }%

```

## 2.25 \xintForpair, \xintForthree, \xintForfour

### 1.09c.

[2013/11/02] 1.09f \xintForpair delegate to \xintCSVtoList and its \xintZapSpacesB the handling of spaces. Does not share code with \xintFor anymore.

[2013/11/03] 1.09f: \xintForpair extended to accept #1#2, #2#3 etc... up to #8#9, \xintForthree, #1#2#3 up to #7#8#9, \xintForfour id.

1.2i: slightly more robust \xintifForFirst/Last in case of nesting.

```

904 \catcode`j 3
905 \long\def\xintForpair #1#2#3in#4#5#6%
906 {%
907 \let\xintifForFirst\xint_firstoftwo
908 \let\xintifForLast\xint_secondoftwo
909 \XINT_toks {\XINT_forpair_d #2{#6}}%
910 \expandafter\the\expandafter\XINT_toks #4jZ%
911 }%
912 \long\def\XINT_forpair_d #1#2#3(#4)#5%
913 {%
914 \long\def\XINT_y ##1##2##3##4##5##6##7##8##9{#2}%
915 \XINT_toks \expandafter{\romannumeral0\xintcsvtolist{ #4}}%
916 \long\edef\XINT_x {\noexpand\XINT_y \csname XINT_for_left#1\endcsname
917 \the\XINT_toks \csname XINT_for_right\the\numexpr#1+\xint_c_i\endcsname}%
918 \ifx #5j\expandafter\XINT_for_last?yes\fi
919 \XINT_x
920 \let\xintifForFirst\xint_secondoftwo
921 \let\xintifForLast\xint_secondoftwo
922 \XINT_forpair_d #1{#2}%
923 }%
924 \long\def\xintForthree #1#2#3in#4#5#6%
925 {%
926 \let\xintifForFirst\xint_firstoftwo
927 \let\xintifForLast\xint_secondoftwo
928 \XINT_toks {\XINT_forthree_d #2{#6}}%
929 \expandafter\the\expandafter\XINT_toks #4jZ%
930 }%
931 \long\def\XINT_forthree_d #1#2#3(#4)#5%
932 {%

```

```

933 \long\def\XINT_y ##1##2##3##4##5##6##7##8##9{#2}%
934 \XINT_toks \expandafter{\romannumeral0\xintcsvtolist{ #4}}%
935 \long\edef\XINT_x {\noexpand\XINT_y \csname XINT_for_left#1\endcsname
936   \the\XINT_toks \csname XINT_for_right\the\numexpr#1+\xint_c_ii\endcsname}%
937 \ifx #5j\expandafter\XINT_for_last?yes\fi
938 \XINT_x
939 \let\xintifForFirst\xint_seconddoftwo
940 \let\xintifForLast\xint_seconddoftwo
941 \XINT_forthree_d #1{#2}%
942 }%
943 \long\def\xintForfour #1#2#3in#4#5#6%
944 {%
945   \let\xintifForFirst\xint_firstoftwo
946   \let\xintifForLast\xint_seconddoftwo
947   \XINT_toks {\XINT_forfour_d #2{#6}}%
948   \expandafter\the\expandafter\XINT_toks #4jZ%
949 }%
950 \long\def\XINT_forfour_d #1#2#3(#4)#5%
951 {%
952   \long\def\XINT_y ##1##2##3##4##5##6##7##8##9{#2}%
953   \XINT_toks \expandafter{\romannumeral0\xintcsvtolist{ #4}}%
954   \long\edef\XINT_x {\noexpand\XINT_y \csname XINT_for_left#1\endcsname
955     \the\XINT_toks \csname XINT_for_right\the\numexpr#1+\xint_c_iii\endcsname}%
956   \ifx #5j\expandafter\XINT_for_last?yes\fi
957   \XINT_x
958   \let\xintifForFirst\xint_seconddoftwo
959   \let\xintifForLast\xint_seconddoftwo
960   \XINT_forfour_d #1{#2}%
961 }%
962 \catcode`Z 11
963 \catcode`j 11

```

## 2.26 \xintAssign, \xintAssignArray, \xintDigitsOf

\xintAssign {a}{b}..{z}\to A\B...Z resp. \xintAssignArray {a}{b}..{z}\to U.  
\xintDigitsOf=\xintAssignArray.

1.1c 2015/09/12 has (belatedly) corrected some "features" of \xintAssign which didn't like the case of a space right before the "\to", or the case with the first token not an opening brace and the subsequent material containing brace groups. The new code handles gracefully these situations.

```

964 \def\xintAssign{\def\XINT_flet_macro {\XINT_assign_fork}\XINT_flet_zapsp }%
965 \def\XINT_assign_fork
966 {%
967   \let\XINT_assign_def\def
968   \ifx\XINT_token[\expandafter\XINT_assign_opt
969     \else\expandafter\XINT_assign_a
970   \fi
971 }%
972 \def\XINT_assign_opt [#1]%
973 {%
974   \ifcsname #1def\endcsname
975     \expandafter\let\expandafter\XINT_assign_def \csname #1def\endcsname
976   \else

```

## 2 Package *xinttools* implementation

```
977 \expandafter\let\expandafter\XINT_assign_def \csname xint#1def\endcsname
978 \fi
979 \XINT_assign_a
980 }%
981 \long\def\XINT_assign_a #1\to
982 {%
983 \def\XINT_flet_macro{\XINT_assign_b}%
984 \expandafter\XINT_flet_zapsp\romannumeral`&&@#1\xint:\to
985 }%
986 \long\def\XINT_assign_b
987 {%
988 \ifx\XINT_token\bgroup
989 \expandafter\XINT_assign_c
990 \else\expandafter\XINT_assign_f
991 \fi
992 }%
993 \long\def\XINT_assign_f #1\xint:\to #2%
994 {%
995 \XINT_assign_def #2{#1}%
996 }%
997 \long\def\XINT_assign_c #1%
998 {%
999 \def\xint_temp {#1}%
1000 \ifx\xint_temp\xint_bracedstopper
1001 \expandafter\XINT_assign_e
1002 \else
1003 \expandafter\XINT_assign_d
1004 \fi
1005 }%
1006 \long\def\XINT_assign_d #1\to #2%
1007 {%
1008 \expandafter\XINT_assign_def\expandafter #2\expandafter{\xint_temp}%
1009 \XINT_assign_c #1\to
1010 }%
1011 \def\XINT_assign_e #1\to {}%
1012 \def\xintRelaxArray #1%
1013 {%
1014 \edef\XINT_restoreescapechar {\escapechar\the\escapechar\relax}%
1015 \escapechar -1
1016 \expandafter\def\expandafter\xint_arrayname\expandafter {\string #1}%
1017 \XINT_restoreescapechar
1018 \xintilop [\csname\xint_arrayname 0\endcsname+-1]
1019 \global
1020 \expandafter\let\csname\xint_arrayname\xintilopindex\endcsname\relax
1021 \ifnum \xintilopindex > \xint_c_
1022 \repeat
1023 \global\expandafter\let\csname\xint_arrayname 00\endcsname\relax
1024 \global\let #1\relax
1025 }%
1026 \def\xintAssignArray{\def\XINT_flet_macro {\XINT_assignarray_fork}%
1027 \XINT_flet_zapsp }%
1028 \def\XINT_assignarray_fork
```

## 2 Package *xinttools* implementation

```

1029 {%
1030   \let\XINT_assignarray_def\def
1031   \ifx\XINT_token[\expandafter\XINT_assignarray_opt
1032       \else\expandafter\XINT_assignarray
1033   \fi
1034 }%
1035 \def\XINT_assignarray_opt [#1]%
1036 {%
1037   \ifcsname #1def\endcsname
1038       \expandafter\let\expandafter\XINT_assignarray_def \csname #1def\endcsname
1039   \else
1040       \expandafter\let\expandafter\XINT_assignarray_def
1041           \csname xint#1def\endcsname
1042   \fi
1043   \XINT_assignarray
1044 }%
1045 \long\def\XINT_assignarray #1\to #2%
1046 {%
1047   \edef\XINT_restoreescapechar {\escapechar\the\escapechar\relax }%
1048   \escapechar -1
1049   \expandafter\def\expandafter\xint_arrayname\expandafter {\string #2}%
1050   \XINT_restoreescapechar
1051   \def\xint_itemcount {0}%
1052   \expandafter\XINT_assignarray_loop \romannumeral`&&@#1\xint:
1053   \csname\xint_arrayname 00\expandafter\endcsname
1054   \csname\xint_arrayname 0\expandafter\endcsname
1055   \expandafter {\xint_arrayname}#2%
1056 }%
1057 \long\def\XINT_assignarray_loop #1%
1058 {%
1059   \def\xint_temp {#1}%
1060   \ifx\xint_temp\xint_bracedstopper
1061       \expandafter\def\csname\xint_arrayname 0\expandafter\endcsname
1062           \expandafter{\the\numexpr\xint_itemcount}%
1063       \expandafter\expandafter\expandafter\XINT_assignarray_end
1064   \else
1065       \expandafter\def\expandafter\xint_itemcount\expandafter
1066           {\the\numexpr\xint_itemcount+\xint_c_i}%
1067       \expandafter\XINT_assignarray_def
1068       \csname\xint_arrayname\xint_itemcount\expandafter\endcsname
1069       \expandafter{\xint_temp }%
1070       \expandafter\XINT_assignarray_loop
1071   \fi
1072 }%
1073 \def\XINT_assignarray_end #1#2#3#4%
1074 {%
1075   \def #4##1%
1076   {%
1077       \romannumeral0\expandafter #1\expandafter{\the\numexpr ##1}%
1078   }%
1079   \def #1##1%
1080   {%

```



```

1081      \ifnum ##1<\xint_c_
1082      \xint_afterfi{\XINT_expandableerror{Array index negative: 0 > ##1} }%
1083      \else
1084      \xint_afterfi {%
1085      \ifnum ##1>#2
1086      \xint_afterfi
1087      {\XINT_expandableerror{Array index beyond range: ##1 > #2} }%
1088      \else\xint_afterfi
1089      {\expandafter\expandafter\expandafter\space\csname #3##1\endcsname}%
1090      \fi}%
1091      \fi
1092  }%
1093 }%
1094 \let\xintDigitsOf\xintAssignArray

```

## 2.27 CSV (non user documented) variants of Length, Keep, Trim, NthElt, Reverse

These routines are for use by `\xintListSel:x:csv` and `\xintListSel:f:csv` from `xintexpr`, and also for the `reversed` and `len` functions. Refactored for 1.2j release, following 1.2i updates to `\xintKeep`, `\xintTrim`, ...

These macros will remain undocumented in the user manual:

-- they exist primarily for internal use by the `xintexpr` parsers, hence don't have to be general purpose; for example, they a priori need to handle only catcode 12 tokens (not true in `\xintNewExpr`, though) hence they are not really worried about controlling brace stripping (nevertheless 1.2j has paid some secondary attention to it, see below.) They are not worried about normalizing leading spaces either, because none will be encountered when the macros are used as auxiliaries to the expression parsers.

-- crucial design elements may change in future:

1. whether the handled lists must have or not have a final comma. Currently, the model is the one of comma separated lists with **no** final comma. But this means that there can not be a distinction of principle between a truly empty list and a list which contains one item which turns out to be empty. More importantly it makes the coding more complicated as it is needed to distinguish the empty list from the single-item list, both lacking commas.

For the internal use of `xintexpr`, it would be ok to require all list items to be terminated by a comma, and this would bring quite some simplifications here, but as initially I started with non-terminated lists, I have left it this way in the 1.2j refactoring.

2. the way to represent the empty list. I was tempted for matter of optimization and synchronization with `xintexpr` context to require the empty list to be always represented by a space token and to not let the macros admit a completely empty input. But there were complications so for the time being 1.2j does accept truly empty output (it is not distinguished from an input equal to a space token) and produces empty output for empty list. This means that the status of the «nil» object for the `xintexpr` parsers is not completely clarified (currently it is represented by a space token).

The original Python slicing code in `xintexpr 1.1` used `\xintCSVtoList` and `\xintListWithSep{,}` to convert back and forth to token lists and apply `\xintKeep`/`\xintTrim`. Release 1.2g switched to devoted f-expandable macros added to `xinttools`. Release 1.2j refactored all these macros as a follow-up to 1.2i improvements to `\xintKeep`/`\xintTrim`. They were made `\long` on this occasion and auxiliary `\xintLengthUpTo:f:csv` was added.

Leading spaces in items are currently maintained as is by the 1.2j macros, even by `\xintNthEltPy:f:csv`, with the exception of the first item, as the list is f-expanded. Perhaps `\xintNthEltPy:f:csv` should remove a leading space if present in the picked item; anyway, there are no spaces for

the lists handled internally by the Python slicer of `xintexpr`, except the «nil» object currently represented by exactly one space.

Kept items (with no leading spaces; but first item special as it will have lost a leading space due to f-expansion) will lose a brace pair under `\xintKeep:f:csv` if the first argument was positive and strictly less than the length of the list. This differs of course from `\xintKeep` (which always braces items it outputs when used with positive first argument) and also from `\xintKeepUnbraced` in the case when the whole list is kept. Actually the case of singleton list is special, and brace removal will happen then.

This behaviour was otherwise for releases earlier than 1.2j and may change again.

Directly usable names are provided, but these macros (and the behaviour as described above) are to be considered *unstable* for the time being.

### 2.27.1 `\xintLength:f:csv`

1.2g. Redone for 1.2j. Contrarily to `\xintLength` from `xintkernel.sty`, this one expands its argument.

```
1095 \def\xintLength:f:csv {\romannumeral0\xintlength:f:csv}%
1096 \def\xintlength:f:csv #1%
1097 {\long\def\xintlength:f:csv ##1{%
1098   \expandafter#1\the\numexpr\expandafter\XINT_length:f:csv_a
1099   \romannumeral'&&@##1\xint:,\xint:,\xint:,\xint:,%
1100   \xint:,\xint:,\xint:,\xint:,\xint:,%
1101   \xint_c_ix,\xint_c_viii,\xint_c_vii,\xint_c_vi,%
1102   \xint_c_v,\xint_c_iv,\xint_c_iii,\xint_c_ii,\xint_c_i,\xint_bye
1103   \relax
1104 }}\xintlength:f:csv { }%
```

Must first check if empty list.

```
1105 \long\def\XINT_length:f:csv_a #1%
1106 {%
1107   \xint_gob_til_xint: #1\xint_c_\xint_bye\xint:%
1108   \XINT_length:f:csv_loop #1%
1109 }%
1110 \long\def\XINT_length:f:csv_loop #1,#2,#3,#4,#5,#6,#7,#8,#9,%
1111 {%
1112   \xint_gob_til_xint: #9\XINT_length:f:csv_finish\xint:%
1113   \xint_c_ix+\XINT_length:f:csv_loop
1114 }%
1115 \def\XINT_length:f:csv_finish\xint:\xint_c_ix+\XINT_length:f:csv_loop
1116   #1,#2,#3,#4,#5,#6,#7,#8,#9,{#9\xint_bye}%
```

### 2.27.2 `\xintLengthUpTo:f:csv`

1.2j. `\xintLengthUpTo:f:csv{N}{comma-list}`. No ending comma. Returns -0 if `length>N`, else returns difference `N-length`. \*\*N must be non-negative!!\*\*

Attention to the dot after `\xint_bye` for the loop interface.

```
1117 \def\xintLengthUpTo:f:csv {\romannumeral0\xintlengthupto:f:csv}%
1118 \long\def\xintlengthupto:f:csv #1#2%
1119 {%
1120   \expandafter\XINT_lengthupto:f:csv_a
```

```

1121 \the\numexpr#1\expandafter.%
1122 \romannumeral'&&#2\xint:,\xint:,\xint:,\xint:,%
1123 \xint:,\xint:,\xint:,\xint:,%
1124 \xint_c_viii,\xint_c_vii,\xint_c_vi,\xint_c_v,%
1125 \xint_c_iv,\xint_c_iii,\xint_c_ii,\xint_c_i,\xint_bye.%
1126 }%

```

Must first recognize if empty list. If this is the case, return N.

```

1127 \long\def\xint_lengthupto:f:csv_a #1.#2%
1128 {%
1129 \xint_gob_til_xint: #2\xint_lengthupto:f:csv_empty\xint:%
1130 \xint_lengthupto:f:csv_loop_b #1.#2%
1131 }%
1132 \def\xint_lengthupto:f:csv_empty\xint:%
1133 \xint_lengthupto:f:csv_loop_b #1.#2\xint_bye.{ #1}%
1134 \def\xint_lengthupto:f:csv_loop_a #1%
1135 {%
1136 \xint_UDsignfork
1137 #1\xint_lengthupto:f:csv_gt
1138 -\xint_lengthupto:f:csv_loop_b
1139 \krof #1%
1140 }%
1141 \long\def\xint_lengthupto:f:csv_gt #1\xint_bye.{-0}%
1142 \long\def\xint_lengthupto:f:csv_loop_b #1.#2,#3,#4,#5,#6,#7,#8,#9,%
1143 {%
1144 \xint_gob_til_xint: #9\xint_lengthupto:f:csv_finish_a\xint:%
1145 \expandafter\xint_lengthupto:f:csv_loop_a\the\numexpr #1-\xint_c_viii.%
1146 }%
1147 \def\xint_lengthupto:f:csv_finish_a\xint:
1148 \expandafter\xint_lengthupto:f:csv_loop_a
1149 \the\numexpr #1-\xint_c_viii.#2,#3,#4,#5,#6,#7,#8,#9,%
1150 {%
1151 \expandafter\xint_lengthupto:f:csv_finish_b\the\numexpr #1-#9\xint_bye
1152 }%
1153 \def\xint_lengthupto:f:csv_finish_b #1#2.%
1154 {%
1155 \xint_UDsignfork
1156 #1{-0}%
1157 -{ #1#2}%
1158 \krof
1159 }%

```

### 2.27.3 \xintKeep:f:csv

1.2g 2016/03/17. Redone for 1.2j with use of \xintLengthUpTo:f:csv. Same code skeleton as \xintKeep but handling comma separated but non terminated lists has complications. The \xintKeep in case of a negative #1 uses \xintgobble, we don't have that for comma delimited items, hence we do a special loop here (this style of loop is surely competitive with xintgobble for a few dozens items and even more). The loop knows before starting that it will not go too far.

```

1160 \def\xintKeep:f:csv {\romannumeral0\xintkeep:f:csv }%
1161 \long\def\xintkeep:f:csv #1#2%

```

```

1162 {%
1163   \expandafter\xint_gobble_thenstop
1164   \romannumeral0\expandafter\XINT_keep:f:csv_a
1165   \the\numexpr #1\expandafter.\expandafter{\romannumeral`&&@#2}%
1166 }%
1167 \def\XINT_keep:f:csv_a #1%
1168 {%
1169   \xint_UDzerominusfork
1170     #1-\XINT_keep:f:csv_keeptime
1171     0#1\XINT_keep:f:csv_neg
1172     0-{\XINT_keep:f:csv_pos #1}%
1173   \krof
1174 }%
1175 \long\def\XINT_keep:f:csv_keeptime .#1{,%
1176 \long\def\XINT_keep:f:csv_neg #1.#2%
1177 {%
1178   \expandafter\XINT_keep:f:csv_neg_done\expandafter,%
1179   \romannumeral0%
1180   \expandafter\XINT_keep:f:csv_neg_a\the\numexpr
1181   #1-\numexpr\XINT_length:f:csv_a
1182   #2\xint:,\xint:,\xint:,\xint:,%
1183   \xint:,\xint:,\xint:,\xint:,\xint:,%
1184   \xint_c_ix,\xint_c_viii,\xint_c_vii,\xint_c_vi,%
1185   \xint_c_v,\xint_c_iv,\xint_c_iii,\xint_c_ii,\xint_c_i,\xint_bye
1186   .#2\xint_bye
1187 }%
1188 \def\XINT_keep:f:csv_neg_a #1%
1189 {%
1190   \xint_UDsignfork
1191     #1{\expandafter\XINT_keep:f:csv_trimloop\the\numexpr-\xint_c_ix+}%
1192     -\XINT_keep:f:csv_keeptime
1193   \krof
1194 }%
1195 \def\XINT_keep:f:csv_keeptime #1.{ }%
1196 \long\def\XINT_keep:f:csv_neg_done #1\xint_bye{#1}%
1197 \def\XINT_keep:f:csv_trimloop #1#2.%
1198 {%
1199   \xint_gob_til_minus#1\XINT_keep:f:csv_trimloop_finish-%
1200   \expandafter\XINT_keep:f:csv_trimloop
1201   \the\numexpr#1#2-\xint_c_ix\expandafter.\XINT_keep:f:csv_trimloop_trimnine
1202 }%
1203 \long\def\XINT_keep:f:csv_trimloop_trimnine #1,#2,#3,#4,#5,#6,#7,#8,#9,{}%
1204 \def\XINT_keep:f:csv_trimloop_finish-%
1205   \expandafter\XINT_keep:f:csv_trimloop
1206   \the\numexpr-#1-\xint_c_ix\expandafter.\XINT_keep:f:csv_trimloop_trimnine
1207   {\csname XINT_trim:f:csv_finish#1\endcsname}%
1208 \long\def\XINT_keep:f:csv_pos #1.#2%
1209 {%
1210   \expandafter\XINT_keep:f:csv_pos_fork
1211   \romannumeral0\XINT_lengthupto:f:csv_a
1212   #1.#2\xint:,\xint:,\xint:,\xint:,%
1213   \xint:,\xint:,\xint:,\xint:,%

```

```

1214      \xint_c_viii,\xint_c_vii,\xint_c_vi,\xint_c_v,%
1215      \xint_c_iv,\xint_c_iii,\xint_c_ii,\xint_c_i,\xint_bye.%
1216      .#1.{}#2\xint_bye%
1217 }%
1218 \def\xint_keep:f:csv_pos_fork #1#2.%
1219 {%
1220     \xint_UDsignfork
1221     #1{\expandafter\xint_keep:f:csv_loop\the\numexpr-\xint_c_viii+}%
1222     -\xint_keep:f:csv_pos_keepall
1223     \krof
1224 }%
1225 \long\def\xint_keep:f:csv_pos_keepall #1.#2#3\xint_bye{,#3}%
1226 \def\xint_keep:f:csv_loop #1#2.%
1227 {%
1228     \xint_gob_til_minus#1\xint_keep:f:csv_loop_end-%
1229     \expandafter\xint_keep:f:csv_loop
1230     \the\numexpr#1#2-\xint_c_viii\expandafter.\xint_keep:f:csv_loop_pickeight
1231 }%
1232 \long\def\xint_keep:f:csv_loop_pickeight
1233     #1#2,#3,#4,#5,#6,#7,#8,#9,{#{#1,#2,#3,#4,#5,#6,#7,#8,#9}}%
1234 \def\xint_keep:f:csv_loop_end-\expandafter\xint_keep:f:csv_loop
1235     \the\numexpr-#1-\xint_c_viii\expandafter.\xint_keep:f:csv_loop_pickeight
1236     {\csname XINT_keep:f:csv_end#1\endcsname}%
1237 \long\expandafter\def\csname XINT_keep:f:csv_end1\endcsname
1238     #1#2,#3,#4,#5,#6,#7,#8,#9\xint_bye {#1,#2,#3,#4,#5,#6,#7,#8}%
1239 \long\expandafter\def\csname XINT_keep:f:csv_end2\endcsname
1240     #1#2,#3,#4,#5,#6,#7,#8\xint_bye {#1,#2,#3,#4,#5,#6,#7}%
1241 \long\expandafter\def\csname XINT_keep:f:csv_end3\endcsname
1242     #1#2,#3,#4,#5,#6,#7\xint_bye {#1,#2,#3,#4,#5,#6}%
1243 \long\expandafter\def\csname XINT_keep:f:csv_end4\endcsname
1244     #1#2,#3,#4,#5,#6\xint_bye {#1,#2,#3,#4,#5}%
1245 \long\expandafter\def\csname XINT_keep:f:csv_end5\endcsname
1246     #1#2,#3,#4,#5\xint_bye {#1,#2,#3,#4}%
1247 \long\expandafter\def\csname XINT_keep:f:csv_end6\endcsname
1248     #1#2,#3,#4\xint_bye {#1,#2,#3}%
1249 \long\expandafter\def\csname XINT_keep:f:csv_end7\endcsname
1250     #1#2,#3\xint_bye {#1,#2}%
1251 \long\expandafter\def\csname XINT_keep:f:csv_end8\endcsname
1252     #1#2\xint_bye {#1}%

```

## 2.27.4 `\xintTrim:f:csv`

1.2g 2016/03/17. Redone for 1.2j 2016/12/20 on the basis of new `\xintTrim`.

```

1253 \def\xintTrim:f:csv {\romannumeral0\xinttrim:f:csv}%
1254 \long\def\xinttrim:f:csv #1#2%
1255 {%
1256     \expandafter\xint_gobble_thenstop
1257     \romannumeral0\expandafter\xint_trim:f:csv_a
1258     \the\numexpr #1\expandafter.\expandafter{\romannumeral`&&@#2}%
1259 }%
1260 \def\xint_trim:f:csv_a #1%
1261 {%

```

## 2 Package *xinttools* implementation

```

1262 \xint_UDzerominusfork
1263 #1-\XINT_trim:f:csv_trimnone
1264 0#1\XINT_trim:f:csv_neg
1265 0-\XINT_trim:f:csv_pos #1}%
1266 \krof
1267 }%
1268 \long\def\XINT_trim:f:csv_trimnone .#1{,#1}%
1269 \long\def\XINT_trim:f:csv_neg #1.#2%
1270 {%
1271 \expandafter\XINT_trim:f:csv_neg_a\the\numexpr
1272 #1-\numexpr\XINT_length:f:csv_a
1273 #2\xint:,\xint:,\xint:,\xint:,%
1274 \xint:,\xint:,\xint:,\xint:,\xint:,%
1275 \xint_c_ix,\xint_c_viii,\xint_c_vii,\xint_c_vi,%
1276 \xint_c_v,\xint_c_iv,\xint_c_iii,\xint_c_ii,\xint_c_i,\xint_bye
1277 .{ }#2\xint_bye
1278 }%
1279 \def\XINT_trim:f:csv_neg_a #1%
1280 {%
1281 \xint_UDsignfork
1282 #1{\expandafter\XINT_keep:f:csv_loop\the\numexpr-\xint_c_viii+}%
1283 -\XINT_trim:f:csv_trimall
1284 \krof
1285 }%
1286 \def\XINT_trim:f:csv_trimall {\expandafter,\xint_bye}%
1287 \long\def\XINT_trim:f:csv_pos #1.#2%
1288 {%
1289 \expandafter\XINT_trim:f:csv_pos_done\expandafter,%
1290 \romannumeral0%
1291 \expandafter\XINT_trim:f:csv_loop\the\numexpr#1-\xint_c_ix.%
1292 #2\xint:,\xint:,\xint:,\xint:,\xint:,%
1293 \xint:,\xint:,\xint:,\xint:,\xint:\xint_bye
1294 }%
1295 \def\XINT_trim:f:csv_loop #1#2.%
1296 {%
1297 \xint_gob_til_minus#1\XINT_trim:f:csv_finish-%
1298 \expandafter\XINT_trim:f:csv_loop\the\numexpr#1#2\XINT_trim:f:csv_loop_trimnine
1299 }%
1300 \long\def\XINT_trim:f:csv_loop_trimnine #1,#2,#3,#4,#5,#6,#7,#8,#9,%
1301 {%
1302 \xint_gob_til_xint: #9\XINT_trim:f:csv_toofew\xint:-\xint_c_ix.%
1303 }%
1304 \def\XINT_trim:f:csv_toofew\xint:{*\xint_c_}%
1305 \def\XINT_trim:f:csv_finish-%
1306 \expandafter\XINT_trim:f:csv_loop\the\numexpr-#1\XINT_trim:f:csv_loop_trimnine
1307 {%
1308 \csname XINT_trim:f:csv_finish#1\endcsname
1309 }%
1310 \long\expandafter\def\csname XINT_trim:f:csv_finish1\endcsname
1311 #1,#2,#3,#4,#5,#6,#7,#8,{ }%
1312 \long\expandafter\def\csname XINT_trim:f:csv_finish2\endcsname
1313 #1,#2,#3,#4,#5,#6,#7,{ }%

```

```

1314 \long\expandafter\def\csname XINT_trim:f:csv_finish3\endcsname
1315   #1,#2,#3,#4,#5,#6,{ }%
1316 \long\expandafter\def\csname XINT_trim:f:csv_finish4\endcsname
1317   #1,#2,#3,#4,#5,{ }%
1318 \long\expandafter\def\csname XINT_trim:f:csv_finish5\endcsname
1319   #1,#2,#3,#4,{ }%
1320 \long\expandafter\def\csname XINT_trim:f:csv_finish6\endcsname
1321   #1,#2,#3,{ }%
1322 \long\expandafter\def\csname XINT_trim:f:csv_finish7\endcsname
1323   #1,#2,{ }%
1324 \long\expandafter\def\csname XINT_trim:f:csv_finish8\endcsname
1325   #1,{ }%
1326 \expandafter\let\csname XINT_trim:f:csv_finish9\endcsname\space
1327 \long\def\XINT_trim:f:csv_pos_done #1\xint:#2\xint_bye{#1}%

```

### 2.27.5 \xintNthEltPy:f:csv

Counts like Python starting at zero. Last refactored with 1.2j. Attention, makes currently no effort at removing leading spaces in the picked item.

```

1328 \def\xintNthEltPy:f:csv {\romannumeral0\xintntheltpy:f:csv }%
1329 \long\def\xintntheltpy:f:csv #1#2%
1330 {%
1331   \expandafter\XINT_nthelt:f:csv_a
1332   \the\numexpr #1\expandafter.\expandafter{\romannumeral`&&@#2}%
1333 }%
1334 \def\XINT_nthelt:f:csv_a #1%
1335 {%
1336   \xint_UDsignfork
1337     #1\XINT_nthelt:f:csv_neg
1338     -\XINT_nthelt:f:csv_pos
1339   \krof #1%
1340 }%
1341 \long\def\XINT_nthelt:f:csv_neg -#1.#2%
1342 {%
1343   \expandafter\XINT_nthelt:f:csv_neg_fork
1344   \the\numexpr\XINT_length:f:csv_a
1345   #2\xint:,\xint:,\xint:,\xint:,%
1346   \xint:,\xint:,\xint:,\xint:,\xint:,%
1347   \xint_c_ix,\xint_c_viii,\xint_c_vii,\xint_c_vi,%
1348   \xint_c_v,\xint_c_iv,\xint_c_iii,\xint_c_ii,\xint_c_i,\xint_bye
1349   -#1.#2,\xint_bye
1350 }%
1351 \def\XINT_nthelt:f:csv_neg_fork #1%
1352 {%
1353   \if#1-\expandafter\xint_bye_thenstop\fi
1354   \expandafter\XINT_nthelt:f:csv_neg_done
1355   \romannumeral0%
1356   \expandafter\XINT_keep:f:csv_trimloop\the\numexpr-\xint_c_ix+#1%
1357 }%
1358 \long\def\XINT_nthelt:f:csv_neg_done#1,#2\xint_bye{ #1}%
1359 \long\def\XINT_nthelt:f:csv_pos #1.#2%
1360 {%

```

```

1361 \expandafter\XINT_nthelt:f:csv_pos_done
1362 \romannumeral0%
1363 \expandafter\XINT_trim:f:csv_loop\the\numexpr#1-\xint_c_ix.%
1364 #2\xint:,\xint:,\xint:,\xint:,\xint:,%
1365 \xint:,\xint:,\xint:,\xint:,\xint:,\xint_bye
1366 }%
1367 \def\XINT_nthelt:f:csv_pos_done #1{%
1368 \long\def\XINT_nthelt:f:csv_pos_done ##1,##2\xint_bye{%
1369 \xint_gob_til_xint:##1\XINT_nthelt:f:csv_pos_cleanup\xint:#1##1}%
1370 }\XINT_nthelt:f:csv_pos_done{ }%

```

This strange thing is in case the picked item was the last one, hence there was an ending `\xint:` (we could not put a comma earlier for matters of not confusing empty list with a singleton list), and we do this here to activate brace-stripping of item as all other items may be brace-stripped if picked. This is done for coherence. Of course, in the context of the `xintexpr.sty` parsers, there are no braces in list items...

```

1371 \xint_firstofone{\long\def\XINT_nthelt:f:csv_pos_cleanup\xint:} %
1372 #1\xint:{ #1}%

```

## 2.27.6 `\xintReverse:f:csv`

1.2g. Contrarily to `\xintReverseOrder` from `xintkernel.sty`, this one expands its argument. Handles empty list too. 2016/03/17. Made `\long` for 1.2j.

```

1373 \def\xintReverse:f:csv {\romannumeral0\xintreverse:f:csv}%
1374 \long\def\xintreverse:f:csv #1%
1375 {%
1376 \expandafter\XINT_reverse:f:csv_loop
1377 \expandafter{\expandafter}\romannumeral`&&@#1,%
1378 \xint:,%
1379 \xint_bye,\xint_bye,\xint_bye,\xint_bye,%
1380 \xint_bye,\xint_bye,\xint_bye,\xint_bye,%
1381 \xint:
1382 }%
1383 \long\def\XINT_reverse:f:csv_loop #1#2,#3,#4,#5,#6,#7,#8,#9,%
1384 {%
1385 \xint_bye #9\XINT_reverse:f:csv_cleanup\xint_bye
1386 \XINT_reverse:f:csv_loop {,#9,#8,#7,#6,#5,#4,#3,#2#1}%
1387 }%
1388 \long\def\XINT_reverse:f:csv_cleanup\xint_bye\XINT_reverse:f:csv_loop #1#2\xint:
1389 {%
1390 \XINT_reverse:f:csv_finish #1%
1391 }%
1392 \long\def\XINT_reverse:f:csv_finish #1\xint:,{ }%

```

## 2.27.7 `\xintFirstItem:f:csv`

Added with 1.2k for use by `first()` in `\xintexpr`-essions, and some amount of compatibility with `\xintNewExpr`.

```

1393 \def\xintFirstItem:f:csv {\romannumeral0\xintfirstitem:f:csv}%
1394 \long\def\xintfirstitem:f:csv #1%

```



```

1395 {%
1396   \expandafter\XINT_first:f:csv_a\romannumeral`&&@#1,\xint_bye
1397 }%
1398 \long\def\XINT_first:f:csv_a #1,#2\xint_bye{ #1}%

```

### 2.27.8 `\xintLastItem:f:csv`

Added with 1.2k, based on and sharing code with `xintkernel`'s `\xintLastItem` from 1.2i. Output empty if input empty. `f`-expands its argument (hence first item, if not protected.) For use by `last()` in `\xintexpr`-essions with to some extent `\xintNewExpr` compatibility.

```

1399 \def\xintLastItem:f:csv {\romannumeral0\xintlastitem:f:csv}%
1400 \long\def\xintlastitem:f:csv #1%
1401 {%
1402   \expandafter\XINT_last:f:csv_loop\expandafter{\expandafter}\expandafter.%
1403   \romannumeral`&&@#1,%
1404   \xint:\XINT_last_loop_enda,\xint:\XINT_last_loop_endb,%
1405   \xint:\XINT_last_loop_endc,\xint:\XINT_last_loop_endd,%
1406   \xint:\XINT_last_loop_ende,\xint:\XINT_last_loop_endf,%
1407   \xint:\XINT_last_loop_endg,\xint:\XINT_last_loop_endh,\xint_bye
1408 }%
1409 \long\def\XINT_last:f:csv_loop #1.#2,#3,#4,#5,#6,#7,#8,#9,%
1410 {%
1411   \xint_gob_til_xint: #9%
1412   {#8}{#7}{#6}{#5}{#4}{#3}{#2}{#1}\xint:
1413   \XINT_last:f:csv_loop {#9}.%
1414 }%

```

### 2.27.9 Public names for the undocumented csv macros

Completely unstable macros: currently they expand the list argument and want no final comma. But for matters of `xintexpr.sty` I could as well decide to require a final comma, and then I could simplify implementation but of course this would break the macros if used with current functionalities.

```

1415 \let\xintCSVLength \xintLength:f:csv
1416 \let\xintCSVKeep \xintKeep:f:csv
1417 \let\xintCSVTrim \xintTrim:f:csv
1418 \let\xintCSVNthEltPy \xintNthEltPy:f:csv
1419 \let\xintCSVReverse \xintReverse:f:csv
1420 \let\xintCSVFirstItem\xintFirstItem:f:csv
1421 \let\xintCSVLastItem \xintLastItem:f:csv
1422 \let\XINT_tmpa\relax \let\XINT_tmpp\relax \let\XINT_tmppc\relax
1423 \XINT_restorecatcodes_endinput%

```

### 3 Package *xintcore* implementation

.1	Catcodes, $\varepsilon$ -T <sub>E</sub> X and reload detection . . .	50	.23	<code>\XINT_div_unsepQ</code> . . . . .	62	
.2	Package identification . . . . .	51	.24	<code>\XINT_div_unsepR</code> . . . . .	63	
.3	(WIP!) Error conditions and exceptions . . .	51	.25	<code>\XINT_zeroes_forviii</code> . . . . .	63	
.4	Counts for holding needed constants . . .	53	.26	<code>\XINT_sepbyviii_Z</code> . . . . .	64	
.5	<code>\xintNum</code> . . . . .	54	.27	<code>\XINT_sepbyviii_andcount</code> . . . . .	64	
Routines handling integers as lists of token digits			54	.28	<code>\XINT_rsepyviii</code> . . . . .	64
.6	<code>\XINT_cuz_small</code> . . . . .	55	.29	<code>\XINT_sepandrev</code> . . . . .	65	
.7	<code>\xintSgn</code> , <code>\xintiiSgn</code> , <code>\XINT_Sgn</code> , <code>\XINT_cntSgn</code> . . . . .	55	.30	<code>\XINT_sepandrev_andcount</code> . . . . .	65	
.8	<code>\xintiOpp</code> , <code>\xintiiOpp</code> . . . . .	56	.31	<code>\XINT_rev_nounsep</code> . . . . .	66	
.9	<code>\xintiAbs</code> , <code>\xintiiAbs</code> . . . . .	56	.32	<code>\XINT_unrevbyviii</code> . . . . .	66	
.10	<code>\xintFDg</code> , <code>\xintiiFDg</code> . . . . .	56	Core arithmetic . . . . .			67
.11	<code>\xintLDg</code> , <code>\xintiiLDg</code> . . . . .	57	.33	<code>\xintiAdd</code> , <code>\xintiiAdd</code> . . . . .	67	
.12	<code>\xintDouble</code> . . . . .	57	.34	<code>\xintCmp</code> , <code>\xintiiCmp</code> . . . . .	70	
.13	<code>\xintHalf</code> . . . . .	58	.35	<code>\xintiSub</code> , <code>\xintiiSub</code> . . . . .	72	
.14	<code>\xintInc</code> . . . . .	58	.36	<code>\xintiMul</code> , <code>\xintiiMul</code> . . . . .	78	
.15	<code>\xintDec</code> . . . . .	59	.37	<code>\xintiDivision</code> , <code>\xintiQuo</code> , <code>\xintiRem</code> , <code>\xintiiDivision</code> , <code>\xintiiQuo</code> , <code>\xintiiRem</code>	82	
.16	<code>\xintDSL</code> . . . . .	59	Derived arithmetic . . . . .			98
.17	<code>\xintDSR</code> . . . . .	60	.38	<code>\xintiDivRound</code> , <code>\xintiiDivRound</code> . . . . .	98	
.18	<code>\xintDSRr</code> . . . . .	60	.39	<code>\xintiDivTrunc</code> , <code>\xintiiDivTrunc</code> . . . . .	99	
Blocks of eight digits . . . . .			61	.40	<code>\xintiMod</code> , <code>\xintiiMod</code> . . . . .	99
.19	<code>\XINT_cuz</code> . . . . .	61	.41	<code>\xintiSqr</code> , <code>\xintiiSqr</code> . . . . .	100	
.20	<code>\XINT_cuz_byviii</code> . . . . .	61	.42	<code>\xintiPow</code> , <code>\xintiiPow</code> . . . . .	101	
.21	<code>\XINT_unsep_loop</code> . . . . .	62	.43	<code>\xintiFac</code> , <code>\xintiiFac</code> . . . . .	104	
.22	<code>\XINT_unsep_cuzsmall</code> . . . . .	62	"Load <code>xintfrac</code> " macros . . . . .			107

Got split off from *xint* with release 1.1.

The core arithmetic routines have been entirely rewritten for release 1.2. The 1.2i and 1.2l brought again some improvements.

The commenting continues (2017/08/06) to be very sparse: actually it got worse than ever with release 1.2. I will possibly add comments at a later date, but for the time being the new routines are not commented at all.

#### 3.1 Catcodes, $\varepsilon$ -T<sub>E</sub>X and reload detection

The code for reload detection was initially copied from HEIKO OBERDIEK's packages, then modified.

The method for catcodes was also initially directly inspired by these packages.

```

1 \begingroup\catcode61\catcode48\catcode32=10\relax%
2 \catcode13=5 % ^^M
3 \endlinechar=13 %
4 \catcode123=1 % {
5 \catcode125=2 % }
6 \catcode64=11 % @
7 \catcode35=6 % #
8 \catcode44=12 % ,
9 \catcode45=12 % -
10 \catcode46=12 % .
11 \catcode58=12 % :
12 \let\z\endgroup
13 \expandafter\let\expandafter\x\csname ver@xintcore.sty\endcsname

```

### 3 Package *xintcore* implementation

```
14 \expandafter\let\expandafter\w\csname ver@xintkernel.sty\endcsname
15 \expandafter
16   \ifx\csname PackageInfo\endcsname\relax
17     \def\y#1#2{\immediate\write-1{Package #1 Info: #2.}}%
18   \else
19     \def\y#1#2{\PackageInfo{#1}{#2}}%
20   \fi
21 \expandafter
22 \ifx\csname numexpr\endcsname\relax
23   \y{xintcore}{numexpr not available, aborting input}%
24   \aftergroup\endinput
25 \else
26   \ifx\x\relax % plain-TeX, first loading of xintcore.sty
27     \ifx\w\relax % but xintkernel.sty not yet loaded.
28       \def\z{\endgroup\input xintkernel.sty\relax}%
29     \fi
30   \else
31     \def\empty {}%
32     \ifx\x\empty % LaTeX, first loading,
33     % variable is initialized, but \ProvidesPackage not yet seen
34       \ifx\w\relax % xintkernel.sty not yet loaded.
35         \def\z{\endgroup\RequirePackage{xintkernel}}%
36       \fi
37     \else
38       \aftergroup\endinput % xintkernel already loaded.
39     \fi
40   \fi
41 \fi
42 \z%
43 \XINTsetupcatcodes% defined in xintkernel.sty
```

### 3.2 Package identification

```
44 \XINT_providespackage
45 \ProvidesPackage{xintcore}%
46 [2017/08/06 1.2n Expandable arithmetic on big integers (JFB)]%
```

### 3.3 (WIP!) Error conditions and exceptions

As per the Mike Cowlishaw/IBM's General Decimal Arithmetic Specification

<http://speleotrove.com/decimal/decarith.html>

and the Python3 implementation in its Decimal module.

Clamped, ConversionSyntax, DivisionByZero, DivisionImpossible, DivisionUndefined, Inexact, InsufficientStorage, InvalidContext, InvalidOperation, Overflow, Inexact, Rounded, Subnormal, Underflow.

X3.274 rajoute LostDigits

Python rajoute FloatOperation (et n'inclut pas InsufficientStorage)

quote de decarith.pdf: The Clamped, Inexact, Rounded, and Subnormal conditions can coincide with each other or with other conditions. In these cases then any trap enabled for another condition takes precedence over (is handled before) all of these, any Subnormal trap takes precedence over Inexact, any Inexact trap takes precedence over Rounded, and any Rounded trap takes precedence over Clamped.

WORK IN PROGRESS ! (1.21, 2017/07/26)

### 3 Package *xintcore* implementation

I follow the Python terminology: a trapped signal means it raises an exception which for us means an expandable error message with some possible user interaction. In this WIP state, the interaction is commented out. A non-trapped signal or condition would activate a (presumably silent) handler.

Here, no signal-raising condition is "ignored" and all are "trapped" which means that error handlers are never activated, thus left in garbage state in the code.

Various conditions can raise the same signal.

Only signals, not conditions, raise Flags.

If a signal is ignored it does not raise a Flag, but it activates the signal handler (by default now no signal is ignored.)

If a signal is not ignored it raises a Flag and then if it is not trapped it activates the handler of the `_condition_`.

If trapped (which is default now) an «exception» is raised, which means an expandable error message (I copied over the LaTeX3 code for expandable error messages, basically) interrupts the TeX run. In future, user input could be solicited, but currently this is commented out.

For now macros to reset flags are done but without public interface nor documentation.

Only four conditions are currently possibly encountered:

- InvalidOperation
- DivisionByZero
- DivisionUndefined (which signals InvalidOperation)
- Underflow

I did it quickly, anyhow this will become more palpable when some of the Decimal Specification is actually implemented. The plan is to first do the X3.274 norm, then more complete implementation will follow... perhaps...

```
47 \csname XINT_Clamped_istrapped\endcsname
48 \csname XINT_ConversionSyntax_istrapped\endcsname
49 \csname XINT_DivisionByZero_istrapped\endcsname
50 \csname XINT_DivisionImpossible_istrapped\endcsname
51 \csname XINT_DivisionUndefined_istrapped\endcsname
52 \csname XINT_InvalidOperation_istrapped\endcsname
53 \csname XINT_Overflow_istrapped\endcsname
54 \csname XINT_Underflow_istrapped\endcsname
55 \catcode`- 11
56 \def\XINT_ConversionSyntax-signal  {{InvalidOperation}}%
57 \let\XINT_DivisionImpossible-signal\XINT_ConversionSyntax-signal
58 \let\XINT_DivisionUndefined-signal \XINT_ConversionSyntax-signal
59 \let\XINT_InvalidContext-signal    \XINT_ConversionSyntax-signal
60 \catcode`- 12
61 \def\XINT_signalcondition #1{\expandafter\XINT_signalcondition_a
62   \romannumeral0\ifcsname XINT_#1-signal\endcsname
63     \xint_dothis{\csname XINT_#1-signal\endcsname}%
64     \fi\xint_orthat{{#1}}{{#1}}}%
65 \def\XINT_signalcondition_a #1#2#3#4#5{% copied over from Python Decimal module
66 % #1=signal, #2=condition, #3=explanation for user,
67 % #4=context for error handlers, #5=used
68   \ifcsname XINT_#1_ignoredflag\endcsname
69     \xint_dothis{\csname XINT_#1.handler\endcsname {#4}}%
70   \fi
71   \expandafter\xint_gobble_i\csname XINT_#1Flag_ON\endcsname
72   \unless\ifcsname XINT_#1_istrapped\endcsname
73     \xint_dothis{\csname XINT_#2.handler\endcsname {#4}}%
74   \fi
```

### 3 Package *xintcore* implementation

```
75 \xint_orthat{%
76   % the flag raised is named after the signal #1, but we show condition #2
77   \XINT_expandableerror{#2 (hit <RET> thrice)}%
78   \XINT_expandableerror{#3}%
79   \XINT_expandableerror{next: #5}%
80   % not for X3.274
81   %\XINT_expandableerror{<RET>, or I\xintUse{...}<RET>, or I\xintCTRLC<RET>}%
82   \xint_firstofone_thenstop{#5}%
83 }%
84}%
85%% \let\xintUse\xint_firstofthree_thenstop % defined in xint.sty
86\def\XINT_ifFlagRaised #1{%
87  \ifcsname XINT_#1Flag_ON\endcsname
88    \expandafter\xint_firstoftwo
89  \else
90    \expandafter\xint_secondoftwo
91  \fi}%
92\def\XINT_resetFlag #1%
93  {\expandafter\let\csname XINT_#1Flag_ON\endcsname\XINT_undefined}%
94\def\XINT_resetFlags {% WIP
95  \XINT_resetFlag{InvalidOperation}% also from DivisionUndefined
96  \XINT_resetFlag{DivisionByZero}%
97  \XINT_resetFlag{Underflow}% (\xintiiPow with negative exponent)
98  \XINT_resetFlag{Overflow}% not encountered so far in xint code 1.21
99  % .. others ..
100}%
101%% NOT IMPLEMENTED! WORK IN PROGRESS! (ALL SIGNALS TRAPPED, NO HANDLERS USED)
102\catcode`. 11
103\let\XINT_Clamped.handler\xint_firstofone % WIP
104\def\XINT_InvalidOperation.handler#1{NaN}% WIP
105\def\XINT_ConversionSyntax.handler#1{NaN}% WIP
106\def\XINT_DivisionByZero.handler#1{SignedInfinity(#1)}% WIP
107\def\XINT_DivisionImpossible.handler#1{NaN}% WIP
108\def\XINT_DivisionUndefined.handler#1{NaN}% WIP
109\let\XINT_Inexact.handler\xint_firstofone % WIP
110\def\XINT_InvalidContext.handler#1{NaN}% WIP
111\let\XINT_Rounded.handler\xint_firstofone % WIP
112\let\XINT_Subnormal.handler\xint_firstofone% WIP
113\def\XINT_Overflow.handler#1{NaN}% WIP
114\def\XINT_Underflow.handler#1{NaN}% WIP
115\catcode`. 12
```

### 3.4 Counts for holding needed constants

```
116 \ifdefined\m@ne\let\xint_c_mone\m@ne
117   \else\csname newcount\endcsname\xint_c_mone \xint_c_mone -1 \fi
118 \newcount\xint_c_x^viii \xint_c_x^viii 1000000000
119 \ifdefined\xint_c_x^ix\else
120 \csname newcount\endcsname\xint_c_x^ix \xint_c_x^ix 1000000000
121 \fi
122 \newcount\xint_c_x^viii_mone \xint_c_x^viii_mone 99999999
123 \newcount\xint_c_xii_e_viii \xint_c_xii_e_viii 12000000000
124 \newcount\xint_c_xi_e_viii_mone \xint_c_xi_e_viii_mone 1099999999
```



### 3.6 `\XINT_cuz_small`

`\XINT_cuz_small` removes leading zeroes from the first eight digits. Expands following `\romannumeral0`. At least one digit is produced.

```
149 \def\XINT_cuz_small#1{%
150 \def\XINT_cuz_small ##1##2##3##4##5##6##7##8%
151 {%
152   \expandafter#1\the\numexpr ##1##2##3##4##5##6##7##8\relax
153 }}\XINT_cuz_small{ }%
```

### 3.7 `\xintSgn`, `\xintiiSgn`, `\XINT_Sgn`, `\XINT_cntSgn`

`xintfrac.sty` will rewrite `\xintSgn` to let it accept general input as recognized by `xintfrac.sty` macros

1.21: `\xintiiSgn` made robust against non terminated input.

```
154 \def\xintiiSgn {\romannumeral0\xintiisgn }%
155 \def\xintiisgn #1%
156 {%
157   \expandafter\XINT_sgn \romannumeral`&&@#1\xint:
158 }%
159 \def\xintSgn {\romannumeral0\xintsgn }%
160 \def\xintsgn #1%
161 {%
162   \expandafter\XINT_sgn \romannumeral0\xintnum{#1}\xint:
163 }%
164 \def\XINT_sgn #1#2\xint:
165 {%
166   \xint_UDzerominusfork
167   #1-{ 0}%
168   0#1{-1}%
169   0-{ 1}%
170   \krof
171 }%
172 \def\XINT_Sgn #1#2\xint:
173 {%
174   \xint_UDzerominusfork
175   #1-{0}%
176   0#1{-1}%
177   0-{1}%
178   \krof
179 }%
180 \def\XINT_cntSgn #1#2\xint:
181 {%
182   \xint_UDzerominusfork
183   #1-\xint_c_
184   0#1\xint_c_mone
185   0-\xint_c_i
186   \krof
187 }%
```

### 3.8 `\xintiOpp`, `\xintiiOpp`

Attention, `\xintiiOpp` non robust against non terminated inputs. Reason is I don't want to have to grab a delimiter at the end, as everything happens "upfront".

```

188 \def\xintiOpp {\romannumeral0\xintiopp }%
189 \def\xintiiOpp #1%
190 {%
191   \expandafter\XINT_opp \romannumeral`&&@#1%
192 }%
193 \def\xintiOpp {\romannumeral0\xintiopp }%
194 \def\xintiopp #1%
195 {%
196   \expandafter\XINT_opp \romannumeral0\xintnum{#1}%
197 }%
198 \def\XINT_Opp #1{\romannumeral0\XINT_opp #1}%
199 \def\XINT_opp #1%
200 {%
201   \xint_UDzerominusfork
202   #1-{ 0}%      zero
203   0#1{ }%      negative
204   0-{ -#1}%    positive
205   \krof
206 }%

```

### 3.9 `\xintiAbs`, `\xintiiAbs`

Attention `\xintiiAbs` non robust against non terminated input.

```

207 \def\xintiiAbs {\romannumeral0\xintiiabs }%
208 \def\xintiiabs #1%
209 {%
210   \expandafter\XINT_abs \romannumeral`&&@#1%
211 }%
212 \def\xintiAbs {\romannumeral0\xintiabs }%
213 \def\xintiabs #1%
214 {%
215   \expandafter\XINT_abs \romannumeral0\xintnum{#1}%
216 }%
217 \def\XINT_abs #1%
218 {%
219   \xint_UDsignfork
220   #1{ }%
221   -{ #1}%
222   \krof
223 }%

```

### 3.10 `\xintFDg`, `\xintiiFDg`

FIRST DIGIT.

1.21: `\xintiiFDg` made robust against non terminated input.

```

224 \def\xintiiFDg {\romannumeral0\xintiifdg }%

```



```

225 \def\xintiifdg #1%
226 {%
227     \expandafter\XINT_fdg \romannumeral`&&@#1\xint:\Z
228 }%
229 \def\xintFDg {\romannumeral0\xintfdg }%
230 \def\xintfdg #1%
231 {%
232     \expandafter\XINT_fdg \romannumeral0\xintnum{#1}\xint:\Z
233 }%
234 \def\XINT_Fdg #1{\romannumeral0\XINT_fdg #1\xint:\Z }%
235 \def\XINT_fdg #1#2#3\Z
236 {%
237     \xint_UDzerominusfork
238     #1-{ 0}%    zero
239     0#1{ #2}%   negative
240     0-{ #1}%    positive
241     \krof
242 }%

```

### 3.11 \xintLDg, \xintiiLDg

LAST DIGIT.

Rewritten for 1.2i (2016/12/10). Surprisingly perhaps, it is faster than `\xintLastItem` from `xintkernel.sty` despite the `\numexpr` operations.

Attention \xintiiLDq non robust against non terminated input.

```

243 \def\xintLDg {\romannumeral0\xintldg}%
244 \def\xintldg #1{\expandafter\XINT_ldg_fork\romannumeral0\xintnum{#1}%
245   \XINT_ldg_c{}{}{}{}{}{}{}{}{}{}{}{}{}{}{}{}{}{}{}{}{}{}{}{}{}{}{}{}{}%
246 \def\xintiILDg {\romannumeral0\xintiildg}%
247 \def\xintiildg #1{\expandafter\XINT_ldg_fork\romannumeral`&&@#1%
248   \XINT_ldg_c{}{}{}{}{}{}{}{}{}{}{}{}{}{}{}{}{}{}{}{}{}{}{}{}{}{}{}{}{}%
249 \def\XINT_ldg_fork #1%
250 {%
251   \xint_UDsignfork
252     #1\XINT_ldg
253     -{\XINT_ldg#1}%
254   \krof
255 }%
256 \def\XINT_ldg #1{%
257 \def\XINT_ldg ##1##2##3###4##5##6##7##8##9%
258   {\expandafter#1%
259     \the\numexpr##9##8##7##6##5##4##3##2##1*\xint_c_+\XINT_ldg_a##9}%
260 }\XINT_ldg{}%
261 \def\XINT_ldg_a#1#2{\XINT_ldg_cbye#2\XINT_ldg_d#1\XINT_ldg_c\XINT_ldg_b#2}%
262 \def\XINT_ldg_b#1#2#3#4#5#6#7#8#9{#9#8#7#6#5#4#3#2#1*\xint_c_+\XINT_ldg_a#9}%
263 \def\XINT_ldg_c    #1#2\xint_bye{#1}%
264 \def\XINT_ldg_cbye #1\XINT_ldg_c{}%
265 \def\XINT_ldg_d#1#2\xint_bye{#1}%

```

### 3.12 \xintDouble

Attention \xintDouble non robust against non terminated input.

### 3 Package *xintcore* implementation

```
266 \def\xintDouble {\romannumeral0\xintdouble}%
267 \def\xintdouble #1{\expandafter\XINT_dbl_fork\romannumeral`&&@#1%
268     \xint_bye2345678\xint_bye*\xint_c_ii\relax}%
269 \def\XINT_dbl_fork #1%
270 {%
271     \xint_UDsignfork
272     #1\XINT_dbl_neg
273     -\XINT_dbl
274     \krof #1%
275 }%
276 \def\XINT_dbl_neg-{\expandafter-\romannumeral0\XINT_dbl}%
277 \def\XINT_dbl #1{%
278 \def\XINT_dbl ##1##2##3##4##5##6##7##8%
279     {\expandafter#1\the\numexpr##1##2##3##4##5##6##7##8\XINT_dbl_a}%
280 }\XINT_dbl{ }%
281 \def\XINT_dbl_a #1#2#3#4#5#6#7#8%
282     {\expandafter\XINT_dbl_e\the\numexpr 1#1#2#3#4#5#6#7#8\XINT_dbl_a}%
283 \def\XINT_dbl_e#1{*\xint_c_ii\if#13+\xint_c_i\fi\relax}%
```

#### 3.13 *\xintHalf*

Attention *\xintHalf* non robust against non terminated input.

```
284 \def\xintHalf {\romannumeral0\xinthalff}%
285 \def\xinthalff #1{\expandafter\XINT_half_fork\romannumeral`&&@#1%
286     \xint_bye\xint_Bye345678\xint_bye
287     *\xint_c_v+\xint_c_v)/\xint_c_x-\xint_c_i\relax}%
288 \def\XINT_half_fork #1%
289 {%
290     \xint_UDsignfork
291     #1\XINT_half_neg
292     -\XINT_half
293     \krof #1%
294 }%
295 \def\XINT_half_neg-{\xintiioopp\XINT_half}%
296 \def\XINT_half #1{%
297 \def\XINT_half ##1##2##3##4##5##6##7##8%
298     {\expandafter#1\the\numexpr(##1##2##3##4##5##6##7##8\XINT_half_a}%
299 }\XINT_half{ }%
300 \def\XINT_half_a#1{\xint_Bye#1\xint_bye\XINT_half_b#1}%
301 \def\XINT_half_b #1#2#3#4#5#6#7#8%
302     {\expandafter\XINT_half_e\the\numexpr(1#1#2#3#4#5#6#7#8\XINT_half_a}%
303 \def\XINT_half_e#1{*\xint_c_v+#1-\xint_c_v)\relax}%
```

#### 3.14 *\xintInc*

1.2i much delayed complete rewrite in 1.2 style.

As we take 9 by 9 with the input save stack at 5000 this allows a bit less than 9 times 2500 = 22500 digits on input.

Attention *\xintInc* non robust against non terminated input.

```
304 \def\xintInc {\romannumeral0\xintinc}%
305 \def\xintinc #1{\expandafter\XINT_inc_fork\romannumeral`&&@#1%
```

### 3 Package *xintcore* implementation

```

306          \xint_bye23456789\xint_bye+\xint_c_i\relax}%
307 \def\xINT_inc_fork #1%
308 {%
309   \xint_UDsignfork
310   #1\xINT_inc_neg
311   -\XINT_inc
312   \krof #1%
313 }%
314 \def\xINT_inc_neg-#1\xint_bye#2\relax
315   {\xintiiopt\xINT_dec #1\xINT_dec_bye234567890\xint_bye}%
316 \def\xINT_inc #1{%
317 \def\xINT_inc ##1##2##3##4##5##6##7##8##9%
318   {\expandafter#1\the\numexpr##1##2##3##4##5##6##7##8##9\xINT_inc_a}%
319 }\xINT_inc{ }%
320 \def\xINT_inc_a #1#2#3#4#5#6#7#8#9%
321   {\expandafter\xINT_inc_e\the\numexpr 1#1#2#3#4#5#6#7#8#9\xINT_inc_a}%
322 \def\xINT_inc_e#1{\if#12+\xint_c_i\fi\relax}%

```

#### 3.15 *\xintDec*

1.2i much delayed complete rewrite in the 1.2 style. Things are a bit more complicated than *\xintInc* because 2999999999 is too big for TeX.

Attention *\xintDec* non robust against non terminated input.

```

323 \def\xintDec {\romannumeral0\xintdec}%
324 \def\xintdec #1{\expandafter\xINT_dec_fork\romannumeral`&&@#1%
325   \XINT_dec_bye234567890\xint_bye}%
326 \def\xINT_dec_fork #1%
327 {%
328   \xint_UDsignfork
329   #1\xINT_dec_neg
330   -\XINT_dec
331   \krof #1%
332 }%
333 \def\xINT_dec_neg-#1\xINT_dec_bye#2\xint_bye
334   {\expandafter-%
335   \romannumeral0\xINT_inc #1\xint_bye23456789\xint_bye+\xint_c_i\relax}%
336 \def\xINT_dec #1{%
337 \def\xINT_dec ##1##2##3##4##5##6##7##8##9%
338   {\expandafter#1\the\numexpr##1##2##3##4##5##6##7##8##9\xINT_dec_a}%
339 }\xINT_dec{ }%
340 \def\xINT_dec_a #1#2#3#4#5#6#7#8#9%
341   {\expandafter\xINT_dec_e\the\numexpr 1#1#2#3#4#5#6#7#8#9\xINT_dec_a}%
342 \def\xINT_dec_bye #1\xINT_dec_a#2#3\xint_bye
343   {\if#20-\xint_c_ii\relax+else-\fi\xint_c_i\relax}%
344 \def\xINT_dec_e#1{\unless\if#11\xint_dothis{-\xint_c_i#1}\fi\xint_orthat\relax}%

```

#### 3.16 *\xintDSL*

DECIMAL SHIFT LEFT (=MULTIPLICATION PAR 10). Rewritten for 1.2i. This was very old code... I never came back to it, but I should have rewritten it long time ago.

Attention *\xintDSL* non robust against non terminated input.

### 3 Package *xintcore* implementation

```
345 \def\xintDSL {\romannumeral0\xintdsl }%
346 \def\xintdsl #1{\expandafter\XINT_dsl\romannumeral`&&@#10}%
347 \def\XINT_dsl#1{%
348 \def\XINT_dsl ##1{\xint_gob_til_zero ##1\xint_dsl_zero 0#1##1}%
349 }\XINT_dsl{ }%
350 \def\xint_dsl_zero 0 0{ }%
```

#### 3.17 *\xintDSR*

Decimal shift right, truncates towards zero. Rewritten for 1.2i. Limited to 22483 digits on input.  
Attention *\xintDSR* non robust against non terminated input.

```
351 \def\xintDSR{\romannumeral0\xintdsr}%
352 \def\xintdsr #1{\expandafter\XINT_dsr_fork\romannumeral`&&@#1%
353   \xint_bye\xint_Bye3456789\xint_bye+\xint_c_v)/\xint_c_x-\xint_c_i\relax}%
354 \def\XINT_dsr_fork #1%
355 {%
356   \xint_UDsignfork
357   #1\XINT_dsr_neg
358   -\XINT_dsr
359   \krof #1%
360 }%
361 \def\XINT_dsr_neg-{\xintiioopp\XINT_dsr}%
362 \def\XINT_dsr #1{%
363 \def\XINT_dsr ##1##2##3##4##5##6##7##8##9%
364   {\expandafter#1\the\numexpr(##1##2##3##4##5##6##7##8##9\XINT_dsr_a}%
365 }\XINT_dsr{ }%
366 \def\XINT_dsr_a#1{\xint_Bye#1\xint_bye\XINT_dsr_b#1}%
367 \def\XINT_dsr_b #1#2#3#4#5#6#7#8#9%
368   {\expandafter\XINT_dsr_e\the\numexpr(1#1#2#3#4#5#6#7#8#9\XINT_dsr_a}%
369 \def\XINT_dsr_e #1{\}\relax}%

```

#### 3.18 *\xintDSRr*

New with 1.2i. Decimal shift right, rounds away from zero; done in the 1.2 spirit (with much delay, sorry). Used by *\xintRound*, *\xintDivRound*.

This is about the first time I am happy that the division in *\numexpr* rounds!

Attention *\xintDSRr* non robust against non terminated input.

```
370 \def\xintDSRr{\romannumeral0\xintdsrr}%
371 \def\xintdsrr #1{\expandafter\XINT_dsrr_fork\romannumeral`&&@#1%
372   \xint_bye\xint_Bye3456789\xint_bye/\xint_c_x\relax}%
373 \def\XINT_dsrr_fork #1%
374 {%
375   \xint_UDsignfork
376   #1\XINT_dsrr_neg
377   -\XINT_dsrr
378   \krof #1%
379 }%
380 \def\XINT_dsrr_neg-{\xintiioopp\XINT_dsrr}%
381 \def\XINT_dsrr #1{%
382 \def\XINT_dsrr ##1##2##3##4##5##6##7##8##9%
383   {\expandafter#1\the\numexpr##1##2##3##4##5##6##7##8##9\XINT_dsrr_a}%

```

```

384 }\XINT_dsrr{ }%
385 \def\XINT_dsrr_a#1{\xint_Bye#1\xint_bye\XINT_dsrr_b#1}%
386 \def\XINT_dsrr_b #1#2#3#4#5#6#7#8#9%
387   {\expandafter\XINT_dsrr_e\the\numexpr1#1#2#3#4#5#6#7#8#9\XINT_dsrr_a}%
388 \let\XINT_dsrr_e\XINT_inc_e

```

## Blocks of eight digits

The lingua of release 1.2.

### 3.19 \XINT\_cuz

This (launched by `\romannumeral0`) iterately removes all leading zeroes from a sequence of 8N digits ended by `\R`.

Rewritten for 1.2l, now uses `\numexpr` governed expansion and `\ifnum` test rather than delimited gobbling macros.

Note 2015/11/28: with only four digits the `gob_til_fourzeroes` had proved in some old testing faster than `\ifnum` test. But with eight digits, the execution times are much closer, as I tested back then.

```

389 \def\XINT_cuz #1{%
390 \def\XINT_cuz {\expandafter#1\the\numexpr\XINT_cuz_loop}%
391 }\XINT_cuz{ }%
392 \def\XINT_cuz_loop #1#2#3#4#5#6#7#8#9%
393 {%
394   #1#2#3#4#5#6#7#8%
395   \xint_gob_til_R #9\XINT_cuz_hitend\R
396   \ifnum #1#2#3#4#5#6#7#8>\xint_c_
397     \expandafter\XINT_cuz_cleantoend
398   \else\expandafter\XINT_cuz_loop
399   \fi #9%
400 }%
401 \def\XINT_cuz_hitend\R #1\R{\relax}%
402 \def\XINT_cuz_cleantoend #1\R{\relax #1}%

```

### 3.20 \XINT\_cuz\_byviii

This removes eight by eight leading zeroes from a sequence of 8N digits ended by `\R`. Thus, we still have 8N digits on output. Expansion started by `\romannumeral0`

```

403 \def\XINT_cuz_byviii #1#2#3#4#5#6#7#8#9%
404 {%
405   \xint_gob_til_R #9\XINT_cuz_byviii_e \R
406   \xint_gob_til_eightzeroes #1#2#3#4#5#6#7#8\XINT_cuz_byviii_z 00000000%
407   \XINT_cuz_byviii_done #1#2#3#4#5#6#7#8#9%
408 }%
409 \def\XINT_cuz_byviii_z 00000000\XINT_cuz_byviii_done 00000000{\XINT_cuz_byviii}%
410 \def\XINT_cuz_byviii_done #1\R { #1}%
411 \def\XINT_cuz_byviii_e\R #1\XINT_cuz_byviii_done #2\R{ #2}%

```

### 3.21 `\XINT_unsep_loop`

This is used as

```
\the\numexpr0\XINT_unsep_loop (blocks of 1<8digits>!)
      \xint_bye!2!3!4!5!6!7!8!9!\xint_bye\xint_c_i\relax
```

It removes the 1's and !'s, and outputs the 8N digits with a 0 token as as prefix which will have to be cleaned out by caller.

Actually it does not matter whether the blocks contain really 8 digits, all that matters is that they have 1 as first digit (and at most 9 digits after that to obey the TeX-`\numexpr` bound).

Done at 1.21 for usage by other macros. The similar code in earlier releases was strangely in  $O(N^2)$  style, apparently to avoid some memory constraints. But these memory constraints related to `\numexpr` chaining seems to be in many places in xint code base. The 1.21 version is written in the 1.2i style of `\xintInc` etc... and is compatible with some 1! block without digits among the treated blocks, they will disappear.

```
412 \def\XINT_unsep_loop #1!#2!#3!#4!#5!#6!#7!#8!#9!%
413 {%
414   \expandafter\XINT_unsep_clean
415   \the\numexpr #1\expandafter\XINT_unsep_clean
416   \the\numexpr #2\expandafter\XINT_unsep_clean
417   \the\numexpr #3\expandafter\XINT_unsep_clean
418   \the\numexpr #4\expandafter\XINT_unsep_clean
419   \the\numexpr #5\expandafter\XINT_unsep_clean
420   \the\numexpr #6\expandafter\XINT_unsep_clean
421   \the\numexpr #7\expandafter\XINT_unsep_clean
422   \the\numexpr #8\expandafter\XINT_unsep_clean
423   \the\numexpr #9\XINT_unsep_loop
424 }%
425 \def\XINT_unsep_clean 1{\relax}%
```

### 3.22 `\XINT_unsep_cuzsmall`

This is used as

```
\romannumeral0\XINT_unsep_cuzsmall (blocks of 1<8d>!)
      \xint_bye!2!3!4!5!6!7!8!9!\xint_bye\xint_c_i\relax
```

It removes the 1's and !'s, and removes the leading zeroes \*of the first block\*.

Redone for 1.21: the 1.2 variant was strangely in  $O(N^2)$  style.

```
426 \def\XINT_unsep_cuzsmall
427 {%
428   \expandafter\XINT_unsep_cuzsmall_x\the\numexpr0\XINT_unsep_loop
429 }%
430 \def\XINT_unsep_cuzsmall_x #1{%
431 \def\XINT_unsep_cuzsmall_x 0##1##2##3##4##5##6##7##8%
432 {%
433   \expandafter#1\the\numexpr ##1##2##3##4##5##6##7##8\relax
434 }}\XINT_unsep_cuzsmall_x{ }%
```

### 3.23 `\XINT_div_unsepQ`

This is used by division to remove separators from the produced quotient. The quotient is produced in the correct order. The routine will also remove leading zeroes. An extra initial block of 8 zeroes is possible and thus if present must be removed. Then the next eight digits must be cleaned

of leading zeroes. Attention that there might be a single block of 8 zeroes. Expansion launched by `\romannumeral0`.

Rewritten for 1.2l in 1.2i style.

```

435 \def\XINT_div_unsepQ_delim {\xint_bye!2!3!4!5!6!7!8!9!\xint_bye\xint_c_i\relax\Z}%
436 \def\XINT_div_unsepQ
437 {%
438   \expandafter\XINT_div_unsepQ_x\the\numexpr0\XINT_unsep_loop
439 }%
440 \def\XINT_div_unsepQ_x #1{%
441 \def\XINT_div_unsepQ_x 0##1##2##3##4##5##6##7##8##9%
442 {%
443   \xint_gob_til_Z ##9\XINT_div_unsepQ_one\Z
444   \xint_gob_til_eightzeroes ##1##2##3##4##5##6##7##8\XINT_div_unsepQ_y 00000000%
445   \expandafter#1\the\numexpr ##1##2##3##4##5##6##7##8\relax ##9%
446 }}\XINT_div_unsepQ_x{ }%
447 \def\XINT_div_unsepQ_y #1{%
448 \def\XINT_div_unsepQ_y ##1\relax ##2##3##4##5##6##7##8##9%
449 {%
450   \expandafter#1\the\numexpr ##2##3##4##5##6##7##8##9\relax
451 }}\XINT_div_unsepQ_y{ }%
452 \def\XINT_div_unsepQ_one#1\expandafter{\expandafter}%

```

### 3.24 `\XINT_div_unsepR`

This is used by division to remove separators from the produced remainder. The remainder is here in correct order. It must be cleaned of leading zeroes, possibly all the way.

Also rewritten for 1.2l, the 1.2 version was  $O(N^2)$  style.

Terminator `\xint_bye!2!3!4!5!6!7!8!9!\xint_bye\xint_c_i\relax\R`

We have a need for something like `\R` because it is not guaranteed the thing is not actually zero.

```

453 \def\XINT_div_unsepR
454 {%
455   \expandafter\XINT_div_unsepR_x\the\numexpr0\XINT_unsep_loop
456 }%
457 \def\XINT_div_unsepR_x#1{%
458 \def\XINT_div_unsepR_x 0{\expandafter#1\the\numexpr\XINT_cuz_loop}%
459 }\XINT_div_unsepR_x{ }%

```

### 3.25 `\XINT_zeroes_forviii`

`\romannumeral0\XINT_zeroes_forviii #1\R\R\R\R\R\R\R\R{10}0000001\W`  
 produces a string of k 0's such that  $k + \text{length}(\#1)$  is smallest bigger multiple of eight.

```

460 \def\XINT_zeroes_forviii #1#2#3#4#5#6#7#8%
461 {%
462   \xint_gob_til_R #8\XINT_zeroes_forviii_end\R\XINT_zeroes_forviii
463 }%
464 \def\XINT_zeroes_forviii_end#1{%
465 \def\XINT_zeroes_forviii_end\R\XINT_zeroes_forviii ##1##2##3##4##5##6##7##8##9\W
466 {%
467   \expandafter#1\xint_gob_til_one ##2##3##4##5##6##7##8%
468 }}\XINT_zeroes_forviii_end{ }%

```

### 3.26 \XINT\_sepbyviii\_Z

This is used as

```
\the\numexpr\XINT_sepbyviii_Z <8Ndigits>\XINT_sepbyviii_Z_end 2345678\relax
```

It produces `1<8d>!\...1<8d>!\;`

Prior to 1.21 it used `\Z` as terminator not the semi-colon (hence the name). The switch to `;` was done at a time I thought perhaps I would use an internal format maintaining such 8 digits blocks, and this has to be compatible with the `\csname...\endcsname` encapsulation in `\xintexpr` parsers.

```
469 \def\XINT_sepbyviii_Z #1#2#3#4#5#6#7#8%
470 {%
471     1#1#2#3#4#5#6#7#8\expandafter!\the\numexpr\XINT_sepbyviii_Z
472 }%
473 \def\XINT_sepbyviii_Z_end #1\relax {;!}%
```

### 3.27 \XINT\_sepbyviii\_andcount

This is used as

```
\the\numexpr\XINT_sepbyviii_andcount <8Ndigits>%
\XINT_sepbyviii_end 2345678\relax
\xint_c_vii!\xint_c_vi!\xint_c_v!\xint_c_iv!%
\xint_c_iii!\xint_c_ii!\xint_c_i!\xint_c_\W
```

It will produce

```
1<8d>!\1<8d>!\...1<8d>!\1\xint:<count of blocks>\xint:
```

Used by `\XINT_div_prepare_g` for `\XINT_div_prepare_h`, and also by `\xintiiCmp`.

```
474 \def\XINT_sepbyviii_andcount
475 {%
476     \expandafter\XINT_sepbyviii_andcount_a\the\numexpr\XINT_sepbyviii
477 }%
478 \def\XINT_sepbyviii #1#2#3#4#5#6#7#8%
479 {%
480     1#1#2#3#4#5#6#7#8\expandafter!\the\numexpr\XINT_sepbyviii
481 }%
482 \def\XINT_sepbyviii_end #1\relax {\relax\XINT_sepbyviii_andcount_end!}%
483 \def\XINT_sepbyviii_andcount_a {\XINT_sepbyviii_andcount_b \xint_c_\xint:}%
484 \def\XINT_sepbyviii_andcount_b #1\xint:#2!#3!#4!#5!#6!#7!#8!#9!%
485 {%
486     #2\expandafter!\the\numexpr#3\expandafter!\the\numexpr#4\expandafter
487     !\the\numexpr#5\expandafter!\the\numexpr#6\expandafter!\the\numexpr
488     #7\expandafter!\the\numexpr#8\expandafter!\the\numexpr#9\expandafter!\the\numexpr
489     \expandafter\XINT_sepbyviii_andcount_b\the\numexpr #1+\xint_c_viii\xint:%
490 }%
491 \def\XINT_sepbyviii_andcount_end #1\XINT_sepbyviii_andcount_b\the\numexpr
492     #2+\xint_c_viii\xint:#3#4\W {\expandafter\xint:\the\numexpr #2+#3\xint:}%

```

### 3.28 \XINT\_rsepbyviii

This is used as

```
\the\numexpr1\XINT_rsepbyviii <8Ndigits>%
\XINT_rsepbyviii_end_A 2345678%
\XINT_rsepbyviii_end_B 2345678\relax UV%
```

and will produce



1<8digits>!1<8digits>\xint:1<8digits>!...

where the original digits are organized by eight, and the order inside successive pairs of blocks separated by \xint: has been reversed. Output ends either in 1<8d>!1<8d>\xint:1U\xint: (even) or 1<8d>!1<8d>\xint:1V!1<8d>\xint: (odd)

The U an V should be \numexpr1 stoppers (or will expand and be ended by !). This macro is currently (1.2..1.21) exclusively used in combination with \XINT\_sepandrev\_andcount or \XINT\_sepandrev.

```

493 \def\xint_rsepbyviii #1#2#3#4#5#6#7#8%
494 {%
495   \XINT_rsepbyviii_b {#1#2#3#4#5#6#7#8}%
496 }%
497 \def\xint_rsepbyviii_b #1#2#3#4#5#6#7#8#9%
498 {%
499   #2#3#4#5#6#7#8#9\expandafter!\the\numexpr
500   1#1\expandafter\xint:\the\numexpr 1\xint_rsepbyviii
501 }%
502 \def\xint_rsepbyviii_end_B #1\relax #2#3{#2\xint:}%
503 \def\xint_rsepbyviii_end_A #1#2\expandafter #3\relax #4#5{#5!1#2\xint:}%

```

### 3.29 \XINT\_sepandrev

This is used typically as

```

\romannumeral0\xint_sepandrev <8Ndigits>%
    \XINT_rsepbyviii_end_A 2345678%
    \XINT_rsepbyviii_end_B 2345678\relax UV%
    \R\xint:\R\xint:\R\xint:\R\xint:\R\xint:\R\xint:\R\xint:\R\xint:\W

```

and will produce

1<8digits>!1<8digits>!1<8digits>!...

where the blocks have been globally reversed. The UV here are only place holders (must be \numexpr1 stoppers) to share same syntax as \XINT\_sepandrev\_andcount, they are gobbled (#2 in \XINT\_sepandrev\_done).

```

504 \def\xint_sepandrev
505 {%
506   \expandafter\xint_sepandrev_a\the\numexpr 1\xint_rsepbyviii
507 }%
508 \def\xint_sepandrev_a {\XINT_sepandrev_b {}}%
509 \def\xint_sepandrev_b #1#2\xint:#3\xint:#4\xint:#5\xint:#6\xint:#7\xint:#8\xint:#9\xint:%
510 {%
511   \xint_gob_til_R #9\xint_sepandrev_end\R
512   \XINT_sepandrev_b {#9!#8!#7!#6!#5!#4!#3!#2!#1}%
513 }%
514 \def\xint_sepandrev_end\R\xint_sepandrev_b #1#2\W {\XINT_sepandrev_done #1}%
515 \def\xint_sepandrev_done #1#2!{ }%

```

### 3.30 \XINT\_sepandrev\_andcount

This is used typically as

```

\romannumeral0\xint_sepandrev_andcount <8Ndigits>%
    \XINT_rsepbyviii_end_A 2345678%
    \XINT_rsepbyviii_end_B 2345678\relax\xint_c_ii\xint_c_i
    \R\xint:\xint_c_xii \R\xint:\xint_c_x \R\xint:\xint_c_viii \R\xint:\xint_c_vi
    \R\xint:\xint_c_iv \R\xint:\xint_c_ii \R\xint:\xint_c\W

```

and will produce

<length>.1<8digits>!1<8digits>!1<8digits>!...

where the blocks have been globally reversed and <length> is the number of blocks.

```

516 \def\XINT_sepandrev_andcount
517 {%
518   \expandafter\XINT_sepandrev_andcount_a\the\numexpr 1\XINT_rsepyviii
519 }%
520 \def\XINT_sepandrev_andcount_a {\XINT_sepandrev_andcount_b 0!{}}%
521 \def\XINT_sepandrev_andcount_b #1!#2#3\xint:#4\xint:#5\xint:#6\xint:#7\xint:#8\xint:#9\xint:%
522 {%
523   \xint_gob_til_R #9\XINT_sepandrev_andcount_end\R
524   \expandafter\XINT_sepandrev_andcount_b \the\numexpr #1+\xint_c_i!%
525   {#9!#8!#7!#6!#5!#4!#3!#2}%
526 }%
527 \def\XINT_sepandrev_andcount_end\R
528   \expandafter\XINT_sepandrev_andcount_b\the\numexpr #1+\xint_c_i!#2#3#4\W
529 {\expandafter\XINT_sepandrev_andcount_done\the\numexpr #3+\xint_c_xiv*#1!#2}%
530 \def\XINT_sepandrev_andcount_done#1{%
531 \def\XINT_sepandrev_andcount_done##1!##21##3!{\expandafter#1\the\numexpr##1-##3\xint:}%
532 }\XINT_sepandrev_andcount_done{ }%

```

### 3.31 \XINT\_rev\_nounsep

This is used as

\romannumeral0\XINT\_rev\_nounsep {<blocks 1<8d>!>\R!\R!\R!\R!\R!\R!\R!\R!\W

It reverses the blocks, keeping the 1's and ! separators. Used multiple times in the division algorithm. The inserted {} here is not optional.

```

533 \def\XINT_rev_nounsep #1#2!#3!#4!#5!#6!#7!#8!#9!%
534 {%
535   \xint_gob_til_R #9\XINT_rev_nounsep_end\R
536   \XINT_rev_nounsep {#9!#8!#7!#6!#5!#4!#3!#2!#1}%
537 }%
538 \def\XINT_rev_nounsep_end\R\XINT_rev_nounsep #1#2\W {\XINT_rev_nounsep_done #1}%
539 \def\XINT_rev_nounsep_done #11{ 1}%

```

### 3.32 \XINT\_unrevbyviii

Used as \romannumeral0\XINT\_unrevbyviii 1<8d>!...1<8d>! terminated by

1;!1\R!1\R!1\R!1\R!1\R!1\R!1\R!1\R!\W

The \romannumeral in unrevbyviii\_a is for special effects (expand some token which was put as 1<token>! at the end of the original blocks). This mechanism is used by 1.2 subtraction (still true for 1.21).

```

540 \def\XINT_unrevbyviii #11#2!1#3!1#4!1#5!1#6!1#7!1#8!1#9!%
541 {%
542   \xint_gob_til_R #9\XINT_unrevbyviii_a\R
543   \XINT_unrevbyviii {#9#8#7#6#5#4#3#2#1}%
544 }%
545 \def\XINT_unrevbyviii_a#1{%
546 \def\XINT_unrevbyviii_a\R\XINT_unrevbyviii ##1##2\W
547   {\expandafter#1\romannumeral`&&@\xint_gob_til_sc ##1}%

```

```
548 }\XINT_unrevbyviii_a{ }%
```

Can work with shorter ending pattern: 1;!1\R!1\R!1\R!1\R!1\R!1\R!\W but the longer one of unrevbyviii is ok here too. Used currently (1.2) only by addition, now (1.2c) with long ending pattern. Does the final clean up of leading zeroes contrarily to general \XINT\_unrevbyviii.

```
549 \def\XINT_smallunrevbyviii 1#1!1#2!1#3!1#4!1#5!1#6!1#7!1#8!#9\W%
550 {%
551   \expandafter\XINT_cuz_small\xint_gob_til_sc #8#7#6#5#4#3#2#1%
552 }%
```

## Core arithmetic

The four operations have been rewritten entirely for release 1.2. The new routines works with separated blocks of eight digits. They all measure first the lengths of the arguments, even addition and subtraction (this was not the case with xintcore.sty 1.1 or earlier.)

The technique of chaining \the\numexpr induces a limitation on the maximal size depending on the size of the input save stack and the maximum expansion depth. For the current (TL2015) settings (5000, resp. 10000), the induced limit for addition of numbers is at 19968 and for multiplication it is observed to be 19959 (valid as of 2015/10/07).

Side remark: I tested that \the\numexpr was more efficient than \number. But it reduced the allowable numbers for addition from 19976 digits to 19968 digits.

### 3.33 \xintiAdd, \xintiiAdd

1.21: \xintiiAdd made robust against non terminated input.

```
553 \def\xintiAdd    {\romannumeral0\xintiadd }%
554 \def\xintiadd   #1{\expandafter\XINT_iadd\romannumeral0\xintnum{#1}\xint:}%
555 \def\xintiiAdd  {\romannumeral0\xintiiadd }%
556 \def\xintiiadd  #1{\expandafter\XINT_iiadd\romannumeral`&&@#1\xint:}%
557 \def\XINT_iiadd #1#2\xint:#3%
558 {%
559   \expandafter\XINT_add_nfork\expandafter#1\romannumeral`&&@#3\xint:#2\xint:
560 }%
561 \def\XINT_iadd  #1#2\xint:#3%
562 {%
563   \expandafter\XINT_add_nfork\expandafter
564   #1\romannumeral0\xintnum{#3}\xint:#2\xint:
565 }%
566 \def\XINT_add_fork #1#2\xint:#3\xint:{\XINT_add_nfork #1#3\xint:#2\xint:}%
567 \def\XINT_add_nfork #1#2%
568 {%
569   \xint_UDzerofork
570   #1\XINT_add_firstiszero
571   #2\XINT_add_secondiszero
572   0{}%
573   \krof
574   \xint_UDsignsfork
575   #1#2\XINT_add_minusminus
576   #1-\XINT_add_minusplus
577   #2-\XINT_add_plusminus
578   --\XINT_add_plusplus
```

### 3 Package *xintcore* implementation

```

579 \krof #1#2%
580 }%
581 \def\XINT_add_firstiszero #1\krof 0#2#3\xint:#4\xint:{ #2#3}%
582 \def\XINT_add_secondiszero #1\krof #20#3\xint:#4\xint:{ #2#4}%
583 \def\XINT_add_minusminus #1#2%
584 {\expandafter\romannumeral0\XINT_add_pp_a {}{}}%
585 \def\XINT_add_minusplus #1#2{\XINT_sub_mm_a {}#2}%
586 \def\XINT_add_plusminus #1#2%
587 {\expandafter\XINT_opp\romannumeral0\XINT_sub_mm_a #1{}}%
588 \def\XINT_add_pp_a #1#2#3\xint:
589 {%
590 \expandafter\XINT_add_pp_b
591 \romannumeral0\expandafter\XINT_sepandrev_andcount
592 \romannumeral0\XINT_zeroes_forviii #2#3\R\R\R\R\R\R\R\R{10}0000001\W
593 #2#3\XINT_rsepbyviii_end_A 2345678%
594 \XINT_rsepbyviii_end_B 2345678\relax\xint_c_ii\xint_c_i
595 \R\xint:\xint_c_xii \R\xint:\xint_c_x \R\xint:\xint_c_viii \R\xint:\xint_c_vi
596 \R\xint:\xint_c_iv \R\xint:\xint_c_ii \R\xint:\xint_c_\W
597 \X #1%
598 }%
599 \let\XINT_add_plusplus \XINT_add_pp_a
600 \def\XINT_add_pp_b #1\xint:#2\X #3\xint:
601 {%
602 \expandafter\XINT_add_checklengths
603 \the\numexpr #1\expandafter\xint:%
604 \romannumeral0\expandafter\XINT_sepandrev_andcount
605 \romannumeral0\XINT_zeroes_forviii #3\R\R\R\R\R\R\R\R{10}0000001\W
606 #3\XINT_rsepbyviii_end_A 2345678%
607 \XINT_rsepbyviii_end_B 2345678\relax\xint_c_ii\xint_c_i
608 \R\xint:\xint_c_xii \R\xint:\xint_c_x \R\xint:\xint_c_viii \R\xint:\xint_c_vi
609 \R\xint:\xint_c_iv \R\xint:\xint_c_ii \R\xint:\xint_c_\W
610 1;!1;!1;!1;!1\W #21;!1;!1;!1;!1\W
611 1\R!1\R!1\R!1\R!1\R!1\R!1\R!1\R!1\W
612 }%

```

I keep #1.#2. to check if at most 6 + 6 base 10<sup>8</sup> digits which can be treated faster for final reverse. But is this overhead at all useful ?

```

613 \def\XINT_add_checklengths #1\xint:#2\xint:%
614 {%
615 \ifnum #2>#1
616 \expandafter\XINT_add_exchange
617 \else
618 \expandafter\XINT_add_A
619 \fi
620 #1\xint:#2\xint:%
621 }%
622 \def\XINT_add_exchange #1\xint:#2\xint:#3\W #4\W
623 {%
624 \XINT_add_A #2\xint:#1\xint:#4\W #3\W
625 }%
626 \def\XINT_add_A #1\xint:#2\xint:%
627 {%

```

### 3 Package *xintcore* implementation

```

628 \ifnum #1>\xint_c_vi
629 \expandafter\XINT_add_aa
630 \else \expandafter\XINT_add_aa_small
631 \fi
632}%
633\def\XINT_add_aa {\expandafter\XINT_add_out\the\numexpr\XINT_add_a \xint_c_ii}%
634\def\XINT_add_out{\expandafter\XINT_cuz_small\romannumeral0\XINT_unrevbyviii {}}%
635\def\XINT_add_aa_small
636 {\expandafter\XINT_smallunrevbyviii\the\numexpr\XINT_add_a \xint_c_ii}%

```

2 as first token of #1 stands for "no carry", 3 will mean a carry (we are adding 1<8digits> to 1<8digits>.) Version 1.2c has terminators of the shape 1;!, replacing the \Z! used in 1.2.

Call: \the\numexpr\XINT\_add\_a 2#11;!!;!!;!!;!!\W #21;!!;!!;!!;!!\W where #1 and #2 are blocks of 1<8d>!, and #1 is at most as long as #2. This last requirement is a bit annoying (if one wants to do recursive algorithms but not have to check lengths), and I will probably remove it at some point.

Output: blocks of 1<8d>! representing the addition, (least significant first), and a final 1;!. In recursive algorithm this 1;! terminator can thus conveniently be reused as part of input terminator (up to the length problem).

```

637\def\XINT_add_a #1!#2!#3!#4!#5\W
638      #6!#7!#8!#9!%
639{%
640  \XINT_add_b
641    #1!#6!#2!#7!#3!#8!#4!#9!%
642    #5\W
643}%
644\def\XINT_add_b #1#2#3!#4!%
645{%
646  \xint_gob_til_sc #2\XINT_add_bi ;%
647  \expandafter\XINT_add_c\the\numexpr#1+1#2#3+#4-\xint_c_ii\xint:%
648}%
649\def\XINT_add_bi;\expandafter\XINT_add_c
650  \the\numexpr#1+#2+#3-\xint_c_ii\xint:#4!#5!#6!#7!#8!#9!\W
651{%
652  \XINT_add_k #1#3!#5!#7!#9!%
653}%
654\def\XINT_add_c #1#2\xint:%
655{%
656  1#2\expandafter!\the\numexpr\XINT_add_d #1%
657}%
658\def\XINT_add_d #1#2#3!#4!%
659{%
660  \xint_gob_til_sc #2\XINT_add_di ;%
661  \expandafter\XINT_add_e\the\numexpr#1+1#2#3+#4-\xint_c_ii\xint:%
662}%
663\def\XINT_add_di;\expandafter\XINT_add_e
664  \the\numexpr#1+#2+#3-\xint_c_ii\xint:#4!#5!#6!#7!#8\W
665{%
666  \XINT_add_k #1#3!#5!#7!%
667}%
668\def\XINT_add_e #1#2\xint:%
669{%
670  1#2\expandafter!\the\numexpr\XINT_add_f #1%

```

```

671 }%
672 \def\XINT_add_f #1#2#3!#4!%
673 {%
674   \xint_gob_til_sc #2\XINT_add_fi ;%
675   \expandafter\XINT_add_g\the\numexpr#1+1#2#3+#4-\xint_c_ii\xint:%
676 }%
677 \def\XINT_add_fi;\expandafter\XINT_add_g
678   \the\numexpr#1+#2+#3-\xint_c_ii\xint:#4!#5!#6\W
679 {%
680   \XINT_add_k #1#3!#5!%
681 }%
682 \def\XINT_add_g #1#2\xint:%
683 {%
684   1#2\expandafter!\the\numexpr\XINT_add_h #1%
685 }%
686 \def\XINT_add_h #1#2#3!#4!%
687 {%
688   \xint_gob_til_sc #2\XINT_add_hi ;%
689   \expandafter\XINT_add_i\the\numexpr#1+1#2#3+#4-\xint_c_ii\xint:%
690 }%
691 \def\XINT_add_hi;%
692   \expandafter\XINT_add_i\the\numexpr#1+#2+#3-\xint_c_ii\xint:#4\W
693 {%
694   \XINT_add_k #1#3!%
695 }%
696 \def\XINT_add_i #1#2\xint:%
697 {%
698   1#2\expandafter!\the\numexpr\XINT_add_a #1%
699 }%
700 \def\XINT_add_k #1{\if #12\expandafter\XINT_add_ke\else\expandafter\XINT_add_l \fi}%
701 \def\XINT_add_ke #11;#2\W {\XINT_add_kf #11;!}%
702 \def\XINT_add_kf 1{1\relax }%
703 \def\XINT_add_l 1#1#2{\xint_gob_til_sc #1\XINT_add_lf ;\XINT_add_m 1#1#2}%
704 \def\XINT_add_lf #1\W {1\relax 00000001!1;!}%
705 \def\XINT_add_m #1!\{\expandafter\XINT_add_n\the\numexpr\xint_c_i+#1\xint:%}%
706 \def\XINT_add_n #1#2\xint:{1#2\expandafter!\the\numexpr\XINT_add_o #1}%

Here 2 stands for "carry", and 1 for "no carry" (we have been adding 1 to 1<8digits>.)

707 \def\XINT_add_o #1{\if #12\expandafter\XINT_add_l\else\expandafter\XINT_add_ke \fi}%

```

### 3.34 \xintCmp, \xintiiCmp

Moved from *xint.sty* to *xintcore.sty* and rewritten for 1.21.

1.21's \xintiiCmp is robust against non terminated input.

```

708 \def\xintCmp    {\romannumeral0\xintcmp }%
709 \def\xintcmp   #1{\expandafter\XINT_icmp\romannumeral0\xintnum{#1}\xint:%}%
710 \def\xintiiCmp {\romannumeral0\xintiiCmp }%
711 \def\xintiiCmp #1{\expandafter\XINT_iicmp\romannumeral`&&@#1\xint:%}%
712 \def\XINT_iicmp #1#2\xint:#3%
713 {%
714   \expandafter\XINT_cmp_nfork\expandafter #1\romannumeral`&&@#3\xint:#2\xint:

```

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```

715 }%
716 \def\XINT_icmp #1#2\xint:#3%
717 {%
718   \expandafter\XINT_cmp_nfork\expandafter #1\romannumeral0\xintnum{#3}\xint:#2\xint:
719 }%
720 \def\XINT_cmp_nfork #1#2%
721 {%
722   \xint_UDzerofork
723   #1\XINT_cmp_firstiszero
724   #2\XINT_cmp_secondiszero
725   0{}%
726   \krof
727   \xint_UDsignsfork
728   #1#2\XINT_cmp_minusminus
729   #1-\XINT_cmp_minusplus
730   #2-\XINT_cmp_plusminus
731   --\XINT_cmp_plusplus
732   \krof #1#2%
733 }%
734 \def\XINT_cmp_firstiszero #1\krof 0#2#3\xint:#4\xint:
735 {%
736   \xint_UDzerominusfork
737   #2-{ 0}%
738   0#2{ 1}%
739   0-{ -1}%
740   \krof
741 }%
742 \def\XINT_cmp_secondiszero #1\krof #20#3\xint:#4\xint:
743 {%
744   \xint_UDzerominusfork
745   #2-{ 0}%
746   0#2{ -1}%
747   0-{ 1}%
748   \krof
749 }%
750 \def\XINT_cmp_plusminus #1\xint:#2\xint:{ 1}%
751 \def\XINT_cmp_minusplus #1\xint:#2\xint:{ -1}%
752 \def\XINT_cmp_minusminus
753   --{\expandafter\XINT_opp\romannumeral0\XINT_cmp_plusplus {}{}}%
754 \def\XINT_cmp_plusplus #1#2#3\xint:
755 {%
756   \expandafter\XINT_cmp_pp
757   \the\numexpr\expandafter\XINT_sepbyviii_andcount
758   \romannumeral0\XINT_zeroes_forviii #2#3\R\R\R\R\R\R\R\R{10}0000001\W
759   #2#3\XINT_sepbyviii_end 2345678\relax
760   \xint_c_vii!\xint_c_vi!\xint_c_v!\xint_c_iv!%
761   \xint_c_iii!\xint_c_ii!\xint_c_i!\xint_c_\W
762   #1%
763 }%
764 \def\XINT_cmp_pp #1\xint:#2\xint:#3\xint:
765 {%
766   \expandafter\XINT_cmp_checklengths

```

```

767 \the\numexpr #2\expandafter\xint:%
768 \the\numexpr\expandafter\XINT_sepbyviii_andcount
769 \romannumeral0\XINT_zeroes_forviii #3\R\R\R\R\R\R\R\R{10}0000001\W
770 #3\XINT_sepbyviii_end 2345678\relax
771 \xint_c_vii!\xint_c_vi!\xint_c_v!\xint_c_iv!%
772 \xint_c_iii!\xint_c_ii!\xint_c_i!\xint_c_\W
773 #1;!1;!1;!1;!1;\W
774 }%
775 \def\XINT_cmp_checklengths #1\xint:#2\xint:#3\xint:
776 {%
777 \ifnum #1=#3
778 \expandafter\xint_firstoftwo
779 \else
780 \expandafter\xint_secondoftwo
781 \fi
782 \XINT_cmp_a {\XINT_cmp_distinctlengths {#1}{#3}}#2;!1;!1;!1;\W
783 }%
784 \def\XINT_cmp_distinctlengths #1#2#3\W #4\W
785 {%
786 \ifnum #1>#2
787 \expandafter\xint_firstoftwo
788 \else
789 \expandafter\xint_secondoftwo
790 \fi
791 { -1}{ 1}%
792 }%
793 \def\XINT_cmp_a 1#1!1#2!1#3!1#4!#5\W 1#6!1#7!1#8!1#9!%
794 {%
795 \xint_gob_til_sc #1\XINT_cmp_equal ;%
796 \ifnum #1>#6 \XINT_cmp_gt\fi
797 \ifnum #1<#6 \XINT_cmp_lt\fi
798 \xint_gob_til_sc #2\XINT_cmp_equal ;%
799 \ifnum #2>#7 \XINT_cmp_gt\fi
800 \ifnum #2<#7 \XINT_cmp_lt\fi
801 \xint_gob_til_sc #3\XINT_cmp_equal ;%
802 \ifnum #3>#8 \XINT_cmp_gt\fi
803 \ifnum #3<#8 \XINT_cmp_lt\fi
804 \xint_gob_til_sc #4\XINT_cmp_equal ;%
805 \ifnum #4>#9 \XINT_cmp_gt\fi
806 \ifnum #4<#9 \XINT_cmp_lt\fi
807 \XINT_cmp_a #5\W
808 }%
809 \def\XINT_cmp_lt#1{\def\XINT_cmp_lt\fi ##1\W ##2\W {\fi#1-1}}\XINT_cmp_lt{ }%
810 \def\XINT_cmp_gt#1{\def\XINT_cmp_gt\fi ##1\W ##2\W {\fi#11}}\XINT_cmp_gt{ }%
811 \def\XINT_cmp_equal #1\W #2\W { 0}%

```

### 3.35 \xintiSub, \xintiiSub

Entirely rewritten for 1.2.

Refactored at 1.2l. I was initially aiming at clinching some internal format of the type `1<8digits>!...1<8digits>!` for chaining the arithmetic operations (as a preliminary step to decided upon some internal format for `xintfrac` macros), thus I wanted to uniformize delimiters in



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particular and have some core macros inputting and outputting such formats. But the way division is implemented makes it currently very hard to obtain a satisfactory solution. For subtraction I got there almost, but there was added overhead and, as the core sub-routine still assumed the shorter number will be positioned first, one would need to record the length also in the basic internal format, or add the overhead to not make assumption on which one is shorter. I thus but back-tracked my steps but in passing I improved the efficiency (probably) in the worst case branch.

The other reason for backtracking was in relation with the decimal numbers. Having a core format in base  $10^8$  but ultimately the radix is actually 10 leads to complications. I could use radix  $10^8$  for `\xintiexpr` only, but then I need to make it compatible with sub-`\xintiexpr` in `\xintexpr`, etc... there are many issues of this type.

I considered also an approach like in the 1.21 `\xintiiCmp`, but decided to stick with the method here for now.

```

812 \def\xintiiSub    {\romannumeral0\xintiisub }%
813 \def\xintiisub #1{\expandafter\XINT_iisub\romannumeral`&&@#1\xint:}%
814 \def\XINT_iisub #1#2\xint:#3%
815 {%
816     \expandafter\XINT_sub_nfork\expandafter
817     #1\romannumeral`&&@#3\xint:#2\xint:
818 }%
819 \def\xintiSub    {\romannumeral0\xintisub }%
820 \def\xintisub #1{\expandafter\XINT_isub\romannumeral0\xintnum{#1}\xint:}%
821 \def\XINT_isub #1#2\xint:#3%
822 {%
823     \expandafter\XINT_sub_nfork\expandafter
824     #1\romannumeral0\xintnum{#3}\xint:#2\xint:
825 }%
826 \def\XINT_sub_nfork #1#2%
827 {%
828     \xint_UDzerofork
829     #1\XINT_sub_firstiszero
830     #2\XINT_sub_secondiszero
831     0{}}%
832     \krof
833     \xint_UDsignsfork
834     #1#2\XINT_sub_minusminus
835     #1-\XINT_sub_minusplus
836     #2-\XINT_sub_plusminus
837     --\XINT_sub_plusplus
838     \krof #1#2%
839 }%
840 \def\XINT_sub_firstiszero #1\krof 0#2#3\xint:#4\xint:{\XINT_opp #2#3}%
841 \def\XINT_sub_secondiszero #1\krof #20#3\xint:#4\xint:{ #2#4}%
842 \def\XINT_sub_plusminus #1#2{\XINT_add_pp_a #1{}}%
843 \def\XINT_sub_plusplus #1#2%
844     {\expandafter\XINT_opp\romannumeral0\XINT_sub_mm_a #1#2}%
845 \def\XINT_sub_minusplus #1#2%
846     {\expandafter-\romannumeral0\XINT_add_pp_a {}}#2}%
847 \def\XINT_sub_minusminus #1#2{\XINT_sub_mm_a {}}}%
848 \def\XINT_sub_mm_a #1#2#3\xint:
849 {%
850     \expandafter\XINT_sub_mm_b
851     \romannumeral0\expandafter\XINT_sepandrev_andcount

```

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```

852 \romannumeral0\XINT_zeroes_forviii #2#3\R\R\R\R\R\R\R{10}0000001\W
853 #2#3\XINT_rsepbyviii_end_A 2345678%
854 \XINT_rsepbyviii_end_B 2345678\relax\xint_c_ii\xint_c_i
855 \R\xint:\xint_c_xii \R\xint:\xint_c_x \R\xint:\xint_c_viii \R\xint:\xint_c_vi
856 \R\xint:\xint_c_iv \R\xint:\xint_c_ii \R\xint:\xint_c_\W
857 \X #1%
858 }%
859 \def\XINT_sub_mm_b #1\xint:#2\X #3\xint:
860 {%
861 \expandafter\XINT_sub_checklengths
862 \the\numexpr #1\expandafter\xint:%
863 \romannumeral0\expandafter\XINT_sepandrev_andcount
864 \romannumeral0\XINT_zeroes_forviii #3\R\R\R\R\R\R\R{10}0000001\W
865 #3\XINT_rsepbyviii_end_A 2345678%
866 \XINT_rsepbyviii_end_B 2345678\relax\xint_c_ii\xint_c_i
867 \R\xint:\xint_c_xii \R\xint:\xint_c_x \R\xint:\xint_c_viii \R\xint:\xint_c_vi
868 \R\xint:\xint_c_iv \R\xint:\xint_c_ii \R\xint:\xint_c_\W
869 1;!1;!1;!1;!1;\W
870 #21;!1;!1;!1;!1;\W
871 1;!1\R!1\R!1\R!1\R!%
872 1\R!1\R!1\R!1\R!\W
873 }%
874 \def\XINT_sub_checklengths #1\xint:#2\xint:%
875 {%
876 \ifnum #2>#1
877 \expandafter\XINT_sub_exchange
878 \else
879 \expandafter\XINT_sub_aa
880 \fi
881 }%
882 \def\XINT_sub_exchange #1\W #2\W
883 {%
884 \expandafter\XINT_opp\romannumeral0\XINT_sub_aa #2\W #1\W
885 }%
886 \def\XINT_sub_aa
887 {%
888 \expandafter\XINT_sub_out\the\numexpr\XINT_sub_a\xint_c_i
889 }%

```

The post-processing (clean-up of zeros, or rescue of situation with A-B where actually B turns out bigger than A) will be done by a macro which depends on circumstances and will be initially last token before the reversion done by `\XINT_unrevbyviii`.

```

890 \def\XINT_sub_out {\XINT_unrevbyviii{}}%

```

1 as first token of #1 stands for "no carry", 0 will mean a carry.

Call: `\the\numexpr`

```

\XINT_sub_a 1#11;!1;!1;!1;\W
#21;!1;!1;!1;\W

```

where #1 and #2 are blocks of  $1 < 8d < 10$ , #1 (=B) *must* be at most as long as #2 (=A), (in radix  $10^8$ ) and the routine wants to compute  $\#2 - \#1 = A - B$

1.2l uses 1;! delimiters to match those of addition (and multiplication). But in the end I reverted the code branch which made it possible to chain such operations keeping internal format in 8 digits blocks throughout.

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\numexpr governed expansion stops with various possibilities:

- Type Ia: #1 shorter than #2, no final carry
- Type Ib: #1 shorter than #2, a final carry but next block of #2 > 1
- Type Ica: #1 shorter than #2, a final carry, next block of #2 is final and = 1
- Type Icb: as Ica except that 00000001 block from #2 was not final
- Type Id: #1 shorter than #2, a final carry, next block of #2 = 0
- Type IIa: #1 same length as #2, turns out it was <= #2.
- Type IIb: #1 same length as #2, but turned out > #2.

Various type of post actions are then needed:

- Ia: clean up of zeros in most significant block of 8 digits
- Ib: as Ia
- Ic: there may be significant blocks of 8 zeros to clean up from result. Only case Ica may have arbitrarily many of them, case Icb has only one such block.
- Id: blocks of 99999999 may propagate and there might a be final zero block created which has to be cleaned up.
- IIa: arbitrarily many zeros might have to be removed.
- IIb: We wanted  $\#2 - \#1 = -(\#1 - \#2)$ , but we got  $10^{\{8N\} + \#2} - \#1 = 10^{\{8N\}} - (\#1 - \#2)$ . We need to do the correction then we are as in IIa situation, except that final result can not be zero.

The 1.2l method for this correction is (presumably, testing takes lots of time, which I do not have) more efficient than in 1.2 release.

```
891 \def\XINT_sub_a #1!#2!#3!#4!#5\W #6!#7!#8!#9!%
892 {%
893   \XINT_sub_b
894   #1!#6!#2!#7!#3!#8!#4!#9!%
895   #5\W
896 }%
```

As 1.2l code uses `l<8digits>!` blocks one has to be careful with the carry digit 1 or 0: A `#11#2#3` pattern would result into an empty `#1` if the carry digit which is upfront is 1, rather than setting `#1=1`.

```
897 \def\XINT_sub_b #1#2#3#4!#5!%
898 {%
899   \xint_gob_til_sc #3\XINT_sub_bi ;%
900   \expandafter\XINT_sub_c\the\numexpr#1+1#5-#3#4-\xint_c_i\xint:%
901 }%
902 \def\XINT_sub_c 1#1#2\xint:%
903 {%
904   1#2\expandafter!\the\numexpr\XINT_sub_d #1%
905 }%
906 \def\XINT_sub_d #1#2#3#4!#5!%
907 {%
908   \xint_gob_til_sc #3\XINT_sub_di ;%
909   \expandafter\XINT_sub_e\the\numexpr#1+1#5-#3#4-\xint_c_i\xint:%
910 }%
911 \def\XINT_sub_e 1#1#2\xint:%
912 {%
913   1#2\expandafter!\the\numexpr\XINT_sub_f #1%
914 }%
915 \def\XINT_sub_f #1#2#3#4!#5!%
916 {%
917   \xint_gob_til_sc #3\XINT_sub_fi ;%
```

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```

918 \expandafter\XINT_sub_g\the\numexpr#1+1#5-#3#4-\xint_c_i\xint:
919 }%
920 \def\XINT_sub_g #1#2\xint:%
921 {%
922     1#2\expandafter!\the\numexpr\XINT_sub_h #1%
923 }%
924 \def\XINT_sub_h #1#2#3#4!#5!%
925 {%
926     \xint_gob_til_sc #3\XINT_sub_hi ;%
927     \expandafter\XINT_sub_i\the\numexpr#1+1#5-#3#4-\xint_c_i\xint:
928 }%
929 \def\XINT_sub_i #1#2\xint:%
930 {%
931     1#2\expandafter!\the\numexpr\XINT_sub_a #1%
932 }%
933 \def\XINT_sub_bi;%
934     \expandafter\XINT_sub_c\the\numexpr#1+1#2-#3\xint:
935     #4!#5!#6!#7!#8!#9!\W
936 {%
937     \XINT_sub_k #1#2!#5!#7!#9!%
938 }%
939 \def\XINT_sub_di;%
940     \expandafter\XINT_sub_e\the\numexpr#1+1#2-#3\xint:
941     #4!#5!#6!#7!#8\W
942 {%
943     \XINT_sub_k #1#2!#5!#7!%
944 }%
945 \def\XINT_sub_fi;%
946     \expandafter\XINT_sub_g\the\numexpr#1+1#2-#3\xint:
947     #4!#5!#6\W
948 {%
949     \XINT_sub_k #1#2!#5!%
950 }%
951 \def\XINT_sub_hi;%
952     \expandafter\XINT_sub_i\the\numexpr#1+1#2-#3\xint:
953     #4\W
954 {%
955     \XINT_sub_k #1#2!%
956 }%

```

B terminated. Have we reached the end of A (necessarily at least as long as B) ? (we are computing A-B, digits of B come first).

If not, then we are certain that even if there is carry it will not propagate beyond the end of A. But it may propagate far transforming chains of 00000000 into 99999999, and if it does go to the final block which possibly is just 1<00000001>!, we will have those eight zeros to clean up.

If A and B have the same length (in base  $10^8$ ) then arbitrarily many zeros might have to be cleaned up, and if  $A < B$ , the whole result will have to be complemented first.

```

957 \def\XINT_sub_k #1#2#3%
958 {%
959     \xint_gob_til_sc #3\XINT_sub_p;\XINT_sub_l #1#2#3%
960 }%
961 \def\XINT_sub_l #1%

```

### 3 Package *xintcore* implementation

```
962 {\xint_UDzerofork #1\XINT_sub_1_carry 0\XINT_sub_1_Ia\krof}%
963 \def\XINT_sub_1_Ia 1#1;!#2\W{1\relax#1;!1\XINT_sub_fix_none!}%

964 \def\XINT_sub_1_carry 1#1!{\ifcase #1
965     \expandafter \XINT_sub_1_Id
966     \or \expandafter \XINT_sub_1_Ic
967     \else\expandafter \XINT_sub_1_Ib\fi 1#1!}%
968 \def\XINT_sub_1_Ib #1;!#2\W {-\xint_c_i+#1;!1\XINT_sub_fix_none!}%
969 \def\XINT_sub_1_Ic 1#1!1#2#3!#4;!#5\W
970 {%
971     \xint_gob_til_sc #2\XINT_sub_1_Ica;%
972     1\relax 00000000!1#2#3!#4;!1\XINT_sub_fix_none!%
973 }%
```

We need to add some extra delimiters at the end for post-action by `\XINT_num`, so we first grab the material up to `\W`

```
974 \def\XINT_sub_1_Ica#1\W
975 {%
976     1;!1\XINT_sub_fix_cuz!%
977     1;!1\R!1\R!1\R!1\R!1\R!1\R!1\R!1\R!1\R!\W
978     \xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\Z
979 }%
980 \def\XINT_sub_1_Id 1#1!%
981     {199999999\expandafter!\the\numexpr \XINT_sub_1_Id_a}%
982 \def\XINT_sub_1_Id_a 1#1!{\ifcase #1
983     \expandafter \XINT_sub_1_Id
984     \or \expandafter \XINT_sub_1_Id_b
985     \else\expandafter \XINT_sub_1_Ib\fi 1#1!}%
986 \def\XINT_sub_1_Id_b 1#1!1#2#3!#4;!#5\W
987 {%
988     \xint_gob_til_sc #2\XINT_sub_1_Ida;%
989     1\relax 00000000!1#2#3!#4;!1\XINT_sub_fix_none!%
990 }%
991 \def\XINT_sub_1_Ida#1\XINT_sub_fix_none{1;!1\XINT_sub_fix_none!}%

This is the case where both operands have same 10^8-base length.
We were handling A-B but perhaps B>A. The situation with A=B is also annoying because we then
have to clean up all zeros but don't know where to stop (if A>B the first non-zero 8 digits block
would tell use when).
Here again we need to grab #3\W to position the actually used terminating delimiters.
```

```
992 \def\XINT_sub_p;\XINT_sub_1 #1#2\W #3\W
993 {%
994     \xint_UDzerofork
995     #1{1;!1\XINT_sub_fix_neg!%
996         1;!1\R!1\R!1\R!1\R!1\R!1\R!1\R!1\R!\W
997         \xint_bye2345678\xint_bye1099999988\relax}% A - B, B > A
998         0{1;!1\XINT_sub_fix_cuz!%
999         1;!1\R!1\R!1\R!1\R!1\R!1\R!1\R!1\R!\W}%
1000     \krof
1001     \xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\Z
1002 }%
```

### 3 Package *xintcore* implementation

Routines for post-processing after reversal, and removal of separators. It is a matter of cleaning up zeros, and possibly in the bad case to take a complement before that.

```
1003 \def\XINT_sub_fix_none;{\XINT_cuz_small}%
1004 \def\XINT_sub_fix_cuz ;{\expandafter\XINT_num_cleanup\the\numexpr\XINT_num_loop}%
```

Case with A and B same number of digits in base  $10^8$  and  $B > A$ .

1.2l subtle chaining on the model of the 1.2i rewrite of `\xintInc` and similar routines. After taking complement, leading zeroes need to be cleaned up as in  $B \leq A$  branch.

```
1005 \def\XINT_sub_fix_neg;%
1006 {%
1007     \expandafter-\romannumeral0\expandafter
1008     \XINT_sub_comp_finish\the\numexpr\XINT_sub_comp_loop
1009 }%
1010 \def\XINT_sub_comp_finish 0{\XINT_sub_fix_cuz;}%
1011 \def\XINT_sub_comp_loop #1#2#3#4#5#6#7#8%
1012 {%
1013     \expandafter\XINT_sub_comp_clean
1014     \the\numexpr \xint_c_xi_e_viii_mone-#1#2#3#4#5#6#7#8\XINT_sub_comp_loop
1015 }%
```

$\#1 = 0$  signifie une retenue,  $\#1 = 1$  pas de retenue, ce qui ne peut arriver que tant qu'il n'y a que des zéros du côté non significatif. Lorsqu'on est revenu au début on a forcément une retenue.

```
1016 \def\XINT_sub_comp_clean 1#1{+#1\relax}%
```

#### 3.36 `\xintiMul`, `\xintiiMul`

Completely rewritten for 1.2.

1.2l: `\xintiiMul` made robust against non terminated input.

```
1017 \def\xintiMul {\romannumeral0\xintimul }%
1018 \def\xintimul #1%
1019 {%
1020     \expandafter\XINT_imul\romannumeral0\xintnum{#1}\xint:
1021 }%
1022 \def\XINT_imul #1#2\xint:#3%
1023 {%
1024     \expandafter\XINT_mul_nfork\expandafter #1\romannumeral0\xintnum{#3}\xint:#2\xint:
1025 }%
1026 \def\xintiiMul {\romannumeral0\xintiimul }%
1027 \def\xintiimul #1%
1028 {%
1029     \expandafter\XINT_iimul\romannumeral`&&@#1\xint:
1030 }%
1031 \def\XINT_iimul #1#2\xint:#3%
1032 {%
1033     \expandafter\XINT_mul_nfork\expandafter #1\romannumeral`&&@#3\xint:#2\xint:
1034 }%
```

(1.2) I have changed the fork, and it complicates matters elsewhere.

```
1035 \def\XINT_mul_fork #1#2\xint:#3\xint:{\XINT_mul_nfork #1#3\xint:#2\xint:}%
```

### 3 Package *xintcore* implementation

```

1036 \def\XINT_mul_nfork #1#2%
1037 {%
1038   \xint_UDzerofork
1039   #1\XINT_mul_zero
1040   #2\XINT_mul_zero
1041   0{}%
1042   \krof
1043   \xint_UDsignsfork
1044   #1#2\XINT_mul_minusminus
1045   #1-\XINT_mul_minusplus
1046   #2-\XINT_mul_plusminus
1047   --\XINT_mul_plusplus
1048   \krof #1#2%
1049 }%
1050 \def\XINT_mul_zero #1\krof #2#3\xint:#4\xint:{ 0}%
1051 \def\XINT_mul_minusminus #1#2{\XINT_mul_plusplus {}{}}%
1052 \def\XINT_mul_minusplus #1#2%
1053   {\expandafter-\romannumeral0\XINT_mul_plusplus {}#2}%
1054 \def\XINT_mul_plusminus #1#2%
1055   {\expandafter-\romannumeral0\XINT_mul_plusplus #1{}}%
1056 \def\XINT_mul_plusplus #1#2#3\xint:
1057 {%
1058   \expandafter\XINT_mul_pre_b
1059   \romannumeral0\expandafter\XINT_sepandrev_andcount
1060   \romannumeral0\XINT_zeroes_forviii #2#3\R\R\R\R\R\R\R\R{10}0000001\W
1061   #2#3\XINT_rsepybviii_end_A 2345678%
1062   \XINT_rsepybviii_end_B 2345678\relax\xint_c_ii\xint_c_i
1063   \R\xint:\xint_c_xii \R\xint:\xint_c_x \R\xint:\xint_c_viii \R\xint:\xint_c_vi
1064   \R\xint:\xint_c_iv \R\xint:\xint_c_ii \R\xint:\xint_c_\W
1065   \W #1%
1066 }%
1067 \def\XINT_mul_pre_b #1\xint:#2\W #3\xint:
1068 {%
1069   \expandafter\XINT_mul_checklengths
1070   \the\numexpr #1\expandafter\xint:%
1071   \romannumeral0\expandafter\XINT_sepandrev_andcount
1072   \romannumeral0\XINT_zeroes_forviii #3\R\R\R\R\R\R\R\R{10}0000001\W
1073   #3\XINT_rsepybviii_end_A 2345678%
1074   \XINT_rsepybviii_end_B 2345678\relax\xint_c_ii\xint_c_i
1075   \R\xint:\xint_c_xii \R\xint:\xint_c_x \R\xint:\xint_c_viii \R\xint:\xint_c_vi
1076   \R\xint:\xint_c_iv \R\xint:\xint_c_ii \R\xint:\xint_c_\W
1077   1;!\W #21;!\%
1078   1\R!1\R!1\R!1\R!1\R!1\R!1\R!1\R!1\W
1079 }%

```

Cooking recipe, 2015/10/05.

```

1080 \def\XINT_mul_checklengths #1\xint:#2\xint:%
1081 {%
1082   \ifnum #2=\xint_c_i\expandafter\XINT_mul_smallbyfirst\fi
1083   \ifnum #1=\xint_c_i\expandafter\XINT_mul_smallbysecond\fi
1084   \ifnum #2<#1
1085     \ifnum \numexpr (#2-\xint_c_i)*(#1-#2)<383

```

### 3 Package *xintcore* implementation

```

1086      \XINT_mul_exchange
1087    \fi
1088  \else
1089    \ifnum \numexpr (#1-\xint_c_i)*(#2-#1)>383
1090      \XINT_mul_exchange
1091    \fi
1092  \fi
1093  \XINT_mul_start
1094 }%
1095 \def\XINT_mul_smallbyfirst #1\XINT_mul_start 1#2!1;!\W
1096 {%
1097   \ifnum#2=\xint_c_i\expandafter\XINT_mul_oneisone\fi
1098   \ifnum#2<\xint_c_xxii\expandafter\XINT_mul_verysmall\fi
1099   \expandafter\XINT_mul_out\the\numexpr\XINT_smallmul 1#2!%
1100 }%
1101 \def\XINT_mul_smallbysecond #1\XINT_mul_start #2\W 1#3!1;!\W
1102 {%
1103   \ifnum#3=\xint_c_i\expandafter\XINT_mul_oneisone\fi
1104   \ifnum#3<\xint_c_xxii\expandafter\XINT_mul_verysmall\fi
1105   \expandafter\XINT_mul_out\the\numexpr\XINT_smallmul 1#3!#2%
1106 }%
1107 \def\XINT_mul_oneisone #1!\XINT_mul_out }%
1108 \def\XINT_mul_verysmall\expandafter\XINT_mul_out
1109       \the\numexpr\XINT_smallmul 1#1!%
1110   {\expandafter\XINT_mul_out\the\numexpr\XINT_verysmallmul 0\xint:#1!}%
1111 \def\XINT_mul_exchange #1\XINT_mul_start #2\W #3!;!\W
1112   {\fi\fi\XINT_mul_start #3!;!\W #2}%

1113 \def\XINT_mul_start
1114   {\expandafter\XINT_mul_out\the\numexpr\XINT_mul_loop 100000000!1;!\W}%
1115 \def\XINT_mul_out
1116   {\expandafter\XINT_cuz_small\romannumeral0\XINT_unrevbyviii {}}%

```

Call:

\the\numexpr \XINT\_mul\_loop 100000000!1;!\W #11;!\W #21;!

where #1 and #2 are (globally reversed) blocks 1<8d>!. Its is generally more efficient if #1 is the shorter one, but a better recipe is implemented in \XINT\_mul\_checklengths. One may call \XINT\_mul\_loop directly (but multiplication by zero will produce many 100000000! blocks on output).

Ends after having produced: 1<8d>!...1<8d>!1;!. The last 8-digits block is significant one. It can not be 100000000! except if the loop was called with a zero operand.

Thus \XINT\_mul\_loop can be conveniently called directly in recursive routines, as the output terminator can serve as input terminator, we can arrange to not have to grab the whole thing again.

```

1117 \def\XINT_mul_loop #1\W #2\W 1#3!%
1118 {%
1119   \xint_gob_til_sc #3\XINT_mul_e ;%
1120   \expandafter\XINT_mul_a\the\numexpr \XINT_smallmul 1#3!#2\W
1121   #1\W #2\W
1122 }%

```



### 3 Package *xintcore* implementation

Each of #1 and #2 brings its 1;! for \XINT\_add\_a.

```
1123 \def\XINT_mul_a #1\W #2\W
1124 {%
1125   \expandafter\XINT_mul_b\the\numexpr
1126   \XINT_add_a \xint_c_ii #21;!1;!1;!W #11;!1;!1;!W\W
1127 }%
1128 \def\XINT_mul_b 1#1!\{1#1\expandafter!\the\numexpr\XINT_mul_loop }%
1129 \def\XINT_mul_e;#1\W 1#2\W #3\W {1\relax #2}%
```

1.2 small and mini multiplication in base  $10^8$  with carry. Used by the main multiplication routines. But division, float factorial, etc.. have their own variants as they need output with specific constraints.

The minimulwc has 1<8digits carry>.<4 high digits>.<4 low digits!<8digits>.

It produces a block 1<8d>! and then jump back into \XINT\_smallmul\_a with the new 8digits carry as argument. The \XINT\_smallmul\_a fetches a new 1<8d>! block to multiply, and calls back \XINT\_minimul\_wc having stored the multiplicand for re-use later. When the loop terminates, the final carry is checked for being nul, and in all cases the output is terminated by a 1;!

Multiplication by zero will produce blocks of zeros.

```
1130 \def\XINT_minimulwc_a 1#1\xint:#2\xint:#3!#4#5#6#7#8\xint:%
1131 {%
1132   \expandafter\XINT_minimulwc_b
1133   \the\numexpr \xint_c_x^ix+#1+#3*#8\xint:
1134               #3*#4#5#6#7+#2*#8\xint:
1135               #2*#4#5#6#7\xint:%
1136 }%
1137 \def\XINT_minimulwc_b 1#1#2#3#4#5#6\xint:#7\xint:%
1138 {%
1139   \expandafter\XINT_minimulwc_c
1140   \the\numexpr \xint_c_x^ix+#1#2#3#4#5+#7\xint:#6\xint:%
1141 }%
1142 \def\XINT_minimulwc_c 1#1#2#3#4#5#6\xint:#7\xint:#8\xint:%
1143 {%
1144   1#6#7\expandafter!%
1145   \the\numexpr\expandafter\XINT_smallmul_a
1146   \the\numexpr \xint_c_x^viii+#1#2#3#4#5+#8\xint:%
1147 }%
1148 \def\XINT_smallmul 1#1#2#3#4#5!\{\XINT_smallmul_a 100000000\xint:#1#2#3#4\xint:#5!}%
1149 \def\XINT_smallmul_a #1\xint:#2\xint:#3!1#4!%
1150 {%
1151   \xint_gob_til_sc #4\XINT_smallmul_e;%
1152   \XINT_minimulwc_a #1\xint:#2\xint:#3!#4\xint:#2\xint:#3!%
1153 }%
1154 \def\XINT_smallmul_e;\XINT_minimulwc_a 1#1\xint:#2;#3!%
1155   {\xint_gob_til_eightzeroes #1\XINT_smallmul_f 000000001\relax #1!1;!}%
1156 \def\XINT_smallmul_f 000000001\relax 00000000!1{1\relax}%

1157 \def\XINT_verysmallmul #1\xint:#2!1#3!%
1158 {%
1159   \xint_gob_til_sc #3\XINT_verysmallmul_e;%
1160   \expandafter\XINT_verysmallmul_a
```

### 3 Package *xintcore* implementation

```
1161 \the\numexpr #2*#3+#1\xint:#2!%
1162 }%
1163 \def\XINT_verysmallmul_e;\expandafter\XINT_verysmallmul_a\the\numexpr
1164 #1+#2#3\xint:#4!%
1165 {\xint_gob_til_zero #2\XINT_verysmallmul_f 0\xint_c_x^viii+#2#3!1;!}%
1166 \def\XINT_verysmallmul_f #1!1{1\relax}%
1167 \def\XINT_verysmallmul_a #1#2\xint:%
1168 {%
1169 \unless\ifnum #1#2<\xint_c_x^ix
1170 \expandafter\XINT_verysmallmul_bi\else
1171 \expandafter\XINT_verysmallmul_bj\fi
1172 \the\numexpr \xint_c_x^ix+#1#2\xint:%
1173 }%
1174 \def\XINT_verysmallmul_bj{\expandafter\XINT_verysmallmul_cj }%
1175 \def\XINT_verysmallmul_cj 1#1#2\xint:%
1176 {1#2\expandafter!\the\numexpr\XINT_verysmallmul #1\xint:}%
1177 \def\XINT_verysmallmul_bi\the\numexpr\xint_c_x^ix+#1#2#3\xint:%
1178 {1#3\expandafter!\the\numexpr\XINT_verysmallmul #1#2\xint:}%

```

Used by division and by squaring, not by multiplication itself.

This routine does not loop, it only does one mini multiplication with input format <4 high digits>.<4 low digits>!<8 digits>!, and on output 1<8d>!1<8d>!, with least significant block first.

```
1179 \def\XINT_minimul_a #1\xint:#2!#3#4#5#6#7!%
1180 {%
1181 \expandafter\XINT_minimul_b
1182 \the\numexpr \xint_c_x^viii+#2*#7\xint:#2*#3#4#5#6+#1*#7\xint:#1*#3#4#5#6\xint:%
1183 }%
1184 \def\XINT_minimul_b 1#1#2#3#4#5\xint:#6\xint:%
1185 {%
1186 \expandafter\XINT_minimul_c
1187 \the\numexpr \xint_c_x^ix+#1#2#3#4+#6\xint:#5\xint:%
1188 }%
1189 \def\XINT_minimul_c 1#1#2#3#4#5#6\xint:#7\xint:#8\xint:%
1190 {%
1191 1#6#7\expandafter!\the\numexpr \xint_c_x^viii+#1#2#3#4#5+#8!%
1192 }%

```

### 3.37 \xintiDivision, \xintiQuo, \xintiRem, \xintiiDivision, \xintiiQuo, \xintiiRem

Completely rewritten for 1.2.

WARNING: some comments below try to describe the flow of tokens but they date back to xint 1.09j and I updated them on the fly while doing the 1.2 version. As the routine now works in base  $10^8$ , not  $10^4$  and "drops" the quotient digits, rather than store them upfront as the earlier code, I may well have not correctly converted all such comments. At the last minute some previously #1 became stuff like #1#2#3#4, then of course the old comments describing what the macro parameters stand for are necessarily wrong.

Side remark: the way tokens are grouped was not essentially modified in 1.2, although the situation has changed. It was fine-tuned in xint 1.0/1.1 but the context has changed, and perhaps I should revisit this. As a corollary to the fact that quotient digits are now left behind thanks to the chains of \numexpr, some macros which in 1.0/1.1 fetched up to 9 parameters now need handle less such parameters. Thus, some rationale for the way the code was structured has disappeared.

1.21: `\xintiiDivision` et al. made robust against non terminated input.

```

1193 \def\xintiiQuo {\romannumeral0\xintiiquo }%
1194 \def\xintiiRem {\romannumeral0\xintiirem }%
1195 \def\xintiiquo {\expandafter\xint_firstoftwo_thenstop\romannumeral0\xintiidivision }%
1196 \def\xintiirem {\expandafter\xint_secondoftwo_thenstop\romannumeral0\xintiidivision }%
1197 \def\xintiQuo {\romannumeral0\xintiquo }%
1198 \def\xintiRem {\romannumeral0\xintirem }%
1199 \def\xintiquo {\expandafter\xint_firstoftwo_thenstop\romannumeral0\xintidivision }%
1200 \def\xintirem {\expandafter\xint_secondoftwo_thenstop\romannumeral0\xintidivision }%
1201 %%\let\xintQuo\xintiQuo\let\xintquo\xintiquo % now removed
1202 %%\let\xintRem\xintiRem\let\xintrem\xintirem % now removed

```

#1 = A, #2 = B. On calcule le quotient et le reste dans la division euclidienne de A par B:  $A=BQ+R$ ,  $0 \leq R < |B|$ .

```

1203 \def\xintiDivision {\romannumeral0\xintidivision }%
1204 \def\xintidivision #1{\expandafter\XINT_idivision\romannumeral0\xintnum{#1}\xint:}%
1205 \def\XINT_idivision #1#2\xint:#3{\expandafter\XINT_iidivision_a\expandafter #1%
1206 \romannumeral0\xintnum{#3}\xint:#2\xint:}%
1207 \def\xintiiDivision {\romannumeral0\xintiidivision }%
1208 \def\xintiidivision #1{\expandafter\XINT_iidivision \romannumeral`&&@#1\xint:}%
1209 \def\XINT_iidivision #1#2\xint:#3{\expandafter\XINT_iidivision_a\expandafter #1%
1210 \romannumeral`&&@#3\xint:#2\xint:}%

```

On regarde les signes de A et de B.

```

1211 \def\XINT_iidivision_a #1#2% #1 de A, #2 de B.
1212 {%
1213 \if0#2\xint_dothis{\XINT_iidivision_divbyzero #1#2}\fi
1214 \if0#1\xint_dothis{\XINT_iidivision_aiszero}\fi
1215 \if-#2\xint_dothis{\expandafter\XINT_iidivision_bneg
1216 \romannumeral0\XINT_iidivision_bpos #1}\fi
1217 \xint_orthat{\XINT_iidivision_bpos #1#2}%
1218 }%
1219 \def\XINT_iidivision_divbyzero#1#2#3\xint:#4\xint:
1220 {\if0#1\xint_dothis{\XINT_signalcondition{DivisionUndefined}}\fi
1221 \xint_orthat{\XINT_signalcondition{DivisionByZero}}%
1222 {Division of #1#4 by #2#3}{\{0\}{0}}}%
1223 \def\XINT_iidivision_aiszero #1\xint:#2\xint:{\{0\}{0}}}%
1224 \def\XINT_iidivision_bneg #1% q->-q, r unchanged
1225 {\expandafter{\romannumeral0\XINT_opp #1}}%
1226 \def\XINT_iidivision_bpos #1%
1227 {%
1228 \xint_UDsignfork
1229 #1\XINT_iidivision_aneg
1230 -{\XINT_iidivision_apos #1}%
1231 \krof
1232 }%

```

Donc attention malgré son nom `\XINT_div_prepare` va jusqu'au bout. C'est donc en fait l'entrée principale (pour  $B > 0$ ,  $A > 0$ ) mais elle va regarder si B est  $< 10^8$  et s'il vaut alors 1 ou 2, et si  $A < 10^8$ . Dans tous les cas le résultat est produit sous la forme  $\{Q\}\{R\}$ , avec Q et R sous leur forme final. On doit ensuite ajuster si le B ou le A initial était négatif. Je n'ai pas fait beaucoup d'efforts pour être un minimum efficace si A ou B n'est pas positif.

### 3 Package *xintcore* implementation

```

1233 \def\XINT_iidivision_apos #1#2\xint:#3\xint:{\XINT_div_prepare {#2}{#1#3}}%
1234 \def\XINT_iidivision_aneg #1\xint:#2\xint:
1235   {\expandafter
1236     \XINT_iidivision_aneg_b\romannumeral0\XINT_div_prepare {#1}{#2}{#1}}%
1237 \def\XINT_iidivision_aneg_b #1#2{\if0\XINT_Sgn #2\xint:
1238   \expandafter\XINT_iidivision_aneg_rzero
1239   \else
1240   \expandafter\XINT_iidivision_aneg_rpos
1241   \fi {#1}{#2}}%
1242 \def\XINT_iidivision_aneg_rzero #1#2#3{{-#1}{0}}% necessarily q was >0
1243 \def\XINT_iidivision_aneg_rpos #1%
1244 {%
1245   \expandafter\XINT_iidivision_aneg_end\expandafter
1246   {\expandafter-\romannumeral0\xintinc {#1}}% q-> -(1+q)
1247 }%
1248 \def\XINT_iidivision_aneg_end #1#2#3%
1249 {%
1250   \expandafter\xint_exchangetwo_keepbraces
1251   \expandafter{\romannumeral0\XINT_sub_mm_a {}}{#3\xint:#2\xint:}{#1}% r-> b-r
1252 }%

```

Le diviseur B va être étendu par des zéros pour que sa longueur soit multiple de huit. Les zéros seront mis du côté non significatif.

```

1253 \def\XINT_div_prepare #1%
1254 {%
1255   \XINT_div_prepare_a #1\R\R\R\R\R\R\R {10}0000001\W !{#1}%
1256 }%
1257 \def\XINT_div_prepare_a #1#2#3#4#5#6#7#8#9%
1258 {%
1259   \xint_gob_til_R #9\XINT_div_prepare_small\R
1260   \XINT_div_prepare_b #9%
1261 }%

```

B a au plus huit chiffres. On se débarrasse des trucs superflus. Si B>0 n'est ni 1 ni 2, le point d'entrée est \XINT\_div\_small\_a {B}{A} (avec un A positif).

```

1262 \def\XINT_div_prepare_small\R #1!#2%
1263 {%
1264   \ifcase #2
1265   \or\expandafter\XINT_div_BisOne
1266   \or\expandafter\XINT_div_BisTwo
1267   \else\expandafter\XINT_div_small_a
1268   \fi {#2}%
1269 }%
1270 \def\XINT_div_BisOne #1#2{{#2}{0}}%
1271 \def\XINT_div_BisTwo #1#2%
1272 {%
1273   \expandafter\expandafter\expandafter\XINT_div_BisTwo_a
1274   \ifodd\xintiiLDg{#2} \expandafter1\else \expandafter0\fi {#2}%
1275 }%
1276 \def\XINT_div_BisTwo_a #1#2%
1277 {%
1278   \expandafter{\romannumeral0\XINT_half

```

### 3 Package *xintcore* implementation

```

1279      #2\xint_bye\xint_Bye345678\xint_bye
1280      *\xint_c_v+\xint_c_v)/\xint_c_x-\xint_c_i\relax}{#1}%
1281 }%
```

B a au plus huit chiffres et est au moins 3. On va l'utiliser directement, sans d'abord le multiplier par une puissance de 10 pour qu'il ait 8 chiffres.

```

1282 \def\xint_div_small_a #1#2%
1283 {%
1284   \expandafter\xint_div_small_b
1285   \the\numexpr #1/\xint_c_ii\expandafter
1286   \xint:\the\numexpr \xint_c_x^viii+#1\expandafter!%
1287   \romannumeral0%
1288   \xint_div_small_ba #2\R\R\R\R\R\R\R\R{10}0000001\W
1289   #2\xint_sepbyviii_Z_end 2345678\relax
1290 }%
```

Le #2 poursuivra l'expansion par `\xint_div_dosmallsmall` ou par `\xint_smalldivx_a` suivi de `\xint_sdiv_out`.

```

1291 \def\xint_div_small_b #1!#2{#2#1!}%
```

On ajoute des zéros avant A, puis on le prépare sous la forme de blocs 1<8d>! Au passage on repère le cas d'un  $A < 10^8$ .

```

1292 \def\xint_div_small_ba #1#2#3#4#5#6#7#8#9%
1293 {%
1294   \xint_gob_til_R #9\xint_div_smallsmall\R
1295   \expandafter\xint_div_dosmallldiv
1296   \the\numexpr\expandafter\xint_sepbyviii_Z
1297   \romannumeral0\xint_zeroes_forviii
1298   #1#2#3#4#5#6#7#8#9%
1299 }%
```

Si  $A < 10^8$ , on va poursuivre par `\xint_div_dosmallsmall round(B/2).10^8+B!{A}`. On fait la division directe par `\numexpr`. Le résultat est produit sous la forme `{Q}{R}`.

```

1300 \def\xint_div_smallsmall\R
1301   \expandafter\xint_div_dosmallldiv
1302   \the\numexpr\expandafter\xint_sepbyviii_Z
1303   \romannumeral0\xint_zeroes_forviii #1\R #2\relax
1304   {{\xint_div_dosmallsmall}{#1}}%
1305 \def\xint_div_dosmallsmall #1\xint:1#2!#3%
1306 {%
1307   \expandafter\xint_div_smallsmallend
1308   \the\numexpr (#3+#1)/#2-\xint_c_i\xint:#2\xint:#3\xint:%
1309 }%
1310 \def\xint_div_smallsmallend #1\xint:#2\xint:#3\xint:{\expandafter
1311   {\the\numexpr #1\expandafter}\expandafter{\the\numexpr #3-#1*#2}}%
```

Si  $A \geq 10^8$ , il est maintenant sous la forme 1<8d>!...1<8d>!1;! avec plus significatifs en premier. Donc on poursuit par `\expandafter\xint_sdiv_out\the\numexpr\xint_smalldivx_a x.1B!1<8d>!...1<8d>!1;! avec  $x = \text{round}(B/2)$ ,  $1B = 10^8 + B$ .`

```

1312 \def\xint_div_dosmallldiv
1313   {{\expandafter\xint_sdiv_out\the\numexpr\xint_smalldivx_a}}%
```

### 3 Package *xintcore* implementation

Ici B est au moins  $10^8$ , on détermine combien de zéros lui adjoindre pour qu'il soit de longueur 8N.

```

1314 \def\XINT_div_prepare_b
1315   {\expandafter\XINT_div_prepare_c\romannumeral0\XINT_zeroes_forviii }%
1316 \def\XINT_div_prepare_c #1!%
1317 {%
1318   \XINT_div_prepare_d #1.00000000!{#1}%
1319 }%
1320 \def\XINT_div_prepare_d #1#2#3#4#5#6#7#8#9%
1321 {%
1322   \expandafter\XINT_div_prepare_e\xint_gob_til_dot #1#2#3#4#5#6#7#8#9!%
1323 }%
1324 \def\XINT_div_prepare_e #1!#2!#3#4%
1325 {%
1326   \XINT_div_prepare_f #4#3\X {#1}{#3}%
1327 }%

```

attention qu'on calcule ici  $x'=x+1$  ( $x$  = huit premiers chiffres du diviseur) et que si  $x=99999999$ ,  $x'$  aura donc 9 chiffres, pas compatible avec `div_mini` (avant 1.2,  $x$  avait 4 chiffres, et on faisait la division avec  $x'$  dans un `\numexpr`). Bon, facile à dire après avoir laissé passer ce bug dans 1.2. C'est le problème lorsqu'au lieu de tout refaire à partir de zéro on recycle d'anciennes routines qui avaient un contexte différent.

```

1328 \def\XINT_div_prepare_f #1#2#3#4#5#6#7#8#9\X
1329 {%
1330   \expandafter\XINT_div_prepare_g
1331   \the\numexpr #1#2#3#4#5#6#7#8+\xint_c_i\expandafter
1332   \xint:\the\numexpr (#1#2#3#4#5#6#7#8+\xint_c_i)/\xint_c_ii\expandafter
1333   \xint:\the\numexpr #1#2#3#4#5#6#7#8\expandafter
1334   \xint:\romannumeral0\XINT_sepandrev_andcount
1335   #1#2#3#4#5#6#7#8#9\XINT_rsepbyviii_end_A 2345678%
1336   \XINT_rsepbyviii_end_B 2345678\relax\xint_c_ii\xint_c_i
1337   \R\xint:\xint_c_xii \R\xint:\xint_c_x \R\xint:\xint_c_viii \R\xint:\xint_c_vi
1338   \R\xint:\xint_c_iv \R\xint:\xint_c_ii \R\xint:\xint_c_W
1339   \X
1340 }%
1341 \def\XINT_div_prepare_g #1\xint:#2\xint:#3\xint:#4\xint:#5\X #6#7#8%
1342 {%
1343   \expandafter\XINT_div_prepare_h
1344   \the\numexpr\expandafter\XINT_sepbyviii_andcount
1345   \romannumeral0\XINT_zeroes_forviii #8#7\R\R\R\R\R\R\R\{10}0000001\W
1346   #8#7\XINT_sepbyviii_end 2345678\relax
1347   \xint_c_vii!\xint_c_vi!\xint_c_v!\xint_c_iv!%
1348   \xint_c_iii!\xint_c_ii!\xint_c_i!\xint_c_W
1349   {#1}{#2}{#3}{#4}{#5}{#6}%
1350 }%
1351 \def\XINT_div_prepare_h #11\xint:#2\xint:#3#4#5#6#7#8%
1352 {%
1353   \XINT_div_start_a {#2}{#6}{#1}{#3}{#4}{#5}{#7}{#8}%
1354 }%

```

L, K, A,  $x'$ , y, x, B, «c». Attention que K est diminué de 1 plus loin. Comme xint 1.2 a déjà repéré  $K=1$ , on a ici au minimum  $K=2$ . Attention B est à l'envers, A est à l'endroit et les deux avec séparateurs.

### 3 Package *xintcore* implementation

Attention que ce n'est pas ici qu'on boucle mais en `\XINT_div_I_a`.

```

1355 \def\XINT_div_start_a #1#2%
1356 {%
1357     \ifnum #1 < #2
1358         \expandafter\XINT_div_zeroQ
1359     \else
1360         \expandafter\XINT_div_start_b
1361     \fi
1362     {#1}{#2}%
1363 }%
1364 \def\XINT_div_zeroQ #1#2#3#4#5#6#7%
1365 {%
1366     \expandafter\XINT_div_zeroQ_end
1367     \romannumeral0\XINT_unsep_cuzsmall
1368     #3\xint_bye!2!3!4!5!6!7!8!9!\xint_bye\xint_c_i\relax\xint:
1369 }%
1370 \def\XINT_div_zeroQ_end #1\xint:#2%
1371     {\expandafter{\expandafter0\expandafter}\XINT_div_cleanR #1#2\xint:}%

```

$L, K, A, x', y, x, B, \langle C \rangle \rightarrow K.A.x\{LK\{x'y\}x\}B\langle C \rangle$

```

1372 \def\XINT_div_start_b #1#2#3#4#5#6%
1373 {%
1374     \expandafter\XINT_div_finish\the\numexpr
1375     \XINT_div_start_c {#2}\xint:#3\xint:{#6}{#{1}{#2}{#{4}{#5}}{#6}}%
1376 }%
1377 \def\XINT_div_finish
1378 {%
1379     \expandafter\XINT_div_finish_a \romannumeral`&&\XINT_div_unsepQ
1380 }%
1381 \def\XINT_div_finish_a #1\Z #2\xint:{\XINT_div_finish_b #2\xint:{#1}}%

```

Ici ce sont routines de fin. Le reste déjà nettoyé.  $R.Q\langle C \rangle$ .

```

1382 \def\XINT_div_finish_b #1%
1383 {%
1384     \if0#1%
1385         \expandafter\XINT_div_finish_bRzero
1386     \else
1387         \expandafter\XINT_div_finish_bRpos
1388     \fi
1389     #1%
1390 }%
1391 \def\XINT_div_finish_bRzero 0\xint:#1#2{#{1}{0}}%
1392 \def\XINT_div_finish_bRpos #1\xint:#2#3%
1393 {%
1394     \expandafter\xint_exchangetwo_keepbraces\XINT_div_cleanR #1#3\xint:{#2}%
1395 }%
1396 \def\XINT_div_cleanR #1000000000\xint:{#{1}}%

```

$K\alpha.A.x\{LK\{x'y\}x\}, B, \langle C \rangle$ , au début  $\#2=\alpha$  est vide. On fait une boucle pour prendre  $K$  unités de  $A$  (on a au moins  $L$  égal à  $K$ ) et les mettre dans  $\alpha$ .

### 3 Package *xintcore* implementation

```

1397 \def\XINT_div_start_c #1%
1398 {%
1399   \ifnum #1>\xint_c_vi
1400     \expandafter\XINT_div_start_ca
1401   \else
1402     \expandafter\XINT_div_start_cb
1403   \fi {#1}%
1404}%
1405 \def\XINT_div_start_ca #1#2\xint:#3!#4!#5!#6!#7!#8!#9!%
1406 {%
1407   \expandafter\XINT_div_start_c\expandafter
1408   {\the\numexpr #1-\xint_c_vii}\xint:#2#3!#4!#5!#6!#7!#8!#9!\xint:%
1409}%
1410 \def\XINT_div_start_cb #1%
1411   {\csname XINT_div_start_c_\romannumeral\xint:#1\endcsname}%
1412 \def\XINT_div_start_c_i #1\xint:#2!%
1413   {\XINT_div_start_c_ #1#2!\xint:}%
1414 \def\XINT_div_start_c_ii #1\xint:#2!#3!%
1415   {\XINT_div_start_c_ #1#2!#3!\xint:}%
1416 \def\XINT_div_start_c_iii #1\xint:#2!#3!#4!%
1417   {\XINT_div_start_c_ #1#2!#3!#4!\xint:}%
1418 \def\XINT_div_start_c_iv #1\xint:#2!#3!#4!#5!%
1419   {\XINT_div_start_c_ #1#2!#3!#4!#5!\xint:}%
1420 \def\XINT_div_start_c_v #1\xint:#2!#3!#4!#5!#6!%
1421   {\XINT_div_start_c_ #1#2!#3!#4!#5!#6!\xint:}%
1422 \def\XINT_div_start_c_vi #1\xint:#2!#3!#4!#5!#6!#7!%
1423   {\XINT_div_start_c_ #1#2!#3!#4!#5!#6!#7!\xint:}%

```

*#1=a, #2=alpha (de longueur K, à l'endroit).#3=reste de A.#4=x, #5={LK{x'y}x},#6=B,«c» -> a, x, alpha, B, {00000000}, L, K, {x'y},x, alpha'=-reste de A, B«c».*

```

1424 \def\XINT_div_start_c_ #1!#2\xint:#3\xint:#4#5#6%
1425 {%
1426   \XINT_div_I_a {#1}{#4}{1#1!#2}{#6}{0000000000}#5{#3}{#6}%
1427}%

```

*Ceci est le point de retour de la boucle principale. a, x, alpha, B, q0, L, K, {x'y}, x, alpha', B«c»*

```

1428 \def\XINT_div_I_a #1#2%
1429 {%
1430   \expandafter\XINT_div_I_b\the\numexpr #1/#2\xint:{#1}{#2}%
1431}%
1432 \def\XINT_div_I_b #1%
1433 {%
1434   \xint_gob_til_zero #1\XINT_div_I_czero 0\XINT_div_I_c #1%
1435}%

```

*On intercepte petit quotient nul: #1=a, x, alpha, B, #5=q0, L, K, {x'y}, x, alpha', B«c» -> on lâche un q puis {alpha} L, K, {x'y}, x, alpha', B«c».*

```

1436 \def\XINT_div_I_czero 0\XINT_div_I_c 0\xint:#1#2#3#4#5{1#5\XINT_div_I_g {#3}}%
1437 \def\XINT_div_I_c #1\xint:#2#3%
1438 {%

```



### 3 Package *xintcore* implementation

```
1439 \expandafter\XINT_div_I_da\the\numexpr #2-#1*#3\xint:#1\xint:{#2}{#3}%
1440 }%
```

*r.q.alpha, B, q0, L, K, {x'y}, x, alpha', B«c»*

```
1441 \def\XINT_div_I_da #1\xint:%
1442 {%
1443   \ifnum #1>\xint_c_ix
1444     \expandafter\XINT_div_I_dP
1445   \else
1446     \ifnum #1<\xint_c_
1447       \expandafter\expandafter\expandafter\XINT_div_I_dN
1448     \else
1449       \expandafter\expandafter\expandafter\XINT_div_I_db
1450     \fi
1451   \fi
1452 }%
```

*attention très mauvaises notations avec \_b et \_db.*

```
1453 \def\XINT_div_I_dN #1\xint:%
1454 {%
1455   \expandafter\XINT_div_I_b\the\numexpr #1-\xint_c_i\xint:%
1456 }%
1457 \def\XINT_div_I_db #1\xint:#2#3#4#5%
1458 {%
1459   \expandafter\XINT_div_I_dc\expandafter #1%
1460   \romannumeral0\expandafter\XINT_div_sub\expandafter
1461     {\romannumeral0\XINT_rev_nounsep }#4\R!\R!\R!\R!\R!\R!\R!\R!\W}%
1462     {\the\numexpr\XINT_div_verysmallmul #1!#51;!}%
1463   \Z {#4}{#5}%
1464 }%
```

*La soustraction spéciale renvoie simplement - si le chiffre q est trop grand. On invoque dans ce cas I\_dP.*

```
1465 \def\XINT_div_I_dc #1#2%
1466 {%
1467   \if-#2\expandafter\XINT_div_I_dd\else\expandafter\XINT_div_I_de\fi
1468   #1#2%
1469 }%
1470 \def\XINT_div_I_dd #1-\Z
1471 {%
1472   \if #11\expandafter\XINT_div_I_dz\fi
1473   \expandafter\XINT_div_I_dP\the\numexpr #1-\xint_c_i\xint: XX%
1474 }%
1475 \def\XINT_div_I_dz #1XX#2#3#4%
1476 {%
1477   1#4\XINT_div_I_g {#2}%
1478 }%
1479 \def\XINT_div_I_de #1#2\Z #3#4#5{1#5+#1\XINT_div_I_g {#2}}%
```

*q.alpha, B, q0, L, K, {x'y},x, alpha'B«c» (q=0 has been intercepted) -> 1nouveauq.nouvel alpha, L, K, {x'y}, x, alpha',B«c»*

### 3 Package *xintcore* implementation

```

1480 \def\XINT_div_I_dP #1\xint:#2#3#4#5#6%
1481 {%
1482     1#6+#1\expandafter\XINT_div_I_g\expandafter
1483     {\romannumeral0\expandafter\XINT_div_sub\expandafter
1484     {\romannumeral0\XINT_rev_nounsep {}}#4\R!\R!\R!\R!\R!\R!\R!\R!\W}%
1485     {\the\numexpr\XINT_div_verysmallmul #1!#51;!}%
1486 }%
1487 }%

1#1=nouveau q. nouvel alpha, L, K, {x'y},x,alpha', BQ«c»

#1=q,#2=nouvel alpha,#3=L, #4=K, #5={x'y}, #6=x, #7= alpha',#8=B, «c» -> on laisse q puis
{x'y}alpha.alpha'.{\x'y}xKL}B«c»

1488 \def\XINT_div_I_g #1#2#3#4#5#6#7%
1489 {%
1490     \expandafter !\the\numexpr
1491     \ifnum#2=#3
1492         \expandafter\XINT_div_exittofinish
1493     \else
1494         \expandafter\XINT_div_I_h
1495     \fi
1496     {#4}#1\xint:#6\xint:{{#4}{#5}{#3}{#2}}{#7}%
1497 }%

{x'y}alpha.alpha'.{\x'y}xKL}B«c» -> Attention retour à l'envoyeur ici par terminaison des \the\numexpr.
On doit reprendre le Q déjà sorti, qui n'a plus de séparateurs, ni de leading 1. Ensuite R sans
leading zeros.«c»

1498 \def\XINT_div_exittofinish #1#2\xint:#3\xint:#4#5%
1499 {%
1500     1\expandafter\expandafter\expandafter!\expandafter\XINT_div_unsepQ_delim
1501     \romannumeral0\XINT_div_unsepR #2#3%
1502     \xint_bye!2!3!4!5!6!7!8!9!\xint_bye\xint_c_i\relax\R\xint:
1503 }%

ATTENTION DESCRIPTION OBSOLÈTE. #1={x'y}alpha.#2!#3=reste de A. #4={{x'y},x,K,L},#5=B,«c» de-
vient {x'y},alpha sur K+4 chiffres.B, {{x'y},x,K,L}, #6= nouvel alpha',B,«c»

1504 \def\XINT_div_I_h #1\xint:#2!#3\xint:#4#5%
1505 {%
1506     \XINT_div_II_b #1#2!\xint:{{#5}{#4}{#3}{#5}}%
1507 }%

{x'y}alpha.B, {{x'y},x,K,L}, nouveau alpha',B,«c»

1508 \def\XINT_div_II_b #1#2!#3!%
1509 {%
1510     \xint_gob_til_eightzeroes #2\XINT_div_II_skipc 00000000%
1511     \XINT_div_II_c #1{1#2}{#3}%
1512 }%

```

### 3 Package *xintcore* implementation

$x'y\{100000000\}\{1<8>\}$ reste de  $\alpha.\#6=B,\#7=\{\{x'y\},x,K,L\}$ ,  $\alpha'$ ,  $B$ ,  $\llcorner c \ggcorner \rightarrow \{x'y\}x,K,L$  (à diminuer de 4),  $\{\alpha$  sur  $K\}B\{q1=00000000\}\{\alpha'\}B,\llcorner c \ggcorner$

```
1513 \def\XINT_div_II_skipc 00000000\XINT_div_II_c #1#2#3#4#5\xint:#6#7%
1514 {%
1515     \XINT_div_II_k #7{\#4!\#5}\#6\{00000000\}%
1516 }%
```

$x'ya \rightarrow 1qx'y\alpha.B, \{\{x'y\},x,K,L\}$ , nouveau  $\alpha'$ ,  $B$ ,  $\llcorner c \ggcorner$ . En fait, attention, ici #3 et #4 sont les 16 premiers chiffres du numérateur, sous la forme blocs  $1<8>$ chiffres.

```
1517 \def\XINT_div_II_c #1#2#3#4%
1518 {%
1519     \expandafter\XINT_div_II_d\the\numexpr\XINT_div_xmini
1520     #1\xint:#2!\#3!\#4!\#1\{\#2\}\#3!\#4!%
1521 }%
1522 \def\XINT_div_xmini #1%
1523 {%
1524     \xint_gob_til_one #1\XINT_div_xmini_a 1\XINT_div_mini #1%
1525 }%
1526 \def\XINT_div_xmini_a 1\XINT_div_mini 1#1%
1527 {%
1528     \xint_gob_til_zero #1\XINT_div_xmini_b 0\XINT_div_mini 1#1%
1529 }%
1530 \def\XINT_div_xmini_b 0\XINT_div_mini 10#1#2#3#4#5#6#7%
1531 {%
1532     \xint_gob_til_zero #7\XINT_div_xmini_c 0\XINT_div_mini 10#1#2#3#4#5#6#7%
1533 }%
```

$x'=10^8$  and we return  $\#1=1<8>$ digits.

```
1534 \def\XINT_div_xmini_c 0\XINT_div_mini 100000000\xint:50000000!\#1!\#2!\#1!}%

```

1 suivi de  $q1$  sur huit chiffres!  $\#2=x'$ ,  $\#3=y$ ,  $\#4=\alpha.\#5=B, \{\{x'y\},x,K,L\}$ ,  $\alpha'$ ,  $B$ ,  $\llcorner c \ggcorner \rightarrow$  nouvel  $\alpha.x',y,B,q1,\{\{x'y\},x,K,L\}$ ,  $\alpha'$ ,  $B$ ,  $\llcorner c \ggcorner$

```
1535 \def\XINT_div_II_d 1#1#2#3#4#5!\#6#7#8\xint:#9%
1536 {%
1537     \expandafter\XINT_div_II_e
1538     \romannumeral0\expandafter\XINT_div_sub\expandafter
1539     {\romannumeral0\XINT_rev_nounsep \{\#8\R!\R!\R!\R!\R!\R!\R!\R!\W\}%
1540     {\the\numexpr\XINT_div_smallmul_a 100000000\xint:#1#2#3#4\xint:#5!\#9!;!}%
1541     \xint:\{\#6\}\{\#7\}\{\#9\}\#1#2#3#4#5}%
1542 }%
```

$\alpha.x',y,B,q1, \{\{x'y\},x,K,L\}$ ,  $\alpha'$ ,  $B$ ,  $\llcorner c \ggcorner$ . Attention la soustraction spéciale doit maintenir les blocs  $1<8>$ !

```
1543 \def\XINT_div_II_e 1#1!%
1544 {%
1545     \xint_gob_til_eightzeroes #1\XINT_div_II_skipf 00000000%
1546     \XINT_div_II_f 1#1!%
1547 }%
```

### 3 Package *xintcore* implementation

100000000! alpha sur K chiffres. #2=x', #3=y, #4=B, #5=q1, #6={{x'y},x,K,L}, #7=alpha', B«c» -> {x'y}x,K,L (à diminuer de 1), {alpha sur K}B{q1}{alpha'}B«c»

1548 \def\XINT\_div\_II\_skipf 00000000\XINT\_div\_II\_f 100000000!#1\xint:#2#3#4#5#6%

1549 {%

1550 \XINT\_div\_II\_k #6{#1}{#4}{#5}%

1551 }%

1<a1>!1<a2>!, alpha (sur K+1 blocs de 8). x', y, B, q1, {{x'y},x,K,L}, alpha', B,«c».

Here also we are dividing with x' which could be  $10^8$  in the exceptional case  $x=99999999$ . Must intercept it before sending to \XINT\_div\_mini.

1552 \def\XINT\_div\_II\_f #1!#2!#3\xint:%

1553 {%

1554 \XINT\_div\_II\_fa {#1!#2!}{#1!#2!#3}%

1555 }%

1556 \def\XINT\_div\_II\_fa #1#2#3#4%

1557 {%

1558 \expandafter\XINT\_div\_II\_g \the\numexpr\XINT\_div\_xmini #3\xint:#4!#1{#2}%

1559 }%

#1=q, #2=alpha (K+4), #3=B, #4=q1, {{x'y},x,K,L}, alpha', BQ«c» -> 1 puis nouveau q sur 8 chiffres. nouvel alpha sur K blocs, B, {{x'y},x,K,L}, alpha', B«c»

1560 \def\XINT\_div\_II\_g 1#1#2#3#4#5!#6#7#8%

1561 {%

1562 \expandafter \XINT\_div\_II\_h

1563 \the\numexpr 1#1#2#3#4#5+#8\expandafter\expandafter\expandafter

1564 \xint:\expandafter\expandafter\expandafter

1565 {\expandafter\xint\_gob\_til\_exclam

1566 \romannumeral0\expandafter\XINT\_div\_sub\expandafter

1567 {\romannumeral0\XINT\_rev\_nounsep }#6\R!\R!\R!\R!\R!\R!\R!\R!\W}%

1568 {\the\numexpr\XINT\_div\_smallmul\_a 100000000\xint:#1#2#3#4\xint:#5!#71;!}%

1569 {#7}%

1570 }%

1 puis nouveau q sur 8 chiffres, #2=nouvel alpha sur K blocs, #3=B, #4={{x'y},x,K,L} avec L à ajuster, alpha', BQ«c» -> {x'y}x,K,L à diminuer de 1, {alpha}B{q}, alpha', BQ«c»

1571 \def\XINT\_div\_II\_h 1#1\xint:#2#3#4%

1572 {%

1573 \XINT\_div\_II\_k #4{#2}{#3}{#1}%

1574 }%

{x'y}x,K,L à diminuer de 1, alpha, B{q}alpha', B«c» -> nouveau L.K,x',y,x,alpha.B,q,alpha',B,«c» -> {LK{x'y}x},x,a,alpha.B,q,alpha',B,«c»

1575 \def\XINT\_div\_II\_k #1#2#3#4#5%

1576 {%

1577 \expandafter\XINT\_div\_II\_l \the\numexpr #4-\xint\_c\_i\xint:{#3}#1{#2}#5\xint:%

1578 }%

1579 \def\XINT\_div\_II\_l #1\xint:#2#3#4#5!#6!%

1580 {%

1581 \XINT\_div\_II\_m {{#1}{#2}}{{#3}{#4}}{{#5}}{{#5}}{{#6}1#6!%

1582 }%

### 3 Package *xintcore* implementation

$\{LK\{x'y\}x\}, x, a, \alpha. B\{q\}\alpha' B \rightarrow a, x, \alpha, B, q, L, K, \{x'y\}, x, \alpha', B \ll c \gg$

```
1583 \def\XINT_div_II_m #1#2#3#4\xint:#5#6%
1584 {%
1585     \XINT_div_I_a {#3}{#2}{#4}{#5}{#6}#1%
1586 }%
```

This multiplication is exactly like `\XINT_smallmul` -- apart from not inserting an ending 1;! --, but keeps ever a vanishing ending carry.

```
1587 \def\XINT_div_minimulwc_a 1#1\xint:#2\xint:#3!#4#5#6#7#8\xint:%
1588 {%
1589     \expandafter\XINT_div_minimulwc_b
1590     \the\numexpr \xint_c_x^ix+#1+#3*#8\xint:#3*#4#5#6#7+#2*#8\xint:#2*#4#5#6#7\xint:%
1591 }%
1592 \def\XINT_div_minimulwc_b 1#1#2#3#4#5#6\xint:#7\xint:%
1593 {%
1594     \expandafter\XINT_div_minimulwc_c
1595     \the\numexpr \xint_c_x^ix+#1#2#3#4#5+#7\xint:#6\xint:%
1596 }%
1597 \def\XINT_div_minimulwc_c 1#1#2#3#4#5#6\xint:#7\xint:#8\xint:%
1598 {%
1599     1#6#7\expandafter!%
1600     \the\numexpr\expandafter\XINT_div_smallmul_a
1601     \the\numexpr \xint_c_x^viii+#1#2#3#4#5+#8\xint:%
1602 }%
1603 \def\XINT_div_smallmul_a #1\xint:#2\xint:#3!1#4!%
1604 {%
1605     \xint_gob_til_sc #4\XINT_div_smallmul_e;%
1606     \XINT_div_minimulwc_a #1\xint:#2\xint:#3!#4\xint:#2\xint:#3!%
1607 }%
1608 \def\XINT_div_smallmul_e;\XINT_div_minimulwc_a 1#1\xint:#2;#3!{1\relax #1!}%

```

Special very small multiplication for division. We only need to cater for multiplicands from 1 to 9. The ending is different from standard `verysmallmul`, a zero carry is not suppressed. And no final 1;! is added. If multiplicand is just 1 let's not forget to add the zero carry 100000000! at the end.

```
1609 \def\XINT_div_verysmallmul #1%
1610     {\xint_gob_til_one #1\XINT_div_verysmallisone 1\XINT_div_verysmallmul_a 0\xint:#1}%
1611 \def\XINT_div_verysmallisone 1\XINT_div_verysmallmul_a 0\xint:1!1#11;!%
1612     {1\relax #1100000000!}%
1613 \def\XINT_div_verysmallmul_a #1\xint:#2!1#3!%
1614 {%
1615     \xint_gob_til_sc #3\XINT_div_verysmallmul_e;%
1616     \expandafter\XINT_div_verysmallmul_b
1617     \the\numexpr \xint_c_x^ix+#2*#3+#1\xint:#2!%
1618 }%
1619 \def\XINT_div_verysmallmul_b 1#1#2\xint:%
1620     {1#2\expandafter!\the\numexpr\XINT_div_verysmallmul_a #1\xint:}%
1621 \def\XINT_div_verysmallmul_e;#1;+#2#3!{1\relax 0000000#2!}%

```

Special subtraction for division purposes. If the subtracted thing turns out to be bigger, then just return a -. If not, then we must reverse the result, keeping the separators.

### 3 Package *xintcore* implementation

```

1622 \def\XINT_div_sub #1#2%
1623 {%
1624     \expandafter\XINT_div_sub_clean
1625     \the\numexpr\expandafter\XINT_div_sub_a\expandafter
1626     1#2;!!;!!;!!\W #1;!!;!!;!!\W
1627 }%
1628 \def\XINT_div_sub_clean #1-#2#3\W
1629 {%
1630     \if1#2\expandafter\XINT_rev_nounsep\else\expandafter\XINT_div_sub_neg\fi
1631     {}#1\R!\R!\R!\R!\R!\R!\R!\R!\W
1632 }%
1633 \def\XINT_div_sub_neg #1\W { -}%
1634 \def\XINT_div_sub_a #1!#2!#3!#4!#5\W #6!#7!#8!#9!%
1635 {%
1636     \XINT_div_sub_b #1!#6!#2!#7!#3!#8!#4!#9!#5\W
1637 }%
1638 \def\XINT_div_sub_b #1#2#3!#4!%
1639 {%
1640     \xint_gob_til_sc #4\XINT_div_sub_bi ;%
1641     \expandafter\XINT_div_sub_c\the\numexpr#1-#3+1#4-\xint_c_i\xint:%
1642 }%
1643 \def\XINT_div_sub_c 1#1#2\xint:%
1644 {%
1645     1#2\expandafter!\the\numexpr\XINT_div_sub_d #1%
1646 }%
1647 \def\XINT_div_sub_d #1#2#3!#4!%
1648 {%
1649     \xint_gob_til_sc #4\XINT_div_sub_di ;%
1650     \expandafter\XINT_div_sub_e\the\numexpr#1-#3+1#4-\xint_c_i\xint:%
1651 }%
1652 \def\XINT_div_sub_e 1#1#2\xint:%
1653 {%
1654     1#2\expandafter!\the\numexpr\XINT_div_sub_f #1%
1655 }%
1656 \def\XINT_div_sub_f #1#2#3!#4!%
1657 {%
1658     \xint_gob_til_sc #4\XINT_div_sub_fi ;%
1659     \expandafter\XINT_div_sub_g\the\numexpr#1-#3+1#4-\xint_c_i\xint:%
1660 }%
1661 \def\XINT_div_sub_g 1#1#2\xint:%
1662 {%
1663     1#2\expandafter!\the\numexpr\XINT_div_sub_h #1%
1664 }%
1665 \def\XINT_div_sub_h #1#2#3!#4!%
1666 {%
1667     \xint_gob_til_sc #4\XINT_div_sub_hi ;%
1668     \expandafter\XINT_div_sub_i\the\numexpr#1-#3+1#4-\xint_c_i\xint:%
1669 }%
1670 \def\XINT_div_sub_i 1#1#2\xint:%
1671 {%
1672     1#2\expandafter!\the\numexpr\XINT_div_sub_a #1%
1673 }%

```

### 3 Package *xintcore* implementation

```

1674 \def\XINT_div_sub_bi;%
1675   \expandafter\XINT_div_sub_c\the\numexpr#1-#2+#3\xint:#4!#5!#6!#7!#8!#9!;! \W
1676 {%
1677   \XINT_div_sub_l #1#2!#5!#7!#9!%
1678 }%
1679 \def\XINT_div_sub_di;%
1680   \expandafter\XINT_div_sub_e\the\numexpr#1-#2+#3\xint:#4!#5!#6!#7!#8\W
1681 {%
1682   \XINT_div_sub_l #1#2!#5!#7!%
1683 }%
1684 \def\XINT_div_sub_fi;%
1685   \expandafter\XINT_div_sub_g\the\numexpr#1-#2+#3\xint:#4!#5!#6\W
1686 {%
1687   \XINT_div_sub_l #1#2!#5!%
1688 }%
1689 \def\XINT_div_sub_hi;%
1690   \expandafter\XINT_div_sub_i\the\numexpr#1-#2+#3\xint:#4\W
1691 {%
1692   \XINT_div_sub_l #1#2!%
1693 }%
1694 \def\XINT_div_sub_l #1%
1695 {%
1696   \xint_UDzerofork
1697   #1{-2\relax}%
1698   0\XINT_div_sub_r
1699   \krof
1700 }%
1701 \def\XINT_div_sub_r #1!%
1702 {%
1703   -\ifnum 0#1=\xint_c_ 1\else2\fi\relax
1704 }%

```

Ici  $B < 10^8$  (et est  $> 2$ ). On exécute

$\backslash\expandafter\XINT_sdiv\_out\the\numexpr\XINT\_smallldivx\_a\ x.1B!1<8d>!\dots1<8d>!1;!;$   
avec  $x = \text{round}(B/2)$ ,  $1B = 10^8 + B$ , et A déjà en blocs  $1<8d>!$  (non renversés). Le  $\backslash\the\numexpr\XINT\_smallldivx\_a$   
va produire  $Q\Z R\W$  avec un  $R < 10^8$ , et un Q sous forme de blocs  $1<8d>!$  terminé par  $1!$  et nécessi-  
tant le nettoyage du premier bloc. Dans cette branche le B n'a pas été multiplié par une puissance  
de 10, il peut avoir moins de huit chiffres.

```

1705 \def\XINT_sdiv_out #1;!#2!%
1706   {\expandafter
1707   {\romannumeral0\XINT_unsep_cuzsmall
1708   #1\xint_bye!2!3!4!5!6!7!8!9!\xint_bye\xint_c_i\relax}%
1709   {#2}}%

```

La toute première étape fait la première division pour être sûr par la suite d'avoir un premier  
bloc pour A qui sera  $< B$ .

```

1710 \def\XINT_smallldivx_a #1\xint:1#2!1#3!%
1711 {%
1712   \expandafter\XINT_smallldivx_b
1713   \the\numexpr (#3+#1)/#2-\xint_c_i!#1\xint:#2!#3!%
1714 }%
1715 \def\XINT_smallldivx_b #1#2!%

```

### 3 Package *xintcore* implementation

```

1716 {%
1717   \if0#1\else
1718     \xint_c_x^viii+#1#2\xint_afterfi{\expandafter!\the\numexpr}\fi
1719   \XINT_smallldiv_c #1#2!%
1720 }%
1721 \def\XINT_smallldiv_c #1!#2\xint:#3!#4!%
1722 {%
1723   \expandafter\XINT_smallldiv_d\the\numexpr #4-#1*#3!#2\xint:#3!%
1724 }%

```

On va boucler ici: #1 est un reste, #2 est x.B (avec B sans le 1 mais sur huit chiffres). #3#4 est le premier bloc qui reste de A. Si on a terminé avec A, alors #1 est le reste final. Le quotient lui est terminé par un 1! ce 1! disparaîtra dans le nettoyage par \XINT\_unsep\_cuzsmall.

```

1725 \def\XINT_smallldiv_d #1!#2!1#3#4!%
1726 {%
1727   \xint_gob_til_sc #3\XINT_smallldiv_end ;%
1728   \XINT_smallldiv_e #1!#2!1#3#4!%
1729 }%
1730 \def\XINT_smallldiv_end;\XINT_smallldiv_e #1!#2!1;!{1!;!#1!}%

```

Il est crucial que le reste #1 est < #3. J'ai documenté cette routine dans le fichier où j'ai préparé 1.2, il faudra transférer ici. Il n'est pas nécessaire pour cette routine que le diviseur B ait au moins 8 chiffres. Mais il doit être < 10^8.

```

1731 \def\XINT_smallldiv_e #1!#2\xint:#3!%
1732 {%
1733   \expandafter\XINT_smallldiv_f\the\numexpr
1734   \xint_c_xi_e_viii_mone+#1*\xint_c_x^viii/#3!#2\xint:#3!#1!%
1735 }%
1736 \def\XINT_smallldiv_f 1#1#2#3#4#5#6!#7\xint:#8!%
1737 {%
1738   \xint_gob_til_zero #1\XINT_smallldiv_fz 0%
1739   \expandafter\XINT_smallldiv_g
1740   \the\numexpr\XINT_minimul_a #2#3#4#5\xint:#6!#8!#2#3#4#5#6!#7\xint:#8!%
1741 }%
1742 \def\XINT_smallldiv_fz 0%
1743   \expandafter\XINT_smallldiv_g\the\numexpr\XINT_minimul_a
1744   9999\xint:9999!#1!99999999!#2!0!1#3!%
1745 {%
1746   \XINT_smallldiv_i \xint:#3!\xint_c!#2!%
1747 }%
1748 \def\XINT_smallldiv_g 1#1!1#2!#3!#4!#5!#6!%
1749 {%
1750   \expandafter\XINT_smallldiv_h\the\numexpr 1#6-#1\xint:#2!#5!#3!#4!%
1751 }%
1752 \def\XINT_smallldiv_h 1#1#2\xint:#3!#4!%
1753 {%
1754   \expandafter\XINT_smallldiv_i\the\numexpr #4-#3+#1-\xint_c_i\xint:#2!%
1755 }%
1756 \def\XINT_smallldiv_i #1\xint:#2!#3!#4\xint:#5!%
1757 {%
1758   \expandafter\XINT_smallldiv_j\the\numexpr (#1#2+#4)/#5-\xint_c_i!#3!#1#2!#4\xint:#5!%
1759 }%

```



### 3 Package *xintcore* implementation

```

1760 \def\XINT_smallldiv_j #1!#2!%
1761 {%
1762   \xint_c_x^viii+#1+#2\expandafter!\the\numexpr\XINT_smallldiv_k
1763   #1!%
1764 }%

```

On boucle vers \XINT\_smallldiv\_d.

```

1765 \def\XINT_smallldiv_k #1!#2!#3\xint:#4!%
1766 {%
1767   \expandafter\XINT_smallldiv_d\the\numexpr #2-#1*#4!#3\xint:#4!%
1768 }%

```

Cette routine fait la division euclidienne d'un nombre de seize chiffres par  $\#1 = C =$  diviseur sur huit chiffres  $\geq 10^7$ , avec  $\#2 =$  sa moitié utilisée dans \numexpr pour contrebalancer l'arrondi (ARRRRRRGGGGGHHH) fait par /. Le nombre divisé  $XY = X \cdot 10^8 + Y$  se présente sous la forme  $1<8\text{chiffres}>1<8\text{chiffres}>!$  avec plus significatif en premier.

Seul le quotient est calculé, pas le reste. En effet la routine de division principale va utiliser ce quotient pour déterminer le "grand" reste, et le petit reste ici ne nous serait d'à peu près aucune utilité.

ATTENTION UNIQUEMENT UTILISÉ POUR DES SITUATIONS OÙ IL EST GARANTI QUE  $X < C$  ! (et  $C$  au moins  $10^7$ ) le quotient euclidien de  $X \cdot 10^8 + Y$  par  $C$  sera donc  $< 10^8$ . Il sera renvoyé sous la forme  $1<8\text{chiffres}>!$ .

```

1769 \def\XINT_div_mini #1\xint:#2!#3!%
1770 {%
1771   \expandafter\XINT_div_mini_a\the\numexpr
1772   \xint_c_xi_eviii_mone+#3*\xint_c_x^viii/#1!#1\xint:#2!#3!%
1773 }%

```

Note (2015/10/08). Attention à la différence dans l'ordre des arguments avec ce que je vois en dans \XINT\_smallldiv\_f. Je ne me souviens plus du tout s'il y a une raison quelconque.

```

1774 \def\XINT_div_mini_a 1#1#2#3#4#5#6!#7\xint:#8!%
1775 {%
1776   \xint_gob_til_zero #1\XINT_div_mini_w 0%
1777   \expandafter\XINT_div_mini_b
1778   \the\numexpr\XINT_minimul_a #2#3#4#5\xint:#6!#7!#2#3#4#5#6!#7\xint:#8!%
1779 }%
1780 \def\XINT_div_mini_w 0%
1781   \expandafter\XINT_div_mini_b\the\numexpr\XINT_minimul_a
1782   9999\xint:9999!#1!99999999!#2\xint:#3!00000000!#4!%
1783 {%
1784   \xint_c_x^viii_mone+(#4+#3)/#2!%
1785 }%
1786 \def\XINT_div_mini_b 1#1!1#2!#3!#4!#5!#6!%
1787 {%
1788   \expandafter\XINT_div_mini_c
1789   \the\numexpr 1#6-#1\xint:#2!#5!#3!#4!%
1790 }%
1791 \def\XINT_div_mini_c 1#1#2\xint:#3!#4!%
1792 {%
1793   \expandafter\XINT_div_mini_d
1794   \the\numexpr #4-#3+#1-\xint_c_i\xint:#2!%

```

```

1795 }%
1796 \def\XINT_div_mini_d #1\xint:#2!#3!#4\xint:#5!%
1797 {%
1798   \xint_c_x^viii_mone+#3+(#1#2+#5)/#4!%
1799 }%

```

## Derived arithmetic

### 3.38 `\xintiDivRound`, `\xintiiDivRound`

1.1, transferred from first release of `bnumexpr`. Rewritten for 1.2. Ending rewritten for 1.2i. (new `\xintDSRr`).

1.2l: `\xintiiDivRound` made robust against non terminated input.

```

1800 \def\xintiDivRound   {\romannumeral0\xintidivround }%
1801 \def\xintidivround   #1%
1802   {\expandafter\XINT_idivround\romannumeral0\xintnum{#1}\xint:}%
1803 \def\xintiiDivRound  {\romannumeral0\xintiidivround }%
1804 \def\xintiidivround  #1{\expandafter\XINT_iidivround\romannumeral`&&@#1\xint:}%
1805 \def\XINT_idivround  #1#2\xint:#3%
1806   {\expandafter\XINT_iidivround_a\expandafter #1%
1807     \romannumeral0\xintnum{#3}\xint:#2\xint:}%
1808 \def\XINT_iidivround #1#2\xint:#3%
1809   {\expandafter\XINT_iidivround_a\expandafter #1\romannumeral`&&@#3\xint:#2\xint:}%
1810 \def\XINT_iidivround_a #1#2% #1 de A, #2 de B.
1811 {%
1812   \if0#2\xint_dothis{\XINT_iidivround_divbyzero#1#2}\fi
1813   \if0#1\xint_dothis\XINT_iidivround_aiszero\fi
1814   \if-#2\xint_dothis{\XINT_iidivround_bneg #1}\fi
1815   \xint_orthat{\XINT_iidivround_bpos #1#2}%
1816 }%
1817 \def\XINT_iidivround_divbyzero #1#2#3\xint:#4\xint:
1818   {\XINT_signalcondition{DivisionByZero}{Division of #1#4 by #2#3}{\{0}\}}%
1819 \def\XINT_iidivround_aiszero  #1\xint:#2\xint:{ 0}%
1820 \def\XINT_iidivround_bpos #1%
1821 {%
1822   \xint_UDsignfork
1823     #1{\xintiiopp\XINT_iidivround_pos {}}%
1824     -{\XINT_iidivround_pos #1}%
1825   \krof
1826 }%
1827 \def\XINT_iidivround_bneg #1%
1828 {%
1829   \xint_UDsignfork
1830     #1{\XINT_iidivround_pos {}}%
1831     -{\xintiiopp\XINT_iidivround_pos #1}%
1832   \krof
1833 }%
1834 \def\XINT_iidivround_pos #1#2\xint:#3\xint:
1835 {%
1836   \expandafter\expandafter\expandafter\XINT_dsrr
1837   \expandafter\xint_firstoftwo
1838   \romannumeral0\XINT_div_prepare {#2}{#1#30}%

```

```
1839 \xint_bye\xint_Bye3456789\xint_bye/\xint_c_x\relax
1840 }%
```

### 3.39 \xintiDivTrunc, \xintiiDivTrunc

1.21: \xintiiDivTrunc made robust against non terminated input.

```
1841 \def\xintiDivTrunc {\romannumeral0\xintidivtrunc }%
1842 \def\xintidivtrunc #1{\expandafter\XINT_iidivtrunc\romannumeral0\xintnum{#1}\xint:}%
1843 \def\xintiiDivTrunc {\romannumeral0\xintiidivtrunc }%
1844 \def\xintiidivtrunc #1{\expandafter\XINT_iidivtrunc\romannumeral`&&@#1\xint:}%
1845 \def\XINT_iidivtrunc #1#2\xint:#3{\expandafter\XINT_iidivtrunc_a\expandafter #1%
1846 \romannumeral`&&@#3\xint:#2\xint:}%
1847 \def\XINT_iidivtrunc_a #1#2% #1 de A, #2 de B.
1848 {%
1849 \if0#2\xint_dothis{\XINT_iidivround_divbyzero#1#2}\fi
1850 \if0#1\xint_dothis\XINT_iidivround_aiszero\fi
1851 \if-#2\xint_dothis{\XINT_iidivtrunc_bneg #1}\fi
1852 \xint_orthat{\XINT_iidivtrunc_bpos #1#2}%
1853 }%
1854 \def\XINT_iidivtrunc_bpos #1%
1855 {%
1856 \xint_UDsignfork
1857 #1{\xintiiopp\XINT_iidivtrunc_pos {}}%
1858 -{\XINT_iidivtrunc_pos #1}%
1859 \krof
1860 }%
1861 \def\XINT_iidivtrunc_bneg #1%
1862 {%
1863 \xint_UDsignfork
1864 #1{\XINT_iidivtrunc_pos {}}%
1865 -{\xintiiopp\XINT_iidivtrunc_pos #1}%
1866 \krof
1867 }%
1868 \def\XINT_iidivtrunc_pos #1#2\xint:#3\xint:
1869 {\expandafter\xint_firstoftwo_thenstop
1870 \romannumeral0\XINT_div_prepare {#2}{#1#3}}%
```

### 3.40 \xintiMod, \xintiiMod

```
1871 \def\xintiMod {\romannumeral0\xintimod }%
1872 \def\xintimod #1{\expandafter\XINT_iimod\romannumeral0\xintnum{#1}\xint:}%
1873 \def\xintiiMod {\romannumeral0\xintiimod }%
1874 \def\xintiimod #1{\expandafter\XINT_iimod\romannumeral`&&@#1\xint:}%
1875 \def\XINT_iimod #1#2\xint:#3{\expandafter\XINT_iimod_a\expandafter #1%
1876 \romannumeral`&&@#3\xint:#2\xint:}%
1877 \def\XINT_iimod_a #1#2% #1 de A, #2 de B.
1878 {%
1879 \if0#2\xint_dothis{\XINT_iidivround_divbyzero#1#2}\fi
1880 \if0#1\xint_dothis\XINT_iidivround_aiszero\fi
1881 \if-#2\xint_dothis{\XINT_iimod_bneg #1}\fi
1882 \xint_orthat{\XINT_iimod_bpos #1#2}%
1883 }%
```

```

1884 \def\XINT_iimod_bpos #1%
1885 {%
1886   \xint_UDsignfork
1887     #1{\xintiiopp\XINT_iimod_pos {}}%
1888     -{\XINT_iimod_pos #1}%
1889   \krof
1890 }%
1891 \def\XINT_iimod_bneg #1%
1892 {%
1893   \xint_UDsignfork
1894     #1{\xintiiopp\XINT_iimod_pos {}}%
1895     -{\XINT_iimod_pos #1}%
1896   \krof
1897 }%
1898 \def\XINT_iimod_pos #1#2\xint:#3\xint:
1899   {\expandafter\xint_secondoftwo_thenstop\romannumeral0\XINT_div_prepare
1900    {#2}{#1#3}}%

```

### 3.41 \xintiSqr, \xintiiSqr

1.2l: \xintiiSqr made robust against non terminated input.

```

1901 \def\xintiiSqr {\romannumeral0\xintiisqr }%
1902 \def\xintiisqr #1%
1903 {%
1904   \expandafter\XINT_sqr\romannumeral0\xintiiabs{#1}\xint:
1905 }%
1906 \def\xintiSqr {\romannumeral0\xintisqr }%
1907 \def\xintisqr #1%
1908 {%
1909   \expandafter\XINT_sqr\romannumeral0\xintiabs{#1}\xint:
1910 }%
1911 \def\XINT_sqr #1\xint:
1912 {%
1913   \expandafter\XINT_sqr_a
1914     \romannumeral0\expandafter\XINT_sepandrev_andcount
1915     \romannumeral0\XINT_zeroes_forviii #1\R\R\R\R\R\R\R\R{10}0000001\W
1916     #1\XINT_rsepbyviii_end_A 2345678%
1917     \XINT_rsepbyviii_end_B 2345678\relax\xint_c_ii\xint_c_i
1918     \R\xint:\xint_c_xii \R\xint:\xint_c_x \R\xint:\xint_c_viii \R\xint:\xint_c_vi
1919     \R\xint:\xint_c_iv \R\xint:\xint_c_ii \R\xint:\xint_c_\W
1920   \xint:
1921 }%

```

1.2c \XINT\_mul\_loop can now be called directly even with small arguments, thus the following check is not anymore a necessity.

```

1922 \def\XINT_sqr_a #1\xint:
1923 {%
1924   \ifnum #1=\xint_c_i \expandafter\XINT_sqr_small
1925   \else\expandafter\XINT_sqr_start\fi
1926 }%
1927 \def\XINT_sqr_small 1#1#2#3#4#5!\xint:
1928 {%

```

### 3 Package *xintcore* implementation

```

1929 \ifnum #1#2#3#4#5<46341 \expandafter\XINT_sqr_verysmall\fi
1930 \expandafter\XINT_sqr_small_out
1931 \the\numexpr\XINT_minimul_a #1#2#3#4\xint:#5!#1#2#3#4#5!%
1932 }%
1933 \def\XINT_sqr_verysmall#1{%
1934 \def\XINT_sqr_verysmall
1935 \expandafter\XINT_sqr_small_out\the\numexpr\XINT_minimul_a ##1!##2!%
1936 {\expandafter#1\the\numexpr ##2*##2\relax}%
1937 }\XINT_sqr_verysmall{ }%
1938 \def\XINT_sqr_small_out #1!1#2!%
1939 {%
1940 \XINT_cuz #2#1\R
1941 }%

```

An ending 1;! is produced on output for \XINT\_mul\_loop and gets incorporated to the delimiter needed by the \XINT\_unrevbyviii done by \XINT\_mul\_out.

```

1942 \def\XINT_sqr_start #1\xint:
1943 {%
1944 \expandafter\XINT_mul_out
1945 \the\numexpr\XINT_mul_loop
1946 100000000!1;!W #11;!W #11;!%
1947 1\R!1\R!1\R!1\R!1\R!1\R!1\R!1\R!\W
1948 }%

```

#### 3.42 \xintiPow, \xintiiPow

The exponent is not limited but with current default settings of tex memory, with xint 1.2, the maximal exponent for  $2^N$  is  $N = 2^{17} = 131072$ .

1.2f Modifies the initial steps: 1) in order to be able to let more easily \xintiPow use \xintNum on the exponent once xintfrac.sty is loaded; 2) also because I noticed it was not very well coded. And it did only a \numexpr on the exponent, contradicting the documentation related to the "i" convention in names.

1.2l: \xintiiPow made robust against non terminated input.

```

1949 \def\xintiiPow {\romannumeral0\xintiipow }%
1950 \def\xintiipow #1#2%
1951 {%
1952 \expandafter\xint_pow\the\numexpr #2\expandafter
1953 .\romannumeral`&&@#1\xint:
1954 }%
1955 \def\xintiPow {\romannumeral0\xintipow }%
1956 \def\xintipow #1#2%
1957 {%
1958 \expandafter\xint_pow\the\numexpr #2\expandafter
1959 .\romannumeral0\xintnum{#1}\xint:
1960 }%
1961 \def\xint_pow #1.#2%#3\xint:
1962 {%
1963 \xint_UDzerominusfork
1964 #2-\XINT_pow_AisZero
1965 0#2\XINT_pow_Aneg
1966 0-{\XINT_pow_Apos #2}%

```

### 3 Package *xintcore* implementation

```

1967 \krof {#1}%
1968 }%
1969 \def\XINT_pow_AisZero #1#2\xint:
1970 {%
1971 \ifcase\XINT_cntSgn #1\xint:
1972 \xint_afterfi { 1}%
1973 \or
1974 \xint_afterfi { 0}%
1975 \else
1976 \xint_afterfi
1977 {\XINT_signalcondition{DivisionByZero}{Zero to power #1}{0}}%
1978 \fi
1979 }%
1980 \def\XINT_pow_Aneg #1%
1981 {%
1982 \ifodd #1
1983 \expandafter\XINT_opp\romannumeral0%
1984 \fi
1985 \XINT_pow_Apos {}{#1}%
1986 }%
1987 \def\XINT_pow_Apos #1#2{\XINT_pow_Apos_a {#2}#1}%
1988 \def\XINT_pow_Apos_a #1#2#3%
1989 {%
1990 \xint_gob_til_xint: #3\XINT_pow_Apos_short\xint:
1991 \XINT_pow_AatleastTwo {#1}#2#3%
1992 }%
1993 \def\XINT_pow_Apos_short\xint:\XINT_pow_AatleastTwo #1#2\xint:
1994 {%
1995 \ifcase #2
1996 \xintError:thiscannothappen
1997 \or \expandafter\XINT_pow_AisOne
1998 \else\expandafter\XINT_pow_AatleastTwo
1999 \fi {#1}#2\xint:
2000 }%
2001 \def\XINT_pow_AisOne #1\xint:{ 1}%
2002 \def\XINT_pow_AatleastTwo #1%
2003 {%
2004 \ifcase\XINT_cntSgn #1\xint:
2005 \expandafter\XINT_pow_BisZero
2006 \or
2007 \expandafter\XINT_pow_I_in
2008 \else
2009 \expandafter\XINT_pow_BisNegative
2010 \fi
2011 {#1}%
2012 }%
2013 \def\XINT_pow_BisNegative #1\xint:{\XINT_signalcondition{Underflow}{Inverse power
2014 can not be represented by an integer}{0}}%
2015 \def\XINT_pow_BisZero #1\xint:{ 1}%

```

*B = #1 > 0, A = #2 > 1. Earlier code checked if size of B did not exceed a given limit (for example 131000).*

### 3 Package *xintcore* implementation

```

2016 \def\XINT_pow_I_in #1#2\xint:
2017 {%
2018   \expandafter\XINT_pow_I_loop
2019   \the\numexpr #1\expandafter\xint:%
2020   \romannumeral0\expandafter\XINT_sepandrev
2021   \romannumeral0\XINT_zeroes_forviii #2\R\R\R\R\R\R\R\{10}0000001\W
2022   #2\XINT_rsepbyviii_end_A 2345678%
2023   \XINT_rsepbyviii_end_B 2345678\relax XX%
2024   \R\xint:\R\xint:\R\xint:\R\xint:\R\xint:\R\xint:\R\xint:\R\xint:\W
2025   1;!\W
2026   1\R!1\R!1\R!1\R!1\R!1\R!1\R!1\R!1\W
2027 }%
2028 \def\XINT_pow_I_loop #1\xint:%
2029 {%
2030   \ifnum #1 = \xint_c_i\expandafter\XINT_pow_I_exit\fi
2031   \ifodd #1
2032     \expandafter\XINT_pow_II_in
2033   \else
2034     \expandafter\XINT_pow_I_squareit
2035   \fi #1\xint:%
2036 }%
2037 \def\XINT_pow_I_exit \ifodd #1\fi #2\xint:#3\W {\XINT_mul_out #3}%

```

The 1.2c `\XINT_mul_loop` can be called directly even with small arguments, hence the "butcheckifsmall" is not a necessity as it was earlier with 1.2. On  $2^{30}$ , it does bring roughly a 40% time gain though, and 30% gain for  $2^{60}$ . The overhead on big computations should be negligible.

```

2038 \def\XINT_pow_I_squareit #1\xint:#2\W%
2039 {%
2040   \expandafter\XINT_pow_I_loop
2041   \the\numexpr #1/\xint_c_ii\expandafter\xint:%
2042   \the\numexpr\XINT_pow_mulbutcheckifsmall #2\W #2\W
2043 }%
2044 \def\XINT_pow_mulbutcheckifsmall #1!1#2%
2045 {%
2046   \xint_gob_til_sc #2\XINT_pow_mul_small;%
2047   \XINT_mul_loop 100000000!1;!\W #1!1#2%
2048 }%
2049 \def\XINT_pow_mul_small;\XINT_mul_loop
2050   100000000!1;!\W 1#1!1;!\W
2051 {%
2052   \XINT_smallmul 1#1!%
2053 }%
2054 \def\XINT_pow_II_in #1\xint:#2\W
2055 {%
2056   \expandafter\XINT_pow_II_loop
2057   \the\numexpr #1/\xint_c_ii-\xint_c_i\expandafter\xint:%
2058   \the\numexpr\XINT_pow_mulbutcheckifsmall #2\W #2\W #2\W
2059 }%
2060 \def\XINT_pow_II_loop #1\xint:%
2061 {%
2062   \ifnum #1 = \xint_c_i\expandafter\XINT_pow_II_exit\fi
2063   \ifodd #1

```

```

2064     \expandafter\XINT_pow_II_odda
2065   \else
2066     \expandafter\XINT_pow_II_even
2067   \fi #1\xint:%
2068 }%
2069 \def\XINT_pow_II_exit\ifodd #1\fi #2\xint:#3\W #4\W
2070 {%
2071   \expandafter\XINT_mul_out
2072   \the\numexpr\XINT_pow_mulbutcheckifsmall #4\W #3%
2073 }%
2074 \def\XINT_pow_II_even #1\xint:#2\W
2075 {%
2076   \expandafter\XINT_pow_II_loop
2077   \the\numexpr #1/\xint_c_ii\expandafter\xint:%
2078   \the\numexpr\XINT_pow_mulbutcheckifsmall #2\W #2\W
2079 }%
2080 \def\XINT_pow_II_odda #1\xint:#2\W #3\W
2081 {%
2082   \expandafter\XINT_pow_II_oddb
2083   \the\numexpr #1/\xint_c_ii-\xint_c_i\expandafter\xint:%
2084   \the\numexpr\XINT_pow_mulbutcheckifsmall #3\W #2\W #2\W
2085 }%
2086 \def\XINT_pow_II_oddb #1\xint:#2\W #3\W
2087 {%
2088   \expandafter\XINT_pow_II_loop
2089   \the\numexpr #1\expandafter\xint:%
2090   \the\numexpr\XINT_pow_mulbutcheckifsmall #3\W #3\W #2\W
2091 }%

```

### 3.43 \xintiFac, \xintiiFac

Moved here from xint.sty with release 1.2 (to be usable by \bnumexpr).

Partially rewritten with release 1.2 to benefit from the inner format of the 1.2 multiplication.

With current default settings of the etex memory and a.t.t.o.w (11/2015) the maximal possible computation is 5971! (which has 19956 digits).

Note (end november 2015): I also tried out a quickly written recursive (binary split) implementation

```

\catcode`\_ 11
\catcode`\^ 11
\long\def\xint_firstofthree #1#2#3{#1}%
\long\def\xint_secondofthree #1#2#3{#2}%
\long\def\xint_thirdofthree #1#2#3{#3}%
% quickly written factorial using binary split recursive method
\def\tFac {\romannumeral-0\tfac}%
\def\tfac #1{\expandafter\XINT_mul_out
  \romannumeral-0\ufac {1}{#1}1\R!1\R!1\R!1\R!1\R!1\R!1\R!1\R!\W}%
\def\ufac #1#2{\ifcase\numexpr#2-#1\relax
  \expandafter\xint_firstofthree
\or
  \expandafter\xint_secondofthree
\else
  \expandafter\xint_thirdofthree

```



### 3 Package *xintcore* implementation

```

\fi
{\the\numexpr\xint_c_x^viii+#1!1;!}%
{\the\numexpr\xint_c_x^viii+#1*#2!1;!}%
{\expandafter\vfac\the\numexpr (#1+#2)/\xint_c_ii.#1.#2.}%
}%
\def\vfac #1.#2.#3.%
{%
\expandafter
\vfac\expandafter
{\romannumeral-`0\expandafter
\ufac\expandafter{\the\numexpr #1+\xint_c_i}{#3}}%
{\ufac {#2}{#1}}%
}%
\def\wfac #1#2{\expandafter\zfac\romannumeral-`0#2\W #1}%
\def\zfac {\the\numexpr\XINT_mul_loop 10000000!1;!\W }% core multiplication...
\catcode`_ 8
\catcode`^ 7

```

and I was quite surprised that it was only about 1.6x--2x slower in the range N=200 to 2000 than the `\xintiifac` here which attempts to be smarter...

Note (2017, 1.21): I found out some code comment of mine that the code here should be more in the style of `\xintiiBinomial`, but I left matters untouched.

```

2092 \def\xintiifac {\romannumeral0\xintiifac }%
2093 \def\xintiifac #1{\expandafter\XINT_fac_fork\the\numexpr#1.}%
2094 \def\xintifac {\romannumeral0\xintifac }%
2095 \let\xintifac\xintiifac
2096 \def\XINT_fac_fork #1#2.%
2097 {%
2098   \xint_UDzerominusfork
2099   #1-\XINT_fac_zero
2100   0#1\XINT_fac_neg
2101   0-\XINT_fac_checksize
2102   \krof #1#2.%
2103 }%
2104 \def\XINT_fac_zero #1.{ 1}%
2105 \def\XINT_fac_neg #1.{\XINT_signalcondition{InvalidOperation}{Factorial of
2106   negative: (#1)!}{0}}%
2107 \def\XINT_fac_checksize #1.%
2108 {%
2109   \ifnum #1>\xint_c_x^iv \xint_dothis{\XINT_fac_toobig #1.}\fi
2110   \ifnum #1>465 \xint_dothis{\XINT_fac_bigloop_a #1.}\fi
2111   \ifnum #1>101 \xint_dothis{\XINT_fac_medloop_a #1.\XINT_mul_out}\fi
2112   \xint_orthat{\XINT_fac_smallloop_a #1.\XINT_mul_out}%
2113   1\R!1\R!1\R!1\R!1\R!1\R!1\R!1\R!\W
2114 }%
2115 \def\XINT_fac_toobig #1.#2\W{\XINT_signalcondition{InvalidOperation}{Factorial
2116   of too big argument: #1 > 10000}{0}}%
2117 \def\XINT_fac_bigloop_a #1.%
2118 {%
2119   \expandafter\XINT_fac_bigloop_b \the\numexpr
2120   #1+\xint_c_i-\xint_c_ii*((#1-464)/\xint_c_ii).#1.%
2121 }%

```

### 3 Package *xintcore* implementation

```

2122 \def\XINT_fac_bigloop_b #1.#2.%
2123 {%
2124   \expandafter\XINT_fac_medloop_a
2125     \the\numexpr #1-\xint_c_i.{\XINT_fac_bigloop_loop #1.#2.}%
2126 }%
2127 \def\XINT_fac_bigloop_loop #1.#2.%
2128 {%
2129   \ifnum #1>#2 \expandafter\XINT_fac_bigloop_exit\fi
2130   \expandafter\XINT_fac_bigloop_loop
2131     \the\numexpr #1+\xint_c_ii\expandafter.%
2132   \the\numexpr #2\expandafter.\the\numexpr\XINT_fac_bigloop_mul #1!%
2133 }%
2134 \def\XINT_fac_bigloop_exit #1!{\XINT_mul_out}%
2135 \def\XINT_fac_bigloop_mul #1!%
2136 {%
2137   \expandafter\XINT_smallmul
2138     \the\numexpr \xint_c_x^viii+#1*(#1+\xint_c_i)!%
2139 }%
2140 \def\XINT_fac_medloop_a #1.%
2141 {%
2142   \expandafter\XINT_fac_medloop_b
2143     \the\numexpr #1+\xint_c_i-\xint_c_iii*((#1-100)/\xint_c_iii).#1.%
2144 }%
2145 \def\XINT_fac_medloop_b #1.#2.%
2146 {%
2147   \expandafter\XINT_fac_smallloop_a
2148     \the\numexpr #1-\xint_c_i.{\XINT_fac_medloop_loop #1.#2.}%
2149 }%
2150 \def\XINT_fac_medloop_loop #1.#2.%
2151 {%
2152   \ifnum #1>#2 \expandafter\XINT_fac_loop_exit\fi
2153   \expandafter\XINT_fac_medloop_loop
2154     \the\numexpr #1+\xint_c_iii\expandafter.%
2155   \the\numexpr #2\expandafter.\the\numexpr\XINT_fac_medloop_mul #1!%
2156 }%
2157 \def\XINT_fac_medloop_mul #1!%
2158 {%
2159   \expandafter\XINT_smallmul
2160     \the\numexpr
2161       \xint_c_x^viii+#1*(#1+\xint_c_i)*(#1+\xint_c_ii)!%
2162 }%
2163 \def\XINT_fac_smallloop_a #1.%
2164 {%
2165   \csname
2166     XINT_fac_smallloop_\the\numexpr #1-\xint_c_iv*(#1/\xint_c_iv)\relax
2167   \endcsname #1.%
2168 }%
2169 \expandafter\def\csname XINT_fac_smallloop_1\endcsname #1.%
2170 {%
2171   \XINT_fac_smallloop_loop 2.#1.1000000011;!%
2172 }%
2173 \expandafter\def\csname XINT_fac_smallloop_-2\endcsname #1.%

```

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```
2174 {%
2175   \XINT_fac_smallloop_loop 3.#1.1000000002!1;!%
2176 }%
2177 \expandafter\def\csname XINT_fac_smallloop_-1\endcsname #1.%
2178 {%
2179   \XINT_fac_smallloop_loop 4.#1.1000000006!1;!%
2180 }%
2181 \expandafter\def\csname XINT_fac_smallloop_0\endcsname #1.%
2182 {%
2183   \XINT_fac_smallloop_loop 5.#1.10000000024!1;!%
2184 }%
2185 \def\XINT_fac_smallloop_loop #1.#2.%
2186 {%
2187   \ifnum #1>#2 \expandafter\XINT_fac_loop_exit\fi
2188   \expandafter\XINT_fac_smallloop_loop
2189   \the\numexpr #1+\xint_c_iv\expandafter.%
2190   \the\numexpr #2\expandafter.\the\numexpr\XINT_fac_smallloop_mul #1!%
2191 }%
2192 \def\XINT_fac_smallloop_mul #1!%
2193 {%
2194   \expandafter\XINT_smallmul
2195   \the\numexpr
2196     \xint_c_x^viii+#1*(#1+\xint_c_i)*(#1+\xint_c_ii)*(#1+\xint_c_iii)!%
2197 }%
2198 \def\XINT_fac_loop_exit #1!#2;!#3{#3#2;!}%
```

#### “Load *xintfrac*” macros

Originally was used in *\xintiexpr*. Transferred from *xintfrac* for 1.1.

```
2199 \catcode`! 11
2200 \def\xintAbs {\Did_you_mean_iiAbs?or_load_xintfrac!}%
2201 \def\xintOpp {\Did_you_mean_iiOpp?or_load_xintfrac!}%
2202 \def\xintAdd {\Did_you_mean_iiAdd?or_load_xintfrac!}%
2203 \def\xintSub {\Did_you_mean_iiSub?or_load_xintfrac!}%
2204 \def\xintMul {\Did_you_mean_iiMul?or_load_xintfrac!}%
2205 \def\xintPow {\Did_you_mean_iiPow?or_load_xintfrac!}%
2206 \def\xintSqr {\Did_you_mean_iiSqr?or_load_xintfrac!}%
2207 \def\xintQuo {\Removed!use_xintiQuo_or_xintiiQuo!}%
2208 \def\xintRem {\Removed!use_xintiRem_or_xintiiRem!}%
2209 \catcode`! 12
2210 \XINT_restorecatcodes_endinput%
```

## 4 Package `xint` implementation

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.14	<code>\xintifGt</code> , <code>\xintiiifGt</code> . . . . .	114	.37	<code>\xintDSx</code> . . . . .	125
.15	<code>\xintifLt</code> , <code>\xintiiifLt</code> . . . . .	114	.38	<code>\xintDecSplit</code> , <code>\xintDecSplitL</code> , <code>\xint-</code> <code>DecSplitR</code> . . . . .	127
.16	<code>\xintifOdd</code> , <code>\xintiiifOdd</code> . . . . .	115	.39	<code>\xintiiSqrt</code> , <code>\xintiiSqrtR</code> , <code>\xinti-</code> <code>iSquareRoot</code> . . . . .	129
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.23	<code>\xintAND</code> , <code>\xintOR</code> , <code>\xintXOR</code> . . . . .	116			

With release 1.1 the core arithmetic routines `\xintiiAdd`, `\xintiiSub`, `\xintiiMul`, `\xintiiQuo`, `\xintiiPow` were separated to be the main component of the then new `xintcore`.

```

1 \begingroup\catcode61\catcode48\catcode32=10\relax%
2 \catcode13=5 % ^^M
3 \endlinechar=13 %
4 \catcode123=1 % {
5 \catcode125=2 % }
6 \catcode64=11 % @
7 \catcode35=6 % #
8 \catcode44=12 % ,
9 \catcode45=12 % -
10 \catcode46=12 % .
11 \catcode58=12 % :
12 \let\z\endgroup
13 \expandafter\let\expandafter\x\csname ver@xint.sty\endcsname
14 \expandafter\let\expandafter\w\csname ver@xintcore.sty\endcsname
15 \expandafter
16 \ifx\csname PackageInfo\endcsname\relax
17 \def\y#1#2{\immediate\write-1{Package #1 Info: #2.}}%
18 \else
19 \def\y#1#2{\PackageInfo{#1}{#2}}%
20 \fi
21 \expandafter
22 \ifx\csname numexpr\endcsname\relax
23 \y{xint}{\numexpr not available, aborting input}%

```

```

24   \aftergroup\endinput
25   \else
26     \ifx\x\relax    % plain-TeX, first loading of xintcore.sty
27     \ifx\w\relax % but xintkernel.sty not yet loaded.
28       \def\z{\endgroup\input xintcore.sty\relax}%
29     \fi
30   \else
31     \def\empty {}%
32     \ifx\x\empty % LaTeX, first loading,
33     % variable is initialized, but \ProvidesPackage not yet seen
34     \ifx\w\relax % xintcore.sty not yet loaded.
35       \def\z{\endgroup\RequirePackage{xintcore}}%
36     \fi
37   \else
38     \aftergroup\endinput % xint already loaded.
39   \fi
40 \fi
41 \fi
42 \z%
43 \XINTsetupcatcodes% defined in xintkernel.sty (loaded by xintcore.sty)

```

#### 4.1 Package identification

```

44 \XINT_providespackage
45 \ProvidesPackage{xint}%
46 [2017/08/06 1.2n Expandable operations on big integers (JFB)]%

```

#### 4.2 More token management

```

47 \long\def\xint_firstofthree #1#2#3{#1}%
48 \long\def\xint_secondofthree #1#2#3{#2}%
49 \long\def\xint_thirdofthree #1#2#3{#3}%
50 \long\def\xint_firstofthree_thenstop #1#2#3{ #1}% 1.09i
51 \long\def\xint_secondofthree_thenstop #1#2#3{ #2}%
52 \long\def\xint_thirdofthree_thenstop #1#2#3{ #3}%

```

#### 4.3 `\xintSgnFork`

Expandable three-way fork added in 1.07. The argument #1 must expand to non-self-ending -1,0 or 1. 1.09i with `_thenstop`.

```

53 \def\xintSgnFork {\romannumeral0\xintsngfork }%
54 \def\xintsngfork #1%
55 {%
56   \ifcase #1 \expandafter\xint_secondofthree_thenstop
57             \or\expandafter\xint_thirdofthree_thenstop
58             \else\expandafter\xint_firstofthree_thenstop
59   \fi
60 }%

```

#### 4.4 `\xintIsOne`, `\xintiiIsOne`

Added in 1.03. 1.09a defines `\xintIsOne`. 1.1a adds `\xintiiIsOne`.

`\XINT_isOne` rewritten for 1.2g. Works with expanded strict integers, positive or negative.

```

61 \def\xintiiIsOne {\romannumeral0\xintiiisone }%
62 \def\xintiiiisone #1{\expandafter\XINT_isone\romannumeral`&&@#1XY}%
63 \def\xintIsOne    {\romannumeral0\xintisone }%
64 \def\xintisone     #1{\expandafter\XINT_isone\romannumeral0\xintnum{#1}XY}%
65 \def\XINT_isone #1#2#3Y%
66 {%
67     \unless\if#2X\xint_dothis{ 0}\fi
68     \unless\if#1l\xint_dothis{ 0}\fi
69     \xint_orthat{ 1}%
70 }%
71 \def\XINT_isOne #1{\XINT_is_One#1XY}%
72 \def\XINT_is_One #1#2#3Y%
73 {%
74     \unless\if#2X\xint_dothis0\fi
75     \unless\if#1l\xint_dothis0\fi
76     \xint_orthat1%
77 }%

```

## 4.5 \xintReverseDigits

## 1.2.

This puts digits in reverse order, not suppressing leading zeros after reverse. Despite lacking the "ii" in its name, it does not apply `\xintNum` to its argument (contrarily to `\xintLen`, this is not very coherent).

1.21 variant is robust against non terminated \the\numexpr input.

This macro is currently not used elsewhere in xint code.

```

78 \def\xintReverseDigits {\romannumeral0\xintreversedigits }%
79 \def\xintreversedigits #1%
80 {%
81     \expandafter\xINT_revdigits\romannumeral`&&@#1%
82     {\xINT_microrevsep_end\W}\xINT_microrevsep_end
83     \xINT_microrevsep_end\xINT_microrevsep_end
84     \xINT_microrevsep_end\xINT_microrevsep_end
85     \xINT_microrevsep_end\xINT_microrevsep_end\xINT_microrevsep_end\Z
86     1\Z!1\R!1\R!1\R!1\R!1\R!1\R!1\R!1\R!1\R!\W
87}%
88 \def\xINT_revdigits #1%
89 {%
90     \xint_UDsignfork
91     #1{\expandafter-\romannumeral0\xINT_revdigits_a}%
92     -{\xINT_revdigits_a #1}%
93     \krof
94}%
95 \def\xINT_revdigits_a
96 {%
97     \expandafter\xINT_revdigits_b\expandafter{\expandafter}%
98     \the\numexpr\xINT_microrevsep
99}%
100 \def\xINT_microrevsep #1#2#3#4#5#6#7#8#9%
101 {%
102     1#9#8#7#6#5#4#3#2#1\expandafter!\the\numexpr\xINT_microrevsep
103}%

```

#### 4 Package *xint* implementation

```
104 \def\XINT_microrevsep_end #1\W #2\expandafter #3\Z{\relax#2!}%
105 \def\XINT_revdigits_b #1#2!1#3!1#4!1#5!1#6!1#7!1#8!1#9!%
106 {%
107     \xint_gob_til_R #9\XINT_revdigits_end\R
108         \XINT_revdigits_b {#9#8#7#6#5#4#3#2#1}%
109 }%
110 \def\XINT_revdigits_end#1{%
111 \def\XINT_revdigits_end\R\XINT_revdigits_b ##1##2\W
112     {\expandafter#1\xint_gob_til_Z ##1}%
113 }\XINT_revdigits_end{ }%
114 \let\xintRev\xintReverseDigits
```

#### 4.6 *\xintLen*

*\xintLen* is ONLY for (possibly long) integers. Gets extended to fractions by *xintfrac.sty*. It applies *\xintNum* to its argument. A minus sign is accepted and ignored.

```
115 \def\xintLen {\romannumeral0\xintlen }%
116 \def\xintlen #1{\def\xintlen ##1%
117 {%
118     \expandafter#1\the\numexpr
119     \expandafter\XINT_len_fork\romannumeral0\xintnum{##1}%
120     \xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:
121     \xint_c_viii\xint_c_vii\xint_c_vi\xint_c_v
122     \xint_c_iv\xint_c_iii\xint_c_ii\xint_c_i\xint_c_\xint_bye\relax
123 }}\xintlen{ }%
124 \def\XINT_len_fork #1%
125 {%
126     \expandafter\XINT_length_loop\xint_UDsignfork#1{-#1\krof
127 }%
```

#### 4.7 *\xintBool*, *\xintToggle*

1.09c

```
128 \def\xintBool #1{\romannumeral`&&@%
129     \csname if#1\endcsname\expandafter1\else\expandafter0\fi }%
130 \def\xintToggle #1{\romannumeral`&&@\iftoggle{#1}{1}{0}}%
```

#### 4.8 *\xintifSgn*, *\xintiiifSgn*

Expandable three-way fork added in 1.09a. Branches expandably depending on whether <0, =0, >0. Choice of branch guaranteed in two steps.

1.09i has *\xint\_firstofthreeafterstop* (now *\_thenstop*) etc for faster expansion.

1.1 adds *\xintiiifSgn* for optimization in *xintexpr*-essions. Should I move them to *xintcore*? (for *bnumexpr*)

```
131 \def\xintifSgn {\romannumeral0\xintifsgn }%
132 \def\xintifsgn #1%
133 {%
134     \ifcase \xintSgn{#1}
135         \expandafter\xint_secondofthree_thenstop
136     \or\expandafter\xint_thirdofthree_thenstop
```

```

137         \else\expandafter\xint_firstofthree_thenstop
138     \fi
139 }%
140 \def\xintiiifSgn {\romannumeral0\xintiiifsgn }%
141 \def\xintiiifsgn #1%
142 {%
143     \ifcase \xintiiSgn{#1}
144         \expandafter\xint_secondofthree_thenstop
145         \or\expandafter\xint_thirdofthree_thenstop
146         \else\expandafter\xint_firstofthree_thenstop
147     \fi
148 }%

```

#### 4.9 `\xintifZero`, `\xintifNotZero`, `\xintiiifZero`, `\xintiiifNotZero`

Expandable two-way fork added in 1.09a. Branches expandably depending on whether the argument is zero (branch A) or not (branch B). 1.09i restyling. By the way it appears (not thoroughly tested, though) that `\if` tests are faster than `\ifnum` tests. 1.1 adds `ii` versions.

```

149 \def\xintifZero {\romannumeral0\xintifzero }%
150 \def\xintifzero #1%
151 {%
152     \if0\xintSgn{#1}%
153         \expandafter\xint_firstoftwo_thenstop
154     \else
155         \expandafter\xint_secondoftwo_thenstop
156     \fi
157 }%
158 \def\xintifNotZero {\romannumeral0\xintifnotzero }%
159 \def\xintifnotzero #1%
160 {%
161     \if0\xintSgn{#1}%
162         \expandafter\xint_secondoftwo_thenstop
163     \else
164         \expandafter\xint_firstoftwo_thenstop
165     \fi
166 }%
167 \def\xintiiifZero {\romannumeral0\xintiiifzero }%
168 \def\xintiiifzero #1%
169 {%
170     \if0\xintiiSgn{#1}%
171         \expandafter\xint_firstoftwo_thenstop
172     \else
173         \expandafter\xint_secondoftwo_thenstop
174     \fi
175 }%
176 \def\xintiiifNotZero {\romannumeral0\xintiiifnotzero }%
177 \def\xintiiifnotzero #1%
178 {%
179     \if0\xintiiSgn{#1}%
180         \expandafter\xint_secondoftwo_thenstop
181     \else
182         \expandafter\xint_firstoftwo_thenstop

```



```

183   \fi
184 }%

```

#### 4.10 `\xintifOne`, `\xintiiifOne`

added in 1.09i. 1.1a adds `\xintiiifOne`.

```

185 \def\xintiiifOne {\romannumeral0\xintiiifone }%
186 \def\xintiiifone #1%
187 {%
188   \if1\xintiiIsOne{#1}%
189     \expandafter\xint_firstoftwo_thenstop
190   \else
191     \expandafter\xint_secondoftwo_thenstop
192   \fi
193 }%
194 \def\xintifOne {\romannumeral0\xintifone }%
195 \def\xintifone #1%
196 {%
197   \if1\xintIsOne{#1}%
198     \expandafter\xint_firstoftwo_thenstop
199   \else
200     \expandafter\xint_secondoftwo_thenstop
201   \fi
202 }%

```

#### 4.11 `\xintifTrueAelseB`, `\xintifFalseAelseB`

1.09i. 1.2i has removed deprecated `\xintifTrueFalse`, `\xintifTrue`.

```

203 \let\xintifTrueAelseB\xintifNotZero
204 \let\xintifFalseAelseB\xintifZero
205 %%\let\xintifTrue\xintifNotZero      % now removed
206 %%\let\xintifTrueFalse\xintifNotZero % now removed

```

#### 4.12 `\xintifCmp`, `\xintiiifCmp`

1.09e `\xintifCmp {n}{m}{if n<m}{if n=m}{if n>m}`. 1.1a adds ii variant

```

207 \def\xintifCmp {\romannumeral0\xintifcmp }%
208 \def\xintifcmp #1#2%
209 {%
210   \ifcase\xintCmp {#1}{#2}
211     \expandafter\xint_secondofthree_thenstop
212   \or\expandafter\xint_thirdofthree_thenstop
213   \else\expandafter\xint_firstofthree_thenstop
214   \fi
215 }%
216 \def\xintiiifCmp {\romannumeral0\xintiiifcmp }%
217 \def\xintiiifcmp #1#2%
218 {%
219   \ifcase\xintiiCmp {#1}{#2}
220     \expandafter\xint_secondofthree_thenstop

```

```

221         \or\expandafter\xint_thirdofthree_thenstop
222         \else\expandafter\xint_firstofthree_thenstop
223     \fi
224 }%
```

#### 4.13 $\backslash$ xintifEq, $\backslash$ xintiiifEq

1.09a  $\backslash$ xintifEq {n}{m}{YES if n=m}{NO if n<>m}. 1.1a adds ii variant

```

225 \def\xintifEq {\romannumeral0\xintifeq }%
226 \def\xintifeq #1#2%
227 {%
228     \if0\xintCmp{#1}{#2}%
229         \expandafter\xint_firstoftwo_thenstop
230     \else\expandafter\xint_secondoftwo_thenstop
231     \fi
232 }%
233 \def\xintiiifEq {\romannumeral0\xintiiifeq }%
234 \def\xintiiifeq #1#2%
235 {%
236     \if0\xintiiCmp{#1}{#2}%
237         \expandafter\xint_firstoftwo_thenstop
238     \else\expandafter\xint_secondoftwo_thenstop
239     \fi
240 }%
```

#### 4.14 $\backslash$ xintifGt, $\backslash$ xintiiifGt

1.09a  $\backslash$ xintifGt {n}{m}{YES if n>m}{NO if n<=m}. 1.1a adds ii variant

```

241 \def\xintifGt {\romannumeral0\xintifgt }%
242 \def\xintifgt #1#2%
243 {%
244     \if1\xintCmp{#1}{#2}%
245         \expandafter\xint_firstoftwo_thenstop
246     \else\expandafter\xint_secondoftwo_thenstop
247     \fi
248 }%
249 \def\xintiiifGt {\romannumeral0\xintiiifgt }%
250 \def\xintiiifgt #1#2%
251 {%
252     \if1\xintiiCmp{#1}{#2}%
253         \expandafter\xint_firstoftwo_thenstop
254     \else\expandafter\xint_secondoftwo_thenstop
255     \fi
256 }%
```

#### 4.15 $\backslash$ xintifLt, $\backslash$ xintiiifLt

1.09a  $\backslash$ xintifLt {n}{m}{YES if n<m}{NO if n>=m}. Restyled in 1.09i. 1.1a adds ii variant

```

257 \def\xintifLt {\romannumeral0\xintiflt }%
258 \def\xintiflt #1#2%
```

```

259 {%
260   \ifnum\xintCmp{#1}{#2}<\xint_c_
261     \expandafter\xint_firstoftwo_thenstop
262   \else \expandafter\xint_secondoftwo_thenstop
263   \fi
264 }%
265 \def\xintiiflt {\romannumeral0\xintiiflt }%
266 \def\xintiiflt #1#2%
267 {%
268   \ifnum\xintiiCmp{#1}{#2}<\xint_c_
269     \expandafter\xint_firstoftwo_thenstop
270   \else \expandafter\xint_secondoftwo_thenstop
271   \fi
272 }%

```

#### 4.16 \xintifOdd, \xintiifOdd

1.09e. Restyled in 1.09i. 1.1a adds \xintiifOdd.

```

273 \def\xintiifOdd {\romannumeral0\xintiifodd }%
274 \def\xintiifodd #1%
275 {%
276   \if\xintiiOdd{#1}1%
277     \expandafter\xint_firstoftwo_thenstop
278   \else
279     \expandafter\xint_secondoftwo_thenstop
280   \fi
281 }%
282 \def\xintifOdd {\romannumeral0\xintifodd }%
283 \def\xintifodd #1%
284 {%
285   \if\xintOdd{#1}1%
286     \expandafter\xint_firstoftwo_thenstop
287   \else
288     \expandafter\xint_secondoftwo_thenstop
289   \fi
290 }%

```

#### 4.17 \xintEq, \xintGt, \xintLt

1.09a.

```

291 \def\xintEq {\romannumeral0\xinteq }\def\xinteq #1#2{\xintifeq{#1}{#2}{1}{0}}%
292 \def\xintGt {\romannumeral0\xintgt }\def\xintgt #1#2{\xintifgt{#1}{#2}{1}{0}}%
293 \def\xintLt {\romannumeral0\xintlts }\def\xintlts #1#2{\xintiflt{#1}{#2}{1}{0}}%

```

#### 4.18 \xintNeq, \xintGtorEq, \xintLtorEq

1.1. Pour *xintexpr*. No lowercase macros

```

294 \def\xintLtorEq #1#2{\romannumeral0\xintifgt {#1}{#2}{0}{1}}%
295 \def\xintGtorEq #1#2{\romannumeral0\xintiflt {#1}{#2}{0}{1}}%
296 \def\xintNeq #1#2{\romannumeral0\xintifeq {#1}{#2}{0}{1}}%

```

## 4.19 `\xintiiEq`, `\xintiiGt`, `\xintiiLt`

1.1a Pour `\xintiiexpr`. No lowercase macros.

```
297 \def\xintiiEq #1#2{\romannumeral0\xintiiifeq{#1}{#2}{1}{0}}%
298 \def\xintiiGt #1#2{\romannumeral0\xintiiifgt{#1}{#2}{1}{0}}%
299 \def\xintiiLt #1#2{\romannumeral0\xintiiiflt{#1}{#2}{1}{0}}%
```

## 4.20 `\xintiiNeq`, `\xintiiGtorEq`, `\xintiiLtorEq`

1.1a. Pour `\xintiiexpr`. No lowercase macros.

```
300 \def\xintiiLtorEq #1#2{\romannumeral0\xintiiifgt {#1}{#2}{0}{1}}%
301 \def\xintiiGtorEq #1#2{\romannumeral0\xintiiiflt {#1}{#2}{0}{1}}%
302 \def\xintiiNeq #1#2{\romannumeral0\xintiiifeq {#1}{#2}{0}{1}}%
```

## 4.21 `\xintIsZero`, `\xintIsNotZero`, `\xintiiIsZero`, `\xintiiIsNotZero`

1.09a. restyled in 1.09i. 1.1 adds `\xintiiIsZero`, etc... for optimization in `\xintexpr`

```
303 \def\xintIsZero {\romannumeral0\xintiszero }%
304 \def\xintiszero #1{\if0\xintSgn{#1}\xint_afterfi{ 1}\else\xint_afterfi{ 0}\fi}%
305 \def\xintIsNotZero {\romannumeral0\xintisnotzero }%
306 \def\xintisnotzero
307 #1{\if0\xintSgn{#1}\xint_afterfi{ 0}\else\xint_afterfi{ 1}\fi}%
308 \def\xintiiIsZero {\romannumeral0\xintiiiszero }%
309 \def\xintiiiszero #1{\if0\xintiiSgn{#1}\xint_afterfi{ 1}\else\xint_afterfi{ 0}\fi}%
310 \def\xintiiIsNotZero {\romannumeral0\xintiiisnotzero }%
311 \def\xintiiisnotzero
312 #1{\if0\xintiiSgn{#1}\xint_afterfi{ 0}\else\xint_afterfi{ 1}\fi}%

```

## 4.22 `\xintIsTrue`, `\xintNot`, `\xintIsFalse`

1.09c

```
313 \let\xintIsTrue\xintIsNotZero
314 \let\xintNot\xintIsZero
315 \let\xintIsFalse\xintIsZero
```

## 4.23 `\xintAND`, `\xintOR`, `\xintXOR`

1.09a. Embarrassing bugs in `\xintAND` and `\xintOR` which inserted a space token corrected in 1.09i. `\xintxor` restyled with `\if` (faster) in 1.09i

```
316 \def\xintAND {\romannumeral0\xintand }%
317 \def\xintand #1#2{\if0\xintSgn{#1}\expandafter\xint_firstoftwo
318 \else\expandafter\xint_secondoftwo\fi
319 { 0}{\xintisnotzero{#2}}}%
320 \def\xintOR {\romannumeral0\xintor }%
321 \def\xintor #1#2{\if0\xintSgn{#1}\expandafter\xint_firstoftwo
322 \else\expandafter\xint_secondoftwo\fi
323 {\xintisnotzero{#2}}{ 1}}%
324 \def\xintXOR {\romannumeral0\xintxor }%
325 \def\xintxor #1#2{\if\xintIsZero{#1}\xintIsZero{#2}%
326 \xint_afterfi{ 0}\else\xint_afterfi{ 1}\fi }%
```

## 4.24 `\xintANDof`

New with 1.09a. `\xintANDof` works also with an empty list. Empty items however are not accepted.

1.21 made `\xintANDof` robust against non terminated items.

```

327 \def\xintANDof      {\romannumeral0\xintandof }%
328 \def\xintandof      #1{\expandafter\xINT_andof_a\romannumeral`&&@#1\xint:}%
329 \def\xINT_andof_a   #1{\expandafter\xINT_andof_b\romannumeral`&&@#1!}%
330 \def\xINT_andof_b   #1%
331       {\xint_gob_til_xint: #1\xINT_andof_e\xint:\xINT_andof_c #1}%
332 \def\xINT_andof_c   #1!%
333       {\xintifTrueAelseB {#1}{\xINT_andof_a}{\xINT_andof_no}}%
334 \def\xINT_andof_no  #1\xint:{ 0}%
335 \def\xINT_andof_e   #1!{ 1}%

```

## 4.25 `\xintORof`

New with 1.09a. Works also with an empty list. Empty items however are not accepted.

1.21 made `\xintORof` robust against non terminated items.

```

336 \def\xintORof      {\romannumeral0\xintorof }%
337 \def\xintorof      #1{\expandafter\xINT_orof_a\romannumeral`&&@#1\xint:}%
338 \def\xINT_orof_a   #1{\expandafter\xINT_orof_b\romannumeral`&&@#1!}%
339 \def\xINT_orof_b   #1%
340       {\xint_gob_til_xint: #1\xINT_orof_e\xint:\xINT_orof_c #1}%
341 \def\xINT_orof_c   #1!%
342       {\xintifTrueAelseB {#1}{\xINT_orof_yes}{\xINT_orof_a}}%
343 \def\xINT_orof_yes #1\xint:{ 1}%
344 \def\xINT_orof_e   #1!{ 0}%

```

## 4.26 `\xintXORof`

New with 1.09a. Works with an empty list, too. Empty items however are not accepted. `\XINT_xorof_c` more efficient in 1.09i.

1.21 made `\xintXORof` robust against non terminated items.

```

345 \def\xintXORof      {\romannumeral0\xintxorof }%
346 \def\xintxorof      #1{\expandafter\xINT_xorof_a\expandafter
347       0\romannumeral`&&@#1\xint:}%
348 \def\xINT_xorof_a   #1#2{\expandafter\xINT_xorof_b\romannumeral`&&@#2!#1}%
349 \def\xINT_xorof_b   #1%
350       {\xint_gob_til_xint: #1\xINT_xorof_e\xint:\xINT_xorof_c #1}%
351 \def\xINT_xorof_c   #1!#2%
352       {\xintifTrueAelseB {#1}{\if #20\xint_afterfi{\xINT_xorof_a 1}%
353       \else\xint_afterfi{\xINT_xorof_a 0}\fi}%
354       {\xINT_xorof_a #2}%
355       }%
356 \def\xINT_xorof_e   #1!#2{ #2}%

```

4.27 `\xintGeq`, `\xintiiGeq`

PLUS GRAND OU ÉGAL attention compare les *\*\*valeurs absolues\*\**

1.2l made `\xintiiGeq` robust against non terminated items.

1.2l rewrote `\xintiiCmp`, but forgot to handle `\xintiiGeq` too. Done at 1.2m.

```

357 \def\xintGeq    {\romannumeral0\xintgeq }%
358 \def\xintgeq    #1{\expandafter\XINT_geq\romannumeral0\xintnum{#1}\xint:}%
359 \def\xintiiGeq   {\romannumeral0\xintiigeq }%
360 \def\xintiigeq   #1{\expandafter\XINT_iigeq\romannumeral`&&@#1\xint:}%
361 \def\XINT_iigeq   #1#2\xint:#3%
362 {%
363   \expandafter\XINT_geq_fork\expandafter #1\romannumeral`&&@#3\xint:#2\xint:
364 }%
365 \def\XINT_geq     #1#2\xint:#3%
366 {%
367   \expandafter\XINT_geq_fork\expandafter #1\romannumeral0\xintnum{#3}\xint:#2\xint:
368 }%
369 \def\XINT_geq_fork #1#2%
370 {%
371   \xint_UDzerofork
372   #1\XINT_geq_firstiszero
373   #2\XINT_geq_secondiszero
374   0{}%
375   \krof
376   \xint_UDsignsfork
377   #1#2\XINT_geq_minusminus
378   #1-\XINT_geq_minusplus
379   #2-\XINT_geq_plusminus
380   --\XINT_geq_plusplus
381   \krof #1#2%
382 }%
383 \def\XINT_geq_firstiszero #1\krof 0#2#3\xint:#4\xint:
384   {\xint_UDzerofork #2{ 1}0{ 0}\krof }%
385 \def\XINT_geq_secondiszero #1\krof #20#3\xint:#4\xint:{ 1}%
386 \def\XINT_geq_plusminus   #1-{\XINT_geq_plusplus #1{}}%
387 \def\XINT_geq_minusplus   -#1{\XINT_geq_plusplus {}#1}%
388 \def\XINT_geq_minusminus   --{\XINT_geq_plusplus {}{}}%
389 \def\XINT_geq_plusplus
390   {\expandafter\XINT_geq_finish\romannumeral0\XINT_cmp_plusplus}%
391 \def\XINT_geq_finish #1{\if-#1\expandafter\XINT_geq_no
392   \else\expandafter\XINT_geq_yes\fi}%
393 \def\XINT_geq_no 1{ 0}%
394 \def\XINT_geq_yes { 1}%

```

4.28 `\xintiMax`, `\xintiiMax`

At 1.2m, a long-standing bug was fixed: `\xintiiMax` had the overhead of applying `\xintNum` to its arguments due to use of a sub-macro of `\xintGeq` code to which this overhead was added at some point.

And on this occasion I reduced even more number of times input is grabbed.

```

395 \def\xintiMax {\romannumeral0\xintimax }%
396 \def\xintimax #1%

```

#### 4 Package `xint` implementation

```

397 {%
398   \expandafter\xint_max\romannumeral0\xintnum{#1}\xint:
399 }%
400 \def\xint_max #1\xint:#2%
401 {%
402   \expandafter\XINT_max_fork\romannumeral0\xintnum{#2}\xint:#1\xint:
403 }%
404 \def\xintiMax {\romannumeral0\xintiimax }%
405 \def\xintiimax #1%
406 {%
407   \expandafter\xint_iimax \romannumeral`&&@#1\xint:
408 }%
409 \def\xint_iimax #1\xint:#2%
410 {%
411   \expandafter\XINT_max_fork\romannumeral`&&@#2\xint:#1\xint:
412 }%

```

*#3#4 vient du \*premier\*, #1#2 vient du \*second\*. I have renamed the sub-macros at 1.2m because the terminology was quite counter-intuitive; there was no bug, but still.*

```

413 \def\XINT_max_fork #1#2\xint:#3#4\xint:
414 {%
415   \xint_UDsignsfork
416     #1#3\XINT_max_minusminus % A < 0, B < 0
417     #1-\XINT_max_plusminus % B < 0, A >= 0
418     #3-\XINT_max_minusplus % A < 0, B >= 0
419     --{\xint_UDzerosfork
420       #1#3\XINT_max_zerozero % A = B = 0
421       #10\XINT_max_pluszero % B = 0, A > 0
422       #30\XINT_max_zeropplus % A = 0, B > 0
423       00\XINT_max_plusplus % A, B > 0
424     \krof }%
425   \krof
426   #3#1#2\xint:#4\xint:
427   \expandafter\xint_firstoftwo_thenstop
428   \else
429   \expandafter\xint_secondoftwo_thenstop
430   \fi
431   {#3#4}{#1#2}%
432 }%

```

*Refactored at 1.2m for avoiding grabbing arguments. Position of inputs shared with `iiCmp` and `iiGeq` code.*

```

433 \def\XINT_max_zerozero #1\fi{\xint_firstoftwo_thenstop }%
434 \def\XINT_max_zeropplus #1\fi{\xint_secondoftwo_thenstop }%
435 \def\XINT_max_pluszero #1\fi{\xint_firstoftwo_thenstop }%
436 \def\XINT_max_minusplus #1\fi{\xint_secondoftwo_thenstop }%
437 \def\XINT_max_plusminus #1\fi{\xint_firstoftwo_thenstop }%
438 \def\XINT_max_plusplus
439 {%
440   \if1\romannumeral0\XINT_geq_plusplus
441 }%

```

Premier des testés  $|A|=-A$ , second est  $|B|=-B$ . On veut le  $\max(A,B)$ , c'est donc  $A$  si  $|A|<|B|$  (ou  $|A|=|B|$ , mais peu importe alors). Donc on peut faire cela avec `\unless`. Simple.

```
442 \def\XINT_max_minusminus --%
443 {%
444   \unless\if1\romannumeral0\XINT_geq_plusplus{}}}%
445 }%
```

#### 4.29 `\xintiMaxof`, `\xintiiMaxof`

New with 1.09a. 1.2 has NO MORE `\xintMaxof`, requires `\xintfracname`. 1.2a adds `\xintiiMaxof`, as `\xintiiMaxof:csv` is not public.

NOT compatible with empty list.

1.2l made `\xintiiMaxof` robust against non terminated items.

```
446 \def\xintiMaxof      {\romannumeral0\xintimaxof }%
447 \def\xintimaxof      #1{\expandafter\XINT_imaxof_a\romannumeral`&&@#1\xint:}%
448 \def\XINT_imaxof_a
449 #1{\expandafter\XINT_imaxof_b\romannumeral0\xintnum{#1}!}%

```

No `\xintnum` on #2 which might be `\xint:`, of course. But if list not terminated the `\xintNum` will be done via `\xintimax`.

```
450 \def\XINT_imaxof_b #1!#2%
451   {\expandafter\XINT_imaxof_c\romannumeral`&&@#2!{#1}!}%
452 \def\XINT_imaxof_c #1%
453   {\xint_gob_til_xint: #1\XINT_imaxof_e\xint:\XINT_imaxof_d #1}%
454 \def\XINT_imaxof_d #1!%
455   {\expandafter\XINT_imaxof_b\romannumeral0\xintimax {#1}}%
456 \def\XINT_imaxof_e #1!#2!{ #2}%
457 \def\xintiiMaxof      {\romannumeral0\xintiimaxof }%
458 \def\xintiimaxof      #1{\expandafter\XINT_iimaxof_a\romannumeral`&&@#1\xint:}%
459 \def\XINT_iimaxof_a #1{\expandafter\XINT_iimaxof_b\romannumeral`&&@#1!}%
460 \def\XINT_iimaxof_b #1!#2%
461   {\expandafter\XINT_iimaxof_c\romannumeral`&&@#2!{#1}!}%
462 \def\XINT_iimaxof_c #1%
463   {\xint_gob_til_xint: #1\XINT_iimaxof_e\xint:\XINT_iimaxof_d #1}%
464 \def\XINT_iimaxof_d #1!%
465   {\expandafter\XINT_iimaxof_b\romannumeral0\xintiimax {#1}}%
466 \def\XINT_iimaxof_e #1!#2!{ #2}%

```

#### 4.30 `\xintiMin`, `\xintiiMin`

`\xintnum` added New with 1.09a. I add `\xintiiMin` in 1.1 and mark as deprecated `\xintMin`, renamed `\xintiMin`. `\xintMin` NOW REMOVED (1.2, as `\xintMax`, `\xintMaxof`), only provided by `\xintfracnameimp`.

At 1.2m, a long-standing bug was fixed: `\xintiiMin` had the overhead of applying `\xintNum` to its arguments due to use of a sub-macro of `\xintGeq` code to which this overhead was added at some point.

And on this occasion I reduced even more number of times input is grabbed.

```
467 \def\xintiMin {\romannumeral0\xintimin }%
468 \def\xintimin #1%
469 {%

```



```

470 \expandafter\xint_min\romannumeral0\xintnum{#1}\xint:
471 }%
472 \def\xint_min #1\xint:#2%
473 {%
474 \expandafter\XINT_min_fork\romannumeral0\xintnum{#2}\xint:#1\xint:
475 }%
476 \def\xintiMin {\romannumeral0\xintiimin }%
477 \def\xintiimin #1%
478 {%
479 \expandafter\xint_iimin \romannumeral`&&@#1\xint:
480 }%
481 \def\xint_iimin #1\xint:#2%
482 {%
483 \expandafter\XINT_min_fork\romannumeral`&&@#2\xint:#1\xint:
484 }%
485 \def\XINT_min_fork #1#2\xint:#3#4\xint:
486 {%
487 \xint_UDsignsfork
488 #1#3\XINT_min_minusminus % A < 0, B < 0
489 #1-\XINT_min_plusminus % B < 0, A >= 0
490 #3-\XINT_min_minusplus % A < 0, B >= 0
491 --{\xint_UDzerosfork
492 #1#3\XINT_min_zerozero % A = B = 0
493 #10\XINT_min_pluszero % B = 0, A > 0
494 #30\XINT_min_zeroplus % A = 0, B > 0
495 00\XINT_min_plusplus % A, B > 0
496 \krof }%
497 \krof
498 #3#1#2\xint:#4\xint:
499 \expandafter\xint_secondoftwo_thenstop
500 \else
501 \expandafter\xint_firstoftwo_thenstop
502 \fi
503 {#3#4}{#1#2}%
504 }%
505 \def\XINT_min_zerozero #1\fi{\xint_firstoftwo_thenstop }%
506 \def\XINT_min_zeroplus #1\fi{\xint_firstoftwo_thenstop }%
507 \def\XINT_min_pluszero #1\fi{\xint_secondoftwo_thenstop }%
508 \def\XINT_min_minusplus #1\fi{\xint_firstoftwo_thenstop }%
509 \def\XINT_min_plusminus #1\fi{\xint_secondoftwo_thenstop }%
510 \def\XINT_min_plusplus
511 {%
512 \if1\romannumeral0\XINT_geq_plusplus
513 }%
514 \def\XINT_min_minusminus --%
515 {%
516 \unless\if1\romannumeral0\XINT_geq_plusplus{}\}%
517 }%

```

#### 4.31 *\xintiMinof*, *\xintiMinof*

1.09a. 1.2a adds *\xintiMinof* which was lacking.

```

518 \def\xintiMinof      {\romannumeral0\xintiminof }%
519 \def\xintiminof      #1{\expandafter\XINT_iminof_a\romannumeral`&&@#1\xint:}%
520 \def\XINT_iminof_a   #1{\expandafter\XINT_iminof_b\romannumeral0\xintnum{#1}!}%
521 \def\XINT_iminof_b   #1!#2%
522     {\expandafter\XINT_iminof_c\romannumeral`&&@#2!{#1}!}%
523 \def\XINT_iminof_c   #1%
524     {\xint_gob_til_xint: #1\XINT_iminof_e\xint:\XINT_iminof_d #1}%
525 \def\XINT_iminof_d   #1!%
526     {\expandafter\XINT_iminof_b\romannumeral0\xintimin {#1}}%
527 \def\XINT_iminof_e   #1!#2!{ #2}%
528 \def\xintiMinof      {\romannumeral0\xintiiminof }%
529 \def\xintiiminof     #1{\expandafter\XINT_iiminof_a\romannumeral`&&@#1\xint:}%
530 \def\XINT_iiminof_a   #1{\expandafter\XINT_iiminof_b\romannumeral`&&@#1!}%
531 \def\XINT_iiminof_b   #1!#2%
532     {\expandafter\XINT_iiminof_c\romannumeral`&&@#2!{#1}!}%
533 \def\XINT_iiminof_c   #1%
534     {\xint_gob_til_xint: #1\XINT_iiminof_e\xint:\XINT_iiminof_d #1}%
535 \def\XINT_iiminof_d   #1!%
536     {\expandafter\XINT_iiminof_b\romannumeral0\xintiimin {#1}}%
537 \def\XINT_iiminof_e   #1!#2!{ #2}%

```

#### 4.32 `\xintiiSum`

`\xintiiSum {{a}{b}...{z}}`

```

538 \def\xintiiSum {\romannumeral0\xintiisum }%
539 \def\xintiisum      #1{\expandafter\XINT_sumexpr\romannumeral`&&@#1\xint:}%
540 \def\XINT_sumexpr    {\XINT_sum_loop_a 0\Z }%
541 \def\XINT_sum_loop_a #1\Z #2%
542     {\expandafter\XINT_sum_loop_b \romannumeral`&&@#2\xint:#1\xint:\Z}%
543 \def\XINT_sum_loop_b #1%
544     {\xint_gob_til_xint: #1\XINT_sum_finished\xint:\XINT_sum_loop_c #1}%
545 \def\XINT_sum_loop_c
546     {\expandafter\XINT_sum_loop_a\romannumeral0\XINT_add_fork }%
547 \def\XINT_sum_finished\xint:\XINT_sum_loop_c\xint:\xint:#1\xint:\Z{ #1}%

```

#### 4.33 `\xintiiPrd`

`\xintiiPrd {{a}...{z}}`

```

548 \def\xintiiPrd {\romannumeral0\xintiiprd }%
549 \def\xintiiprd      #1{\expandafter\XINT_prdexpr\romannumeral`&&@#1\xint:}%
550 \def\XINT_prdexpr    {\XINT_prod_loop_a 1\Z }%
551 \def\XINT_prod_loop_a #1\Z #2%
552     {\expandafter\XINT_prod_loop_b\romannumeral`&&@#2\xint:#1\xint:\Z}%
553 \def\XINT_prod_loop_b #1%
554     {\xint_gob_til_xint: #1\XINT_prod_finished\xint:\XINT_prod_loop_c #1}%
555 \def\XINT_prod_loop_c
556     {\expandafter\XINT_prod_loop_a\romannumeral0\XINT_mul_fork }%
557 \def\XINT_prod_finished\xint:\XINT_prod_loop_c\xint:\xint:#1\xint:\Z { #1}%

```

-----  
 -----

DECIMAL OPERATIONS: FIRST DIGIT, LASTDIGIT, (<- moved to xintcore because xintiLDg needed by division macros) ODDNESS, MULTIPLICATION BY TEN, QUOTIENT BY TEN, (moved to xintcore 1.2i) QUOTIENT OR MULTIPLICATION BY POWER OF TEN, SPLIT OPERATION.

#### 4.34 `\xintMON`, `\xintMMON`, `\xintiiMON`, `\xintiiMMON`

MINUS ONE TO THE POWER N and  $(-1)^{N-1}$

```

558 \def\xintiiMON {\romannumeral0\xintiimon }%
559 \def\xintiimon #1%
560 {%
561   \ifodd\xintiILDg {#1} %<- intentional space
562   \xint_afterfi{ -1}%
563   \else
564   \xint_afterfi{ 1}%
565   \fi
566 }%
567 \def\xintiiMMON {\romannumeral0\xintiimmon }%
568 \def\xintiimmon #1%
569 {%
570   \ifodd\xintiILDg {#1} %<- intentional space
571   \xint_afterfi{ 1}%
572   \else
573   \xint_afterfi{ -1}%
574   \fi
575 }%
576 \def\xintMON {\romannumeral0\xintmon }%
577 \def\xintmon #1%
578 {%
579   \ifodd\xintLDg {#1} %<- intentional space
580   \xint_afterfi{ -1}%
581   \else
582   \xint_afterfi{ 1}%
583   \fi
584 }%
585 \def\xintMMON {\romannumeral0\xintmmon }%
586 \def\xintmmon #1%
587 {%
588   \ifodd\xintLDg {#1} %<- intentional space
589   \xint_afterfi{ 1}%
590   \else
591   \xint_afterfi{ -1}%
592   \fi
593 }%

```

#### 4.35 `\xintOdd`, `\xintiiOdd`, `\xintEven`, `\xintiiEven`

```

594 \def\xintiiOdd {\romannumeral0\xintiiodd }%
595 \def\xintiiodd #1%
596 {%
597   \ifodd\xintiILDg{#1} %<- intentional space
598   \xint_afterfi{ 1}%

```

```

599   \else
600     \xint_afterfi{ 0}%
601   \fi
602 }%
603 \def\xintiEven {\romannumeral0\xintiieven }%
604 \def\xintiieven #1%
605 {%
606   \ifodd\xintiLDg{#1} %<- intentional space
607     \xint_afterfi{ 0}%
608   \else
609     \xint_afterfi{ 1}%
610   \fi
611 }%
612 \def\xintOdd {\romannumeral0\xintodd }%
613 \def\xintodd #1%
614 {%
615   \ifodd\xintLDg{#1} %<- intentional space
616     \xint_afterfi{ 1}%
617   \else
618     \xint_afterfi{ 0}%
619   \fi
620 }%
621 \def\xintEven {\romannumeral0\xinteven }%
622 \def\xinteven #1%
623 {%
624   \ifodd\xintLDg{#1} %<- intentional space
625     \xint_afterfi{ 0}%
626   \else
627     \xint_afterfi{ 1}%
628   \fi
629 }%

```

#### 4.36 `\xintDSH`, `\xintDSHr`

DECIMAL SHIFTS `\xintDSH {x}{A}`  
 si  $x \leq 0$ , fait  $A \rightarrow A \cdot 10^{|x|}$ . si  $x > 0$ , et  $A \geq 0$ , fait  $A \rightarrow \text{quo}(A, 10^x)$   
 si  $x > 0$ , et  $A < 0$ , fait  $A \rightarrow -\text{quo}(-A, 10^x)$   
 (donc pour  $x > 0$  c'est comme DSR itéré  $x$  fois)  
`\xintDSHr` donne le 'reste' (si  $x \leq 0$  donne zéro).  
 Badly named macros.  
 Rewritten for 1.2i, this was old code and `\xintDSx` has changed interface.

```

630 \def\xintDSHr {\romannumeral0\xintdshr }%
631 \def\xintdshr #1#2%
632 {%
633   \expandafter\XINT_dshr_fork\the\numexpr#1\expandafter.\romannumeral`&&@#2;%
634 }%
635 \def\XINT_dshr_fork #1%
636 {%
637   \xint_UDzerominusfork
638     0#1\XINT_dshr_xzeroorneg
639     #1-\XINT_dshr_xzeroorneg
640     0-\XINT_dshr_xpositive
641   \krof #1%

```

```

642 }%
643 \def\XINT_dshr_xzeroorneg #1;{ 0}%
644 \def\XINT_dshr_xpositive
645 {%
646   \expandafter\xint_secondoftwo_thenstop\romannumeral0\XINT_dsx_xisPos
647 }%
648 \def\xintDSH {\romannumeral0\xintdsh }%
649 \def\xintdsh #1#2%
650 {%
651   \expandafter\XINT_dsh_fork\the\numexpr#1\expandafter.\romannumeral`&&@#2;%
652 }%
653 \def\XINT_dsh_fork #1%
654 {%
655   \xint_UDzerominusfork
656   #1-\XINT_dsh_xiszero
657   0#1\XINT_dsx_xisNeg_checkA
658   0-\XINT_dsh_xisPos #1}%
659 \krof
660 }%
661 \def\XINT_dsh_xiszero #1.#2;{ #2}%
662 \def\XINT_dsh_xisPos
663 {%
664   \expandafter\xint_firstoftwo_thenstop\romannumeral0\XINT_dsx_xisPos
665 }%

```

#### 4.37 `\xintDSx`

--> Attention le cas  $x=0$  est traité dans la même catégorie que  $x > 0$  <--

si  $x < 0$ , fait  $A \rightarrow A \cdot 10^{|x|}$

si  $x \geq 0$ , et  $A \geq 0$ , fait  $A \rightarrow \{ \text{quo}(A, 10^x) \} \{ \text{rem}(A, 10^x) \}$

si  $x \geq 0$ , et  $A < 0$ , d'abord on calcule  $\{ \text{quo}(-A, 10^x) \} \{ \text{rem}(-A, 10^x) \}$

puis, si le premier n'est pas nul on lui donne le signe -

si le premier est nul on donne le signe - au second.

On peut donc toujours reconstituer l'original  $A$  par  $10^x Q \pm R$  où il faut prendre le signe plus si  $Q$  est positif ou nul et le signe moins si  $Q$  est strictement négatif.

Rewritten for 1.2i, this was old code.

```

666 \def\xintDSx {\romannumeral0\xintdsx }%
667 \def\xintdsx #1#2%
668 {%
669   \expandafter\XINT_dsx_fork\the\numexpr#1\expandafter.\romannumeral`&&@#2;%
670 }%
671 \def\XINT_dsx_fork #1%
672 {%
673   \xint_UDzerominusfork
674   #1-\XINT_dsx_xisZero
675   0#1\XINT_dsx_xisNeg_checkA
676   0-\XINT_dsx_xisPos #1}%
677 \krof
678 }%
679 \def\XINT_dsx_xisZero #1.#2;{{#2}{0}}%
680 \def\XINT_dsx_xisNeg_checkA #1.#2%
681 {%

```

#### 4 Package *xint* implementation

```

682 \xint_gob_til_zero #2\XINT_dsx_xisNeg_Azero 0%
683 \expandafter\XINT_dsx_append\romannumeral\XINT_rep #1\endcsname 0.#2%
684 }%
685 \def\XINT_dsx_xisNeg_Azero #1;{ 0}%
686 \def\XINT_dsx_addzeros #1%
687 {\expandafter\XINT_dsx_append\romannumeral\XINT_rep#1\endcsname0.}%
688 \def\XINT_dsx_addzerosnofuss #1%
689 {\expandafter\XINT_dsx_append\romannumeral\xintreplicate{#1}0.}%
690 \def\XINT_dsx_append #1.#2;{ #2#1}%
691 \def\XINT_dsx_xisPos #1.#2%
692 {%
693 \xint_UDzerominusfork
694 #2-\XINT_dsx_AisZero
695 0#2\XINT_dsx_AisNeg
696 0-\XINT_dsx_AisPos
697 \krof #1.#2%
698 }%
699 \def\XINT_dsx_AisZero #1;{{0}{0}}%
700 \def\XINT_dsx_AisNeg #1.-#2;%
701 {%
702 \expandafter\XINT_dsx_AisNeg_checkiffirstempty
703 \romannumeral0\XINT_split_xfork #1.#2\xint_bye2345678\xint_bye..%
704 }%
705 \def\XINT_dsx_AisNeg_checkiffirstempty #1%
706 {%
707 \xint_gob_til_dot #1\XINT_dsx_AisNeg_finish_zero.%
708 \XINT_dsx_AisNeg_finish_notzero #1%
709 }%
710 \def\XINT_dsx_AisNeg_finish_zero.\XINT_dsx_AisNeg_finish_notzero.#1.%
711 {%
712 \expandafter\XINT_dsx_end
713 \expandafter {\romannumeral0\XINT_num {-#1}}{0}%
714 }%
715 \def\XINT_dsx_AisNeg_finish_notzero #1.#2.%
716 {%
717 \expandafter\XINT_dsx_end
718 \expandafter {\romannumeral0\XINT_num {#2}}{-#1}%
719 }%
720 \def\XINT_dsx_AisPos #1.#2;%
721 {%
722 \expandafter\XINT_dsx_AisPos_finish
723 \romannumeral0\XINT_split_xfork #1.#2\xint_bye2345678\xint_bye..%
724 }%
725 \def\XINT_dsx_AisPos_finish #1.#2.%
726 {%
727 \expandafter\XINT_dsx_end
728 \expandafter {\romannumeral0\XINT_num {#2}}%
729 {\romannumeral0\XINT_num {#1}}%
730 }%
731 \def\XINT_dsx_end #1#2{\expandafter{#2}{#1}}%

```

4.38 `\xintDecSplit`, `\xintDecSplitL`, `\xintDecSplitR`

## DECIMAL SPLIT

The macro `\xintDecSplit {x}{A}` cuts *A* which is composed of digits (leading zeroes ok, but no sign) (\*) into two (each possibly empty) pieces *L* and *R*. The concatenation *LR* always reproduces *A*.

The position of the cut is specified by the first argument *x*. If *x* is zero or positive the cut location is *x* slots to the left of the right end of the number. If *x* becomes equal to or larger than the length of the number then *L* becomes empty. If *x* is negative the location of the cut is  $|x|$  slots to the right of the left end of the number.

(\*) versions earlier than 1.2i first replaced *A* with its absolute value. This is not the case anymore. This macro should NOT be used for *A* with a leading sign (+ or -).

Entirely rewritten for 1.2i (2016/12/11).

Attention: `\xintDecSplit` not robust against non terminated second argument.

```

732 \def\xintDecSplit {\romannumeral0\xintdecsplit }%
733 \def\xintdecsplit #1#2%
734 {%
735   \expandafter\XINT_split_finish
736   \romannumeral0\expandafter\XINT_split_xfork
737   \the\numexpr #1\expandafter.\romannumeral`&&@#2%
738   \xint_bye2345678\xint_bye..%
739 }%
740 \def\xintDecSplitL {\romannumeral0\xintdecsplitl }%
741 \def\xintdecsplitl #1#2%
742 {%
743   \expandafter\XINT_splitl_finish
744   \romannumeral0\expandafter\XINT_split_xfork
745   \the\numexpr #1\expandafter.\romannumeral`&&@#2%
746   \xint_bye2345678\xint_bye..%
747 }%
748 \def\xintDecSplitR {\romannumeral0\xintdecsplitr }%
749 \def\xintdecsplitr #1#2%
750 {%
751   \expandafter\XINT_splitr_finish
752   \romannumeral0\expandafter\XINT_split_xfork
753   \the\numexpr #1\expandafter.\romannumeral`&&@#2%
754   \xint_bye2345678\xint_bye..%
755 }%
756 \def\XINT_split_finish #1.#2.{{#1}{#2}}%
757 \def\XINT_splitl_finish #1.#2.{ #1}%
758 \def\XINT_splitr_finish #1.#2.{ #2}%
759 \def\XINT_split_xfork #1%
760 {%
761   \xint_UDzerominusfork
762   #1-\XINT_split_zerosplit
763   0#1\XINT_split_fromleft
764   0-\XINT_split_fromright #1}%
765   \krof
766 }%
767 \def\XINT_split_zerosplit .#1\xint_bye#2\xint_bye..{ #1..}%
768 \def\XINT_split_fromleft
769   {\expandafter\XINT_split_fromleft_a\the\numexpr\xint_c_viii-}%
770 \def\XINT_split_fromleft_a #1%

```

#### 4 Package `xint` implementation

```

771 {%
772   \xint_UDsignfork
773   #1\XINT_split_fromleft_b
774   -{\XINT_split_fromleft_end_a #1}%
775   \krof
776 }%
777 \def\XINT_split_fromleft_b #1.#2#3#4#5#6#7#8#9%
778 {%
779   \expandafter\XINT_split_fromleft_clean
780   \the\numexpr1#2#3#4#5#6#7#8#9\expandafter
781   \XINT_split_fromleft_a\the\numexpr\xint_c_viii-#1.%
782 }%
783 \def\XINT_split_fromleft_end_a #1.%
784 {%
785   \expandafter\XINT_split_fromleft_clean
786   \the\numexpr1\csname XINT_split_fromleft_end#1\endcsname
787 }%
788 \def\XINT_split_fromleft_clean 1{ }%
789 \expandafter\def\csname XINT_split_fromleft_end7\endcsname #1%
790   {#1\XINT_split_fromleft_end_b}%
791 \expandafter\def\csname XINT_split_fromleft_end6\endcsname #1#2%
792   {#1#2\XINT_split_fromleft_end_b}%
793 \expandafter\def\csname XINT_split_fromleft_end5\endcsname #1#2#3%
794   {#1#2#3\XINT_split_fromleft_end_b}%
795 \expandafter\def\csname XINT_split_fromleft_end4\endcsname #1#2#3#4%
796   {#1#2#3#4\XINT_split_fromleft_end_b}%
797 \expandafter\def\csname XINT_split_fromleft_end3\endcsname #1#2#3#4#5%
798   {#1#2#3#4#5\XINT_split_fromleft_end_b}%
799 \expandafter\def\csname XINT_split_fromleft_end2\endcsname #1#2#3#4#5#6%
800   {#1#2#3#4#5#6\XINT_split_fromleft_end_b}%
801 \expandafter\def\csname XINT_split_fromleft_end1\endcsname #1#2#3#4#5#6#7%
802   {#1#2#3#4#5#6#7\XINT_split_fromleft_end_b}%
803 \expandafter\def\csname XINT_split_fromleft_end0\endcsname #1#2#3#4#5#6#7#8%
804   {#1#2#3#4#5#6#7#8\XINT_split_fromleft_end_b}%
805 \def\XINT_split_fromleft_end_b #1\xint_bye#2\xint_bye.{.#1}% puis .
806 \def\XINT_split_fromright #1.#2\xint_bye
807 {%
808   \expandafter\XINT_split_fromright_a
809   \the\numexpr#1-\numexpr\XINT_length_loop
810   #2\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:
811   \xint_c_viii\xint_c_vii\xint_c_vi\xint_c_v
812   \xint_c_iv\xint_c_iii\xint_c_ii\xint_c_i\xint_c_\xint_bye
813   .#2\xint_bye
814 }%
815 \def\XINT_split_fromright_a #1%
816 {%
817   \xint_UDsignfork
818   #1\XINT_split_fromleft
819   -\XINT_split_fromright_Lempty
820   \krof
821 }%
822 \def\XINT_split_fromright_Lempty #1.#2\xint_bye#3..{.#2.%}

```



4.39 `\xintiiSqrt`, `\xintiiSqrtR`, `\xintiiSquareRoot`

First done with 1.08.

1.1 added `\xintiiSquareRoot`.

1.1a added `\xintiiSqrtR`.

1.2f (2016/03/01-02-03) has rewritten the implementation, the underlying mathematics remaining about the same. The routine is much faster for inputs having up to 16 digits (because it does it all with `\numexpr` directly now), and also much faster for very long inputs (because it now fetches only the needed new digits after the first 16 (or 17) ones, via the geometric sequence 16, then 32, then 64, etc...; earlier version did the computations with all remaining digits after a suitable starting point with correct 4 or 5 leading digits). Note however that the fetching of tokens is via intrinsically  $O(N^2)$  macros, hence inevitably inputs with thousands of digits start being treated less well.

Actually there is some room for improvements, one could prepare better input *X* for the upcoming treatment of fetching its digits by 16, then 32, then 64, etc...

Incidentally, as `\xintiiSqrt` uses subtraction and subtraction was broken from 1.2 to 1.2c, then for another reason from 1.2c to 1.2f, it could get wrong in certain (relatively rare) cases. There was also a bug that made it unneedlessly slow for odd number of digits on input.

1.2f also modifies `\xintFloatSqrt` in `xintfrac.sty` which now has more code in common with here and benefits from the same speed improvements.

1.2k belatedly corrects the output to `{1}{1}` and not `11` when input is zero. As braces are used in all other cases they should have been used here too.

Also, 1.2k adds an `\xintiSqrtR` macro, for coherence as `\xintiSqrt` is defined (and mentioned in user manual.)

```
823 \def\xintiiSqrt {\romannumeral0\xintiisqrt }%
824 \def\xintiiSqrtR {\romannumeral0\xintiisqrtr }%
825 \def\xintiiSquareRoot {\romannumeral0\xintiisquareroot }%
826 \def\xintiSqrt {\romannumeral0\xintisqrt }%
827 \def\xintiSqrtR {\romannumeral0\xintisqrtr }%
828 \def\xintiSquareRoot {\romannumeral0\xintisquareroot }%
829 \def\xintisqrt {\expandafter\XINT_sqrt_post\romannumeral0\xintisquareroot }%
830 \def\xintisqrtr {\expandafter\XINT_sqrtr_post\romannumeral0\xintisquareroot }%
831 \def\xintiisqrt {\expandafter\XINT_sqrt_post\romannumeral0\xintiisquareroot }%
832 \def\xintiisqrtr {\expandafter\XINT_sqrtr_post\romannumeral0\xintiisquareroot }%
833 \def\XINT_sqrt_post #1#2{\XINT_dec #1\XINT_dec_bye234567890\xint_bye}%

```

$N = (\#1)^2 - \#2$  avec  $\#1$  le plus petit possible et  $\#2 > 0$  (hence  $\#2 < 2 * \#1$ ).  $(\#1 - .5)^2 = \#1^2 - \#1 + .25 = N + \#2 - \#1 + .25$ . Si  $0 < \#2 < \#1$ ,  $\leq N - 0.75 < N$ , donc rounded- $\rightarrow \#1$  si  $\#2 \geq \#1$ ,  $(\#1 - .5)^2 \geq N + .25 > N$ , donc rounded- $\rightarrow \#1 - 1$ .

```
834 \def\XINT_sqrtr_post #1#2{\xintiiiflt {#2}{#1}%
835 { #1}{\XINT_dec #1\XINT_dec_bye234567890\xint_bye}}%
836 \def\xintisquareroot #1%
837 {\expandafter\XINT_sqrt_checkin\romannumeral0\xintnum{#1}\xint:}%
838 \def\xintiisquareroot #1{\expandafter\XINT_sqrt_checkin\romannumeral`&&@#1\xint:}%
839 \def\XINT_sqrt_checkin #1%
840 {%
841 \xint_UDzerominusfork
842 #1-\XINT_sqrt_iszero
843 0#1\XINT_sqrt_isneg
844 0-\XINT_sqrt
845 \krof #1%
846 }%

```

#### 4 Package *xint* implementation

```

847 \def\XINT_sqrt_iszero #1\xint:{{1}{1}}%
848 \def\XINT_sqrt_isneg #1\xint:{\XINT_signalcondition{InvalidOperation}{square
849   root of negative: #1}}{\{0}{0}}}%
850 \def\XINT_sqrt #1\xint:
851 {%
852   \expandafter\XINT_sqrt_start\romannumeral0\xintlength {#1}.#1.%
853 }%
854 \def\XINT_sqrt_start #1.%
855 {%
856   \ifnum #1<\xint_c_x\xint_dothis\XINT_sqrt_small_a\fi
857   \xint_orthat\XINT_sqrt_big_a #1.%
858 }%
859 \def\XINT_sqrt_small_a #1.{\XINT_sqrt_a #1.\XINT_sqrt_small_d }%
860 \def\XINT_sqrt_big_a #1.{\XINT_sqrt_a #1.\XINT_sqrt_big_d }%
861 \def\XINT_sqrt_a #1.%
862 {%
863   \ifodd #1
864     \expandafter\XINT_sqrt_b0
865   \else
866     \expandafter\XINT_sqrt_bE
867   \fi
868   #1.%
869 }%
870 \def\XINT_sqrt_bE #1.#2#3#4%
871 {%
872   \XINT_sqrt_c {#3#4}#2{#1}#3#4%
873 }%
874 \def\XINT_sqrt_b0 #1.#2#3%
875 {%
876   \XINT_sqrt_c #3#2{#1}#3%
877 }%
878 \def\XINT_sqrt_c #1#2%
879 {%
880   \expandafter #2%
881   \the\numexpr \ifnum #1>\xint_c_ii
882     \ifnum #1>\xint_c_vi
883       \ifnum #1>12 \ifnum #1>20 \ifnum #1>30
884         \ifnum #1>42 \ifnum #1>56 \ifnum #1>72
885           \ifnum #1>90
886             10\else 9\fi \else 8\fi \else 7\fi \else 6\fi \else 5\fi
887             \else 4\fi \else 3\fi \else 2\fi \else 1\fi .%
888 }%
889 \def\XINT_sqrt_small_d #1.#2%
890 {%
891   \expandafter\XINT_sqrt_small_e
892   \the\numexpr #1\ifcase \numexpr #2/\xint_c_ii-\xint_c_i\relax
893     \or 0\or 00\or 000\or 0000\fi .%
894 }%
895 \def\XINT_sqrt_small_e #1.#2.%
896 {%
897   \expandafter\XINT_sqrt_small_ea\the\numexpr #1*#1-#2.#1.%
898 }%

```

#### 4 Package `xint` implementation

```

899 \def\XINT_sqrt_small_ea #1%
900 {%
901   \if0#1\xint_dothis\XINT_sqrt_small_ez\fi
902   \if-#1\xint_dothis\XINT_sqrt_small_eb\fi
903   \xint_orthat\XINT_sqrt_small_f #1%
904 }%
905 \def\XINT_sqrt_small_ez 0.#1.{\expandafter{\the\numexpr#1+\xint_c_i
906   \expandafter}\expandafter{\the\numexpr #1*\xint_c_ii+\xint_c_i}}%
907 \def\XINT_sqrt_small_eb -#1.#2.%
908 {%
909   \expandafter\XINT_sqrt_small_ec \the\numexpr
910   (#1-\xint_c_i+#2)/(\xint_c_ii*#2).#1.#2.%
911 }%
912 \def\XINT_sqrt_small_ec #1.#2.#3.%
913 {%
914   \expandafter\XINT_sqrt_small_f \the\numexpr
915   -#2+\xint_c_ii*#3*#1+#1*#1\expandafter.\the\numexpr #3+#1.%
916 }%
917 \def\XINT_sqrt_small_f #1.#2.%
918 {%
919   \expandafter\XINT_sqrt_small_g
920   \the\numexpr (#1+#2)/(\xint_c_ii*#2)-\xint_c_i.#1.#2.%
921 }%
922 \def\XINT_sqrt_small_g #1#2.%
923 {%
924   \if 0#1%
925     \expandafter\XINT_sqrt_small_end
926   \else
927     \expandafter\XINT_sqrt_small_h
928   \fi
929   #1#2.%
930 }%
931 \def\XINT_sqrt_small_h #1.#2.#3.%
932 {%
933   \expandafter\XINT_sqrt_small_f
934   \the\numexpr #2-\xint_c_ii*#1*#3+#1*#1\expandafter.%
935   \the\numexpr #3-#1.%
936 }%
937 \def\XINT_sqrt_small_end #1.#2.#3.{{#3}{#2}}%
938 \def\XINT_sqrt_big_d #1.#2%
939 {%
940   \ifodd #2 \xint_dothis{\expandafter\XINT_sqrt_big_e0}\fi
941   \xint_orthat{\expandafter\XINT_sqrt_big_eE}%
942   \the\numexpr (#2-\xint_c_i)/\xint_c_ii.#1;%
943 }%
944 \def\XINT_sqrt_big_eE #1;#2#3#4#5#6#7#8#9%
945 {%
946   \XINT_sqrt_big_eE_a #1;{#2#3#4#5#6#7#8#9}%
947 }%
948 \def\XINT_sqrt_big_eE_a #1.#2;#3%
949 {%
950   \expandafter\XINT_sqrt_bigormed_f

```

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```

951 \romannumeral0\XINT_sqrt_small_e #2000.#3.#1;%
952 }%
953 \def\XINT_sqrt_big_e0 #1;#2#3#4#5#6#7#8#9%
954 {%
955 \XINT_sqrt_big_e0_a #1;{#2#3#4#5#6#7#8#9}%
956 }%
957 \def\XINT_sqrt_big_e0_a #1.#2;#3#4%
958 {%
959 \expandafter\XINT_sqrt_bigormed_f
960 \romannumeral0\XINT_sqrt_small_e #20000.#3#4.#1;%
961 }%
962 \def\XINT_sqrt_bigormed_f #1#2#3;%
963 {%
964 \ifnum#3<\xint_c_ix
965 \xint_dothis {\csname XINT_sqrt_med_f\romannumeral#3\endcsname}%
966 \fi
967 \xint_orthat\XINT_sqrt_big_f #1.#2.#3;%
968 }%
969 \def\XINT_sqrt_med_fv {\XINT_sqrt_med_fa .}%
970 \def\XINT_sqrt_med_fvi {\XINT_sqrt_med_fa 0.}%
971 \def\XINT_sqrt_med_fvii {\XINT_sqrt_med_fa 00.}%
972 \def\XINT_sqrt_med_fviii{\XINT_sqrt_med_fa 000.}%
973 \def\XINT_sqrt_med_fa #1.#2.#3.#4;%
974 {%
975 \expandafter\XINT_sqrt_med_fb
976 \the\numexpr (#30#1-5#1)/(\xint_c_ii*#2).#1.#2.#3.%
977 }%
978 \def\XINT_sqrt_med_fb #1.#2.#3.#4.#5.%
979 {%
980 \expandafter\XINT_sqrt_small_ea
981 \the\numexpr (#40#2-\xint_c_ii*#3*#1)*10#2+(#1*#1-#5)\expandafter.%
982 \the\numexpr #30#2-#1.%
983 }%
984 \def\XINT_sqrt_big_f #1;#2#3#4#5#6#7#8#9%
985 {%
986 \XINT_sqrt_big_fa #1;{#2#3#4#5#6#7#8#9}%
987 }%
988 \def\XINT_sqrt_big_fa #1.#2.#3;#4%
989 {%
990 \expandafter\XINT_sqrt_big_ga
991 \the\numexpr #3-\xint_c_viii\expandafter.%
992 \romannumeral0\XINT_sqrt_med_fa 000.#1.#2.;#4.%
993 }%
994 %
995 \def\XINT_sqrt_big_ga #1.#2#3%
996 {%
997 \ifnum #1>\xint_c_viii
998 \expandafter\XINT_sqrt_big_gb\else
999 \expandafter\XINT_sqrt_big_ka
1000 \fi #1.#3.#2.%
1001 }%
1002 \def\XINT_sqrt_big_gb #1.#2.#3.%

```

#### 4 Package *xint* implementation

```

1003 {%
1004   \expandafter\XINT_sqrt_big_gc
1005   \the\numexpr (\xint_c_ii*#2-\xint_c_i)*\xint_c_x^viii/(\xint_c_iv*#3).%
1006   #3.#2.#1;%
1007 }%
1008 \def\XINT_sqrt_big_gc #1.#2.#3.%
1009 {%
1010   \expandafter\XINT_sqrt_big_gd
1011   \romannumeral0\xintiiaadd
1012     {\xintiiSub {#3000000000}\xintDouble{\xintiiMul{#2}{#1}}00000000}%
1013     {\xintiiSqr {#1}}.%
1014   \romannumeral0\xintiisub{#2000000000}{#1}.%
1015 }%
1016 \def\XINT_sqrt_big_gd #1.#2.%
1017 {%
1018   \expandafter\XINT_sqrt_big_ge #2.#1.%
1019 }%
1020 \def\XINT_sqrt_big_ge #1;#2#3#4#5#6#7#8#9%
1021   {\XINT_sqrt_big_gf #1.#2#3#4#5#6#7#8#9;}%
1022 \def\XINT_sqrt_big_gf #1;#2#3#4#5#6#7#8#9%
1023   {\XINT_sqrt_big_gg #1#2#3#4#5#6#7#8#9.}%
1024 \def\XINT_sqrt_big_gg #1.#2.#3.#4.%
1025 {%
1026   \expandafter\XINT_sqrt_big_gloop
1027   \expandafter\xint_c_xvi\expandafter.%
1028   \the\numexpr #3-\xint_c_viii\expandafter.%
1029   \romannumeral0\xintiisub {#2}{\xintiNum{#4}}.#1.%
1030 }%
1031 \def\XINT_sqrt_big_gloop #1.#2.%
1032 {%
1033   \unless\ifnum #1<#2 \xint_dothis\XINT_sqrt_big_ka \fi
1034   \xint_orthat{\XINT_sqrt_big_gi #1.}#2.%
1035 }%
1036 \def\XINT_sqrt_big_gi #1.%
1037 {%
1038   \expandafter\XINT_sqrt_big_gj\romannumeral\xintreplicate{#1}0.#1.%
1039 }%
1040 \def\XINT_sqrt_big_gj #1.#2.#3.#4.#5.%
1041 {%
1042   \expandafter\XINT_sqrt_big_gk
1043   \romannumeral0\xintiidivision {#4#1}%
1044     {\XINT_dbl #5\xint_bye2345678\xint_bye*\xint_c_ii\relax}.%
1045   #1.#5.#2.#3.%
1046 }%
1047 \def\XINT_sqrt_big_gk #1#2.#3.#4.%
1048 {%
1049   \expandafter\XINT_sqrt_big_gl
1050   \romannumeral0\xintiiaadd {#2#3}{\xintiiSqr{#1}}.%
1051   \romannumeral0\xintiisub {#4#3}{#1}.%
1052 }%
1053 \def\XINT_sqrt_big_gl #1.#2.%
1054 {%

```

#### 4 Package *xint* implementation

```

1055 \expandafter\XINT_sqrt_big_gm #2.#1.%
1056 }%
1057 \def\XINT_sqrt_big_gm #1.#2.#3.#4.#5.%
1058 {%
1059 \expandafter\XINT_sqrt_big_gn
1060 \romannumeral0\XINT_split_fromleft\xint_c_ii*#3.#5\xint_bye2345678\xint_bye. .%
1061 #1.#2.#3.#4.%
1062 }%
1063 \def\XINT_sqrt_big_gn #1.#2.#3.#4.#5.#6.%
1064 {%
1065 \expandafter\XINT_sqrt_big_gloop
1066 \the\numexpr \xint_c_ii*#5\expandafter.%
1067 \the\numexpr #6-#5\expandafter.%
1068 \romannumeral0\xintiisub{#4}{\xintiNum{#1}}.#3.#2.%
1069 }%
1070 \def\XINT_sqrt_big_ka #1.#2.#3.#4.%
1071 {%
1072 \expandafter\XINT_sqrt_big_kb
1073 \romannumeral0\XINT_dsx_addzeros {#1}#3;.%
1074 \romannumeral0\xintiisub
1075 {\XINT_dsx_addzerosnofuss {\xint_c_ii*#1}#2;}%
1076 {\xintiNum{#4}}.%
1077 }%
1078 \def\XINT_sqrt_big_kb #1.#2.%
1079 {%
1080 \expandafter\XINT_sqrt_big_kc #2.#1.%
1081 }%
1082 \def\XINT_sqrt_big_kc #1%
1083 {%
1084 \if0#1\xint_dothis\XINT_sqrt_big_kz\fi
1085 \xint_orthat\XINT_sqrt_big_kloop #1%
1086 }%
1087 \def\XINT_sqrt_big_kz 0.#1.%
1088 {%
1089 \expandafter\XINT_sqrt_big_kend
1090 \romannumeral0%
1091 \xintinc{\XINT_dbl#1\xint_bye2345678\xint_bye*\xint_c_ii\relax}.#1.%
1092 }%
1093 \def\XINT_sqrt_big_kend #1.#2.%
1094 {%
1095 \expandafter{\romannumeral0\xintinc{#2}}{#1}%
1096 }%
1097 \def\XINT_sqrt_big_kloop #1.#2.%
1098 {%
1099 \expandafter\XINT_sqrt_big_ke
1100 \romannumeral0\xintiidivision{#1}%
1101 {\romannumeral0\XINT_dbl #2\xint_bye2345678\xint_bye*\xint_c_ii\relax}{#2}%
1102 }%
1103 \def\XINT_sqrt_big_ke #1%
1104 {%
1105 \if0\XINT_Sgn #1\xint:
1106 \expandafter \XINT_sqrt_big_end

```

```

1107 \else \expandafter \XINT_sqrt_big_kf
1108 \fi {#1}%
1109 }%
1110 \def\XINT_sqrt_big_kf #1#2#3%
1111 {%
1112 \expandafter\XINT_sqrt_big_kg
1113 \romannumeral0\xintiisub {#3}{#1}.%
1114 \romannumeral0\xintiiaadd {#2}{\xintiiSqr {#1}}.%
1115 }%
1116 \def\XINT_sqrt_big_kg #1.#2.%
1117 {%
1118 \expandafter\XINT_sqrt_big_kloop #2.#1.%
1119 }%
1120 \def\XINT_sqrt_big_end #1#2#3{{#3}{#2}}%

```

#### 4.40 \xintiiBinomial, \xintiBinomial

2015/11/28-29 for 1.2f.

2016/11/19 for 1.2h: I truly can't understand why I hard-coded last year an error-message for arguments outside of the range for binomial formula. Naturally there should be no error but a rather a 0 return value for binomial(x,y), if  $y < 0$  or  $x < y$  !

I really lack some kind of infinity or NaN value.

```

1121 \def\xintiiBinomial {\romannumeral0\xintiibinomial }%
1122 \def\xintiibinomial #1#2%
1123 {%
1124 \expandafter\XINT_binom_pre\the\numexpr #1\expandafter.\the\numexpr #2.%
1125 }%
1126 \def\XINT_binom_pre #1.#2.%
1127 {%
1128 \expandafter\XINT_binom_fork \the\numexpr#1-#2.#2.#1.%
1129 }%
1130 \def\xintiBinomial{\romannumeral0\xintibinomial}%
1131 \let\xintibinomial\xintiibinomial

```

k.x-k.x. I hesitated to restrict maximal allowed value of x to 10000. Finally I don't. But due to using small multiplication and small division, x must have at most eight digits. If  $x \geq 2^{31}$  an arithmetic overflow error will have happened already.

```

1132 \def\XINT_binom_fork #1#2.#3#4.#5#6.%
1133 {%
1134 \if-#5\xint_dothis{\XINT_signalcondition{InvalidOperation}{Binomial with
1135 negative first arg: #5#6}{0}}\fi
1136 \if-#1\xint_dothis{ 0}\fi
1137 \if-#3\xint_dothis{ 0}\fi
1138 \if0#1\xint_dothis{ 1}\fi
1139 \if0#3\xint_dothis{ 1}\fi
1140 \ifnum #5#6>\xint_c_x^viii_mone\xint_dothis
1141 {\XINT_signalcondition{InvalidOperation}{Binomial with too
1142 large argument: 99999999 < #5#6}{0}}\fi
1143 \ifnum #1#2>#3#4 \xint_dothis{\XINT_binom_a #1#2.#3#4.}\fi
1144 \xint_orthat{\XINT_binom_a #3#4.#1#2.}%
1145 }%

```

#### 4 Package *xint* implementation

$x-k.k.$  avec  $0 < k < x$ ,  $k \leq x-k$ . Les divisions produiront en extra après le quotient un terminateur  $!!\backslash Z!0!$ . On va procéder par petite multiplication suivie par petite division. Donc ici on met le  $!!\backslash Z!0!$  pour amorcer.

Le  $\backslash xint\_bye!2!3!4!5!6!7!8!9!\backslash xint\_bye\backslash xint\_c\_i\backslash relax$  est le terminateur pour le  $\backslash XINT\_unsep\_cuzsmall$  final.

```
1146 \def\XINT_binom_a #1.#2.%
1147 {%
1148   \expandafter\XINT_binom_b\the\numexpr \xint_c_i+#1.1.#2.100000001!!;!0!%
1149 }%
```

$y=x-k+1.j=1.k$ . On va évaluer par  $y/1*(y+1)/2*(y+2)/3$  etc... On essaie de regrouper de manière à utiliser au mieux  $\backslash numexpr$ . On peut aller jusqu'à  $x=10000$  car  $9999*10000 < 10^8$ .  $463*464*465=99896880$ ,  $98*99*100*101=97990200$ . On va vérifier à chaque étape si on dépasse un seuil. Le style de l'implémentation diffère de celui que j'avais utilisé pour  $\backslash xintiiFac$ . On pourrait tout-à-fait avoir une *verybigloop*, mais bon. Je rajoute aussi un *verysmall*. Le traitement est un peu différent pour elle afin d'aller jusqu'à  $x=29$  (et pas seulement 26 si je suivais le modèle des autres, mais je veux pouvoir faire  $\text{binomial}(29,1)$ ,  $\text{binomial}(29,2)$ , ... en *vsmall*).

```
1150 \def\XINT_binom_b #1.%
1151 {%
1152   \ifnum #1>9999 \xint_dothis\XINT_binom_vbigloop \fi
1153   \ifnum #1>463 \xint_dothis\XINT_binom_bigloop \fi
1154   \ifnum #1>98 \xint_dothis\XINT_binom_medloop \fi
1155   \ifnum #1>29 \xint_dothis\XINT_binom_smallloop \fi
1156   \xint_orthat\XINT_binom_vsmallloop #1.%
1157 }%
```

$y.j.k$ . Au départ on avait  $x-k+1.1.k$ . Ensuite on a des blocs  $1<8d>!$  donnant le résultat intermédiaire, dans l'ordre, et à la fin on a  $!!1;!0!$ . Dans *smallloop* on peut prendre 4 par 4.

```
1158 \def\XINT_binom_smallloop #1.#2.#3.%
1159 {%
1160   \ifcase\numexpr #3-#2\relax
1161     \expandafter\XINT_binom_end_
1162   \or \expandafter\XINT_binom_end_i
1163   \or \expandafter\XINT_binom_end_ii
1164   \or \expandafter\XINT_binom_end_iii
1165   \else\expandafter\XINT_binom_smallloop_a
1166   \fi #1.#2.#3.%
1167 }%
```

Ça m'ennuie un peu de reprendre les #1, #2, #3 ici. On a besoin de  $\backslash numexpr$  pour  $\backslash XINT\_binom\_div$ , mais de  $\backslash romannumeral0$  pour le unsep après  $\backslash XINT\_binom\_mul$ .

```
1168 \def\XINT_binom_smallloop_a #1.#2.#3.%
1169 {%
1170   \expandafter\XINT_binom_smallloop_b
1171   \the\numexpr #1+\xint_c_iv\expandafter.%
1172   \the\numexpr #2+\xint_c_iv\expandafter.%
1173   \the\numexpr #3\expandafter.%
1174   \the\numexpr\expandafter\XINT_binom_div
1175   \the\numexpr #2*(#2+\xint_c_i)*(#2+\xint_c_ii)*(#2+\xint_c_iii)\expandafter
1176   !\romannumeral0\expandafter\XINT_binom_mul
```



#### 4 Package `xint` implementation

```
1177 \the\numexpr #1*(#1+\xint_c_i)*(#1+\xint_c_ii)*(#1+\xint_c_iii)!%
1178 }%
1179 \def\xint_binom_smallloop_b #1.%
1180 {%
1181 \ifnum #1>98 \expandafter\xint_binom_medloop \else
1182 \expandafter\xint_binom_smallloop \fi #1.%
1183 }%
```

Ici on prend trois par trois.

```
1184 \def\xint_binom_medloop #1.#2.#3.%
1185 {%
1186 \ifcase\numexpr #3-#2\relax
1187 \expandafter\xint_binom_end_
1188 \or \expandafter\xint_binom_end_i
1189 \or \expandafter\xint_binom_end_ii
1190 \else\expandafter\xint_binom_medloop_a
1191 \fi #1.#2.#3.%
1192 }%
1193 \def\xint_binom_medloop_a #1.#2.#3.%
1194 {%
1195 \expandafter\xint_binom_medloop_b
1196 \the\numexpr #1+\xint_c_iii\expandafter.%
1197 \the\numexpr #2+\xint_c_iii\expandafter.%
1198 \the\numexpr #3\expandafter.%
1199 \the\numexpr\expandafter\xint_binom_div
1200 \the\numexpr #2*(#2+\xint_c_i)*(#2+\xint_c_ii)\expandafter
1201 !\romannumeral0\expandafter\xint_binom_mul
1202 \the\numexpr #1*(#1+\xint_c_i)*(#1+\xint_c_ii)!%
1203 }%
1204 \def\xint_binom_medloop_b #1.%
1205 {%
1206 \ifnum #1>463 \expandafter\xint_binom_bigloop \else
1207 \expandafter\xint_binom_medloop \fi #1.%
1208 }%
```

Ici on prend deux par deux.

```
1209 \def\xint_binom_bigloop #1.#2.#3.%
1210 {%
1211 \ifcase\numexpr #3-#2\relax
1212 \expandafter\xint_binom_end_
1213 \or \expandafter\xint_binom_end_i
1214 \else\expandafter\xint_binom_bigloop_a
1215 \fi #1.#2.#3.%
1216 }%
1217 \def\xint_binom_bigloop_a #1.#2.#3.%
1218 {%
1219 \expandafter\xint_binom_bigloop_b
1220 \the\numexpr #1+\xint_c_ii\expandafter.%
1221 \the\numexpr #2+\xint_c_ii\expandafter.%
1222 \the\numexpr #3\expandafter.%
1223 \the\numexpr\expandafter\xint_binom_div
1224 \the\numexpr #2*(#2+\xint_c_i)\expandafter
```

#### 4 Package *xint* implementation

```

1225    !\romannumeral0\expandafter\XINT_binom_mul
1226      \the\numexpr #1*(#1+\xint_c_i)!%
1227 }%
1228 \def\XINT_binom_bigloop_b #1.%
1229 {%
1230   \ifnum #1>9999 \expandafter\XINT_binom_vbigloop \else
1231     \expandafter\XINT_binom_bigloop \fi #1.%
1232 }%

```

Et finalement un par un.

```

1233 \def\XINT_binom_vbigloop #1.#2.#3.%
1234 {%
1235   \ifnum #3=#2
1236     \expandafter\XINT_binom_end_
1237   \else\expandafter\XINT_binom_vbigloop_a
1238   \fi #1.#2.#3.%
1239 }%
1240 \def\XINT_binom_vbigloop_a #1.#2.#3.%
1241 {%
1242   \expandafter\XINT_binom_vbigloop
1243   \the\numexpr #1+\xint_c_i\expandafter.%
1244   \the\numexpr #2+\xint_c_i\expandafter.%
1245   \the\numexpr #3\expandafter.%
1246   \the\numexpr\expandafter\XINT_binom_div\the\numexpr #2\expandafter
1247   !\romannumeral0\XINT_binom_mul #1!%
1248 }%

```

y.j.k. La partie *very small*. y est au plus 26 (non 29 mais retesté dans `\XINT_binom_vsmallloop_a`), et tous les binomial(29,n) sont  $<10^8$ . On peut donc faire  $y(y+1)(y+2)(y+3)$  et aussi il y a le fait que *etex* fait  $a*b/c$  en double precision. Pour ne pas bifurquer à la fin sur *smallloop*, si  $n=27$ , 27, ou 29 on procède un peu différemment des autres boucles. Si je testais aussi #1 après #3-#2 pour les autres il faudrait des terminaisons différentes.

```

1249 \def\XINT_binom_vsmallloop #1.#2.#3.%
1250 {%
1251   \ifcase\numexpr #3-#2\relax
1252     \expandafter\XINT_binom_vsmallend_
1253   \or \expandafter\XINT_binom_vsmallend_i
1254   \or \expandafter\XINT_binom_vsmallend_ii
1255   \or \expandafter\XINT_binom_vsmallend_iii
1256   \else\expandafter\XINT_binom_vsmallloop_a
1257   \fi #1.#2.#3.%
1258 }%
1259 \def\XINT_binom_vsmallloop_a #1.%
1260 {%
1261   \ifnum #1>26 \expandafter\XINT_binom_smallloop_a \else
1262     \expandafter\XINT_binom_vsmallloop_b \fi #1.%
1263 }%
1264 \def\XINT_binom_vsmallloop_b #1.#2.#3.%
1265 {%
1266   \expandafter\XINT_binom_vsmallloop
1267   \the\numexpr #1+\xint_c_iv\expandafter.%
1268   \the\numexpr #2+\xint_c_iv\expandafter.%

```

#### 4 Package `xint` implementation

```

1269 \the\numexpr #3\expandafter.%
1270 \the\numexpr \expandafter\XINT_binom_vsmallmuldiv
1271 \the\numexpr #2*(#2+\xint_c_i)*(#2+\xint_c_ii)*(#2+\xint_c_iii)\expandafter
1272 !\the\numexpr #1*(#1+\xint_c_i)*(#1+\xint_c_ii)*(#1+\xint_c_iii)!%
1273 }%

1274 \def\XINT_binom_mul #1!#21!;!0!%
1275 {%
1276 \expandafter\XINT_rev_nounsep\expandafter{\expandafter}%
1277 \the\numexpr\expandafter\XINT_smallmul
1278 \the\numexpr\xint_c_x^viii+#1\expandafter
1279 !\romannumeral0\XINT_rev_nounsep {}1;!#2%
1280 \R!\R!\R!\R!\R!\R!\R!\R!\W
1281 \R!\R!\R!\R!\R!\R!\R!\R!\W
1282 1;!%
1283 }%

1284 \def\XINT_binom_div #1!1;!%
1285 {%
1286 \expandafter\XINT_smalldivx_a
1287 \the\numexpr #1/\xint_c_ii\expandafter\xint:
1288 \the\numexpr \xint_c_x^viii+#1!%
1289 }%

```

Vaguement envisagé d'éviter le  $10^8+$  mais bon.

```
1290 \def\XINT_binom_vsmallmuldiv #1!#2!1#3!{\xint_c_x^viii+#2*#3/#1!}%
```

On a des terminaisons communes aux trois situations small, med, big, et on est sûr de pouvoir faire les multiplications dans \numexpr, car on vient ici *\*après\** avoir comparé à 9999 ou 463 ou 98.

```

1291 \def\XINT_binom_end_iii #1.#2.#3.%
1292 {%
1293     \expandafter\XINT_binom_finish
1294     \the\numexpr\expandafter\XINT_binom_div
1295         \the\numexpr #2*(#2+\xint_c_i)*(#2+\xint_c_ii)*(#2+\xint_c_iii)\expandafter
1296         !\romannumeral0\expandafter\XINT_binom_mul
1297         \the\numexpr #1*(#1+\xint_c_i)*(#1+\xint_c_ii)*(#1+\xint_c_iii)!%
1298 }%
1299 \def\XINT_binom_end_ii #1.#2.#3.%
1300 {%
1301     \expandafter\XINT_binom_finish
1302     \the\numexpr\expandafter\XINT_binom_div
1303         \the\numexpr #2*(#2+\xint_c_i)*(#2+\xint_c_ii)\expandafter
1304         !\romannumeral0\expandafter\XINT_binom_mul
1305         \the\numexpr #1*(#1+\xint_c_i)*(#1+\xint_c_ii)!%
1306 }%
1307 \def\XINT_binom_end_i #1.#2.#3.%
1308 {%
1309     \expandafter\XINT_binom_finish
1310     \the\numexpr\expandafter\XINT_binom_div
1311         \the\numexpr #2*(#2+\xint_c_i)\expandafter
1312         !\romannumeral0\expandafter\XINT_binom_mul
1313         \the\numexpr #1*(#1+\xint_c_i)!%
1314 }%

```

#### 4 Package *xint* implementation

```

1315 \def\XINT_binom_end_ #1.#2.#3.%
1316 {%
1317   \expandafter\XINT_binom_finish
1318   \the\numexpr\expandafter\XINT_binom_div\the\numexpr #2\expandafter
1319   !\romannumeral0\XINT_binom_mul #1!%
1320 }%

1321 \def\XINT_binom_finish #1;!0!%
1322   {\XINT_unsep_cuzsmall #1\xint_bye!2!3!4!5!6!7!8!9!\xint_bye\xint_c_i\relax}%

```

Duplication de code seulement pour la boucle avec très petits coeffs, mais en plus on fait au maximum des possibilités. (on pourrait tester plus le résultat déjà obtenu).

```

1323 \def\XINT_binom_vsmallend_iii #1.%
1324 {%
1325   \ifnum #1>26 \expandafter\XINT_binom_end_iii \else
1326             \expandafter\XINT_binom_vsmallend_iiib \fi #1.%
1327 }%
1328 \def\XINT_binom_vsmallend_iiib #1.#2.#3.%
1329 {%
1330   \expandafter\XINT_binom_vsmallfinish
1331   \the\numexpr \expandafter\XINT_binom_vsmallmuldiv
1332   \the\numexpr #2*(#2+\xint_c_i)*(#2+\xint_c_ii)*(#2+\xint_c_iii)\expandafter
1333   !\the\numexpr #1*(#1+\xint_c_i)*(#1+\xint_c_ii)*(#1+\xint_c_iii)!%
1334 }%
1335 \def\XINT_binom_vsmallend_ii #1.%
1336 {%
1337   \ifnum #1>27 \expandafter\XINT_binom_end_ii \else
1338             \expandafter\XINT_binom_vsmallend_iib \fi #1.%
1339 }%
1340 \def\XINT_binom_vsmallend_iib #1.#2.#3.%
1341 {%
1342   \expandafter\XINT_binom_vsmallfinish
1343   \the\numexpr \expandafter\XINT_binom_vsmallmuldiv
1344   \the\numexpr #2*(#2+\xint_c_i)*(#2+\xint_c_ii)\expandafter
1345   !\the\numexpr #1*(#1+\xint_c_i)*(#1+\xint_c_ii)!%
1346 }%
1347 \def\XINT_binom_vsmallend_i #1.%
1348 {%
1349   \ifnum #1>28 \expandafter\XINT_binom_end_i \else
1350             \expandafter\XINT_binom_vsmallend_ib \fi #1.%
1351 }%
1352 \def\XINT_binom_vsmallend_ib #1.#2.#3.%
1353 {%
1354   \expandafter\XINT_binom_vsmallfinish
1355   \the\numexpr \expandafter\XINT_binom_vsmallmuldiv
1356   \the\numexpr #2*(#2+\xint_c_i)\expandafter
1357   !\the\numexpr #1*(#1+\xint_c_i)!%
1358 }%
1359 \def\XINT_binom_vsmallend_ #1.%
1360 {%
1361   \ifnum #1>29 \expandafter\XINT_binom_end_ \else
1362             \expandafter\XINT_binom_vsmallend_b \fi #1.%
1363 }%

```

```

1364 \def\XINT_binom_vsmallend_b #1.#2.#3.%
1365 {%
1366     \expandafter\XINT_binom_vsmallfinish
1367     \the\numexpr\XINT_binom_vsmallmuldiv #2!#1!%
1368 }%
1369 \def\XINT_binom_vsmallfinish#1{%
1370 \def\XINT_binom_vsmallfinish1##1!1!;!0!{\expandafter#1\the\numexpr##1\relax}%
1371 }\XINT_binom_vsmallfinish{ }%

```

#### 4.41 \xintiiPFactorial, \xintiPFactorial

2015/11/29 for 1.2f. Partial factorial pfac(a,b)=(a+1)...b, only for non-negative integers with  $a \leq b < 10^8$ .

1.2h (2016/11/20) removes the non-negativity condition. It was a bit unfortunate that the code raised \xintError:OutOfRangePFac if  $0 \leq a \leq b < 10^8$  was violated. The rule now applied is to interpret pfac(a,b) as the product for  $a < j \leq b$  (not as a ratio of Gamma function), hence if  $a \geq b$ , return 1 because of an empty product. If  $a < b$ : if  $a < 0$ , return 0 for  $b \geq 0$  and  $(-1)^{(b-a)}$  times  $|b| \dots (|a|-1)$  for  $b < 0$ . But only for the range  $0 \leq a \leq b < 10^8$  is the macro result to be considered as stable.

```

1372 \def\xintiiPFactorial {\romannumeral0\xintiipfactorial }%
1373 \def\xintiipfactorial #1#2%
1374 {%
1375     \expandafter\XINT_pfac_fork\the\numexpr#1\expandafter.\the\numexpr #2.%
1376 }%
1377 \def\xintiPFactorial{\romannumeral0\xintipfactorial}%
1378 \let\xintipfactorial\xintiipfactorial

```

Code is a simplified version of the one for \xintiiBinomial, with no attempt at implementing a "very small" branch.

```

1379 \def\XINT_pfac_fork #1#2.#3#4.%
1380 {%
1381     \unless\ifnum #1#2<#3#4 \xint_dothis\XINT_pfac_one\fi
1382     \if-#3\xint_dothis\XINT_pfac_neg\fi
1383     \if-#1\xint_dothis\XINT_pfac_zero\fi
1384     \ifnum #3#4>\xint_c_x^viii_mone\xint_dothis\XINT_pfac_outofrange\fi
1385     \xint_orthat \XINT_pfac_a #1#2.#3#4.%
1386 }%
1387 \def\XINT_pfac_outofrange #1.#2.%
1388     {\XINT_signalcondition{InvalidOperation}{PFactorial with
1389     too big second arg: 99999999 < #2}\{0}\}%
1390 \def\XINT_pfac_one #1.#2.{ 1}%
1391 \def\XINT_pfac_zero #1.#2.{ 0}%
1392 \def\XINT_pfac_neg -#1.-#2.%
1393 {%
1394     \ifnum #1>\xint_c_x^viii\xint_dothis\XINT_pfac_outofrange\fi
1395     \xint_orthat
1396     {\ifodd\numexpr#2-#1\relax\xint_afterfi{\expandafter-\romannumeral`&&@\}\fi
1397     \expandafter\XINT_pfac_a }%
1398     \the\numexpr #2-\xint_c_i\expandafter.\the\numexpr#1-\xint_c_i.%
1399 }%
1400 \def\XINT_pfac_a #1.#2.%
1401 {%

```

#### 4 Package *xint* implementation

```

1402 \expandafter\XINT_pfac_b\the\numexpr \xint_c_i+#1.#2.1000000011!;!%
1403 1\R!1\R!1\R!1\R!1\R!1\R!1\R!1\R!\W
1404 }%
1405 \def\XINT_pfac_b #1.%
1406 {%
1407 \ifnum #1>9999 \xint_dothis\XINT_pfac_vbigloop \fi
1408 \ifnum #1>463 \xint_dothis\XINT_pfac_bigloop \fi
1409 \ifnum #1>98 \xint_dothis\XINT_pfac_medloop \fi
1410 \xint_orthat\XINT_pfac_smallloop #1.%
1411 }%
1412 \def\XINT_pfac_smallloop #1.#2.%
1413 {%
1414 \ifcase\numexpr #2-#1\relax
1415 \expandafter\XINT_pfac_end_
1416 \or \expandafter\XINT_pfac_end_i
1417 \or \expandafter\XINT_pfac_end_ii
1418 \or \expandafter\XINT_pfac_end_iii
1419 \else\expandafter\XINT_pfac_smallloop_a
1420 \fi #1.#2.%
1421 }%
1422 \def\XINT_pfac_smallloop_a #1.#2.%
1423 {%
1424 \expandafter\XINT_pfac_smallloop_b
1425 \the\numexpr #1+\xint_c_iv\expandafter.%
1426 \the\numexpr #2\expandafter.%
1427 \the\numexpr\expandafter\XINT_smallmul
1428 \the\numexpr \xint_c_x^viii+#1*(#1+\xint_c_i)*(#1+\xint_c_ii)*(#1+\xint_c_iii)!%
1429 }%
1430 \def\XINT_pfac_smallloop_b #1.%
1431 {%
1432 \ifnum #1>98 \expandafter\XINT_pfac_medloop \else
1433 \expandafter\XINT_pfac_smallloop \fi #1.%
1434 }%
1435 \def\XINT_pfac_medloop #1.#2.%
1436 {%
1437 \ifcase\numexpr #2-#1\relax
1438 \expandafter\XINT_pfac_end_
1439 \or \expandafter\XINT_pfac_end_i
1440 \or \expandafter\XINT_pfac_end_ii
1441 \else\expandafter\XINT_pfac_medloop_a
1442 \fi #1.#2.%
1443 }%
1444 \def\XINT_pfac_medloop_a #1.#2.%
1445 {%
1446 \expandafter\XINT_pfac_medloop_b
1447 \the\numexpr #1+\xint_c_iii\expandafter.%
1448 \the\numexpr #2\expandafter.%
1449 \the\numexpr\expandafter\XINT_smallmul
1450 \the\numexpr \xint_c_x^viii+#1*(#1+\xint_c_i)*(#1+\xint_c_ii)!%
1451 }%
1452 \def\XINT_pfac_medloop_b #1.%
1453 {%

```

#### 4 Package *xint* implementation

```

1454 \ifnum #1>463 \expandafter\XINT_pfac_bigloop \else
1455 \expandafter\XINT_pfac_medloop \fi #1.%
1456 }%
1457 \def\XINT_pfac_bigloop #1.#2.%
1458 {%
1459 \ifcase\numexpr #2-#1\relax
1460 \expandafter\XINT_pfac_end_
1461 \or \expandafter\XINT_pfac_end_i
1462 \else\expandafter\XINT_pfac_bigloop_a
1463 \fi #1.#2.%
1464 }%
1465 \def\XINT_pfac_bigloop_a #1.#2.%
1466 {%
1467 \expandafter\XINT_pfac_bigloop_b
1468 \the\numexpr #1+\xint_c_ii\expandafter.%
1469 \the\numexpr #2\expandafter.%
1470 \the\numexpr\expandafter
1471 \XINT_smallmul\the\numexpr \xint_c_x^viii+#1*(#1+\xint_c_i)!%
1472 }%
1473 \def\XINT_pfac_bigloop_b #1.%
1474 {%
1475 \ifnum #1>9999 \expandafter\XINT_pfac_vbigloop \else
1476 \expandafter\XINT_pfac_bigloop \fi #1.%
1477 }%
1478 \def\XINT_pfac_vbigloop #1.#2.%
1479 {%
1480 \ifnum #2=#1
1481 \expandafter\XINT_pfac_end_
1482 \else\expandafter\XINT_pfac_vbigloop_a
1483 \fi #1.#2.%
1484 }%
1485 \def\XINT_pfac_vbigloop_a #1.#2.%
1486 {%
1487 \expandafter\XINT_pfac_vbigloop
1488 \the\numexpr #1+\xint_c_i\expandafter.%
1489 \the\numexpr #2\expandafter.%
1490 \the\numexpr\expandafter\XINT_smallmul\the\numexpr\xint_c_x^viii+#1!%
1491 }%
1492 \def\XINT_pfac_end_iii #1.#2.%
1493 {%
1494 \expandafter\XINT_mul_out
1495 \the\numexpr\expandafter\XINT_smallmul
1496 \the\numexpr \xint_c_x^viii+#1*(#1+\xint_c_i)*(#1+\xint_c_ii)*(#1+\xint_c_iii)!%
1497 }%
1498 \def\XINT_pfac_end_ii #1.#2.%
1499 {%
1500 \expandafter\XINT_mul_out
1501 \the\numexpr\expandafter\XINT_smallmul
1502 \the\numexpr \xint_c_x^viii+#1*(#1+\xint_c_i)*(#1+\xint_c_ii)!%
1503 }%
1504 \def\XINT_pfac_end_i #1.#2.%
1505 {%

```

```

1506 \expandafter\XINT_mul_out
1507 \the\numexpr\expandafter\XINT_smallmul
1508 \the\numexpr \xint_c_x^viii+#1*(#1+\xint_c_i)!%
1509 }%
1510 \def\XINT_pfac_end_ #1.#2.%
1511 {%
1512 \expandafter\XINT_mul_out
1513 \the\numexpr\expandafter\XINT_smallmul\the\numexpr \xint_c_x^viii+#1!%
1514 }%

```

#### 4.42 `\xintiie`

Originally was used in `\xintiexpr`. Transferred from `xintfrac` for 1.1. Code rewritten for 1.2i.

```

1515 \def\xintiie {\romannumeral0\xintiie }% used in \xintMod.
1516 \def\xintiie #1#2%
1517 {\expandafter\XINT_ii_fork\the\numexpr #2\expandafter.\romannumeral`&&@#1;}%
1518 \def\XINT_ii_fork #1%
1519 {%
1520 \xint_UDsignfork
1521 #1\XINT_ii_neg
1522 -\XINT_ii_a
1523 \krof #1%
1524 }%
1525 \def\XINT_ii_a #1.%
1526 {\expandafter\XINT_dsx_append\romannumeral\XINT_rep #1\endcsname 0.}%
1527 \def\XINT_ii_neg #1.#2;{ #2}%

```

#### “Load `xintfrac`” macros

Originally was used in `\xintiexpr`. Transferred from `xintfrac` for 1.1.

```

1528 \catcode`! 11
1529 \def\xintMax {\Did_you_mean_iiMax?or_load_xintfrac!}%
1530 \def\xintMin {\Did_you_mean_iiMin?or_load_xintfrac!}%
1531 \def\xintMaxof {\Did_you_mean_iMaxof?or_load_xintfrac!}%
1532 \def\xintMinof {\Did_you_mean_iMinof?or_load_xintfrac!}%
1533 \def\xintSum {\Did_you_mean_iiSum?or_load_xintfrac!}%
1534 \def\xintPrd {\Did_you_mean_iiPrd?or_load_xintfrac!}%
1535 \catcode`! 12
1536 \XINT_restorecatcodes_endinput%

```



## 5 Package *xintbinhex* implementation

.1	Catcodes, $\varepsilon$ -TeX and reload detection . . .	145	.6	<code>\xintDecToBin</code> . . . . .	150
.2	Package identification . . . . .	146	.7	<code>\xintHexToDec</code> . . . . .	152
.3	Constants, etc... . . . . .	146	.8	<code>\xintBinToDec</code> . . . . .	154
.4	Helper macros . . . . .	147	.9	<code>\xintBinToHex</code> . . . . .	154
.4.1	<code>\XINT_zeroes_foriv</code> . . . . .	147	.10	<code>\xintHexToBin</code> . . . . .	155
.4.2	<code>\XINT_unsepb_loop</code> . . . . .	147	.11	<code>\xintCHexToBin</code> . . . . .	156
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The commenting is currently (2017/08/06) very sparse.

The macros from 1.08 (2013/06/07) remained unchanged until their complete rewrite at 1.2m (2012/07/07/31).

At 1.2n dependencies on *xintcore* were removed, so now the package loads only *xintkernel* (this could have been done earlier).

Also at 1.2n, macros evolved again, the main improvements being in the increased allowable sizes of the input for `\xintDecToHex`, `\xintDecToBin`, `\xintBinToHex`. Use of `\csname` governed expansion at some places rather than `\numexpr` with some clean-up after it.

### 5.1 Catcodes, $\varepsilon$ -TeX and reload detection

The code for reload detection was initially copied from HEIKO OBERDIEK's packages, then modified.

The method for catcodes was also initially directly inspired by these packages.

```

1 \begingroup\catcode61\catcode48\catcode32=10\relax%
2  \catcode13=5      % ^^M
3  \endlinechar=13 %
4  \catcode123=1     % {
5  \catcode125=2     % }
6  \catcode64=11     % @
7  \catcode35=6      % #
8  \catcode44=12     % ,
9  \catcode45=12     % -
10 \catcode46=12     % .
11 \catcode58=12     % :
12 \let\z\endgroup
13 \expandafter\let\expandafter\x\csname ver@xintbinhex.sty\endcsname
14 \expandafter\let\expandafter\w\csname ver@xintkernel.sty\endcsname
15 \expandafter
16   \ifx\csname PackageInfo\endcsname\relax
17     \def\y#1#2{\immediate\write-1{Package #1 Info: #2.}}%
18   \else
19     \def\y#1#2{\PackageInfo{#1}{#2}}%
20   \fi
21 \expandafter
22 \ifx\csname numexpr\endcsname\relax
23   \y{xintbinhex}{\numexpr not available, aborting input}%
24   \aftergroup\endinput
25 \else
26   \ifx\x\relax % plain-TeX, first loading of xintbinhex.sty
27     \ifx\w\relax % but xintkernel.sty not yet loaded.
28       \def\z{\endgroup\input xintkernel.sty\relax}%
29     \fi

```

```

30 \else
31 \def\empty {}%
32 \ifx\empty % LaTeX, first loading,
33 % variable is initialized, but \ProvidesPackage not yet seen
34 \ifx\w\relax % xintkernel.sty not yet loaded.
35 \def\z{\endgroup\RequirePackage{xintkernel}}%
36 \fi
37 \else
38 \aftergroup\endinput % xintbinhex already loaded.
39 \fi
40 \fi
41 \fi
42 \z%
43 \XINTsetupcatcodes% defined in xintkernel.sty

```

## 5.2 Package identification

```

44 \XINT_providespackage
45 \ProvidesPackage{xintbinhex}%
46 [2017/08/06 1.2n Expandable binary and hexadecimal conversions (JFB)]%

```

## 5.3 Constants, etc...

1.2n switches to \csname-governed expansion at various places.

```

47 \newcount\xint_c_ii^xv \xint_c_ii^xv 32768
48 \newcount\xint_c_ii^xvi \xint_c_ii^xvi 65536
49 \def\XINT_tmpa #1{\ifx\relax#1\else
50 \expandafter\edef\csname XINT_csdth_#1\endcsname
51 {\endcsname\ifcase #1 0\or 1\or 2\or 3\or 4\or 5\or 6\or 7\or
52 8\or 9\or A\or B\or C\or D\or E\or F\fi}%
53 \expandafter\XINT_tmpa\fi }%
54 \XINT_tmpa {0}{1}{2}{3}{4}{5}{6}{7}{8}{9}{10}{11}{12}{13}{14}{15}\relax
55 \def\XINT_tmpa #1{\ifx\relax#1\else
56 \expandafter\edef\csname XINT_csdtb_#1\endcsname
57 {\endcsname\ifcase #1
58 0000\or 0001\or 0010\or 0011\or 0100\or 0101\or 0110\or 0111\or
59 1000\or 1001\or 1010\or 1011\or 1100\or 1101\or 1110\or 1111\fi}%
60 \expandafter\XINT_tmpa\fi }%
61 \XINT_tmpa {0}{1}{2}{3}{4}{5}{6}{7}{8}{9}{10}{11}{12}{13}{14}{15}\relax
62 \let\XINT_tmpa\relax
63 \expandafter\def\csname XINT_csbth_0000\endcsname {\endcsname0}%
64 \expandafter\def\csname XINT_csbth_0001\endcsname {\endcsname1}%
65 \expandafter\def\csname XINT_csbth_0010\endcsname {\endcsname2}%
66 \expandafter\def\csname XINT_csbth_0011\endcsname {\endcsname3}%
67 \expandafter\def\csname XINT_csbth_0100\endcsname {\endcsname4}%
68 \expandafter\def\csname XINT_csbth_0101\endcsname {\endcsname5}%
69 \expandafter\def\csname XINT_csbth_0110\endcsname {\endcsname6}%
70 \expandafter\def\csname XINT_csbth_0111\endcsname {\endcsname7}%
71 \expandafter\def\csname XINT_csbth_1000\endcsname {\endcsname8}%
72 \expandafter\def\csname XINT_csbth_1001\endcsname {\endcsname9}%
73 \expandafter\def\csname XINT_csbth_1010\endcsname {\endcsname A}%
74 \expandafter\def\csname XINT_csbth_1011\endcsname {\endcsname B}%
75 \expandafter\def\csname XINT_csbth_1100\endcsname {\endcsname C}%

```

```

76 \expandafter\def\csname XINT_csbth_1101\endcsname {\endcsname D}%
77 \expandafter\def\csname XINT_csbth_1110\endcsname {\endcsname E}%
78 \expandafter\def\csname XINT_csbth_1111\endcsname {\endcsname F}%
79 \let\XINT_csbth_none \endcsname
80 \expandafter\def\csname XINT_cshtb_0\endcsname {\endcsname0000}%
81 \expandafter\def\csname XINT_cshtb_1\endcsname {\endcsname0001}%
82 \expandafter\def\csname XINT_cshtb_2\endcsname {\endcsname0010}%
83 \expandafter\def\csname XINT_cshtb_3\endcsname {\endcsname0011}%
84 \expandafter\def\csname XINT_cshtb_4\endcsname {\endcsname0100}%
85 \expandafter\def\csname XINT_cshtb_5\endcsname {\endcsname0101}%
86 \expandafter\def\csname XINT_cshtb_6\endcsname {\endcsname0110}%
87 \expandafter\def\csname XINT_cshtb_7\endcsname {\endcsname0111}%
88 \expandafter\def\csname XINT_cshtb_8\endcsname {\endcsname1000}%
89 \expandafter\def\csname XINT_cshtb_9\endcsname {\endcsname1001}%
90 \def\XINT_cshtb_A {\endcsname1010}%
91 \def\XINT_cshtb_B {\endcsname1011}%
92 \def\XINT_cshtb_C {\endcsname1100}%
93 \def\XINT_cshtb_D {\endcsname1101}%
94 \def\XINT_cshtb_E {\endcsname1110}%
95 \def\XINT_cshtb_F {\endcsname1111}%
96 \let\XINT_cshtb_none \endcsname

```

## 5.4 Helper macros

### 5.4.1 `\XINT_zeroes_foriv`

`\romannumeral0\XINT_zeroes_foriv #1\R{0\R}{00\R}{000\R}%  
\endcsname\R{0\R}{00\R}{000\R}\R\W`

expands to the <empty> or 0 or 00 or 000 needed which when adjoined to #1 extend it to length 4N.

```

97 \def\XINT_zeroes_foriv #1#2#3#4#5#6#7#8%
98 {%
99   \xint_gob_til_R #8\XINT_zeroes_foriv_end\R\XINT_zeroes_foriv
100}%
101 \def\XINT_zeroes_foriv_end\R\XINT_zeroes_foriv #1#2\W
102   {\XINT_zeroes_foriv_done #1}%
103 \def\XINT_zeroes_foriv_done #1\R{ #1}%

```

### 5.4.2 `\XINT_unsepb_loop`

This is used as

`\the\numexpr0\XINT_unsepb_loop (blocks of digits with ! as separator)  
\xint_bye!2!3!4!5!6!7!8!9!\xint_bye\xint_c_i\relax`

It removes the !'s and outputs the digits (being careful not to suppress leading zeroes) with a 0 prefix to remove later. Each block is allowed up to nine digits.

This is the same as `\XINT_unsepb_loop` from `xintcore.sty` except that the digits blocks have no 1-prefix. Was done for `\xintHexToDec` at 1.2m.

```

104 \def\XINT_unsepb_loop #1!#2!#3!#4!#5!#6!#7!#8!#9!%
105 {%
106   \expandafter\XINT_unsep_clean
107   \the\numexpr 1#1\expandafter\XINT_unsep_clean

```

```

108 \the\numexpr 1#2\expandafter\XINT_unsep_clean
109 \the\numexpr 1#3\expandafter\XINT_unsep_clean
110 \the\numexpr 1#4\expandafter\XINT_unsep_clean
111 \the\numexpr 1#5\expandafter\XINT_unsep_clean
112 \the\numexpr 1#6\expandafter\XINT_unsep_clean
113 \the\numexpr 1#7\expandafter\XINT_unsep_clean
114 \the\numexpr 1#8\expandafter\XINT_unsep_clean
115 \the\numexpr 1#9\XINT_unsepb_loop
116 }%
117 \def\XINT_unsep_clean 1{\relax}% also in xintcore

```

## 5.5 \xintDecToHex

Complete rewrite at 1.2m in the 1.2 style. Also, 1.2m is robust against non terminated inputs.

Improvements of coding at 1.2n, increased maximal size.

An input without leading zeroes gives an output without leading zeroes.

```

118 \def\xintDecToHex {\romannumeral0\xintdectohex }%
119 \def\xintdectohex #1%
120 {%
121   \expandafter\XINT_dth_checkin\romannumeral`&&@#1\xint:
122 }%
123 \def\XINT_dth_checkin #1%
124 {%
125   \xint_UDsignfork
126   #1\XINT_dth_neg
127   -{\XINT_dth_main #1}%
128   \krof
129 }%
130 \def\XINT_dth_neg {\expandafter-\romannumeral0\XINT_dth_main}%
131 \def\XINT_dth_main #1\xint:
132 {%
133   \expandafter\XINT_dth_finish
134   \romannumeral`&&\expandafter\XINT_dthb_start
135   \romannumeral0\XINT_zeroes_foriv
136   #1\R{0\R}{00\R}{000\R}\R{0\R}{00\R}{000\R}\R\W
137   #1\xint_bye\XINT_dth_tohex
138 }%
139 \def\XINT_dthb_start #1#2#3#4#5%
140 {%
141   \xint_bye#5\XINT_dthb_small\xint_bye\XINT_dthb_start_a #1#2#3#4#5%
142 }%
143 \def\XINT_dthb_small\xint_bye\XINT_dthb_start_a #1\xint_bye#2{#2#1!}%
144 \def\XINT_dthb_start_a #1#2#3#4#5#6#7#8#9%
145 {%
146   \expandafter\XINT_dthb_again\the\numexpr\expandafter\XINT_dthb_update
147   \the\numexpr#1#2#3#4%
148   \xint_bye#9\XINT_dthb_lastpass\xint_bye
149   #5#6#7#8!\XINT_dthb_exclam\relax\XINT_dthb_nextfour!2!3!4!5!6!7!8!9!\Z #9%
150 }%
151 \def\XINT_dthb_exclam {!\XINT_dthb_exclam!}%
152 \def\XINT_dthb_update #1!%
153 {%

```

## 5 Package *xintbinhex* implementation

```

154 \expandafter\XINT_dthb_update_a
155 \the\numexpr (#1+\xint_c_ii^xv)/\xint_c_ii^xvi-\xint_c_i\xint:
156 #1\xint:%
157 }%
158 \def\XINT_dthb_update_a #1\xint:#2\xint:#3%
159 {%
160 0000+#1\expandafter#3\the\numexpr#2-#1*\xint_c_ii^xvi
161 }%
162 \def\XINT_dthb_nextfour #1\Z #2#3#4#5#6%
163 {%
164 \xint_bye#6\XINT_dthb_lastpass\xint_bye
165 #2#3#4#5!\XINT_dthb_exclam\relax\XINT_dthb_nextfour!2!3!4!5!6!7!8!9!\Z #6%
166 }%
167 \def\XINT_dthb_lastpass\xint_bye #1!#2\xint_bye#3{#1!#3!}%
168 \def\XINT_dth_tohex
169 {%
170 \expandafter\expandafter\expandafter\XINT_dth_tohex_a\csname\XINT_tofourhex
171 }%
172 \def\XINT_dth_tohex_a\endcsname{!\XINT_dth_tohex!}%
173 \def\XINT_dthb_a #1!#2!#3!#4!#5!#6!#7!#8!#9!%
174 {%
175 \expandafter\XINT_dthb_update
176 \the\numexpr #1\expandafter\XINT_dthb_update
177 \the\numexpr #2\expandafter\XINT_dthb_update
178 \the\numexpr #3\expandafter\XINT_dthb_update
179 \the\numexpr #4\expandafter\XINT_dthb_update
180 \the\numexpr #5\expandafter\XINT_dthb_update
181 \the\numexpr #6\expandafter\XINT_dthb_update
182 \the\numexpr #7\expandafter\XINT_dthb_update
183 \the\numexpr #8\expandafter\XINT_dthb_update
184 \the\numexpr #9\XINT_dthb_a
185 }%
186 \def\XINT_dthb_again #1!#2!%
187 {%
188 \ifx\XINT_dthb_exclam#2%
189 \expandafter\xint_firstoftwo
190 \else
191 \expandafter\xint_secondoftwo
192 \fi
193 {\expandafter\XINT_dthb_again\the\numexpr\expandafter\XINT_dthb_a
194 \romannumeral`&&\ifnum #1>\xint_c_ \xint_dothis{#1!}\fi\xint_orthat{}}}%
195 {\ifnum #1>\xint_c_ \xint_dothis{#2#1!}\fi\xint_orthat{!#2!}}}%
196 }%
197 \def\XINT_tofourhex #1!%
198 {%
199 \expandafter\XINT_tofourhex_a
200 \the\numexpr (#1+\xint_c_ii^vii)/\xint_c_ii^viii-\xint_c_i\xint:
201 #1\xint:
202 }%
203 \def\XINT_tofourhex_a #1\xint:#2\xint:
204 {%
205 \expandafter\XINT_tofourhex_c

```

## 5 Package *xintbinhex* implementation

```
206 \the\numexpr (#1+\xint_c_viii)/\xint_c_xvi-\xint_c_i\xint:
207 #1\xint:
208 \the\numexpr #2-\xint_c_ii^viii*#1!%
209 }%
210 \def\xINT_tofourhex_c #1\xint:#2\xint:
211 {%
212 XINT_csdth_#1%
213 \csname XINT_csdth_\the\numexpr #2-\xint_c_xvi*#1\relax
214 \csname \expandafter\xINT_tofourhex_d
215 }%
216 \def\xINT_tofourhex_d #1!%
217 {%
218 \expandafter\xINT_tofourhex_e
219 \the\numexpr (#1+\xint_c_viii)/\xint_c_xvi-\xint_c_i\xint:
220 #1\xint:
221 }%
222 \def\xINT_tofourhex_e #1\xint:#2\xint:
223 {%
224 XINT_csdth_#1%
225 \csname XINT_csdth_\the\numexpr #2-\xint_c_xvi*#1\endcsname
226 }%
```

We only clean-up up to 3 zero hexadecimal digits, as output was produced in chunks of 4 hex digits. If input had no leading zero, output will have none either. If input had many leading zeroes, output will have some number (unspecified, but a recipe can be given...) of leading zeroes...

The coding is for varying a bit, I did not check if efficient, it does not matter.

```
227 \def\xINT_dth_finish !\xINT_dth_tohex!#1#2#3%
228 {%
229 \unless\if#10\xint_dothis{ #1#2#3}\fi
230 \unless\if#20\xint_dothis{ #2#3}\fi
231 \unless\if#30\xint_dothis{ #3}\fi
232 \xint_orthat{ }%
233 }%
```

### 5.6 *\xintDecToBin*

Complete rewrite at 1.2m in the 1.2 style. Also, 1.2m is robust against non terminated inputs.

Revisited at 1.2n like in *\xintDecToHex*: increased maximal size.

An input without leading zeroes gives an output without leading zeroes.

Most of the code canvas is shared with *\xintDecToHex*.

```
234 \def\xintDecToBin {\romannumeral0\xintdectobin }%
235 \def\xintdectobin #1%
236 {%
237 \expandafter\xINT_dtb_checkin\romannumeral`&&@#1\xint:
238 }%
239 \def\xINT_dtb_checkin #1%
240 {%
241 \xint_UDsignfork
242 #1\xINT_dtb_neg
243 -{\xINT_dtb_main #1}%
244 \krof
```

## 5 Package *xintbinhex* implementation

```

245 }%
246 \def\XINT_dtb_neg {\expandafter-\romannumeral0\XINT_dtb_main}%
247 \def\XINT_dtb_main #1\xint:
248 {%
249   \expandafter\XINT_dtb_finish
250   \romannumeral'&&\expandafter\XINT_dthb_start
251   \romannumeral0\XINT_zeroes_foriv
252   #1\R{0\R}{00\R}{000\R}\R{0\R}{00\R}{000\R}\R\W
253   #1\xint_bye\XINT_dtb_tobin
254 }%
255 \def\XINT_dtb_tobin
256 {%
257   \expandafter\expandafter\expandafter\XINT_dtb_tobin_a\csname\XINT_tosixteenbits
258 }%
259 \def\XINT_dtb_tobin_a\endcsname{!\XINT_dtb_tobin!}%
260 \def\XINT_tosixteenbits #1!%
261 {%
262   \expandafter\XINT_tosixteenbits_a
263   \the\numexpr (#1+\xint_c_ii^vii)/\xint_c_ii^viii-\xint_c_i\xint:
264   #1\xint:
265 }%
266 \def\XINT_tosixteenbits_a #1\xint:#2\xint:
267 {%
268   \expandafter\XINT_tosixteenbits_c
269   \the\numexpr (#1+\xint_c_viii)/\xint_c_xvi-\xint_c_i\xint:
270   #1\xint:
271   \the\numexpr #2-\xint_c_ii^viii*#1!%
272 }%
273 \def\XINT_tosixteenbits_c #1\xint:#2\xint:
274 {%
275   XINT_csdtb_#1%
276   \csname XINT_csdtb_\the\numexpr #2-\xint_c_xvi*#1\relax
277   \csname \expandafter\XINT_tosixteenbits_d
278 }%
279 \def\XINT_tosixteenbits_d #1!%
280 {%
281   \expandafter\XINT_tosixteenbits_e
282   \the\numexpr (#1+\xint_c_viii)/\xint_c_xvi-\xint_c_i\xint:
283   #1\xint:
284 }%
285 \def\XINT_tosixteenbits_e #1\xint:#2\xint:
286 {%
287   XINT_csdtb_#1%
288   \csname XINT_csdtb_\the\numexpr #2-\xint_c_xvi*#1\endcsname
289 }%
290 \def\XINT_dtb_finish !\XINT_dtb_tobin!#1#2#3#4#5#6#7#8%
291 {%
292   \expandafter\XINT_dtb_finish_a\the\numexpr #1#2#3#4#5#6#7#8\relax
293 }%
294 \def\XINT_dtb_finish_a #1{%
295 \def\XINT_dtb_finish_a ##1##2##3##4##5##6##7##8##9%
296 }%

```

```

297 \expandafter#1\the\numexpr ##1##2##3##4##5##6##7##8##9\relax
298 }}\XINT_dtb_finish_a { }%

```

## 5.7 \xintHexToDec

Completely (and belatedly) rewritten at 1.2m in the 1.2 style.

1.2m version robust against non terminated inputs, but there is no primitive from TeX which may generate hexadecimal digits and provoke expansion ahead, afaik, except of course if decimal digits are treated as hexadecimal. This robustness is not on purpose but from need to expand argument and then grab it again. So we do it safely.

Increased maximal size at 1.2n.

1.2m version robust against non terminated inputs.

An input without leading zeroes gives an output without leading zeroes.

```

299 \def\xintHexToDec {\romannumeral0\xinthextodec }%
300 \def\xinthextodec #1%
301 {%
302   \expandafter\XINT_htd_checkin\romannumeral`&&@#1\xint:
303 }%
304 \def\XINT_htd_checkin #1%
305 {%
306   \xint_UDsignfork
307     #1\XINT_htd_neg
308     -{\XINT_htd_main #1}%
309   \krof
310 }%
311 \def\XINT_htd_neg {\expandafter-\romannumeral0\XINT_htd_main}%
312 \def\XINT_htd_main #1\xint:
313 {%
314   \expandafter\XINT_htd_startb
315   \the\numexpr\expandafter\XINT_htd_starta
316   \romannumeral0\XINT_zeroes_foriv
317   #1\R{0\R}{00\R}{000\R}{R{0\R}{00\R}{000\R}\R\W
318   #1\xint_bye!2!3!4!5!6!7!8!9!\xint_bye\relax
319 }%
320 \def\XINT_htd_starta #1#2#3#4{"#1#2#3#4+100000!}%
321 \def\XINT_htd_startb 1#1%
322 {%
323   \if#10\expandafter\XINT_htd_startba\else
324     \expandafter\XINT_htd_startbb
325   \fi 1#1%
326 }%
327 \def\XINT_htd_startba 10#1!{\XINT_htd_again #1%
328   \xint_bye!2!3!4!5!6!7!8!9!\xint_bye\XINT_htd_nextfour}%
329 \def\XINT_htd_startbb 1#1#2!{\XINT_htd_again #1!#2%
330   \xint_bye!2!3!4!5!6!7!8!9!\xint_bye\XINT_htd_nextfour}%

```

It is a bit annoying to grab all to the end here. I have a version, modeled on the 1.2n variant of \xintDecToHex which solved that problem there, but it did not prove enough if at all faster in my brief testing and it had the defect of a reduced maximal allowed size of the input.

```

331 \def\XINT_htd_again #1\XINT_htd_nextfour #2%
332 {%

```



## 5 Package *xintbinhex* implementation

```

333 \xint_bye #2\XINT_htd_finish\xint_bye
334 \expandafter\XINT_htd_A\the\numexpr
335 \XINT_htd_a #1\XINT_htd_nextfour #2%
336 }%
337 \def\XINT_htd_a #1!#2!#3!#4!#5!#6!#7!#8!#9!%
338 {%
339 #1\expandafter\XINT_htd_update
340 \the\numexpr #2\expandafter\XINT_htd_update
341 \the\numexpr #3\expandafter\XINT_htd_update
342 \the\numexpr #4\expandafter\XINT_htd_update
343 \the\numexpr #5\expandafter\XINT_htd_update
344 \the\numexpr #6\expandafter\XINT_htd_update
345 \the\numexpr #7\expandafter\XINT_htd_update
346 \the\numexpr #8\expandafter\XINT_htd_update
347 \the\numexpr #9\expandafter\XINT_htd_update
348 \the\numexpr \XINT_htd_a
349 }%
350 \def\XINT_htd_nextfour #1#2#3#4%
351 {%
352 *\xint_c_ii^xvi+"#1#2#3#4+1000000000\relax\xint_bye!%
353 2!3!4!5!6!7!8!9!\xint_bye\XINT_htd_nextfour
354 }%

```

If the innocent looking commented out #6 is left in the pattern as was the case at 1.2m, the maximal size becomes limited at 5538 digits, not 8298! (with parameter stack size = 10000.)

```

355 \def\XINT_htd_update 1#1#2#3#4#5#6!%
356 {%
357 *\xint_c_ii^xvi+10000#1#2#3#4#5!#6!%
358 }%
359 \def\XINT_htd_A 1#1%
360 {%
361 \if#10\expandafter\XINT_htd_Aa\else
362 \expandafter\XINT_htd_Ab
363 \fi 1#1%
364 }%
365 \def\XINT_htd_Aa 10#1#2#3#4{\XINT_htd_again #1#2#3#4!}%
366 \def\XINT_htd_Ab 1#1#2#3#4#5{\XINT_htd_again #1!#2#3#4#5!}%
367 \def\XINT_htd_finish\xint_bye
368 \expandafter\XINT_htd_A\the\numexpr \XINT_htd_a #1\XINT_htd_nextfour
369 {%
370 \expandafter\XINT_htd_finish_cuz\the\numexpr0\XINT_htd_unsep_loop #1%
371 }%
372 \def\XINT_htd_unsep_loop #1!#2!#3!#4!#5!#6!#7!#8!#9!%
373 {%
374 \expandafter\XINT_unsep_clean
375 \the\numexpr 1#1#2\expandafter\XINT_unsep_clean
376 \the\numexpr 1#3#4\expandafter\XINT_unsep_clean
377 \the\numexpr 1#5#6\expandafter\XINT_unsep_clean
378 \the\numexpr 1#7#8\expandafter\XINT_unsep_clean
379 \the\numexpr 1#9\XINT_htd_unsep_loop_a
380 }%
381 \def\XINT_htd_unsep_loop_a #1!#2!#3!#4!#5!#6!#7!#8!#9!%

```

```

382 {%
383   #1\expandafter\XINT_unsep_clean
384   \the\numexpr 1#2#3\expandafter\XINT_unsep_clean
385   \the\numexpr 1#4#5\expandafter\XINT_unsep_clean
386   \the\numexpr 1#6#7\expandafter\XINT_unsep_clean
387   \the\numexpr 1#8#9\XINT_htd_unsep_loop
388 }%
389 \def\XINT_unsep_clean 1{\relax}% also in xintcore
390 \def\XINT_htd_finish_cuz #1{%
391 \def\XINT_htd_finish_cuz ##1##2##3##4##5%
392   {\expandafter#1\the\numexpr ##1##2##3##4##5\relax}%
393 }\XINT_htd_finish_cuz{ }%

```

## 5.8 \xintBinToDec

Redone entirely for 1.2m. Starts by converting to hexadecimal first.

Increased maximal size at 1.2n.

An input without leading zeroes gives an output without leading zeroes.

Robust against non-terminated input.

```

394 \def\xintBinToDec {\romannumeral0\xintbintodec }%
395 \def\xintbintodec #1%
396 {%
397   \expandafter\XINT_btd_checkin\romannumeral`&&@#1\xint:
398 }%
399 \def\XINT_btd_checkin #1%
400 {%
401   \xint_UDsignfork
402   #1\XINT_btd_N
403   -{\XINT_btd_main #1}%
404   \krof
405 }%
406 \def\XINT_btd_N {\expandafter-\romannumeral0\XINT_btd_main }%
407 \def\XINT_btd_main #1\xint:
408 {%
409   \csname XINT_btd_htd\csname\expandafter\XINT_bth_loop
410   \romannumeral0\XINT_zeroes_foriv
411   #1\R{0\R}{00\R}{000\R}\R{0\R}{00\R}{000\R}\R\W
412   #1\xint_bye2345678\xint_bye none\endcsname\xint:
413 }%
414 \def\XINT_btd_htd #1\xint:
415 {%
416   \expandafter\XINT_htd_startb
417   \the\numexpr\expandafter\XINT_htd_starta
418   \romannumeral0\XINT_zeroes_foriv
419   #1\R{0\R}{00\R}{000\R}\R{0\R}{00\R}{000\R}\R\W
420   #1\xint_bye!2!3!4!5!6!7!8!9!\xint_bye\relax
421 }%

```

## 5.9 \xintBinToHex

Complete rewrite for 1.2m. But input for 1.2m version limited to about 13320 binary digits (expansion depth=10000).

## 5 Package *xintbinhex* implementation

Again redone for 1.2n for \csname governed expansion: increased maximal size.  
Size of output is ceil(size(input)/4), leading zeroes in output (inherited from the input) are not trimmed.

An input without leading zeroes gives an output without leading zeroes.

Robust against non-terminated input.

```
422 \def\xintBinToHex {\romannumeral0\xintbintohehex }%
423 \def\xintbintohehex #1%
424 {%
425   \expandafter\XINT_bth_checkin\romannumeral`&&@#1\xint:
426 }%
427 \def\XINT_bth_checkin #1%
428 {%
429   \xint_UDsignfork
430   #1\XINT_bth_N
431   -{\XINT_bth_main #1}%
432   \krof
433 }%
434 \def\XINT_bth_N {\expandafter-\romannumeral0\XINT_bth_main }%
435 \def\XINT_bth_main #1\xint:
436 {%
437   \csname space\csname\expandafter\XINT_bth_loop
438   \romannumeral0\XINT_zeroes_foriv
439   #1\R{0\R}{00\R}{000\R}\R{0\R}{00\R}{000\R}\R\W
440   #1\xint_bye2345678\xint_bye none\endcsname
441 }%
442 \def\XINT_bth_loop #1#2#3#4#5#6#7#8%
443 {%
444   XINT_csbth_#1#2#3#4%
445   \csname XINT_csbth_#5#6#7#8%
446   \csname\XINT_bth_loop
447 }%
```

### 5.10 \xintHexToBin

Completely rewritten for 1.2m.

Attention this macro is not robust against arguments expanding after themselves.

Only up to three zeros are removed on front of output: if the input had a leading zero, there will be a leading zero (and then possibly 4n of them if inputs had more leading zeroes) on output.

Rewritten again at 1.2n for \csname governed expansion.

```
448 \def\xintHexToBin {\romannumeral0\xinthextobin }%
449 \def\xinthextobin #1%
450 {%
451   \expandafter\XINT_hth_checkin\romannumeral`&&@#1%
452   \xint_bye 23456789\xint_bye none\endcsname
453 }%
454 \def\XINT_hth_checkin #1%
455 {%
456   \xint_UDsignfork
457   #1\XINT_hth_N
458   -{\XINT_hth_main #1}%
459   \krof
```

```

460 }%
461 \def\XINT_htb_N {\expandafter-\romannumeral0\XINT_htb_main }%
462 \def\XINT_htb_main {\csname XINT_htb_cuz\csname\XINT_htb_loop}%
463 \def\XINT_htb_loop #1#2#3#4#5#6#7#8#9%
464 {%
465     XINT_cshtb_#1%
466     \csname XINT_cshtb_#2%
467     \csname XINT_cshtb_#3%
468     \csname XINT_cshtb_#4%
469     \csname XINT_cshtb_#5%
470     \csname XINT_cshtb_#6%
471     \csname XINT_cshtb_#7%
472     \csname XINT_cshtb_#8%
473     \csname XINT_cshtb_#9%
474     \csname \XINT_htb_loop
475 }%
476 \def\XINT_htb_cuz #1{%
477 \def\XINT_htb_cuz ##1##2##3##4%
478     {\expandafter#1\the\numexpr##1##2##3##4\relax}%
479 }\XINT_htb_cuz { }%

```

### 5.11 \xintCHexToBin

The 1.08 macro had same functionality as \xintHexToBin, and slightly different code, the 1.2m version has the same code as \xintHexToBin except that it does not remove leading zeros from output: if the input had  $N$  hexadecimal digits, the output will have exactly  $4N$  binary digits.

Rewritten again at 1.2n for \csname governed expansion.

```

480 \def\xintCHexToBin {\romannumeral0\xintchextobin }%
481 \def\xintchextobin #1%
482 {%
483     \expandafter\XINT_chtb_checkin\romannumeral`&&@#1%
484     \xint_bye 23456789\xint_bye none\endcsname
485 }%
486 \def\XINT_chtb_checkin #1%
487 {%
488     \xint_UDsignfork
489     #1\XINT_chtb_N
490     -{\XINT_chtb_main #1}%
491     \krof
492 }%
493 \def\XINT_chtb_N {\expandafter-\romannumeral0\XINT_chtb_main }%
494 \def\XINT_chtb_main {\csname space\csname\XINT_htb_loop}%
495 \XINT_restorecatcodes_endinput%

```

## 6 Package *xintgcd* implementation

.1	Catcodes, $\varepsilon$ -TeX and reload detection . .	157	.7	<code>\xintBezoutAlgorithm</code> . . . . .	164
.2	Package identification . . . . .	158	.8	<code>\xintGCDof</code> . . . . .	166
.3	<code>\xintGCD</code> , <code>\xintiiGCD</code> . . . . .	158	.9	<code>\xintLCMof</code> . . . . .	166
.4	<code>\xintLCM</code> , <code>\xintiiLCM</code> . . . . .	159	.10	<code>\xintTypesetEuclideanAlgorithm</code> . . . .	166
.5	<code>\xintBezout</code> . . . . .	159	.11	<code>\xintTypesetBezoutAlgorithm</code> . . . .	167
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The commenting is currently (2017/08/06) very sparse. Release 1.09h has modified a bit the `\xintTypesetEuclideanAlgorithm` and `\xintTypesetBezoutAlgorithm` layout with respect to line indentation in particular. And they use the `xinttools` `\xintloop` rather than the Plain TeX or  $\mathbb{X}$ TeX's `\loop`.

Since 1.1 the package only loads `xintcore`, not `xint`. And for the `\xintTypesetEuclideanAlgorithm` and `\xintTypesetBezoutAlgorithm` macros to be functional the package `xinttools` needs to be loaded explicitly by the user.

### 6.1 Catcodes, $\varepsilon$ -TeX and reload detection

The code for reload detection was initially copied from HEIKO OBERDIEK's packages, then modified.

The method for catcodes was also initially directly inspired by these packages.

```

1 \begingroup\catcode61\catcode48\catcode32=10\relax%
2   \catcode13=5      % ^^M
3   \endlinechar=13 %
4   \catcode123=1     % {
5   \catcode125=2     % }
6   \catcode64=11     % @
7   \catcode35=6      % #
8   \catcode44=12     % ,
9   \catcode45=12     % -
10  \catcode46=12     % .
11  \catcode58=12     % :
12  \let\z\endgroup
13  \expandafter\let\expandafter\x\csname ver@xintgcd.sty\endcsname
14  \expandafter\let\expandafter\w\csname ver@xintcore.sty\endcsname
15  \expandafter
16    \ifx\csname PackageInfo\endcsname\relax
17      \def\y#1#2{\immediate\write-1{Package #1 Info: #2.}}%
18    \else
19      \def\y#1#2{\PackageInfo{#1}{#2}}%
20    \fi
21  \expandafter
22  \ifx\csname numexpr\endcsname\relax
23    \y{xintgcd}{\numexpr not available, aborting input}%
24    \aftergroup\endinput
25  \else
26    \ifx\x\relax % plain-TeX, first loading of xintgcd.sty
27      \ifx\w\relax % but xintcore.sty not yet loaded.
28        \def\z{\endgroup\input xintcore.sty\relax}%
29      \fi
30    \else
31      \def\empty {}%
32      \ifx\x\empty % LaTeX, first loading,
```

```

33      % variable is initialized, but \ProvidesPackage not yet seen
34      \ifx\w\relax % xintcore.sty not yet loaded.
35      \def\z{\endgroup\RequirePackage{xintcore}}%
36      \fi
37      \else
38      \aftergroup\endinput % xintgcd already loaded.
39      \fi
40      \fi
41      \fi
42 \z%
43 \XINTsetupcatcodes% defined in xintkernel.sty

```

## 6.2 Package identification

```

44 \XINT_providespackage
45 \ProvidesPackage{xintgcd}%
46 [2017/08/06 1.2n Euclidean algorithm with xint package (JFB)]%

```

## 6.3 *\xintGCD*, *\xintiGCD*

```

47 \def\xintGCD {\romannumeral0\xintgcd}%
48 \def\xintgcd #1%
49 {%
50   \expandafter\XINT_gcd\expandafter{\romannumeral0\xintiabs {#1}}%
51 }%
52 \def\XINT_gcd #1#2%
53 {%
54   \expandafter\XINT_gcd_fork\romannumeral0\xintiabs {#2}\Z #1\Z
55 }%
56 \def\xintiGCD {\romannumeral0\xintiigcd}%
57 \def\xintiigcd #1%
58 {%
59   \expandafter\XINT_iigcd\expandafter{\romannumeral0\xintiiabs {#1}}%
60 }%
61 \def\XINT_iigcd #1#2%
62 {%
63   \expandafter\XINT_gcd_fork\romannumeral0\xintiiabs {#2}\Z #1\Z
64 }%

Ici #3#4=A, #1#2=B

65 \def\XINT_gcd_fork #1#2\Z #3#4\Z
66 {%
67   \xint_UDzerofork
68   #1\XINT_gcd_BisZero
69   #3\XINT_gcd_AisZero
70   0\XINT_gcd_loop
71   \krof
72   {#1#2}{#3#4}%
73 }%
74 \def\XINT_gcd_AisZero #1#2{ #1}%
75 \def\XINT_gcd_BisZero #1#2{ #2}%
76 \def\XINT_gcd_CheckRem #1#2\Z
77 {%
78   \xint_gob_til_zero #1\XINT_gcd_end0\XINT_gcd_loop {#1#2}%

```

```

79 }%
80 \def\XINT_gcd_end0\XINT_gcd_loop #1#2{ #2}%

#1=B, #2=A

81 \def\XINT_gcd_loop #1#2%
82 {%
83   \expandafter\expandafter\expandafter
84     \XINT_gcd_CheckRem
85   \expandafter\xint_seconddoftwo
86   \romannumeral0\XINT_div_prepare {#1}{#2}\Z
87   {#1}%
88 }%

```

#### 6.4 \xintLCM, \xintiilCM

```

89 \def\xintLCM {\romannumeral0\xintlcm}%
90 \def\xintlcm #1%
91 {%
92   \expandafter\XINT_lcm\expandafter{\romannumeral0\xintiabs {#1}}%
93 }%
94 \def\XINT_lcm #1#2%
95 {%
96   \expandafter\XINT_lcm_fork\romannumeral0\xintiabs {#2}\Z #1\Z
97 }%
98 \def\xintiilCM {\romannumeral0\xintiilcm}%
99 \def\xintiilcm #1%
100 {%
101   \expandafter\XINT_iilcm\expandafter{\romannumeral0\xintiabs {#1}}%
102 }%
103 \def\XINT_iilcm #1#2%
104 {%
105   \expandafter\XINT_lcm_fork\romannumeral0\xintiabs {#2}\Z #1\Z
106 }%
107 \def\XINT_lcm_fork #1#2\Z #3#4\Z
108 {%
109   \xint_UDzerofork
110   #1\XINT_lcm_BisZero
111   #3\XINT_lcm_AisZero
112   0\expandafter
113   \krof
114   \XINT_lcm_notzero\expandafter{\romannumeral0\XINT_gcd_loop {#1#2}{#3#4}}%
115   {#1#2}{#3#4}%
116 }%
117 \def\XINT_lcm_AisZero #1#2#3#4#5{ 0}%
118 \def\XINT_lcm_BisZero #1#2#3#4#5{ 0}%
119 \def\XINT_lcm_notzero #1#2#3{\xintiimul {#2}{\xintiiQuo{#3}{#1}}}%

```

#### 6.5 \xintBezout

Produces  $\{A\}\{B\}\{U\}\{V\}\{D\}$  with  $UA-VB=D$ ,  $D = \text{PGCD}(A,B)$  (positive).

1.2l raises `InvalidOperation` if both  $A$  and  $B$  vanish.

```

120 \def\xintBezout {\romannumeral0\xintbezout }%
121 \def\xintbezout #1%

```

```

122 {%
123   \expandafter\XINT_bezout\expandafter {\romannumeral0\xintnum{#1}}%
124 }%
125 \def\XINT_bezout #1#2%
126 {%
127   \expandafter\XINT_bezout_fork \romannumeral0\xintnum{#2}\Z #1\Z
128 }%

#3#4 = A, #1#2=B. Micro improvement for 1.2l.

129 \def\XINT_bezout_fork #1#2\Z #3#4\Z
130 {%
131   \xint_UDzerosfork
132   #1#3\XINT_bezout_botharezero
133   #10\XINT_bezout_secondiszero
134   #30\XINT_bezout_firstiszero
135   00\xint_UDsignsfork
136   \krof
137     #1#3\XINT_bezout_minusminus % A < 0, B < 0
138     #1-\XINT_bezout_minusplus % A > 0, B < 0
139     #3-\XINT_bezout_plusminus % A < 0, B > 0
140     --\XINT_bezout_plusplus % A > 0, B > 0
141   \krof
142   {#2}{#4}#1#3{#3#4}{#1#2}% #1#2=B, #3#4=A
143 }%
144 \def\XINT_bezout_botharezero #1\krof#2#3#4#5#6#7%
145   {\XINT_signalcondition{InvalidOperation}}
146   {No Bezout identity for 0 and 0}{0}{0}{0}{0}{0}}%

```

I stayed without looking at this file for perhaps three years and much to my dismay I realized in January 2017 that both `\xintBezout{0}{B}` and `\xintBezout{A}{0}` were completely buggy, due to a confusion about macro parameters I guess... and no testing ! I must have tested, I don't understand. (regression testing for xint was put in place only late 2016)

Thus rewritten for 1.2l.

```

147 \def\XINT_bezout_firstiszero #1\krof#2#3#4#5#6#7%
148 {%
149   \xint_UDsignfork
150   #4{{0}{#7}{0}{1}{#2}}%
151   -{{0}{#7}{0}{-1}{#7}}%
152   \krof
153 }%
154 \def\XINT_bezout_secondiszero #1\krof#2#3#4#5#6#7%
155 {%
156   \xint_UDsignfork
157   #5{{#6}{0}{-1}{0}{#3}}%
158   -{{#6}{0}{1}{0}{#6}}%
159   \krof
160 }%

#4#2= A < 0, #3#1 = B < 0

161 \def\XINT_bezout_minusminus #1#2#3#4%
162 {%

```



## 6 Package *xintgcd* implementation

```

163 \expandafter\XINT_bezout_mm_post
164 \romannumeral0\XINT_bezout_loop_a 1{#1}{#2}1001%
165 }%
166 \def\XINT_bezout_mm_post #1#2%
167 {%
168 \expandafter\XINT_bezout_mm_postb\expandafter
169 {\romannumeral0\xintiopp{#2}}{\romannumeral0\xintiopp{#1}}%
170 }%
171 \def\XINT_bezout_mm_postb #1#2%
172 {%
173 \expandafter\XINT_bezout_mm_postc\expandafter {#2}{#1}%
174 }%

```

I was using `\edef` to insert a space token upfront, where there is in fact no need for it ! Such ignorance is appalling ...

```

175 \def\XINT_bezout_mm_postc #1#2#3#4#5{{#4}{#5}{#1}{#2}{#3}}%

```

*minusplus*  $\#4\#2 = A > 0, B < 0$

```

176 \def\XINT_bezout_minusplus #1#2#3#4%
177 {%
178 \expandafter\XINT_bezout_mp_post
179 \romannumeral0\XINT_bezout_loop_a 1{#1}{#4#2}1001%
180 }%
181 \def\XINT_bezout_mp_post #1#2%
182 {%
183 \expandafter\XINT_bezout_mp_postb\expandafter
184 {\romannumeral0\xintiopp {#2}}{#1}%
185 }%
186 \def\XINT_bezout_mp_postb #1#2#3#4#5{{#4}{#5}{#2}{#1}{#3}}%

```

*plusminus*  $A < 0, B > 0$

```

187 \def\XINT_bezout_plusminus #1#2#3#4%
188 {%
189 \expandafter\XINT_bezout_pm_post
190 \romannumeral0\XINT_bezout_loop_a 1{#3#1}{#2}1001%
191 }%
192 \def\XINT_bezout_pm_post #1%
193 {%
194 \expandafter \XINT_bezout_pm_postb \expandafter
195 {\romannumeral0\xintiopp{#1}}%
196 }%
197 \def\XINT_bezout_pm_postb #1#2#3#4#5{{#4}{#5}{#1}{#2}{#3}}%

```

*plusplus*

```

198 \def\XINT_bezout_plusplus #1#2#3#4%
199 {%
200 \expandafter\XINT_bezout_pp_post
201 \romannumeral0\XINT_bezout_loop_a 1{#3#1}{#4#2}1001%
202 }%

```

la parité  $(-1)^N$  est en #1, et on la jette ici.

```
203 \def\XINT_bezout_pp_post #1#2#3#4#5{{#4}{#5}{#1}{#2}{#3}}%
```

$n = 0$ : 1BAalpha(0)beta(0)alpha(-1)beta(-1)

$n$  général:  $\{(-1)^n\{r(n)\}\{r(n-2)\}\{\alpha(n-1)\}\{\beta(n-1)\}\{\alpha(n-2)\}\{\beta(n-2)\}$

$\#2 = B$ ,  $\#3 = A$

```
204 \def\XINT_bezout_loop_a #1#2#3%
```

```
205 {%
```

```
206   \expandafter\XINT_bezout_loop_b\the\numexpr -#1\expandafter.%
```

```
207   \romannumeral0\XINT_div_prepare {#2}{#3}{#2}%
```

```
208 }%
```

Le  $q(n)$  a ici une existence éphémère, dans le version Bezout Algorithm il faudra le conserver. On voudra à la fin  $\{q(n)\{r(n)\}\{\alpha(n)\}\{\beta(n)\}\}$ . De plus ce n'est plus  $(-1)^n$  que l'on veut mais  $n$ . (ou dans un autre ordre)

$\{-(-1)^n\{q(n)\}\{r(n)\}\{r(n-1)\}\{\alpha(n-1)\}\{\beta(n-1)\}\{\alpha(n-2)\}\{\beta(n-2)\}$

```
209 \def\XINT_bezout_loop_b #1.#2#3#4#5#6#7#8%
```

```
210 {%
```

```
211   \expandafter\XINT_bezout_loop_c\expandafter
```

```
212   {\romannumeral0\xintiiadd{\XINT_mul_fork #5\xint:#2\xint:}{#7}}%
```

```
213   {\romannumeral0\xintiiadd{\XINT_mul_fork #6\xint:#2\xint:}{#8}}%
```

```
214   {#1}{#3}{#4}{#5}{#6}%
```

```
215 }%
```

$\{\alpha(n)\}\{-\beta(n)\}\{-(-1)^n\{r(n)\}\{r(n-1)\}\{\alpha(n-1)\}\{\beta(n-1)\}$

```
216 \def\XINT_bezout_loop_c #1#2%
```

```
217 {%
```

```
218   \expandafter\XINT_bezout_loop_d\expandafter{#2}{#1}%
```

```
219 }%
```

$\{\beta(n)\}\{\alpha(n)\}\{(-1)^{(n+1)}\{r(n)\}\{r(n-1)\}\{\alpha(n-1)\}\{\beta(n-1)\}$

```
220 \def\XINT_bezout_loop_d #1#2#3#4#5%
```

```
221 {%
```

```
222   \XINT_bezout_loop_e #4\Z {#3}{#5}{#2}{#1}%
```

```
223 }%
```

$r(n)\Z \{(-1)^{(n+1)}\{r(n-1)\}\{\alpha(n)\}\{\beta(n)\}\{\alpha(n-1)\}\{\beta(n-1)\}$

```
224 \def\XINT_bezout_loop_e #1#2\Z
```

```
225 {%
```

```
226   \xint_gob_til_zero #1\XINT_bezout_loop_exit0\XINT_bezout_loop_f {#1#2}%
```

```
227 }%
```

$\{r(n)\}\{(-1)^{(n+1)}\{r(n-1)\}\{\alpha(n)\}\{\beta(n)\}\{\alpha(n-1)\}\{\beta(n-1)\} \rightarrow \{(-1)^{(n+1)}\{r(n)\}\{r(n-1)\}\{\alpha(n)\}\{\beta(n)\}\{\alpha(n-1)\}\{\beta(n-1)\}$  et itération

```
228 \def\XINT_bezout_loop_f #1#2%
```

```
229 {%
```

```
230   \XINT_bezout_loop_a {#2}{#1}%
```

```
231 }%
```

```
232 \def\XINT_bezout_loop_exit0\XINT_bezout_loop_f #1#2%
```

```

233 {%
234   \ifcase #2
235   \or \expandafter\XINT_bezout_exiteven
236   \else\expandafter\XINT_bezout_exitodd
237   \fi
238 }%
239 \def\XINT_bezout_exiteven #1#2#3#4#5{{#5}{#4}{#1}}%
240 \def\XINT_bezout_exitodd #1#2#3#4#5{{-#5}{-#4}{#1}}%

```

## 6.6 \xintEuclideanAlgorithm

Pour Euclide:  $\{N\}\{A\}\{D=r(n)\}\{B\}\{q_1\}\{r_1\}\{q_2\}\{r_2\}\{q_3\}\{r_3\}\dots\{q_N\}\{r_N=0\}$   
 $u<2n> = u<2n+3>u<2n+2> + u<2n+4>$  à la  $n$  ième étape

```

241 \def\xintEuclideanAlgorithm {\romannumeral0\xinteucclideanalgorithm }%
242 \def\xinteucclideanalgorithm #1%
243 {%
244   \expandafter\XINT_euc\expandafter{\romannumeral0\xintiabs {#1}}%
245 }%
246 \def\XINT_euc #1#2%
247 {%
248   \expandafter\XINT_euc_fork\romannumeral0\xintiabs {#2}\Z #1\Z
249 }%

```

Ici  $\#3\#4=A$ ,  $\#1\#2=B$

```

250 \def\XINT_euc_fork #1#2\Z #3#4\Z
251 {%
252   \xint_UDzerofork
253   #1\XINT_euc_BisZero
254   #3\XINT_euc_AisZero
255   0\XINT_euc_a
256   \krof
257   {0}{#1#2}{#3#4}{{#3#4}{#1#2}}{\Z
258 }%

```

Le  $\{\}$  pour protéger  $\{A\}\{B\}$  si on s'arrête après une étape ( $B$  divise  $A$ ). On va renvoyer:  
 $\{N\}\{A\}\{D=r(n)\}\{B\}\{q_1\}\{r_1\}\{q_2\}\{r_2\}\{q_3\}\{r_3\}\dots\{q_N\}\{r_N=0\}$

```

259 \def\XINT_euc_AisZero #1#2#3#4#5#6{{1}{0}{#2}{#2}{0}{0}}%
260 \def\XINT_euc_BisZero #1#2#3#4#5#6{{1}{0}{#3}{#3}{0}{0}}%

```

$\{n\}\{r_n\}\{a_n\}\{\{q_n\}\{r_n\}\}\dots\{\{A\}\{B\}\}\{\Z$   
 $a(n) = r(n-1)$ . Pour  $n=0$  on a juste  $\{0\}\{B\}\{A\}\{\{A\}\{B\}\}\{\Z$   
 $\backslash\text{XINT\_div\_prepare } \{u\}\{v\}$  divise  $v$  par  $u$

```

261 \def\XINT_euc_a #1#2#3%
262 {%
263   \expandafter\XINT_euc_b\the\numexpr #1+\xint_c_i\expandafter.%
264   \romannumeral0\XINT_div_prepare {#2}{#3}{#2}%
265 }%

```

$\{n+1\}\{q(n+1)\}\{r(n+1)\}\{r_n\}\{\{q_n\}\{r_n\}\}\dots$

```

266 \def\XINT_euc_b #1.#2#3#4%

```

```

267 {%
268   \XINT_euc_c #3\Z {#1}{#3}{#4}{{#2}{#3}}%
269 }%

r(n+1)\Z {n+1}{r(n+1)}{r(n)}{{q(n+1)}{r(n+1)}}{{qn}{rn}}...
Test si r(n+1) est nul.

270 \def\XINT_euc_c #1#2\Z
271 {%
272   \xint_gob_til_zero #1\XINT_euc_end0\XINT_euc_a
273 }%

{n+1}{r(n+1)}{r(n)}{{q(n+1)}{r(n+1)}}...}\Z Ici r(n+1) = 0. On arrête on se prépare à inverser
{n+1}{0}{r(n)}{{q(n+1)}{r(n+1)}}....{q1}{r1}}{{A}{B}}}\Z
On veut renvoyer: {N=n+1}{A}{D=r(n)}{B}{q1}{r1}{q2}{r2}{q3}{r3}....{qN}{rN=0}

274 \def\XINT_euc_end0\XINT_euc_a #1#2#3#4\Z%
275 {%
276   \expandafter\XINT_euc_end_a
277   \romannumeral0%
278   \XINT_rord_main {}#4{{#1}{#3}}%
279   \xint:
280     \xint_bye\xint_bye\xint_bye\xint_bye
281     \xint_bye\xint_bye\xint_bye\xint_bye
282   \xint:
283 }%
284 \def\XINT_euc_end_a #1#2#3{{#1}{#3}{#2}}%

6.7 \xintBezoutAlgorithm

Pour Bezout: objectif, renvoyer
{N}{A}{0}{1}{D=r(n)}{B}{1}{0}{q1}{r1}{alpha1=q1}{beta1=1}
{q2}{r2}{alpha2}{beta2}...{qN}{rN=0}{alphaN=A/D}{betaN=B/D}
alpha0=1, beta0=0, alpha(-1)=0, beta(-1)=1

285 \def\xintBezoutAlgorithm {\romannumeral0\xintbezoutalgorithm }%
286 \def\xintbezoutalgorithm #1%
287 {%
288   \expandafter \XINT_bezalg \expandafter{\romannumeral0\xintiabs {#1}}%
289 }%
290 \def\XINT_bezalg #1#2%
291 {%
292   \expandafter\XINT_bezalg_fork \romannumeral0\xintiabs {#2}\Z #1\Z
293 }%

Ici #3#4=A, #1#2=B

294 \def\XINT_bezalg_fork #1#2\Z #3#4\Z
295 {%
296   \xint_UDzerofork
297     #1\XINT_bezalg_BisZero
298     #3\XINT_bezalg_AisZero
299     0\XINT_bezalg_a
300   \krof

```

```

301      0{#1#2}{#3#4}1001{#3#4}{#1#2}}{\Z
302 }%
303 \def\XINT_bezalg_AisZero #1#2#3\Z{{1}{0}{1}{#2}{#2}{1}{0}{0}{0}{0}{1}}%
304 \def\XINT_bezalg_BisZero #1#2#3#4\Z{{1}{0}{0}{1}{#3}{#3}{1}{0}{0}{0}{0}{1}}%

pour préparer l'étape n+1 il faut {n}{r(n)}{r(n-1)}{alpha(n)}{beta(n)}{alpha(n-1)}{beta(n-1)}
{{q(n)}{r(n)}{alpha(n)}{beta(n)}}... division de #3 par #2

305 \def\XINT_bezalg_a #1#2#3%
306 {%
307     \expandafter\XINT_bezalg_b\the\numexpr #1+\xint_c_i\expandafter.%
308     \romannumeral0\XINT_div_prepare {#2}{#3}{#2}%
309 }%

{n+1}{q(n+1)}{r(n+1)}{r(n)}{alpha(n)}{beta(n)}{alpha(n-1)}{beta(n-1)}...

310 \def\XINT_bezalg_b #1.#2#3#4#5#6#7#8%
311 {%
312     \expandafter\XINT_bezalg_c\expandafter
313     {\romannumeral0\xintiiadd {\xintiiMul {#6}{#2}}{#8}}%
314     {\romannumeral0\xintiiadd {\xintiiMul {#5}{#2}}{#7}}%
315     {#1}{#2}{#3}{#4}{#5}{#6}%
316 }%

{beta(n+1)}{alpha(n+1)}{n+1}{q(n+1)}{r(n+1)}{r(n)}{alpha(n)}{beta(n)}

317 \def\XINT_bezalg_c #1#2#3#4#5#6%
318 {%
319     \expandafter\XINT_bezalg_d\expandafter {#2}{#3}{#4}{#5}{#6}{#1}%
320 }%

{alpha(n+1)}{n+1}{q(n+1)}{r(n+1)}{r(n)}{beta(n+1)}

321 \def\XINT_bezalg_d #1#2#3#4#5#6#7#8%
322 {%
323     \XINT_bezalg_e #4\Z {#2}{#4}{#5}{#1}{#6}{#7}{#8}{{#3}{#4}{#1}{#6}}%
324 }%

r(n+1)\Z {n+1}{r(n+1)}{r(n)}{alpha(n+1)}{beta(n+1)}
{alpha(n)}{beta(n)}{q,r,alpha,beta(n+1)}
Test si r(n+1) est nul.

325 \def\XINT_bezalg_e #1#2\Z
326 {%
327     \xint_gob_til_zero #1\XINT_bezalg_end0\XINT_bezalg_a
328 }%

Ici r(n+1) = 0. On arrête on se prépare à inverser.
{n+1}{r(n+1)}{r(n)}{alpha(n+1)}{beta(n+1)}{alpha(n)}{beta(n)}
{q,r,alpha,beta(n+1)}...{{A}{B}}{\Z
On veut renvoyer
{N}{A}{0}{1}{D=r(n)}{B}{1}{0}{q1}{r1}{alpha1=q1}{beta1=1}
{q2}{r2}{alpha2}{beta2}...{qN}{rN=0}{alphaN=A/D}{betaN=B/D}

329 \def\XINT_bezalg_end0\XINT_bezalg_a #1#2#3#4#5#6#7#8\Z
330 {%

```

```

331 \expandafter\XINT_bezalg_end_a
332 \romannumeral0%
333 \XINT_rord_main {}#8{{#1}{#3}}%
334 \xint:
335 \xint_bye\xint_bye\xint_bye\xint_bye
336 \xint_bye\xint_bye\xint_bye\xint_bye
337 \xint:
338 }%

{N}{D}{A}{B}{q1}{r1}{alpha1=q1}{beta1=1}{q2}{r2}{alpha2}{beta2}
...{qN}{rN=0}{alphaN=A/D}{betaN=B/D}
On veut renvoyer
{N}{A}{0}{1}{D=r(n)}{B}{1}{0}{q1}{r1}{alpha1=q1}{beta1=1}
{q2}{r2}{alpha2}{beta2}...{qN}{rN=0}{alphaN=A/D}{betaN=B/D}

339 \def\XINT_bezalg_end_a #1#2#3#4{{#1}{#3}{0}{1}{#2}{#4}{1}{0}}%

```

## 6.8 \xintGCDof

1.2l adds protection against items being non-terminated \the\numexpr...

```

340 \def\xintGCDof {\romannumeral0\xintgcdof }%
341 \def\xintgcdof #1{\expandafter\XINT_gcdof_a\romannumeral`&&@#1\xint:}%
342 \def\XINT_gcdof_a #1{\expandafter\XINT_gcdof_b\romannumeral`&&@#1!}%
343 \def\XINT_gcdof_b #1!#2{\expandafter\XINT_gcdof_c\romannumeral`&&@#2!{#1}!}%
344 \def\XINT_gcdof_c #1{\xint_gob_til_xint: #1\XINT_gcdof_e\xint:\XINT_gcdof_d #1}%
345 \def\XINT_gcdof_d #1!{\expandafter\XINT_gcdof_b\romannumeral0\xintgcd {#1}}%
346 \def\XINT_gcdof_e #1!#2!{ #2}%

```

## 6.9 \xintLCMof

New with 1.09a

1.2l adds protection against items being non-terminated \the\numexpr...

```

347 \def\xintLCMof {\romannumeral0\xintlcmof }%
348 \def\xintlcmof #1{\expandafter\XINT_lcmof_a\romannumeral`&&@#1\xint:}%
349 \def\XINT_lcmof_a #1{\expandafter\XINT_lcmof_b\romannumeral`&&@#1!}%
350 \def\XINT_lcmof_b #1!#2{\expandafter\XINT_lcmof_c\romannumeral`&&@#2!{#1}!}%
351 \def\XINT_lcmof_c #1{\xint_gob_til_xint: #1\XINT_lcmof_e\xint:\XINT_lcmof_d #1}%
352 \def\XINT_lcmof_d #1!{\expandafter\XINT_lcmof_b\romannumeral0\xintlcm {#1}}%
353 \def\XINT_lcmof_e #1!#2!{ #2}%

```

## 6.10 \xintTypesetEuclideanAlgorithm

TYPESETTING

Organisation:

$\{N\}\{A\}\{D\}\{B\}\{q_1\}\{r_1\}\{q_2\}\{r_2\}\{q_3\}\{r_3\}...\{q_N\}\{r_N=0\}$

$\backslash U1 = N = \text{nombre d'étapes}$ ,  $\backslash U3 = \text{PGCD}$ ,  $\backslash U2 = A$ ,  $\backslash U4 = B$   $q_1 = \backslash U5$ ,  $q_2 = \backslash U7 \rightarrow q_n = \backslash U<2n+3>$ ,  $r_n = \backslash U<2n+4>$   $bn = rn$ .  $B = r_0$ .  $A = r(-1)$

$r(n-2) = q(n)r(n-1) + r(n)$  (n e étape)

$\backslash U\{2n\} = \backslash U\{2n+3\} \times \backslash U\{2n+2\} + \backslash U\{2n+4\}$ , n e étape. (avec n entre 1 et N)

1.09h uses \xintloop, and \par rather than \endgraf; and \par rather than \hfill\break

```

354 \def\xintTypesetEuclideanAlgorithm {%
355   \unless\ifdefined\xintAssignArray
356     \errmessage
357       {xintgcd: package xinttools is required for \string\xintTypesetEuclideanAlgorithm}%
358     \expandafter\xint_gobble_iii
359   \fi
360   \XINT_TypesetEuclideanAlgorithm
361 }%
362 \def\XINT_TypesetEuclideanAlgorithm #1#2%
363 {% l'algo remplace #1 et #2 par |#1| et |#2|
364   \par
365   \begingroup
366     \xintAssignArray\xintEuclideanAlgorithm {#1}{#2}\to\U
367     \edef\A{\U2}\edef\B{\U4}\edef\N{\U1}%
368     \setbox 0 \vbox{\halign {$##$\cr \A\cr \B \cr}}%
369     \count 255 1
370     \xintloop
371       \indent\hbox to \wd 0 {\hfil$\U{\numexpr 2*\count255\relax}$}%
372       $\{ = \U{\numexpr 2*\count255 + 3\relax}
373       \times \U{\numexpr 2*\count255 + 2\relax}
374       + \U{\numexpr 2*\count255 + 4\relax}$%
375       \ifnum \count255 < \N
376         \par
377         \advance \count255 1
378       \repeat
379   \endgroup
380 }%

```

### 6.11 \xintTypesetBezoutAlgorithm

Pour Bezout on a:  $\{N\}\{A\}\{0\}\{1\}\{D=r(n)\}\{B\}\{1\}\{0\}\{q_1\}\{r_1\}\{\alpha_1=q_1\}\{\beta_1=1\}$   
 $\{q_2\}\{r_2\}\{\alpha_2\}\{\beta_2\}\dots\{q_N\}\{r_N=0\}\{\alpha_N=A/D\}\{\beta_N=B/D\}$   
 Donc  $4N+8$  termes:  $U_1 = N$ ,  $U_2 = A$ ,  $U_5 = D$ ,  $U_6 = B$ ,  $q_1 = U_9$ ,  $q_n = U_{4n+5}$ ,  $n$  au moins 1  
 $r_n = U_{4n+6}$ ,  $n$  au moins -1  
 $\alpha(n) = U_{4n+7}$ ,  $n$  au moins -1  
 $\beta(n) = U_{4n+8}$ ,  $n$  au moins -1  
 1.09h uses \xintloop, and \par rather than \endgraf; and no more \parindent0pt

```

381 \def\xintTypesetBezoutAlgorithm {%
382   \unless\ifdefined\xintAssignArray
383     \errmessage
384       {xintgcd: package xinttools is required for \string\xintTypesetBezoutAlgorithm}%
385     \expandafter\xint_gobble_iii
386   \fi
387   \XINT_TypesetBezoutAlgorithm
388 }%
389 \def\XINT_TypesetBezoutAlgorithm #1#2%
390 {%
391   \par
392   \begingroup
393     \xintAssignArray\xintBezoutAlgorithm {#1}{#2}\to\BEZ
394     \edef\A{\BEZ2}\edef\B{\BEZ6}\edef\N{\BEZ1}% A = |#1|, B = |#2|
395     \setbox 0 \vbox{\halign {$##$\cr \A\cr \B \cr}}%

```

```

396   \count255 1
397   \xintloop
398     \indent\hbox to \wd 0 {\hfil$\BEZ{4*}\count255 - 2}$}%
399     ${} = \BEZ{4*}\count255 + 5}
400     \times \BEZ{4*}\count255 + 2}
401     + \BEZ{4*}\count255 + 6}$\hfill\break
402     \hbox to \wd 0 {\hfil$\BEZ{4*}\count255 + 7}$}%
403     ${} = \BEZ{4*}\count255 + 5}
404     \times \BEZ{4*}\count255 + 3}
405     + \BEZ{4*}\count255 - 1}$\hfill\break
406     \hbox to \wd 0 {\hfil$\BEZ{4*}\count255 + 8}$}%
407     ${} = \BEZ{4*}\count255 + 5}
408     \times \BEZ{4*}\count255 + 4}
409     + \BEZ{4*}\count255 }$
410   \par
411   \ifnum \count255 < \N
412     \advance \count255 1
413   \repeat
414     \edef\U{\BEZ{4*\N + 4}}%
415     \edef\V{\BEZ{4*\N + 3}}%
416     \edef\D{\BEZ5}%
417     \ifodd\N
418       $\U\times\A - \V\times \B = -\D$%
419     \else
420       $\U\times\A - \V\times\B = \D$%
421     \fi
422   \par
423 \endgroup
424 }%
425 \XINT_restorecatcodes_endinput%

```



## 7 Package `xintfrac` implementation

.1	Catcodes, $\varepsilon$ -T <sub>E</sub> X and reload detection . . .	169	.39	<code>\xintiBinomial</code> . . . . .	199
.2	Package identification . . . . .	170	.40	<code>\xintiPFactorial</code> . . . . .	199
.3	<code>\XINT_cntSgnFork</code> . . . . .	170	.41	<code>\xintPrd</code> . . . . .	200
.4	<code>\xintLen</code> . . . . .	171	.42	<code>\xintDiv</code> . . . . .	200
.5	<code>\XINT_outfrac</code> . . . . .	171	.43	<code>\xintDivFloor</code> . . . . .	200
.6	<code>\XINT_inFrac</code> . . . . .	172	.44	<code>\xintDivTrunc</code> . . . . .	201
.7	<code>\XINT_frac_gen</code> . . . . .	173	.45	<code>\xintDivRound</code> . . . . .	201
.8	<code>\XINT_factoritens</code> , <code>\XINT_cuz_cnt</code> . . .	175	.46	<code>\xintMod</code> . . . . .	201
.9	<code>\xintRaw</code> . . . . .	177	.47	<code>\xintIsOne</code> . . . . .	202
.10	<code>\xintPRaw</code> . . . . .	178	.48	<code>\xintGeq</code> . . . . .	202
.11	<code>\xintRawWithZeros</code> . . . . .	178	.49	<code>\xintMax</code> . . . . .	203
.12	<code>\xintFloor</code> , <code>\xintiFloor</code> . . . . .	178	.50	<code>\xintMaxof</code> . . . . .	204
.13	<code>\xintCeil</code> , <code>\xintiCeil</code> . . . . .	179	.51	<code>\xintMin</code> . . . . .	204
.14	<code>\xintNumerator</code> . . . . .	179	.52	<code>\xintMinof</code> . . . . .	205
.15	<code>\xintDenominator</code> . . . . .	179	.53	<code>\xintCmp</code> . . . . .	205
.16	<code>\xintFrac</code> . . . . .	180	.54	<code>\xintAbs</code> . . . . .	206
.17	<code>\xintSignedFrac</code> . . . . .	180	.55	<code>\xintOpp</code> . . . . .	206
.18	<code>\xintFwOver</code> . . . . .	181	.56	<code>\xintSgn</code> . . . . .	207
.19	<code>\xintSignedFwOver</code> . . . . .	181	.57	Floating point macros . . . . .	207
.20	<code>\xintREZ</code> . . . . .	182	.58	<code>\xintFloat</code> . . . . .	207
.21	<code>\xintE</code> . . . . .	182	.59	<code>\XINTinFloat</code> , <code>\XINTinFloatS</code> . . . .	209
.22	<code>\xintIrr</code> . . . . .	183	.60	<code>\xintPFloat</code> . . . . .	215
.23	<code>\xintifInt</code> . . . . .	184	.61	<code>\XINTinFloatFracdigits</code> . . . . .	216
.24	<code>\xintJrr</code> . . . . .	184	.62	<code>\xintFloatAdd</code> , <code>\XINTinFloatAdd</code> . . .	217
.25	<code>\xintTFrac</code> . . . . .	185	.63	<code>\xintFloatSub</code> , <code>\XINTinFloatSub</code> . . .	218
.26	<code>\xintTrunc</code> , <code>\xintiTrunc</code> . . . . .	186	.64	<code>\xintFloatMul</code> , <code>\XINTinFloatMul</code> . . .	218
.27	<code>\xintTTrunc</code> . . . . .	188	.65	<code>\xintFloatDiv</code> , <code>\XINTinFloatDiv</code> . . .	219
.28	<code>\xintNum</code> . . . . .	188	.66	<code>\xintFloatPow</code> , <code>\XINTinFloatPow</code> . . .	220
.29	<code>\xintRound</code> , <code>\xintiRound</code> . . . . .	188	.67	<code>\xintFloatPower</code> , <code>\XINTinFloatPower</code> .	223
.30	<code>\xintXTrunc</code> . . . . .	189	.68	<code>\xintFloatFac</code> , <code>\XINTFloatFac</code> . . . .	227
.31	<code>\xintDigits</code> . . . . .	195	.69	<code>\xintFloatPFactorial</code> , <code>\XINTinFloatP-</code> <code>Factorial</code> . . . . .	232
.32	<code>\xintAdd</code> . . . . .	195	.70	<code>\xintFloatBinomial</code> , <code>\XINTinFloatBino-</code> <code>mial</code> . . . . .	236
.33	<code>\xintSub</code> . . . . .	197	.71	<code>\xintFloatSqrt</code> , <code>\XINTinFloatSqrt</code> . . .	237
.34	<code>\xintSum</code> . . . . .	197	.72	<code>\xintFloatE</code> , <code>\XINTinFloatE</code> . . . . .	239
.35	<code>\xintMul</code> . . . . .	197	.73	<code>\XINTinFloatMod</code> . . . . .	240
.36	<code>\xintSqr</code> . . . . .	198			
.37	<code>\xintPow</code> . . . . .	198			
.38	<code>\xintiFac</code> . . . . .	199			

The commenting is currently (2017/08/06) very sparse.

### 7.1 Catcodes, $\varepsilon$ -T<sub>E</sub>X and reload detection

The code for reload detection was initially copied from HEIKO OBERDIEK's packages, then modified.

The method for catcodes was also initially directly inspired by these packages.

```

1 \begingroup\catcode61\catcode48\catcode32=10\relax%
2   \catcode13=5      % ^^M
3   \endlinechar=13 %
4   \catcode123=1     % {
5   \catcode125=2     % }
```

```

6 \catcode64=11 % @
7 \catcode35=6 % #
8 \catcode44=12 % ,
9 \catcode45=12 % -
10 \catcode46=12 % .
11 \catcode58=12 % :
12 \let\z\endgroup
13 \expandafter\let\expandafter\x\csname ver@xintfrac.sty\endcsname
14 \expandafter\let\expandafter\w\csname ver@xint.sty\endcsname
15 \expandafter
16 \ifx\csname PackageInfo\endcsname\relax
17 \def\y#1#2{\immediate\write-1{Package #1 Info: #2.}}%
18 \else
19 \def\y#1#2{\PackageInfo{#1}{#2}}%
20 \fi
21 \expandafter
22 \ifx\csname numexpr\endcsname\relax
23 \y{xintfrac}{\numexpr not available, aborting input}%
24 \aftergroup\endinput
25 \else
26 \ifx\x\relax % plain-TeX, first loading of xintfrac.sty
27 \ifx\w\relax % but xint.sty not yet loaded.
28 \def\z{\endgroup\input xint.sty\relax}%
29 \fi
30 \else
31 \def\empty {}%
32 \ifx\x\empty % LaTeX, first loading,
33 % variable is initialized, but \ProvidesPackage not yet seen
34 \ifx\w\relax % xint.sty not yet loaded.
35 \def\z{\endgroup\RequirePackage{xint}}%
36 \fi
37 \else
38 \aftergroup\endinput % xintfrac already loaded.
39 \fi
40 \fi
41 \fi
42 \z%
43 \XINTsetupcatcodes% defined in xintkernel.sty

```

## 7.2 Package identification

```

44 \XINT_providespackage
45 \ProvidesPackage{xintfrac}%
46 [2017/08/06 1.2n Expandable operations on fractions (JFB)]%

```

## 7.3 `\XINT_cntSgnFork`

1.09i. Used internally, #1 must expand to `\m@ne`, `\z@`, or `\@ne` or equivalent. `\XINT_cntSgnFork` does not insert a romannumeral stopper.

```

47 \def\XINT_cntSgnFork #1%
48 {%
49 \ifcase #1\expandafter\xint_secondofthree
50 \or\expandafter\xint_thirdofthree

```

```

51      \else\expandafter\xint_firstofthree
52      \fi
53 }%

```

## 7.4 `\xintLen`

The used formula is disputable, the idea is that  $A/1$  and  $A$  should have same length. Venerable code rewritten for 1.2i, following updates to `\xintLength` in `xintkernel.sty`. And sadly, I forgot on this occasion that this macro is not supposed to count the sign... Fixed in 1.2k.

```

54 \def\xintLen {\romannumeral0\xintlen }%
55 \def\xintlen #1%
56 {%
57     \expandafter\XINT_flen\romannumeral0\XINT_infrac {#1}%
58 }%
59 \def\XINT_flen#1{\def\XINT_flen ##1##2##3%
60 {%
61     \expandafter#1%
62     \the\numexpr \XINT_abs##1+%
63     \XINT_len_fork ##2##3\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:
64     \xint_c_viii\xint_c_vii\xint_c_vi\xint_c_v
65     \xint_c_iv\xint_c_iii\xint_c_ii\xint_c_i\xint_c_\xint_bye-\xint_c_i
66     \relax
67 }}\XINT_flen{ }%

```

## 7.5 `\XINT_outfrac`

Months later (2014/10/22): perhaps I should document what this macro does before I forget? from `{e}{N}{D}` it outputs  $N/D[e]$ , checking in passing if  $D=0$  or if  $N=0$ . It also makes sure  $D$  is not  $< 0$ . I am not sure but I don't think there is any place in the code which could call `\XINT_outfrac` with a  $D < 0$ , but I should check.

```

68 \def\XINT_outfrac #1#2#3%
69 {%
70     \ifcase\XINT_cntSgn #3\xint:
71         \expandafter \XINT_outfrac_divisionbyzero
72     \or
73         \expandafter \XINT_outfrac_P
74     \else
75         \expandafter \XINT_outfrac_N
76     \fi
77     {#2}{#3}[#1]%
78 }%
79 \def\XINT_outfrac_divisionbyzero #1#2%
80 {%
81     \XINT_signalcondition{DivisionByZero}{Division of #1 by #2}{0/1[0]}%
82 }%
83 \def\XINT_outfrac_P#1{%
84 \def\XINT_outfrac_P ##1##2%
85     {\if0\XINT_Sgn ##1\xint:\expandafter\XINT_outfrac_Zero\fi#1##1/##2}%
86 }\XINT_outfrac_P{ }%
87 \def\XINT_outfrac_Zero #1[#2]{ 0/1[0]}%
88 \def\XINT_outfrac_N #1#2%

```

```

89 {%
90   \expandafter\XINT_outfrac_N_a\expandafter
91   {\romannumeral0\XINT_opp #2}{\romannumeral0\XINT_opp #1}%
92 }%
93 \def\XINT_outfrac_N_a #1#2%
94 {%
95   \expandafter\XINT_outfrac_P\expandafter {#2}{#1}%
96 }%

```

## 7.6 `\XINT_inFrac`

Parses fraction, scientific notation, etc... and produces  $\{n\}{A}{B}$  corresponding to  $A/B$  times  $10^n$ . No reduction to smallest terms.

Extended in 1.07 to accept scientific notation on input. With lowercase e only. The `\xintexpr` parser does accept uppercase E also. Ah, by the way, perhaps I should at least say what this macro does? (belated addition 2014/10/22...), before I forget! It prepares the fraction in the internal format  $\{\text{exponent}\}\{\text{Numerator}\}\{\text{Denominator}\}$  where Denominator is at least 1.

2015/10/09: this venerable macro from the very early days (1.03, 2013/04/14) has gotten a lifting for release 1.2. There were two kinds of issues:

- 1) use of `\W`, `\Z`, `\T` delimiters was very poor choice as this could clash with user input,
- 2) the new `\XINT_frac_gen` handles macros (possibly empty) in the input as general as `\A.\Be\C\D.\Ee\F`. The earlier version would not have expanded the `\B` or `\E`: digits after decimal mark were constrained to arise from expansion of the first token. Thus the 1.03 original code would have expanded only `\A`, `\D`, `\C`, and `\F` for this input.

This reminded me think I should revisit the remaining earlier portions of code, as I was still learning TeX coding when I wrote them.

Also I thought about parsing even faster the  $A/B[N]$  input, not expanding  $B$ , but this turned out to clash with some established uses in the documentation such as `1/\xintiiSqr{...}[0]`. For the implementation, careful here about potential brace removals with parameter patterns such as like `#1/#2#3[#4]` for example.

While I was at it 1.2 added `\numexpr` parsing of the  $N$ , which earlier was restricted to be only explicit digits. I allowed `[]` with empty  $N$ , but the way I did it in 1.2 with `\the\numexpr 0#1` was buggy, as it did not allow `#1` to be a `\count` for example or itself a `\numexpr` (although such inputs were not previously allowed, I later turned out to use them in the code itself, e.g. the float factorial of version 1.2f). The better way would be `\the\numexpr#1+\xint_c_` but 1.2f finally does only `\the\numexpr #1` and `#1` is not allowed to be empty.

The 1.2 `\XINT_frac_gen` had two locations with such a problematic `\numexpr 0#1` which I replaced for 1.2f with `\numexpr#1+\xint_c_`.

Regarding calling the macro with an argument  $A[\text{<expression>}]$ , a `/` in the expression must be suitably hidden for example in `\firstofone` type constructs.

Note: when the numerator is found to be zero `\XINT_inFrac` *always* returns  $\{0\}{0}\{1\}$ . This behaviour must not change because 1.2g `\xintFloat` and `XINTinFloat` (for example) rely upon it: if the denominator on output is not 1, then `\xintFloat` assumes that the numerator is not zero.

As described in the manual, if the input contains a (final)  $[N]$  part, it is assumed that it is in the shape  $A[N]$  or  $A/B[N]$  with  $A$  (and  $B$ ) not containing neither decimal mark nor scientific part, moreover  $B$  must be positive and  $A$  have at most one minus sign (and no plus sign). Else there will be errors, for example `-0/2[0]` would not be recognized as being zero at this stage and this could cause issues afterwards. When there is no ending  $[N]$  part, both numerator and denominator will be parsed for the more general format allowing decimal digits and scientific part and possibly multiple leading signs.

1.2l fixes frailty of `\XINT_infrac` (hence basically of all `xintfrac` macros) respective to non terminated `\numexpr` input: `\xintRaw{\the\numexpr1}` for example. The issue was that `\numexpr` sees

the / and expands what's next. But even `\numexpr 1//` for example creates an error, and to my mind this is a defect of `\numexpr`. It should be able to trace back and see that / was used as delimiter not as operator. Anyway, I thus fixed this problem belatedly here regarding `\XINT_infrac`.

```

97 \def\XINT_inFrac {\romannumeral0\XINT_infrac }%
98 \def\XINT_infrac #1%
99 {%
100   \expandafter\XINT_infrac_fork\romannumeral`&&@#1\xint:/\XINT_W[\XINT_W\XINT_T
101 }%
102 \def\XINT_infrac_fork #1[#2%
103 {%
104   \xint_UDXINTWfork
105   #2\XINT_frac_gen          % input has no brackets [N]
106   \XINT_W\XINT_infrac_res_a % there is some [N], must be strict A[N] or A/B[N] input
107   \krof
108   #1[#2%
109 }%
110 \def\XINT_infrac_res_a #1%
111 {%
112   \xint_gob_til_zero #1\XINT_infrac_res_zero 0\XINT_infrac_res_b #1%
113 }%

```

Note that input exponent is here ignored and forced to be zero.

```

114 \def\XINT_infrac_res_zero 0\XINT_infrac_res_b #1\XINT_T {{0}{0}{1}}%
115 \def\XINT_infrac_res_b #1/#2%
116 {%
117   \xint_UDXINTWfork
118   #2\XINT_infrac_res_ca      % it was A[N] input
119   \XINT_W\XINT_infrac_res_cb % it was A/B[N] input
120   \krof
121   #1/#2%
122 }%

```

An empty [] is not allowed. (this was authorized in 1.2, removed in 1.2f). As nobody reads `xint` documentation, no one will have noticed the fleeting possibility.

```

123 \def\XINT_infrac_res_ca #1[#2]\xint:/\XINT_W[\XINT_W\XINT_T
124   {\expandafter{\the\numexpr #2}{#1}{1}}%
125 \def\XINT_infrac_res_cb #1/#2[%
126   {\expandafter\XINT_infrac_res_cc\romannumeral`&&@#2~#1}%
127 \def\XINT_infrac_res_cc #1~#2[#3]\xint:/\XINT_W[\XINT_W\XINT_T
128   {\expandafter{\the\numexpr #3}{#2}{#1}}%

```

## 7.7 `\XINT_frac_gen`

Extended in 1.07 to recognize and accept scientific notation both at the numerator and (possible) denominator. Only a lowercase e will do here, but uppercase E is possible within an `\xint-expr`. `\relax`

Completely rewritten for 1.2 2015/10/10. The parsing handles inputs such as `\A.\Be\C/\D.\Ee\F` where each of `\A`, `\B`, `\D`, and `\E` may need f-expansion and `\C` and `\F` will end up in `\numexpr`.

1.2f corrects an issue to allow `\C` and `\F` to be `\count` variable (or expressions with `\numexpr`): 1.2 did a bad `\numexpr0#1` which allowed only explicit digits for expanded `#1`.

```

129 \def\XINT_frac_gen #1/#2%
130 {%
131     \xint_UDXINTWfork
132     #2\XINT_frac_gen_A      % there was no /
133     \XINT_W\XINT_frac_gen_B % there was a /
134     \krof
135     #1/#2%
136 }%

```

Note that #1 is only expanded so far up to decimal mark or "e".

```

137 \def\XINT_frac_gen_A #1\xint:\/\XINT_W [\XINT_W {\XINT_W }%
138 \def\XINT_frac_gen_B #1/#2\xint:\/\XINT_W[%\XINT_W
139 {%
140     \expandafter\XINT_frac_gen_Ba
141     \romannumeral`&&@#2ee.\XINT_W\XINT_Z #1ee.%\XINT_W
142 }%
143 \def\XINT_frac_gen_Ba #1.#2%
144 {%
145     \xint_UDXINTWfork
146     #2\XINT_frac_gen_Bb
147     \XINT_W\XINT_frac_gen_Bc
148     \krof
149     #1.#2%
150 }%
151 \def\XINT_frac_gen_Bb #1e#2e#3\XINT_Z
152     {\expandafter\XINT_frac_gen_C\the\numexpr #2+\xint_c_~#1!}%
153 \def\XINT_frac_gen_Bc #1.#2e%
154 {%
155     \expandafter\XINT_frac_gen_Bd\romannumeral`&&@#2.#1e%
156 }%
157 \def\XINT_frac_gen_Bd #1.#2e#3e#4\XINT_Z
158 {%
159     \expandafter\XINT_frac_gen_C\the\numexpr #3-%
160     \numexpr\XINT_length_loop
161     #1\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:
162     \xint_c_viii\xint_c_vii\xint_c_vi\xint_c_v
163     \xint_c_iv\xint_c_iii\xint_c_ii\xint_c_i\xint_c_\xint_bye
164     ~#2#1!%
165 }%
166 \def\XINT_frac_gen_C #1!#2.#3%
167 {%
168     \xint_UDXINTWfork
169     #3\XINT_frac_gen_Ca
170     \XINT_W\XINT_frac_gen_Cb
171     \krof
172     #1!#2.#3%
173 }%
174 \def\XINT_frac_gen_Ca #1~#2!#3e#4e#5\XINT_T
175 {%
176     \expandafter\XINT_frac_gen_F\the\numexpr #4-#1\expandafter
177     ~\romannumeral0\expandafter\XINT_num_cleanup\the\numexpr\XINT_num_loop
178     #2\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\Z~#3~%

```

```

179 }%
180 \def\XINT_frac_gen_Cb #1.#2e%
181 {%
182   \expandafter\XINT_frac_gen_Cc\romannumeral`&&@#2.#1e%
183 }%
184 \def\XINT_frac_gen_Cc #1.#2~#3!#4e#5e#6\XINT_T
185 {%
186   \expandafter\XINT_frac_gen_F\the\numexpr #5-#2-%
187   \numexpr\XINT_length_loop
188   #1\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:
189   \xint_c_viii\xint_c_vii\xint_c_vi\xint_c_v
190   \xint_c_iv\xint_c_iii\xint_c_ii\xint_c_i\xint_c_\xint_bye
191   \relax\expandafter~%
192   \romannumeral0\expandafter\XINT_num_cleanup\the\numexpr\XINT_num_loop
193   #3\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:
194   ~#4#1~%
195 }%
196 \def\XINT_frac_gen_F #1~#2%
197 {%
198   \xint_UDzerominusfork
199   #2-\XINT_frac_gen_Gdivbyzero
200   0#2{\XINT_frac_gen_G -{}}%
201   0-{\XINT_frac_gen_G {}#2}%
202   \krof #1~%
203 }%
204 \def\XINT_frac_gen_Gdivbyzero #1~~#2~%
205 {%
206   \expandafter\XINT_frac_gen_Gdivbyzero_a
207   \romannumeral0\expandafter\XINT_num_cleanup\the\numexpr\XINT_num_loop
208   #2\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:Z~#1~%
209 }%
210 \def\XINT_frac_gen_Gdivbyzero_a #1~#2~%
211 {%
212   \XINT_signalcondition{DivisionByZero}{Division of #1 by zero}{\{#2\}{#1\}{0}}%
213 }%
214 \def\XINT_frac_gen_G #1#2#3~#4~#5~%
215 {%
216   \expandafter\XINT_frac_gen_Ga
217   \romannumeral0\expandafter\XINT_num_cleanup\the\numexpr\XINT_num_loop
218   #1#5\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:Z~#3~{#2#4}%
219 }%
220 \def\XINT_frac_gen_Ga #1#2~#3~%
221 {%
222   \xint_gob_til_zero #1\XINT_frac_gen_zero 0%
223   {#3}{#1#2}%
224 }%
225 \def\XINT_frac_gen_zero 0#1#2#3{\{0\}{0}{1}}%

```

## 7.8 \XINT\_factortens, \XINT\_cuz\_cnt

Old routines.

```

226 \def\XINT_factortens #1%

```

```

227 {%
228   \expandafter\XINT_cuz_cnt_loop\expandafter
229   {\expandafter}\romannumeral0\XINT_rord_main {}#1%
230   \xint:
231     \xint_bye\xint_bye\xint_bye\xint_bye
232     \xint_bye\xint_bye\xint_bye\xint_bye
233   \xint:
234   \R\R\R\R\R\R\R\R\Z
235 }%
236 \def\XINT_cuz_cnt #1%
237 {%
238   \XINT_cuz_cnt_loop {}#1\R\R\R\R\R\R\R\R\Z
239 }%
240 \def\XINT_cuz_cnt_loop #1#2#3#4#5#6#7#8#9%
241 {%
242   \xint_gob_til_R #9\XINT_cuz_cnt_toofara \R
243   \expandafter\XINT_cuz_cnt_checka\expandafter
244   {\the\numexpr #1+8\relax}{#2#3#4#5#6#7#8#9}%
245 }%
246 \def\XINT_cuz_cnt_toofara\R
247   \expandafter\XINT_cuz_cnt_checka\expandafter #1#2%
248 {%
249   \XINT_cuz_cnt_toofarb {}#1}#2%
250 }%
251 \def\XINT_cuz_cnt_toofarb #1#2\Z {\XINT_cuz_cnt_toofarc #2\Z {}#1}}%
252 \def\XINT_cuz_cnt_toofarc #1#2#3#4#5#6#7#8%
253 {%
254   \xint_gob_til_R #2\XINT_cuz_cnt_toofard 7%
255     #3\XINT_cuz_cnt_toofard 6%
256     #4\XINT_cuz_cnt_toofard 5%
257     #5\XINT_cuz_cnt_toofard 4%
258     #6\XINT_cuz_cnt_toofard 3%
259     #7\XINT_cuz_cnt_toofard 2%
260     #8\XINT_cuz_cnt_toofard 1%
261     \Z #1#2#3#4#5#6#7#8%
262 }%
263 \def\XINT_cuz_cnt_toofard #1#2\Z #3\R #4\Z #5%
264 {%
265   \expandafter\XINT_cuz_cnt_toofare
266   \the\numexpr #3\relax \R\R\R\R\R\R\R\R\Z
267   {\the\numexpr #5-#1\relax}\R\Z
268 }%
269 \def\XINT_cuz_cnt_toofare #1#2#3#4#5#6#7#8%
270 {%
271   \xint_gob_til_R #2\XINT_cuz_cnt_stopc 1%
272     #3\XINT_cuz_cnt_stopc 2%
273     #4\XINT_cuz_cnt_stopc 3%
274     #5\XINT_cuz_cnt_stopc 4%
275     #6\XINT_cuz_cnt_stopc 5%
276     #7\XINT_cuz_cnt_stopc 6%
277     #8\XINT_cuz_cnt_stopc 7%
278     \Z #1#2#3#4#5#6#7#8%

```



```

279 }%
280 \def\XINT_cuz_cnt_checka #1#2%
281 {%
282   \expandafter\XINT_cuz_cnt_checkb\the\numexpr #2\relax \Z {#1}%
283 }%
284 \def\XINT_cuz_cnt_checkb #1%
285 {%
286   \xint_gob_til_zero #1\expandafter\XINT_cuz_cnt_loop\xint_gob_til_Z
287   0\XINT_cuz_cnt_stopa #1%
288 }%
289 \def\XINT_cuz_cnt_stopa #1\Z
290 {%
291   \XINT_cuz_cnt_stopb #1\R\R\R\R\R\R\R\R\Z %
292 }%
293 \def\XINT_cuz_cnt_stopb #1#2#3#4#5#6#7#8#9%
294 {%
295   \xint_gob_til_R #2\XINT_cuz_cnt_stopc 1%
296       #3\XINT_cuz_cnt_stopc 2%
297       #4\XINT_cuz_cnt_stopc 3%
298       #5\XINT_cuz_cnt_stopc 4%
299       #6\XINT_cuz_cnt_stopc 5%
300       #7\XINT_cuz_cnt_stopc 6%
301       #8\XINT_cuz_cnt_stopc 7%
302       #9\XINT_cuz_cnt_stopc 8%
303       \Z #1#2#3#4#5#6#7#8#9%
304 }%
305 \def\XINT_cuz_cnt_stopc #1#2\Z #3\R #4\Z #5%
306 {%
307   \expandafter\XINT_cuz_cnt_stopd\expandafter
308   {\the\numexpr #5-#1}\#3%
309 }%
310 \def\XINT_cuz_cnt_stopd #1#2\R #3\Z
311 {%
312   \expandafter\space\expandafter
313   {\romannumeral0\XINT_rord_main {}}#2%
314   \xint:
315       \xint_bye\xint_bye\xint_bye\xint_bye
316       \xint_bye\xint_bye\xint_bye\xint_bye
317   \xint:}{#1}%
318 }%

```

## 7.9 \xintRaw

1.07: this macro simply prints in a user readable form the fraction after its initial scanning. Useful when put inside braces in an `\xintexpr`, when the input is not yet in the  $A/B[n]$  form.

```

319 \def\xintRaw {\romannumeral0\xintraw }%
320 \def\xintraw
321 {%
322   \expandafter\XINT_raw\romannumeral0\XINT_infrac
323 }%
324 \def\XINT_raw #1#2#3{ #2/#3[#1]}%

```

## 7.10 `\xintPraw`

1.09b

```

325 \def\xintPraw {\romannumeral0\xintpraw }%
326 \def\xintpraw
327 {%
328   \expandafter\XINT_praw\romannumeral0\XINT_infrac
329 }%
330 \def\XINT_praw #1%
331 {%
332   \ifnum #1=\xint_c_ \expandafter\XINT_praw_a\fi \XINT_praw_A {#1}%
333 }%
334 \def\XINT_praw_A #1#2#3%
335 {%
336   \if\XINT_isOne{#3}1\expandafter\xint_firstoftwo
337     \else\expandafter\xint_secondoftwo
338   \fi { #2[#1]}{ #2/#3[#1]}%
339 }%
340 \def\XINT_praw_a\XINT_praw_A #1#2#3%
341 {%
342   \if\XINT_isOne{#3}1\expandafter\xint_firstoftwo
343     \else\expandafter\xint_secondoftwo
344   \fi { #2}{ #2/#3}%
345 }%

```

## 7.11 `\xintRawWithZeros`

This was called `\xintRaw` in versions earlier than 1.07

```

346 \def\xintRawWithZeros {\romannumeral0\xinrawwithzeros }%
347 \def\xinrawwithzeros
348 {%
349   \expandafter\XINT_rawz_fork\romannumeral0\XINT_infrac
350 }%
351 \def\XINT_rawz_fork #1%
352 {%
353   \ifnum#1<\xint_c_
354     \expandafter\XINT_rawz_Ba
355   \else
356     \expandafter\XINT_rawz_A
357   \fi
358   #1.%
359 }%
360 \def\XINT_rawz_A #1.#2#3{\XINT_dsx_addzeros{#1}#2;/#3}%
361 \def\XINT_rawz_Ba -#1.#2#3{\expandafter\XINT_rawz_Bb
362   \expandafter{\romannumeral0\XINT_dsx_addzeros{#1}#3;}{#2}}%
363 \def\XINT_rawz_Bb #1#2{ #2/#1}%

```

## 7.12 `\xintFloor`, `\xintiFloor`

1.09a, 1.1 for `\xintiFloor`/`\xintFloor`. Not efficient if big negative decimal exponent. Also sub-efficient if big positive decimal exponent.

```

364 \def\xintFloor {\romannumeral0\xintfloor }%
365 \def\xintfloor #1% devrais-je faire \xintREZ?
366     {\expandafter\XINT_ifloor \romannumeral0\xintraffwithzeros {#1}./1[0]}%
367 \def\xintiFloor {\romannumeral0\xintifloor }%
368 \def\xintifloor #1%
369     {\expandafter\XINT_ifloor \romannumeral0\xintraffwithzeros {#1}.}%
370 \def\XINT_ifloor #1/#2.{\xintiifquo {#1}{#2}}%

```

### 7.13 \xintCeil, \xintiCeil

1.09a

```

371 \def\xintCeil {\romannumeral0\xintceil }%
372 \def\xintceil #1{\xintiifopp {\xintFloor {\xintOpp{#1}}}}%
373 \def\xintiCeil {\romannumeral0\xinticeil }%
374 \def\xinticeil #1{\xintiifopp {\xintiFloor {\xintOpp{#1}}}}%

```

### 7.14 \xintNumerator

```

375 \def\xintNumerator {\romannumeral0\xintnumerator }%
376 \def\xintnumerator
377 {%
378     \expandafter\XINT_numer\romannumeral0\XINT_infrac
379 }%
380 \def\XINT_numer #1%
381 {%
382     \ifcase\XINT_cntSgn #1\xint:
383         \expandafter\XINT_numer_B
384     \or
385         \expandafter\XINT_numer_A
386     \else
387         \expandafter\XINT_numer_B
388     \fi
389     {#1}%
390 }%
391 \def\XINT_numer_A #1#2#3{\XINT_dsx_addzeros{#1}{#2};}%
392 \def\XINT_numer_B #1#2#3{ #2}%

```

### 7.15 \xintDenominator

```

393 \def\xintDenominator {\romannumeral0\xintdenominator }%
394 \def\xintdenominator
395 {%
396     \expandafter\XINT_denom_fork\romannumeral0\XINT_infrac
397 }%
398 \def\XINT_denom_fork #1%
399 {%
400     \ifnum#1<\xint_c_
401         \expandafter\XINT_denom_B
402     \else
403         \expandafter\XINT_denom_A
404     \fi
405     #1.%
406 }%

```

```

407 \def\XINT_denom_A #1.#2#3{ #3}%
408 \def\XINT_denom_B -#1.#2#3{\XINT_dsx_addzeros{#1}#3;}%

```

## 7.16 \xintFrac

Useless typesetting macro.

```

409 \def\xintFrac {\romannumeral0\xintfrac }%
410 \def\xintfrac #1%
411 {%
412   \expandafter\XINT_fracfrac_A\romannumeral0\XINT_infrac {#1}%
413 }%
414 \def\XINT_fracfrac_A #1{\XINT_fracfrac_B #1\Z }%
415 \catcode`^=7
416 \def\XINT_fracfrac_B #1#2\Z
417 {%
418   \xint_gob_til_zero #1\XINT_fracfrac_C 0\XINT_fracfrac_D {10^{#1#2}}}%
419 }%
420 \def\XINT_fracfrac_C 0\XINT_fracfrac_D #1#2#3%
421 {%
422   \if1\XINT_isOne {#3}%
423     \xint_afterfi {\expandafter\xint_firstoftwo_thenstop\xint_gobble_ii }%
424   \fi
425   \space
426   \frac {#2}{#3}%
427 }%
428 \def\XINT_fracfrac_D #1#2#3%
429 {%
430   \if1\XINT_isOne {#3}\XINT_fracfrac_E\fi
431   \space
432   \frac {#2}{#3}#1%
433 }%
434 \def\XINT_fracfrac_E \fi\space\frac #1#2{\fi \space #1\cdot }%

```

## 7.17 \xintSignedFrac

```

435 \def\xintSignedFrac {\romannumeral0\xintsignedfrac }%
436 \def\xintsignedfrac #1%
437 {%
438   \expandafter\XINT_sgnfrac_a\romannumeral0\XINT_infrac {#1}%
439 }%
440 \def\XINT_sgnfrac_a #1#2%
441 {%
442   \XINT_sgnfrac_b #2\Z {#1}%
443 }%
444 \def\XINT_sgnfrac_b #1%
445 {%
446   \xint_UDsignfork
447     #1\XINT_sgnfrac_N
448     -{\XINT_sgnfrac_P #1}%
449   \krof
450 }%
451 \def\XINT_sgnfrac_P #1\Z #2%
452 {%

```

```

453 \XINT_fracfrac_A {#2}{#1}%
454 }%
455 \def\XINT_sgnfrac_N
456 {%
457 \expandafter\romannumeral0\XINT_sgnfrac_P
458 }%

```

### 7.18 \xintFwOver

```

459 \def\xintFwOver {\romannumeral0\xintfwover }%
460 \def\xintfwover #1%
461 {%
462 \expandafter\XINT_fwover_A\romannumeral0\XINT_infrac {#1}%
463 }%
464 \def\XINT_fwover_A #1{\XINT_fwover_B #1\Z }%
465 \def\XINT_fwover_B #1#2\Z
466 {%
467 \xint_gob_til_zero #1\XINT_fwover_C 0\XINT_fwover_D {10^{#1#2}}%
468 }%
469 \catcode\^=11
470 \def\XINT_fwover_C #1#2#3#4#5%
471 {%
472 \if0\XINT_isOne {#5}\xint_afterfi { {#4\over #5}}%
473 \else\xint_afterfi { #4}%
474 \fi
475 }%
476 \def\XINT_fwover_D #1#2#3%
477 {%
478 \if0\XINT_isOne {#3}\xint_afterfi { {#2\over #3}}%
479 \else\xint_afterfi { #2\cdot }%
480 \fi
481 #1%
482 }%

```

### 7.19 \xintSignedFwOver

```

483 \def\xintSignedFwOver {\romannumeral0\xintsignedfwover }%
484 \def\xintsignedfwover #1%
485 {%
486 \expandafter\XINT_sgnfwover_a\romannumeral0\XINT_infrac {#1}%
487 }%
488 \def\XINT_sgnfwover_a #1#2%
489 {%
490 \XINT_sgnfwover_b #2\Z {#1}%
491 }%
492 \def\XINT_sgnfwover_b #1%
493 {%
494 \xint_UDsignfork
495 #1\XINT_sgnfwover_N
496 -{\XINT_sgnfwover_P #1}%
497 \krof
498 }%
499 \def\XINT_sgnfwover_P #1\Z #2%
500 {%
501 \XINT_fwover_A {#2}{#1}%

```

```

502 }%
503 \def\XINT_sgnfwover_N
504 {%
505   \expandafter-\romannumeral0\XINT_sgnfwover_P
506 }%

```

## 7.20 \xintREZ

Removes trailing zeros from A and B and adjust the N in A/B[N].

```

507 \def\xintREZ {\romannumeral0\xintrez }%
508 \def\xintrez
509 {%
510   \expandafter\XINT_rez_A\romannumeral0\XINT_infrac
511 }%
512 \def\XINT_rez_A #1#2%
513 {%
514   \XINT_rez_AB #2\Z {#1}%
515 }%
516 \def\XINT_rez_AB #1%
517 {%
518   \xint_UDzerominusfork
519   #1-\XINT_rez_zero
520   0#1\XINT_rez_neg
521   0-{\XINT_rez_B #1}%
522   \krof
523 }%
524 \def\XINT_rez_zero #1\Z #2#3{ 0/1[0]}%
525 \def\XINT_rez_neg {\expandafter-\romannumeral0\XINT_rez_B }%
526 \def\XINT_rez_B #1\Z
527 {%
528   \expandafter\XINT_rez_C\romannumeral0\XINT_factortens {#1}%
529 }%
530 \def\XINT_rez_C #1#2#3#4%
531 {%
532   \expandafter\XINT_rez_D\romannumeral0\XINT_factortens {#4}{#3}{#2}{#1}%
533 }%
534 \def\XINT_rez_D #1#2#3#4#5%
535 {%
536   \expandafter\XINT_rez_E\expandafter
537   {\the\numexpr #3+#4-#2}{#1}{#5}%
538 }%
539 \def\XINT_rez_E #1#2#3{ #3/#2[#1]}%

```

## 7.21 \xintE

1.07: The fraction is the first argument contrarily to \xintTrunc and \xintRound.  
 1.1 modifies and moves \xintiiE to xint.sty.

```

540 \def\xintE {\romannumeral0\xinte }%
541 \def\xinte #1%
542 {%
543   \expandafter\XINT_e \romannumeral0\XINT_infrac {#1}%

```

```

544 }%
545 \def\XINT_e #1#2#3#4%
546 {%
547   \expandafter\XINT_e_end\the\numexpr #1+#4.{#2}{#3}%
548 }%
549 \def\XINT_e_end #1.#2#3{ #2/#3[#1]}%

```

## 7.22 \xintIrr

```

550 \def\xintIrr {\romannumeral0\xintirr }%
551 \def\xintirr #1%
552 {%
553   \expandafter\XINT_irr_start\romannumeral0\xintrawithzeros {#1}\Z
554 }%
555 \def\XINT_irr_start #1#2/#3\Z
556 {%
557   \if0\XINT_isOne {#3}%
558     \xint_afterfi
559     {\xint_UDsignfork
560       #1\XINT_irr_negative
561       -{\XINT_irr_nonneg #1}%
562     \krof}%
563   \else
564     \xint_afterfi{\XINT_irr_denomisine #1}%
565   \fi
566   #2\Z {#3}%
567 }%
568 \def\XINT_irr_denomisine #1\Z #2{ #1/1}% changed in 1.08
569 \def\XINT_irr_negative #1\Z #2{\XINT_irr_D #1\Z #2\Z -}%
570 \def\XINT_irr_nonneg #1\Z #2{\XINT_irr_D #1\Z #2\Z \space}%
571 \def\XINT_irr_D #1#2\Z #3#4\Z
572 {%
573   \xint_UDzerosfork
574     #3#1\XINT_irr_indeterminate
575     #30\XINT_irr_divisionbyzero
576     #10\XINT_irr_zero
577     00\XINT_irr_loop_a
578   \krof
579   {#3#4}{#1#2}{#3#4}{#1#2}%
580 }%
581 \def\XINT_irr_indeterminate #1#2#3#4#5%
582 {%
583   \XINT_signalcondition{DivisionUndefined}{indeterminate: 0/0}{0/1}%
584 }%
585 \def\XINT_irr_divisionbyzero #1#2#3#4#5%
586 {%
587   \XINT_signalcondition{DivisionByZero}{vanishing denominator: #5#2/0}{0/1}%
588 }%
589 \def\XINT_irr_zero #1#2#3#4#5{ 0/1}% changed in 1.08
590 \def\XINT_irr_loop_a #1#2%
591 {%
592   \expandafter\XINT_irr_loop_d
593   \romannumeral0\XINT_div_prepare {#1}{#2}{#1}%

```

```

594 }%
595 \def\XINT_irr_loop_d #1#2%
596 {%
597   \XINT_irr_loop_e #2\Z
598 }%
599 \def\XINT_irr_loop_e #1#2\Z
600 {%
601   \xint_gob_til_zero #1\XINT_irr_loop_exit0\XINT_irr_loop_a {#1#2}%
602 }%
603 \def\XINT_irr_loop_exit0\XINT_irr_loop_a #1#2#3#4%
604 {%
605   \expandafter\XINT_irr_loop_exitb\expandafter
606   {\romannumeral0\xintiique {#3}{#2}}%
607   {\romannumeral0\xintiique {#4}{#2}}%
608 }%
609 \def\XINT_irr_loop_exitb #1#2%
610 {%
611   \expandafter\XINT_irr_finish\expandafter {#2}{#1}%
612 }%
613 \def\XINT_irr_finish #1#2#3{#3#1/#2}% changed in 1.08

```

### 7.23 \xintifInt

```

614 \def\xintifInt {\romannumeral0\xintifint }%
615 \def\xintifint #1{\expandafter\XINT_ifint\romannumeral0\xintraawithzeros {#1}.}%
616 \def\XINT_ifint #1/#2.%
617 {%
618   \if 0\xintiiRem {#1}{#2}%
619   \expandafter\xint_firstoftwo_thenstop
620   \else
621   \expandafter\xint_secondoftwo_thenstop
622   \fi
623 }%

```

### 7.24 \xintJrr

```

624 \def\xintJrr {\romannumeral0\xintjrr }%
625 \def\xintjrr #1%
626 {%
627   \expandafter\XINT_jrr_start\romannumeral0\xintraawithzeros {#1}\Z
628 }%
629 \def\XINT_jrr_start #1#2/#3\Z
630 {%
631   \if0\XINT_isOne {#3}\xint_afterfi
632     {\xint_UDsignfork
633       #1\XINT_jrr_negative
634       -{\XINT_jrr_nonneg #1}%
635       \krof}%
636   \else
637     \xint_afterfi{\XINT_jrr_denomiseone #1}%
638   \fi
639   #2\Z {#3}%
640 }%
641 \def\XINT_jrr_denomiseone #1\Z #2{ #1/1}% changed in 1.08
642 \def\XINT_jrr_negative #1\Z #2{\XINT_jrr_D #1\Z #2\Z -}%

```



```

643 \def\XINT_jrr_nonneg      #1\Z #2{\XINT_jrr_D #1\Z #2\Z \space}%
644 \def\XINT_jrr_D #1#2\Z #3#4\Z
645 {%
646   \xint_UDzerosfork
647     #3#1\XINT_jrr_indeterminate
648     #30\XINT_jrr_divisionbyzero
649     #10\XINT_jrr_zero
650     00\XINT_jrr_loop_a
651   \krof
652   {#3#4}{#1#2}1001%
653 }%
654 \def\XINT_jrr_indeterminate #1#2#3#4#5#6#7%
655 {%
656   \XINT_signalcondition{DivisionUndefined}{indeterminate: 0/0}{0/1}%
657 }%
658 \def\XINT_jrr_divisionbyzero #1#2#3#4#5#6#7%
659 {%
660   \XINT_signalcondition{DivisionByZero}{Vanishing denominator: #7#2/0}{0/1}%
661 }%
662 \def\XINT_jrr_zero #1#2#3#4#5#6#7{ 0/1}% changed in 1.08
663 \def\XINT_jrr_loop_a #1#2%
664 {%
665   \expandafter\XINT_jrr_loop_b
666   \romannumeral0\XINT_div_prepare {#1}{#2}{#1}%
667 }%
668 \def\XINT_jrr_loop_b #1#2#3#4#5#6#7%
669 {%
670   \expandafter \XINT_jrr_loop_c \expandafter
671     {\romannumeral0\xintiiadd{\XINT_mul_fork #4\xint:#1\xint:}{#6}}%
672     {\romannumeral0\xintiiadd{\XINT_mul_fork #5\xint:#1\xint:}{#7}}%
673     {#2}{#3}{#4}{#5}%
674 }%
675 \def\XINT_jrr_loop_c #1#2%
676 {%
677   \expandafter \XINT_jrr_loop_d \expandafter{#2}{#1}%
678 }%
679 \def\XINT_jrr_loop_d #1#2#3#4%
680 {%
681   \XINT_jrr_loop_e #3\Z {#4}{#2}{#1}%
682 }%
683 \def\XINT_jrr_loop_e #1#2\Z
684 {%
685   \xint_gob_til_zero #1\XINT_jrr_loop_exit0\XINT_jrr_loop_a {#1#2}%
686 }%
687 \def\XINT_jrr_loop_exit0\XINT_jrr_loop_a #1#2#3#4#5#6%
688 {%
689   \XINT_irr_finish {#3}{#4}%
690 }%

```

## 7.25 \xintTFrac

1.09i, for `frac` in `\xintexpr`. And `\xintFrac` is already assigned. T for truncation. However, potentially not very efficient with numbers in scientific notations, with big exponents. Will have

to think it again some day. I hesitated how to call the macro. Same convention as in maple, but some people reserve fractional part to  $x - \text{floor}(x)$ . Also, not clear if I had to make it negative (or zero) if  $x < 0$ , or rather always positive. There should be in fact such a thing for each rounding function, trunc, round, floor, ceil.

```

691 \def\xintTFrac {\romannumeral0\xinttfrac }%
692 \def\xinttfrac #1{\expandafter\XINT_tfrac_fork\romannumeral0\xintrawwithzeros {#1}\Z }%
693 \def\XINT_tfrac_fork #1%
694 {%
695     \xint_UDzerominusfork
696     #1-\XINT_tfrac_zero
697     0#1{\xintiopp\XINT_tfrac_P }%
698     0-{\XINT_tfrac_P #1}%
699     \krof
700 }%
701 \def\XINT_tfrac_zero #1\Z { 0/1[0]}%
702 \def\XINT_tfrac_P #1/#2\Z {\expandafter\XINT_rez_AB
703     \romannumeral0\xintiirem{#1}{#2}\Z {0}{#2}}%

```

## 7.26 \xintTrunc, \xintiTrunc

1.2i release notes: ever since its inception this macro was stupid for a decimal input: it did not handle it separately from the general fraction case  $A/B[N]$  with  $B > 1$ , hence ended up doing divisions by powers of ten. But this meant that nesting `\xintTrunc` with itself was very inefficient.

1.2i version is better. However it still handles  $B > 1$ ,  $N < 0$  via adding zeros to  $B$  and dividing with this extended  $B$ . A possibly more efficient approach is implemented in `\xintXTrunc`, but its logic is more complicated, the code is quite longer and making it f-expandable would not shorten it... I decided for the time being to not complicate things here.

```

704 \def\xintTrunc {\romannumeral0\xinttrunc }%
705 \def\xintiTrunc {\romannumeral0\xintitrunc}%
706 \def\xinttrunc #1{\expandafter\XINT_trunc\the\numexpr#1.\XINT_trunc_G}%
707 \def\xintitrunc #1{\expandafter\XINT_trunc\the\numexpr#1.\XINT_itrunc_G}%
708 \def\XINT_trunc #1.#2#3%
709 {%
710     \expandafter\XINT_trunc_a\romannumeral0\XINT_infrac{#3}#1.#2%
711 }%
712 \def\XINT_trunc_a #1#2#3#4.#5%
713 {%
714     \if0\XINT_Sgn#2\xint:\xint_dothis\XINT_trunc_zero\fi
715     \if1\XINT_is_One#3XY\xint_dothis\XINT_trunc_sp_b\fi
716     \xint_orthat\XINT_trunc_b #1+#4.{#2}{#3}#5#4.%
717 }%
718 \def\XINT_trunc_zero #1.#2.{ 0}%
719 \def\XINT_trunc_b {\expandafter\XINT_trunc_B\the\numexpr}%
720 \def\XINT_trunc_sp_b {\expandafter\XINT_trunc_sp_B\the\numexpr}%
721 \def\XINT_trunc_B #1%
722 {%
723     \xint_UDsignfork
724     #1\XINT_trunc_C
725     -\XINT_trunc_D
726     \krof #1%
727 }%

```

```

728 \def\XINT_trunc_sp_B #1%
729 {%
730   \xint_UDsignfork
731   #1\XINT_trunc_sp_C
732   -\XINT_trunc_sp_D
733   \krof #1%
734 }%
735 \def\XINT_trunc_C -#1.#2#3%
736 {%
737   \expandafter\XINT_trunc_CE
738   \romannumeral0\XINT_dsx_addzeros{#1}#3;.{#2}%
739 }%
740 \def\XINT_trunc_CE #1.#2{\XINT_trunc_E #2.{#1}}%
741 \def\XINT_trunc_sp_C -#1.#2#3{\XINT_trunc_sp_Ca #2.#1.%}
742 \def\XINT_trunc_sp_Ca #1%
743 {%
744   \xint_UDsignfork
745   #1{\XINT_trunc_sp_Cb -}%
746   -{\XINT_trunc_sp_Cb \space#1}%
747   \krof
748 }%
749 \def\XINT_trunc_sp_Cb #1#2.#3.%
750 {%
751   \expandafter\XINT_trunc_sp_Cc
752   \romannumeral0\expandafter\XINT_split_fromright_a
753   \the\numexpr#3-\numexpr\XINT_length_loop
754   #2\xint:\xint:\xint:\xint:\xint:\xint:\xint:\xint:
755   \xint_c_viii\xint_c_vii\xint_c_vi\xint_c_v
756   \xint_c_iv\xint_c_iii\xint_c_ii\xint_c_i\xint_c_\xint_bye
757   .#2\xint_bye2345678\xint_bye..#1%
758 }%
759 \def\XINT_trunc_sp_Cc #1%
760 {%
761   \if.#1\xint_dothis{\XINT_trunc_sp_Cd 0.}\fi
762   \xint_orthat {\XINT_trunc_sp_Cd #1}%
763 }%
764 \def\XINT_trunc_sp_Cd #1.#2.#3%
765 {%
766   \XINT_trunc_sp_F #3#1.%
767 }%
768 \def\XINT_trunc_D #1.#2%
769 {%
770   \expandafter\XINT_trunc_E
771   \romannumeral0\XINT_dsx_addzeros {#1}#2;.%
772 }%
773 \def\XINT_trunc_sp_D #1.#2#3%
774 {%
775   \expandafter\XINT_trunc_sp_E
776   \romannumeral0\XINT_dsx_addzeros {#1}#2;.%
777 }%
778 \def\XINT_trunc_E #1%
779 {%

```

```

780 \xint_UDsignfork
781 #1{\XINT_trunc_F -}%
782 -{\XINT_trunc_F \space#1}%
783 \krof
784 }%
785 \def\XINT_trunc_sp_E #1%
786 {%
787 \xint_UDsignfork
788 #1{\XINT_trunc_sp_F -}%
789 -{\XINT_trunc_sp_F\space#1}%
790 \krof
791 }%
792 \def\XINT_trunc_F #1#2.#3#4%
793 {\expandafter#4\romannumeral`&&\expandafter\xint_firstoftwo
794 \romannumeral0\XINT_div_prepare {#3}{#2}.#1}%
795 \def\XINT_trunc_sp_F #1#2.#3{#3#2.#1}%
796 \def\XINT_itrunc_G #1#2.#3#4.{\if10\xint_dothis{ 0}\fi\xint_orthat{#3#1}#2}%
797 \def\XINT_trunc_G #1.#2#3.%
798 {%
799 \expandafter\XINT_trunc_H
800 \the\numexpr\romannumeral0\xintlength {#1}-#3.#3.{#1}#2%
801 }%
802 \def\XINT_trunc_H #1.#2.%
803 {%
804 \ifnum #1 > \xint_c_
805 \xint_afterfi {\XINT_trunc_Ha {#2}}%
806 \else
807 \xint_afterfi {\XINT_trunc_Hb {-#1}}% -0,--1,--2, ....
808 \fi
809 }%
810 \def\XINT_trunc_Ha{\expandafter\XINT_trunc_Haa\romannumeral0\xintdecsplit}%
811 \def\XINT_trunc_Haa #1#2#3{#3#1.#2}%
812 \def\XINT_trunc_Hb #1#2#3%
813 {%
814 \expandafter #3\expandafter0\expandafter.%
815 \romannumeral\xintreplicate{#1}0#2%
816 }%

```

## 7.27 \xintTTrunc

1.1. Modified in 1.2i, it does simply \xintiTrunc with no shortcut (the latter having been modified)

```

817 \def\xintTTrunc {\romannumeral0\xintttrunc }%
818 \def\xintttrunc {\xintitrunc\xint_c_}%

```

## 7.28 \xintNum

```

819 \let\xintNum \xintTTrunc
820 \let\xintnum \xintttrunc

```

## 7.29 \xintRound, \xintiRound

Modified in 1.2i.

It benefits first of all from the faster `\xintTrunc`, particularly when the input is already a decimal number (denominator  $B=1$ ).

And the rounding is now done in 1.2 style (with much delay, sorry), like of the rewritten `\xintInc` and `\xintDec`.

```

821 \def\xintRound {\romannumeral0\xintround}%
822 \def\xintiRound {\romannumeral0\xintiround}%
823 \def\xintround #1{\expandafter\XINT_round\the\numexpr #1.\XINT_round_A}%
824 \def\xintiround #1{\expandafter\XINT_round\the\numexpr #1.\XINT_iround_A}%
825 \def\XINT_round #1.{\expandafter\XINT_round_aa\the\numexpr #1+\xint_c_i.#1.}%
826 \def\XINT_round_aa #1.#2.#3#4%
827 {%
828   \expandafter\XINT_round_a\romannumeral0\XINT_infrac{#4}#1.#3#2.%
829 }%
830 \def\XINT_round_a #1#2#3#4.%
831 {%
832   \if0\XINT_Sgn#2\xint:\xint_dothis\XINT_trunc_zero\fi
833   \if1\XINT_is_One#3XY\xint_dothis\XINT_trunc_sp_b\fi
834   \xint_orthat\XINT_trunc_b #1+#4.{#2}{#3}%
835 }%
836 \def\XINT_round_A{\expandafter\XINT_trunc_G\romannumeral0\XINT_round_B}%
837 \def\XINT_iround_A{\expandafter\XINT_itrunc_G\romannumeral0\XINT_round_B}%
838 \def\XINT_round_B #1.%
839   {\XINT_dsrr #1\xint_bye\xint_Bye3456789\xint_bye/\xint_c_x\relax.}%

```

### 7.30 `\xintXTrunc`

1.09j [2014/01/06] This is completely expandable but not f-expandable. Rewritten for 1.2i (2016/12/04):

- no more use of `\xintiloop` from `xinttools.sty` (replaced by `\xintreplicate...` from `xintkernel.sty`),
  - no more use in  $0>N>-D$  case of a dummy control sequence name via `\csname...\endcsname`
  - handles better the case of an input already a decimal number
- Need to transfer code comments into public dtx.

```

840 \def\xintXTrunc #1#2%
841 {%
842   \expandafter\XINT_xtrunc_a
843   \the\numexpr #1\expandafter.\romannumeral0\xintraw
844 }%
845 \def\XINT_xtrunc_a #1.% ?? faire autre chose
846 {%
847   \expandafter\XINT_xtrunc_b\the\numexpr\ifnum#1<\xint_c_i \xint_c_i-\fi #1.%
848 }%
849 \def\XINT_xtrunc_b #1.#2{\XINT_xtrunc_c #2{#1}}%
850 \def\XINT_xtrunc_c #1%
851 {%
852   \xint_UDzerominusfork
853   #1-\XINT_xtrunc_zero
854   0#1{-\XINT_xtrunc_d {}}%
855   0-{\XINT_xtrunc_d #1}%
856   \krof
857 }%[

```

```

858 \def\XINT_xtrunc_zero #1#2]{0.\romannumeral\xintreplicate{#1}0}%
859 \def\XINT_xtrunc_d #1#2#3/#4[#5]%
860 {%
861   \XINT_xtrunc_prepare_a#4\R\R\R\R\R\R\R {10}0000001\W
862   !{#4};{#5}{#2}{#1#3}%
863 }%
864 \def\XINT_xtrunc_prepare_a #1#2#3#4#5#6#7#8#9%
865 {%
866   \xint_gob_til_R #9\XINT_xtrunc_prepare_small\R
867   \XINT_xtrunc_prepare_b #9%
868 }%
869 \def\XINT_xtrunc_prepare_small\R #1!#2;%
870 {%
871   \ifcase #2
872   \or\expandafter\XINT_xtrunc_BisOne
873   \or\expandafter\XINT_xtrunc_BisTwo
874   \or
875   \or\expandafter\XINT_xtrunc_BisFour
876   \or\expandafter\XINT_xtrunc_BisFive
877   \or
878   \or
879   \or\expandafter\XINT_xtrunc_BisEight
880   \fi\XINT_xtrunc_BisSmall {#2}%
881 }%
882 \def\XINT_xtrunc_BisOne\XINT_xtrunc_BisSmall #1#2#3#4%
883   {\XINT_xtrunc_sp_e {#2}{#4}{#3}}%
884 \def\XINT_xtrunc_BisTwo\XINT_xtrunc_BisSmall #1#2#3#4%
885 {%
886   \expandafter\XINT_xtrunc_sp_e\expandafter
887   {\the\numexpr #2-\xint_c_i\expandafter}\expandafter
888   {\romannumeral0\xintiimul 5{#4}}{#3}%
889 }%
890 \def\XINT_xtrunc_BisFour\XINT_xtrunc_BisSmall #1#2#3#4%
891 {%
892   \expandafter\XINT_xtrunc_sp_e\expandafter
893   {\the\numexpr #2-\xint_c_ii\expandafter}\expandafter
894   {\romannumeral0\xintiimul {25}{#4}}{#3}%
895 }%
896 \def\XINT_xtrunc_BisFive\XINT_xtrunc_BisSmall #1#2#3#4%
897 {%
898   \expandafter\XINT_xtrunc_sp_e\expandafter
899   {\the\numexpr #2-\xint_c_i\expandafter}\expandafter
900   {\romannumeral0\xintdouble {#4}}{#3}%
901 }%
902 \def\XINT_xtrunc_BisEight\XINT_xtrunc_BisSmall #1#2#3#4%
903 {%
904   \expandafter\XINT_xtrunc_sp_e\expandafter
905   {\the\numexpr #2-\xint_c_iii\expandafter}\expandafter
906   {\romannumeral0\xintiimul {125}{#4}}{#3}%
907 }%
908 \def\XINT_xtrunc_BisSmall #1%
909 {%

```

```

910 \expandafter\XINT_xtrunc_e\expandafter
911 {\expandafter\XINT_xtrunc_small_a
912 \the\numexpr #1/\xint_c_ii\expandafter
913 .\the\numexpr \xint_c_x^viii+#1!}%
914 }%
915 \def\XINT_xtrunc_small_a #1.#2!#3%
916 {%
917 \expandafter\XINT_div_small_b\the\numexpr #1\expandafter
918 \xint:\the\numexpr #2\expandafter!%
919 \romannumeral0\XINT_div_small_ba #3\R\R\R\R\R\R\R\R{10}0000001\W
920 #3\XINT_sepbyviii_Z_end 2345678\relax
921 }%
922 \def\XINT_xtrunc_prepare_b
923 {\expandafter\XINT_xtrunc_prepare_c\romannumeral0\XINT_zeroes_forviii }%
924 \def\XINT_xtrunc_prepare_c #1!%
925 {%
926 \XINT_xtrunc_prepare_d #1.00000000!{#1}%
927 }%
928 \def\XINT_xtrunc_prepare_d #1#2#3#4#5#6#7#8#9%
929 {%
930 \expandafter\XINT_xtrunc_prepare_e
931 \xint_gob_til_dot #1#2#3#4#5#6#7#8#9!%
932 }%
933 \def\XINT_xtrunc_prepare_e #1!#2!#3#4%
934 {%
935 \XINT_xtrunc_prepare_f #4#3\X {#1}{#3}%
936 }%
937 \def\XINT_xtrunc_prepare_f #1#2#3#4#5#6#7#8#9\X
938 {%
939 \expandafter\XINT_xtrunc_prepare_g\expandafter
940 \XINT_div_prepare_g
941 \the\numexpr #1#2#3#4#5#6#7#8+\xint_c_i\expandafter
942 \xint:\the\numexpr (#1#2#3#4#5#6#7#8+\xint_c_i)/\xint_c_ii\expandafter
943 \xint:\the\numexpr #1#2#3#4#5#6#7#8\expandafter
944 \xint:\romannumeral0\XINT_sepandrev_andcount
945 #1#2#3#4#5#6#7#8#9\XINT_rsepbyviii_end_A 2345678%
946 \XINT_rsepbyviii_end_B 2345678\relax\xint_c_ii\xint_c_i
947 \R\xint:\xint_c_xii \R\xint:\xint_c_x \R\xint:\xint_c_viii \R\xint:\xint_c_vi
948 \R\xint:\xint_c_iv \R\xint:\xint_c_ii \R\xint:\xint_c_W
949 \X
950 }%
951 \def\XINT_xtrunc_prepare_g #1;{\XINT_xtrunc_e {#1}}%
952 \def\XINT_xtrunc_e #1#2%
953 {%
954 \ifnum #2<\xint_c_
955 \expandafter\XINT_xtrunc_I
956 \else
957 \expandafter\XINT_xtrunc_II
958 \fi #2\xint:{#1}%
959 }%
960 \def\XINT_xtrunc_I -#1\xint:#2#3#4%
961 {%

```

## 7 Package *xintfrac* implementation

```

962 \expandafter\XINT_xtrunc_I_a\romannumeral0#2{#4}{#2}{#1}{#3}%
963 }%
964 \def\XINT_xtrunc_I_a #1#2#3#4#5%
965 {%
966 \expandafter\XINT_xtrunc_I_b\the\numexpr #4-#5\xint:#4\xint:{#5}{#2}{#3}{#1}%
967 }%
968 \def\XINT_xtrunc_I_b #1%
969 {%
970 \xint_UDsignfork
971 #1\XINT_xtrunc_IA_c
972 -\XINT_xtrunc_IB_c
973 \krof #1%
974 }%
975 \def\XINT_xtrunc_IA_c -#1\xint:#2\xint:#3#4#5#6%
976 {%
977 \expandafter\XINT_xtrunc_IA_d
978 \the\numexpr#2-\xintLength{#6}\xint:{#6}%
979 \expandafter\XINT_xtrunc_IA_xd
980 \the\numexpr (#1+\xint_c_ii^v)/\xint_c_ii^vi-\xint_c_i\xint:#1\xint:{#5}{#4}%
981 }%
982 \def\XINT_xtrunc_IA_d #1%
983 {%
984 \xint_UDsignfork
985 #1\XINT_xtrunc_IAA_e
986 -\XINT_xtrunc_IAB_e
987 \krof #1%
988 }%
989 \def\XINT_xtrunc_IAA_e -#1\xint:#2%
990 {%
991 \romannumeral0\XINT_split_fromleft
992 #1.#2\xint_gobble_i\xint_bye2345678\xint_bye..%
993 }%
994 \def\XINT_xtrunc_IAB_e #1\xint:#2%
995 {%
996 0.\romannumeral\XINT_rep#1\endcsname0#2%
997 }%
998 \def\XINT_xtrunc_IA_xd #1\xint:#2\xint:%
999 {%
1000 \expandafter\XINT_xtrunc_IA_xe\the\numexpr #2-\xint_c_ii^vi*#1\xint:#1\xint:%
1001 }%
1002 \def\XINT_xtrunc_IA_xe #1\xint:#2\xint:#3#4%
1003 {%
1004 \XINT_xtrunc_loop {#2}{#4}{#3}{#1}%
1005 }%
1006 \def\XINT_xtrunc_IB_c #1\xint:#2\xint:#3#4#5#6%
1007 {%
1008 \expandafter\XINT_xtrunc_IB_d
1009 \romannumeral0\XINT_split_xfork #1.#6\xint_bye2345678\xint_bye..{#3}%
1010 }%
1011 \def\XINT_xtrunc_IB_d #1.#2.#3%
1012 {%
1013 \expandafter\XINT_xtrunc_IA_d\the\numexpr#3-\xintLength {#1}\xint:{#1}%

```



## 7 Package `xintfrac` implementation

[illegible]

## 7 Package *xintfrac* implementation

```

1066 \ifnum #1<\xint_c_
1067 \expandafter\XINT_xtrunc_sp_I
1068 \else
1069 \expandafter\XINT_xtrunc_sp_II
1070 \fi #1\xint:%
1071 }%
1072 \def\XINT_xtrunc_sp_I -#1\xint:#2#3%
1073 {%
1074 \expandafter\XINT_xtrunc_sp_I_a\the\numexpr #1-#3\xint:#1\xint:{#3}{#2}%
1075 }%
1076 \def\XINT_xtrunc_sp_I_a #1%
1077 {%
1078 \xint_UDsignfork
1079 #1\XINT_xtrunc_sp_IA_b
1080 -\XINT_xtrunc_sp_IB_b
1081 \krof #1%
1082 }%
1083 \def\XINT_xtrunc_sp_IA_b -#1\xint:#2\xint:#3#4%
1084 {%
1085 \expandafter\XINT_xtrunc_sp_IA_c
1086 \the\numexpr#2-\xintLength{#4}\xint:{#4}\romannumeral\XINT_rep#1\endcsname0%
1087 }%
1088 \def\XINT_xtrunc_sp_IA_c #1%
1089 {%
1090 \xint_UDsignfork
1091 #1\XINT_xtrunc_sp_IAA
1092 -\XINT_xtrunc_sp_IAB
1093 \krof #1%
1094 }%
1095 \def\XINT_xtrunc_sp_IAA -#1\xint:#2%
1096 {%
1097 \romannumeral0\XINT_split_fromleft
1098 #1.#2\xint_gobble_i\xint_bye2345678\xint_bye..%
1099 }%
1100 \def\XINT_xtrunc_sp_IAB #1\xint:#2%
1101 {%
1102 0.\romannumeral\XINT_rep#1\endcsname0#2%
1103 }%
1104 \def\XINT_xtrunc_sp_IB_b #1\xint:#2\xint:#3#4%
1105 {%
1106 \expandafter\XINT_xtrunc_sp_IB_c
1107 \romannumeral0\XINT_split_xfork #1.#4\xint_bye2345678\xint_bye..{#3}%
1108 }%
1109 \def\XINT_xtrunc_sp_IB_c #1.#2.#3%
1110 {%
1111 \expandafter\XINT_xtrunc_sp_IA_c\the\numexpr#3-\xintLength {#1}\xint:{#1}%
1112 }%
1113 \def\XINT_xtrunc_sp_II #1\xint:#2#3%
1114 {%
1115 #2\romannumeral\XINT_rep#1\endcsname0.\romannumeral\XINT_rep#3\endcsname0%
1116 }%

```

### 7.31 `\xintDigits`

The `mathchardef` used to be called `\XINT_digits`, but for reasons originating in `\xintNewExpr` (and now obsolete), release 1.09a uses `\XINTdigits` without underscore.

```

1117 \mathchardef\XINTdigits 16
1118 \def\xintDigits #1#2%
1119   {\afterassignment \xint_gobble_i \mathchardef\XINTdigits=}%
1120 \def\xinttheDigits {\number\XINTdigits }%

```

### 7.32 `\xintAdd`

```

1121 \def\xintAdd {\romannumeral0\xintadd }%
1122 \def\xintadd #1{\expandafter\XINT_fadd\romannumeral0\xintra {#1}}%
1123 \def\XINT_fadd #1{\xint_gob_til_zero #1\XINT_fadd_Azero 0\XINT_fadd_a #1}%
1124 \def\XINT_fadd_Azero #1{\xintra }%
1125 \def\XINT_fadd_a #1/#2[#3]#4%
1126   {\expandafter\XINT_fadd_b\romannumeral0\xintra {#4}{#3}{#1}{#2}}%
1127 \def\XINT_fadd_b #1{\xint_gob_til_zero #1\XINT_fadd_Bzero 0\XINT_fadd_c #1}%
1128 \def\XINT_fadd_Bzero #1#2#3#4{ #3/#4[#2]}%
1129 \def\XINT_fadd_c #1/#2[#3]#4%
1130 {%
1131   \expandafter\XINT_fadd_Aa\the\numexpr #4-#3.{#3}{#4}{#1}{#2}%
1132 }%
1133 \def\XINT_fadd_Aa #1%
1134 {%
1135   \xint_UDzerominusfork
1136     #1-\XINT_fadd_B
1137     0#1\XINT_fadd_Bb
1138     0-\XINT_fadd_Ba
1139   \krof #1%
1140 }%
1141 \def\XINT_fadd_B #1.#2#3#4#5#6#7{\XINT_fadd_C {#4}{#5}{#7}{#6}[#3]}%
1142 \def\XINT_fadd_Ba #1.#2#3#4#5#6#7%
1143 {%
1144   \expandafter\XINT_fadd_C\expandafter
1145     {\romannumeral0\XINT_dsx_addzeros {#1}#6;}%
1146     {#7}{#5}{#4}[#2]}%
1147 }%
1148 \def\XINT_fadd_Bb -#1.#2#3#4#5#6#7%
1149 {%
1150   \expandafter\XINT_fadd_C\expandafter
1151     {\romannumeral0\XINT_dsx_addzeros {#1}#4;}%
1152     {#5}{#7}{#6}[#3]}%
1153 }%
1154 \def\XINT_fadd_C #1#2#3%
1155 {%
1156   \ifcase\romannumeral0\xintiicmp {#2}{#3} %<- intentional space here.
1157     \expandafter\XINT_fadd_eq
1158   \or\expandafter\XINT_fadd_D
1159   \else\expandafter\XINT_fadd_Da
1160   \fi {#2}{#3}{#1}%
1161 }%

```

## 7 Package *xintfrac* implementation

```

1162 \def\XINT_fadd_eq #1#2#3#4#5%
1163 {%
1164   \expandafter\XINT_fadd_G
1165   \romannumeral0\xintiiadd {#3}{#4}/#1[#5]%
1166 }%
1167 \def\XINT_fadd_D #1#2%
1168 {%
1169   \expandafter\XINT_fadd_E\romannumeral0\XINT_div_prepare {#2}{#1}{#1}{#2}%
1170 }%
1171 \def\XINT_fadd_E #1#2%
1172 {%
1173   \if0\XINT_Sgn #2\xint:
1174     \expandafter\XINT_fadd_F
1175   \else\expandafter\XINT_fadd_K
1176   \fi {#1}%
1177 }%
1178 \def\XINT_fadd_F #1#2#3#4#5#6%
1179 {%
1180   \expandafter\XINT_fadd_G
1181   \romannumeral0\xintiiadd {\xintiiMul {#5}{#1}}{#4}/#2[#6]%
1182 }%
1183 \def\XINT_fadd_Da #1#2%
1184 {%
1185   \expandafter\XINT_fadd_Ea\romannumeral0\XINT_div_prepare {#1}{#2}{#1}{#2}%
1186 }%
1187 \def\XINT_fadd_Ea #1#2%
1188 {%
1189   \if0\XINT_Sgn #2\xint:
1190     \expandafter\XINT_fadd_Fa
1191   \else\expandafter\XINT_fadd_K
1192   \fi {#1}%
1193 }%
1194 \def\XINT_fadd_Fa #1#2#3#4#5#6%
1195 {%
1196   \expandafter\XINT_fadd_G
1197   \romannumeral0\xintiiadd {\xintiiMul {#4}{#1}}{#5}/#3[#6]%
1198 }%
1199 \def\XINT_fadd_G #1{%
1200 \def\XINT_fadd_G ##1{\if0##1\expandafter\XINT_fadd_iszero\fi#1##1}%
1201 }\XINT_fadd_G{ }%
1202 \def\XINT_fadd_K #1#2#3#4#5%
1203 {%
1204   \expandafter\XINT_fadd_L
1205   \romannumeral0\xintiiadd {\xintiiMul {#2}{#5}}{\xintiiMul {#3}{#4}}.%
1206   {{#2}{#3}}%
1207 }%
1208 \def\XINT_fadd_L #1{\if0#1\expandafter\XINT_fadd_iszero\fi\XINT_fadd_M #1}%
1209 \def\XINT_fadd_M #1.#2{\expandafter\XINT_fadd_N \expandafter
1210   {\romannumeral0\xintiimul #2}{#1}}%
1211 \def\XINT_fadd_N #1#2{ #2/#1}%
1212 \def\XINT_fadd_iszero #1[#2]{ 0/1[0]}% ou [#2] originel?

```

### 7.33 `\xintSub`

```

1213 \def\xintSub {\romannumeral0\xintsub }%
1214 \def\xintsub #1{\expandafter\XINT_fsub\romannumeral0\xintra {#1}}%
1215 \def\XINT_fsub #1{\xint_gob_til_zero #1\XINT_fsub_Azero 0\XINT_fsub_a #1}%
1216 \def\XINT_fsub_Azero #1{\xintopp }%
1217 \def\XINT_fsub_a #1/#2[#3]#4%
1218 {\expandafter\XINT_fsub_b\romannumeral0\xintra {#4}{#3}{#1}{#2}}%
1219 \def\XINT_fsub_b #1{\xint_UDzerominusfork
1220      #1-\XINT_fadd_Bzero
1221      0#1\XINT_fadd_c
1222      0-\XINT_fadd_c -#1}%
1223 \krof }%

```

### 7.34 `\xintSum`

There was (not documented anymore since 1.09d, 2013/10/22) a macro `\xintSumExpr`, but it has been deleted at 1.21.

Empty items are not accepted by this macro.

```

1224 \def\xintSum {\romannumeral0\xintsum }%
1225 \def\xintsum #1{\expandafter\XINT_fsumexpr\romannumeral`&&@#1\xint:}%
1226 \def\XINT_fsumexpr {\XINT_fsum_loop_a {0/1[0]}}%
1227 \def\XINT_fsum_loop_a #1#2%
1228 {%
1229   \expandafter\XINT_fsum_loop_b \romannumeral`&&@#2\xint:{#1}%
1230 }%
1231 \def\XINT_fsum_loop_b #1%
1232 {%
1233   \xint_gob_til_xint: #1\XINT_fsum_finished\xint:\XINT_fsum_loop_c #1%
1234 }%
1235 \def\XINT_fsum_loop_c #1\xint:#2%
1236 {%
1237   \expandafter\XINT_fsum_loop_a\expandafter{\romannumeral0\xintadd {#2}{#1}}%
1238 }%
1239 \def\XINT_fsum_finished #1\xint:\xint:#2{ #2}%

```

### 7.35 `\xintMul`

```

1240 \def\xintMul {\romannumeral0\xintmul }%
1241 \def\xintmul #1{\expandafter\XINT_fmula\romannumeral0\xintra {#1}.}%
1242 \def\XINT_fmula #1{\xint_gob_til_zero #1\XINT_fmula_zero 0\XINT_fmula_a #1}%
1243 \def\XINT_fmula_a #1[#2].#3%
1244 {\expandafter\XINT_fmula_b\romannumeral0\xintra {#3}#1[#2.]}%
1245 \def\XINT_fmula_b #1{\xint_gob_til_zero #1\XINT_fmula_zero 0\XINT_fmula_c #1}%
1246 \def\XINT_fmula_c #1/#2[#3]#4/#5[#6.]%
1247 {%
1248   \expandafter\XINT_fmula_d
1249   \expandafter{\the\numexpr #3+#6\expandafter}%
1250   \expandafter{\romannumeral0\xintiimul {#5}{#2}}%
1251   {\romannumeral0\xintiimul {#4}{#1}}%
1252 }%
1253 \def\XINT_fmula_d #1#2#3%
1254 {%

```

```

1255 \expandafter \XINT_fmulo \expandafter{#3}{#1}{#2}%
1256 }%
1257 \def\XINT_fmulo #1#2{\XINT_outfrac {#2}{#1}}%
1258 \def\XINT_fmulo_zero #1.#2{ 0/1[0]}%

```

### 7.36 \xintSqr

#### 1.1 modifs comme xintMul.

```

1259 \def\xintSqr {\romannumeral0\xintsqr }%
1260 \def\xintsqr #1{\expandafter\XINT_fsqr\romannumeral0\xintraw {#1}}%
1261 \def\XINT_fsqr #1{\xint_gob_til_zero #1\XINT_fsqr_zero 0\XINT_fsqr_a #1}%
1262 \def\XINT_fsqr_a #1/#2[#3]%
1263 {%
1264 \expandafter\XINT_fsqr_b
1265 \expandafter{\the\numexpr #3+#3\expandafter}%
1266 \expandafter{\romannumeral0\xintiisqr {#2}}%
1267 {\romannumeral0\xintiisqr {#1}}%
1268 }%
1269 \def\XINT_fsqr_b #1#2#3{\expandafter \XINT_fmulo \expandafter{#3}{#1}{#2}}%
1270 \def\XINT_fsqr_zero #1{ 0/1[0]}%

```

### 7.37 \xintPow

1.2f: to be coherent with the "i" convention \xintiPow should parse also its exponent via \xintNum when xintfrac.sty is loaded. This was not the case so far. Cependant le problème est que le fait d'appliquer \xintNum rend impossible certains inputs qui auraient pu être gérés par \numexpr. Le \numexpr externe est ici pour intercepter trop grand input.

```

1271 \def\xintipow #1#2%
1272 {%
1273 \expandafter\xint_pow\the\numexpr \xintNum{#2}\expandafter
1274 .\romannumeral0\xintnum{#1}\xint:
1275 }%
1276 \def\xintPow {\romannumeral0\xintpow }%
1277 \def\xintpow #1%
1278 {%
1279 \expandafter\XINT_fpow\expandafter {\romannumeral0\XINT_infrac {#1}}%
1280 }%
1281 \def\XINT_fpow #1#2%
1282 {%
1283 \expandafter\XINT_fpow_fork\the\numexpr \xintNum{#2}\relax\Z #1%
1284 }%
1285 \def\XINT_fpow_fork #1#2\Z
1286 {%
1287 \xint_UDzerominusfork
1288 #1-\XINT_fpow_zero
1289 0#1\XINT_fpow_neg
1290 0-{\XINT_fpow_pos #1}%
1291 \krof
1292 {#2}%
1293 }%
1294 \def\XINT_fpow_zero #1#2#3#4{ 1/1[0]}%

```

```

1295 \def\XINT_fpow_pos #1#2#3#4#5%
1296 {%
1297   \expandafter\XINT_fpow_pos_A\expandafter
1298   {\the\numexpr #1#2*#3\expandafter}\expandafter
1299   {\romannumeral0\xintiipow {#5}{#1#2}}%
1300   {\romannumeral0\xintiipow {#4}{#1#2}}%
1301 }%
1302 \def\XINT_fpow_neg #1#2#3#4%
1303 {%
1304   \expandafter\XINT_fpow_pos_A\expandafter
1305   {\the\numexpr -#1*#2\expandafter}\expandafter
1306   {\romannumeral0\xintiipow {#3}{#1}}%
1307   {\romannumeral0\xintiipow {#4}{#1}}%
1308 }%
1309 \def\XINT_fpow_pos_A #1#2#3%
1310 {%
1311   \expandafter\XINT_fpow_pos_B\expandafter {#3}{#1}{#2}%
1312 }%
1313 \def\XINT_fpow_pos_B #1#2{\XINT_outfrac {#2}{#1}}%

```

### 7.38 `\xintiFac`

Note pour 1.2f: il y avait un peu de confusion avec `\xintFac`, `\xintiFac`, `\xintiiFac`, car `\xintiFac` aurait dû aussi utiliser `\xintNum` une fois `xintfrac.sty` chargé ce qu'elle ne faisait pas. `\xintNum` est nécessaire pour gérer des inputs fractionnaires ou avec [N], car il les transforme en entiers stricts, et la doc dit que les macros avec "i" l'utilise. Maintenant `\xintiFac` fait la chose correcte. `\xintFac` est synonyme.

2015/11/29: NO MORE a `\xintFac`, only `\xintiFac`/`\xintiiFac`.

```

1314 \def\xintifac #1{\expandafter\XINT_fac_fork\the\numexpr \xintNum{#1}.}%

```

### 7.39 `\xintiBinomial`

1.2f. Binomial coefficients.

```

1315 \def\xintibinomial #1#2%
1316 {%
1317   \expandafter\XINT_binom_pre
1318   \the\numexpr\xintNum{#1}\expandafter.\the\numexpr\xintNum{#2}.%
1319 }%

```

### 7.40 `\xintiPFactorial`

1.2f. Partial factorial.

```

1320 \def\xintipfactorial #1#2%
1321 {%
1322   \expandafter\XINT_pfac_fork
1323   \the\numexpr\xintNum{#1}\expandafter.\the\numexpr\xintNum{#2}.%
1324 }%

```

## 7.41 `\xintPrd`

There was (not documented anymore since 1.09d, 2013/10/22) a macro `\xintPrdExpr`, but it has been deleted at 1.21

```

1325 \def\xintPrd {\romannumeral0\xintprd }%
1326 \def\xintprd #1{\expandafter\XINT_fprdexpr \romannumeral`&&@#1\xint:}%
1327 \def\XINT_fprdexpr {\XINT_fprod_loop_a {1/1[0]}}%
1328 \def\XINT_fprod_loop_a #1#2%
1329 {%
1330   \expandafter\XINT_fprod_loop_b \romannumeral`&&@#2\xint:{#1}%
1331 }%
1332 \def\XINT_fprod_loop_b #1%
1333 {%
1334   \xint_gob_til_xint: #1\XINT_fprod_finished\xint:\XINT_fprod_loop_c #1%
1335 }%
1336 \def\XINT_fprod_loop_c #1\xint:#2%
1337 {%
1338   \expandafter\XINT_fprod_loop_a\expandafter{\romannumeral0\xintmul {#1}{#2}}%
1339 }%
1340 \def\XINT_fprod_finished#1\xint:\xint:#2{ #2}%

```

## 7.42 `\xintDiv`

```

1341 \def\xintDiv {\romannumeral0\xintdiv }%
1342 \def\xintdiv #1%
1343 {%
1344   \expandafter\XINT_fdiv\expandafter {\romannumeral0\XINT_infrac {#1}}%
1345 }%
1346 \def\XINT_fdiv #1#2%
1347   {\expandafter\XINT_fdiv_A\romannumeral0\XINT_infrac {#2}#1}%
1348 \def\XINT_fdiv_A #1#2#3#4#5#6%
1349 {%
1350   \expandafter\XINT_fdiv_B
1351   \expandafter{\the\numexpr #4-#1\expandafter}%
1352   \expandafter{\romannumeral0\xintiimul {#2}{#6}}%
1353   {\romannumeral0\xintiimul {#3}{#5}}%
1354 }%
1355 \def\XINT_fdiv_B #1#2#3%
1356 {%
1357   \expandafter\XINT_fdiv_C
1358   \expandafter{#3}{#1}{#2}%
1359 }%
1360 \def\XINT_fdiv_C #1#2{\XINT_outfrac {#2}{#1}}%

```

## 7.43 `\xintDivFloor`

### 1.1

```

1361 \def\xintDivFloor {\romannumeral0\xintdivfloor }%
1362 \def\xintdivfloor #1#2{\xintfloor{\xintDiv {#1}{#2}}}%

```



## 7.44 `\xintDivTrunc`

### 1.1. `\xintttrunc` rather than `\xintitrunc0` in 1.1a

```
1363 \def\xintDivTrunc      {\romannumeral0\xintdivtrunc }%
1364 \def\xintdivtrunc #1#2{\xintttrunc {\xintDiv {#1}{#2}}}%
```

## 7.45 `\xintDivRound`

### 1.1

```
1365 \def\xintDivRound      {\romannumeral0\xintdivround }%
1366 \def\xintdivround #1#2{\xintiround 0{\xintDiv {#1}{#2}}}%
```

## 7.46 `\xintMod`

1.1. `\xintMod {q1}{q2}` computes  $q2 * t(q1/q2)$  with  $t(q1/q2)$  equal to the truncated division of two arbitrary fractions  $q1$  and  $q2$ . We put some efforts into minimizing the amount of computations. Oui, et bien cela aurait été bien si j'avais aussi daigné commenté ce que je faisais.

```
1367 \def\xintMod {\romannumeral0\xintmod }%
1368 \def\xintmod #1{\expandafter\XINT_mod_a\romannumeral0\xintra{#1}.}%
1369 \def\XINT_mod_a #1#2.#3%
1370   {\expandafter\XINT_mod_b\expandafter #1\romannumeral0\xintra{#3}#2.}%
1371 \def\XINT_mod_b #1#2% #1 de A, #2 de B.
1372 {%
1373   \if0#2\xint_dothis{\XINT_mod_divbyzero #1#2}\fi
1374   \if0#1\xint_dothis\XINT_mod_aiszero\fi
1375   \if-#2\xint_dothis{\XINT_mod_bneg #1}\fi
1376   \xint_orthat{\XINT_mod_bpos #1#2}%
1377 }%
1378 \def\XINT_mod_bpos #1%
1379 {%
1380   \xint_UDsignfork
1381     #1{\xintiiopp\XINT_mod_pos {}}%
1382     -{\XINT_mod_pos #1}%
1383   \krof
1384 }%
1385 \def\XINT_mod_bneg #1%
1386 {%
1387   \xint_UDsignfork
1388     #1{\xintiiopp\XINT_mod_pos {}}%
1389     -{\XINT_mod_pos #1}%
1390   \krof
1391 }%
1392 \def\XINT_mod_divbyzero #1#2[#3]#4.%
1393 {%
1394   \XINT_signalcondition{DivisionByZero}{Division by #2[#3] of #1#4}{\{0/1[0]\}}%
1395 }%
1396 \def\XINT_mod_aiszero #1.{ 0/1[0]}%
1397 \def\XINT_mod_pos #1#2/#3[#4]#5/#6[#7].%
1398 {%
1399   \expandafter\XINT_mod_pos_a
```

```

1400 \the\numexpr\ifnum#7>#4 #4\else #7\fi\expandafter.\expandafter
1401 {\romannumeral0\xintiimul {#6}{#3}}%      n fois u
1402 {\xintiiE{\xintiiMul {#1#5}{#3}}{#7-#4}}%  m fois u
1403 {\xintiiE{\xintiiMul {#2}{#6}}{#4-#7}}%    t fois n
1404 }%
1405 \def\XINT_mod_pos_a #1.#2#3#4{\xintiirem {#3}{#4}/#2[#1]}%

```

### 7.47 `\xintIsOne`

New with 1.09a. Could be more efficient. For fractions with big powers of tens, it is better to use `\xintCmp{f}{1}`. Restyled in 1.09i.

```

1406 \def\xintIsOne {\romannumeral0\xintisone }%
1407 \def\xintisone #1{\expandafter\XINT_fracisone
1408 \romannumeral0\xintraewithzeros{#1}\Z }%
1409 \def\XINT_fracisone #1/#2\Z
1410 {\if0\xintiiCmp {#1}{#2}\xint_afterfi{ 1}\else\xint_afterfi{ 0}\fi}%

```

### 7.48 `\xintGeq`

```

1411 \def\xintGeq {\romannumeral0\xintgeq }%
1412 \def\xintgeq #1%
1413 {%
1414 \expandafter\XINT_fgeq\expandafter {\romannumeral0\xintabs {#1}}%
1415 }%
1416 \def\XINT_fgeq #1#2%
1417 {%
1418 \expandafter\XINT_fgeq_A \romannumeral0\xintabs {#2}#1%
1419 }%
1420 \def\XINT_fgeq_A #1%
1421 {%
1422 \xint_gob_til_zero #1\XINT_fgeq_Zii 0%
1423 \XINT_fgeq_B #1%
1424 }%
1425 \def\XINT_fgeq_Zii 0\XINT_fgeq_B #1[#2]#3[#4]{ 1}%
1426 \def\XINT_fgeq_B #1/#2[#3]#4#5/#6[#7]%
1427 {%
1428 \xint_gob_til_zero #4\XINT_fgeq_Zi 0%
1429 \expandafter\XINT_fgeq_C\expandafter
1430 {\the\numexpr #7-#3\expandafter}\expandafter
1431 {\romannumeral0\xintiimul {#4#5}{#2}}%
1432 {\romannumeral0\xintiimul {#6}{#1}}%
1433 }%
1434 \def\XINT_fgeq_Zi 0#1#2#3#4#5#6#7{ 0}%
1435 \def\XINT_fgeq_C #1#2#3%
1436 {%
1437 \expandafter\XINT_fgeq_D\expandafter
1438 {#3}{#1}{#2}%
1439 }%
1440 \def\XINT_fgeq_D #1#2#3%
1441 {%
1442 \expandafter\XINT_cntSgnFork\romannumeral`&&\expandafter\XINT_cntSgn
1443 \the\numexpr #2+\xintLength{#3}-\xintLength{#1}\relax\xint:

```

```

1444 { 0}{\XINT_fgeq_E #2\Z {#3}{#1}}{ 1}%
1445 }%
1446 \def\XINT_fgeq_E #1%
1447 {%
1448   \xint_UDsignfork
1449     #1\XINT_fgeq_Fd
1450     -{\XINT_fgeq_Fn #1}%
1451   \krof
1452 }%
1453 \def\XINT_fgeq_Fd #1\Z #2#3%
1454 {%
1455   \expandafter\XINT_fgeq_Fe
1456   \romannumeral0\XINT_dsx_addzeros {#1}#3;\xint:#2\xint:
1457 }%
1458 \def\XINT_fgeq_Fe #1\xint:#2#3\xint:{\XINT_geq_plusplus #2#1\xint:#3\xint:}%
1459 \def\XINT_fgeq_Fn #1\Z #2#3%
1460 {%
1461   \expandafter\XINT_fgeq_Fo
1462   \romannumeral0\XINT_dsx_addzeros {#1}#2;\xint:#3\xint:
1463 }%
1464 \def\XINT_fgeq_Fo #1#2\xint:#3\xint:{\XINT_geq_plusplus #1#3\xint:#2\xint:}%

```

#### 7.49 *\xintMax*

```

1465 \def\xintMax {\romannumeral0\xintmax }%
1466 \def\xintmax #1%
1467 {%
1468   \expandafter\XINT_fmax\expandafter {\romannumeral0\xintra #1}%
1469 }%
1470 \def\XINT_fmax #1#2%
1471 {%
1472   \expandafter\XINT_fmax_A\romannumeral0\xintra #2}%1%
1473 }%
1474 \def\XINT_fmax_A #1#2/#3[#4]#5#6/#7[#8]%
1475 {%
1476   \xint_UDsignsfork
1477     #1#5\XINT_fmax_minusminus
1478     -#5\XINT_fmax_firstneg
1479     #1-\XINT_fmax_secondneg
1480     --\XINT_fmax_nonneg_a
1481   \krof
1482   #1#5{#2/#3[#4]}{#6/#7[#8]}%
1483 }%
1484 \def\XINT_fmax_minusminus --%
1485 {\expandafter-\romannumeral0\XINT_fmin_nonneg_b }%
1486 \def\XINT_fmax_firstneg #1-#2#3{ #1#2}%
1487 \def\XINT_fmax_secondneg -#1#2#3{ #1#3}%
1488 \def\XINT_fmax_nonneg_a #1#2#3#4%
1489 {%
1490   \XINT_fmax_nonneg_b {#1#3}{#2#4}%
1491 }%
1492 \def\XINT_fmax_nonneg_b #1#2%
1493 {%
1494   \if0\romannumeral0\XINT_fgeq_A #1#2%

```

```

1495     \xint_afterfi{ #1}%
1496 \else \xint_afterfi{ #2}%
1497 \fi
1498 }%

```

### 7.50 `\xintMaxof`

1.21 protects `\xintMaxof` against items with non terminated `\the\numexpr` expressions.  
The macro is not compatible with an empty list.

```

1499 \def\xintMaxof      {\romannumeral0\xintmaxof }%
1500 \def\xintmaxof      #1{\expandafter\XINT_maxof_a\romannumeral`&&@#1\xint:}%
1501 \def\XINT_maxof_a #1{\expandafter\XINT_maxof_b\romannumeral0\xintra{#1}!}%
1502 \def\XINT_maxof_b #1!#2%
1503     {\expandafter\XINT_maxof_c\romannumeral`&&@#2!{#1}!}%
1504 \def\XINT_maxof_c #1%
1505     {\xint_gob_til_xint: #1\XINT_maxof_e\xint:\XINT_maxof_d #1}%
1506 \def\XINT_maxof_d #1!%
1507     {\expandafter\XINT_maxof_b\romannumeral0\xintmax {#1}}%
1508 \def\XINT_maxof_e #1!#2!{ #2}%

```

### 7.51 `\xintMin`

```

1509 \def\xintMin {\romannumeral0\xintmin }%
1510 \def\xintmin #1%
1511 {%
1512     \expandafter\XINT_fmin\expandafter {\romannumeral0\xintra{#1}}%
1513 }%
1514 \def\XINT_fmin #1#2%
1515 {%
1516     \expandafter\XINT_fmin_A\romannumeral0\xintra{#2}#1%
1517 }%
1518 \def\XINT_fmin_A #1#2/#3[#4]#5#6/#7[#8]%
1519 {%
1520     \xint_UDsignsfork
1521     #1#5\XINT_fmin_minusminus
1522     -#5\XINT_fmin_firstneg
1523     #1-\XINT_fmin_secondneg
1524     --\XINT_fmin_nonneg_a
1525     \krof
1526     #1#5{#2/#3[#4]}{#6/#7[#8]}%
1527 }%
1528 \def\XINT_fmin_minusminus --%
1529     {\expandafter-\romannumeral0\XINT_fmax_nonneg_b }%
1530 \def\XINT_fmin_firstneg #1-#2#3{ -#3}%
1531 \def\XINT_fmin_secondneg -#1#2#3{ -#2}%
1532 \def\XINT_fmin_nonneg_a #1#2#3#4%
1533 {%
1534     \XINT_fmin_nonneg_b {#1#3}{#2#4}%
1535 }%
1536 \def\XINT_fmin_nonneg_b #1#2%
1537 {%
1538     \if0\romannumeral0\XINT_fgeq_A #1#2%
1539         \xint_afterfi{ #2}%

```

```

1540 \else \xint_afterfi{ #1}%
1541 \fi
1542 }%

```

## 7.52 `\xintMinof`

1.21 protects `\xintMinof` against items with non terminated `\the\numexpr` expressions.  
The macro is not compatible with an empty list.

```

1543 \def\xintMinof      {\romannumeral0\xintminof }%
1544 \def\xintminof      #1{\expandafter\XINT_minof_a\romannumeral`&&@#1\xint:}%
1545 \def\XINT_minof_a #1{\expandafter\XINT_minof_b\romannumeral0\xintra{#1}!}%
1546 \def\XINT_minof_b #1!#2%
1547     {\expandafter\XINT_minof_c\romannumeral`&&@#2!{#1}!}%
1548 \def\XINT_minof_c #1%
1549     {\xint_gob_til_xint: #1\XINT_minof_e\xint:\XINT_minof_d #1}%
1550 \def\XINT_minof_d #1!%
1551     {\expandafter\XINT_minof_b\romannumeral0\xintmin {#1}}%
1552 \def\XINT_minof_e #1!#2!{ #2}%

```

## 7.53 `\xintCmp`

```

1553 \def\xintCmp {\romannumeral0\xintcmp }%
1554 \def\xintcmp #1%
1555 {%
1556     \expandafter\XINT_fcmp\expandafter {\romannumeral0\xintra{#1}}%
1557 }%
1558 \def\XINT_fcmp #1#2%
1559 {%
1560     \expandafter\XINT_fcmp_A\romannumeral0\xintra{#2}#1%
1561 }%
1562 \def\XINT_fcmp_A #1#2/#3[#4]#5#6/#7[#8]%
1563 {%
1564     \xint_UDsignsfork
1565     #1#5\XINT_fcmp_minusminus
1566     -#5\XINT_fcmp_firstneg
1567     #1-\XINT_fcmp_secondneg
1568     --\XINT_fcmp_nonneg_a
1569     \krof
1570     #1#5{#2/#3[#4]}{#6/#7[#8]}%
1571 }%
1572 \def\XINT_fcmp_minusminus --#1#2{\XINT_fcmp_B #2#1}%
1573 \def\XINT_fcmp_firstneg #1-#2#3{ -1}%
1574 \def\XINT_fcmp_secondneg -#1#2#3{ 1}%
1575 \def\XINT_fcmp_nonneg_a #1#2%
1576 {%
1577     \xint_UDzerosfork
1578     #1#2\XINT_fcmp_zerozero
1579     0#2\XINT_fcmp_firstzero
1580     #10\XINT_fcmp_secondzero
1581     00\XINT_fcmp_pos
1582     \krof
1583     #1#2%
1584 }%

```

```

1585 \def\XINT_fcmp_zerozero #1#2#3#4{ 0}%
1586 \def\XINT_fcmp_firstzero #1#2#3#4{ -1}%
1587 \def\XINT_fcmp_secondzero #1#2#3#4{ 1}%
1588 \def\XINT_fcmp_pos #1#2#3#4%
1589 {%
1590     \XINT_fcmp_B #1#3#2#4%
1591 }%
1592 \def\XINT_fcmp_B #1/#2[#3]#4/#5[#6]%
1593 {%
1594     \expandafter\XINT_fcmp_C\expandafter
1595     {\the\numexpr #6-#3\expandafter}\expandafter
1596     {\romannumeral0\xintiimul {#4}{#2}}%
1597     {\romannumeral0\xintiimul {#5}{#1}}%
1598 }%
1599 \def\XINT_fcmp_C #1#2#3%
1600 {%
1601     \expandafter\XINT_fcmp_D\expandafter
1602     {#3}{#1}{#2}%
1603 }%
1604 \def\XINT_fcmp_D #1#2#3%
1605 {%
1606     \expandafter\XINT_cntSgnFork\romannumeral`&&\expandafter\XINT_cntSgn
1607     \the\numexpr #2+\xintLength{#3}-\xintLength{#1}\relax\xint:
1608     { -1}{\XINT_fcmp_E #2\Z {#3}{#1}}{ 1}%
1609 }%
1610 \def\XINT_fcmp_E #1%
1611 {%
1612     \xint_UDsignfork
1613     #1\XINT_fcmp_Fd
1614     -{\XINT_fcmp_Fn #1}%
1615     \krof
1616 }%
1617 \def\XINT_fcmp_Fd #1\Z #2#3%
1618 {%
1619     \expandafter\XINT_fcmp_Fe
1620     \romannumeral0\XINT_dsx_addzeros {#1}#3;\xint:#2\xint:
1621 }%
1622 \def\XINT_fcmp_Fe #1\xint:#2#3\xint:{\XINT_cmp_plusplus #2#1\xint:#3\xint:}%
1623 \def\XINT_fcmp_Fn #1\Z #2#3%
1624 {%
1625     \expandafter\XINT_fcmp_Fo
1626     \romannumeral0\XINT_dsx_addzeros {#1}#2;\xint:#3\xint:
1627 }%
1628 \def\XINT_fcmp_Fo #1#2\xint:#3\xint:{\XINT_cmp_plusplus #1#3\xint:#2\xint:}%

```

### 7.54 \xintAbs

```

1629 \def\xintAbs {\romannumeral0\xintabs }%
1630 \def\xintabs #1{\expandafter\XINT_abs\romannumeral0\xintraw {#1}}%

```

### 7.55 \xintOpp

```

1631 \def\xintOpp {\romannumeral0\xintopp }%
1632 \def\xintopp #1{\expandafter\XINT_opp\romannumeral0\xintraw {#1}}%

```

## 7.56 `\xintSgn`

```
1633 \def\xintSgn {\romannumeral0\xintsgn}%
1634 \def\xintsgn #1{\expandafter\XINT_sgn\romannumeral0\xintraw {#1}\xint:}%
```

## 7.57 Floating point macros

For a long time the float routines dating back to releases 1.07/1.08a (May–June 2013) were not modified.

Since 1.2f (March 2016) the four operations first round their arguments to `\xinttheDigits`-floats (or  $P$ -floats), not `(\xinttheDigits+2)`-floats or  $(P+2)$ -floats as was the case with earlier releases.

The four operations addition, subtraction, multiplication, division have always produced the correct rounding of the theoretical exact value to  $P$  or `\xinttheDigits` digits when the inputs are decimal numbers with at most  $P$  digits, and arbitrary decimal exponent part.

From 1.08a to 1.2j, `\xintFloat` (and `\XINTinFloat` which is used to parse inputs to other float macros) handled a fractional input  $A/B$  via an initial replacement to  $A'/B'$  where  $A'$  and  $B'$  were  $A$  and  $B$  truncated to  $Q+2$  digits (where asked-for precision is  $Q$ ), and then they correctly rounded  $A/B$  to  $Q$  digits. But this meant that this rounding of the input could differ (by up to one unit in the last place) from the correct rounding of the original  $A/B$  to the asked-for number of digits (which until 1.2f in uses as auxiliary to the macros for the basic operations was 2 more than the prevailing precision).

Since 1.2k all inputs are correctly rounded to the asked-for number of digits (this was, I think, the case in the 1.07 release -- there are no code comments -- but was, afaicr, not very efficiently done, and this is why the 1.08a release opted for truncation of the numerator and denominator.)

Notice that in float expressions, the `/` is treated as operator, hence the above discussion makes a difference only for the special input form `qfloat(A/B)` or for an `\xintexpr A/B\relax` embedded in the float expression, with  $A$  or  $B$  having more digits than the prevailing float precision.

Internally there is no inner representation of  $P$ -floats as such !!!!!

The input parser will again compute the length of the mantissa on each use !!! This is obviously something that must be improved upon before implementation of higher functions.

Currently, special tricks are used to quickly recognize inputs having no denominators, or fractions whose numerators and denominators are not too long compared to the target precision  $P$ , and in particular  $P$ -floats or quotients of two such.

Another long-standing issue is that float multiplication will first compute the  $2P$  or  $2P-2$  digits of the exact product, and then round it to  $P$  digits. This is sub-optimal for large  $P$  particularly as the multiplication algorithm is basically the schoolbook one, hence worse than quadratic in the  $\text{\TeX}$  implementation which has extra cost of fetching long sequences of tokens.

## 7.58 `\xintFloat`

1.2f and 1.2g brought some refactoring which resulted in faster treatment of decimal inputs. 1.2i dropped use of some old routines dating back to pre 1.2 era in favor of more modern `\xintDSRr` for rounding. Then 1.2k improves again the handling of denominators  $B$  with few digits.

But the main change with 1.2k is a complete rewrite of the  $B>1$  case in order to achieve again correct rounding in all cases.

The original version from 1.07 (May 2013) computed the exact rounding to  $P$  digits for all inputs. But from 1.08 on (June 2013), the macro handled  $A/B$  input by first truncating both  $A$  and  $B$  to at most  $P+2$  digits. This meant that decimal input (arbitrarily long, with scientific part) was correctly rounded, but in case of fractional input there could be up to 0.6 unit in the last place difference of the produced rounding to the input, hence the output could differ from the correct rounding.

## 7 Package *xintfrac* implementation

Example with 16 digits (the default): `\xintFloat {1/17597472569900621233}`  
with `xintfrac 1.07`: 5.682634230727187e-20  
with `xintfrac 1.08b--1.2j`: 5.682634230727188e-20  
with `xintfrac 1.2k`: 5.682634230727187e-20  
The exact value is 5.682634230727187499924124...e-20, showing that 1.07 and 1.2k produce the correct rounding.

Currently the code ends in a more costly branch in about 1 case among 500, where it does some extra operations (a multiplication in particular). There is a free parameter `delta` (here set at 4), I have yet to make some numerical explorations, to see if it could be favorable to set it to a higher value (with `delta=5`, there is only 1 exceptional case in 5000, etc...).

I have always hesitated about the policy of printing 10.00...0 in case of rounding upwards to the next power of ten. Already since 1.2f `\XINTinFloat` always produced a mantissa with exactly `P` digits (except for the zero value). Starting with 1.2k, `\xintFloat` drops this habit of printing 10.00...0 in such cases. Side note: the rounding-up detection worked when the input `A/B` was with numerator `A` and denominator `B` having each less than `P+2` digits, or with `B=1`, else, it could happen that the output was a power of ten but not detected to be a rounding up of the original fraction. The value was ok, but printed 1.0...0eN with `P-1` zeroes, not 10.0...0e(N-1).

I decided it was not worth the effort to enhance the algorithm to detect with 100% fiability all cases of rounding up to next power of ten, hence 1.2k dropped this.

To avoid duplication of code, and any extra burden on `\XINTinFloat`, which is the macro used internally by the float macros for parsing their inputs, we simply make now `\xintFloat` a wrapper of `\XINTinFloat`.

```

1635 \def\xintFloat    {\romannumeral0\xintfloat}%
1636 \def\xintfloat #1{\XINT_float_chkopt #1\xint:}%
1637 \def\XINT_float_chkopt #1%
1638 {%
1639     \ifx [#1\expandafter\XINT_float_opt
1640         \else\expandafter\XINT_float_noopt
1641     \fi #1%
1642}%
1643 \def\XINT_float_noopt #1\xint:%
1644 {%
1645     \expandafter\XINT_float_post
1646     \romannumeral0\XINTinfloat[\XINTdigits]{#1}\XINTdigits.%
1647}%
1648 \def\XINT_float_opt [\xint:#1]%
1649 {%
1650     \expandafter\XINT_float_opt_a\the\numexpr #1.%
1651}%
1652 \def\XINT_float_opt_a #1.#2%
1653 {%
1654     \expandafter\XINT_float_post
1655     \romannumeral0\XINTinfloat[#1]{#2}#1.%
1656}%
1657 \def\XINT_float_post #1%
1658 {%
1659     \xint_UDzerominusfork
1660     #1-\XINT_float_zero
1661     0#1\XINT_float_neg
1662     0-\XINT_float_pos
1663     \krof #1%
1664}%[

```



```

1665 \def\XINT_float_zero #1]#2.{ 0.e0}%
1666 \def\XINT_float_neg-{\expandafter-\romannumeral0\XINT_float_pos}%
1667 \def\XINT_float_pos #1#2[#3]#4.%
1668 {%
1669   \expandafter\XINT_float_pos_done\the\numexpr#3+#4-\xint_c_i.#1.#2;%
1670 }%
1671 \def\XINT_float_pos_done #1.#2;{ #2e#1}%

```

### 7.59 \XINTinFloat, \XINTinFloatS

This routine is like `\xintFloat` but produces an output of the shape `A[N]` which is then parsed faster as input to other float macros. Float operations in `\xintfloatexpr...` relax use internally this format.

It must be used in form `\XINTinFloat[P]{f}`: the optional `[P]` is mandatory.

Since 1.2f, the mantissa always has exactly `P` digits even in case of rounding up to next power of ten. This simplifies other routines.

1.2g added a variant `\XINTinFloatS` which, in case of decimal input with less than the asked for precision `P` will not add extra zeros to the mantissa. For example it may output `2[0]` even if `P=500`, rather than the canonical representation `200...000[-499]`. This is how `\xintFloatMul` and `\xintFloatDiv` parse their inputs, which speeds-up follow-up processing. But `\xintFloatAdd` and `\xintFloatSub` still use `\XINTinFloat` for parsing their inputs; anyway this will have to be changed again when inner structure will carry upfront at least the length of mantissa as data.

Each time `\XINTinFloat` is called it at least computes a length. Naturally if we had some format for floats that would be dispensed of...

something like `<letterP><length of mantissa>.mantissa.exponent`, etc... not yet.

Since 1.2k, `\XINTinFloat` always correctly rounds its argument, even if it is a fraction with very big numerator and denominator. See the discussion of `\xintFloat`.

```

1672 \def\XINTinFloat {\romannumeral0\XINTinfloat }%
1673 \def\XINTinfloat
1674   {\expandafter\XINT_infloat_clean\romannumeral0\XINT_infloat}%
1675 \def\XINT_infloat_clean #1%
1676   {\if #1!\xint_dothis\XINT_infloat_clean_a\fi\xint_orthat{ }#1}%

```

Ici on ajoute les zeros pour faire exactement avec `P` chiffres. Car le `#1 = P - L` avec `L` la longueur de `#2`, (ou de `abs(#2)`, ici le `#2` peut avoir un signe) qui est `< P`

```

1677 \def\XINT_infloat_clean_a !#1.#2[#3]%
1678 {%
1679   \expandafter\XINT_infloat_done
1680   \the\numexpr #3-#1\expandafter.%
1681   \romannumeral0\XINT_dsx_addzeros {#1}#2;;%
1682 }%
1683 \def\XINT_infloat_done #1.#2;{ #2[#1]}%

```

variant which allows output with shorter mantissas.

```

1684 \def\XINTinFloatS {\romannumeral0\XINTinfloatS}%
1685 \def\XINTinfloatS
1686   {\expandafter\XINT_infloatS_clean\romannumeral0\XINT_infloat}%
1687 \def\XINT_infloatS_clean #1%
1688   {\if #1!\xint_dothis\XINT_infloatS_clean_a\fi\xint_orthat{ }#1}%
1689 \def\XINT_infloatS_clean_a !#1.{ }%

```

## 7 Package *xintfrac* implementation

début de la routine proprement dite, l'argument optionnel est obligatoire.

```
1690 \def\XINT_infloat [#1]#2%
1691 {%
1692   \expandafter\XINT_infloat_a\the\numexpr #1\expandafter.%
1693   \romannumeral0\XINT_infrac {#2}%
1694 }%
```

#1=P, #2=n, #3=A, #4=B.

```
1695 \def\XINT_infloat_a #1.#2#3#4%
1696 {%
```

micro boost au lieu d'utiliser \XINT\_isOne{#4}, mais pas bon style.

```
1697   \if1\XINT_is_One#4XY%
1698     \expandafter\XINT_infloat_sp
1699   \else\expandafter\XINT_infloat_fork
1700   \fi #3.{#1}{#2}{#4}%
1701 }%
```

Special quick treatment of B=1 case (1.2f then again 1.2g.)  
maintenant: A.{P}{N}{1} Il est possible que A soit nul.

```
1702 \def\XINT_infloat_sp #1%
1703 {%
1704   \xint_UDzerominusfork
1705   #1-\XINT_infloat_spzero
1706   0#1\XINT_infloat_spneg
1707   0-\XINT_infloat_sppos
1708   \krof #1%
1709 }%
```

Attention surtout pas 0/1[0] ici.

```
1710 \def\XINT_infloat_spzero 0.#1#2#3{ 0[0]}%
1711 \def\XINT_infloat_spneg-%
1712   {\expandafter\XINT_infloat_spnegend\romannumeral0\XINT_infloat_sppos}%
1713 \def\XINT_infloat_spnegend #1%
1714   {\if#1!\expandafter\XINT_infloat_spneg_needzeros\fi -#1}%
1715 \def\XINT_infloat_spneg_needzeros -!#1.{!#1.-}%
```

in: A.{P}{N}{1}  
out: P-L.A.P.N.

```
1716 \def\XINT_infloat_sppos #1.#2#3#4%
1717 {%
1718   \expandafter\XINT_infloat_sp_b\the\numexpr#2-\xintLength{#1}.#1.#2.#3.%
1719 }%
```

#1= P-L. Si c'est positif ou nul il faut retrancher #1 à l'exposant, et ajouter autant de zéros.  
On regarde premier token. P-L.A.P.N.

```
1720 \def\XINT_infloat_sp_b #1%
1721 {%
1722   \xint_UDzerominusfork
```

## 7 Package *xintfrac* implementation

```

1723      #1-\XINT_infloat_sp_quick
1724      0#1\XINT_infloat_sp_c
1725      0-\XINT_infloat_sp_needzeros
1726      \krof #1%
1727 }%

```

Ici  $P=L$ . Le cas usuel dans `\xintfloatexpr`.

```

1728 \def\XINT_infloat_sp_quick 0.#1.#2.#3.{ #1[#3]}%

```

Ici  $\#1=P-L$  est  $>0$ . L'exposant sera  $N-(P-L)$ .  $\#2=A$ .  $\#3=P$ .  $\#4=N$ .

18 mars 2016. En fait dans certains contextes il est sous-optimal d'ajouter les zéros. Par exemple quand c'est appelé par la multiplication ou la division, c'est idiot de convertir 2 en 200000...00000[-499]. Donc je redéfinis `addzeros` en `needzeroes`. Si on appelle sous la forme `\XINTinFloatS`, on ne fait pas l'addition de zeros.

```

1729 \def\XINT_infloat_sp_needzeros #1.#2.#3.#4.{!#1.#2[#4]}%

```

$L-P=\#1$ .  $A=\#2$ .  $P=\#3$ .  $N=\#4$ .

Ici  $P<L$ . Il va falloir arrondir. Attention si on va à la puissance de 10 suivante. En  $\#1$  on a  $L-P$  qui est  $>0$ . L'exposant final sera  $N+L-P$ , sauf dans le cas spécial, il sera alors  $N+L-P+1$ . L'ajustement final est fait par `\XINT_infloat_Y`.

```

1730 \def\XINT_infloat_sp_c -#1.#2#3.#4.#5.%
1731 {%
1732   \expandafter\XINT_infloat_Y
1733   \the\numexpr #5+#1\expandafter.%
1734   \romannumeral0\expandafter\XINT_infloat_sp_round
1735   \romannumeral0\XINT_split_fromleft
1736   (\xint_c_i+#4).#2#3\xint_bye2345678\xint_bye..#2%
1737 }%
1738 \def\XINT_infloat_sp_round #1.#2.%
1739 {%
1740   \XINT_dsrr#1\xint_bye\xint_Bye3456789\xint_bye/\xint_c_x\relax.%
1741 }%

```

General branch for  $A/B$  with  $B>1$  inputs. It achieves correct rounding always since 1.2k (done January 2, 2017.) This branch is never taken for  $A=0$  because `\XINT_infrac` will have returned  $B=1$  then.

```

1742 \def\XINT_infloat_fork #1%
1743 {%
1744   \xint_UDsignfork
1745   #1\XINT_infloat_J
1746   -\XINT_infloat_K
1747   \krof #1%
1748 }%
1749 \def\XINT_infloat_J-{\expandafter-\romannumeral0\XINT_infloat_K }%

```

$A.\{P\}\{n\}\{B\}$  avec  $B>1$ .

```

1750 \def\XINT_infloat_K #1.#2%
1751 {%
1752   \expandafter\XINT_infloat_L
1753   \the\numexpr\xintLength{#1}\expandafter.\the\numexpr #2+\xint_c_iv.{#1}\{#2}%
1754 }%

```

## 7 Package *xintfrac* implementation

$|A|.P+4.\{A\}\{P\}\{n\}\{B\}$ . We check if A already has length  $\leq P+4$ .

```
1755 \def\XINT_infloat_L #1.#2.%
1756 {%
1757     \ifnum #1>#2
1758         \expandafter\XINT_infloat_Ma
1759     \else
1760         \expandafter\XINT_infloat_Mb
1761     \fi #1.#2.%
1762 }%
```

$|A|.P+4.\{A\}\{P\}\{n\}\{B\}$ . We will keep only the first  $P+4$  digits of A, denoted  $A'$  in what follows.  
output:  $u=-0.A'.$ junk. $P+4.$  $|A|. \{A\}\{P\}\{n\}\{B\}$

```
1763 \def\XINT_infloat_Ma #1.#2.#3%
1764 {%
1765     \expandafter\XINT_infloat_MtoN\expandafter-\expandafter0\expandafter.%
1766     \romannumeral0\XINT_split_fromleft#2.#3\xint_bye2345678\xint_bye..%
1767     #2.#1.{#3}%
1768 }%
```

$|A|.P+4.\{A\}\{P\}\{n\}\{B\}$ .  
Here A is short. We set  $u = P+4 - |A|$ , and  $A' = A$  ( $A' = 10^u A$ )  
output:  $u.A'.$ junk. $P+4.$  $|A|. \{A\}\{P\}\{n\}\{B\}$

```
1769 \def\XINT_infloat_Mb #1.#2.#3%
1770 {%
1771     \expandafter\XINT_infloat_MtoN\the\numexpr#2-#1.%
1772     #3..#2.#1.{#3}%
1773 }%
```

input  $u.A'.$ junk. $P+4.$  $|A|. \{A\}\{P\}\{n\}\{B\}$   
output  $|B|.P+4.\{B\}u.A'.$ P. $|A|.n.\{A\}\{B\}$

```
1774 \def\XINT_infloat_MtoN #1.#2.#3.#4.#5.#6#7#8#9%
1775 {%
1776     \expandafter\XINT_infloat_N
1777     \the\numexpr\xintLength{#9}.#4.{#9}#1.#2.#7.#5.#8.{#6}{#9}%
1778 }%
1779 \def\XINT_infloat_N #1.#2.%
1780 {%
1781     \ifnum #1>#2
1782         \expandafter\XINT_infloat_Oa
1783     \else
1784         \expandafter\XINT_infloat_Ob
1785     \fi #1.#2.%
1786 }%
```

input  $|B|.P+4.\{B\}u.A'.$ P. $|A|.n.\{A\}\{B\}$   
output  $v=-0.B'.$ junk. $|B|.u.A'.$ P. $|A|.n.\{A\}\{B\}$

```
1787 \def\XINT_infloat_Oa #1.#2.#3%
1788 {%
1789     \expandafter\XINT_infloat_P\expandafter-\expandafter0\expandafter.%
1790     \romannumeral0\XINT_split_fromleft#2.#3\xint_bye2345678\xint_bye..%
```

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```

1791      #1.%
1792 }%

    output v=P+4-|B|>=0.B''.junk.|B|.u.A''.P.|A|.n.{A}{B}

1793 \def\XINT_infloat_0b #1.#2.#3%
1794 {%
1795     \expandafter\XINT_infloat_P\the\numexpr#2-#1.#3..#1.%
1796 }%

    input v.B''.junk.|B|.u.A''.P.|A|.n.{A}{B}
    output Q1.P.|B|. |A|.n.{A}{B}
    Q1 = division euclidienne de A''.10^{u-v+P+3} par B''.
    Special detection of cases with A and B both having length at most P+4: this will happen when
    called from \xintFloatDiv as A and B (produced then via \XINTinFloatS) will have at most P digits.
    We then only need integer division with P+1 extra zeros, not P+3.

1797 \def\XINT_infloat_P #1#2.#3.#4.#5.#6#7.#8.#9.%
1798 {%
1799     \csname XINT_infloat_Q\if-#1\else\if-#6\else q\fi\fi\expandafter\endcsname
1800     \romannumeral0\xintiique
1801     {\romannumeral0\XINT_dsx_addzerosnofuss
1802      {#6#7-#1#2+#9+\xint_c_iii\if-#1\else\if-#6\else-\xint_c_ii\fi\fi}#8;}%
1803     {#3}.#9.#5.%
1804 }%

    «quick» branch.

1805 \def\XINT_infloat_Qq #1.#2.%
1806 {%
1807     \expandafter\XINT_infloat_Rq
1808     \romannumeral0\XINT_split_fromleft#2.#1\xint_bye2345678\xint_bye..#2.%
1809 }%
1810 \def\XINT_infloat_Rq #1.#2#3.%
1811 {%
1812     \ifnum#2<\xint_c_v
1813         \expandafter\XINT_infloat_SEq
1814     \else\expandafter\XINT_infloat_SUP
1815     \fi
1816     {\if.#3.\xint_c_\else\xint_c_i\fi}#1.%
1817 }%

    standard branch which will have to handle undecided rounding, if too close to a mid-value.

1818 \def\XINT_infloat_Q #1.#2.%
1819 {%
1820     \expandafter\XINT_infloat_R
1821     \romannumeral0\XINT_split_fromleft#2.#1\xint_bye2345678\xint_bye..#2.%
1822 }%
1823 \def\XINT_infloat_R #1.#2#3#4#5.%
1824 {%
1825     \if.#5.\expandafter\XINT_infloat_Sa\else\expandafter\XINT_infloat_Sb\fi
1826     #2#3#4#5.#1.%
1827 }%

```

trailing digits.Q.P.|B|. |A|.n.{A}{B}  
 #1=trailing digits (they may have leading zeros.)

```
1828 \def\XINT_infloat_Sa #1.%
1829 {%
1830   \ifnum#1>500 \xint_dothis\XINT_infloat_SUP\fi
1831   \ifnum#1<499 \xint_dothis\XINT_infloat_SEQ\fi
1832   \xint_orthat\XINT_infloat_X\xint_c_
1833 }%
1834 \def\XINT_infloat_Sb #1.%
1835 {%
1836   \ifnum#1>5009 \xint_dothis\XINT_infloat_SUP\fi
1837   \ifnum#1<4990 \xint_dothis\XINT_infloat_SEQ\fi
1838   \xint_orthat\XINT_infloat_X\xint_c_i
1839 }%
```

epsilon #2=Q.#3=P.#4=|B|. #5=|A|. #6=n.{A}{B}  
 exposant final est n+|A|-|B|-P+epsilon

```
1840 \def\XINT_infloat_SEQ #1#2.#3.#4.#5.#6.#7#8%
1841 {%
1842   \expandafter\XINT_infloat_SY
1843   \the\numexpr #6+#5-#4-#3+#1.#2.%
1844 }%
1845 \def\XINT_infloat_SY #1.#2.{ #2[#1]}%
```

initial digit #2 put aside to check for case of rounding up to next power of ten, which will need adjustment of mantissa and exponent.

```
1846 \def\XINT_infloat_SUP #1#2#3.#4.#5.#6.#7.#8#9%
1847 {%
1848   \expandafter\XINT_infloat_Y
1849   \the\numexpr#7+#6-#5-#4+#1\expandafter.%
1850   \romannumeral0\xintinc{#2#3}.#2%
1851 }%
```

epsilon Q.P.|B|. |A|.n.{A}{B}

\xintDSH{-x}{U} multiplies U by  $10^x$ . When x is negative, this means it truncates (i.e. it drops the last -x digits).

We don't try to optimize too much macro calls here, the odds are 2 per 1000 for this branch to be taken. Perhaps in future I will use higher free parameter d, which currently is set at 4.

#1=epsilon, #2#3=Q, #4=P, #5=|B|, #6=|A|, #7=n, #8=A, #9=B

```
1852 \def\XINT_infloat_X #1#2#3.#4.#5.#6.#7.#8#9%
1853 {%
1854   \expandafter\XINT_infloat_Y
1855   \the\numexpr #7+#6-#5-#4+#1\expandafter.%
1856   \romannumeral`&&\romannumeral0\xintiiiflt
1857   {\xintDSH{#6-#5-#4+#1}{\xintDouble{#8}}}%
1858   {\xintiiMul{\xintInc{\xintDouble{#2#3}}}{#9}}%
1859   \xint_firstofone
1860   \xintinc{#2#3}.#2%
1861 }%
```

check for rounding up to next power of ten.

```

1862 \def\XINT_infloat_Y #1{%
1863 \def\XINT_infloat_Y ##1.##2##3.##4%
1864 {%
1865   \if##49\if##21\expandafter\expandafter\expandafter\XINT_infloat_Z\fi\fi
1866   #1##2##3[##1]%
1867 }}\XINT_infloat_Y{ }%

#1=1, #2=0.

1868 \def\XINT_infloat_Z #1#2#3[#4]%
1869 {%
1870   \expandafter\XINT_infloat_ZZ\the\numexpr#4+\xint_c_i.#3.%
1871 }%
1872 \def\XINT_infloat_ZZ #1.#2.{ 1#2[#1]}%
```

## 7.60 \xintPFloat

1.1. This is a prettifying printing macro for floats.

The macro applies one simple rule: `xyz...eN` will drop scientific notation in favor of pure decimal notation if  $-5 \leq N \leq 5$ . This is the default behaviour of Maple. The `N` here is as produced on output by `\xintFloat`.

Special case: the zero value is printed 0. (with a dot)

The coding got simpler with 1.2k as its `\xintFloat` always produces a mantissa with exactly `P` digits (no more `10.0...0eN` annoying exception).

```

1873 \def\xintPFloat {\romannumeral0\xintpfloat }%
1874 \def\xintpfloat #1{\XINT_pfloat_chkopt #1\xint:}%
1875 \def\XINT_pfloat_chkopt #1%
1876 {%
1877   \ifx [#1\expandafter\XINT_pfloat_opt
1878   \else\expandafter\XINT_pfloat_noopt
1879   \fi #1%
1880 }%
1881 \def\XINT_pfloat_noopt #1\xint:%
1882 {%
1883   \expandafter\XINT_pfloat_a
1884   \romannumeral0\xintfloat [\XINTdigits]{#1};\XINTdigits.%
1885 }%
1886 \def\XINT_pfloat_opt [\xint:#1]%
1887 {%
1888   \expandafter\XINT_pfloat_opt_a \the\numexpr #1.%
1889 }%
1890 \def\XINT_pfloat_opt_a #1.#2%
1891 {%
1892   \expandafter\XINT_pfloat_a\romannumeral0\xintfloat [#1]{#2};#1.%
1893 }%
1894 \def\XINT_pfloat_a #1%
1895 {%
1896   \xint_UDzerominusfork
1897   #1-\XINT_pfloat_zero
1898   0#1\XINT_pfloat_neg
```

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```
1899      0-\XINT_pfloat_pos
1900      \krof #1%
1901 }%
1902 \def\XINT_pfloat_zero #1;#2.{ 0.}%
1903 \def\XINT_pfloat_neg-{\expandafter-\romannumeral0\XINT_pfloat_pos }%
1904 \def\XINT_pfloat_pos #1.#2e#3;#4.%
1905 {%
1906     \ifnum #3>\xint_c_v \xint_dothis\XINT_pfloat_no\fi
1907     \ifnum #3<-\xint_c_v \xint_dothis\XINT_pfloat_no\fi
1908     \ifnum #3<\xint_c_ \xint_dothis\XINT_pfloat_N\fi
1909     \ifnum #3>\numexpr #4-\xint_c_i\relax \xint_dothis\XINT_pfloat_Ps\fi
1910     \xint_orthat\XINT_pfloat_P #1#2e#3;%
1911 }%
1912 \def\XINT_pfloat_no #1#2;{ #1.#2}%
```

This is all simpler coded, now that 1.2k's `\xintFloat` always outputs a mantissa with exactly one digits before decimal mark always.

```
1913 \def\XINT_pfloat_N #1e-#2;%
1914 {%
1915     \csname XINT_pfloat_N-\romannumeral#2\endcsname #1%
1916 }%
1917 \def\XINT_pfloat_N_i { 0.}%
1918 \def\XINT_pfloat_N_ii { 0.0}%
1919 \def\XINT_pfloat_N_iii{ 0.00}%
1920 \def\XINT_pfloat_N_iv { 0.000}%
1921 \def\XINT_pfloat_N_v { 0.0000}%
1922 \def\XINT_pfloat_P #1e#2;%
1923 {%
1924     \csname XINT_pfloat_P-\romannumeral#2\endcsname #1%
1925 }%
1926 \def\XINT_pfloat_P_ #1{ #1.}%
1927 \def\XINT_pfloat_P_i #1#2{ #1#2.}%
1928 \def\XINT_pfloat_P_ii #1#2#3{ #1#2#3.}%
1929 \def\XINT_pfloat_P_iii#1#2#3#4{ #1#2#3#4.}%
1930 \def\XINT_pfloat_P_iv #1#2#3#4#5{ #1#2#3#4#5.}%
1931 \def\XINT_pfloat_P_v #1#2#3#4#5#6{ #1#2#3#4#5#6.}%
1932 \def\XINT_pfloat_Ps #1e#2;%
1933 {%
1934     \csname XINT_pfloat_Ps\romannumeral#2\endcsname #100000;%
1935 }%
1936 \def\XINT_pfloat_Psi #1#2#3;{ #1#2.}%
1937 \def\XINT_pfloat_Psii #1#2#3#4;{ #1#2#3.}%
1938 \def\XINT_pfloat_Psiii#1#2#3#4#5;{ #1#2#3#4.}%
1939 \def\XINT_pfloat_Psiv #1#2#3#4#5#6;{ #1#2#3#4#5.}%
1940 \def\XINT_pfloat_Psv #1#2#3#4#5#6#7;{ #1#2#3#4#5#6.}%
```

### 7.61 `\XINTinFloatFracdigits`

1.09i, for `frac` function in `\xintfloatexpr`. This version computes exactly from the input the fractional part and then only converts it into a float with the asked-for number of digits. I will have to think it again some day, certainly.



1.1 removes optional argument for which there was anyhow no interface, for technical reasons having to do with `\xintNewExpr`.

1.1a renames the macro as `\XINTinFloatFracdigits` (from `\XINTinFloatFrac`) to be synchronous with the `\XINTinFloatSqrt` and `\XINTinFloat` habits related to `\xintNewExpr` problems.

Note to myself: I still have to rethink the whole thing about what is the best to do, the initial way of going through `\xintfrac` was just a first implementation.

```

1941 \def\XINTinFloatFracdigits {\romannumeral0\XINTinfloatfracdigits }%
1942 \def\XINTinfloatfracdigits #1%
1943 {%
1944   \expandafter\XINT_infloatfracdg_a\expandafter {\romannumeral0\xintfrac{#1}}%
1945 }%
1946 \def\XINT_infloatfracdg_a {\XINTinfloat [\XINTdigits]}%

```

## 7.62 `\xintFloatAdd`, `\XINTinFloatAdd`

First included in release 1.07.

1.09ka improved a bit the efficiency. However the add, sub, mul, div routines were provisory and supposed to be revised soon.

Which didn't happen until 1.2f. Now, the inputs are first rounded to P digits, not P+2 as earlier.

```

1947 \def\xintFloatAdd      {\romannumeral0\xintfloatadd }%
1948 \def\xintfloatadd      #1{\XINT_fladd_chkopt \xintfloat #1\xint:}%
1949 \def\XINTinFloatAdd    {\romannumeral0\XINTinfloatadd }%
1950 \def\XINTinfloatadd    #1{\XINT_fladd_chkopt \XINTinfloatS #1\xint:}%
1951 \def\XINT_fladd_chkopt #1#2%
1952 {%
1953   \ifx [#2\expandafter\XINT_fladd_opt
1954     \else\expandafter\XINT_fladd_noopt
1955   \fi #1#2%
1956 }%
1957 \def\XINT_fladd_noopt #1#2\xint:#3%
1958 {%
1959   #1[\XINTdigits]%
1960   {\expandafter\XINT_FL_add_a
1961     \romannumeral0\XINTinfloat[\XINTdigits]{#2}\XINTdigits.{#3}}%
1962 }%
1963 \def\XINT_fladd_opt #1[\xint:#2]#3#4%
1964 {%
1965   \expandafter\XINT_fladd_opt_a\the\numexpr #2.#1%
1966 }%
1967 \def\XINT_fladd_opt_a #1.#2#3#4%
1968 {%
1969   #2[#1]{\expandafter\XINT_FL_add_a\romannumeral0\XINTinfloat[#1]{#3}#1.{#4}}%
1970 }%
1971 \def\XINT_FL_add_a #1%
1972 {%
1973   \xint_gob_til_zero #1\XINT_FL_add_zero 0\XINT_FL_add_b #1%
1974 }%
1975 \def\XINT_FL_add_zero #1.#2{#2}%[
1976 \def\XINT_FL_add_b #1]#2.#3%
1977 {%
1978   \expandafter\XINT_FL_add_c\romannumeral0\XINTinfloat[#2]{#3}#2.#1%

```

```

1979 }%
1980 \def\XINT_FL_add_c #1%
1981 {%
1982   \xint_gob_til_zero #1\XINT_FL_add_zero 0\XINT_FL_add_d #1%
1983 }%
1984 \def\XINT_FL_add_d #1[#2]#3.#4[#5]%
1985 {%
1986   \ifnum\numexpr #2-#3-#5>\xint_c_\xint_dothis\xint_firstoftwo\fi
1987   \ifnum\numexpr #5-#3-#2>\xint_c_\xint_dothis\xint_secondoftwo\fi
1988   \xint_orthat\xintAdd {#1[#2]}{#4[#5]}%
1989 }%

```

### 7.63 \xintFloatSub, \XINTinFloatSub

First done 1.07.

Starting with 1.2f the arguments undergo an initial rounding to the target precision P not P+2.

```

1990 \def\xintFloatSub      {\romannumeral0\xintfloatsub }%
1991 \def\xintfloatsub      #1{\XINT_fsub_chkopt \xintfloat #1\xint:}%
1992 \def\XINTinFloatSub    {\romannumeral0\XINTinfloatsub }%
1993 \def\XINTinfloatsub    #1{\XINT_fsub_chkopt \XINTinfloatS #1\xint:}%
1994 \def\XINT_fsub_chkopt #1#2%
1995 {%
1996   \ifx [#2\expandafter\XINT_fsub_opt
1997   \else\expandafter\XINT_fsub_noopt
1998   \fi #1#2%
1999 }%
2000 \def\XINT_fsub_noopt #1#2\xint:#3%
2001 {%
2002   #1[\XINTdigits]%
2003   {\expandafter\XINT_FL_add_a
2004     \romannumeral0\XINTinfloat[\XINTdigits]{#2}\XINTdigits.{\xintOpp{#3}}}%
2005 }%
2006 \def\XINT_fsub_opt #1[\xint:#2]#3#4%
2007 {%
2008   \expandafter\XINT_fsub_opt_a\the\numexpr #2.#1%
2009 }%
2010 \def\XINT_fsub_opt_a #1.#2#3#4%
2011 {%
2012   #2[#1]{\expandafter\XINT_FL_add_a\romannumeral0\XINTinfloat[#1]{#3}#1.{\xintOpp{#4}}}%
2013 }%

```

### 7.64 \xintFloatMul, \XINTinFloatMul

1.07.

Starting with 1.2f the arguments are rounded to the target precision P not P+2.

1.2g handles the inputs via \XINTinFloatS which will be more efficient when the precision is large and the input is for example a small constant like 2.

1.2k does a micro improvement to the way the macro passes over control to its output routine (former version used a higher level \xintE causing some extra un-needed processing with two calls to \XINT\_infrac where one was amply enough).

```

2014 \def\xintFloatMul      {\romannumeral0\xintfloatmul }%

```

```

2015 \def\xintfloatmul #1{\XINT_flmul_chkopt \xintfloat #1\xint:}%
2016 \def\XINTinFloatMul {\romannumeral0\XINTinfloatmul }%
2017 \def\XINTinfloatmul #1{\XINT_flmul_chkopt \XINTinfloatS #1\xint:}%
2018 \def\XINT_flmul_chkopt #1#2%
2019 {%
2020   \ifx [#2\expandafter\XINT_flmul_opt
2021     \else\expandafter\XINT_flmul_noopt
2022   \fi #1#2%
2023 }%
2024 \def\XINT_flmul_noopt #1#2\xint:#3%
2025 {%
2026   #1[\XINTdigits]%
2027   {\expandafter\XINT_FL_mul_a
2028     \romannumeral0\XINTinfloatS[\XINTdigits]{#2}\XINTdigits.{#3}}%
2029 }%
2030 \def\XINT_flmul_opt #1[\xint:#2]%#3#4%
2031 {%
2032   \expandafter\XINT_flmul_opt_a\the\numexpr #2.#1%
2033 }%
2034 \def\XINT_flmul_opt_a #1.#2#3#4%
2035 {%
2036   #2[#1]{\expandafter\XINT_FL_mul_a\romannumeral0\XINTinfloatS[#1]{#3}#1.#4}%
2037 }%
2038 \def\XINT_FL_mul_a #1[#2]#3.#4%
2039 {%
2040   \expandafter\XINT_FL_mul_b\romannumeral0\XINTinfloatS[#3]{#4}#1[#2]%
2041 }%
2042 \def\XINT_FL_mul_b #1[#2]#3[#4]{\xintiiMul{#3}{#1}/1[#4+#2]}%

```

## 7.65 \xintFloatDiv, \XINTinFloatDiv

### 1.07.

Starting with 1.2f the arguments are rounded to the target precision  $P$  not  $P+2$ .

1.2g handles the inputs via `\XINTinFloatS` which will be more efficient when the precision is large and the input is for example a small constant like 2.

The actual rounding of the quotient is handled via `\xintfloat` (or `\XINTinfloatS`).

1.2k does the same kind of improvement in `\XINT_FL_div_b` as for multiplication: earlier code was unnecessarily high level.

```

2043 \def\xintFloatDiv {\romannumeral0\xintfloatdiv }%
2044 \def\xintfloatdiv #1{\XINT_fldiv_chkopt \xintfloat #1\xint:}%
2045 \def\XINTinFloatDiv {\romannumeral0\XINTinfloatdiv }%
2046 \def\XINTinfloatdiv #1{\XINT_fldiv_chkopt \XINTinfloatS #1\xint:}%
2047 \def\XINT_fldiv_chkopt #1#2%
2048 {%
2049   \ifx [#2\expandafter\XINT_fldiv_opt
2050     \else\expandafter\XINT_fldiv_noopt
2051   \fi #1#2%
2052 }%
2053 \def\XINT_fldiv_noopt #1#2\xint:#3%
2054 {%
2055   #1[\XINTdigits]%
2056   {\expandafter\XINT_FL_div_a

```

```

2057 \romannumeral0\XINTinfloatS[\XINTdigits]{#3}\XINTdigits.{#2}}%
2058 }%
2059 \def\XINT_fldiv_opt #1[\xint:#2]#3#4%
2060 {%
2061 \expandafter\XINT_fldiv_opt_a\the\numexpr #2.#1%
2062 }%
2063 \def\XINT_fldiv_opt_a #1.#2#3#4%
2064 {%
2065 #2[#1]{\expandafter\XINT_FL_div_a\romannumeral0\XINTinfloatS[#1]{#4}#1.{#3}}%
2066 }%
2067 \def\XINT_FL_div_a #1[#2]#3.#4%
2068 {%
2069 \expandafter\XINT_FL_div_b\romannumeral0\XINTinfloatS[#3]{#4}/#1e#2%
2070 }%
2071 \def\XINT_FL_div_b #1[#2]{#1e#2}%

```

## 7.66 \xintFloatPow, \XINTinFloatPow

1.07: initial version. 1.09j has re-organized the core loop.

2015/12/07. I have hesitated to map  $\wedge$  in expressions to \xintFloatPow rather than \xintFloatPower. But for 1.234567890123456 to the power 2145678912 with P=16, using Pow rather than Power seems to bring only about 5% gain.

This routine requires the exponent  $x$  to be compatible with \numexpr parsing.

1.2f has rewritten the code for better efficiency. Also, now the argument  $A$  for  $A^x$  is first rounded to  $P$  digits before switching to the increased working precision (which depends upon  $x$ ).

```

2072 \def\xintFloatPow {\romannumeral0\xintfloatpow}%
2073 \def\xintfloatpow #1{\XINT_flpow_chkopt \xintfloat #1\xint:}%
2074 \def\XINTinFloatPow {\romannumeral0\XINTinfloatpow}%
2075 \def\XINTinfloatpow #1{\XINT_flpow_chkopt \XINTinfloatS #1\xint:}%
2076 \def\XINT_flpow_chkopt #1#2%
2077 {%
2078 \ifx [#2\expandafter\XINT_flpow_opt
2079 \else\expandafter\XINT_flpow_noopt
2080 \fi
2081 #1#2%
2082 }%
2083 \def\XINT_flpow_noopt #1#2\xint:#3%
2084 {%
2085 \expandafter\XINT_flpow_checkB_a
2086 \the\numexpr #3.\XINTdigits.{#2}{#1[\XINTdigits]]}%
2087 }%
2088 \def\XINT_flpow_opt #1[\xint:#2]#3%
2089 {%
2090 \expandafter\XINT_flpow_opt_a\the\numexpr #2.#1%
2091 }%
2092 \def\XINT_flpow_opt_a #1.#2#3#4%
2093 {%
2094 \expandafter\XINT_flpow_checkB_a\the\numexpr #4.#1.{#3}{#2[#1]]}%
2095 }%
2096 \def\XINT_flpow_checkB_a #1%
2097 {%
2098 \xint_UDzerominusfork

```

```

2099      #1-\XINT_flpow_BisZero
2100      0#1{\XINT_flpow_checkB_b -}%
2101      0-{\XINT_flpow_checkB_b {}#1}%
2102      \krof
2103 }%
2104 \def\XINT_flpow_BisZero .#1.#2#3{#3{1[0]}}%
2105 \def\XINT_flpow_checkB_b #1#2.#3.%
2106 {%
2107     \expandafter\XINT_flpow_checkB_c
2108     \the\numexpr\xintLength{#2}+\xint_c_iii.#3.#2.{#1}%
2109 }%
2110 \def\XINT_flpow_checkB_c #1.#2.%
2111 {%
2112     \expandafter\XINT_flpow_checkB_d\the\numexpr#1+#2.#1.#2.%
2113 }%

```

1.2f rounds input to P digits, first.

```

2114 \def\XINT_flpow_checkB_d #1.#2.#3.#4.#5#6%
2115 {%
2116     \expandafter \XINT_flpow_aa
2117     \romannumeral0\XINTinfloat [#3]{#6}{#2}{#1}{#4}{#5}%
2118 }%
2119 \def\XINT_flpow_aa #1[#2]#3%
2120 {%
2121     \expandafter\XINT_flpow_ab\the\numexpr #2-#3\expandafter.%
2122     \romannumeral\XINT_rep #3\endcsname0.#1.%
2123 }%
2124 \def\XINT_flpow_ab #1.#2.#3.{\XINT_flpow_a #3#2[#1]}%
2125 \def\XINT_flpow_a #1%
2126 {%
2127     \xint_UDzerominusfork
2128     #1-\XINT_flpow_zero
2129     0#1{\XINT_flpow_b \iftrue}%
2130     0-{\XINT_flpow_b \iffalse#1}%
2131     \krof
2132 }%
2133 \def\XINT_flpow_zero #1[#2]#3#4#5#6%
2134 {%
2135     #6{\if 1#51\xint_dothis {0[0]}\fi
2136         \xint_orthat
2137         {\XINT_signalcondition{DivisionByZero}{0 to the power #4}{0[0]}}%
2138     }%
2139 }%
2140 \def\XINT_flpow_b #1#2[#3]#4#5%
2141 {%
2142     \XINT_flpow_loopI #5.#3.#2.#4.{#1\ifodd #5 \xint_c_i\fi\fi}%
2143 }%
2144 \def\XINT_flpow_truncate #1.#2.#3.%
2145 {%
2146     \expandafter\XINT_flpow_truncate_a
2147     \romannumeral0\XINT_split_fromleft
2148     #3.#2\xint_bye2345678\xint_bye..#1.#3.%

```

```

2149 }%
2150 \def\XINT_flpow_truncate_a #1.#2.#3.{#3+\xintLength{#2}.#1.}%
2151 \def\XINT_flpow_loopI #1.%
2152 {%
2153   \ifnum #1=\xint_c_i\expandafter\XINT_flpow_ItoIII\fi
2154   \ifodd #1
2155     \expandafter\XINT_flpow_loopI_odd
2156   \else
2157     \expandafter\XINT_flpow_loopI_even
2158   \fi
2159   #1.%
2160 }%
2161 \def\XINT_flpow_ItoIII\ifodd #1\fi #2.#3.#4.#5.#6%
2162 {%
2163   \expandafter\XINT_flpow_III\the\numexpr #6+\xint_c_.#3.#4.#5.%
2164 }%
2165 \def\XINT_flpow_loopI_even #1.#2.#3.##4.%
2166 {%
2167   \expandafter\XINT_flpow_loopI
2168   \the\numexpr #1/\xint_c_ii\expandafter.%
2169   \the\numexpr\expandafter\XINT_flpow_truncate
2170   \the\numexpr\xint_c_ii*#2\expandafter.\romannumeral0\xintiisqr{#3}.%
2171 }%
2172 \def\XINT_flpow_loopI_odd #1.#2.#3.#4.%
2173 {%
2174   \expandafter\XINT_flpow_loopII
2175   \the\numexpr #1/\xint_c_ii-\xint_c_i\expandafter.%
2176   \the\numexpr\expandafter\XINT_flpow_truncate
2177   \the\numexpr\xint_c_ii*#2\expandafter.\romannumeral0\xintiisqr{#3}.#4.#2.#3.%
2178 }%
2179 \def\XINT_flpow_loopII #1.%
2180 {%
2181   \ifnum #1 = \xint_c_i\expandafter\XINT_flpow_ItoIII\fi
2182   \ifodd #1
2183     \expandafter\XINT_flpow_loopII_odd
2184   \else
2185     \expandafter\XINT_flpow_loopII_even
2186   \fi
2187   #1.%
2188 }%
2189 \def\XINT_flpow_loopII_even #1.#2.#3.##4.%
2190 {%
2191   \expandafter\XINT_flpow_loopII
2192   \the\numexpr #1/\xint_c_ii\expandafter.%
2193   \the\numexpr\expandafter\XINT_flpow_truncate
2194   \the\numexpr\xint_c_ii*#2\expandafter.\romannumeral0\xintiisqr{#3}.%
2195 }%
2196 \def\XINT_flpow_loopII_odd #1.#2.#3.#4.#5.#6.%
2197 {%
2198   \expandafter\XINT_flpow_loopII_odda
2199   \the\numexpr\expandafter\XINT_flpow_truncate
2200   \the\numexpr#2+#5\expandafter.\romannumeral0\xintiimul{#3}{#6}.#4.%

```

```

2201      #1.#2.#3.%
2202 }%
2203 \def\XINT_flpow_loopII_odda #1.#2.#3.#4.#5.#6.%
2204 {%
2205     \expandafter\XINT_flpow_loopII
2206     \the\numexpr #4/\xint_c_ii-\xint_c_i\expandafter.%
2207     \the\numexpr\expandafter\XINT_flpow_truncate
2208     \the\numexpr\xint_c_ii*#5\expandafter.\romannumeral0\xintiisqr{#6}.#3.%
2209     #1.#2.%
2210 }%
2211 \def\XINT_flpow_IItoIII\ifodd #1\fi #2.#3.#4.#5.#6.#7.#8%
2212 {%
2213     \expandafter\XINT_flpow_III\the\numexpr #8+\xint_c_\expandafter.%
2214     \the\numexpr\expandafter\XINT_flpow_truncate
2215     \the\numexpr#3+#6\expandafter.\romannumeral0\xintiimul{#4}{#7}.#5.%
2216 }%

```

This ending is common with `\xintFloatPower`.

In the case of negative exponent we need to inverse the Q-digits mantissa. This requires no special attention now as 1.2k's `\xintFloat` does correct rounding of fractions hence it is easy to bound the total error. It can be checked that the algorithm after final rounding to the target precision computes a value Z whose distance to the exact theoretical will be less than 0.52 ulp(Z) (and worst cases can only be slightly worse than 0.51 ulp(Z)).

In the case of the half-integer exponent (only via the expression interface,) the computation (which proceeds via `\XINTinFloatPowerH`) ends with a square root. This square root extraction is done with 3 guard digits (the power operations were done with more.) Then the value is rounded to the target precision. There is thus this rounding to 3 guard digits (in the case of negative exponent the reciprocal is computed before the square-root), then the square root is (computed with exact rounding for these 3 guard digits), and then there is the final rounding of this to the target precision. The total error (for positive as well as negative exponent) has been estimated to at worst possibly exceed slightly 0.5125 ulp(Z), and at any rate it is less than 0.52 ulp(Z).

```

2217 \def\XINT_flpow_III #1.#2.#3.#4.#5%
2218 {%
2219     \expandafter\XINT_flpow_IIIend
2220     \xint_UDsignfork
2221         #5{{1/#3[-#2]}}}%
2222         -{{#3[#2]}}}%
2223     \krof #1%
2224 }%
2225 \def\XINT_flpow_IIIend #1#2#3%
2226     {#3{\if#21\xint_afterfi{\expandafter-\romannumeral`&&}\fi#1}}}%

```

## 7.67 `\xintFloatPower`, `\XINTinFloatPower`

1.07. The core loop has been re-organized in 1.09j for some slight efficiency gain. The exponent B is given to `\xintNum`. The `^` in expressions is mapped to this routine.

Same modifications as in `\xintFloatPow` for 1.2f.

1.2f adds a special private macro for allowing half-integral exponents for use with `^` within `\xintfloatexpr`. The exponent will be first truncated to either an integer or an half-integer. The macro is not for general use.

1.2k does anew this 1.2f handling of half-integer exponents for the `\xintfloatexpr` parser: with 1.2f's code the final square-root extraction was applied to a value already rounded to the target

precision, unneedlessly losing precision.

```

2227 \def\xintFloatPower {\romannumeral0\xintfloatpower}%
2228 \def\xintfloatpower #1{\XINT_flpower_chkopt \xintfloat #1\xint:}%
2229 \def\XINTinFloatPower {\romannumeral0\XINTinfloatpower }%
2230 \def\XINTinfloatpower #1{\XINT_flpower_chkopt \XINTinfloatS #1\xint:}%

```

First the special macro for use by the expression parser which checks if one raises to an half-integer exponent. This is always with `\XINTdigits` precision. Rewritten for 1.2k in order for the final square root to keep three guard digits.

We have to be careful that exponent #2 is not constrained by TeX bound. And we must allow fractions. The 1.2k variant does a rounding to nearest integer of half-integer, 1.2f did a truncation rather (this is done after truncation of #2 to fixed point with one digit after mark.) We try to recognize quickly the case of integer exponent, for speed, but there is overhead of going through `\xintiTrunc1`.

```

2231 \def\XINTinFloatPowerH {\romannumeral0\XINTinfloatpowerh }%
2232 \def\XINTinfloatpowerh #1#2%
2233 {%
2234   \expandafter\XINT_flpowerh_a\romannumeral0\xintiTrunc1{#2};%
2235   \XINTdigits.{#1}\XINTinfloatS[\XINTdigits]}%
2236 }%
2237 \def\XINT_flpowerh_a #1;%
2238 {%
2239   \if0\xintiLDg{#1}\expandafter\XINT_flpowerh_int
2240   \else\expandafter\XINT_flpowerh_b
2241   \fi #1.%
2242 }%
2243 \def\XINT_flpowerh_int #1%
2244 {%
2245   \if0#1\expandafter\XINT_flpower_BisZero
2246   \else\expandafter\XINT_flpowerh_i
2247   \fi #1%
2248 }%
2249 \def\XINT_flpowerh_i #10.{\expandafter\XINT_flpower_checkB_a#1.}%
2250 \def\XINT_flpowerh_b #1.%
2251 {%
2252   \expandafter\XINT_flpowerh_c\romannumeral0\xintdsrr{\xintDouble{#1}}.%
2253 }%
2254 \def\XINT_flpowerh_c #1.%
2255 {%
2256   \ifodd\xintiLDg{#1} %<- intentional space
2257   \expandafter\XINT_flpowerh_d\else\expandafter\XINT_flpowerh_e
2258   \fi #1.%
2259 }%
2260 \def\XINT_flpowerh_d #1.\XINTdigits.#2#3%
2261 {%
2262   \XINT_flpower_checkB_a #1.\XINTdigits.{#2}\XINT_flpowerh_finish
2263 }%
2264 \def\XINT_flpowerh_finish #1%
2265   {\XINTinfloatS[\XINTdigits]{\XINTinFloatSqrt[\XINTdigits+\xint_c_iii]{#1}}}%
2266 \def\XINT_flpowerh_e #1.%
2267   {\expandafter\XINT_flpower_checkB_a\romannumeral0\xinthal{#1}.}%

```



Start of macro. Check for optional argument.

```

2268 \def\XINT_flpower_chkopt #1#2%
2269 {%
2270   \ifx [#2\expandafter\XINT_flpower_opt
2271     \else\expandafter\XINT_flpower_noopt
2272   \fi
2273   #1#2%
2274 }%
2275 \def\XINT_flpower_noopt #1#2\xint:#3%
2276 {%
2277   \expandafter\XINT_flpower_checkB_a
2278   \romannumeral0\xintnum{#3}.\XINTdigits.{#2}{#1[\XINTdigits]]}%
2279 }%
2280 \def\XINT_flpower_opt #1[\xint:#2]%
2281 {%
2282   \expandafter\XINT_flpower_opt_a\the\numexpr #2.#1%
2283 }%
2284 \def\XINT_flpower_opt_a #1.#2#3#4%
2285 {%
2286   \expandafter\XINT_flpower_checkB_a
2287   \romannumeral0\xintnum{#4}.#1.{#3}{#2[#1]}%
2288 }%
2289 \def\XINT_flpower_checkB_a #1%
2290 {%
2291   \xint_UDzerominusfork
2292   #1-{\XINT_flpower_BisZero 0}%
2293   0#1{\XINT_flpower_checkB_b -}%
2294   0-{\XINT_flpower_checkB_b }{#1}%
2295   \krof
2296 }%
2297 \def\XINT_flpower_BisZero 0.#1.#2#3{#3{1[0]}}%
2298 \def\XINT_flpower_checkB_b #1#2.#3.%
2299 {%
2300   \expandafter\XINT_flpower_checkB_c
2301   \the\numexpr\xintLength{#2}+\xint_c_iii.#3.#2.{#1}%
2302 }%
2303 \def\XINT_flpower_checkB_c #1.#2.%
2304 {%
2305   \expandafter\XINT_flpower_checkB_d\the\numexpr#1+#2.#1.#2.%
2306 }%
2307 \def\XINT_flpower_checkB_d #1.#2.#3.#4.#5#6%
2308 {%
2309   \expandafter \XINT_flpower_aa
2310   \romannumeral0\XINTinfloat [#3]{#6}{#2}{#1}{#4}{#5}%
2311 }%
2312 \def\XINT_flpower_aa #1[#2]#3%
2313 {%
2314   \expandafter\XINT_flpower_ab\the\numexpr #2-#3\expandafter.%
2315   \romannumeral\XINT_rep #3\endcsname0.#1.%
2316 }%
2317 \def\XINT_flpower_ab #1.#2.#3.{\XINT_flpower_a #3#2[#1]}%
2318 \def\XINT_flpower_a #1%

```

```

2319 {%
2320   \xint_UDzerominusfork
2321   #1-\XINT_flpow_zero
2322   0#1{\XINT_flpower_b \iftrue}%
2323   0-{\XINT_flpower_b \iffalse#1}%
2324   \krof
2325 }%
2326 \def\XINT_flpower_b #1#2[#3]#4#5%
2327 {%
2328   \XINT_flpower_loopI #5.#3.#2.#4.{#1\xintiioOdd{#5}\fi}%
2329 }%
2330 \def\XINT_flpower_loopI #1.%
2331 {%
2332   \if1\XINT_isOne {#1}\xint_dothis\XINT_flpower_ItoIII\fi
2333   \ifodd\xintiioDg{#1} %<- intentional space
2334   \xint_dothis{\expandafter\XINT_flpower_loopI_odd}\fi
2335   \xint_orthat{\expandafter\XINT_flpower_loopI_even}%
2336   \romannumeral0\XINT_half
2337   #1\xint_bye\xint_Bye345678\xint_bye
2338   *\xint_c_v+\xint_c_v)/\xint_c_x-\xint_c_i\relax.%
2339 }%
2340 \def\XINT_flpower_ItoIII #1.#2.#3.#4.#5%
2341 {%
2342   \expandafter\XINT_flpow_III\the\numexpr #5+\xint_c_.#2.#3.#4.%
2343 }%
2344 \def\XINT_flpower_loopI_even #1.#2.#3.#4.%
2345 {%
2346   \expandafter\XINT_flpower_toloopI
2347   \the\numexpr\expandafter\XINT_flpow_truncate
2348   \the\numexpr\xint_c_ii*#2\expandafter.\romannumeral0\xintiisqr{#3}.#4.#1.%
2349 }%
2350 \def\XINT_flpower_toloopI #1.#2.#3.#4.{\XINT_flpower_loopI #4.#1.#2.#3.}%
2351 \def\XINT_flpower_loopI_odd #1.#2.#3.#4.%
2352 {%
2353   \expandafter\XINT_flpower_toloopII
2354   \the\numexpr\expandafter\XINT_flpow_truncate
2355   \the\numexpr\xint_c_ii*#2\expandafter.\romannumeral0\xintiisqr{#3}.#4.%
2356   #1.#2.#3.%
2357 }%
2358 \def\XINT_flpower_toloopII #1.#2.#3.#4.{\XINT_flpower_loopII #4.#1.#2.#3.}%
2359 \def\XINT_flpower_loopII #1.%
2360 {%
2361   \if1\XINT_isOne{#1}\xint_dothis\XINT_flpower_ItoIII\fi
2362   \ifodd\xintiioDg{#1} %<- intentional space
2363   \xint_dothis{\expandafter\XINT_flpower_loopII_odd}\fi
2364   \xint_orthat{\expandafter\XINT_flpower_loopII_even}%
2365   \romannumeral0\XINT_half#1\xint_bye\xint_Bye345678\xint_bye
2366   *\xint_c_v+\xint_c_v)/\xint_c_x-\xint_c_i\relax.%
2367 }%
2368 \def\XINT_flpower_loopII_even #1.#2.#3.#4.%
2369 {%
2370   \expandafter\XINT_flpower_toloopII

```

```

2371 \the\numexpr\expandafter\XINT_flpow_truncate
2372 \the\numexpr\xint_c_ii*#2\expandafter.\romannumeral0\xintiisqr{#3}.#4.#1.%
2373 }%
2374 \def\XINT_flpower_loopII_odd #1.#2.#3.#4.#5.#6.%
2375 {%
2376 \expandafter\XINT_flpower_loopII_odda
2377 \the\numexpr\expandafter\XINT_flpow_truncate
2378 \the\numexpr#2+#5\expandafter.\romannumeral0\xintiimul{#3}{#6}.#4.%
2379 #1.#2.#3.%
2380 }%
2381 \def\XINT_flpower_loopII_odda #1.#2.#3.#4.#5.#6.%
2382 {%
2383 \expandafter\XINT_flpower_toloopII
2384 \the\numexpr\expandafter\XINT_flpow_truncate
2385 \the\numexpr\xint_c_ii*#5\expandafter.\romannumeral0\xintiisqr{#6}.#3.%
2386 #4.#1.#2.%
2387 }%
2388 \def\XINT_flpower_IItoIII #1.#2.#3.#4.#5.#6.#7%
2389 {%
2390 \expandafter\XINT_flpow_III\the\numexpr #7+\xint_c_\expandafter.%
2391 \the\numexpr\expandafter\XINT_flpow_truncate
2392 \the\numexpr#2+#5\expandafter.\romannumeral0\xintiimul{#3}{#6}.#4.%
2393 }%

```

## 7.68 \xintFloatFac, \XINTFloatFac

```

2394 \def\xintFloatFac {\romannumeral0\xintfloatfac}%
2395 \def\xintfloatfac #1{\XINT_flfac_chkopt \xintfloat #1\xint:}%
2396 \def\XINTinFloatFac {\romannumeral0\XINTinfloatfac }%
2397 \def\XINTinfloatfac #1{\XINT_flfac_chkopt \XINTinfloat #1\xint:}%
2398 \def\XINT_flfac_chkopt #1#2%
2399 {%
2400 \ifx [#2\expandafter\XINT_flfac_opt
2401 \else\expandafter\XINT_flfac_noopt
2402 \fi
2403 #1#2%
2404 }%
2405 \def\XINT_flfac_noopt #1#2\xint:
2406 {%
2407 \expandafter\XINT_FL_fac_fork_a
2408 \the\numexpr \xintNum{#2}.\xint_c_i \XINTdigits\XINT_FL_fac_out{#1[\XINTdigits]}%
2409 }%
2410 \def\XINT_flfac_opt #1[\xint:#2]%
2411 {%
2412 \expandafter\XINT_flfac_opt_a\the\numexpr #2.#1%
2413 }%
2414 \def\XINT_flfac_opt_a #1.#2#3%
2415 {%
2416 \expandafter\XINT_FL_fac_fork_a\the\numexpr \xintNum{#3}.\xint_c_i {#1}\XINT_FL_fac_out{#2[#1]}%
2417 }%
2418 \def\XINT_FL_fac_fork_a #1%
2419 {%
2420 \xint_UDzerominusfork

```

## 7 Package *xintfrac* implementation

```

2421      #1-\XINT_FL_fac_iszero
2422      0#1\XINT_FL_fac_isneg
2423      0-\XINT_FL_fac_fork_b #1}%
2424      \krof
2425 }%
2426 \def\XINT_FL_fac_iszero #1.#2#3#4#5{#5{1[0]}}%

1.2f XINT_FL_fac_isneg returns 0, earlier versions used 1 here.

2427 \def\XINT_FL_fac_isneg #1.#2#3#4#5%
2428 {%
2429      #5{\XINT_signalcondition{InvalidOperation}
2430          {Factorial of negative: (-#1)!}}{0[0]}}%
2431 }%
2432 \def\XINT_FL_fac_fork_b #1.%
2433 {%
2434      \ifnum #1>\xint_c_x^viii_mone\xint_dothis\XINT_FL_fac_toobig\fi
2435      \ifnum #1>\xint_c_x^iv\xint_dothis\XINT_FL_fac_vbig \fi
2436      \ifnum #1>465 \xint_dothis\XINT_FL_fac_big\fi
2437      \ifnum #1>101 \xint_dothis\XINT_FL_fac_med\fi
2438          \xint_orthat\XINT_FL_fac_small
2439      #1.%
2440 }%
2441 \def\XINT_FL_fac_toobig #1.#2#3#4#5%
2442 {%
2443      #5{\XINT_signalcondition{InvalidOperation}
2444          {Factorial of too big: (#1)!}}{0[0]}}%
2445 }%

```

Computations are done with  $Q$  blocks of eight digits. When a multiplication has a carry, hence creates  $Q+1$  blocks, the least significant one is dropped. The goal is to compute an approximate value  $X'$  to the exact value  $X$ , such that the final relative error  $(X-X')/X$  will be at most  $10^{-P-1}$  with  $P$  the desired precision. Then, when we round  $X'$  to  $X''$  with  $P$  significant digits, we can prove that the absolute error  $|X-X''|$  is bounded (strictly) by  $0.6 \text{ ulp}(X'')$ . (ulp= unit in the last (significant) place). Let  $N$  be the number of such operations, the formula for  $Q$  deduces from the previous explanations is that  $8Q$  should be at least  $P+9+k$ , with  $k$  the number of digits of  $N$  (in base 10). Note that 1.2 version used  $P+10+k$ , for 1.2f I reduced to  $P+9+k$ . Also,  $k$  should be the number of digits of the number  $N$  of multiplications done, hence for  $n \leq 10000$  we can take  $N=n/2$ , or  $N/3$ , or  $N/4$ . This is rounded above by `numexpr` and always an overestimate of the actual number of approximate multiplications done (the first ones are exact). (vérifier ce que je raconte, j'ai la flemme là).

We then want  $\text{ceil}((P+k+n)/8)$ . Using `\numexpr` rounding division (ARRRRRGGGHHHH), if  $m$  is a positive integer,  $\text{ceil}(m/8)$  can be computed as  $(m+3)/8$ . Thus with  $m=P+10+k$ , this gives  $Q < -(P+13+k)/8$ . The routine actually computes  $8(Q-1)$  for use in `\XINT_FL_fac_addzeros`.

With 1.2f the formula is  $m=P+9+k$ ,  $Q < -(P+12+k)/8$ , and we use now  $4=12-8$  rather than the earlier  $5=13-8$ . Whatever happens, the value computed in `\XINT_FL_fac_increaseP` is at least 8. There will always be an extra block.

Note: with `Digits:=32`; Maple gives for  $200!$ :

```
> factorial(200.);
```

```
375
```

```
0.78865786736479050355236321393218 10
```

My 1.2f routine (and also 1.2) outputs:

```
7.8865786736479050355236321393219e374
```

and this is the correct rounding because for 40 digits it computes

7.886578673647905035523632139321850622951e374

Maple's result (contrarily to xint) is thus not the correct rounding but still it is less than 0.6 ulp wrong.

```

2446 \def\XINT_FL_fac_vbig
2447   {\expandafter\XINT_FL_fac_vbigloop_a
2448     \the\numexpr \XINT_FL_fac_increaseP \xint_c_i }%
2449 \def\XINT_FL_fac_big
2450   {\expandafter\XINT_FL_fac_bigloop_a
2451     \the\numexpr \XINT_FL_fac_increaseP \xint_c_ii }%
2452 \def\XINT_FL_fac_med
2453   {\expandafter\XINT_FL_fac_medloop_a
2454     \the\numexpr \XINT_FL_fac_increaseP \xint_c_iii }%
2455 \def\XINT_FL_fac_small
2456   {\expandafter\XINT_FL_fac_smallloop_a
2457     \the\numexpr \XINT_FL_fac_increaseP \xint_c_iv }%
2458 \def\XINT_FL_fac_increaseP #1#2.#3#4%
2459 {%
2460   #2\expandafter.\the\numexpr\xint_c_viii*%
2461   ((\xint_c_iv+#4+\expandafter\XINT_FL_fac_countdigits
2462     \the\numexpr #2/((#1*#3)\relax 87654321\Z)/\xint_c_viii).)%
2463 }%
2464 \def\XINT_FL_fac_countdigits #1#2#3#4#5#6#7#8{\XINT_FL_fac_countdone }%
2465 \def\XINT_FL_fac_countdone #1#2\Z {#1}%
2466 \def\XINT_FL_fac_out #1;![#2]#3%
2467   {#3{\romannumeral0\XINT_mul_out
2468     #1;!1\R!1\R!1\R!1\R!1\R!%
2469     1\R!1\R!1\R!1\R!1\R!W [#2]}}%
2470 \def\XINT_FL_fac_vbigloop_a #1.#2.%
2471 {%
2472   \XINT_FL_fac_bigloop_a \xint_c_x^iv.#2.%
2473   {\expandafter\XINT_FL_fac_vbigloop_loop\the\numexpr 100010001\expandafter.%
2474     \the\numexpr \xint_c_x^viii+#1.}%
2475 }%
2476 \def\XINT_FL_fac_vbigloop_loop #1.#2.%
2477 {%
2478   \ifnum #1>#2 \expandafter\XINT_FL_fac_loop_exit\fi
2479   \expandafter\XINT_FL_fac_vbigloop_loop
2480   \the\numexpr #1+\xint_c_i\expandafter.%
2481   \the\numexpr #2\expandafter.\the\numexpr\XINT_FL_fac_mul #1!%
2482 }%
2483 \def\XINT_FL_fac_bigloop_a #1.%
2484 {%
2485   \expandafter\XINT_FL_fac_bigloop_b \the\numexpr
2486   #1+\xint_c_i-\xint_c_ii*((#1-464)/\xint_c_ii).#1.%
2487 }%
2488 \def\XINT_FL_fac_bigloop_b #1.#2.#3.%
2489 {%
2490   \expandafter\XINT_FL_fac_medloop_a
2491   \the\numexpr #1-\xint_c_i.#3.{\XINT_FL_fac_bigloop_loop #1.#2.}%
2492 }%
2493 \def\XINT_FL_fac_bigloop_loop #1.#2.%
2494 {%

```

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```

2495 \ifnum #1>#2 \expandafter\XINT_FL_fac_loop_exit\fi
2496 \expandafter\XINT_FL_fac_bigloop_loop
2497 \the\numexpr #1+\xint_c_ii\expandafter.%
2498 \the\numexpr #2\expandafter.\the\numexpr\XINT_FL_fac_bigloop_mul #1!%
2499 }%
2500 \def\XINT_FL_fac_bigloop_mul #1!%
2501 {%
2502 \expandafter\XINT_FL_fac_mul
2503 \the\numexpr \xint_c_x^viii+#1*(#1+\xint_c_i)!%
2504 }%
2505 \def\XINT_FL_fac_medloop_a #1.%
2506 {%
2507 \expandafter\XINT_FL_fac_medloop_b
2508 \the\numexpr #1+\xint_c_i-\xint_c_iii*((#1-100)/\xint_c_iii).#1.%
2509 }%
2510 \def\XINT_FL_fac_medloop_b #1.#2.#3.%
2511 {%
2512 \expandafter\XINT_FL_fac_smallloop_a
2513 \the\numexpr #1-\xint_c_i.#3.{\XINT_FL_fac_medloop_loop #1.#2.}%
2514 }%
2515 \def\XINT_FL_fac_medloop_loop #1.#2.%
2516 {%
2517 \ifnum #1>#2 \expandafter\XINT_FL_fac_loop_exit\fi
2518 \expandafter\XINT_FL_fac_medloop_loop
2519 \the\numexpr #1+\xint_c_iii\expandafter.%
2520 \the\numexpr #2\expandafter.\the\numexpr\XINT_FL_fac_medloop_mul #1!%
2521 }%
2522 \def\XINT_FL_fac_medloop_mul #1!%
2523 {%
2524 \expandafter\XINT_FL_fac_mul
2525 \the\numexpr
2526 \xint_c_x^viii+#1*(#1+\xint_c_i)*(#1+\xint_c_ii)!%
2527 }%
2528 \def\XINT_FL_fac_smallloop_a #1.%
2529 {%
2530 \csname
2531 XINT_FL_fac_smallloop_\the\numexpr #1-\xint_c_iv*(#1/\xint_c_iv)\relax
2532 \endcsname #1.%
2533 }%
2534 \expandafter\def\csname XINT_FL_fac_smallloop_1\endcsname #1.#2.%
2535 {%
2536 \XINT_FL_fac_addzeros #2.100000001!.{2.#1.}{#2}%
2537 }%
2538 \expandafter\def\csname XINT_FL_fac_smallloop_2\endcsname #1.#2.%
2539 {%
2540 \XINT_FL_fac_addzeros #2.100000002!.{3.#1.}{#2}%
2541 }%
2542 \expandafter\def\csname XINT_FL_fac_smallloop_3\endcsname #1.#2.%
2543 {%
2544 \XINT_FL_fac_addzeros #2.100000003!.{4.#1.}{#2}%
2545 }%
2546 \expandafter\def\csname XINT_FL_fac_smallloop_0\endcsname #1.#2.%

```

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```

2547 {%
2548   \XINT_FL_fac_addzeros #2.1000000024!.{5.#1.}{#2}%
2549 }%
2550 \def\XINT_FL_fac_addzeros #1.%
2551 {%
2552   \ifnum #1=\xint_c_viii \expandafter\XINT_FL_fac_addzeros_exit\fi
2553   \expandafter\XINT_FL_fac_addzeros
2554   \the\numexpr #1-\xint_c_viii.1000000000!%
2555 }%

We will manipulate by successive small multiplications Q blocks 1<8d>!, terminated by 1;! . We
need a custom small multiplication which tells us when it has create a new block, and the least
significant one should be dropped.

2556 \def\XINT_FL_fac_addzeros_exit #1.#2.#3#4{\XINT_FL_fac_smallloop_loop #3#21;![ -#4]}%
2557 \def\XINT_FL_fac_smallloop_loop #1.#2.%
2558 {%
2559   \ifnum #1>#2 \expandafter\XINT_FL_fac_loop_exit\fi
2560   \expandafter\XINT_FL_fac_smallloop_loop
2561   \the\numexpr #1+\xint_c_iv\expandafter.%
2562   \the\numexpr #2\expandafter.\romannumeral0\XINT_FL_fac_smallloop_mul #1!%
2563 }%
2564 \def\XINT_FL_fac_smallloop_mul #1!%
2565 {%
2566   \expandafter\XINT_FL_fac_mul
2567   \the\numexpr
2568     \xint_c_x^viii+#1*(#1+\xint_c_i)*(#1+\xint_c_ii)*(#1+\xint_c_iii)!%
2569 }%[[
2570 \def\XINT_FL_fac_loop_exit #1!#2]#3{#3#2]}%
2571 \def\XINT_FL_fac_mul 1#1!%
2572   {\expandafter\XINT_FL_fac_mul_a\the\numexpr\XINT_FL_fac_smallmul 10!{#1}}%
2573 \def\XINT_FL_fac_mul_a #1-#2%
2574 {%
2575   \if#21\xint_afterfi{\expandafter\space\xint_gob_til_exclam}\else
2576   \expandafter\space\fi #11;!%
2577 }%
2578 \def\XINT_FL_fac_minimulwc_a #1#2#3#4#5!#6#7#8#9%
2579 {%
2580   \XINT_FL_fac_minimulwc_b {#1#2#3#4}{#5}{#6#7#8#9}%
2581 }%
2582 \def\XINT_FL_fac_minimulwc_b #1#2#3#4!#5%
2583 {%
2584   \expandafter\XINT_FL_fac_minimulwc_c
2585   \the\numexpr \xint_c_x^ix+#5+#2*#4!{#1}{#2}{#3}{#4}%
2586 }%
2587 \def\XINT_FL_fac_minimulwc_c 1#1#2#3#4#5#6!#7%
2588 {%
2589   \expandafter\XINT_FL_fac_minimulwc_d {#1#2#3#4#5}#7{#6}%
2590 }%
2591 \def\XINT_FL_fac_minimulwc_d #1#2#3#4#5%
2592 {%
2593   \expandafter\XINT_FL_fac_minimulwc_e
2594   \the\numexpr \xint_c_x^ix+#1+#2*#5+#3*#4!{#2}{#4}%
2595 }%

```

```

2596 \def\XINT_FL_fac_minimulwc_e 1#1#2#3#4#5#6!#7#8#9%
2597 {%
2598     1#6#9\expandafter!%
2599     \the\numexpr\expandafter\XINT_FL_fac_smallmul
2600     \the\numexpr \xint_c_x^viii+#1#2#3#4#5+#7*#8!%
2601 }%
2602 \def\XINT_FL_fac_smallmul 1#1!#21#3!%
2603 {%
2604     \xint_gob_til_sc #3\XINT_FL_fac_smallmul_end;%
2605     \XINT_FL_fac_minimulwc_a #2!#3!{#1}{#2}%
2606 }%

```

This is the crucial ending. I note that I used here an `\ifnum` test rather than the `gob_til_eightzeroes` thing. Actually for eight digits there is much less difference than for only four.

The "carry" situation is marked by a final `!-1` rather than `!-2` for no-carry. (a `\numexpr` must be stopped, and leaving a `-` as delimiter is good as it will not arise earlier.)

```

2607 \def\XINT_FL_fac_smallmul_end;\XINT_FL_fac_minimulwc_a #1!;!#2#3[#4]%
2608 {%
2609     \ifnum #2=\xint_c_
2610         \expandafter\xint_firstoftwo\else
2611         \expandafter\xint_secondoftwo
2612     \fi
2613     {-2\relax[#4]}%
2614     {1#2\expandafter!\expandafter-\expandafter1\expandafter
2615         [\the\numexpr #4+\xint_c_viii]}%
2616 }%

```

## 7.69 `\xintFloatPFactorial`, `\XINTinFloatPFactorial`

2015/11/29 for 1.2f. Partial factorial  $\text{pfactorial}(a,b)=(a+1)\dots b$ , only for non-negative integers with  $a\leq b<10^8$ .

1.2h (2016/11/20) now avoids raising `\xintError:OutOfRangePFac` if the condition  $0\leq a\leq b<10^8$  is violated. Same as for `\xintiipFactorial`.

```

2617 \def\xintFloatPFactorial {\romannumeral0\xintfloatpfactorial}%
2618 \def\xintfloatpfactorial #1{\XINT_flpfac_chkopt \xintfloat #1\xint:}%
2619 \def\XINTinFloatPFactorial {\romannumeral0\XINTinfloatpfactorial}%
2620 \def\XINTinfloatpfactorial #1{\XINT_flpfac_chkopt \XINTinfloat #1\xint:}%
2621 \def\XINT_flpfac_chkopt #1#2%
2622 {%
2623     \ifx [#2\expandafter\XINT_flpfac_opt
2624         \else\expandafter\XINT_flpfac_noopt
2625     \fi
2626     #1#2%
2627 }%
2628 \def\XINT_flpfac_noopt #1#2\xint:#3%
2629 {%
2630     \expandafter\XINT_FL_pfac_fork
2631     \the\numexpr \xintNum{#2}\expandafter.%
2632     \the\numexpr \xintNum{#3}.\xint_c_i{\XINTdigits}{#1[\XINTdigits]}%
2633 }%
2634 \def\XINT_flpfac_opt #1[\xint:#2]%
2635 {%

```



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```

2636 \expandafter\XINT_flpfac_opt_b\the\numexpr #2.#1%
2637 }%
2638 \def\XINT_flpfac_opt_b #1.#2#3#4%
2639 {%
2640 \expandafter\XINT_FL_pfac_fork
2641 \the\numexpr \xintNum{#3}\expandafter.%
2642 \the\numexpr \xintNum{#4}.\xint_c_i{#1}{#2[#1]}%
2643 }%
2644 \def\XINT_FL_pfac_fork #1#2.#3#4.%
2645 {%
2646 \unless\ifnum #1#2<#3#4 \xint_dothis\XINT_FL_pfac_one\fi
2647 \if-#3\xint_dothis\XINT_FL_pfac_neg \fi
2648 \if-#1\xint_dothis\XINT_FL_pfac_zero\fi
2649 \ifnum #3#4>\xint_c_x^viii_mone\xint_dothis\XINT_FL_pfac_outofrange\fi
2650 \xint_orthat \XINT_FL_pfac_increaseP #1#2.#3#4.%
2651 }%
2652 \def\XINT_FL_pfac_outofrange #1.#2.#3#4#5%
2653 {%
2654 #5{\XINT_signalcondition{InvalidOperation}
2655 {pfactorial second arg too big: 99999999 < #2}}{0[0]}}%
2656 }%
2657 \def\XINT_FL_pfac_one #1.#2.#3#4#5{#5{1[0]}}%
2658 \def\XINT_FL_pfac_zero #1.#2.#3#4#5{#5{0[0]}}%
2659 \def\XINT_FL_pfac_neg -#1.-#2.%
2660 {%
2661 \ifnum #1>\xint_c_x^viii\xint_dothis\XINT_FL_pfac_outofrange\fi
2662 \xint_orthat {%
2663 \ifodd\numexpr#2-#1\relax\xint_afterfi{\expandafter-\romannumeral`&&@}\fi
2664 \expandafter\XINT_FL_pfac_increaseP}%
2665 \the\numexpr #2-\xint_c_i\expandafter.\the\numexpr#1-\xint_c_i.%
2666 }%

```

See the comments for `\XINT_FL_pfac_increaseP`. Case of  $b=a+1$  should be filtered out perhaps. We only needed here to copy the `\xintPFactorial` macros and re-use `\XINT_FL_fac_mul/\XINT_FL_fac_out`. Had to modify a bit `\XINT_FL_pfac_addzeroes`. We can enter here directly with #3 equal to specify the precision (the calculated value before final rounding has a relative error less than  $3 \cdot 10^{-(\#4-1)}$ ), and #5 would hold the macro doing the final rounding (or truncating, if I make a `FloatTrunc` available) to a given number of digits, possibly not #4. By default the #3 is 1, but `FloatBinomial` calls it with #3=4.

```

2667 \def\XINT_FL_pfac_increaseP #1.#2.#3#4%
2668 {%
2669 \expandafter\XINT_FL_pfac_a
2670 \the\numexpr \xint_c_viii*(\xint_c_iv+#4+\expandafter
2671 \XINT_FL_fac_countdigits\the\numexpr (#2-#1-\xint_c_i)%
2672 /\ifnum #2>\xint_c_x^iv #3\else(#3*\xint_c_ii)\fi\relax
2673 87654321\Z)/\xint_c_viii).#1.#2.%
2674 }%
2675 \def\XINT_FL_pfac_a #1.#2.#3.%
2676 {%
2677 \expandafter\XINT_FL_pfac_b\the\numexpr \xint_c_i+#2\expandafter.%
2678 \the\numexpr#3\expandafter.%
2679 \romannumeral0\XINT_FL_pfac_addzeroes #1.100000001!1;![ -#1]%

```

```

2680 }%
2681 \def\XINT_FL_pfac_addzeroes #1.%
2682 {%
2683   \ifnum #1=\xint_c_viii \expandafter\XINT_FL_pfac_addzeroes_exit\fi
2684   \expandafter\XINT_FL_pfac_addzeroes\the\numexpr #1-\xint_c_viii.1000000000!%
2685 }%
2686 \def\XINT_FL_pfac_addzeroes_exit #1.{ }%
2687 \def\XINT_FL_pfac_b #1.%
2688 {%
2689   \ifnum #1>9999 \xint_dothis\XINT_FL_pfac_vbigloop \fi
2690   \ifnum #1>463 \xint_dothis\XINT_FL_pfac_bigloop \fi
2691   \ifnum #1>98 \xint_dothis\XINT_FL_pfac_medloop \fi
2692   \xint_orthat\XINT_FL_pfac_smallloop #1.%
2693 }%
2694 \def\XINT_FL_pfac_smallloop #1.#2.%
2695 {%
2696   \ifcase\numexpr #2-#1\relax
2697     \expandafter\XINT_FL_pfac_end_
2698   \or \expandafter\XINT_FL_pfac_end_i
2699   \or \expandafter\XINT_FL_pfac_end_ii
2700   \or \expandafter\XINT_FL_pfac_end_iii
2701   \else\expandafter\XINT_FL_pfac_smallloop_a
2702   \fi #1.#2.%
2703 }%
2704 \def\XINT_FL_pfac_smallloop_a #1.#2.%
2705 {%
2706   \expandafter\XINT_FL_pfac_smallloop_b
2707   \the\numexpr #1+\xint_c_iv\expandafter.%
2708   \the\numexpr #2\expandafter.%
2709   \romannumeral0\expandafter\XINT_FL_fac_mul
2710   \the\numexpr \xint_c_x^viii+#1*(#1+\xint_c_i)*(#1+\xint_c_ii)*(#1+\xint_c_iii)!%
2711 }%
2712 \def\XINT_FL_pfac_smallloop_b #1.%
2713 {%
2714   \ifnum #1>98 \expandafter\XINT_FL_pfac_medloop \else
2715     \expandafter\XINT_FL_pfac_smallloop \fi #1.%
2716 }%
2717 \def\XINT_FL_pfac_medloop #1.#2.%
2718 {%
2719   \ifcase\numexpr #2-#1\relax
2720     \expandafter\XINT_FL_pfac_end_
2721   \or \expandafter\XINT_FL_pfac_end_i
2722   \or \expandafter\XINT_FL_pfac_end_ii
2723   \else\expandafter\XINT_FL_pfac_medloop_a
2724   \fi #1.#2.%
2725 }%
2726 \def\XINT_FL_pfac_medloop_a #1.#2.%
2727 {%
2728   \expandafter\XINT_FL_pfac_medloop_b
2729   \the\numexpr #1+\xint_c_iii\expandafter.%
2730   \the\numexpr #2\expandafter.%
2731   \romannumeral0\expandafter\XINT_FL_fac_mul

```

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```

2732 \the\numexpr \xint_c_x^viii+#1*(#1+\xint_c_i)*(#1+\xint_c_ii)!%
2733 }%
2734 \def\xint_FL_pfac_medloop_b #1.%
2735 {%
2736 \ifnum #1>463 \expandafter\xint_FL_pfac_bigloop \else
2737 \expandafter\xint_FL_pfac_medloop \fi #1.%
2738 }%
2739 \def\xint_FL_pfac_bigloop #1.#2.%
2740 {%
2741 \ifcase\numexpr #2-#1\relax
2742 \expandafter\xint_FL_pfac_end_
2743 \or \expandafter\xint_FL_pfac_end_i
2744 \else\expandafter\xint_FL_pfac_bigloop_a
2745 \fi #1.#2.%
2746 }%
2747 \def\xint_FL_pfac_bigloop_a #1.#2.%
2748 {%
2749 \expandafter\xint_FL_pfac_bigloop_b
2750 \the\numexpr #1+\xint_c_ii\expandafter.%
2751 \the\numexpr #2\expandafter.%
2752 \romannumeral0\expandafter\xint_FL_fac_mul
2753 \the\numexpr \xint_c_x^viii+#1*(#1+\xint_c_i)!%
2754 }%
2755 \def\xint_FL_pfac_bigloop_b #1.%
2756 {%
2757 \ifnum #1>9999 \expandafter\xint_FL_pfac_vbigloop \else
2758 \expandafter\xint_FL_pfac_bigloop \fi #1.%
2759 }%
2760 \def\xint_FL_pfac_vbigloop #1.#2.%
2761 {%
2762 \ifnum #2=#1
2763 \expandafter\xint_FL_pfac_end_
2764 \else\expandafter\xint_FL_pfac_vbigloop_a
2765 \fi #1.#2.%
2766 }%
2767 \def\xint_FL_pfac_vbigloop_a #1.#2.%
2768 {%
2769 \expandafter\xint_FL_pfac_vbigloop
2770 \the\numexpr #1+\xint_c_i\expandafter.%
2771 \the\numexpr #2\expandafter.%
2772 \romannumeral0\expandafter\xint_FL_fac_mul
2773 \the\numexpr\xint_c_x^viii+#1!%
2774 }%
2775 \def\xint_FL_pfac_end_iii #1.#2.%
2776 {%
2777 \expandafter\xint_FL_fac_out
2778 \romannumeral0\expandafter\xint_FL_fac_mul
2779 \the\numexpr \xint_c_x^viii+#1*(#1+\xint_c_i)*(#1+\xint_c_ii)*(#1+\xint_c_iii)!%
2780 }%
2781 \def\xint_FL_pfac_end_ii #1.#2.%
2782 {%
2783 \expandafter\xint_FL_fac_out

```

```

2784 \romannumeral0\expandafter\XINT_FL_fac_mul
2785 \the\numexpr \xint_c_x^viii+#1*(#1+\xint_c_i)*(#1+\xint_c_ii)!%
2786 }%
2787 \def\XINT_FL_pfac_end_i #1.#2.%
2788 {%
2789 \expandafter\XINT_FL_fac_out
2790 \romannumeral0\expandafter\XINT_FL_fac_mul
2791 \the\numexpr \xint_c_x^viii+#1*(#1+\xint_c_i)!%
2792 }%
2793 \def\XINT_FL_pfac_end_ #1.#2.%
2794 {%
2795 \expandafter\XINT_FL_fac_out
2796 \romannumeral0\expandafter\XINT_FL_fac_mul
2797 \the\numexpr \xint_c_x^viii+#1!%
2798 }%

```

### 7.70 *\xintFloatBinomial*, *\XINTinFloatBinomial*

1.2f. We compute  $\text{binomial}(x,y)$  as  $\text{pfac}(x-y,x)/y!$ , where the numerator and denominator are computed with a relative error at most  $4 \cdot 10^{-P-2}$ , then rounded (once I have a float truncation, I will use truncation rather) to  $P+3$  digits, and finally the quotient is correctly rounded to  $P$  digits. This will guarantee that the exact value  $X$  differs from the computed one  $Y$  by at most  $0.6 \text{ ulp}(Y)$ . (2015/12/01).

2016/11/19 for 1.2h. As for *\xintiiBinomial*, hard to understand why last year I coded this to raise an error if  $y < 0$  or  $y > x$  ! The question of the Gamma function is for another occasion, here  $x$  and  $y$  must be (small) integers.

```

2799 \def\xintFloatBinomial {\romannumeral0\xintfloatbinomial}%
2800 \def\xintfloatbinomial #1{\XINT_flbinom_chkopt \xintfloat #1\xint:}%
2801 \def\XINTinFloatBinomial {\romannumeral0\XINTinfloatbinomial}%
2802 \def\XINTinfloatbinomial #1{\XINT_flbinom_chkopt \XINTinfloat #1\xint:}%
2803 \def\XINT_flbinom_chkopt #1#2%
2804 {%
2805 \ifx [#2\expandafter\XINT_flbinom_opt
2806 \else\expandafter\XINT_flbinom_noopt
2807 \fi #1#2%
2808 }%
2809 \def\XINT_flbinom_noopt #1#2\xint:#3%
2810 {%
2811 \expandafter\XINT_FL_binom_a
2812 \the\numexpr\xintNum{#2}\expandafter.\the\numexpr\xintNum{#3}.\XINTdigits.#1%
2813 }%
2814 \def\XINT_flbinom_opt #1[\xint:#2]#3#4%
2815 {%
2816 \expandafter\XINT_FL_binom_a
2817 \the\numexpr\xintNum{#3}\expandafter.\the\numexpr\xintNum{#4}\expandafter.%
2818 \the\numexpr #2.#1%
2819 }%
2820 \def\XINT_FL_binom_a #1.#2.%
2821 {%
2822 \expandafter\XINT_FL_binom_fork \the\numexpr #1-#2.#2.#1.%
2823 }%
2824 \def\XINT_FL_binom_fork #1#2.#3#4.#5#6.%

```

```

2825 {%
2826   \if-#5\xint_dothis \XINT_FL_binom_neg\fi
2827   \if-#1\xint_dothis \XINT_FL_binom_zero\fi
2828   \if-#3\xint_dothis \XINT_FL_binom_zero\fi
2829   \if0#1\xint_dothis \XINT_FL_binom_one\fi
2830   \if0#3\xint_dothis \XINT_FL_binom_one\fi
2831   \ifnum #5#6>\xint_c_x^viii_mone \xint_dothis\XINT_FL_binom_toobig\fi
2832   \ifnum #1#2>#3#4 \xint_dothis\XINT_FL_binom_ab \fi
2833   \xint_orthat\XINT_FL_binom_aa
2834   #1#2.#3#4.#5#6.%
2835 }%
2836 \def\XINT_FL_binom_neg #1.#2.#3.#4.#5%
2837 {%
2838   #5[#4]{\XINT_signalcondition{InvalidOperation}
2839           {binomial with first arg negative: #3}{\{0[0]\}}}%
2840 }%
2841 \def\XINT_FL_binom_toobig #1.#2.#3.#4.#5%
2842 {%
2843   #5[#4]{\XINT_signalcondition{InvalidOperation}
2844           {binomial with first arg too big: 99999999 < #3}{\{0[0]\}}}%
2845 }%
2846 \def\XINT_FL_binom_one #1.#2.#3.#4.#5{#5[#4]{1[0]}}%
2847 \def\XINT_FL_binom_zero #1.#2.#3.#4.#5{#5[#4]{0[0]}}%
2848 \def\XINT_FL_binom_aa #1.#2.#3.#4.#5%
2849 {%
2850   #5[#4]{\xintDiv{\XINT_FL_pfac_increaseP
2851                 #2.#3.\xint_c_iv{#4+\xint_c_i}{\XINTinfloat[#4+\xint_c_iii]}}%
2852           {\XINT_FL_fac_fork_b
2853           #1.\xint_c_iv{#4+\xint_c_i}\XINT_FL_fac_out{\XINTinfloat[#4+\xint_c_iii]}}}%
2854 }%
2855 \def\XINT_FL_binom_ab #1.#2.#3.#4.#5%
2856 {%
2857   #5[#4]{\xintDiv{\XINT_FL_pfac_increaseP
2858                 #1.#3.\xint_c_iv{#4+\xint_c_i}{\XINTinfloat[#4+\xint_c_iii]}}%
2859           {\XINT_FL_fac_fork_b
2860           #2.\xint_c_iv{#4+\xint_c_i}\XINT_FL_fac_out{\XINTinfloat[#4+\xint_c_iii]}}}%
2861 }%

```

### 7.71 `\xintFloatSqrt`, `\XINTinFloatSqrt`

First done for 1.08.

The float version was developed at the same time as the integer one and even a bit earlier. As a result the integer variant had some sub-optimal parts. Anyway, for 1.2f I have rewritten the integer variant, and the float variant delegates all preparatory work for it until the last step. In particular the very low precisions are not penalized anymore from doing computations for at least 17 or 18 digits. Both the large and small precisions give quite shorter computation times.

Also, after examining more closely the achieved precision I decided to extend the float version in order for it to obtain the correct rounding (for inputs already of at most P digits with P the precision) of the theoretical exact value.

Beyond about 500 digits of precision the efficiency decreases swiftly, as is the case generally speaking with `xintcore`/`xint`/`xintfrac` arithmetic macros.

Final note: with 1.2f the input is always first rounded to P significant places.

## 7 Package *xintfrac* implementation

```

2862 \def\xintFloatSqrt      {\romannumeral0\xintfloatsqr }%
2863 \def\xintfloatsqr      #1{\XINT_flsqrt_chkopt \xintfloat #1\xint:}%
2864 \def\XINTinFloatSqr    {\romannumeral0\XINTinfloatsqr }%
2865 \def\XINTinfloatsqr    #1{\XINT_flsqrt_chkopt \XINTinfloat #1\xint:}%
2866 \def\XINT_flsqrt_chkopt #1#2%
2867 {%
2868   \ifx [#2\expandafter\XINT_flsqrt_opt
2869     \else\expandafter\XINT_flsqrt_noopt
2870   \fi #1#2%
2871 }%
2872 \def\XINT_flsqrt_noopt #1#2\xint:%
2873 {%
2874   \expandafter\XINT_FL_sqrt_a
2875     \romannumeral0\XINTinfloat[\XINTdigits]{#2}\XINTdigits.#1%
2876 }%
2877 \def\XINT_flsqrt_opt #1[\xint:#2]%#3%
2878 {%
2879   \expandafter\XINT_flsqrt_opt_a\the\numexpr #2.#1%
2880 }%
2881 \def\XINT_flsqrt_opt_a #1.#2#3%
2882 {%
2883   \expandafter\XINT_FL_sqrt_a\romannumeral0\XINTinfloat[#1]{#3}#1.#2%
2884 }%
2885 \def\XINT_FL_sqrt_a #1%
2886 {%
2887   \xint_UDzerominusfork
2888   #1-\XINT_FL_sqrt_iszero
2889   0#1\XINT_FL_sqrt_isneg
2890   0-\XINT_FL_sqrt_pos #1}%
2891 \krof
2892 }%[
2893 \def\XINT_FL_sqrt_iszero #1]#2.#3{#3[#2]{0[0]}}%
2894 \def\XINT_FL_sqrt_isneg #1]#2.#3%
2895 {%
2896   #3[#2]{\XINT_signalcondition{InvalidOperation}
2897     {Square root of negative: -#1]}}{0[0]}}%
2898 }%

2899 \def\XINT_FL_sqrt_pos #1[#2]#3.%
2900 {%
2901   \expandafter\XINT_flsqrt
2902   \the\numexpr #3\ifodd #2 \xint_dothis {+\xint_c_iii.(#2+\xint_c_i).0}\fi
2903   \xint_orthat {+\xint_c_ii.#2.}}{#100.#3.%
2904 }%
2905 \def\XINT_flsqrt #1.#2.%
2906 {%
2907   \expandafter\XINT_flsqrt_a
2908   \the\numexpr #2/\xint_c_ii-(#1-\xint_c_i)/\xint_c_ii.#1.%
2909 }%
2910 \def\XINT_flsqrt_a #1.#2.#3#4.#5.%
2911 {%

```

```

2912 \expandafter\XINT_flsqrt_b
2913 \the\numexpr (#2-\xint_c_i)/\xint_c_ii\expandafter.%
2914 \romannumeral0\XINT_sqrt_start #2.#4#3.#5.#2.#4#3.#5.#1.%
2915 }%
2916 \def\XINT_flsqrt_b #1.#2#3%
2917 {%
2918 \expandafter\XINT_flsqrt_c
2919 \romannumeral0\xintiisub
2920 {\XINT_dsx_addzeros {#1}#2;}%
2921 {\xintiiDivRound{\XINT_dsx_addzeros {#1}#3;}%
2922 {\XINT_dbl#2\xint_bye2345678\xint_bye*\xint_c_ii\relax}}.%
2923 }%
2924 \def\XINT_flsqrt_c #1.#2.%
2925 {%
2926 \expandafter\XINT_flsqrt_d
2927 \romannumeral0\XINT_split_fromleft#2.#1\xint_bye2345678\xint_bye..%
2928 }%
2929 \def\XINT_flsqrt_d #1.#2#3.%
2930 {%
2931 \ifnum #2=\xint_c_v
2932 \expandafter\XINT_flsqrt_f\else\expandafter\XINT_flsqrt_finish\fi
2933 #2#3.#1.%
2934 }%
2935 \def\XINT_flsqrt_finish #1#2.#3.#4.#5.#6.#7.#8{#8[#6]{#3#1[#7]}}%
2936 \def\XINT_flsqrt_f 5#1.%
2937 {\expandafter\XINT_flsqrt_g\romannumeral0\xintinum{#1}\relax.%
2938 \def\XINT_flsqrt_g #1#2#3.{\if\relax#2\xint_dothis{\XINT_flsqrt_h #1}\fi
2939 \xint_orthat{\XINT_flsqrt_finish 5.}}%
2940 \def\XINT_flsqrt_h #1{\ifnum #1<\xint_c_iii\xint_dothis{\XINT_flsqrt_again}\fi
2941 \xint_orthat{\XINT_flsqrt_finish 5.}}%
2942 \def\XINT_flsqrt_again #1.#2.%
2943 {%
2944 \expandafter\XINT_flsqrt_again_a\the\numexpr #2+\xint_c_viii.%
2945 }%
2946 \def\XINT_flsqrt_again_a #1.#2.#3.%
2947 {%
2948 \expandafter\XINT_flsqrt_b
2949 \the\numexpr (#1-\xint_c_i)/\xint_c_ii\expandafter.%
2950 \romannumeral0\XINT_sqrt_start #1.#2000000000.#3.%
2951 #1.#2000000000.#3.%
2952 }%

```

## 7.72 \xintFloatE, \XINTinFloatE

1.07: The fraction is the first argument contrarily to \xintTrunc and \xintRound.

1.2k had to rewrite this since there is no more a \XINT\_float\_a macro. Attention about \XINTinFloatE: it is for use by xintexpr.sty, contrarily to other \XINTinFloat<foo> macros it inserts itself the [\XINTdigits] thing, and with value 0 it produces on output 0[N], not 0[0].

```

2953 \def\xintFloatE {\romannumeral0\xintfloate }%
2954 \def\xintfloate #1{\XINT_floate_chkopt #1\xint:}%
2955 \def\XINT_floate_chkopt #1%
2956 {%

```

```

2957 \ifx [#1\expandafter\XINT_floate_opt
2958 \else\expandafter\XINT_floate_noopt
2959 \fi #1%
2960 }%
2961 \def\XINT_floate_noopt #1\xint:%
2962 {%
2963 \expandafter\XINT_floate_post
2964 \romannumeral0\XINTinfloat[\XINTdigits]{#1}\XINTdigits.%
2965 }%
2966 \def\XINT_floate_opt [\xint:#1]%
2967 {%
2968 \expandafter\XINT_floate_opt_a\the\numexpr #1.%
2969 }%
2970 \def\XINT_floate_opt_a #1.#2%
2971 {%
2972 \expandafter\XINT_floate_post
2973 \romannumeral0\XINTinfloat[#1]{#2}#1.%
2974 }%
2975 \def\XINT_floate_post #1%
2976 {%
2977 \xint_UDzerominusfork
2978 #1-\XINT_floate_zero
2979 0#1\XINT_floate_neg
2980 0-\XINT_floate_pos
2981 \krof #1%
2982 }%[
2983 \def\XINT_floate_zero #1]#2.#3{ 0.e0}%
2984 \def\XINT_floate_neg-{\expandafter-\romannumeral0\XINT_floate_pos}%
2985 \def\XINT_floate_pos #1#2[#3]#4.#5%
2986 {%
2987 \expandafter\XINT_float_pos_done\the\numexpr#3+#4+#5-\xint_c_i.#1.#2;%
2988 }%
2989 \def\XINTinFloatE {\romannumeral0\XINTinfloate }%
2990 \def\XINTinfloate
2991 {\expandafter\XINT_infloate\romannumeral0\XINTinfloat[\XINTdigits]}%
2992 \def\XINT_infloate #1[#2]#3%
2993 {\expandafter\XINT_infloate_end\the\numexpr #3+#2.{#1}}%
2994 \def\XINT_infloate_end #1.#2{ #2[#1]}%

```

### 7.73 \XINTinFloatMod

```

2995 \def\XINTinFloatMod {\romannumeral0\XINTinfloatmod [\XINTdigits]}%
2996 \def\XINTinfloatmod [#1]#2#3{\expandafter\XINT_infloatmod\expandafter
2997 {\romannumeral0\XINTinfloat[#1]{#2}}%
2998 {\romannumeral0\XINTinfloat[#1]{#3}}{#1}}%
2999 \def\XINT_infloatmod #1#2{\expandafter\XINT_infloatmod_a\expandafter {#2}{#1}}%
3000 \def\XINT_infloatmod_a #1#2#3{\XINTinfloat [#3]{\xintMod {#2}{#1}}}%
3001 \XINT_restorecatcodes_endinput%

```



## 8 Package *xintseries* implementation

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The commenting is currently (2017/08/06) very sparse.

### 8.1 Catcodes, $\varepsilon$ -TeX and reload detection

The code for reload detection was initially copied from HEIKO OBERDIEK's packages, then modified. The method for catcodes was also initially directly inspired by these packages.

```

1 \begingroup\catcode61\catcode48\catcode32=10\relax%
2 \catcode13=5      % ^^M
3 \endlinechar=13 %
4 \catcode123=1     % {
5 \catcode125=2     % }
6 \catcode64=11     % @
7 \catcode35=6      % #
8 \catcode44=12     % ,
9 \catcode45=12     % -
10 \catcode46=12    % .
11 \catcode58=12    % :
12 \let\z\endgroup
13 \expandafter\let\expandafter\x\csname ver@xintseries.sty\endcsname
14 \expandafter\let\expandafter\w\csname ver@xintfrac.sty\endcsname
15 \expandafter
16 \ifx\csname PackageInfo\endcsname\relax
17   \def\y#1#2{\immediate\write-1{Package #1 Info: #2.}}%
18   \else
19     \def\y#1#2{\PackageInfo{#1}{#2}}%
20   \fi
21 \expandafter
22 \ifx\csname numexpr\endcsname\relax
23   \y{xintseries}{\numexpr not available, aborting input}%
24   \aftergroup\endinput
25 \else
26   \ifx\x\relax % plain-TeX, first loading of xintseries.sty
27     \ifx\w\relax % but xintfrac.sty not yet loaded.
28       \def\z{\endgroup\input xintfrac.sty\relax}%
29     \fi
30   \else
31     \def\empty {}%
32     \ifx\x\empty % LaTeX, first loading,
33     % variable is initialized, but \ProvidesPackage not yet seen
34     \ifx\w\relax % xintfrac.sty not yet loaded.
35       \def\z{\endgroup\RequirePackage{xintfrac}}%
36     \fi
37   \else

```

```

38      \aftergroup\endinput % xintseries already loaded.
39      \fi
40      \fi
41      \fi
42 \z%
43 \XINTsetupcatcodes% defined in xintkernel.sty

```

## 8.2 Package identification

```

44 \XINT_providespackage
45 \ProvidesPackage{xintseries}%
46 [2017/08/06 1.2n Expandable partial sums with xint package (JFB)]%

```

## 8.3 *\xintSeries*

```

47 \def\xintSeries {\romannumeral0\xintseries }%
48 \def\xintseries #1#2%
49 {%
50   \expandafter\XINT_series\expandafter
51   {\the\numexpr #1\expandafter}\expandafter{\the\numexpr #2}%
52 }%
53 \def\XINT_series #1#2#3%
54 {%
55   \ifnum #2<#1
56     \xint_afterfi { 0/1[0]}%
57   \else
58     \xint_afterfi {\XINT_series_loop {#1}{0}{#2}{#3}}%
59   \fi
60 }%
61 \def\XINT_series_loop #1#2#3#4%
62 {%
63   \ifnum #3>#1 \else \XINT_series_exit \fi
64   \expandafter\XINT_series_loop\expandafter
65   {\the\numexpr #1+1\expandafter }\expandafter
66   {\romannumeral0\xintadd {#2}{#4{#1}}}%
67   {#3}{#4}%
68 }%
69 \def\XINT_series_exit \fi #1#2#3#4#5#6#7#8%
70 {%
71   \fi\xint_gobble_ii #6%
72 }%

```

## 8.4 *\xintiSeries*

```

73 \def\xintiSeries {\romannumeral0\xintiseries }%
74 \def\xintiseries #1#2%
75 {%
76   \expandafter\XINT_iseries\expandafter
77   {\the\numexpr #1\expandafter}\expandafter{\the\numexpr #2}%
78 }%
79 \def\XINT_iseries #1#2#3%
80 {%
81   \ifnum #2<#1
82     \xint_afterfi { 0}%
83   \else

```

```

84     \xint_afterfi {\XINT_iseries_loop {#1}{0}{#2}{#3}}%
85   \fi
86 }%
87 \def\XINT_iseries_loop #1#2#3#4%
88 {%
89   \ifnum #3>#1 \else \XINT_iseries_exit \fi
90   \expandafter\XINT_iseries_loop\expandafter
91   {\the\numexpr #1+1\expandafter }\expandafter
92   {\romannumeral0\xintiadd {#2}{#4{#1}}}%
93   {#3}{#4}%
94 }%
95 \def\XINT_iseries_exit \fi #1#2#3#4#5#6#7#8%
96 {%
97   \fi\xint_gobble_ii #6%
98 }%

```

### 8.5 \xintPowerSeries

The 1.03 version was very lame and created a build-up of denominators. (this was at a time \xintAdd always multiplied denominators, by the way) The Horner scheme for polynomial evaluation is used in 1.04, this cures the denominator problem and drastically improves the efficiency of the macro. Modified in 1.06 to give the indices first to a \numexpr rather than expanding twice. I just use \the\numexpr and maintain the previous code after that. 1.08a adds the forgotten optimization following that previous change.

```

99 \def\xintPowerSeries {\romannumeral0\xintpowerseries }%
100 \def\xintpowerseries #1#2%
101 {%
102   \expandafter\XINT_powseries\expandafter
103   {\the\numexpr #1\expandafter}\expandafter{\the\numexpr #2}%
104 }%
105 \def\XINT_powseries #1#2#3#4%
106 {%
107   \ifnum #2<#1
108     \xint_afterfi { 0/1[0]}%
109   \else
110     \xint_afterfi
111     {\XINT_powseries_loop_i {#3{#2}}{#1}{#2}{#3}{#4}}%
112   \fi
113 }%
114 \def\XINT_powseries_loop_i #1#2#3#4#5%
115 {%
116   \ifnum #3>#2 \else\XINT_powseries_exit_i\fi
117   \expandafter\XINT_powseries_loop_ii\expandafter
118   {\the\numexpr #3-1\expandafter}\expandafter
119   {\romannumeral0\xintmul {#1}{#5}}{#2}{#4}{#5}%
120 }%
121 \def\XINT_powseries_loop_ii #1#2#3#4%
122 {%
123   \expandafter\XINT_powseries_loop_i\expandafter
124   {\romannumeral0\xintadd {#4{#1}}{#2}}{#3}{#1}{#4}%
125 }%
126 \def\XINT_powseries_exit_i\fi #1#2#3#4#5#6#7#8#9%
127 {%

```

```

128   \fi \XINT_powseries_exit_ii  #6{#7}%
129 }%
130 \def\XINT_powseries_exit_ii #1#2#3#4#5#6%
131 {%
132   \xintmul{\xintPow {#5}{#6}}{#4}%
133 }%

```

## 8.6 \xintPowerSeriesX

Same as `\xintPowerSeries` except for the initial expansion of the `x` parameter. Modified in 1.06 to give the indices first to a `\numexpr` rather than expanding twice. I just use `\the\numexpr` and maintain the previous code after that. 1.08a adds the forgotten optimization following that previous change.

```

134 \def\xintPowerSeriesX {\romannumeral0\xintpowerseriesx }%
135 \def\xintpowerseriesx #1#2%
136 {%
137   \expandafter\XINT_powseriesx\expandafter
138   {\the\numexpr #1\expandafter}\expandafter{\the\numexpr #2}%
139 }%
140 \def\XINT_powseriesx #1#2#3#4%
141 {%
142   \ifnum #2<#1
143     \xint_afterfi { 0/1[0]}%
144   \else
145     \xint_afterfi
146     {\expandafter\XINT_powseriesx_pre\expandafter
147      {\romannumeral`&&@#4}{#1}{#2}{#3}%
148     }%
149   \fi
150 }%
151 \def\XINT_powseriesx_pre #1#2#3#4%
152 {%
153   \XINT_powseries_loop_i {#4{#3}}{#2}{#3}{#4}{#1}%
154 }%

```

## 8.7 \xintRationalSeries

This computes  $F(a)+\dots+F(b)$  on the basis of the value of  $F(a)$  and the ratios  $F(n)/F(n-1)$ . As in `\xintPowerSeries` we use an iterative scheme which has the great advantage to avoid denominator build-up. This makes exact computations possible with exponential type series, which would be completely inaccessible to `\xintSeries`. #1=a, #2=b, #3=F(a), #4=ratio function Modified in 1.06 to give the indices first to a `\numexpr` rather than expanding twice. I just use `\the\numexpr` and maintain the previous code after that. 1.08a adds the forgotten optimization following that previous change.

```

155 \def\xintRationalSeries {\romannumeral0\xintratseries }%
156 \def\xintratseries #1#2%
157 {%
158   \expandafter\XINT_ratseries\expandafter
159   {\the\numexpr #1\expandafter}\expandafter{\the\numexpr #2}%
160 }%
161 \def\XINT_ratseries #1#2#3#4%

```

```

162 {%
163   \ifnum #2<#1
164     \xint_afterfi { 0/1[0]}%
165   \else
166     \xint_afterfi
167     {\XINT_ratseries_loop {#2}{1}{#1}{#4}{#3}}%
168   \fi
169}%
170 \def\XINT_ratseries_loop #1#2#3#4%
171 {%
172   \ifnum #1>#3 \else\XINT_ratseries_exit_i\fi
173   \expandafter\XINT_ratseries_loop\expandafter
174   {\the\numexpr #1-1\expandafter}\expandafter
175   {\romannumeral0\xintadd {1}{\xintMul {#2}{#4{#1}}}{#3}{#4}}%
176}%
177 \def\XINT_ratseries_exit_i\fi #1#2#3#4#5#6#7#8%
178 {%
179   \fi \XINT_ratseries_exit_ii #6%
180}%
181 \def\XINT_ratseries_exit_ii #1#2#3#4#5%
182 {%
183   \XINT_ratseries_exit_iii #5%
184}%
185 \def\XINT_ratseries_exit_iii #1#2#3#4%
186 {%
187   \xintmul{#2}{#4}%
188}%

```

## 8.8 \xintRationalSeriesX

*a,b,initial,ratiofunction,x*

This computes  $F(a,x)+\dots+F(b,x)$  on the basis of the value of  $F(a,x)$  and the ratios  $F(n,x)/F(n-1,x)$ . The argument  $x$  is first expanded and it is the value resulting from this which is used then throughout. The initial term  $F(a,x)$  must be defined as one-parameter macro which will be given  $x$ . Modified in 1.06 to give the indices first to a `\numexpr` rather than expanding twice. I just use `\the\numexpr` and maintain the previous code after that. 1.08a adds the forgotten optimization following that previous change.

```

189 \def\xintRationalSeriesX {\romannumeral0\xintratseriesx}%
190 \def\xintratseriesx #1#2%
191 {%
192   \expandafter\XINT_ratseriesx\expandafter
193   {\the\numexpr #1\expandafter}\expandafter{\the\numexpr #2}%
194}%
195 \def\XINT_ratseriesx #1#2#3#4#5%
196 {%
197   \ifnum #2<#1
198     \xint_afterfi { 0/1[0]}%
199   \else
200     \xint_afterfi
201     {\expandafter\XINT_ratseriesx_pre\expandafter
202      {\romannumeral`&&@#5}{#2}{#1}{#4}{#3}}%
203  }%

```

```

204 \fi
205 }%
206 \def\XINT_ratseriesx_pre #1#2#3#4#5%
207 {%
208 \XINT_ratseries_loop {#2}{1}{#3}{#4{#1}}{#5{#1}}%
209 }%

```

## 8.9 \xintFxpPowerSeries

I am not two happy with this piece of code. Will make it more economical another day. Modified in 1.06 to give the indices first to a \numexpr rather than expanding twice. I just use \the\numexpr and maintain the previous code after that. 1.08a: forgot last time some optimization from the change to \numexpr.

```

210 \def\xintFxpPowerSeries {\romannumeral0\xintfxptpowerseries }%
211 \def\xintfxptpowerseries #1#2%
212 {%
213 \expandafter\XINT_fppowseries\expandafter
214 {\the\numexpr #1\expandafter}\expandafter{\the\numexpr #2}%
215 }%
216 \def\XINT_fppowseries #1#2#3#4#5%
217 {%
218 \ifnum #2<#1
219 \xint_afterfi { 0}%
220 \else
221 \xint_afterfi
222 {\expandafter\XINT_fppowseries_loop_pre\expandafter
223 {\romannumeral0\xinttrunc {#5}{\xintPow {#4}{#1}}}%
224 {#1}{#4}{#2}{#3}{#5}%
225 }%
226 \fi
227 }%
228 \def\XINT_fppowseries_loop_pre #1#2#3#4#5#6%
229 {%
230 \ifnum #4>#2 \else\XINT_fppowseries_dont_i \fi
231 \expandafter\XINT_fppowseries_loop_i\expandafter
232 {\the\numexpr #2+\xint_c_i\expandafter}\expandafter
233 {\romannumeral0\xintitrunc {#6}{\xintMul {#5{#2}}{#1}}}%
234 {#1}{#3}{#4}{#5}{#6}%
235 }%
236 \def\XINT_fppowseries_dont_i \fi\expandafter\XINT_fppowseries_loop_i
237 {\fi \expandafter\XINT_fppowseries_dont_ii }%
238 \def\XINT_fppowseries_dont_ii #1#2#3#4#5#6#7{\xinttrunc {#7}{#2[-#7]}}%
239 \def\XINT_fppowseries_loop_i #1#2#3#4#5#6#7%
240 {%
241 \ifnum #5>#1 \else \XINT_fppowseries_exit_i \fi
242 \expandafter\XINT_fppowseries_loop_ii\expandafter
243 {\romannumeral0\xinttrunc {#7}{\xintMul {#3}{#4}}}%
244 {#1}{#4}{#2}{#5}{#6}{#7}%
245 }%
246 \def\XINT_fppowseries_loop_ii #1#2#3#4#5#6#7%
247 {%
248 \expandafter\XINT_fppowseries_loop_i\expandafter

```

```

249   {\the\numexpr #2+\xint_c_i\expandafter}\expandafter
250   {\romannumeral0\xintiiadd {#4}{\xintiTrunc {#7}{\xintMul {#6{#2}}{#1}}}%
251   {#1}{#3}{#5}{#6}{#7}%
252 }%
253 \def\xINT_fppowseries_exit_i\fi\expandafter\xINT_fppowseries_loop_ii
254   {\fi \expandafter\xINT_fppowseries_exit_ii }%
255 \def\xINT_fppowseries_exit_ii #1#2#3#4#5#6#7%
256 {%
257   \xinttrunc {#7}
258   {\xintiiadd {#4}{\xintiTrunc {#7}{\xintMul {#6{#2}}{#1}}}{-#7}}%
259 }%

```

## 8.10 \xintFxFtPowerSeriesX

*a,b,coeff,x,D*

Modified in 1.06 to give the indices first to a `\numexpr` rather than expanding twice. I just use `\the\numexpr` and maintain the previous code after that. 1.08a adds the forgotten optimization following that previous change.

```

260 \def\xintFxFtPowerSeriesX {\romannumeral0\xintfxptpowerseriesx }%
261 \def\xintfxptpowerseriesx #1#2%
262 {%
263   \expandafter\xINT_fppowseriesx\expandafter
264   {\the\numexpr #1\expandafter}\expandafter{\the\numexpr #2}%
265 }%
266 \def\xINT_fppowseriesx #1#2#3#4#5%
267 {%
268   \ifnum #2<#1
269     \xint_afterfi { 0}%
270   \else
271     \xint_afterfi
272     {\expandafter \XINT_fppowseriesx_pre \expandafter
273     {\romannumeral`&&@#4}{#1}{#2}{#3}{#5}%
274     }%
275   \fi
276 }%
277 \def\xINT_fppowseriesx_pre #1#2#3#4#5%
278 {%
279   \expandafter\xINT_fppowseries_loop_pre\expandafter
280   {\romannumeral0\xinttrunc {#5}{\xintPow {#1}{#2}}}%
281   {#2}{#1}{#3}{#4}{#5}%
282 }%

```

## 8.11 \xintFloatPowerSeries

1.08a. I still have to re-visit `\xintFxFtPowerSeries`; temporarily I just adapted the code to the case of floats.

```

283 \def\xintFloatPowerSeries {\romannumeral0\xintfloatpowerseries }%
284 \def\xintfloatpowerseries #1{\XINT_flpowseries_chkopt #1\xint:}%
285 \def\xINT_flpowseries_chkopt #1%
286 {%
287   \ifx [#1\expandafter\xINT_flpowseries_opt

```

```

288     \else\expandafter\XINT_flpowseries_noopt
289     \fi
290     #1%
291 }%
292 \def\XINT_flpowseries_noopt #1\xint:#2%
293 {%
294     \expandafter\XINT_flpowseries\expandafter
295     {\the\numexpr #1\expandafter}\expandafter
296     {\the\numexpr #2}\XINTdigits
297 }%
298 \def\XINT_flpowseries_opt [\xint:#1]#2#3%
299 {%
300     \expandafter\XINT_flpowseries\expandafter
301     {\the\numexpr #2\expandafter}\expandafter
302     {\the\numexpr #3\expandafter}{\the\numexpr #1}%
303 }%
304 \def\XINT_flpowseries #1#2#3#4#5%
305 {%
306     \ifnum #2<#1
307         \xint_afterfi { 0.e0}%
308     \else
309         \xint_afterfi
310         {\expandafter\XINT_flpowseries_loop_pre\expandafter
311          {\romannumeral0\XINTinfloatpow [#3]{#5}{#1}}%
312          {#1}{#5}{#2}{#4}{#3}%
313         }%
314     \fi
315 }%
316 \def\XINT_flpowseries_loop_pre #1#2#3#4#5#6%
317 {%
318     \ifnum #4>#2 \else\XINT_flpowseries_dont_i \fi
319     \expandafter\XINT_flpowseries_loop_i\expandafter
320     {\the\numexpr #2+\xint_c_i\expandafter}\expandafter
321     {\romannumeral0\XINTinfloatmul [#6]{#5}{#2}}{#1}%
322     {#1}{#3}{#4}{#5}{#6}%
323 }%
324 \def\XINT_flpowseries_dont_i \fi\expandafter\XINT_flpowseries_loop_i
325     {\fi \expandafter\XINT_flpowseries_dont_ii }%
326 \def\XINT_flpowseries_dont_ii #1#2#3#4#5#6#7{\xintfloat [#7]{#2}}%
327 \def\XINT_flpowseries_loop_i #1#2#3#4#5#6#7%
328 {%
329     \ifnum #5>#1 \else \XINT_flpowseries_exit_i \fi
330     \expandafter\XINT_flpowseries_loop_ii\expandafter
331     {\romannumeral0\XINTinfloatmul [#7]{#3}{#4}}%
332     {#1}{#4}{#2}{#5}{#6}{#7}%
333 }%
334 \def\XINT_flpowseries_loop_ii #1#2#3#4#5#6#7%
335 {%
336     \expandafter\XINT_flpowseries_loop_i\expandafter
337     {\the\numexpr #2+\xint_c_i\expandafter}\expandafter
338     {\romannumeral0\XINTinfloatadd [#7]{#4}%
339      {\XINTinfloatmul [#7]{#6}{#2}}{#1}}}%

```



```

340     {#1}{#3}{#5}{#6}{#7}%
341 }%
342 \def\XINT_flpowseries_exit_i\fi\expandafter\XINT_flpowseries_loop_ii
343     {\fi \expandafter\XINT_flpowseries_exit_ii }%
344 \def\XINT_flpowseries_exit_ii #1#2#3#4#5#6#7%
345 {%
346     \xintfloatadd [#7]{#4}{\XINTinfloatmul [#7]{#6{#2}}{#1}}%
347 }%

```

## 8.12 \xintFloatPowerSeriesX

### 1.08a

```

348 \def\xintFloatPowerSeriesX {\romannumeral0\xintfloatpowerseriesx }%
349 \def\xintfloatpowerseriesx #1{\XINT_flpowseriesx_chkopt #1\xint:}%
350 \def\XINT_flpowseriesx_chkopt #1%
351 {%
352     \ifx [#1\expandafter\XINT_flpowseriesx_opt
353         \else\expandafter\XINT_flpowseriesx_noopt
354     \fi
355     #1%
356 }%
357 \def\XINT_flpowseriesx_noopt #1\xint:#2%
358 {%
359     \expandafter\XINT_flpowseriesx\expandafter
360     {\the\numexpr #1\expandafter}\expandafter
361     {\the\numexpr #2}\XINTdigits
362 }%
363 \def\XINT_flpowseriesx_opt [\xint:#1]#2#3%
364 {%
365     \expandafter\XINT_flpowseriesx\expandafter
366     {\the\numexpr #2\expandafter}\expandafter
367     {\the\numexpr #3\expandafter}{\the\numexpr #1}%
368 }%
369 \def\XINT_flpowseriesx #1#2#3#4#5%
370 {%
371     \ifnum #2<#1
372         \xint_afterfi { 0.e0}%
373     \else
374         \xint_afterfi
375         {\expandafter \XINT_flpowseriesx_pre \expandafter
376         {\romannumeral`&&@#5}{#1}{#2}{#4}{#3}%
377         }%
378     \fi
379 }%
380 \def\XINT_flpowseriesx_pre #1#2#3#4#5%
381 {%
382     \expandafter\XINT_flpowseries_loop_pre\expandafter
383     {\romannumeral0\XINTinfloatpow [#5]{#1}{#2}}%
384     {#2}{#1}{#3}{#4}{#5}%
385 }%
386 \XINT_restorecatcodes_endinput%

```

## 9 Package `xintcfrac` implementation

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The commenting is currently (2017/08/06) very sparse. Release 1.09m (2014/02/26) has modified a few things: `\xintFtoCs` and `\xintCntoCs` insert spaces after the commas, `\xintCstoF` and `\xintCstoCv` authorize spaces in the input also before the commas, `\xintCntoCs` does not brace the produced coefficients, new macros `\xintFtoC`, `\xintCtoF`, `\xintCtoCv`, `\xintFGtoC`, and `\xintGGCFrac`.

### 9.1 Catcodes, $\varepsilon$ - $\text{\TeX}$ and reload detection

The code for reload detection was initially copied from HEIKO OBERDIEK's packages, then modified.

The method for catcodes was also initially directly inspired by these packages.

```

1 \begingroup\catcode61\catcode48\catcode32=10\relax%
2   \catcode13=5      % ^^M
3   \endlinechar=13 %
4   \catcode123=1     % {
5   \catcode125=2     % }
6   \catcode64=11    % @
7   \catcode35=6     % #
8   \catcode44=12    % ,
9   \catcode45=12    % -
10  \catcode46=12    % .
11  \catcode58=12    % :
12  \let\z\endgroup
13  \expandafter\let\expandafter\x\csname ver@xintcfrac.sty\endcsname
14  \expandafter\let\expandafter\w\csname ver@xintfrac.sty\endcsname
15  \expandafter
16    \ifx\csname PackageInfo\endcsname\relax
17      \def\y#1#2{\immediate\write-1{Package #1 Info: #2.}}%
18    \else
19      \def\y#1#2{\PackageInfo{#1}{#2}}%
20    \fi
21  \expandafter
22  \ifx\csname numexpr\endcsname\relax
23    \y{xintcfrac}{\numexpr not available, aborting input}%
24    \aftergroup\endinput
25  \else

```

```

26 \ifx\x\relax % plain-TeX, first loading of xintcfrac.sty
27 \ifx\w\relax % but xintfrac.sty not yet loaded.
28 \def\z{\endgroup\input xintfrac.sty\relax}%
29 \fi
30 \else
31 \def\empty {}%
32 \ifx\x\empty % LaTeX, first loading,
33 % variable is initialized, but \ProvidesPackage not yet seen
34 \ifx\w\relax % xintfrac.sty not yet loaded.
35 \def\z{\endgroup\RequirePackage{xintfrac}}%
36 \fi
37 \else
38 \aftergroup\endinput % xintcfrac already loaded.
39 \fi
40 \fi
41 \fi
42 \z%
43 \XINTsetupcatcodes% defined in xintkernel.sty

```

## 9.2 Package identification

```

44 \XINT_providespackage
45 \ProvidesPackage{xintcfrac}%
46 [2017/08/06 1.2n Expandable continued fractions with xint package (JFB)]%

```

## 9.3 *\xintCFrac*

```

47 \def\xintCFrac {\romannumeral0\xintcfrac }%
48 \def\xintcfrac #1%
49 {%
50 \XINT_cfrac_opt_a #1\xint:
51 }%
52 \def\XINT_cfrac_opt_a #1%
53 {%
54 \ifx[#1\XINT_cfrac_opt_b\fi \XINT_cfrac_noopt #1%
55 }%
56 \def\XINT_cfrac_noopt #1\xint:
57 {%
58 \expandafter\XINT_cfrac_A\romannumeral0\xintrawwithzeros {#1}\Z
59 \relax\relax
60 }%
61 \def\XINT_cfrac_opt_b\fi\XINT_cfrac_noopt [\xint:#1]%
62 {%
63 \fi\csname XINT_cfrac_opt#1\endcsname
64 }%
65 \def\XINT_cfrac_optl #1%
66 {%
67 \expandafter\XINT_cfrac_A\romannumeral0\xintrawwithzeros {#1}\Z
68 \relax\hfill
69 }%
70 \def\XINT_cfrac_optc #1%
71 {%
72 \expandafter\XINT_cfrac_A\romannumeral0\xintrawwithzeros {#1}\Z
73 \relax\relax

```

```

74 }%
75 \def\XINT_cfrac_optr #1%
76 {%
77   \expandafter\XINT_cfrac_A\romannumeral0\xintraewithzeros {#1}\Z
78   \hfill\relax
79 }%
80 \def\XINT_cfrac_A #1/#2\Z
81 {%
82   \expandafter\XINT_cfrac_B\romannumeral0\xintiidivision {#1}{#2}{#2}%
83 }%
84 \def\XINT_cfrac_B #1#2%
85 {%
86   \XINT_cfrac_C #2\Z {#1}%
87 }%
88 \def\XINT_cfrac_C #1%
89 {%
90   \xint_gob_til_zero #1\XINT_cfrac_integer 0\XINT_cfrac_D #1%
91 }%
92 \def\XINT_cfrac_integer 0\XINT_cfrac_D 0#1\Z #2#3#4#5{ #2}%
93 \def\XINT_cfrac_D #1\Z #2#3{\XINT_cfrac_loop_a {#1}{#3}{#1}{#2}}%
94 \def\XINT_cfrac_loop_a
95 {%
96   \expandafter\XINT_cfrac_loop_d\romannumeral0\XINT_div_prepare
97 }%
98 \def\XINT_cfrac_loop_d #1#2%
99 {%
100   \XINT_cfrac_loop_e #2.{#1}%
101 }%
102 \def\XINT_cfrac_loop_e #1%
103 {%
104   \xint_gob_til_zero #1\xint_cfrac_loop_exit0\XINT_cfrac_loop_f #1%
105 }%
106 \def\XINT_cfrac_loop_f #1.#2#3#4%
107 {%
108   \XINT_cfrac_loop_a {#1}{#3}{#1}{#2#4}%
109 }%
110 \def\xint_cfrac_loop_exit0\XINT_cfrac_loop_f #1.#2#3#4#5#6%
111   {\XINT_cfrac_T #5#6{#2#4}\Z }%
112 \def\XINT_cfrac_T #1#2#3#4%
113 {%
114   \xint_gob_til_Z #4\XINT_cfrac_end\Z\XINT_cfrac_T #1#2{#4+\cfrac{#11#2}{#3}}%
115 }%
116 \def\XINT_cfrac_end\Z\XINT_cfrac_T #1#2#3%
117 {%
118   \XINT_cfrac_end_b #3%
119 }%
120 \def\XINT_cfrac_end_b \Z+\cfrac#1#2{ #2}%

```

#### 9.4 *\xintGCFrac*

```

121 \def\xintGCFrac {\romannumeral0\xintgcfrac }%
122 \def\xintgcfrac #1{\XINT_gcfrac_opt_a #1\xint:}%
123 \def\XINT_gcfrac_opt_a #1%
124 {%

```

```

125 \ifx[#1\XINT_gcfrac_opt_b\fi \XINT_gcfrac_noopt #1%
126 }%
127 \def\XINT_gcfrac_noopt #1\xint:%
128 {%
129 \XINT_gcfrac #1+!\relax\relax
130 }%
131 \def\XINT_gcfrac_opt_b\fi\XINT_gcfrac_noopt [\xint:#1]%
132 {%
133 \fi\csname XINT_gcfrac_opt#1\endcsname
134 }%
135 \def\XINT_gcfrac_optl #1%
136 {%
137 \XINT_gcfrac #1+!\relax\hfill
138 }%
139 \def\XINT_gcfrac_optc #1%
140 {%
141 \XINT_gcfrac #1+!\relax\relax
142 }%
143 \def\XINT_gcfrac_opttr #1%
144 {%
145 \XINT_gcfrac #1+!\hfill\relax
146 }%
147 \def\XINT_gcfrac
148 {%
149 \expandafter\XINT_gcfrac_enter\romannumeral`&&@%
150 }%
151 \def\XINT_gcfrac_enter {\XINT_gcfrac_loop {}}%
152 \def\XINT_gcfrac_loop #1#2+#3/%
153 {%
154 \xint_gob_til_exclam #3\XINT_gcfrac_endloop!%
155 \XINT_gcfrac_loop {{#3}{#2}{#1}}%
156 }%
157 \def\XINT_gcfrac_endloop!\XINT_gcfrac_loop #1#2#3%
158 {%
159 \XINT_gcfrac_T #2#3#1!!%
160 }%
161 \def\XINT_gcfrac_T #1#2#3#4{\XINT_gcfrac_U #1#2{\xintFrac{#4}}}%
162 \def\XINT_gcfrac_U #1#2#3#4#5%
163 {%
164 \xint_gob_til_exclam #5\XINT_gcfrac_end!\XINT_gcfrac_U
165 #1#2{\xintFrac{#5}}%
166 \ifcase\xintSgn{#4}
167 +\or+\else-\fi
168 \cfrac{#1\xintFrac{\xintAbs{#4}}#2}{#3}}%
169 }%
170 \def\XINT_gcfrac_end!\XINT_gcfrac_U #1#2#3%
171 {%
172 \XINT_gcfrac_end_b #3%
173 }%
174 \def\XINT_gcfrac_end_b #1\cfrac#2#3{ #3}%

```

9.5 *\xintGGCFrac*

New with 1.09m

```

175 \def\xintGGCFrac {\romannumeral0\xintggcfrac }%
176 \def\xintggcfrac #1{\XINT_ggcfrac_opt_a #1\xint:}%
177 \def\XINT_ggcfrac_opt_a #1%
178 {%
179   \ifx[#1\XINT_ggcfrac_opt_b\fi \XINT_ggcfrac_noopt #1%
180 }%
181 \def\XINT_ggcfrac_noopt #1\xint:
182 {%
183   \XINT_ggcfrac #1+!\relax\relax
184 }%
185 \def\XINT_ggcfrac_opt_b\fi\XINT_ggcfrac_noopt [\xint:#1]%
186 {%
187   \fi\csname XINT_ggcfrac_opt#1\endcsname
188 }%
189 \def\XINT_ggcfrac_optl #1%
190 {%
191   \XINT_ggcfrac #1+!\relax\hfill
192 }%
193 \def\XINT_ggcfrac_optc #1%
194 {%
195   \XINT_ggcfrac #1+!\relax\relax
196 }%
197 \def\XINT_ggcfrac_optr #1%
198 {%
199   \XINT_ggcfrac #1+!\hfill\relax
200 }%
201 \def\XINT_ggcfrac
202 {%
203   \expandafter\XINT_ggcfrac_enter\romannumeral`&&@%
204 }%
205 \def\XINT_ggcfrac_enter {\XINT_ggcfrac_loop {}}%
206 \def\XINT_ggcfrac_loop #1#2+#3/%
207 {%
208   \xint_gob_til_exclam #3\XINT_ggcfrac_endloop!%
209   \XINT_ggcfrac_loop {{#3}{#2}{#1}}%
210 }%
211 \def\XINT_ggcfrac_endloop!\XINT_ggcfrac_loop #1#2#3%
212 {%
213   \XINT_ggcfrac_T #2#3#1!!%
214 }%
215 \def\XINT_ggcfrac_T #1#2#3#4{\XINT_ggcfrac_U #1#2{#4}}%
216 \def\XINT_ggcfrac_U #1#2#3#4#5%
217 {%
218   \xint_gob_til_exclam #5\XINT_ggcfrac_end!\XINT_ggcfrac_U
219     #1#2{#5+\cfrac{#1#4#2}{#3}}%
220 }%
221 \def\XINT_ggcfrac_end!\XINT_ggcfrac_U #1#2#3%
222 {%
223   \XINT_ggcfrac_end_b #3%

```

```

224 }%
225 \def\XINT_ggcfrac_end_b #1\cfrac#2#3{ #3}%

```

## 9.6 \xintGctoGCx

```

226 \def\xintGctoGCx {\romannumeral0\xintgctogcx }%
227 \def\xintgctogcx #1#2#3%
228 {%
229   \expandafter\XINT_gctgcx_start\expandafter {\romannumeral`&&@#3}{#1}{#2}%
230 }%
231 \def\XINT_gctgcx_start #1#2#3{\XINT_gctgcx_loop_a {}{#2}{#3}#1+!/}%
232 \def\XINT_gctgcx_loop_a #1#2#3#4+#5/%
233 {%
234   \xint_gob_til_exclam #5\XINT_gctgcx_end!%
235   \XINT_gctgcx_loop_b {#1{#4}}{#2{#5}#3}{#2}{#3}%
236 }%
237 \def\XINT_gctgcx_loop_b #1#2%
238 {%
239   \XINT_gctgcx_loop_a {#1#2}%
240 }%
241 \def\XINT_gctgcx_end!\XINT_gctgcx_loop_b #1#2#3#4{ #1}%

```

## 9.7 \xintFtoCs

Modified in 1.09m: a space is added after the inserted commas.

```

242 \def\xintFtoCs {\romannumeral0\xintftocs }%
243 \def\xintftocs #1%
244 {%
245   \expandafter\XINT_ftc_A\romannumeral0\xintrawwithzeros {#1}\Z
246 }%
247 \def\XINT_ftc_A #1/#2\Z
248 {%
249   \expandafter\XINT_ftc_B\romannumeral0\xintiidivision {#1}{#2}{#2}%
250 }%
251 \def\XINT_ftc_B #1#2%
252 {%
253   \XINT_ftc_C #2.{#1}%
254 }%
255 \def\XINT_ftc_C #1%
256 {%
257   \xint_gob_til_zero #1\XINT_ftc_integer 0\XINT_ftc_D #1%
258 }%
259 \def\XINT_ftc_integer 0\XINT_ftc_D 0#1.#2#3{ #2}%
260 \def\XINT_ftc_D #1.#2#3{\XINT_ftc_loop_a {#1}{#3}{#1}{#2, }}% 1.09m adds a space
261 \def\XINT_ftc_loop_a
262 {%
263   \expandafter\XINT_ftc_loop_d\romannumeral0\XINT_div_prepare
264 }%
265 \def\XINT_ftc_loop_d #1#2%
266 {%
267   \XINT_ftc_loop_e #2.{#1}%
268 }%
269 \def\XINT_ftc_loop_e #1%

```

```

270 {%
271   \xint_gob_til_zero #1\xint_ftc_loop_exit0\XINT_ftc_loop_f #1%
272 }%
273 \def\XINT_ftc_loop_f #1.#2#3#4%
274 {%
275   \XINT_ftc_loop_a {#1}{#3}{#1}{#4#2, }% 1.09m has an added space here
276 }%
277 \def\xint_ftc_loop_exit0\XINT_ftc_loop_f #1.#2#3#4{ #4#2}%

```

## 9.8 \xintFtoCx

```

278 \def\xintFtoCx {\romannumeral0\xintftocx }%
279 \def\xintftocx #1#2%
280 {%
281   \expandafter\XINT_ftcx_A\romannumeral0\xintraewithzeros {#2}\Z {#1}%
282 }%
283 \def\XINT_ftcx_A #1/#2\Z
284 {%
285   \expandafter\XINT_ftcx_B\romannumeral0\xintiidivision {#1}{#2}{#2}%
286 }%
287 \def\XINT_ftcx_B #1#2%
288 {%
289   \XINT_ftcx_C #2.{#1}%
290 }%
291 \def\XINT_ftcx_C #1%
292 {%
293   \xint_gob_til_zero #1\XINT_ftcx_integer 0\XINT_ftcx_D #1%
294 }%
295 \def\XINT_ftcx_integer 0\XINT_ftcx_D 0#1.#2#3#4{ #2}%
296 \def\XINT_ftcx_D #1.#2#3#4{\XINT_ftcx_loop_a {#1}{#3}{#1}{#2#4}{#4}}%
297 \def\XINT_ftcx_loop_a
298 {%
299   \expandafter\XINT_ftcx_loop_d\romannumeral0\XINT_div_prepare
300 }%
301 \def\XINT_ftcx_loop_d #1#2%
302 {%
303   \XINT_ftcx_loop_e #2.{#1}%
304 }%
305 \def\XINT_ftcx_loop_e #1%
306 {%
307   \xint_gob_til_zero #1\xint_ftcx_loop_exit0\XINT_ftcx_loop_f #1%
308 }%
309 \def\XINT_ftcx_loop_f #1.#2#3#4#5%
310 {%
311   \XINT_ftcx_loop_a {#1}{#3}{#1}{#4#2#5}{#5}%
312 }%
313 \def\xint_ftcx_loop_exit0\XINT_ftcx_loop_f #1.#2#3#4#5{ #4#2}%

```

## 9.9 \xintFtoC

New in 1.09m: this is the same as \xintFtoCx with empty separator. I had temporarily during preparation of 1.09m removed braces from \xintFtoCx, but I recalled later why that was useful (see doc), thus let's just here do \xintFtoCx {}



```

314 \def\xintFtoC {\romannumeral0\xintftoc}%
315 \def\xintftoc {\xintftocx {}}%

```

## 9.10 `\xintFtoGC`

```

316 \def\xintFtoGC {\romannumeral0\xintftogc}%
317 \def\xintftogc {\xintftocx {+1/}}%

```

## 9.11 `\xintFGtoC`

New with 1.09m of 2014/02/26. Computes the common initial coefficients for the two fractions *f* and *g*, and outputs them as a sequence of braced items.

```

318 \def\xintFGtoC {\romannumeral0\xintfgtoc}%
319 \def\xintfgtoc#1%
320 {%
321   \expandafter\XINT_fgtc_a\romannumeral0\xintraewithzeros {#1}\Z
322 }%
323 \def\XINT_fgtc_a #1/#2\Z #3%
324 {%
325   \expandafter\XINT_fgtc_b\romannumeral0\xintraewithzeros {#3}\Z #1/#2\Z { }%
326 }%
327 \def\XINT_fgtc_b #1/#2\Z
328 {%
329   \expandafter\XINT_fgtc_c\romannumeral0\xintiidivision {#1}{#2}{#2}%
330 }%
331 \def\XINT_fgtc_c #1#2#3#4/#5\Z
332 {%
333   \expandafter\XINT_fgtc_d\romannumeral0\xintiidivision
334     {#4}{#5}{#5}{#1}{#2}{#3}%
335 }%
336 \def\XINT_fgtc_d #1#2#3#4#5#6#7%
337 {%
338   \xintifEq {#1}{#4}{\XINT_fgtc_da {#1}{#2}{#3}{#4}}%
339     {\xint_thirdofthree}%
340 }%
341 \def\XINT_fgtc_da #1#2#3#4#5#6#7%
342 {%
343   \XINT_fgtc_e {#2}{#5}{#3}{#6}{#7}{#1}}%
344 }%
345 \def\XINT_fgtc_e #1%
346 {%
347   \xintifZero {#1}{\expandafter\xint_firstofone\xint_gobble_iii}%
348     {\XINT_fgtc_f {#1}}%
349 }%
350 \def\XINT_fgtc_f #1#2%
351 {%
352   \xintifZero {#2}{\xint_thirdofthree}{\XINT_fgtc_g {#1}{#2}}%
353 }%
354 \def\XINT_fgtc_g #1#2#3%
355 {%
356   \expandafter\XINT_fgtc_h\romannumeral0\XINT_div_prepare {#1}{#3}{#1}{#2}%
357 }%
358 \def\XINT_fgtc_h #1#2#3#4#5%

```

```

359 {%
360   \expandafter\XINT_fgtd\romannumeral0\XINT_div_prepare
361   {#4}{#5}{#4}{#1}{#2}{#3}%
362 }%

```

## 9.12 \xintFtoCC

```

363 \def\xintFtoCC {\romannumeral0\xintftocc }%
364 \def\xintftocc #1%
365 {%
366   \expandafter\XINT_ftcc_A\expandafter {\romannumeral0\xintrawwithzeros {#1}}%
367 }%
368 \def\XINT_ftcc_A #1%
369 {%
370   \expandafter\XINT_ftcc_B
371   \romannumeral0\xintrawwithzeros {\xintAdd {1/2[0]}{#1[0]}}\Z {#1[0]}%
372 }%
373 \def\XINT_ftcc_B #1/#2\Z
374 {%
375   \expandafter\XINT_ftcc_C\expandafter {\romannumeral0\xintiiquo {#1}{#2}}%
376 }%
377 \def\XINT_ftcc_C #1#2%
378 {%
379   \expandafter\XINT_ftcc_D\romannumeral0\xintsub {#2}{#1}\Z {#1}%
380 }%
381 \def\XINT_ftcc_D #1%
382 {%
383   \xint_UDzerominusfork
384   #1-\XINT_ftcc_integer
385   0#1\XINT_ftcc_En
386   0-{\XINT_ftcc_Ep #1}%
387   \krof
388 }%
389 \def\XINT_ftcc_Ep #1\Z #2%
390 {%
391   \expandafter\XINT_ftcc_loop_a\expandafter
392   {\romannumeral0\xintdiv {1[0]}{#1}}{#2+1/}%
393 }%
394 \def\XINT_ftcc_En #1\Z #2%
395 {%
396   \expandafter\XINT_ftcc_loop_a\expandafter
397   {\romannumeral0\xintdiv {1[0]}{#1}}{#2+-1/}%
398 }%
399 \def\XINT_ftcc_integer #1\Z #2{ #2}%
400 \def\XINT_ftcc_loop_a #1%
401 {%
402   \expandafter\XINT_ftcc_loop_b
403   \romannumeral0\xintrawwithzeros {\xintAdd {1/2[0]}{#1}}\Z {#1}%
404 }%
405 \def\XINT_ftcc_loop_b #1/#2\Z
406 {%
407   \expandafter\XINT_ftcc_loop_c\expandafter
408   {\romannumeral0\xintiiquo {#1}{#2}}%

```

```

409 }%
410 \def\XINT_ftcc_loop_c #1#2%
411 {%
412   \expandafter\XINT_ftcc_loop_d
413   \romannumeral0\xintsub {#2}{#1[0]}\Z {#1}%
414 }%
415 \def\XINT_ftcc_loop_d #1%
416 {%
417   \xint_UDzerominusfork
418   #1-\XINT_ftcc_end
419   0#1\XINT_ftcc_loop_N
420   0-\XINT_ftcc_loop_P #1}%
421 \krof
422 }%
423 \def\XINT_ftcc_end #1\Z #2#3{ #3#2}%
424 \def\XINT_ftcc_loop_P #1\Z #2#3%
425 {%
426   \expandafter\XINT_ftcc_loop_a\expandafter
427   {\romannumeral0\xintdiv {1[0]}\Z {#1}}{#3#2+1/}%
428 }%
429 \def\XINT_ftcc_loop_N #1\Z #2#3%
430 {%
431   \expandafter\XINT_ftcc_loop_a\expandafter
432   {\romannumeral0\xintdiv {1[0]}\Z {#1}}{#3#2+-1/}%
433 }%

```

### 9.13 \xintCtoF, \xintCstof

1.09m uses \xintCSVtoList on the argument of \xintCstof to allow spaces also before the commas. And the original \xintCstof code became the one of the new \xintCtoF dealing with a braced rather than comma separated list.

```

434 \def\xintCstof {\romannumeral0\xintcstof }%
435 \def\xintcstof #1%
436 {%
437   \expandafter\XINT_ctf_prep \romannumeral0\xintcsvtolist{#1}!%
438 }%
439 \def\xintCtoF {\romannumeral0\xintctof }%
440 \def\xintctof #1%
441 {%
442   \expandafter\XINT_ctf_prep \romannumeral`&&@#1!%
443 }%
444 \def\XINT_ctf_prep
445 {%
446   \XINT_ctf_loop_a 1001%
447 }%
448 \def\XINT_ctf_loop_a #1#2#3#4#5%
449 {%
450   \xint_gob_til_exclam #5\XINT_ctf_end!%
451   \expandafter\XINT_ctf_loop_b
452   \romannumeral0\xintraewithzeros {#5}.{#1}{#2}{#3}{#4}%
453 }%
454 \def\XINT_ctf_loop_b #1/#2.#3#4#5#6%
455 {%

```

```

456 \expandafter\XINT_ctf_loop_c\expandafter
457 {\romannumeral0\XINT_mul_fork #2\xint:#4\xint:}%
458 {\romannumeral0\XINT_mul_fork #2\xint:#3\xint:}%
459 {\romannumeral0\xintiiadd {\XINT_mul_fork #2\xint:#6\xint:}%
460 {\XINT_mul_fork #1\xint:#4\xint:}}%
461 {\romannumeral0\xintiiadd {\XINT_mul_fork #2\xint:#5\xint:}%
462 {\XINT_mul_fork #1\xint:#3\xint:}}%
463 }%
464 \def\XINT_ctf_loop_c #1#2%
465 {%
466 \expandafter\XINT_ctf_loop_d\expandafter {\expandafter{#2}{#1}}%
467 }%
468 \def\XINT_ctf_loop_d #1#2%
469 {%
470 \expandafter\XINT_ctf_loop_e\expandafter {\expandafter{#2}#1}%
471 }%
472 \def\XINT_ctf_loop_e #1#2%
473 {%
474 \expandafter\XINT_ctf_loop_a\expandafter{#2}#1%
475 }%
476 \def\XINT_ctf_end #1.#2#3#4#5{\xintrawithzeros {#2/#3}}% 1.09b removes [0]

```

### 9.14 \xintiCstof

```

477 \def\xintiCstof {\romannumeral0\xinticstof }%
478 \def\xinticstof #1%
479 {%
480 \expandafter\XINT_icstf_prep \romannumeral`&&@#1,!,%
481 }%
482 \def\XINT_icstf_prep
483 {%
484 \XINT_icstf_loop_a 1001%
485 }%
486 \def\XINT_icstf_loop_a #1#2#3#4#5,%
487 {%
488 \xint_gob_til_exclam #5\XINT_icstf_end!%
489 \expandafter
490 \XINT_icstf_loop_b \romannumeral`&&@#5.{#1}{#2}{#3}{#4}%
491 }%
492 \def\XINT_icstf_loop_b #1.#2#3#4#5%
493 {%
494 \expandafter\XINT_icstf_loop_c\expandafter
495 {\romannumeral0\xintiiadd {#5}{\XINT_mul_fork #1\xint:#3\xint:}}%
496 {\romannumeral0\xintiiadd {#4}{\XINT_mul_fork #1\xint:#2\xint:}}%
497 {#2}{#3}%
498 }%
499 \def\XINT_icstf_loop_c #1#2%
500 {%
501 \expandafter\XINT_icstf_loop_a\expandafter {#2}{#1}%
502 }%
503 \def\XINT_icstf_end#1.#2#3#4#5{\xintrawithzeros {#2/#3}}% 1.09b removes [0]

```

### 9.15 \xintGctof

```

504 \def\xintGctoF {\romannumeral0\xintgctof }%
505 \def\xintgctof #1%
506 {%
507   \expandafter\xINT_gctf_prep \romannumeral`&&@#1+!/ %
508 }%
509 \def\xINT_gctf_prep
510 {%
511   \XINT_gctf_loop_a 1001%
512 }%
513 \def\xINT_gctf_loop_a #1#2#3#4#5+%
514 {%
515   \expandafter\xINT_gctf_loop_b
516   \romannumeral0\xintraewithzeros {#5}. {#1}{#2}{#3}{#4}%
517 }%
518 \def\xINT_gctf_loop_b #1/#2.#3#4#5#6%
519 {%
520   \expandafter\xINT_gctf_loop_c\expandafter
521   {\romannumeral0\xINT_mul_fork #2\xint:#4\xint:}%
522   {\romannumeral0\xINT_mul_fork #2\xint:#3\xint:}%
523   {\romannumeral0\xintiiadd {\XINT_mul_fork #2\xint:#6\xint:}%
524     {\XINT_mul_fork #1\xint:#4\xint:}}%
525   {\romannumeral0\xintiiadd {\XINT_mul_fork #2\xint:#5\xint:}%
526     {\XINT_mul_fork #1\xint:#3\xint:}}%
527 }%
528 \def\xINT_gctf_loop_c #1#2%
529 {%
530   \expandafter\xINT_gctf_loop_d\expandafter {\expandafter{#2}{#1}}%
531 }%
532 \def\xINT_gctf_loop_d #1#2%
533 {%
534   \expandafter\xINT_gctf_loop_e\expandafter {\expandafter{#2}{#1}}%
535 }%
536 \def\xINT_gctf_loop_e #1#2%
537 {%
538   \expandafter\xINT_gctf_loop_f\expandafter {\expandafter{#2}{#1}}%
539 }%
540 \def\xINT_gctf_loop_f #1#2/%
541 {%
542   \xint_gob_til_exclam #2\xINT_gctf_end!%
543   \expandafter\xINT_gctf_loop_g
544   \romannumeral0\xintraewithzeros {#2}.#1%
545 }%
546 \def\xINT_gctf_loop_g #1/#2.#3#4#5#6%
547 {%
548   \expandafter\xINT_gctf_loop_h\expandafter
549   {\romannumeral0\xINT_mul_fork #1\xint:#6\xint:}%
550   {\romannumeral0\xINT_mul_fork #1\xint:#5\xint:}%
551   {\romannumeral0\xINT_mul_fork #2\xint:#4\xint:}%
552   {\romannumeral0\xINT_mul_fork #2\xint:#3\xint:}%
553 }%
554 \def\xINT_gctf_loop_h #1#2%
555 {%

```

```

556 \expandafter\XINT_gctf_loop_i\expandafter {\expandafter{#2}{#1}}%
557 }%
558 \def\XINT_gctf_loop_i #1#2%
559 {%
560 \expandafter\XINT_gctf_loop_j\expandafter {\expandafter{#2}{#1}}%
561 }%
562 \def\XINT_gctf_loop_j #1#2%
563 {%
564 \expandafter\XINT_gctf_loop_a\expandafter {#2}{#1}%
565 }%
566 \def\XINT_gctf_end #1.#2#3#4#5{\xintrowwithzeros {#2/#3}}% 1.09b removes [0]

```

### 9.16 \xintiGctoF

```

567 \def\xintiGctoF {\romannumeral0\xintigctoF}%
568 \def\xintigctoF #1%
569 {%
570 \expandafter\XINT_igctf_prep \romannumeral`&&@#1+!/ %
571 }%
572 \def\XINT_igctf_prep
573 {%
574 \XINT_igctf_loop_a 1001%
575 }%
576 \def\XINT_igctf_loop_a #1#2#3#4#5+%
577 {%
578 \expandafter\XINT_igctf_loop_b
579 \romannumeral`&&@#5.{#1}{#2}{#3}{#4}%
580 }%
581 \def\XINT_igctf_loop_b #1.#2#3#4#5%
582 {%
583 \expandafter\XINT_igctf_loop_c\expandafter
584 {\romannumeral0\xintiiadd {#5}{\XINT_mul_fork #1\xint:#3\xint:}}%
585 {\romannumeral0\xintiiadd {#4}{\XINT_mul_fork #1\xint:#2\xint:}}%
586 {#2}{#3}%
587 }%
588 \def\XINT_igctf_loop_c #1#2%
589 {%
590 \expandafter\XINT_igctf_loop_f\expandafter {\expandafter{#2}{#1}}%
591 }%
592 \def\XINT_igctf_loop_f #1#2#3#4/%
593 {%
594 \xint_gob_til_exclam #4\XINT_igctf_end!%
595 \expandafter\XINT_igctf_loop_g
596 \romannumeral`&&@#4.{#2}{#3}{#1}%
597 }%
598 \def\XINT_igctf_loop_g #1.#2#3%
599 {%
600 \expandafter\XINT_igctf_loop_h\expandafter
601 {\romannumeral0\XINT_mul_fork #1\xint:#3\xint:}%
602 {\romannumeral0\XINT_mul_fork #1\xint:#2\xint:}%
603 }%
604 \def\XINT_igctf_loop_h #1#2%
605 {%
606 \expandafter\XINT_igctf_loop_i\expandafter {#2}{#1}%

```

```

607 }%
608 \def\XINT_igctf_loop_i #1#2#3#4%
609 {%
610   \XINT_igctf_loop_a {#3}{#4}{#1}{#2}%
611 }%
612 \def\XINT_igctf_end #1.#2#3#4#5{\xintrawithzeros {#4/#5}}% 1.09b removes [0]

```

### 9.17 `\xintCtoCv`, `\xintCstoCv`

1.09m uses `\xintCSVtoList` on the argument of `\xintCstoCv` to allow spaces also before the commas. The original `\xintCstoCv` code became the one of the new `\xintCtoF` dealing with a braced rather than comma separated list.

```

613 \def\xintCstoCv {\romannumeral0\xintcstocv }%
614 \def\xintcstocv #1%
615 {%
616   \expandafter\XINT_ctcv_prep\romannumeral0\xintcsvtolist{#1}!%
617 }%
618 \def\xintCtoCv {\romannumeral0\xintctocv }%
619 \def\xintctocv #1%
620 {%
621   \expandafter\XINT_ctcv_prep\romannumeral`&&@#1!%
622 }%
623 \def\XINT_ctcv_prep
624 {%
625   \XINT_ctcv_loop_a {}1001%
626 }%
627 \def\XINT_ctcv_loop_a #1#2#3#4#5#6%
628 {%
629   \xint_gob_til_exclam #6\XINT_ctcv_end!%
630   \expandafter\XINT_ctcv_loop_b
631   \romannumeral0\xintrawithzeros {#6}#{#2}{#3}{#4}{#5}{#1}%
632 }%
633 \def\XINT_ctcv_loop_b #1/#2.#3#4#5#6%
634 {%
635   \expandafter\XINT_ctcv_loop_c\expandafter
636   {\romannumeral0\XINT_mul_fork #2\xint:#4\xint:}%
637   {\romannumeral0\XINT_mul_fork #2\xint:#3\xint:}%
638   {\romannumeral0\xintiiadd {\XINT_mul_fork #2\xint:#6\xint:}%
639     {\XINT_mul_fork #1\xint:#4\xint:}}%
640   {\romannumeral0\xintiiadd {\XINT_mul_fork #2\xint:#5\xint:}%
641     {\XINT_mul_fork #1\xint:#3\xint:}}%
642 }%
643 \def\XINT_ctcv_loop_c #1#2%
644 {%
645   \expandafter\XINT_ctcv_loop_d\expandafter {\expandafter{#2}{#1}}%
646 }%
647 \def\XINT_ctcv_loop_d #1#2%
648 {%
649   \expandafter\XINT_ctcv_loop_e\expandafter {\expandafter{#2}#1}%
650 }%
651 \def\XINT_ctcv_loop_e #1#2%
652 {%
653   \expandafter\XINT_ctcv_loop_f\expandafter{#2}#1%

```

```

654 }%
655 \def\XINT_ctcv_loop_f #1#2#3#4#5%
656 {%
657   \expandafter\XINT_ctcv_loop_g\expandafter
658   {\romannumeral0\xintraawithzeros {#1/#2}}{#5}{#1}{#2}{#3}{#4}%
659 }%
660 \def\XINT_ctcv_loop_g #1#2{\XINT_ctcv_loop_a {#2{#1}}}% 1.09b removes [0]
661 \def\XINT_ctcv_end #1.#2#3#4#5#6{ #6}%

```

### 9.18 *\xintiCstoCv*

```

662 \def\xintiCstoCv {\romannumeral0\xinticstocv }%
663 \def\xinticstocv #1%
664 {%
665   \expandafter\XINT_icstcv_prep \romannumeral`&&@#1,!,%
666 }%
667 \def\XINT_icstcv_prep
668 {%
669   \XINT_icstcv_loop_a {}1001%
670 }%
671 \def\XINT_icstcv_loop_a #1#2#3#4#5#6,%
672 {%
673   \xint_gob_til_exclam #6\XINT_icstcv_end!%
674   \expandafter
675   \XINT_icstcv_loop_b \romannumeral`&&@#6.{#2}{#3}{#4}{#5}{#1}%
676 }%
677 \def\XINT_icstcv_loop_b #1.#2#3#4#5%
678 {%
679   \expandafter\XINT_icstcv_loop_c\expandafter
680   {\romannumeral0\xintiiadd {#5}{\XINT_mul_fork #1\xint:#3\xint:}}%
681   {\romannumeral0\xintiiadd {#4}{\XINT_mul_fork #1\xint:#2\xint:}}%
682   {{#2}{#3}}%
683 }%
684 \def\XINT_icstcv_loop_c #1#2%
685 {%
686   \expandafter\XINT_icstcv_loop_d\expandafter {#2}{#1}%
687 }%
688 \def\XINT_icstcv_loop_d #1#2%
689 {%
690   \expandafter\XINT_icstcv_loop_e\expandafter
691   {\romannumeral0\xintraawithzeros {#1/#2}}{#1}{#2}}%
692 }%
693 \def\XINT_icstcv_loop_e #1#2#3#4{\XINT_icstcv_loop_a {#4{#1}}#2#3}%
694 \def\XINT_icstcv_end #1.#2#3#4#5#6{ #6}% 1.09b removes [0]

```

### 9.19 *\xintGctoCv*

```

695 \def\xintGctoCv {\romannumeral0\xintgctocv }%
696 \def\xintgctocv #1%
697 {%
698   \expandafter\XINT_gctcv_prep \romannumeral`&&@#1+!/,%
699 }%
700 \def\XINT_gctcv_prep
701 {%

```



```

702 \XINT_gctcv_loop_a {}1001%
703 }%
704 \def\XINT_gctcv_loop_a #1#2#3#4#5#6+%
705 {%
706 \expandafter\XINT_gctcv_loop_b
707 \romannumeral0\xintraewithzeros {#6}. {#2}{#3}{#4}{#5}{#1}%
708 }%
709 \def\XINT_gctcv_loop_b #1/#2.#3#4#5#6%
710 {%
711 \expandafter\XINT_gctcv_loop_c\expandafter
712 {\romannumeral0\XINT_mul_fork #2\xint:#4\xint:}%
713 {\romannumeral0\XINT_mul_fork #2\xint:#3\xint:}%
714 {\romannumeral0\xintiiadd {\XINT_mul_fork #2\xint:#6\xint:}%
715 {\XINT_mul_fork #1\xint:#4\xint:}}%
716 {\romannumeral0\xintiiadd {\XINT_mul_fork #2\xint:#5\xint:}%
717 {\XINT_mul_fork #1\xint:#3\xint:}}%
718 }%
719 \def\XINT_gctcv_loop_c #1#2%
720 {%
721 \expandafter\XINT_gctcv_loop_d\expandafter {\expandafter{#2}{#1}}%
722 }%
723 \def\XINT_gctcv_loop_d #1#2%
724 {%
725 \expandafter\XINT_gctcv_loop_e\expandafter {\expandafter{#2}{#1}}%
726 }%
727 \def\XINT_gctcv_loop_e #1#2%
728 {%
729 \expandafter\XINT_gctcv_loop_f\expandafter {#2}#1%
730 }%
731 \def\XINT_gctcv_loop_f #1#2%
732 {%
733 \expandafter\XINT_gctcv_loop_g\expandafter
734 {\romannumeral0\xintraewithzeros {#1/#2}}{#1}{#2}}%
735 }%
736 \def\XINT_gctcv_loop_g #1#2#3#4%
737 {%
738 \XINT_gctcv_loop_h {#4{#1}}{#2#3}% 1.09b removes [0]
739 }%
740 \def\XINT_gctcv_loop_h #1#2#3/%
741 {%
742 \xint_gob_til_exclam #3\XINT_gctcv_end!%
743 \expandafter\XINT_gctcv_loop_i
744 \romannumeral0\xintraewithzeros {#3}.#2{#1}%
745 }%
746 \def\XINT_gctcv_loop_i #1/#2.#3#4#5#6%
747 {%
748 \expandafter\XINT_gctcv_loop_j\expandafter
749 {\romannumeral0\XINT_mul_fork #1\xint:#6\xint:}%
750 {\romannumeral0\XINT_mul_fork #1\xint:#5\xint:}%
751 {\romannumeral0\XINT_mul_fork #2\xint:#4\xint:}%
752 {\romannumeral0\XINT_mul_fork #2\xint:#3\xint:}%
753 }%

```

```

754 \def\XINT_gctcv_loop_j #1#2%
755 {%
756   \expandafter\XINT_gctcv_loop_k\expandafter {\expandafter{#2}{#1}}%
757 }%
758 \def\XINT_gctcv_loop_k #1#2%
759 {%
760   \expandafter\XINT_gctcv_loop_l\expandafter {\expandafter{#2}{#1}}%
761 }%
762 \def\XINT_gctcv_loop_l #1#2%
763 {%
764   \expandafter\XINT_gctcv_loop_m\expandafter {\expandafter{#2}{#1}}%
765 }%
766 \def\XINT_gctcv_loop_m #1#2{\XINT_gctcv_loop_a {#2}{#1}}%
767 \def\XINT_gctcv_end #1.#2#3#4#5#6{ #6}%

```

## 9.20 \xintiGctoCv

```

768 \def\xintiGctoCv {\romannumeral0\xintigctocv }%
769 \def\xintigctocv #1%
770 {%
771   \expandafter\XINT_igctcv_prep \romannumeral`&&@#1+!/;%
772 }%
773 \def\XINT_igctcv_prep
774 {%
775   \XINT_igctcv_loop_a {}1001%
776 }%
777 \def\XINT_igctcv_loop_a #1#2#3#4#5#6+%
778 {%
779   \expandafter\XINT_igctcv_loop_b
780   \romannumeral`&&@#6.{#2}{#3}{#4}{#5}{#1}%
781 }%
782 \def\XINT_igctcv_loop_b #1.#2#3#4#5%
783 {%
784   \expandafter\XINT_igctcv_loop_c\expandafter
785   {\romannumeral0\xintiiadd {#5}{\XINT_mul_fork #1\xint:#3\xint:}}%
786   {\romannumeral0\xintiiadd {#4}{\XINT_mul_fork #1\xint:#2\xint:}}%
787   {{#2}{#3}}%
788 }%
789 \def\XINT_igctcv_loop_c #1#2%
790 {%
791   \expandafter\XINT_igctcv_loop_f\expandafter {\expandafter{#2}{#1}}%
792 }%
793 \def\XINT_igctcv_loop_f #1#2#3#4/%
794 {%
795   \xint_gob_til_exclam #4\XINT_igctcv_end_a!%
796   \expandafter\XINT_igctcv_loop_g
797   \romannumeral`&&@#4.#1#2{#3}%
798 }%
799 \def\XINT_igctcv_loop_g #1.#2#3#4#5%
800 {%
801   \expandafter\XINT_igctcv_loop_h\expandafter
802   {\romannumeral0\XINT_mul_fork #1\xint:#5\xint:}%
803   {\romannumeral0\XINT_mul_fork #1\xint:#4\xint:}%
804   {{#2}{#3}}%

```

```

805 }%
806 \def\XINT_igctcv_loop_h #1#2%
807 {%
808   \expandafter\XINT_igctcv_loop_i\expandafter {\expandafter{#2}{#1}}%
809 }%
810 \def\XINT_igctcv_loop_i #1#2{\XINT_igctcv_loop_k #2{#2#1}}%
811 \def\XINT_igctcv_loop_k #1#2%
812 {%
813   \expandafter\XINT_igctcv_loop_l\expandafter
814   {\romannumeral0\xintraewithzeros {#1/#2}}%
815 }%
816 \def\XINT_igctcv_loop_l #1#2#3{\XINT_igctcv_loop_a {#3{#1}}#2}%1.09i removes [0]
817 \def\XINT_igctcv_end_a #1.#2#3#4#5%
818 {%
819   \expandafter\XINT_igctcv_end_b\expandafter
820   {\romannumeral0\xintraewithzeros {#2/#3}}%
821 }%
822 \def\XINT_igctcv_end_b #1#2{ #2{#1}}% 1.09b removes [0]

```

### 9.21 `\xintFtoCv`

Still uses `\xinticstocv` `\xintFtoCs` rather than `\xintctocv` `\xintFtoC`.

```

823 \def\xintFtoCv {\romannumeral0\xintftocv }%
824 \def\xintftocv #1%
825 {%
826   \xinticstocv {\xintFtoCs {#1}}%
827 }%

```

### 9.22 `\xintFtoCCv`

```

828 \def\xintFtoCCv {\romannumeral0\xintftoccv }%
829 \def\xintftoccv #1%
830 {%
831   \xintigctocv {\xintFtoCC {#1}}%
832 }%

```

### 9.23 `\xintCntoF`

Modified in 1.06 to give the N first to a `\numexpr` rather than expanding twice. I just use `\the\numexpr` and maintain the previous code after that.

```

833 \def\xintCntoF {\romannumeral0\xintcntof }%
834 \def\xintcntof #1%
835 {%
836   \expandafter\XINT_cntf\expandafter {\the\numexpr #1}%
837 }%
838 \def\XINT_cntf #1#2%
839 {%
840   \ifnum #1>\xint_c_
841     \xint_afterfi {\expandafter\XINT_cntf_loop\expandafter
842                   {\the\numexpr #1-1\expandafter}\expandafter
843                   {\romannumeral`&&@#2{#1}}{#2}}%
844   \else

```

```

845     \xint_afterfi
846     {\ifnum #1=\xint_c_
847       \xint_afterfi {\expandafter\space \romannumeral`&&@#2{0}}}%
848       \else \xint_afterfi { }% 1.09m now returns nothing.
849     \fi}%
850   \fi
851 }%
852 \def\xint_cntf_loop #1#2#3%
853 {%
854   \ifnum #1>\xint_c_ \else \XINT_cntf_exit \fi
855   \expandafter\XINT_cntf_loop\expandafter
856   {\the\numexpr #1-1\expandafter }\expandafter
857   {\romannumeral0\xintadd {\xintDiv {1[0]}\{#2}\{#3{#1}}}%
858   {#3}%
859 }%
860 \def\xint_cntf_exit \fi
861   \expandafter\XINT_cntf_loop\expandafter
862   #1\expandafter #2#3%
863 {%
864   \fi\xint_gobble_ii #2%
865 }%

```

## 9.24 \xintGCntoF

Modified in 1.06 to give the N argument first to a \numexpr rather than expanding twice. I just use \the\numexpr and maintain the previous code after that.

```

866 \def\xintGCntoF {\romannumeral0\xintgcntof }%
867 \def\xintgcntof #1%
868 {%
869   \expandafter\XINT_gcntf\expandafter {\the\numexpr #1}%
870 }%
871 \def\XINT_gcntf #1#2#3%
872 {%
873   \ifnum #1>\xint_c_
874     \xint_afterfi {\expandafter\XINT_gcntf_loop\expandafter
875       {\the\numexpr #1-1\expandafter}\expandafter
876       {\romannumeral`&&@#2{#1}\{#2}\{#3}}}%
877   \else
878     \xint_afterfi
879     {\ifnum #1=\xint_c_
880       \xint_afterfi {\expandafter\space\romannumeral`&&@#2{0}}}%
881       \else \xint_afterfi { }% 1.09m now returns nothing rather than 0/1[0]
882     \fi}%
883   \fi
884 }%
885 \def\XINT_gcntf_loop #1#2#3#4%
886 {%
887   \ifnum #1>\xint_c_ \else \XINT_gcntf_exit \fi
888   \expandafter\XINT_gcntf_loop\expandafter
889   {\the\numexpr #1-1\expandafter }\expandafter
890   {\romannumeral0\xintadd {\xintDiv {#4{#1}}\{#2}\{#3{#1}}}%
891   {#3}\{#4}%

```

```

892 }%
893 \def\XINT_gcntf_exit \fi
894   \expandafter\XINT_gcntf_loop\expandafter
895   #1\expandafter #2#3#4%
896 {%
897   \fi\xint_gobble_ii #2%
898 }%

```

## 9.25 `\xintCntoCs`

Modified in 1.09m: added spaces after the commas in the produced list. Moreover the coefficients are not braced anymore. A slight induced limitation is that the macro argument should not contain some explicit comma (cf. `\XINT_cntcs_exit_b`), hence `\xintCntoCs {\macro,}` with `\def\macro,#1{<stuff>}` would crash. Not a very serious limitation, I believe.

```

899 \def\xintCntoCs {\romannumeral0\xintcntocs }%
900 \def\xintcntocs #1%
901 {%
902   \expandafter\XINT_cntcs\expandafter {\the\numexpr #1}%
903 }%
904 \def\XINT_cntcs #1#2%
905 {%
906   \ifnum #1<0
907     \xint_afterfi { }% 1.09i: a 0/1[0] was here, now the macro returns nothing
908   \else
909     \xint_afterfi {\expandafter\XINT_cntcs_loop\expandafter
910                   {\the\numexpr #1-\xint_c_i\expandafter}\expandafter
911                   {\romannumeral`&&@#2{#1}}{#2}}% produced coeff not braced
912   \fi
913 }%
914 \def\XINT_cntcs_loop #1#2#3%
915 {%
916   \ifnum #1>-\xint_c_i \else \XINT_cntcs_exit \fi
917   \expandafter\XINT_cntcs_loop\expandafter
918   {\the\numexpr #1-\xint_c_i\expandafter}\expandafter
919   {\romannumeral`&&@#3{#1}, #2}{#3}% space added, 1.09m
920 }%
921 \def\XINT_cntcs_exit \fi
922   \expandafter\XINT_cntcs_loop\expandafter
923   #1\expandafter #2#3%
924 {%
925   \fi\XINT_cntcs_exit_b #2%
926 }%
927 \def\XINT_cntcs_exit_b #1,{}% romannumeral stopping space already there

```

## 9.26 `\xintCntoGC`

Modified in 1.06 to give the N first to a `\numexpr` rather than expanding twice. I just use `\the\numexpr` and maintain the previous code after that.

1.09m maintains the braces, as the coeff are allowed to be fraction and the slash can not be naked in the GC format, contrarily to what happens in `\xintCntoCs`. Also the separators given to `\xintGctoGCx` may then fetch the coefficients as argument, as they are braced.

```

928 \def\xintCntoGC {\romannumeral0\xintcntogc }%
929 \def\xintcntogc #1%
930 {%
931   \expandafter\XINT_cntgc\expandafter {\the\numexpr #1}%
932 }%
933 \def\XINT_cntgc #1#2%
934 {%
935   \ifnum #1<0
936     \xint_afterfi { }% 1.09i there was as strange 0/1[0] here, removed
937   \else
938     \xint_afterfi {\expandafter\XINT_cntgc_loop\expandafter
939                   {\the\numexpr #1-\xint_c_i\expandafter}\expandafter
940                   {\expandafter{\romannumeral`&&@#2{#1}}{#2}}}%
941   \fi
942 }%
943 \def\XINT_cntgc_loop #1#2#3%
944 {%
945   \ifnum #1>-\xint_c_i \else \XINT_cntgc_exit \fi
946   \expandafter\XINT_cntgc_loop\expandafter
947   {\the\numexpr #1-\xint_c_i\expandafter }\expandafter
948   {\expandafter{\romannumeral`&&@#3{#1}}+1/#2}{#3}%
949 }%
950 \def\XINT_cntgc_exit \fi
951   \expandafter\XINT_cntgc_loop\expandafter
952   #1\expandafter #2#3%
953 {%
954   \fi\XINT_cntgc_exit_b #2%
955 }%
956 \def\XINT_cntgc_exit_b #1+1/{ }%

```

## 9.27 \xintGCntoGC

Modified in 1.06 to give the N first to a \numexpr rather than expanding twice. I just use \the\numexpr and maintain the previous code after that.

```

957 \def\xintGCntoGC {\romannumeral0\xintgcntogc }%
958 \def\xintgcntogc #1%
959 {%
960   \expandafter\XINT_gcntgc\expandafter {\the\numexpr #1}%
961 }%
962 \def\XINT_gcntgc #1#2#3%
963 {%
964   \ifnum #1<0
965     \xint_afterfi { }% 1.09i now returns nothing
966   \else
967     \xint_afterfi {\expandafter\XINT_gcntgc_loop\expandafter
968                   {\the\numexpr #1-\xint_c_i\expandafter}\expandafter
969                   {\expandafter{\romannumeral`&&@#2{#1}}{#2}{#3}}}%
970   \fi
971 }%
972 \def\XINT_gcntgc_loop #1#2#3#4%
973 {%
974   \ifnum #1>-\xint_c_i \else \XINT_gcntgc_exit \fi

```

```

975 \expandafter\XINT_gcntgc_loop_b\expandafter
976 {\expandafter{\romannumeral`&&@#4{#1}}/#2}{#3{#1}}{#1}{#3}{#4}%
977 }%
978 \def\XINT_gcntgc_loop_b #1#2#3%
979 {%
980 \expandafter\XINT_gcntgc_loop\expandafter
981 {\the\numexpr #3-\xint_c_i \expandafter}\expandafter
982 {\expandafter{\romannumeral`&&@#2}+#1}%
983 }%
984 \def\XINT_gcntgc_exit \fi
985 \expandafter\XINT_gcntgc_loop_b\expandafter #1#2#3#4#5%
986 {%
987 \fi\XINT_gcntgc_exit_b #1%
988 }%
989 \def\XINT_gcntgc_exit_b #1/{ }%

```

### 9.28 \xintCstoGC

```

990 \def\xintCstoGC {\romannumeral0\xintcstogc }%
991 \def\xintcstogc #1%
992 {%
993 \expandafter\XINT_cstc_prep \romannumeral`&&@#1,!,%
994 }%
995 \def\XINT_cstc_prep #1,{\XINT_cstc_loop_a {{#1}}}%
996 \def\XINT_cstc_loop_a #1#2,%
997 {%
998 \xint_gob_til_exclam #2\XINT_cstc_end!%
999 \XINT_cstc_loop_b {#1}{#2}%
1000 }%
1001 \def\XINT_cstc_loop_b #1#2{\XINT_cstc_loop_a {#1+1/{#2}}}%
1002 \def\XINT_cstc_end!\XINT_cstc_loop_b #1#2{ #1}%

```

### 9.29 \xintGctoGC

```

1003 \def\xintGctoGC {\romannumeral0\xintgctogc }%
1004 \def\xintgctogc #1%
1005 {%
1006 \expandafter\XINT_gctgc_start \romannumeral`&&@#1+!/,%
1007 }%
1008 \def\XINT_gctgc_start {\XINT_gctgc_loop_a {}}%
1009 \def\XINT_gctgc_loop_a #1#2+#3/%
1010 {%
1011 \xint_gob_til_exclam #3\XINT_gctgc_end!%
1012 \expandafter\XINT_gctgc_loop_b\expandafter
1013 {\romannumeral`&&@#2}{#3}{#1}%
1014 }%
1015 \def\XINT_gctgc_loop_b #1#2%
1016 {%
1017 \expandafter\XINT_gctgc_loop_c\expandafter
1018 {\romannumeral`&&@#2}{#1}%
1019 }%
1020 \def\XINT_gctgc_loop_c #1#2#3%
1021 {%
1022 \XINT_gctgc_loop_a {#3{#2}+#1}/}%

```

## 9 Package *xintcfrac* implementation

```
1023 }%
1024 \def\XINT_gctgc_end!\expandafter\XINT_gctgc_loop_b
1025 {%
1026     \expandafter\XINT_gctgc_end_b
1027 }%
1028 \def\XINT_gctgc_end_b #1#2#3{ #3{#1}}%
1029 \XINT_restorecatcodes_endinput%
```



## 10 Package `xintexpr` implementation

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This is release 1.2n of [2017/08/06].

## 10.1 Old comments

These general comments were last updated at the end of the 1.09x series in 2014. The principles remain in place to this day but refer to [CHANGES.html](#) for some significant evolutions since.

The first version was released in June 2013. I was greatly helped in this task of writing an expandable parser of infix operations by the comments provided in `l3fp-parse.dtx` (in its version as available in April-May 2013). One will recognize in particular the idea of the ``until'` macros; I have not looked into the actual `l3fp` code beyond the very useful comments provided in its documentation.

A main worry was that my data has no a priori bound on its size; to keep the code reasonably efficient, I experimented with a technique of storing and retrieving data expandably as *names* of control sequences. Intermediate computation results are stored as control sequences `\.=a/b[n]`.

Roughly speaking, the parser mechanism is as follows: at any given time the last found ``operator'` has its associated `until` macro awaiting some news from the token flow; first `getnext` expands forward in the hope to construct some number, which may come from a parenthesized sub-expression, from some braced material, or from a digit by digit scan. After this number has been formed the next operator is looked for by the `getop` macro. Once `getop` has finished its job, `until` is presented with three tokens: the first one is the precedence level of the new found operator (which may be an end of expression marker), the second is the operator character token (earlier versions had here already some macro name, but in order to keep as much common code to `expr` and `floatexpr` common as possible, this was modified) of the new found operator, and the third one is the newly found number (which was encountered just before the new operator).

The `until` macro of the earlier operator examines the precedence level of the new found one, and either executes the earlier operator (in the case of a binary operation, with the found number and a previously stored one) or it delays execution, giving the hand to the `until` macro of the operator having been found of higher precedence.

A minus sign acting as prefix gets converted into a (unary) operator inheriting the precedence level of the previous operator.

Once the end of the expression is found (it has to be marked by a `\relax`) the final result is output as four tokens (five tokens since 1.09j) the first one a catcode 11 exclamation mark, the second one an error generating macro, the third one is a protection mechanism, the fourth one a printing macro and the fifth is `\.=a/b[n]`. The prefix `\xintthe` makes the output printable by killing the first three tokens.

## 10.2 Catcodes, $\varepsilon$ -T<sub>E</sub>X and reload detection

The code for reload detection was initially copied from HEIKO OBERDIEK's packages, then modified.

The method for catcodes was also initially directly inspired by these packages.

```
1 \begingroup\catcode61\catcode48\catcode32=10\relax%
```

```

2 \catcode13=5 % ^^M
3 \endlinechar=13 %
4 \catcode123=1 % {
5 \catcode125=2 % }
6 \catcode64=11 % @
7 \catcode35=6 % #
8 \catcode44=12 % ,
9 \catcode45=12 % -
10 \catcode46=12 % .
11 \catcode58=12 % :
12 \def\z {\endgroup}%
13 \expandafter\let\expandafter\x\csname ver@xintexpr.sty\endcsname
14 \expandafter\let\expandafter\w\csname ver@xintfrac.sty\endcsname
15 \expandafter\let\expandafter\t\csname ver@xinttools.sty\endcsname
16 \expandafter
17 \ifx\csname PackageInfo\endcsname\relax
18 \def\y#1#2{\immediate\write-1{Package #1 Info: #2.}}%
19 \else
20 \def\y#1#2{\PackageInfo{#1}{#2}}%
21 \fi
22 \expandafter
23 \ifx\csname numexpr\endcsname\relax
24 \y{xintexpr}{numexpr not available, aborting input}%
25 \aftergroup\endinput
26 \else
27 \ifx\x\relax % plain-TeX, first loading of xintexpr.sty
28 \ifx\w\relax % but xintfrac.sty not yet loaded.
29 \expandafter\def\expandafter\z\expandafter
30 {\z\input xintfrac.sty\relax}%
31 \fi
32 \ifx\t\relax % but xinttools.sty not yet loaded.
33 \expandafter\def\expandafter\z\expandafter
34 {\z\input xinttools.sty\relax}%
35 \fi
36 \else
37 \def\empty {}%
38 \ifx\x\empty % LaTeX, first loading,
39 % variable is initialized, but \ProvidesPackage not yet seen
40 \ifx\w\relax % xintfrac.sty not yet loaded.
41 \expandafter\def\expandafter\z\expandafter
42 {\z\RequirePackage{xintfrac}}%
43 \fi
44 \ifx\t\relax % xinttools.sty not yet loaded.
45 \expandafter\def\expandafter\z\expandafter
46 {\z\RequirePackage{xinttools}}%
47 \fi
48 \else
49 \aftergroup\endinput % xintexpr already loaded.
50 \fi
51 \fi
52 \fi
53 \z%
```

```
54 \XINTsetupcatcodes%
```

### 10.3 Package identification

```
55 \XINT_providespackage
56 \ProvidesPackage{xintexpr}%
57 [2017/08/06 1.2n Expandable expression parser (JFB)]%
58 \catcode\! 11
59 \let\XINT_Cmp \xintiiCmp
```

### 10.4 Locking and unlocking

Some renaming and modifications here with release 1.2 to switch from using chains of `\romannumeral-`0` in order to gather numbers, possibly hexadecimal, to using a `\csname` governed expansion. In this way no more limit at 5000 digits, and besides this is a logical move because the `\xintexpr` parser is already based on `\csname...\endcsname` storage of numbers as one token.

The limitation at 5000 digits didn't worry me too much because it was not very realistic to launch computations with thousands of digits... such computations are still slow with 1.2 but less so now. Chains or `\romannumeral` are still used for the gathering of function names and other stuff which I have half-forgotten because the parser does many things.

In the earlier versions we used the `lockscan` macro after a chain of `\romannumeral-`0` had ended gathering digits; this uses has been replaced by direct processing inside a `\csname...\endcsname` and the macro is kept only for matters of dummy variables.

Currently, the parsing of hexadecimal numbers needs two nested `\csname...\endcsname`, first to gather the letters (possibly with a hexadecimal fractional part), and in a second stage to apply `\xintHexToDec` to do the actual conversion. This should be faster than updating on the fly the number (which would be hard for the fraction part...). The macro `\xintHexToDec` could probably be made faster by using techniques similar as the ones 1.2 uses in `xintcore.sty`.

```
60 \def\xint_gob_til_! #1!{% ! with catcode 11
61 \def\XINT_expr_lockscan#1{% not used for decimal numbers in xintexpr 1.2
62 \def\XINT_expr_lockscan##1!{\expandafter#1\csname .##1\endcsname}%
63 }\XINT_expr_lockscan{ }%
64 \def\XINT_expr_lockit#1{%
65 \def\XINT_expr_lockit##1{\expandafter#1\csname .##1\endcsname}%
66 }\XINT_expr_lockit{ }%
67 \def\XINT_expr_unlock_hex_in #1% expanded inside \csname...\endcsname
68 {\expandafter\XINT_expr_inhex\romannumeral`&&\XINT_expr_unlock#1;}%
69 \def\XINT_expr_inhex #1.#2#3;% expanded inside \csname...\endcsname
70 {%
71 \if#2>\xintHexToDec{#1}%
72 \else
73 \xintiiMul{\xintiiPow{625}{\xintLength{#3}}}{\xintHexToDec{#1#3}}%
74 [\the\numexpr-4*\xintLength{#3}]%
75 \fi
76 }%
77 \def\XINT_expr_unlock {\expandafter\XINT_expr_unlock_a\string }%
78 \def\XINT_expr_unlock_a #1.={}%
79 \def\XINT_expr_unexpectedtoken {\xintError:ignored }%
80 \let\XINT_expr_done\space
```

## 10.5 `\XINT_expr_wrap`, `\XINT_iexpr_wrap`

```
81 \def\XINT_expr_wrap { !\XINT_expr_usethe\XINT_protectii\XINT_expr_print }%
82 \def\XINT_iexpr_wrap { !\XINT_expr_usethe\XINT_protectii\XINT_iexpr_print }%
```

## 10.6 `\XINT_protectii`, `\XINT_expr_usethe`

```
83 \def\XINT_protectii #1{\noexpand\XINT_protectii\noexpand #1\noexpand }%
84 \protected\def\XINT_expr_usethe\XINT_protectii {\xintError:missing_xintthe!}%
```

## 10.7 `\XINT_expr_print`, `\XINT_iexpr_print`, `\XINT_boolexpr_print`

See also the `\XINT_flexpr_print` which is special, below.

```
85 \def\XINT_expr_print #1{\xintSPRaw::csv {\XINT_expr_unlock #1}}%
86 \def\XINT_iexpr_print #1{\xintCSV::csv {\XINT_expr_unlock #1}}%
87 \def\XINT_boolexpr_print #1{\xintIsTrue::csv {\XINT_expr_unlock #1}}%
```

## 10.8 `\xintexpr`, `\xintiexpr`, `\xintfloatexpr`, `\xintiexpr`

```
88 \def\xintexpr {\romannumeral0\xinteval }%
89 \def\xintiexpr {\romannumeral0\xintieval }%
90 \def\xintfloatexpr {\romannumeral0\xintfloateval }%
91 \def\xintiexpr {\romannumeral0\xintiieval }%
```

## 10.9 `\xinttheexpr`, `\xinttheiexpr`, `\xintthefloatexpr`, `\xinttheiexpr`

```
92 \def\xinttheexpr
93 {\romannumeral`&&\expandafter\XINT_expr_print\romannumeral0\xintbareeval }%
94 \def\xinttheiexpr {\romannumeral`&&\xintthe\xintiexpr }%
95 \def\xintthefloatexpr {\romannumeral`&&\xintthe\xintfloatexpr }%
96 \def\xinttheiexpr
97 {\romannumeral`&&\expandafter\XINT_iexpr_print\romannumeral0\xintbareiieval }%
```

## 10.10 `\xintthe`

```
98 \def\xintthe #1{\romannumeral`&&\expandafter\xint_gobble_iii\romannumeral`&&#1}%
```

## 10.11 `\thexintexpr`, `\thexintiexpr`, `\thexintfloatexpr`, `\thexintiexpr`

New with 1.2h. I have been three years long very strict in terms of prefixing macros, but well.

```
99 \let\thexintexpr \xinttheexpr
100 \let\thexintiexpr \xinttheiexpr
101 \let\thexintfloatexpr\xintthefloatexpr
102 \let\thexintiexpr \xinttheiexpr
```

## 10.12 `\xintthecoords`

1.1 Wraps up an even number of comma separated items into pairs of TikZ coordinates; for use in the following way:

```
coordinates {\xintthecoords\xintfloatexpr ... \relax}
```

The crazyness with the `\csname` and `unlock` is due to TikZ somewhat STRANGE control of the TOTAL number of expansions which should not exceed the very low value of 100 !! As we implemented `\XINT_thecoords_b` in an "inline" style for efficiency, we need to hide its expansions.

Not to be used as `\xintthecoords\xintthefloatexpr`, only as `\xintthecoords\xintfloatexpr` (or `\xintiexpr` etc...). Perhaps `\xintthecoords` could make an extra check, but one should not accustom users to too loose requirements!

```

103 \def\xintthecoords #1{\romannumeral`&&\expandafter\expandafter\expandafter
104     \XINT_thecoords_a
105     \expandafter\xint_gobble_iii\romannumeral0#1}%
106 \def\XINT_thecoords_a #1#2% #1=print macro, indispensable for scientific notation
107     {\expandafter\XINT_expr_unlock\csname.=\expandafter\XINT_thecoords_b
108         \romannumeral`&&@#1#2,!,!,^'\endcsname }%
109 \def\XINT_thecoords_b #1#2,#3#4,%
110     {\xint_gob_til_! #3\XINT_thecoords_c ! (#1#2, #3#4)\XINT_thecoords_b }%
111 \def\XINT_thecoords_c #1^{}%

```

### 10.13 \xintbareeval, \xintbarefloateval, \xintbareiieval

```

112 \def\xintbareeval
113     {\expandafter\XINT_expr_until_end_a\romannumeral`&&\XINT_expr_getnext }%
114 \def\xintbarefloateval
115     {\expandafter\XINT_flexpr_until_end_a\romannumeral`&&\XINT_expr_getnext }%
116 \def\xintbareiieval
117     {\expandafter\XINT_iexpr_until_end_a\romannumeral`&&\XINT_expr_getnext }%

```

### 10.14 \xintthebareeval, \xintthebarefloateval, \xintthebareiieval

```

118 \def\xintthebareeval      {\expandafter\XINT_expr_unlock\romannumeral0\xintbareeval}%
119 \def\xintthebarefloateval {\expandafter\XINT_expr_unlock\romannumeral0\xintbarefloateval}%
120 \def\xintthebareiieval    {\expandafter\XINT_expr_unlock\romannumeral0\xintbareiieval}%

```

### 10.15 \xinteval, \xintiieval

```

121 \def\xinteval    {\expandafter\XINT_expr_wrap\romannumeral0\xintbareeval }%
122 \def\xintiieval {\expandafter\XINT_iexpr_wrap\romannumeral0\xintbareiieval }%

```

### 10.16 \xintieval, \XINT\_iexpr\_wrap

Optional argument since 1.1.

```

123 \def\xintieval #1%
124     {\ifx [#1\expandafter\XINT_iexpr_withopt\else\expandafter\XINT_iexpr_noopt \fi #1}%
125 \def\XINT_iexpr_noopt
126     {\expandafter\XINT_iexpr_wrap \expandafter 0\romannumeral0\xintbareeval }%
127 \def\XINT_iexpr_withopt [#1]%
128 {%
129     \expandafter\XINT_iexpr_wrap\expandafter
130     {\the\numexpr \xint_zapspaces #1 \xint_gobble_i\expandafter}%
131     \romannumeral0\xintbareeval
132 }%
133 \def\XINT_iexpr_wrap #1#2%
134 {%
135     \expandafter\XINT_expr_wrap
136     \csname .=\xintRound::csv {#1}{\XINT_expr_unlock #2}\endcsname
137 }%

```

### 10.17 \xintfloateval, \XINT\_flexpr\_wrap, \XINT\_flexpr\_print

Optional argument since 1.1

```

138 \def\xintfloateval #1%

```

```

139 {%
140   \ifx [#1\expandafter\XINT_flexpr_withopt_a\else\expandafter\XINT_flexpr_noopt
141   \fi #1%
142 }%
143 \def\XINT_flexpr_noopt
144 {%
145   \expandafter\XINT_flexpr_withopt_b\expandafter\xinttheDigits
146   \romannumeral0\xintbarefloateval
147 }%
148 \def\XINT_flexpr_withopt_a [#1]%
149 {%
150   \expandafter\XINT_flexpr_withopt_b\expandafter
151   {\the\numexpr\xint_zapspace #1 \xint_gobble_i\expandafter}%
152   \romannumeral0\xintbarefloateval
153 }%
154 \def\XINT_flexpr_withopt_b #1#2%
155 {%
156   \expandafter\XINT_flexpr_wrap\csname .;#1.=% ; and not : as before b'cause NewExpr
157   \XINTinFloat::csv {#1}{\XINT_expr_unlock #2}\endcsname
158 }%
159 \def\XINT_flexpr_wrap { !\XINT_expr_usethe\XINT_protectii\XINT_flexpr_print }%
160 \def\XINT_flexpr_print #1%
161 {%
162   \expandafter\xintPFloat::csv
163   \romannumeral`&&\expandafter\XINT_expr_unlock_sp\string #1!%
164 }%
165 \catcode`: 12
166   \def\XINT_expr_unlock_sp #1.;#2.=#3!{{#2}{#3}}%
167 \catcode`: 11

```

## 10.18 \xintboolexpr, \xinttheboolexpr, \thexintboolexpr

```

168 \def\xintboolexpr      {\romannumeral0\expandafter\expandafter\expandafter
169   \XINT_boolexpr_done \expandafter\xint_gobble_iv\romannumeral0\xinteval }%
170 \def\xinttheboolexpr   {\romannumeral`&&\expandafter\expandafter\expandafter
171   \XINT_boolexpr_print\expandafter\xint_gobble_iv\romannumeral0\xinteval }%
172 \let\thexintboolexpr\xinttheboolexpr
173 \def\XINT_boolexpr_done { !\XINT_expr_usethe\XINT_protectii\XINT_boolexpr_print }%

```

## 10.19 \xintifboolexpr, \xintifboolfloatexpr, \xintifboolliexpr

Do not work with comma separated expressions.

```

174 \def\xintifboolexpr    #1{\romannumeral0\xintifnotzero {\xinttheexpr #1\relax}}%
175 \def\xintifboolfloatexpr #1{\romannumeral0\xintifnotzero {\xintthefloatexpr #1\relax}}%
176 \def\xintifboolliexpr  #1{\romannumeral0\xintifnotzero {\xinttheiiexpr #1\relax}}%

```

## 10.20 Macros handling csv lists on output (for \XINT\_expr\_print et al. routines)

10.20.1	\XINT:::end . . . . .	280
10.20.2	\xintCSV:::csv . . . . .	280
10.20.3	\xintSPRaw, \xintSPRaw:::csv . . . . .	280
10.20.4	\xintIsTrue:::csv . . . . .	280
10.20.5	\xintRound:::csv . . . . .	280

10.20.6	<code>\XINTinFloat::csv</code>	281
10.20.7	<code>\xintPFloat::csv</code>	281

Changed completely for 1.1, which adds the optional arguments to `\xintiexpr` and `\xintfloatexpr`.

### 10.20.1 `\XINT::_end`

Le mécanisme est le suivant, #2 est dans des accolades et commence par ,<sp>. Donc le gobble se débarrasse du, et le <sp> après brace stripping arrête un `\romannumeral0` ou `\romannumeral-`0`

```
177 \def\XINT::_end #1,#2{\xint_gobble_i #2}%
```

### 10.20.2 `\xintCSV::csv`

```
178 \def\xintCSV::csv #1{\expandafter\XINT_csv::_a\romannumeral`&&@#1,^}%
179 \def\XINT_csv::_a {\XINT_csv::_b {}}%
180 \def\XINT_csv::_b #1#2,{\expandafter\XINT_csv::_c \romannumeral`&&@#2,{#1}}%
181 \def\XINT_csv::_c #1{\if ^#1\expandafter\XINT::_end\fi\XINT_csv::_d #1}%
182 \def\XINT_csv::_d #1,#2{\XINT_csv::_b {#2, #1}}% possibly, item #1 is empty.
```

### 10.20.3 `\xintSPRaw, \xintSPRaw::csv`

```
183 \def\xintSPRaw {\romannumeral0\xintspraw }%
184 \def\xintspraw #1{\expandafter\XINT_spraw\romannumeral`&&@#1[\W]}%
185 \def\XINT_spraw #1[#2#3]{\xint_gob_til_W #2\XINT_spraw_a\W\XINT_spraw_p #1[#2#3]}%
186 \def\XINT_spraw_a\W\XINT_spraw_p #1[\W]{ #1}%
187 \def\XINT_spraw_p #1[\W]{\xintpraw {#1}}%
188 \def\xintSPRaw::csv #1{\romannumeral0\expandafter\XINT_spraw::_a\romannumeral`&&@#1,^}%
189 \def\XINT_spraw::_a {\XINT_spraw::_b {}}%
190 \def\XINT_spraw::_b #1#2,{\expandafter\XINT_spraw::_c \romannumeral`&&@#2,{#1}}%
191 \def\XINT_spraw::_c #1{\if ,#1\xint_dothis\XINT_spraw::_e\fi
192     \if ^#1\xint_dothis\XINT::_end\fi
193     \xint_orthat\XINT_spraw::_d #1}%
194 \def\XINT_spraw::_d #1,{\expandafter\XINT_spraw::_e\romannumeral0\XINT_spraw #1[\W],}%
195 \def\XINT_spraw::_e #1,#2{\XINT_spraw::_b {#2, #1}}%
```

### 10.20.4 `\xintIsTrue::csv`

```
196 \def\xintIsTrue::csv #1{\romannumeral0\expandafter\XINT_istrue::_a\romannumeral`&&@#1,^}%
197 \def\XINT_istrue::_a {\XINT_istrue::_b {}}%
198 \def\XINT_istrue::_b #1#2,{\expandafter\XINT_istrue::_c \romannumeral`&&@#2,{#1}}%
199 \def\XINT_istrue::_c #1{\if ,#1\xint_dothis\XINT_istrue::_e\fi
200     \if ^#1\xint_dothis\XINT::_end\fi
201     \xint_orthat\XINT_istrue::_d #1}%
202 \def\XINT_istrue::_d #1,{\expandafter\XINT_istrue::_e\romannumeral0\xintisnotzero {#1},}%
203 \def\XINT_istrue::_e #1,#2{\XINT_istrue::_b {#2, #1}}%
```

### 10.20.5 `\xintRound::csv`

```
204 \def\XINT::_end #1,#2#3{\xint_gobble_i #3}%
205 \def\xintRound::csv #1#2{\romannumeral0\expandafter\XINT_round::_b\expandafter
206     {\the\numexpr#1\expandafter}\expandafter{\expandafter}\romannumeral`&&@#2,^}%
207 \def\XINT_round::_b #1#2#3,{\expandafter\XINT_round::_c \romannumeral`&&@#3,{#1}{#2}}%
208 \def\XINT_round::_c #1{\if ,#1\xint_dothis\XINT_round::_e\fi
209     \if ^#1\xint_dothis\XINT::_end\fi
210     \xint_orthat\XINT_round::_d #1}%

```



```

211 \def\XINT_round::_d #1,#2{%
212     \expandafter\XINT_round::_e\romannumeral0\ifnum#2>\xint_c_
213     \expandafter\xintround\else\expandafter\xintiround\fi {#2}{#1},{#2}}%
214 \def\XINT_round::_e #1,#2#3{\XINT_round::_b {#2}{#3, #1}}%

```

#### 10.20.6 \XINTinFloat::csv

```

215 \def\XINTinFloat::csv #1#2{\romannumeral0\expandafter\XINT_infloat::_b\expandafter
216     {\the\numexpr #1\expandafter}\expandafter{\expandafter}\romannumeral`&&@#2,^,%}
217 \def\XINT_infloat::_b #1#2#3,{\XINT_infloat::_c #3,{#1}{#2}}%
218 \def\XINT_infloat::_c #1{\if ,#1\xint_dothis\XINT_infloat::_e\fi
219     \if ^#1\xint_dothis\XINT_:::_end\fi
220     \xint_orthat\XINT_infloat::_d #1}%
221 \def\XINT_infloat::_d #1,#2%
222     {\expandafter\XINT_infloat::_e\romannumeral0\XINTinfloat [#2]{#1},{#2}}%
223 \def\XINT_infloat::_e #1,#2#3{\XINT_infloat::_b {#2}{#3, #1}}%

```

#### 10.20.7 \xintPFloat::csv

```

224 \def\xintPFloat::csv #1#2{\romannumeral0\expandafter\XINT_pfloat::_b\expandafter
225     {\the\numexpr #1\expandafter}\expandafter{\expandafter}\romannumeral`&&@#2,^,%}
226 \def\XINT_pfloat::_b #1#2#3,{\expandafter\XINT_pfloat::_c \romannumeral`&&@#3,{#1}{#2}}%
227 \def\XINT_pfloat::_c #1{\if ,#1\xint_dothis\XINT_pfloat::_e\fi
228     \if ^#1\xint_dothis\XINT_:::_end\fi
229     \xint_orthat\XINT_pfloat::_d #1}%
230 \def\XINT_pfloat::_d #1,#2%
231     {\expandafter\XINT_pfloat::_e\romannumeral0\XINT_pfloat_opt [\xint:#2]{#1},{#2}}%
232 \def\XINT_pfloat::_e #1,#2#3{\XINT_pfloat::_b {#2}{#3, #1}}%

```

### 10.21 \XINT\_expr\_getnext: fetching some number then an operator

Big change in 1.1, no attempt to detect braced stuff anymore as the [N] notation is implemented otherwise. Now, braces should not be used at all; one level removed, then \romannumeral-`0 expansion.

```

233 \def\XINT_expr_getnext #1%
234 {%
235     \expandafter\XINT_expr_getnext_a\romannumeral`&&@#1%
236 }%
237 \def\XINT_expr_getnext_a #1%
238 {% screens out sub-expressions and \count or \dimen registers/variables
239     \xint_gob_til_! #1\XINT_expr_subexpr !% recall this ! has catcode 11
240     \ifcat\relax#1% \count or \numexpr etc... token or count, dimen, skip cs
241         \expandafter\XINT_expr_countetc
242     \else
243         \expandafter\expandafter\expandafter\XINT_expr_getnextfork\expandafter\string
244         \fi
245     #1%
246 }%
247 \def\XINT_expr_subexpr !#1\fi !{\expandafter\XINT_expr_getop\xint_gobble_iii }%

```

1.2 adds \ht, \dp, \wd and the eTeX font things.

```

248 \def\XINT_expr_countetc #1%
249 {%
250     \ifx\count#1\else\ifx\dimen#1\else\ifx\numexpr#1\else\ifx\dimexpr#1\else

```

```

251 \ifx\skip#1\else\ifx\glueexpr#1\else\ifx\fontdimen#1\else\ifx\ht#1\else
252 \ifx\dp#1\else\ifx\wd#1\else\ifx\fontcharht#1\else\ifx\fontcharwd#1\else
253 \ifx\fontchardp#1\else\ifx\fontcharic#1\else
254 \XINT_expr_unpackvar
255 \fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi
256 \expandafter\XINT_expr_getnext\number #1%
257 }%
258 \def\XINT_expr_unpackvar\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi
259 \expandafter\XINT_expr_getnext\number #1%
260 {\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi\fi
261 \expandafter\XINT_expr_getop\csname .=\number#1\endcsname }%
262 \begingroup
263 \lccode`*=`#
264 \lowercase{\endgroup
265 \def\XINT_expr_getnextfork #1{%
266 \if#1*\xint_dothis {\XINT_expr_scan_macropar *}\fi
267 \if#1[\xint_dothis {\xint_c_xviii {}}\fi
268 \if#1+\xint_dothis \XINT_expr_getnext \fi
269 \if#1.\xint_dothis {\XINT_expr_startdec}\fi
270 \if#1-\xint_dothis -\fi
271 \if#1(\xint_dothis {\xint_c_xviii {}}\fi
272 \xint_orthat {\XINT_expr_scan_nbr_or_func #1}%
273 }}%
274 \def\XINT_expr_scan_macropar #1#2{\expandafter\XINT_expr_getop\csname .=#1#2\endcsname }%

```

## 10.22 The integer or decimal number or hexa-decimal number or function name or variable name or special hacky things big parser

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1.2 release has replaced chains of `\romannumeral-`0` by `\csname` governed expansion. Thus there is no more the limit at about 5000 digits for parsed numbers.

In order to avoid having to lock and unlock in succession to handle the scientific part and adjust the exponent according to the number of digits of the decimal part, the parsing of this decimal part counts on the fly the number of digits it encounters.

There is some slight annoyance with `\xintiexpr` which should never be given a `[n]` inside its `\csname.<digits>\endcsname` storage of numbers (because its arithmetic uses the `ii` macros which know nothing about the `[N]` notation). Hence if the parser has only seen digits when hitting something else than the dot or e (or E), it will not insert a `[0]`. Thus we very slightly compromise the efficiency of `\xintexpr` and `\xintfloatexpr` in order to be able to share the same code with `\xintiexpr`.

Indeed, the parser at this location is completely common to all, it does not know if it is working inside `\xintexpr` or `\xintiexpr`. On the other hand if a dot or a e (or E) is met, then the (common) parser has no scruples ending this number with a `[n]`, this will provoke an error later if that was within an `\xintiexpr`, as soon as an arithmetic macro is used.

As the gathered numbers have no spaces, no pluses, no minuses, the only remaining issue is with leading zeroes, which are discarded on the fly. The hexadecimal numbers leading zeroes are stripped in a second stage by the `\xintHexToDec` macro.

With 1.2, `\xinttheexpr . \relax` does not work anymore (it did in earlier releases). There must be digits either before or after the decimal mark. Thus both `\xinttheexpr 1.\relax` and `\xinttheexpr .1\relax` are legal.

The ``` syntax is here used for special constructs like ``+`(..)`, ``*`(..)` where `+` or `*` will be treated as functions. Current implementation pick only one token (could have been braced stuff), thus here it will be `+` or `*`, and via `\XINT_expr_op_`` this into becomes a suitable `\XINT_{expr|iiexpr|flexpr}_func_+` (or `*`). Documentation of 1.1 said to use ``+`(..)`, but ``+`(...)` is also valid. The opening parenthesis must be there, it is not allowed to come from expansion.

```

275 \catcode96 11 % `
276 \def\XINT_expr_scan_nbr_or_func #1% this #1 has necessarily here catcode 12
277 {%
278   \if "#1\xint_dothis \XINT_expr_scanhex_I\fi
279   \if `#1\xint_dothis {\XINT_expr_onlitteral_`}\fi
280   \ifnum \xint_c_ix<1#1 \xint_dothis \XINT_expr_startint\fi
281   \xint_orthat \XINT_expr_scanfunc #1%
282 }%
283 \def\XINT_expr_onlitteral_` #1#2#3({\xint_c_xviii `{#2}}%
284 \catcode96 12 % `
285 \def\XINT_expr_startint #1%
286 {%
287   \if #10\expandafter\XINT_expr_gobz_a\else\XINT_expr_scanint_a\fi #1%
288 }%
289 \def\XINT_expr_scanint_a #1#2%
290   {\expandafter\XINT_expr_getop\curname.=#1%
291   \expandafter\XINT_expr_scanint_b\romannumeral`&&@#2}%
292 \def\XINT_expr_gobz_a #1%
293   {\expandafter\XINT_expr_getop\curname.=
294   \expandafter\XINT_expr_gobz_scanint_b\romannumeral`&&@#1}%
295 \def\XINT_expr_startdec #1%
296   {\expandafter\XINT_expr_getop\curname.=
297   \expandafter\XINT_expr_scandec_a\romannumeral`&&@#1}%

```

### 10.22.1 Integral part (skipping zeroes)

1.2 has modified the code to give highest priority to digits, the accelerating impact is non-negligeable. I don't think the doubled `\string` is a serious penalty.

```

298 \def\XINT_expr_scanint_b #1%
299 {%
300   \ifcat \relax #1\expandafter\XINT_expr_scanint_endbycs\expandafter #1\fi
301   \ifnum\xint_c_ix<1\string#1 \else\expandafter\XINT_expr_scanint_c\fi
302   \string#1\XINT_expr_scanint_d
303 }%
304 \def\XINT_expr_scanint_d #1%
305 {%
306   \expandafter\XINT_expr_scanint_b\romannumeral`&&@#1%
307 }%
308 \def\XINT_expr_scanint_endbycs#1#2\XINT_expr_scanint_d{\endcsname #1}%

```

With 1.2d the tacit multiplication in front of a variable name or function name is now done with a higher precedence, intermediate between the common one of `*` and `/` and the one of `^`. Thus `x/2y` is like `x/(2y)`, but `x^2y` is like `x^2*y` and `2y!` is not `(2y)!` but `2*y!`.

Finally, 1.2d has moved away from the `_scan` macros all the business of the tacit multiplication in one unique place via `\XINT_expr_getop`. For this, the ending token is not first given to `\string` as was done earlier before handing over back control to `\XINT_expr_getop`. Earlier we had to identify the catcode 11 ! signaling a sub-expression here. With no `\string` applied we can do it in `\XINT_expr_getop`. As a corollary of this displacement, parsing of big numbers should be a tiny bit faster now.

Extended for 1.2l to ignore underscore character `_` if encountered within digits; so it can serve as separator for better readability.

```

309 \def\XINT_expr_scanint_c\string #1\XINT_expr_scanint_d
310 {%
311   \if _#1\xint_dothis\XINT_expr_scanint_d\fi
312   \if e#1\xint_dothis{[\the\numexpr0\XINT_expr_scanexp_a +}\fi
313   \if E#1\xint_dothis{[\the\numexpr0\XINT_expr_scanexp_a +}\fi
314   \if .#1\xint_dothis{\XINT_expr_startdec_a .}\fi
315   \xint_orthat {\endcsname #1}%
316 }%
317 \def\XINT_expr_startdec_a .#1%
318 {%
319   \expandafter\XINT_expr_scandec_a\romannumeral`&&@#1%
320 }%
321 \def\XINT_expr_scandec_a #1%
322 {%
323   \if .#1\xint_dothis{\endcsname.}\fi
324   \xint_orthat {\XINT_expr_scandec_b 0.#1}%
325 }%
326 \def\XINT_expr_gobz_scanint_b #1%
327 {%
328   \ifcat \relax #1\expandafter\XINT_expr_gobz_scanint_endbycs\expandafter #1\fi
329   \ifnum\xint_c_x<1\string#1 \else\expandafter\XINT_expr_gobz_scanint_c\fi
330   \string#1\XINT_expr_scanint_d
331 }%
332 \def\XINT_expr_gobz_scanint_endbycs#1#2\XINT_expr_scanint_d{0\endcsname #1}%
333 \def\XINT_expr_gobz_scanint_c\string #1\XINT_expr_scanint_d
334 {%
335   \if _#1\xint_dothis\XINT_expr_gobz_scanint_d\fi
336   \if e#1\xint_dothis{0[\the\numexpr0\XINT_expr_scanexp_a +}\fi
337   \if E#1\xint_dothis{0[\the\numexpr0\XINT_expr_scanexp_a +}\fi
338   \if .#1\xint_dothis{\XINT_expr_gobz_startdec_a .}\fi
339   \if 0#1\xint_dothis\XINT_expr_gobz_scanint_d\fi
340   \xint_orthat {0\endcsname #1}%
341 }%
342 \def\XINT_expr_gobz_scanint_d #1%
343 {%
344   \expandafter\XINT_expr_gobz_scanint_b\romannumeral`&&@#1%
345 }%
346 \def\XINT_expr_gobz_startdec_a .#1%
347 {%
348   \expandafter\XINT_expr_gobz_scandec_a\romannumeral`&&@#1%
349 }%
350 \def\XINT_expr_gobz_scandec_a #1%
351 {%
352   \if .#1\xint_dothis{0\endcsname.}\fi

```

```
353 \xint_orthat {\XINT_expr_gobz_scandec_b 0.#1}%
354 }%
```

### 10.22.2 Fractional part

Annoying duplication of code to allow 0. as input.

1.2a corrects a very bad bug in 1.2 \XINT\_expr\_gobz\_scandec\_b which should have stripped leading zeroes in the fractional part but didn't; as a result \xinttheexpr 0.01\relax returned 0 =:-((( Thanks to Kroum Tzanev who reported the issue. Does it improve things if I say the bug was introduced in 1.2, it wasn't present before ?

```
355 \def\XINT_expr_scandec_b #1.#2%
356 {%
357   \ifcat \relax #2\expandafter\XINT_expr_scandec_endbycs\expandafter#2\fi
358   \ifnum\xint_c_ix<1\string#2 \else\expandafter\XINT_expr_scandec_c\fi
359   \string#2\expandafter\XINT_expr_scandec_d\the\numexpr #1-\xint_c_i.%
360 }%
361 \def\XINT_expr_scandec_endbycs #1#2\XINT_expr_scandec_d
362   \the\numexpr#3-\xint_c_i.{[#3]\endcsname #1}%
363 \def\XINT_expr_scandec_d #1.#2%
364 {%
365   \expandafter\XINT_expr_scandec_b
366   \the\numexpr #1\expandafter.\romannumeral`&&@#2%
367 }%
368 \def\XINT_expr_scandec_c\string #1#2\the\numexpr#3-\xint_c_i.%
369 {%
370   \if _#1\xint_dothis{\XINT_expr_scandec_d#3.}\fi
371   \if e#1\xint_dothis{[\the\numexpr#3\XINT_expr_scanexp_a +}\fi
372   \if E#1\xint_dothis{[\the\numexpr#3\XINT_expr_scanexp_a +}\fi
373   \xint_orthat {[#3]\endcsname #1}%
374 }%
375 \def\XINT_expr_gobz_scandec_b #1.#2%
376 {%
377   \ifcat \relax #2\expandafter\XINT_expr_gobz_scandec_endbycs\expandafter#2\fi
378   \ifnum\xint_c_ix<1\string#2 \else\expandafter\XINT_expr_gobz_scandec_c\fi
379   \if0#2\expandafter\xint_firstoftwo\else\expandafter\xint_secondoftwo\fi
380   {\expandafter\XINT_expr_gobz_scandec_b}%
381   {\string#2\expandafter\XINT_expr_scandec_d}\the\numexpr#1-\xint_c_i.%
382 }%
383 \def\XINT_expr_gobz_scandec_endbycs #1#2\xint_c_i.{0[0]\endcsname #1}%
384 \def\XINT_expr_gobz_scandec_c\if0#1#2\fi #3\numexpr#4-\xint_c_i.%
385 {%
386   \if _#1\xint_dothis{\XINT_expr_gobz_scandec_b #4.}\fi
387   \if e#1\xint_dothis{0[\the\numexpr0\XINT_expr_scanexp_a +}\fi
388   \if E#1\xint_dothis{0[\the\numexpr0\XINT_expr_scanexp_a +}\fi
389   \xint_orthat {0[0]\endcsname #1}%
390 }%
```

### 10.22.3 Scientific notation

Some pluses and minuses are allowed at the start of the scientific part, however not later, and no parenthesis.

```

391 \def\XINT_expr_scanexp_a #1#2%
392 {%
393   #1\expandafter\XINT_expr_scanexp_b\romannumeral`&&@#2%
394 }%
395 \def\XINT_expr_scanexp_b #1%
396 {%
397   \ifcat \relax #1\expandafter\XINT_expr_scanexp_endbycs\expandafter #1\fi
398   \ifnum\xint_c_ix<1\string#1 \else\expandafter\XINT_expr_scanexp_c\fi
399   \string#1\XINT_expr_scanexp_d
400 }%
401 \def\XINT_expr_scanexp_endbycs#1#2\XINT_expr_scanexp_d {}\endcsname #1}%
402 \def\XINT_expr_scanexp_d #1%
403 {%
404   \expandafter\XINT_expr_scanexp_bb\romannumeral`&&@#1%
405 }%
406 \def\XINT_expr_scanexp_c\string #1\XINT_expr_scanexp_d
407 {%
408   \if _#1\xint_dothis \XINT_expr_scanexp_d \fi
409   \if +#1\xint_dothis {\XINT_expr_scanexp_a +}\fi
410   \if -#1\xint_dothis {\XINT_expr_scanexp_a -}\fi
411   \xint_orthat {}\endcsname #1}%
412 }%
413 \def\XINT_expr_scanexp_bb #1%
414 {%
415   \ifcat \relax #1\expandafter\XINT_expr_scanexp_endbycs_b\expandafter #1\fi
416   \ifnum\xint_c_ix<1\string#1 \else\expandafter\XINT_expr_scanexp_cb\fi
417   \string#1\XINT_expr_scanexp_db
418 }%
419 \def\XINT_expr_scanexp_endbycs_b#1#2\XINT_expr_scanexp_db {}\endcsname #1}%
420 \def\XINT_expr_scanexp_db #1%
421 {%
422   \expandafter\XINT_expr_scanexp_bb\romannumeral`&&@#1%
423 }%
424 \def\XINT_expr_scanexp_cb\string #1\XINT_expr_scanexp_db
425 {%
426   \if _#1\xint_dothis\XINT_expr_scanexp_d\fi
427   \xint_orthat{}\endcsname #1}%
428 }%

```

#### 10.22.4 Hexadecimal numbers

1.2d has moved most of the handling of tacit multiplication to `\XINT_expr_getop`, but we have to do some of it here, because we apply `\string` before calling `\XINT_expr_scanhexI_aa`. I do not insert the `*` in `\XINT_expr_scanhexI_a`, because it is its higher precedence variant which will be expected, to do the same as when a non-hexadecimal number prefixes a sub-expression. Tacit multiplication in front of variable or function names will not work (because of this `\string`).

Extended for 1.2l to ignore underscore character `_` if encountered within digits.

```

429 \def\XINT_expr_scanhex_I #1% #1="
430 {%
431   \expandafter\XINT_expr_getop\csname.=\expandafter
432   \XINT_expr_unlock_hex_in\csname.=\XINT_expr_scanhexI_a
433 }%

```

```

434 \def\XINT_expr_scanhexI_a #1%
435 {%
436   \ifcat #1\relax\xint_dothis{.>\endcsname\endcsname #1}\fi
437   \ifx !#1\xint_dothis{.>\endcsname\endcsname !}\fi
438   \xint_orthat {\expandafter\XINT_expr_scanhexI_aa\string #1}%
439 }%
440 \def\XINT_expr_scanhexI_aa #1%
441 {%
442   \if\ifnum`#1>`/
443     \ifnum`#1>`9
444     \ifnum`#1>`@
445     \ifnum`#1>`F
446     0\else1\fi\else0\fi\else1\fi\else0\fi 1%
447     \expandafter\XINT_expr_scanhexI_b
448   \else
449     \if_#1\xint_dothis{\expandafter\XINT_expr_scanhexI_bgob}\fi
450     \if .#1\xint_dothis{\expandafter\XINT_expr_scanhex_transition}\fi
451     \xint_orthat % gather what we got so far, leave catcode 12 #1 in stream
452     {\xint_afterfi {.>\endcsname\endcsname}}%
453   \fi
454   #1%
455 }%
456 \def\XINT_expr_scanhexI_b #1#2%
457 {%
458   #1\expandafter\XINT_expr_scanhexI_a\romannumeral`&&@#2%
459 }%
460 \def\XINT_expr_scanhexI_bgob #1#2%
461 {%
462   \expandafter\XINT_expr_scanhexI_a\romannumeral`&&@#2%
463 }%
464 \def\XINT_expr_scanhex_transition .#1%
465 {%
466   \expandafter.\expandafter.\expandafter
467   \XINT_expr_scanhexII_a\romannumeral`&&@#1%
468 }%
469 \def\XINT_expr_scanhexII_a #1%
470 {%
471   \ifcat #1\relax\xint_dothis{\endcsname\endcsname#1}\fi
472   \ifx !#1\xint_dothis{\endcsname\endcsname !}\fi
473   \xint_orthat {\expandafter\XINT_expr_scanhexII_aa\string #1}%
474 }%
475 \def\XINT_expr_scanhexII_aa #1%
476 {%
477   \if\ifnum`#1>`/
478     \ifnum`#1>`9
479     \ifnum`#1>`@
480     \ifnum`#1>`F
481     0\else1\fi\else0\fi\else1\fi\else0\fi 1%
482     \expandafter\XINT_expr_scanhexII_b
483   \else
484     \if_#1\xint_dothis{\expandafter\XINT_expr_scanhexII_bgob}\fi
485     \xint_orthat{\xint_afterfi {\endcsname\endcsname}}%

```

```

486 \fi
487 #1%
488 }%
489 \def\XINT_expr_scanhexII_b #1#2%
490 {%
491 #1\expandafter\XINT_expr_scanhexII_a\romannumeral`&&@#2%
492 }%
493 \def\XINT_expr_scanhexII_bgob #1#2%
494 {%
495 \expandafter\XINT_expr_scanhexII_a\romannumeral`&&@#2%
496 }%

```

### 10.22.5 Parsing names of functions and variables

```

497 \def\XINT_expr_scanfunc
498 {%
499 \expandafter\XINT_expr_func\romannumeral`&&\XINT_expr_scanfunc_a
500 }%
501 \def\XINT_expr_scanfunc_a #1#2%
502 {%
503 \expandafter #1\romannumeral`&&\expandafter\XINT_expr_scanfunc_b\romannumeral`&&@#2%
504 }%

```

This handles: 1) (indirectly) tacit multiplication by a variable in front of a sub-expression, 2) (indirectly) tacit multiplication in front of a \count etc..., 3) functions which are recognized via an encountered opening parenthesis (but later this must be disambiguated from variables with tacit multiplication) 4) 5) 6) 7) acceptable components of a variable or function names: @, underscore, digits, letters (or chars of category code letter.)

The short lived 1.2d which followed the even shorter lived 1.2c managed to introduce a bug here as it removed the check for catcode 11 !, which must be recognized if ! is not to be taken as part of a variable name. Don't know what I was thinking, it was the time when I was moving the handling of tacit multiplication entirely to the \XINT\_expr\_getop side. Fixed in 1.2e.

I almost decided to remove the \ifcat\relax test whose rôle is to avoid the \string#1 to do something bad is the escape char is a digit! Perhaps I will remove it at some point ! I truly almost did it, but also the case of no escape char is a problem (\string\0, if \0 is a count ...)

The (indirectly) above means that via \XINT\_expr\_func then \XINT\_expr\_op\_\_ one goes back to \XINT\_expr\_getop then \XINT\_expr\_getop\_b which is the location where tacit multiplication is now centralized. This makes the treatment of tacit multiplication for situations such as <variable>\count or <variable>\xintexpr.\relax, perhaps a bit sub-optimal, but first the variable name must be gathered, second the variable must expand to its value.

```

505 \def\XINT_expr_scanfunc_b #1%
506 {%
507 \ifx !#1\xint_dothis{(_)\fi
508 \ifcat \relax#1\xint_dothis{(_)\fi
509 \if (#1\xint_dothis{\xint_firstoftwo{(`)}\fi
510 \if @#1\xint_dothis \XINT_expr_scanfunc_a \fi
511 \if _#1\xint_dothis \XINT_expr_scanfunc_a \fi
512 \ifnum \xint_c_ix<1\string#1 \xint_dothis \XINT_expr_scanfunc_a \fi
513 \ifcat a#1\xint_dothis \XINT_expr_scanfunc_a \fi
514 \xint_orthat {(_}%
515 #1%
516 }%

```



Comments written 2015/11/12: earlier there was an `\ifcsname` test for checking if we had a variable in front of a (, for tacit multiplication for example in  $x(y+z(x+w))$  to work. But after I had implemented functions (that was yesterday...), I had the problem if was impossible to re-declare a variable name such as "f" as a function name. The problem is that here we can not test if the function is available because we don't know if we are in `expr`, `iiexpr` or `floatexpr`. The `\xint_c_xviii` causes all fetching operations to stop and control is handed over to the routines which will be `expr`, `iiexpr` ou `floatexpr` specific, i.e. the `\XINT_{expr|iiexpr|flexpr}_op_{`|_}` which are invoked by the `until_{<op>}_b` macros earlier in the stream. Functions may exist for one but not the two other parsers. Variables are declared via one parser and usable in the others, but naturally `\xintiexpr` has its restrictions.

Thinking about this again I decided to treat a priori cases such as  $x(...)$  as functions, after having assigned to each variable a low-weight macro which will convert this into `_getop\.=<value of x>*(...)`. To activate that macro at the right time I could for this exploit the "onlitteral" intercept, which is parser independent (1.2c).

This led to me necessarily to rewrite partially the `seq`, `add`, `mul`, `subs`, `iter` ... routines as now the variables fetch only one token. I think the thing is more efficient.

1.2c had `\def\XINT_expr_func #1(#2{\xint_c_xviii #2{#1}}`

In `\XINT_expr_func` the #2 is `_` if #1 must be a variable name, or #2=``` if #1 must be either a function name or possibly a variable name which will then have to be followed by tacit multiplication before the opening parenthesis.

The `\xint_c_xviii` is there because `_op_`` must know in which parser it works. Dispendious for `_`. Hence I modify for 1.2d.

```
517 \def\XINT_expr_func #1(#2{\if _#2\xint_dothis\XINT_expr_op__\fi
518 \xint_orthat{\xint_c_xviii #2}{#1}}%
```

## 10.23 `\XINT_expr_getop`: finding the next operator or closing parenthesis or end of expression

Release 1.1 implements multi-character operators.

1.2d adds tacit mutiplication also in front of variable or functions names starting with a letter, not only a @ or a `_` as was already the case. This is for  $(x+y)z$  situations. It also applies higher precedence in cases like  $x/2y$  or  $x/2@$ , or  $x/2\max(3,5)$ , or  $x/2\xintexpr 3\relax$ .

In fact, finally I decide that all sorts of tacit multiplication will always use the higher precedence.

Indeed I hesitated somewhat: with the current code one does not know if `\XINT_expr_getop` as invoked after a closing parenthesis or because a number parsing ended, and I felt distinguishing the two was unneeded extra stuff. This means cases like  $(a+b)/(c+d)(e+f)$  will first multiply the last two parenthesized terms.

The `!` starting a sub-expression must be distinguished from the post-fix `!` for factorial, thus we must not do a too early `\string`. In versions < 1.2c, the catcode `11 !` had to be identified in all branches of the number or function scans. Here it is simply treated as a special case of a letter.

```
519 \def\XINT_expr_getop #1#2% this #1 is the current locked computed value
520 {%
521 \expandafter\XINT_expr_getop_a\expandafter #1\romannumeral`&&@#2%
522 }%
523 \catcode`* 11
524 \def\XINT_expr_getop_a #1#2%
525 {%
526 \ifx \relax #2\xint_dothis\xint_firstofthree\fi
527 \ifcat \relax #2\xint_dothis\xint_secondofthree\fi
528 \if _#2\xint_dothis \xint_secondofthree\fi
529 \if @#2\xint_dothis \xint_secondofthree\fi
```

```

530 \if (#2\xint_dothis \xint_secon dofthree\fi
531 \ifcat a#2\xint_dothis \xint_secon dofthree\fi
532 \xint_orthat \xint_third ofthree
533 {\XINT_expr_foundend #1}%
534 {\XINT_expr_precedence_*** *#1#2}% tacit multiplication with higher precedence
535 {\expandafter\XINT_expr_getop_b \string#2#1}%
536 }%
537 \catcode`* 12
538 \def\XINT_expr_foundend {\xint_c_ \relax }% \relax is a place holder here.

```

? is a very special operator with top precedence which will check if the next token is another ?, while avoiding removing a brace pair from token stream due to its syntax. Pre 1.1 releases used : rather than ??, but we need : for Python like slices of lists.

```

539 \def\XINT_expr_getop_b #1%
540 {%
541 \if '#1\xint_dothis{\XINT_expr_binopwr d }\fi
542 \if ?#1\xint_dothis{\XINT_expr_precedence_? ?}\fi
543 \xint_orthat {\XINT_expr_scanop_a #1}%
544 }%
545 \def\XINT_expr_binopwr d #1#2'\{\expandafter\XINT_expr_foundop_a
546 \csname XINT_expr_itself_\xint_zapspaces #2 \xint_gobble_i\endcsname #1}%
547 \def\XINT_expr_scanop_a #1#2#3%
548 {\expandafter\XINT_expr_scanop_b\expandafter #1\expandafter #2\romannumeral`&&@#3}%
549 \def\XINT_expr_scanop_b #1#2#3%
550 {%
551 \ifcat#3\relax\xint_dothis{\XINT_expr_foundop_a #1#2#3}\fi
552 \ifcsname XINT_expr_itself_#1#3\endcsname
553 \xint_dothis
554 {\expandafter\XINT_expr_scanop_c\csname XINT_expr_itself_#1#3\endcsname #2}\fi
555 \xint_orthat {\XINT_expr_foundop_a #1#2#3}%
556 }%
557 \def\XINT_expr_scanop_c #1#2#3%
558 {%
559 \expandafter\XINT_expr_scanop_d\expandafter #1\expandafter #2\romannumeral`&&@#3%
560 }%
561 \def\XINT_expr_scanop_d #1#2#3%
562 {%
563 \ifcat#3\relax \xint_dothis{\XINT_expr_foundop #1#2#3}\fi
564 \ifcsname XINT_expr_itself_#1#3\endcsname
565 \xint_dothis
566 {\expandafter\XINT_expr_scanop_c\csname XINT_expr_itself_#1#3\endcsname #2}\fi
567 \xint_orthat {\csname XINT_expr_precedence_#1\endcsname #1#2#3}%
568 }%
569 \def\XINT_expr_foundop_a #1%
570 {%
571 \ifcsname XINT_expr_precedence_#1\endcsname
572 \csname XINT_expr_precedence_#1\expandafter\endcsname
573 \expandafter #1%
574 \else
575 \xint_afterfi{\XINT_expr_unknown_operator {#1}\XINT_expr_getop}%
576 \fi
577 }%

```

```
578 \def\XINT_expr_unknown_operator #1{\xintError:removed \xint_gobble_i {#1}}%
579 \def\XINT_expr_foundedop #1{\csname XINT_expr_precedence_#1\endcsname #1}%
```

## 10.24 Expansion spanning; opening and closing parentheses

Version 1.1 had a hack inside the until macros for handling the omit and abort in iterations over dummy variables. This has been removed by 1.2c, see the subsection where omit and abort are discussed.

```
580 \catcode`) 11
581 \def\XINT_tmpa #1#2#3#4%
582 {%
583   \def#1##1%
584   {%
585     \xint_UDsignfork
586       ##1{\expandafter#1\romannumeral`&&@#3}%
587       -{#2##1}%
588     \krof
589   }%
590   \def#2##1##2%
591   {%
592     \ifcase ##1\expandafter\XINT_expr_done
593     \or\xint_afterfi{\XINT_expr_extra_)
594       \expandafter #1\romannumeral`&&\XINT_expr_getop }%
595     \else
596     \xint_afterfi{\expandafter#1\romannumeral`&&\csname XINT_#4_op_##2\endcsname }%
597     \fi
598   }%
599 }%
600 \def\XINT_expr_extra_) {\xintError:removed }%
601 \xintFor #1 in {expr,flexpr,iiexpr} \do {%
602   \expandafter\XINT_tmpa
603   \csname XINT_#1_until_end_a\expandafter\endcsname
604   \csname XINT_#1_until_end_b\expandafter\endcsname
605   \csname XINT_#1_op_-vi\endcsname
606   {#1}%
607 }%
608 \def\XINT_tmpa #1#2#3#4#5#6%
609 {%
610   \def #1##1{\expandafter #3\romannumeral`&&\XINT_expr_getnext }%
611   \def #2{\expandafter #3\romannumeral`&&\XINT_expr_getnext }%
612   \def #3##1{\xint_UDsignfork
613     ##1{\expandafter #3\romannumeral`&&@#5}%
614     -{#4##1}%
615     \krof }%
616   \def #4##1##2{\ifcase ##1\expandafter\XINT_expr_missing_)
617   \or \csname XINT_#6_op_##2\expandafter\endcsname
618   \else
619   \xint_afterfi{\expandafter #3\romannumeral`&&\csname XINT_#6_op_##2\endcsname }%
620   \fi
621 }%
622 }%
623 \def\XINT_expr_missing_) {\xintError:inserted \xint_c_ \XINT_expr_done }%
```

We should be using `until_`( notation to stay synchronous with `until_+`, `until_*` etc..., but I found that `until_`) was more telling.

```

624 \catcode`) 12
625 \xintFor #1 in {expr,flexpr,iiexpr} \do {%
626   \expandafter\XINT_tmpa
627   \csname XINT_#1_op_(\expandafter\endcsname
628   \csname XINT_#1_oparen\expandafter\endcsname
629   \csname XINT_#1_until_)_a\expandafter\endcsname
630   \csname XINT_#1_until_)_b\expandafter\endcsname
631   \csname XINT_#1_op_-vi\endcsname
632   {#1}%
633 }%
634 \expandafter\let\csname XINT_expr_precedence_\endcsname\xint_c_i

```

## 10.25 |, ||, &, &&, <, >, =, ==, <=, >=, !=, +, -, \*, /, ^, \*\*, //, /:, ..., ..[, ].., ][, ][: ], and ++ operators

10.25.1	Square brackets for lists, the !? for omit and abort, and the ++ postfix construct . . . .	292
10.25.2	The  , &, xor, <, >, =, <=, >=, !=, //, /:, ..., +, -, *, /, ^, ..[, and ].. operators for expr, floatexpr and iiexpr operators . . . . .	293
10.25.3	The ]+, ]-, ]*, ]/, ]^, +[, -[, *[, /[, and ^[ list operators . . . . .	295
10.25.4	The 'and', 'or', 'xor', and 'mod' as infix operator words . . . . .	297
10.25.5	The   , &&, **, **[, ]** operators as synonyms . . . . .	297

### 10.25.1 Square brackets for lists, the !? for omit and abort, and the ++ postfix construct

This is all very clever and only need setting some suitable precedence levels, if only I could understand what I did in 2014... just joking. Notice that `op_`) macros are defined here in the `\xintFor` loop.

There is some clever business going on here with the letter `a` for handling constructs such as `[3..5]*2` (I think...).

1.2c has replaced 1.1's private dealings with `"^C"` (which was done before dummy variables got implemented) by use of `"!?"`. See discussion of omit and abort.

```

635 \expandafter\let\csname XINT_expr_precedence_]\endcsname\xint_c_i
636 \expandafter\let\csname XINT_expr_precedence_;\endcsname\xint_c_i
637 \let\XINT_expr_precedence_a \xint_c_xviii
638 \let\XINT_expr_precedence_!? \xint_c_ii
639 \expandafter\let\csname XINT_expr_precedence_++\endcsname \xint_c_i

```

Comments added 2015/11/13 Here we have in particular the mechanism for post action on lists via `op_]` The precedence\_] is the one of a closing parenthesis. We need the closing parenthesis to do its job, hence we can not define a `op_]+` operator for example, as we want to assign it the precedence of addition not the one of closing parenthesis. The trick I used in 1.1 was to let the `op_]` insert the letter `a`, this letter exceptionnally also being a legitimate operator, launch the `_getop` and let it find a `a*`, `a+`, `a/`, `a-`, `a^`, `a**` operator standing for `]*`, `]+`, `]/`, `]^`, `]**` postfix item by item list operator. I thought I had in mind an example to show that having defined `op_a` and `precedence_a` for the letter `a` caused a reduction in syntax for this letter, but it seems I am lacking now an example.

2015/11/18: for 1.2d I accelerate `\XINT_expr_op_]` to jump over the `\XINT_expr_getop_a` which now does tacit multiplications also in front of letters, for reasons of things like, `(x+y)z`, hence it must not see the `"a"`. I could have used a `catcode12` a possibly, but anyhow jumping straight

to `\XINT_expr_scanop_a` skips a few expansion steps (up to the potential price of less conceptual programming if I change things in the future.)

```
640 \catcode`. 11 \catcode`= 11 \catcode`+ 11
641 \xintFor #1 in {expr,flexpr,iiexpr} \do {%
642   \expandafter\let\csname XINT_#1_op_\}\endcsname \XINT_expr_getop
643   \expandafter\let\csname XINT_#1_op_;\endcsname \space
644   \expandafter\def\csname XINT_#1_op_]\endcsname ##1{\XINT_expr_scanop_a a##1}%
645   \expandafter\let\csname XINT_#1_op_a]\endcsname \XINT_expr_getop
```

1.1 2014/10/29 did `\expandafter\.=\xintiCeil` which transformed it into `\romannumeral0\xinticeil`, which seems a bit weird. This exploited the fact that dummy variables macros could back then pick braced material (which in the case at hand here ended being `{\romannumeral0\xinticeil...}` and were submitted to two expansions. The result of this was to provide a not value which got expanded only in the first loop of the `:_A` and following macros of `seq`, `iter`, `rseq`, etc...

Anyhow with 1.2c I have changed the implementation of dummy variables which now need to fetch a single locked token, which they do not expand.

The `\xintiCeil` appears a bit dispensious, but I need the starting value in a `\numexpr` compatible form in the iteration loops.

```
646   \expandafter\def\csname XINT_#1_op_++\}\endcsname ##1##2\relax
647   {\expandafter\XINT_expr_foundedend \expandafter
648     {\expandafter\.=+\csname .=\xintiCeil{\XINT_expr_unlock ##1}\endcsname }}%
649 }%
650 \catcode`. 12 \catcode`= 12 \catcode`+ 12
```

1.2d adds the `***` for tying via tacit multiplication, for example `x/2y`. Actually I don't need the `_itself` mechanism for `***`, only a precedence.

```
651 \catcode`& 12
652 \xintFor* #1 in {{==}{<=}{>=}{!=}{&&}{||}{**}{//}{/:}{..}{.}{.}{.}{.}{.}{.}%
653   {+}{-}{*}{/}{^}{a+}{a-}{a*}{a/}{a^}{a^}%
654   {}[]{}[:]{:}{!}{?}{++}{++}}}%{***}}
655   \do {\expandafter\def\csname XINT_expr_itself_#1\endcsname {#1}}%
656 \catcode`& 7
657 \expandafter\let\csname XINT_expr_precedence_***\endcsname \xint_c_viii
```

### 10.25.2 The `|`, `&`, `xor`, `<`, `>`, `=`, `<=`, `>=`, `!=`, `//`, `/:`, `..`, `+`, `-`, `*`, `/`, `^`, `..[`, and `]`.. operators for `expr`, `floatexpr` and `iiexpr` operators

1.2d needed some room between `/`, `*` and `^`. Hence precedence for `^` is now at 9

```
658 \def\XINT_expr_defbin_c #1#2#3#4#5#6#7#8%
659 {%
660   \def #1##1% \XINT_expr_op_<op> ou flexpr ou iiexpr
661   {% keep value, get next number and operator, then do until
662     \expandafter #2\expandafter ##1%
663     \romannumeral`&&\expandafter\XINT_expr_getnext }%
664   \def #2##1##2% \XINT_expr_until_<op>_a ou flexpr ou iiexpr
665   {\xint_UDsignfork ##2{\expandafter #2\expandafter ##1\romannumeral`&&@#4}%
666     -{#3##1##2}%
667     \krof }%
668   \def #3##1##2##3##4% \XINT_expr_until_<op>_b ou flexpr ou iiexpr
669   {% either execute next operation now, or first do next (possibly unary)
```

```

670 \ifnum ##2>#7%
671 \xint_afterfi {\expandafter #2\expandafter ##1\romannumeral`&&@%
672 \csname XINT_#8_op_##3\endcsname {##4}}%
673 \else \xint_afterfi {\expandafter ##2\expandafter ##3%
674 \csname .=#6{\XINT_expr_unlock ##1}{\XINT_expr_unlock ##4}\endcsname }%
675 \fi }%
676 \let #7#5%
677 }%
678 \def\XINT_expr_defbin_b #1#2#3#4#5%
679 {%
680 \expandafter\XINT_expr_defbin_c
681 \csname XINT_#1_op_#2\expandafter\endcsname
682 \csname XINT_#1_until_#2_a\expandafter\endcsname
683 \csname XINT_#1_until_#2_b\expandafter\endcsname
684 \csname XINT_#1_op_#4\expandafter\endcsname
685 \csname xint_c_#3\expandafter\endcsname
686 \csname #5\expandafter\endcsname
687 \csname XINT_expr_precedence_#2\endcsname {#1}%
688 }%
689 \XINT_expr_defbin_b {expr} | {iii}{vi} {xintOR}%
690 \XINT_expr_defbin_b {flexpr} | {iii}{vi} {xintOR}%
691 \XINT_expr_defbin_b {iiexpr} | {iii}{vi} {xintOR}%
692 \XINT_expr_defbin_b {expr} & {iv}{vi} {xintAND}%
693 \XINT_expr_defbin_b {flexpr} & {iv}{vi} {xintAND}%
694 \XINT_expr_defbin_b {iiexpr} & {iv}{vi} {xintAND}%
695 \XINT_expr_defbin_b {expr} {xor}{iii}{vi} {xintXOR}%
696 \XINT_expr_defbin_b {flexpr}{xor}{iii}{vi} {xintXOR}%
697 \XINT_expr_defbin_b {iiexpr}{xor}{iii}{vi} {xintXOR}%
698 \XINT_expr_defbin_b {expr} < {v}{vi} {xintLt}%
699 \XINT_expr_defbin_b {flexpr} < {v}{vi} {xintLt}%
700 \XINT_expr_defbin_b {iiexpr} < {v}{vi} {xintiiLt}%
701 \XINT_expr_defbin_b {expr} > {v}{vi} {xintGt}%
702 \XINT_expr_defbin_b {flexpr} > {v}{vi} {xintGt}%
703 \XINT_expr_defbin_b {iiexpr} > {v}{vi} {xintiiGt}%
704 \XINT_expr_defbin_b {expr} = {v}{vi} {xintEq}%
705 \XINT_expr_defbin_b {flexpr} = {v}{vi} {xintEq}%
706 \XINT_expr_defbin_b {iiexpr} = {v}{vi} {xintiiEq}%
707 \XINT_expr_defbin_b {expr} {<=} {v}{vi} {xintLtorEq}%
708 \XINT_expr_defbin_b {flexpr}{<=} {v}{vi} {xintLtorEq}%
709 \XINT_expr_defbin_b {iiexpr}{<=} {v}{vi} {xintiiLtorEq}%
710 \XINT_expr_defbin_b {expr} {>=} {v}{vi} {xintGtorEq}%
711 \XINT_expr_defbin_b {flexpr}{>=} {v}{vi} {xintGtorEq}%
712 \XINT_expr_defbin_b {iiexpr}{>=} {v}{vi} {xintiiGtorEq}%
713 \XINT_expr_defbin_b {expr} {!=} {v}{vi} {xintNeq}%
714 \XINT_expr_defbin_b {flexpr}{!=} {v}{vi} {xintNeq}%
715 \XINT_expr_defbin_b {iiexpr}{!=} {v}{vi} {xintiiNeq}%
716 \XINT_expr_defbin_b {expr} {..} {iii}{vi} {xintSeq::csv}%
717 \XINT_expr_defbin_b {flexpr}{..} {iii}{vi} {xintSeq::csv}%
718 \XINT_expr_defbin_b {iiexpr}{..} {iii}{vi} {xintiiSeq::csv}%
719 \XINT_expr_defbin_b {expr} {///} {vii}{vii}{xintDivTrunc}%
720 \XINT_expr_defbin_b {flexpr}{///} {vii}{vii}{xintDivTrunc}%
721 \XINT_expr_defbin_b {iiexpr}{///} {vii}{vii}{xintiiDivTrunc}%

```

```

722 \XINT_expr_defbin_b {expr} {/:} {vii}{vii}{xintMod}%
723 \XINT_expr_defbin_b {flexpr}{/:} {vii}{vii}{xintMod}%
724 \XINT_expr_defbin_b {iiexpr}{/:} {vii}{vii}{xintiiMod}%
725 \XINT_expr_defbin_b {expr} + {vi}{vi} {xintAdd}%
726 \XINT_expr_defbin_b {flexpr} + {vi}{vi} {XINTinFloatAdd}%
727 \XINT_expr_defbin_b {iiexpr} + {vi}{vi} {xintiiAdd}%
728 \XINT_expr_defbin_b {expr} - {vi}{vi} {xintSub}%
729 \XINT_expr_defbin_b {flexpr} - {vi}{vi} {XINTinFloatSub}%
730 \XINT_expr_defbin_b {iiexpr} - {vi}{vi} {xintiiSub}%
731 \XINT_expr_defbin_b {expr} * {vii}{vii}{xintMul}%
732 \XINT_expr_defbin_b {flexpr} * {vii}{vii}{XINTinFloatMul}%
733 \XINT_expr_defbin_b {iiexpr} * {vii}{vii}{xintiiMul}%
734 \XINT_expr_defbin_b {expr} / {vii}{vii}{xintDiv}%
735 \XINT_expr_defbin_b {flexpr} / {vii}{vii}{XINTinFloatDiv}%
736 \XINT_expr_defbin_b {iiexpr} / {vii}{vii}{xintiiDivRound}% CHANGED IN 1.1!
737 \XINT_expr_defbin_b {expr} ^ {ix}{ix} {xintPow}%
738 \XINT_expr_defbin_b {flexpr} ^ {ix}{ix} {XINTinFloatPowerH}%
739 \XINT_expr_defbin_b {iiexpr} ^ {ix}{ix} {xintiiPow}%
740 \XINT_expr_defbin_b {expr} {..[]}{iii}{vi} {xintSeqA::csv}%
741 \XINT_expr_defbin_b {flexpr}{..[]}{iii}{vi} {XINTinFloatSeqA::csv}%
742 \XINT_expr_defbin_b {iiexpr}{..[]}{iii}{vi} {xintiiSeqA::csv}%
743 \XINT_expr_defbin_b {expr} {[]}{}{iii}{vi} {xintSeqB::csv}%
744 \XINT_expr_defbin_b {flexpr}{[]}{}{iii}{vi} {XINTinFloatSeqB::csv}%
745 \XINT_expr_defbin_b {iiexpr}{[]}{}{iii}{vi} {xintiiSeqB::csv}%

```

### 10.25.3 The `+`, `-`, `*`, `/`, `^`, `+`, `-`, `*`, `/`, and `^` list operators

`\XINT_expr_binop_inline_b` This handles acting on comma separated values (no need to bother about spaces in this context; expansion in a `\csname...\endcsname`).

```

746 \def\XINT_expr_binop_inline_a
747   {\expandafter\xint_gobble_i\romannumeral`&&\XINT_expr_binop_inline_b}%
748 \def\XINT_expr_binop_inline_b #1#2,{\XINT_expr_binop_inline_c #2,{#1}}%
749 \def\XINT_expr_binop_inline_c #1{%
750   \if ,#1\xint_dothis\XINT_expr_binop_inline_e\fi
751   \if ^#1\xint_dothis\XINT_expr_binop_inline_end\fi
752   \xint_orthat\XINT_expr_binop_inline_d #1}%
753 \def\XINT_expr_binop_inline_d #1,#2{,#2{#1}\XINT_expr_binop_inline_b {#2}}%
754 \def\XINT_expr_binop_inline_e #1,#2{,\XINT_expr_binop_inline_b {#2}}%
755 \def\XINT_expr_binop_inline_end #1,#2{}%
756 \def\XINT_expr_deflistopr_c #1#2#3#4#5#6#7#8%
757 {%
758   \def #1#1% \XINT_expr_op_<op> ou flexpr ou iiexpr
759   {% keep value, get next number and operator, then do until
760     \expandafter #2\expandafter ##1%
761     \romannumeral`&&\expandafter\XINT_expr_getnext}%
762   \def #2#1#1#2% \XINT_expr_until_<op>_a ou flexpr ou iiexpr
763   {\xint_UDsignfork ##2{\expandafter #2\expandafter ##1\romannumeral`&&@#4}%
764     -{#3##1#2}}%
765   \krof}%
766   \def #3#1#1#2#3#4% \XINT_expr_until_<op>_b ou flexpr ou iiexpr
767   {% either execute next operation now, or first do next (possibly unary)
768     \ifnum ##2>#7%

```



```

769 \xint_afterfi {\expandafter #2\expandafter ##1\romannumeral`&&@%
770 \csname XINT_#8_op_##3\endcsname {##4}}%
771 \else \xint_afterfi {\expandafter ##2\expandafter ##3%
772 \csname .=\expandafter\XINT_expr_binop_inline_a\expandafter
773 {\expandafter\expandafter\expandafter#6\expandafter
774 \xint_exchangetwo_keepbraces\expandafter
775 {\expandafter\XINT_expr_unlock\expandafter ##4\expandafter}\expandafter}%
776 \romannumeral`&&\XINT_expr_unlock ##1,^,\endcsname }%
777 \fi }%
778 \let #7#5%
779 }%
780 \def\XINT_expr_deflistopr_b #1#2#3#4%
781 {%
782 \expandafter\XINT_expr_deflistopr_c
783 \csname XINT_#1_op_#2\expandafter\endcsname
784 \csname XINT_#1_until_#2_a\expandafter\endcsname
785 \csname XINT_#1_until_#2_b\expandafter\endcsname
786 \csname XINT_#1_op_#3\expandafter\endcsname
787 \csname xint_c_#3\expandafter\endcsname
788 \csname #4\expandafter\endcsname
789 \csname XINT_expr_precedence_#2\endcsname {#1}%
790 }%

```

This is for [x..y]\*z syntax etc.... Attention that with 1.2d, precedence level of ^ raised to ix to make room for \*\*\*.

```

791 \XINT_expr_deflistopr_b {expr} {a+}{vi} {xintAdd}%
792 \XINT_expr_deflistopr_b {expr} {a-}{vi} {xintSub}%
793 \XINT_expr_deflistopr_b {expr} {a*}{vii} {xintMul}%
794 \XINT_expr_deflistopr_b {expr} {a/}{vii} {xintDiv}%
795 \XINT_expr_deflistopr_b {expr} {a^}{ix} {xintPow}%
796 \XINT_expr_deflistopr_b {iiexpr}{a+}{vi} {xintiiAdd}%
797 \XINT_expr_deflistopr_b {iiexpr}{a-}{vi} {xintiiSub}%
798 \XINT_expr_deflistopr_b {iiexpr}{a*}{vii} {xintiiMul}%
799 \XINT_expr_deflistopr_b {iiexpr}{a/}{vii} {xintiiDivRound}%
800 \XINT_expr_deflistopr_b {iiexpr}{a^}{ix} {xintiiPow}%
801 \XINT_expr_deflistopr_b {flexpr}{a+}{vi} {XINTinFloatAdd}%
802 \XINT_expr_deflistopr_b {flexpr}{a-}{vi} {XINTinFloatSub}%
803 \XINT_expr_deflistopr_b {flexpr}{a*}{vii} {XINTinFloatMul}%
804 \XINT_expr_deflistopr_b {flexpr}{a/}{vii} {XINTinFloatDiv}%
805 \XINT_expr_deflistopr_b {flexpr}{a^}{ix} {XINTinFloatPowerH}%
806 \def\XINT_expr_deflistopl_c #1#2#3#4#5#6#7%
807 {%
808 \def #1#1{\expandafter#2\expandafter##1\romannumeral`&&@%
809 \expandafter #3\romannumeral`&&\XINT_expr_getnext }%
810 \def #2##1##2##3##4%
811 {% either execute next operation now, or first do next (possibly unary)
812 \ifnum ##2>#6%
813 \xint_afterfi {\expandafter #2\expandafter ##1\romannumeral`&&@%
814 \csname XINT_#7_op_##3\endcsname {##4}}%
815 \else \xint_afterfi {\expandafter ##2\expandafter ##3%
816 \csname .=\expandafter\XINT_expr_binop_inline_a\expandafter
817 {\expandafter#5\expandafter

```



```

818      {\expandafter\XINT_expr_unlock\expandafter ##1\expandafter}\expandafter}%
819      \romannumeral`&&\XINT_expr_unlock ##4,^,\endcsname }%
820      \fi }%
821      \let #6#4%
822 }%
823 \def\XINT_expr_deflistopl_b #1#2#3#4%
824 {%
825   \expandafter\XINT_expr_deflistopl_c
826   \csname XINT_#1_op_#2\expandafter\endcsname
827   \csname XINT_#1_until_#2\expandafter\endcsname
828   \csname XINT_#1_until_)_a\expandafter\endcsname
829   \csname xint_c_#3\expandafter\endcsname
830   \csname #4\expandafter\endcsname
831   \csname XINT_expr_precedence_#2\endcsname {#1}%
832 }%

```

This is for  $z*[x..y]$  syntax etc...

```

833 \XINT_expr_deflistopl_b {expr} {+[] {vi} {xintAdd}%
834 \XINT_expr_deflistopl_b {expr} {-[] {vi} {xintSub}%
835 \XINT_expr_deflistopl_b {expr} {*[] {vii} {xintMul}%
836 \XINT_expr_deflistopl_b {expr} {/[] {vii} {xintDiv}%
837 \XINT_expr_deflistopl_b {expr} {^[] {ix} {xintPow}%
838 \XINT_expr_deflistopl_b {iiexpr} {+[] {vi} {xintiiAdd}%
839 \XINT_expr_deflistopl_b {iiexpr} {-[] {vi} {xintiiSub}%
840 \XINT_expr_deflistopl_b {iiexpr} {*[] {vii} {xintiiMul}%
841 \XINT_expr_deflistopl_b {iiexpr} {/[] {vii} {xintiiDivRound}%
842 \XINT_expr_deflistopl_b {iiexpr} {^[] {ix} {xintiiPow}%
843 \XINT_expr_deflistopl_b {flexpr} {+[] {vi} {XINTinFloatAdd}%
844 \XINT_expr_deflistopl_b {flexpr} {-[] {vi} {XINTinFloatSub}%
845 \XINT_expr_deflistopl_b {flexpr} {*[] {vii} {XINTinFloatMul}%
846 \XINT_expr_deflistopl_b {flexpr} {/[] {vii} {XINTinFloatDiv}%
847 \XINT_expr_deflistopl_b {flexpr} {^[] {ix} {XINTinFloatPowerH}%

```

#### 10.25.4 The 'and', 'or', 'xor', and 'mod' as infix operator words

```

848 \xintFor #1 in {and,or,xor,mod} \do {%
849   \expandafter\def\csname XINT_expr_itself_#1\endcsname {#1}}%
850 \expandafter\let\csname XINT_expr_precedence_and\expandafter\endcsname
851   \csname XINT_expr_precedence_&\endcsname
852 \expandafter\let\csname XINT_expr_precedence_or\expandafter\endcsname
853   \csname XINT_expr_precedence_| \endcsname
854 \expandafter\let\csname XINT_expr_precedence_mod\expandafter\endcsname
855   \csname XINT_expr_precedence_/\endcsname
856 \xintFor #1 in {expr, flexpr, iiexpr} \do {%
857   \expandafter\let\csname XINT_#1_op_and\expandafter\endcsname
858     \csname XINT_#1_op_&\endcsname
859   \expandafter\let\csname XINT_#1_op_or\expandafter\endcsname
860     \csname XINT_#1_op_| \endcsname
861   \expandafter\let\csname XINT_#1_op_mod\expandafter\endcsname
862     \csname XINT_#1_op_/\endcsname
863 }%

```

#### 10.25.5 The ||, &&, \*\*, \*\*[, ]\*\* operators as synonyms

```

864 \expandafter\let\csname XINT_expr_precedence_==\expandafter\endcsname
865         \csname XINT_expr_precedence_=\endcsname
866 \expandafter\let\csname XINT_expr_precedence_&\string&\expandafter\endcsname
867         \csname XINT_expr_precedence_&\endcsname
868 \expandafter\let\csname XINT_expr_precedence_||\expandafter\endcsname
869         \csname XINT_expr_precedence_||\endcsname
870 \expandafter\let\csname XINT_expr_precedence_**\expandafter\endcsname
871         \csname XINT_expr_precedence_^\endcsname
872 \expandafter\let\csname XINT_expr_precedence_a**\expandafter\endcsname
873         \csname XINT_expr_precedence_a^\endcsname
874 \expandafter\let\csname XINT_expr_precedence_**[\expandafter\endcsname
875         \csname XINT_expr_precedence_^\endcsname
876 \xintFor #1 in {expr, flexpr, iexpr} \do {%
877     \expandafter\let\csname XINT_#1_op_==\expandafter\endcsname
878         \csname XINT_#1_op_=\endcsname
879     \expandafter\let\csname XINT_#1_op_&\string&\expandafter\endcsname
880         \csname XINT_#1_op_&\endcsname
881     \expandafter\let\csname XINT_#1_op_||\expandafter\endcsname
882         \csname XINT_#1_op_||\endcsname
883     \expandafter\let\csname XINT_#1_op_**\expandafter\endcsname
884         \csname XINT_#1_op_^\endcsname
885     \expandafter\let\csname XINT_#1_op_a**\expandafter\endcsname
886         \csname XINT_#1_op_a^\endcsname
887     \expandafter\let\csname XINT_#1_op_**[\expandafter\endcsname
888         \csname XINT_#1_op_^\endcsname
889 }%
```

## 10.26 Macros for list selectors: [list][N], [list][:b], [list][a:], [list][a:b]

10.26.1	<code>\xintListSel:x:csv</code>	300
10.26.2	<code>\xintListSel:f:csv</code>	301
10.26.3	<code>\xintKeep:x:csv</code>	302
10.26.4	<code>\xintKeep:f:csv</code>	303
10.26.5	<code>\xintTrim:f:csv</code>	303
10.26.6	<code>\xintNthEltPy:f:csv</code>	303
10.26.7	<code>\xintLength:f:csv</code>	303
10.26.8	<code>\xintReverse:f:csv</code>	303

Python slicing was first implemented for 1.1 (27 octobre 2014). But it used `\xintCSVtoList` and `\xintListWithSep{,}` to convert back and forth to token lists for use of `\xintKeep`, `\xintTrim`, `\xintNthElt`. Not very efficient! Also `[list][a:b]` was Python like but not `[list][N]` which counted items starting at one, and returned the length for `N=0`.

Release 1.2g changed this so `[list][N]` now counts starting at zero and `len(list)` computes the number of items. Also 1.2g had its own f-expandable macros handling directly the comma separated lists. They are located into `xinttools.sty`.

1.2j improved the `xinttools.sty` macros and furthermore it made the Python slicing in expressions a bit more efficient still by exploiting in some cases that expansion happens in `\csname...\endcsname` and does not have to be f-expandable. But the f-expandable variants must be kept for use by `\xintNewExpr` and `\xintdeffunc`.

```

890 \def\xINT_tmpa #1#2#3#4#5#6%
891 {%
892     \def #1##1% \XINT_expr_op_][
```

```

893  {%
894    \expandafter #2\expandafter ##1\romannumeral`&&\XINT_expr_getnext
895  }%
896  \def #2##1##2% \XINT_expr_until_][_a
897  {\xint_UDsignfork
898    ##2{\expandafter #2\expandafter ##1\romannumeral`&&#4}%
899    -{##1##2}%
900    \krof }%
901  \def #3##1##2##3##4% \XINT_expr_until_][_b
902  {%
903    \ifnum ##2>#5%
904      \xint_afterfi {\expandafter #2\expandafter ##1\romannumeral`&&%
905                    \csname XINT_#6_op_##3\endcsname {##4}}%
906    \else
907      \xint_afterfi
908      {\expandafter ##2\expandafter ##3\csname
909        .=\expandafter\xintListSel:x:csv % will be \xintListSel:f:csv in \xintNewExpr output
910        \romannumeral`&&\XINT_expr_unlock ##4;% selector
911        \XINT_expr_unlock ##1;\endcsname % unlock already pre-positioned for \xintNewExpr
912      }%
913    \fi
914  }%
915  \let #5\xint_c_ii
916 }%
917 \xintFor #1 in {expr,flexpr,iiexpr} \do {%
918 \expandafter\XINT_tmpa
919   \csname XINT_#1_op_][_ \expandafter\endcsname
920   \csname XINT_#1_until_][_a\expandafter\endcsname
921   \csname XINT_#1_until_][_b\expandafter\endcsname
922   \csname XINT_#1_op_-vi\expandafter\endcsname
923   \csname XINT_expr_precedence_][_ \endcsname {#1}%
924 }%
925 \def\XINT_tmpa #1#2#3#4#5#6%
926 {%
927   \def #1##1% \XINT_expr_op_:
928   {%
929     \expandafter #2\expandafter ##1\romannumeral`&&\XINT_expr_getnext
930   }%
931   \def #2##1##2% \XINT_expr_until_:_a
932   {\xint_UDsignfork
933     ##2{\expandafter #2\expandafter ##1\romannumeral`&&#4}%
934     -{##1##2}%
935     \krof }%
936   \def #3##1##2##3##4% \XINT_expr_until_:_b
937   {%
938     \ifnum ##2>#5%
939       \xint_afterfi {\expandafter #2\expandafter ##1\romannumeral`&&%
940                     \csname XINT_#6_op_##3\endcsname {##4}}%
941     \else
942       \xint_afterfi
943       {\expandafter ##2\expandafter ##3\csname
944         .:=\xintNum{\XINT_expr_unlock ##1};\xintNum{\XINT_expr_unlock ##4}%

```

```

945      \endcsname
946    }%
947  \fi
948 }%
949 \let #5\xint_c_iii
950 }%
951 \xintFor #1 in {expr,flexpr,iiexpr} \do {%
952 \expandafter\XINT_tmpa
953   \csname XINT_#1_op_:\expandafter\endcsname
954   \csname XINT_#1_until:_a\expandafter\endcsname
955   \csname XINT_#1_until:_b\expandafter\endcsname
956   \csname XINT_#1_op_-vi\expandafter\endcsname
957   \csname XINT_expr_precedence_:\endcsname {#1}%
958 }%
959 \catcode`[ 11 \catcode`] 11
960 \let\XINT_expr_precedence_:\xint_c_iii
961 \def\XINT_expr_op_:\ #1%
962 {%
963   \expandafter\xint_c_i\expandafter )%
964   \csname .=\xintNum{\XINT_expr_unlock #1}\endcsname
965 }%
966 \let\XINT_flexpr_op_:\XINT_expr_op_:\
967 \let\XINT_iiexpr_op_:\XINT_expr_op_:\
968 \let\XINT_expr_precedence_[: \xint_c_iii

```

At the end of the replacement text of `\XINT_expr_op_[:`, the `:` after index 0 must be catcode 12, else will be mistaken for the start of variable by expression parser (as `<digits><variable>` is allowed by the syntax and does tacit multiplication).

```

969 \edef\XINT_expr_op_[: #1{\xint_c_ii\noexpand\XINT_expr_itself_}[#10\string :}%
970 \let\XINT_flexpr_op_[: \XINT_expr_op_[:
971 \let\XINT_iiexpr_op_[: \XINT_expr_op_[:
972 \catcode`[ 12 \catcode`] 12

```

### 10.26.1 `\xintListSel:x:csv`

1.2j. Because there is `\xintKeep:x:csv` which is faster than `\xintKeep:f:csv`.

```

973 \def\xintListSel:x:csv #1%
974 {%
975   \if ]\noexpand#1\xint_dothis\XINT_listsel:_s\fi
976   \if : \noexpand#1\xint_dothis\XINT_listxsel:_:\fi
977   \xint_orthat {\XINT_listsel:_nth #1}%
978 }%
979 \def\XINT_listsel:_s #1#2;#3;%
980 {%
981   \if-#1\expandafter\xintKeep:f:csv\else\expandafter\xintTrim:f:csv\fi
982   {#1#2}{#3}%
983 }%
984 \def\XINT_listsel:_nth #1;#2;{\xintNthEltPy:f:csv {\xintNum{#1}}{#2}}%

```

`\XINT_listsel:_nth` and `\XINT_listsel:_s` located in `\xintListSel:f:csv`.

```

985 \def\XINT_listxsel:_: #1#2;#3#4;%

```

```

986 {%
987   \xint_UDsignsfork
988     #1#3\XINT_listxsels:_N:N
989     #1-\XINT_listxsels:_N:P
990     -#3\XINT_listxsels:_P:N
991     --\XINT_listxsels:_P:P
992   \krof #1#2;#3#4;%
993 }%
994 \def\XINT_listxsels:_P:P #1;#2;#3;%
995 {%
996   \unless\ifnum #1<#2 \expandafter\xint_gobble_iii\fi
997   \xintKeep:x:csv{#2-#1}{\xintTrim:f:csv{#1}{#3}}%
998 }%
999 \def\XINT_listxsels:_N:N #1;#2;#3;%
1000 {%
1001   \expandafter\XINT_listxsels:_N:N_a
1002   \the\numexpr #2-#1\expandafter;\the\numexpr#1+\xintLength:f:csv{#3};#3;%
1003 }%
1004 \def\XINT_listxsels:_N:N_a #1;#2;#3;%
1005 {%
1006   \unless\ifnum #1>\xint_c_ \expandafter\xint_gobble_iii\fi
1007   \xintKeep:x:csv{#1}{\xintTrim:f:csv{\ifnum#2<\xint_c_\xint_c_\else#2\fi}{#3}}%
1008 }%
1009 \def\XINT_listxsels:_N:P #1;#2;#3;{\expandafter\XINT_listxsels:_N:P_a
1010   \the\numexpr #1+\xintLength:f:csv{#3};#2;#3;%}
1011 \def\XINT_listxsels:_N:P_a #1#2;%
1012   {\if -#1\expandafter\XINT_listxsels:_O:P\fi\XINT_listxsels:_P:P #1#2;%}
1013 \def\XINT_listxsels:_O:P\XINT_listxsels:_P:P #1;{\XINT_listxsels:_P:P 0;%}
1014 \def\XINT_listxsels:_P:N #1;#2;#3;{\expandafter\XINT_listxsels:_P:N_a
1015   \the\numexpr #2+\xintLength:f:csv{#3};#1;#3;%}
1016 \def\XINT_listxsels:_P:N_a #1#2;#3;%
1017   {\if -#1\expandafter\XINT_listxsels:_P:O\fi\XINT_listxsels:_P:P #3;#1#2;%}
1018 \def\XINT_listxsels:_P:O\XINT_listxsels:_P:P #1;#2;{\XINT_listxsels:_P:P #1;0;%}

```

## 10.26.2 \xintListSel:f:csv

1.2g. Since 1.2j this is needed only for \xintNewExpr and user defined functions. Some extras compared to \xintListSel:x:csv because things may not yet have been expanded in the \xintNewExpr context.

```

1019 \def\xintListSel:f:csv #1%
1020 {%
1021   \if ]\noexpand#1\xint_dothis{\expandafter\XINT_listsel:_s\romannumeral`&&@\fi
1022   \if :\noexpand#1\xint_dothis{\XINT_listsel:_:}\fi
1023   \xint_orthat {\XINT_listsel:_nth #1}%
1024 }%
1025 \def\XINT_listsel:_: #1;#2;%
1026 {%
1027   \expandafter\XINT_listsel:_:a
1028   \the\numexpr #1\expandafter;\the\numexpr #2\expandafter;\romannumeral`&&@%
1029 }%
1030 \def\XINT_listsel:_:a #1#2;#3#4;%
1031 {%

```

```

1032 \xint_UDsignsfork
1033 #1#3\XINT_listsel:_N:N
1034 #1-\XINT_listsel:_N:P
1035 -#3\XINT_listsel:_P:N
1036 --\XINT_listsel:_P:P
1037 \krof #1#2;#3#4;%
1038 }%
1039 \def\XINT_listsel:_P:P #1;#2;#3;%
1040 {%
1041 \unless\ifnum #1<#2 \xint_afterfi{\expandafter\space\xint_gobble_iii}\fi
1042 \xintKeep:f:csv{#2-#1}{\xintTrim:f:csv{#1}{#3}}}%
1043 }%
1044 \def\XINT_listsel:_N:N #1;#2;#3;%
1045 {%
1046 \unless\ifnum #1<#2 \expandafter\XINT_listsel:_N:N_abort\fi
1047 \expandafter\XINT_listsel:_N:N_a
1048 \the\numexpr#1+\xintLength:f:csv{#3}\expandafter;\the\numexpr#2-#1;#3;%
1049 }%
1050 \def\XINT_listsel:_N:N_abort #1;#2;#3;{ }%
1051 \def\XINT_listsel:_N:N_a #1;#2;#3;%
1052 {%
1053 \xintKeep:f:csv{#2}{\xintTrim:f:csv{\ifnum#1<\xint_c\xint_c\else#1\fi}{#3}}}%
1054 }%
1055 \def\XINT_listsel:_N:P #1;#2;#3;{\expandafter\XINT_listsel:_N:P_a
1056 \the\numexpr #1+\xintLength:f:csv{#3};#2;#3;%}
1057 \def\XINT_listsel:_N:P_a #1#2;%
1058 { \if -#1\expandafter\XINT_listsel:_O:P\fi\XINT_listsel:_P:P #1#2;}%
1059 \def\XINT_listsel:_O:P\XINT_listsel:_P:P #1;{\XINT_listsel:_P:P 0;}%
1060 \def\XINT_listsel:_P:N #1;#2;#3;{\expandafter\XINT_listsel:_P:N_a
1061 \the\numexpr #2+\xintLength:f:csv{#3};#1;#3;%}
1062 \def\XINT_listsel:_P:N_a #1#2;#3;%
1063 { \if -#1\expandafter\XINT_listsel:_P:O\fi\XINT_listsel:_P:P #3;#1#2;}%
1064 \def\XINT_listsel:_P:O\XINT_listsel:_P:P #1;#2;{\XINT_listsel:_P:P #1;0;}%

```

### 10.26.3 \xintKeep:x:csv

1.2j. This macro is used only with positive first argument.

```

1065 \def\xintKeep:x:csv #1#2%
1066 {%
1067 \expandafter\xint_gobble_i
1068 \romannumeral0\expandafter\XINT_keep:x:csv_pos
1069 \the\numexpr #1\expandafter.\expandafter{\romannumeral`&&@#2}%
1070 }%
1071 \def\XINT_keep:x:csv_pos #1.#2%
1072 {%
1073 \expandafter\XINT_keep:x:csv_loop\the\numexpr#1-\xint_c_viii.%
1074 #2\xint_Bye,\xint_Bye,\xint_Bye,\xint_Bye,%
1075 \xint_Bye,\xint_Bye,\xint_Bye,\xint_Bye,\xint_bye
1076 }%
1077 \def\XINT_keep:x:csv_loop #1%
1078 {%
1079 \xint_gob_til_minus#1\XINT_keep:x:csv_finish-%

```

```

1080 \XINT_keep:x:csv_loop_pickeight #1%
1081 }%
1082 \def\XINT_keep:x:csv_loop_pickeight #1.#2,#3,#4,#5,#6,#7,#8,#9,%
1083 {%
1084     ,#2,#3,#4,#5,#6,#7,#8,#9%
1085     \expandafter\XINT_keep:x:csv_loop\the\numexpr#1-\xint_c_viii.%
1086 }%
1087 \def\XINT_keep:x:csv_finish-\XINT_keep:x:csv_loop_pickeight -#1.%
1088 {%
1089     \csname XINT_keep:x:csv_finish#1\endcsname
1090 }%
1091 \expandafter\def\csname XINT_keep:x:csv_finish1\endcsname
1092     #1,#2,#3,#4,#5,#6,#7,{, #1,#2,#3,#4,#5,#6,#7\xint_Bye}%
1093 \expandafter\def\csname XINT_keep:x:csv_finish2\endcsname
1094     #1,#2,#3,#4,#5,#6,{, #1,#2,#3,#4,#5,#6\xint_Bye}%
1095 \expandafter\def\csname XINT_keep:x:csv_finish3\endcsname
1096     #1,#2,#3,#4,#5,{, #1,#2,#3,#4,#5\xint_Bye}%
1097 \expandafter\def\csname XINT_keep:x:csv_finish4\endcsname
1098     #1,#2,#3,#4,{, #1,#2,#3,#4\xint_Bye}%
1099 \expandafter\def\csname XINT_keep:x:csv_finish5\endcsname
1100     #1,#2,#3,{, #1,#2,#3\xint_Bye}%
1101 \expandafter\def\csname XINT_keep:x:csv_finish6\endcsname
1102     #1,#2,{, #1,#2\xint_Bye}%
1103 \expandafter\def\csname XINT_keep:x:csv_finish7\endcsname
1104     #1,{, #1\xint_Bye}%
1105 \expandafter\let\csname XINT_keep:x:csv_finish8\endcsname\xint_Bye

```

#### 10.26.4 `\xintKeep:f:csv`

1.2g, code in `xinttools.sty`. Refactored in 1.2j.

#### 10.26.5 `\xintTrim:f:csv`

1.2g, code in `xinttools.sty`. Refactored in 1.2j.

#### 10.26.6 `\xintNthEltPy:f:csv`

1.2g, code in `xinttools.sty`. Refactored in 1.2j.

#### 10.26.7 `\xintLength:f:csv`

1.2g, code in `xinttools.sty`. Refactored in 1.2j.

#### 10.26.8 `\xintReverse:f:csv`

1.2g, code in `xinttools.sty`.

## 10.27 Macros for a..b list generation

10.27.1	<code>\xintSeq::csv</code>	304
10.27.2	<code>\xintiiSeq::csv</code>	305

Ne produit que des listes d'entiers inférieurs à la borne de TeX ! mais sous la forme  $N/1[0]$  en ce qui concerne `\xintSeq::csv`.

### 10.27.1 `\xintSeq::csv`

Commence par remplacer a par `ceil(a)` et b par `floor(b)` et renvoie ensuite les entiers entre les deux, possiblement en décroissant, et extrémités comprises. Si  $a=b$  est non entier en obtient donc `ceil(a)` et `floor(a)`. Ne renvoie jamais une liste vide.

Note: le a..b dans `\xintfloatexpr` utilise cette routine.

```

1106 \def\xintSeq::csv {\romannumeral0\xintseq::csv}%
1107 \def\xintseq::csv #1#2%
1108 {%
1109   \expandafter\XINT_seq::csv\expandafter
1110     {\the\numexpr \xintiCeil{#1}\expandafter}\expandafter
1111     {\the\numexpr \xintiFloor{#2}}}%
1112}%
1113 \def\XINT_seq::csv #1#2%
1114 {%
1115   \ifcase\ifnum #1=#2 0\else\ifnum #2>#1 1\else -1\fi\fi\space
1116   \expandafter\XINT_seq::csv_z
1117   \or
1118   \expandafter\XINT_seq::csv_p
1119   \else
1120   \expandafter\XINT_seq::csv_n
1121   \fi
1122   {#2}{#1}}%
1123}%
1124 \def\XINT_seq::csv_z #1#2{ #1/1[0]}%
1125 \def\XINT_seq::csv_p #1#2%
1126 {%
1127   \ifnum #1>#2
1128     \expandafter\expandafter\expandafter\XINT_seq::csv_p
1129   \else
1130     \expandafter\XINT_seq::csv_e
1131   \fi
1132   \expandafter{\the\numexpr #1-\xint_c_i}{#2},#1/1[0]}%
1133}%
1134 \def\XINT_seq::csv_n #1#2%
1135 {%
1136   \ifnum #1<#2
1137     \expandafter\expandafter\expandafter\XINT_seq::csv_n
1138   \else
1139     \expandafter\XINT_seq::csv_e
1140   \fi
1141   \expandafter{\the\numexpr #1+\xint_c_i}{#2},#1/1[0]}%
1142}%
1143 \def\XINT_seq::csv_e #1,{ }%

```



**10.27.2 \xintiiSeq::csv**

```

1144 \def\xintiiSeq::csv {\romannumeral0\xintiiseq::csv}%
1145 \def\xintiiseq::csv #1#2%
1146 {%
1147   \expandafter\XINT_iiseq::csv\expandafter
1148     {\the\numexpr #1\expandafter}\expandafter{\the\numexpr #2}%
1149}%
1150 \def\XINT_iiseq::csv #1#2%
1151 {%
1152   \ifcase\ifnum #1=#2 0\else\ifnum #2>#1 1\else -1\fi\fi\space
1153   \expandafter\XINT_iiseq::csv_z
1154   \or
1155   \expandafter\XINT_iiseq::csv_p
1156   \else
1157   \expandafter\XINT_iiseq::csv_n
1158   \fi
1159   {#2}{#1}%
1160}%
1161 \def\XINT_iiseq::csv_z #1#2{ #1}%
1162 \def\XINT_iiseq::csv_p #1#2%
1163 {%
1164   \ifnum #1>#2
1165     \expandafter\expandafter\expandafter\XINT_iiseq::csv_p
1166   \else
1167     \expandafter\XINT_seq::csv_e
1168   \fi
1169   \expandafter{\the\numexpr #1-\xint_c_i}{#2},#1%
1170}%
1171 \def\XINT_iiseq::csv_n #1#2%
1172 {%
1173   \ifnum #1<#2
1174     \expandafter\expandafter\expandafter\XINT_iiseq::csv_n
1175   \else
1176     \expandafter\XINT_seq::csv_e
1177   \fi
1178   \expandafter{\the\numexpr #1+\xint_c_i}{#2},#1%
1179}%
1180 \def\XINT_seq::csv_e #1,{ }%

```

**10.28 Macros for a..[d].b list generation**

10.28.1	\xintSeqA::csv, \xintiiSeqA::csv, \XINTinFloatSeqA::csv	305
10.28.2	\xintSeqB::csv	306
10.28.3	\xintiiSeqB::csv	306
10.28.4	\XINTinFloatSeqB::csv	307

Contrarily to a..b which is limited to small integers, this works with a, b, and d (big) fractions. It will produce a «nil» list, if a>b and d<0 or a<b and d>0.

**10.28.1 \xintSeqA::csv, \xintiiSeqA::csv, \XINTinFloatSeqA::csv**

```

1181 \def\xintSeqA::csv #1%
1182   {\expandafter\XINT_seqa::csv\expandafter{\romannumeral0\xintra {#1}}}%

```

```

1183 \def\XINT_seqa::csv #1#2{\expandafter\XINT_seqa::csv_a \romannumeral0\xintra {#2};#1;}%
1184 \def\xintiiSeqA::csv #1{\expandafter\XINT_iiseqa::csv\expandafter{\romannumeral`&&@#1}}%
1185 \def\XINT_iiseqa::csv #1#2{\expandafter\XINT_seqa::csv_a\romannumeral`&&@#2;#1;}%
1186 \def\XINTinFloatSeqA::csv #1{\expandafter\XINT_flseqa::csv\expandafter
1187   {\romannumeral0\XINTinfloat [\XINTdigits]{#1}}}%
1188 \def\XINT_flseqa::csv #1#2%
1189   {\expandafter\XINT_seqa::csv_a\romannumeral0\XINTinfloat [\XINTdigits]{#2};#1;}%
1190 \def\XINT_seqa::csv_a #1{\xint_UDzerominusfork
1191   #1-{z}%
1192   0#1{n}%
1193   0-{p}%
1194   \krof #1}%

```

### 10.28.2 \xintSeqB::csv

With one year late documentation, let's just say, the #1 is \XINT\_expr\_unlock\.=Ua;b; with U=z or n or p, a=step, b=start.

```

1195 \def\xintSeqB::csv #1#2%
1196   {\expandafter\XINT_seqb::csv \expandafter{\romannumeral0\xintra {#2}}{#1}}%
1197 \def\XINT_seqb::csv #1#2{\expandafter\XINT_seqb::csv_a\romannumeral`&&@#2#1!}%
1198 \def\XINT_seqb::csv_a #1#2;#3;#4!\expandafter\XINT_expr_seq_empty?
1199   \romannumeral0\csname XINT_seqb::csv_#1\endcsname {#3}{#4}{#2}}%
1200 \def\XINT_seqb::csv_p #1#2#3%
1201 {%
1202   \xintifCmp {#1}{#2}{, #1\expandafter\XINT_seqb::csv_p\expandafter}%
1203   {, #1\xint_gobble_iii}{\xint_gobble_iii}%

```

\romannumeral0 stopped by \endcsname, XINT\_expr\_seq\_empty? constructs "nil".

```

1204   {\romannumeral0\xintadd {#3}{#1}}{#2}{#3}%
1205 }%
1206 \def\XINT_seqb::csv_n #1#2#3%
1207 {%
1208   \xintifCmp {#1}{#2}{\xint_gobble_iii}{, #1\xint_gobble_iii}%
1209   {, #1\expandafter\XINT_seqb::csv_n\expandafter}%
1210   {\romannumeral0\xintadd {#3}{#1}}{#2}{#3}%
1211 }%
1212 \def\XINT_seqb::csv_z #1#2#3{, #1}%

```

### 10.28.3 \xintiiSeqB::csv

```

1213 \def\xintiiSeqB::csv #1#2{\XINT_iiseqb::csv #1#2}%
1214 \def\XINT_iiseqb::csv #1#2#3#4%
1215   {\expandafter\XINT_iiseqb::csv_a
1216     \romannumeral`&&\expandafter \XINT_expr_unlock\expandafter#2%
1217     \romannumeral`&&\XINT_expr_unlock #4!}%
1218 \def\XINT_iiseqb::csv_a #1#2;#3;#4!\expandafter\XINT_expr_seq_empty?
1219   \romannumeral`&&\csname XINT_iiseqb::csv_#1\endcsname {#3}{#4}{#2}}%
1220 \def\XINT_iiseqb::csv_p #1#2#3%
1221 {%
1222   \xintSgnFork{\XINT_Cmp {#1}{#2}}{, #1\expandafter\XINT_iiseqb::csv_p\expandafter}%
1223   {, #1\xint_gobble_iii}{\xint_gobble_iii}%
1224   {\romannumeral0\xintiiadd {#3}{#1}}{#2}{#3}%

```

```

1225 }%
1226 \def\XINT_iiseqb::csv_n #1#2#3%
1227 {%
1228   \xintSgnFork{\XINT_Cmp {#1}{#2}}{\xint_gobble_iii}{, #1\xint_gobble_iii}%
1229   {, #1\expandafter\XINT_iiseqb::csv_n\expandafter}%
1230   {\romannumeral0\xintiadd {#3}{#1}}{#2}{#3}%
1231 }%
1232 \def\XINT_iiseqb::csv_z #1#2#3{, #1}%

```

#### 10.28.4 \XINTinFloatSeqB::csv

```

1233 \def\XINTinFloatSeqB::csv #1#2{\expandafter\XINT_flseqb::csv \expandafter
1234   {\romannumeral0\XINTinfloat [\XINTdigits]{#2}}{#1}}%
1235 \def\XINT_flseqb::csv #1#2{\expandafter\XINT_flseqb::csv_a\romannumeral`&&@#2#1!}%
1236 \def\XINT_flseqb::csv_a #1#2;#3;#4!\expandafter\XINT_expr_seq_empty?
1237   \romannumeral`&&@\csname XINT_flseqb::csv_#1\endcsname {#3}{#4}{#2}}%
1238 \def\XINT_flseqb::csv_p #1#2#3%
1239 {%
1240   \xintifCmp {#1}{#2}{, #1\expandafter\XINT_flseqb::csv_p\expandafter}%
1241   {, #1\xint_gobble_iii}{\xint_gobble_iii}%
1242   {\romannumeral0\XINTinfloatadd {#3}{#1}}{#2}{#3}%
1243 }%
1244 \def\XINT_flseqb::csv_n #1#2#3%
1245 {%
1246   \xintifCmp {#1}{#2}{\xint_gobble_iii}{, #1\xint_gobble_iii}%
1247   {, #1\expandafter\XINT_flseqb::csv_n\expandafter}%
1248   {\romannumeral0\XINTinfloatadd {#3}{#1}}{#2}{#3}%
1249 }%
1250 \def\XINT_flseqb::csv_z #1#2#3{, #1}%

```

### 10.29 The comma as binary operator

New with 1.09a. Suffices to set its precedence level to two.

```

1251 \def\XINT_tmpa #1#2#3#4#5#6%
1252 {%
1253   \def #1##1% \XINT_expr_op_,
1254   {%
1255     \expandafter #2\expandafter ##1\romannumeral`&&@\XINT_expr_getnext
1256   }%
1257   \def #2##1##2% \XINT_expr_until_,_a
1258   {\xint_UDsignfork
1259     ##2{\expandafter #2\expandafter ##1\romannumeral`&&@#4}%
1260     -{#3##1##2}%
1261   \krof }%
1262   \def #3##1##2##3##4% \XINT_expr_until_,_b
1263   {%
1264     \ifnum ##2>\xint_c_ii
1265       \xint_afterfi {\expandafter #2\expandafter ##1\romannumeral`&&@%
1266         \csname XINT_#6_op_##3\endcsname {##4}}%
1267     \else
1268       \xint_afterfi
1269       {\expandafter ##2\expandafter ##3%
1270       \csname .=\XINT_expr_unlock ##1,\XINT_expr_unlock ##4\endcsname }%
1271     \fi

```

```

1272 }%
1273 \let #5\xint_c_ii
1274 }%
1275 \xintFor #1 in {expr,flexpr,iiexpr} \do {%
1276 \expandafter\XINT_tmpa
1277 \csname XINT_#1_op_,\expandafter\endcsname
1278 \csname XINT_#1_until_,_a\expandafter\endcsname
1279 \csname XINT_#1_until_,_b\expandafter\endcsname
1280 \csname XINT_#1_op_-vi\expandafter\endcsname
1281 \csname XINT_expr_precedence_,\endcsname {#1}%
1282 }%

```

## 10.30 The minus as prefix operator of variable precedence level

Inherits the precedence level of the previous infix operator.

```

1283 \def\XINT_tmpa #1#2#3%
1284 {%
1285 \expandafter\XINT_tmppb
1286 \csname XINT_#1_op_-#3\expandafter\endcsname
1287 \csname XINT_#1_until_-#3_a\expandafter\endcsname
1288 \csname XINT_#1_until_-#3_b\expandafter\endcsname
1289 \csname xint_c_#3\endcsname {#1}#2%
1290 }%
1291 \def\XINT_tmppb #1#2#3#4#5#6%
1292 {%
1293 \def #1% \XINT_expr_op_-<level>
1294 {% get next number+operator then switch to _until macro
1295 \expandafter #2\romannumeral`&&\XINT_expr_getnext
1296 }%
1297 \def #2##1% \XINT_expr_until_-<l>_a
1298 {\xint_UDsignfork
1299 ##1{\expandafter #2\romannumeral`&&@#1}%
1300 -{#3##1}%
1301 \krof }%
1302 \def #3##1##2##3% \XINT_expr_until_-<l>_b
1303 {% _until tests precedence level with next op, executes now or postpones
1304 \ifnum ##1>#4%
1305 \xint_afterfi {\expandafter #2\romannumeral`&&@%
1306 \csname XINT_#5_op_##2\endcsname {##3}}%
1307 \else
1308 \xint_afterfi {\expandafter ##1\expandafter ##2%
1309 \csname .=#6{\XINT_expr_unlock ##3}\endcsname }%
1310 \fi
1311 }%
1312 }%

```

1.2d needs precedence 8 for \*\*\* and 9 for ^. Earlier, precedence level for ^ was only 8 but nevertheless the code did also "ix" here, which I think was unneeded back then.

```

1313 \xintApplyInline{\XINT_tmpa {expr}\xintOpp}{vi}{vii}{viii}{ix}}%
1314 \xintApplyInline{\XINT_tmpa {flexpr}\xintOpp}{vi}{vii}{viii}{ix}}%
1315 \xintApplyInline{\XINT_tmpa {iiexpr}\xintiiOpp}{vi}{vii}{viii}{ix}}%

```

### 10.31 ? as two-way and ?? as three-way conditionals with braced branches

In 1.1, I overload ? with ??, as : will be used for list extraction, problem with (stuff)?{?(1)}{0} for example, one should put a space (stuff)?{ ?(1)}{0} will work. Small idiosyncrasy. (which has been removed in 1.2h, there is no problem anymore with (test)?{?(1)}{0}, however (test)?{?}{!(x)} is not accepted; but (test)?{?(x)}{!(x)} is or even with {?(}{!(x)}.)

syntax: ?{yes}{no} and ??{<0}{=0}{>0}.

The difficulty is to recognize the second ? without removing braces as would be the case with standard parsing of operators. Hence the ? operator is intercepted in \XINT\_expr\_getop\_b.

1.2h corrects a bug in \XINT\_expr\_op\_? which in context like (test)?{foo}{bar} would provoke expansion of \foo, or also with (test)?{bar} would result in an error. The fix also solves the (test)?{?(1)}{0} issue mentioned above.

```

1316 \let\XINT_expr_precedence_? \xint_c_x
1317 \def\XINT_expr_op_? #1#2%
1318   {\XINT_expr_op_?checka #2!\xint_bye\XINT_expr_op_?a #1{#2}}%
1319 \def\XINT_expr_op_?checka #1{\expandafter\XINT_expr_op_?checkb\detokenize{#1}}%
1320 \def\XINT_expr_op_?checkb #1{\if ?#1\expandafter\XINT_expr_op_?checkc
1321   \else\expandafter\xint_bye\fi }%
1322 \def\XINT_expr_op_?checkc #1{\xint_gob_til_! #1\XINT_expr_op_?? !\xint_bye}%
1323 \def\XINT_expr_op_?a #1#2#3%
1324 {%
1325   \xintiiifNotZero{\XINT_expr_unlock #1}{\XINT_expr_getnext #2}{\XINT_expr_getnext #3}%
1326 }%
1327 \let\XINT_flexpr_op_?\XINT_expr_op_?
1328 \let\XINT_iiexpr_op_?\XINT_expr_op_?
1329 \def\XINT_expr_op_?? !\xint_bye\xint_bye\XINT_expr_op_?a #1#2#3#4#5%
1330 {%
1331   \xintiiifSgn {\XINT_expr_unlock #1}%
1332   {\XINT_expr_getnext #3}{\XINT_expr_getnext #4}{\XINT_expr_getnext #5}%
1333 }%

```

### 10.32 ! as postfix factorial operator

A float version \xintFloatFac was at last done 2015/10/06 for 1.2. Attention 2015/11/29 for 1.2f: no more \xintFac, but \xintiFac.

```

1334 \let\XINT_expr_precedence_! \xint_c_x
1335 \def\XINT_expr_op_! #1{\expandafter\XINT_expr_getop
1336   \csname .=\xintiFac{\XINT_expr_unlock #1}\endcsname }%
1337 \def\XINT_flexpr_op_! #1{\expandafter\XINT_expr_getop
1338   \csname .=\XINTinFloatFac{\XINT_expr_unlock #1}\endcsname }%
1339 \def\XINT_iiexpr_op_! #1{\expandafter\XINT_expr_getop
1340   \csname .=\xintiiFac{\XINT_expr_unlock #1}\endcsname }%

```

### 10.33 The A/B[N] mechanism

Releases earlier than 1.1 required the use of braces around A/B[N] input. The [N] is now implemented directly. \*BUT\* this uses a delimited macro! thus N is not allowed to be itself an expression (I could add it...). \xintE, \xintiiE, and \XINTinFloatE all put #2 in a \numexpr. But attention to the fact that \numexpr stops at spaces separating digits: \the\numexpr 3 + 7 9\relax gives 109\relax !! Hence we have to be careful.

`\numexpr` will not handle catcode 11 digits, but adding a `\detokenize` will suddenly make illicit for N to rely on macro expansion.

```

1341 \catcode`[ 11
1342 \catcode`* 11
1343 \let\XINT_expr_precedence_ \xint_c_vii
1344 \def\XINT_expr_op_[ #1#2]{\expandafter\XINT_expr_getop
1345     \csname .=\xintE{\XINT_expr_unlock #1}%
1346     {\xint_zapspace #2 \xint_gobble_i}\endcsname}%
1347 \def\XINT_iiexpr_op_[ #1#2]{\expandafter\XINT_expr_getop
1348     \csname .=\xintiE{\XINT_expr_unlock #1}%
1349     {\xint_zapspace #2 \xint_gobble_i}\endcsname}%
1350 \def\XINT_flexpr_op_[ #1#2]{\expandafter\XINT_expr_getop
1351     \csname .=\XINTinFloatE{\XINT_expr_unlock #1}%
1352     {\xint_zapspace #2 \xint_gobble_i}\endcsname}%
1353 \catcode`[ 12
1354 \catcode`* 12

```

### 10.34 `\XINT_expr_op_`` for recognizing functions

The "onlitteral" intercepts is for bool, togl, protect, ... but also for add, mul, seq, etc... Genuine functions have expr, iiexpr and flexpr versions (or only one or two of the three).

With 1.2c "onlitteral" is also used to disambiguate variables from functions. However as I use only a `\ifcsname` test, in order to be able to re-define a variable as function, I move the check for being a function first. Each variable name now has its `onlitteral_<name>` associated macro which is the new way tacit multiplication in front of a parenthesis is implemented. This used to be decided much earlier at the time of `\XINT_expr_func`.

The advantage of our choices for 1.2c is that the same name can be used for a variable or a function, the parser will apply the correct interpretation which is decided by the presence or not of an opening parenthesis next.

```

1355 \def\XINT_tmpa #1#2#3{%
1356     \def #1##1%
1357     {%
1358         \ifcsname XINT_#3_func_##1\endcsname
1359         \xint_dothis{\expandafter\expandafter
1360             \csname XINT_#3_func_##1\endcsname\romannumeral`&&@#2}\fi
1361         \ifcsname XINT_expr_onlitteral_##1\endcsname
1362         \xint_dothis{\csname XINT_expr_onlitteral_##1\endcsname}\fi
1363         \xint_orthat{\XINT_expr_unknown_function {##1}%
1364             \expandafter\XINT_expr_func_unknown\romannumeral`&&@#2}%
1365     }%
1366 }%
1367 \def\XINT_expr_unknown_function #1{\xintError:removed \xint_gobble_i {#1}}%
1368 \xintFor #1 in {expr,flexpr,iiexpr} \do {%
1369     \expandafter\XINT_tmpa
1370     \csname XINT_#1_op_`\expandafter\endcsname
1371     \csname XINT_#1_oparen\endcsname
1372     {#1}%
1373 }%
1374 \def\XINT_expr_func_unknown #1#2#3%
1375     {\expandafter #1\expandafter #2\csname .=\endcsname }%

```

### 10.35 The bool, togl, protect pseudo “functions”

`bool`, `togl` and `protect` use delimited macros. They are not true functions, they turn off the parser to gather their “variable”.

```

1376 \def\XINT_expr_onlitteral_bool #1)%
1377     {\expandafter\XINT_expr_getop\csname .=\xintBool{#1}\endcsname }%
1378 \def\XINT_expr_onlitteral_togl #1)%
1379     {\expandafter\XINT_expr_getop\csname .=\xintToggle{#1}\endcsname }%
1380 \def\XINT_expr_onlitteral_protect #1)%
1381     {\expandafter\XINT_expr_getop\csname .=\detokenize{#1}\endcsname }%

```

### 10.36 The break function

`break` is a true function, the parsing via expansion of the succeeding material proceeded via `_oparen` macros as with any other function.

```

1382 \def\XINT_expr_func_break #1#2#3%
1383     {\expandafter #1\expandafter #2\csname .=?\romannumeral`&&\XINT_expr_unlock #3\endcsname }%
1384 \let\XINT_flexpr_func_break \XINT_expr_func_break
1385 \let\XINT_iiexpr_func_break \XINT_expr_func_break

```

### 10.37 The qint, qfrac, qfloat “functions”

New with 1.2. Allows the user to hand over quickly a big number to the parser, spaces not immediately removed but should be harmless in general.

```

1386 \def\XINT_expr_onlitteral_qint #1)%
1387     {\expandafter\XINT_expr_getop\csname .=\xintiNum{#1}\endcsname }%
1388 \def\XINT_expr_onlitteral_qfrac #1)%
1389     {\expandafter\XINT_expr_getop\csname .=\xintRaw{#1}\endcsname }%
1390 \def\XINT_expr_onlitteral_qfloat #1)%
1391     {\expandafter\XINT_expr_getop\csname .=\XINTinFloatdigits{#1}\endcsname }%

```

### 10.38 `\XINT_expr_op__` for recognizing variables

The 1.1 mechanism for `\XINT_expr_var_<varname>` has been modified in 1.2c. The `<varname>` associated macro is now only expanded once, not twice. We arrive here via `\XINT_expr_func`.

```

1392 \def\XINT_expr_op__ #1% op__ with two _'s
1393     {%
1394         \ifcsname XINT_expr_var_#1\endcsname
1395             \expandafter\xint_firstoftwo
1396         \else
1397             \expandafter\xint_secondoftwo
1398         \fi
1399         {\expandafter\expandafter\expandafter
1400             \XINT_expr_getop\csname XINT_expr_var_#1\endcsname}%
1401         {\XINT_expr_unknown_variable {#1}%
1402             \expandafter\XINT_expr_getop\csname .:=0\endcsname}%
1403     }%
1404 \def\XINT_expr_unknown_variable #1{\xintError:removed \xint_gobble_i {#1}}%
1405 \let\XINT_flexpr_op__ \XINT_expr_op__
1406 \let\XINT_iiexpr_op__ \XINT_expr_op__

```

### 10.39 User defined variables: `\xintdefvar`, `\xintdefiivar`, `\xintdeffloatvar`

1.1 An active `:` character will be a pain with our delimited macros and I almost decided not to use `:=` but rather `=` as assignation operator, but this is the same problem inside expressions with the modulo operator `/:`, or with `babel+frenchb` with all high punctuation `?`, `!`, `:`, `;`.

Variable names may contain letters, digits, underscores, and must not start with a digit. Names starting with `@` or `_` are reserved.

Note (2015/11/11): although defined since october 2014 with 1.1, they were only very briefly mentioned in the user documentation, I should have expanded more. I am now adding functions to variables, and will rewrite entirely the documentation of `xintexpr.sty`.

1.2c adds the "onlitteral" macros as we changed our tricks to disambiguate variables from functions if followed by a parenthesis, in order to allow function names to have precedence on variable names.

I don't issue warnings if a an attempt to define a variable name clashes with a pre-existing function name, as I would have to check `expr`, `iiexpr` and also `floatexpr`. And anyhow overloading a function name with a variable name is allowed, the only thing to know is that if an opening parenthesis follows it is the function meaning which prevails.

2015/11/13: I now first do an a priori complete expansion of `#1`, and then apply `\detokenize` to the result, and remove spaces.

2015/11/21: finally I do not detokenize the variable name. Because this complicated the `\xintunassignvar` if it did the same and we wanted to use it to redeclare a letter as dummy variable.

Documentation of 1.2d said that the tacit multiplication always was done with increased precedence, but I had not at that time made up my mind for the case of `variable(stuff)` and pushed to CTAN early because I need to fix the bug I had introduced in 1.2c which itself I had pushed to CTAN early because I had to fix the 1.2 bug with subtraction....

Finally I decide to do it indeed. Hence for 1.2e. This only impacts situations such as `A/B(stuff)`, which are thus interpreted as `A/(B*(stuff))`.

```

1407 \catcode`* 11
1408 \def\xINT_expr_defvar #1#2#3;{%
1409   \edef\xINT_expr_tmpa{#2}%
1410   \edef\xINT_expr_tmpa {\xint_zapspace_o\xINT_expr_tmpa}%
1411   \ifnum\expandafter\xintLength\expandafter{\xINT_expr_tmpa}=\z@
1412     \xintMessage {xintexpr}{Warning}
1413     {Error: impossible to declare variable with empty name.}%
1414   \else
1415     \edef\xINT_expr_tmpb {\romannumeral0#1#3\relax }%
1416     \expandafter\edef\csname XINT_expr_var_\xINT_expr_tmpa\endcsname
1417       {\expandafter\noexpand\xINT_expr_tmpb}%
1418     \expandafter\edef\csname XINT_expr_onlitteral_\xINT_expr_tmpa\endcsname
1419       {\XINT_expr_precedence_*** *\expandafter\noexpand\xINT_expr_tmpb }{%
1420     \ifxintverbose\xintMessage {xintexpr}{Info}
1421       {Variable "\XINT_expr_tmpa" defined with value
1422         \expandafter\xINT_expr_unlock\xINT_expr_tmpb.}%
1423     \fi
1424   \fi
1425 }%
1426 \catcode`* 12
1427 \catcode`: 12
1428 \def\xintdefvar      #1:={\XINT_expr_defvar\xintbareeval      {#1}}%
1429 \def\xintdefiivar    #1:={\XINT_expr_defvar\xintbareiieval    {#1}}%
1430 \def\xintdeffloatvar #1:={\XINT_expr_defvar\xintbarefloateval {#1}}%
1431 \catcode`: 11

```



## 10.40 \xintunassignvar

1.2e. Currently not possible to genuinely ``undefine'' a variable, all we can do is to let it stand for zero and generate an error. The reason is that I chose to use `\ifcsname` tests in `\XINT_expr_op__` and `\XINT_expr_op``.

```

1432 \def\xintunassignvar #1{%
1433   \edef\XINT_expr_tmpa{#1}%
1434   \edef\XINT_expr_tmpa {\xint_zapspace\XINT_expr_tmpa}%
1435   \ifcsname XINT_expr_var_\XINT_expr_tmpa\endcsname
1436     \ifnum\expandafter\xintlength\expandafter{\XINT_expr_tmpa}=\@ne
1437       \expandafter\XINT_expr_makedummy\XINT_expr_tmpa
1438       \ifxintverbose\xintMessage {xintexpr}{Info}%
1439         {Character \XINT_expr_tmpa\space usable as dummy variable (if with catcode letter).}%
1440       \fi
1441     \else
1442       \expandafter\edef\csname XINT_expr_var_\XINT_expr_tmpa\endcsname
1443         {\csname .=\0\endcsname\noexpand\XINT_expr_undefined {\XINT_expr_tmpa}}%
1444       \expandafter\edef\csname XINT_expr_onlitteral_\XINT_expr_tmpa\endcsname
1445         {\csname .=\0\endcsname\noexpand\XINT_expr_undefined {\XINT_expr_tmpa}*}%
1446       \ifxintverbose\xintMessage {xintexpr}{Info}%
1447         {Variable \XINT_expr_tmpa\space has been ``unassigned''.}%
1448       \fi
1449     \fi
1450   \else
1451     \xintMessage {xintexpr}{Warning}%
1452     {Error: there was no such variable \XINT_expr_tmpa\space to unassign.}%
1453   \fi
1454 }%
1455 \def\XINT_expr_undefined #1{\xintError:replaced_by_zero\xint_gobble_i {#1}}%

```

## 10.41 seq and the implementation of dummy variables

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All of seq, add, mul, rseq, etc... (actually all of the extensive changes from xintexpr 1.09n to 1.1) was done around June 15-25th 2014, but the problem is that I did not document the code enough, and I had a hard time understanding in October what I had done in June. Despite the lesson, again being short on time, I do not document enough my current understanding of the innards of the beast...

I added subs, and iter in October (also the [:n], [n:] list extractors), proving I did at least understand a bit (or rather could imitate) my earlier code (but don't ask me to explain \xintNewExpr !)

The `\XINT_expr_onlitteral_seq_a` parses: "expression, variable=list)" (when it is called the opening ( has been swallowed, and it looks for the ending one.) Both expression and list may themselves contain parentheses and commas, we allow nesting. For example " $x^2, x=1..10$ ", at the end of `seq_a` we have {variable{expression}}{list}, in this example { $x^2$ }{1..10}, or more complicated "`seq(add(y,y=1..x),x=1..10)`" will work too. The variable is a single lowercase Latin letter.

The complications with `\xint_c_xviii` in `seq_f` is for the recurrent thing that we don't know in what type of expressions we are, hence we must move back up, with some loss of efficiency (superfluous check for minus sign, etc...). But the code manages simultaneously `expr`, `flexpr` and `iiexpr`.

### 10.41.1 All letters usable as dummy variables

The `nil` variable was introduced in 1.1 but isn't used under that name. However macros handling `a..[d]..b`, or for `seq` with dummy variable where `omit` has omitted everything may in practice inject a `nil` value as current number.

1.2c has changed the way variables are disambiguated from functions and for this it has added here the definitions of `\XINT_expr_onlitteral_<name>`.

In 1.1 a letter variable say `X` was acting as a delimited macro looking for `!X{stuff}` and then would expand the stuff inside a `\csname.=...\endcsname`. I don't think I used the possibilities this opened and the 1.2c version has `stuff_already_` encapsulated thus a single token. Only one expansion, not two is then needed in `\XINT_expr_op__`.

I had to accordingly modify `seq`, `add`, `mul` and `subs`, but fortunately realized that the `@`, `@1`, etc... variables for `rseq`, `rrseq` and `iter` already had been defined in the way now also followed by the Latin letters as dummy variables.

The 1.2e `\XINT_expr_makedummy` was adjoined `\xintnewdummy` by 1.2k for a public interface. It should not be used with multi-letter argument. The `add`, `mul`, `seq`, etc... can only work with one-letter long dummy variable. And this will almost certainly not change.

Also 1.2e does the tacit multiplication `x(stuff)->x*(stuff)` in its higher precedence form. Things are easy now that variables always fetch a single already locked value `\.=<number>`.

The tacit multiplication in case of the `'nil'` variable doesn't make much sense but we do it anyhow.

```

1456 \catcode`* 11
1457 \def\XINT_expr_makedummy #1%
1458 {%
1459   \expandafter\def\csname XINT_expr_var_#1\endcsname ##1\relax !#1##2%
1460   {##2##1\relax !#1##2}%
1461   \expandafter\def\csname XINT_expr_onlitteral_#1\endcsname ##1\relax !#1##2%
1462   {\XINT_expr_precedence_*** *##2(##1\relax !#1##2}%
1463 }%
1464 \xintApplyUnbraced \XINT_expr_makedummy {abcdefghijklmnopqrstuvwxyz}%
1465 \xintApplyUnbraced \XINT_expr_makedummy {ABCDEFGHIJKLMNOPQRSTUVWXYZ}%
1466 \def\xintnewdummy #1{%
1467   \XINT_expr_makedummy{#1}%
1468   \ifxintverbose\xintMessage {xintexpr}{Info}%
1469     {Character #1 now usable as dummy variable (if with catcode letter).}%
1470   \fi
1471 }%
1472 \edef\XINT_expr_var_nil {\expandafter\noexpand\csname . = \endcsname}%
1473 \edef\XINT_expr_onlitteral_nil
1474   {\XINT_expr_precedence_*** *\expandafter\noexpand\csname . = \endcsname (}%
1475 \catcode`* 12

```

### 10.41.2 omit and abort

June 24 and 25, 2014.

Added comments 2015/11/13:

Et la documentation ? on n'y comprend plus rien. Trop rusé.

```
\def\XINT_expr_var_omit #1\relax !{1^C!}{}}{\}\relax !}
```

```
\def\XINT_expr_var_abort #1\relax !{1^C!}{}}{\}\relax !}
```

C'était accompagné de `\XINT_expr_precedence_^C=0` et d'un hack au sein même des macros until de plus bas niveau.

Le mécanisme sioux était le suivant: `^C` est déclaré comme un opérateur de précedence nulle. Lorsque le parseur trouve un "omit" dans un seq ou autre, il va insérer dans le stream `\XINT_expr_getop` suivi du texte de remplacement. Donc ici on avait un 1 comme place holder, puis l'opérateur `^C`. Celui-ci étant de précedence zéro provoque la finalisation de tous les calculs antérieurs dans le sous-bareeval. Mais j'ai dû hacker le `until_end_b` (et le `until_*)_b`) qui confronté à `^C`, va se relancer à zéro, le `getnext` va trouver le `!{}}{\}\relax !}` et ensuite il y aura `\relax`, et le résultat sera `\relax !}` pour omit ou `\relax !}` pour abort. Les routines des boucles seq, iter, etc... peuvent alors repérer le `!` ou `^` et agir en conséquence (un long paragraphe pour ne décrire que partiellement une ou deux lignes de codes...).

Mais `^C` a été fait alors que je n'avais pas encore les variables muettes. Je dois trouver autre chose, car `seq(2^C, C=1..5)` est alors impossible. De toute façon ce `^C` était à usage interne uniquement.

Il me faut un symbole d'opérateur qui ne rentre pas en conflit. Bon je vais prendre `!?`. Ensuite au lieu de hacker `until_end`, il vaut mieux lui donner précedence 2 (mais ça ne pourra pas marcher à l'intérieur de parenthèses il faut d'abord les fermer manuellement) et lui associer un simplement un op spécial. Je n'avais pas fait cela peut-être pour éviter d'avoir à définir plusieurs macros. Le `#1` dans la définition de `\XINT_expr_op_!?` est le résultat de l'évaluation forcée précédente.

Attention que les premier `!` doivent être de catcode 12 sinon ils signalent une sous-expression qui déclenche une multiplication tacite.

```
1476 \edef\XINT_expr_var_omit #1\relax !{1\string !?!\relax !}%
1477 \edef\XINT_expr_var_abort #1\relax !{1\string !?^\relax !}%
1478 \def\XINT_expr_op_!#1#2\relax {\expandafter\XINT_expr_foundend\csname .=#2\endcsname}%
1479 \let\XINT_iiexpr_op_!?\XINT_expr_op_!%
1480 \let\XINT_flexpr_op_!?\XINT_expr_op_!%
```

### 10.41.3 The special variables @, @1, @2, @3, @4, @@, @@(1), ..., @@@, @@@(1), ... for recursion

October 2014: I had completely forgotten what the @@@ etc... stuff were supposed to do: this is for nesting recursions! (I was mad back in June). `@@(N)` gives the Nth back, `@@@(N)` gives the Nth back of the higher recursion!

1.2c adds the needed "onlitteral" now that tacit multiplication between a variable and a ( has a new mechanism. 1.2e does this tacit multiplication with higher precedence.

For the record, the `~` has catcode 3 in this code.

```
1481 \catcode`? 3 \catcode`* 11
1482 \def\XINT_expr_var_@ #1~#2{#2#1~#2}%
1483 \expandafter\let\csname XINT_expr_var_@1\endcsname \XINT_expr_var_@
1484 \expandafter\def\csname XINT_expr_var_@2\endcsname #1~#2#3{#3#1~#2#3}%
1485 \expandafter\def\csname XINT_expr_var_@3\endcsname #1~#2#3#4{#4#1~#2#3#4}%
1486 \expandafter\def\csname XINT_expr_var_@4\endcsname #1~#2#3#4#5{#5#1~#2#3#4#5}%
1487 \def\XINT_expr_onlitteral_@ #1~#2{\XINT_expr_precedence_*** *#2(#1~#2)%
1488 \expandafter\let\csname XINT_expr_onlitteral_@1\endcsname \XINT_expr_onlitteral_@
1489 \expandafter\def\csname XINT_expr_onlitteral_@2\endcsname #1~#2#3%
```

```

1490      {\XINT_expr_precedence_*** *#3(#1~#2#3}%
1491 \expandafter\def\csname XINT_expr_onlitteral_@3\endcsname #1~#2#3#4%
1492      {\XINT_expr_precedence_*** *#4(#1~#2#3#4}%
1493 \expandafter\def\csname XINT_expr_onlitteral_@4\endcsname #1~#2#3#4#5%
1494      {\XINT_expr_precedence_*** *#5(#1~#2#3#4#5}%
1495 \catcode`* 12
1496 \def\XINT_expr_func_@@ #1#2#3#4~#5?%
1497 {%
1498   \expandafter#1\expandafter#2\romannumeral0\xintntheltnoexpand
1499       {\xintNum{\XINT_expr_unlock#3}}{#5}#4~#5?%
1500 }%
1501 \def\XINT_expr_func_@@@ #1#2#3#4~#5~#6?%
1502 {%
1503   \expandafter#1\expandafter#2\romannumeral0\xintntheltnoexpand
1504   {\xintNum{\XINT_expr_unlock#3}}{#6}#4~#5~#6?%
1505 }%
1506 \def\XINT_expr_func_@@@# #1#2#3#4~#5~#6~#7?%
1507 {%
1508   \expandafter#1\expandafter#2\romannumeral0\xintntheltnoexpand
1509   {\xintNum{\XINT_expr_unlock#3}}{#7}#4~#5~#6~#7?%
1510 }%
1511 \let\XINT_flexpr_func_@@\XINT_expr_func_@@
1512 \let\XINT_flexpr_func_@@@\XINT_expr_func_@@@
1513 \let\XINT_flexpr_func_@@@#\XINT_expr_func_@@@
1514 \def\XINT_iiexpr_func_@@ #1#2#3#4~#5?%
1515 {%
1516   \expandafter#1\expandafter#2\romannumeral0\xintntheltnoexpand
1517   {\XINT_expr_unlock#3}{#5}#4~#5?%
1518 }%
1519 \def\XINT_iiexpr_func_@@@ #1#2#3#4~#5~#6?%
1520 {%
1521   \expandafter#1\expandafter#2\romannumeral0\xintntheltnoexpand
1522   {\XINT_expr_unlock#3}{#6}#4~#5~#6?%
1523 }%
1524 \def\XINT_iiexpr_func_@@@# #1#2#3#4~#5~#6~#7?%
1525 {%
1526   \expandafter#1\expandafter#2\romannumeral0\xintntheltnoexpand
1527   {\XINT_expr_unlock#3}{#7}#4~#5~#6~#7?%
1528 }%
1529 \catcode`? 11

```

#### 10.41.4 \XINT\_expr\_onlitteral\_seq

```

1530 \def\XINT_expr_onlitteral_seq
1531 {\expandafter\XINT_expr_onlitteral_seq_f\romannumeral`&&\XINT_expr_onlitteral_seq_a {}}%
1532 \def\XINT_expr_onlitteral_seq_f #1#2{\xint_c_xviii `{seqx}#2)\relax #1}%

```

#### 10.41.5 \XINT\_expr\_onlitteral\_seq\_a

```

1533 \def\XINT_expr_onlitteral_seq_a #1#2,%
1534 {%
1535   \ifcase\XINT_isbalanced_a \relax #1#2(\xint_bye)\xint_bye
1536   \expandafter\XINT_expr_onlitteral_seq_c
1537   \or\expandafter\XINT_expr_onlitteral_seq_b

```

```

1538     \else\expandafter\xintError:we_are_doomed
1539     \fi {#1#2},%
1540 }%
1541 \def\XINT_expr_onlitteral_seq_b #1,{\XINT_expr_onlitteral_seq_a {#1,}}%
1542 \def\XINT_expr_onlitteral_seq_c #1,#2#3% #3 pour absorber le =
1543 {%
1544     \XINT_expr_onlitteral_seq_d {#2{#1}}{}%
1545 }%
1546 \def\XINT_expr_onlitteral_seq_d #1#2#3)%
1547 {%
1548     \ifcase\XINT_isbalanced_a \relax #2#3(\xint_bye)\xint_bye
1549     \or\expandafter\XINT_expr_onlitteral_seq_e
1550     \else\expandafter\xintError:we_are_doomed
1551     \fi
1552     {#1}{#2#3}%
1553 }%
1554 \def\XINT_expr_onlitteral_seq_e #1#2{\XINT_expr_onlitteral_seq_d {#1}{#2}}}%

```

#### 10.41.6 \XINT\_isbalanced\_a for \XINT\_expr\_onlitteral\_seq\_a

Expands to \xint\_c\_mone in case a closing ) had no opening ( matching it, to \@ne if opening ) had no closing ) matching it, to \z@ if expression was balanced.

```

1555 % use as \XINT_isbalanced_a \relax #1(\xint_bye)\xint_bye
1556 \def\XINT_isbalanced_a #1({\XINT_isbalanced_b #1)\xint_bye }%
1557 \def\XINT_isbalanced_b #1)#2%
1558     {\xint_bye #2\XINT_isbalanced_c\xint_bye\XINT_isbalanced_error }%

    if #2 is not \xint_bye, a ) was found, but there was no (. Hence error -> -1

1559 \def\XINT_isbalanced_error #1)\xint_bye {\xint_c_mone}%

    #2 was \xint_bye, was there a ) in original #1?

1560 \def\XINT_isbalanced_c\xint_bye\XINT_isbalanced_error #1%
1561     {\xint_bye #1\XINT_isbalanced_yes\xint_bye\XINT_isbalanced_d #1}%

    #1 is \xint_bye, there was never ( nor ) in original #1, hence OK.

1562 \def\XINT_isbalanced_yes\xint_bye\XINT_isbalanced_d\xint_bye )\xint_bye {\xint_c_ }%

    #1 is not \xint_bye, there was indeed a ( in original #1. We check if we see a ). If we do, we then
    loop until no ( nor ) is to be found.

1563 \def\XINT_isbalanced_d #1)#2%
1564     {\xint_bye #2\XINT_isbalanced_no\xint_bye\XINT_isbalanced_a #1#2}%

    #2 was \xint_bye, we did not find a closing ) in original #1. Error.

1565 \def\XINT_isbalanced_no\xint_bye #1\xint_bye\xint_bye {\xint_c_i }%

```

### 10.41.7 `\XINT_allexpr_func_seqx`

1.2c uses `\xintthebareval`, ... which strangely were not available at 1.1 time. This spares some tokens from `\XINT_expr_seq:_d` and cousins. Also now variables have changed their mode of operation they pick only one token which must be an already encapsulated value.

In `\XINT_allexpr_seqx`, #2 is the list, evaluated and encapsulated, #3 is the dummy variable, #4 is the expression to evaluate repeatedly.

A special case is a list generated by `<variable>++`: then #2 is `{\.=+\.=<start>}`.

```

1566 \def\XINT_expr_func_seqx #1#2{\XINT_allexpr_seqx \xintthebareval}%
1567 \def\XINT_flexpr_func_seqx #1#2{\XINT_allexpr_seqx \xintthebarefloateval}%
1568 \def\XINT_iexpr_func_seqx #1#2{\XINT_allexpr_seqx \xintthebareiieval}%
1569 \def\XINT_allexpr_seqx #1#2#3#4%
1570 {%
1571     \expandafter \XINT_expr_getop
1572     \csname .=\expandafter\XINT_expr_seq:_aa
1573         \romannumeral`&&\XINT_expr_unlock #2!{#1#4\relax !#3}\endcsname
1574 }%
1575 \def\XINT_expr_seq:_aa #1{\if +#1\expandafter\XINT_expr_seq:_A\else
1576     \expandafter\XINT_expr_seq:_a\fi #1}%

```

### 10.41.8 Evaluation over list, `\XINT_expr_seq:_a` with `break`, `abort`, `omit`

The #2 here is `\...bareeval <expression>\relax !<variable name>`. The #1 is a comma separated list of values to assign to the dummy variable. The `\XINT_expr_seq_empty?` intervenes immediately after handling of firstvalue.

1.2c has rewritten to a large extent this and other similar loops because the dummy variables now fetch a single encapsulated token (apart from a good means to lose a few hours needlessly -- as I have had to rewrite and review most everything, this change could make the thing more efficient if the same variable is used many times in an expression, but we are talking micro-seconds here anyhow.)

```

1577 \def\XINT_expr_seq:_a #1!#2{\expandafter\XINT_expr_seq_empty?
1578     \romannumeral0\XINT_expr_seq:_b {#2}#1,^,%}
1579 \def\XINT_expr_seq:_b #1#2#3,{%
1580     \if ,#2\xint_dothis\XINT_expr_seq:_noop\fi
1581     \if ^#2\xint_dothis\XINT_expr_seq:_end\fi
1582     \xint_orthat{\expandafter\XINT_expr_seq:_c}\csname .=#2#3\endcsname {#1}%
1583 }%
1584 \def\XINT_expr_seq:_noop\csname .,=#1\endcsname #2{\XINT_expr_seq:_b {#2}#1,%}
1585 \def\XINT_expr_seq:_end \csname .^=\endcsname #1{%}
1586 \def\XINT_expr_seq:_c #1#2{\expandafter\XINT_expr_seq:_d\romannumeral`&&\#2#1{#2}}%
1587 \def\XINT_expr_seq:_d #1{\if #1^\xint_dothis\XINT_expr_seq:_abort\fi
1588     \if #1?\xint_dothis\XINT_expr_seq:_break\fi
1589     \if #1!\xint_dothis\XINT_expr_seq:_omit\fi
1590     \xint_orthat{\XINT_expr_seq:_goon #1}}%
1591 \def\XINT_expr_seq:_abort #1!#2#3#4#5^,{}%
1592 \def\XINT_expr_seq:_break #1!#2#3#4#5^,{,#1}%
1593 \def\XINT_expr_seq:_omit #1!#2#3#4{\XINT_expr_seq:_b {#4}}%
1594 \def\XINT_expr_seq:_goon #1!#2#3#4{,#1\XINT_expr_seq:_b {#4}}%

```

If all is omitted or list is empty, `_empty?` will fetch within the #1 a `\endcsname` token and construct "nil" via `<space>\endcsname`, if not #1 will be a comma and the gobble will swallow the space token and the extra `\endcsname`.

```

1595 \def\XINT_expr_seq_empty? #1{%
1596 \def\XINT_expr_seq_empty? ##1{\if ,##1\expandafter\xint_gobble_i\fi #1\endcsname }}%
1597 \XINT_expr_seq_empty? { }%

```

#### 10.41.9 Evaluation over ++ generated lists with \XINT\_expr\_seq:\_A

This is for index lists generated by n++. The starting point will have been replaced by its ceil (added: in fact with version 1.1. the ceil was not yet evaluated, but `_var_<letter>` did an expansion of what they fetch). We use `\numexpr` rather than `\xintInc`, hence the indexing is limited to small integers.

The 1.2c version of n++ produces a #1 here which is already a single `\.=<value>` token.

```

1598 \def\XINT_expr_seq:_A +#1!%
1599   {\expandafter\XINT_expr_seq_empty?\romannumeral0\XINT_expr_seq:_D #1}%
1600 \def\XINT_expr_seq:_D #1#2{\expandafter\XINT_expr_seq:_E\romannumeral`&&@#2#1{#2}}%
1601 \def\XINT_expr_seq:_E #1{\if #1^\xint_dothis\XINT_expr_seq:_Abort\fi
1602   \if #1?\xint_dothis\XINT_expr_seq:_Break\fi
1603   \if #1!\xint_dothis\XINT_expr_seq:_Omit\fi
1604   \xint_orthat{\XINT_expr_seq:_Goon #1}}%
1605 \def\XINT_expr_seq:_Abort #1!#2#3#4{}%
1606 \def\XINT_expr_seq:_Break #1!#2#3#4{,#1}%
1607 \def\XINT_expr_seq:_Omit #1!#2#3%
1608   {\expandafter\XINT_expr_seq:_D
1609     \csname.=\the\numexpr \XINT_expr_unlock#3+\xint_c_i\endcsname}%
1610 \def\XINT_expr_seq:_Goon #1!#2#3%
1611   {,#1\expandafter\XINT_expr_seq:_D
1612     \csname.=\the\numexpr \XINT_expr_unlock#3+\xint_c_i\endcsname}%

```

#### 10.42 add, mul

1.2c uses more directly the `\xintiiAdd` etc... macros and has `opxadd/opxmul` rather than a single `opx`. This is less conceptual as I use explicitly the associated macro names for +, \* but this makes other things more efficient, and the code more readable.

```

1613 \def\XINT_expr_onlitteral_add
1614   {\expandafter\XINT_expr_onlitteral_add_f\romannumeral`&&\XINT_expr_onlitteral_seq_a {}}%
1615 \def\XINT_expr_onlitteral_add_f #1#2{\xint_c_xviii `{opxadd}#2)\relax #1}%
1616 \def\XINT_expr_onlitteral_mul
1617   {\expandafter\XINT_expr_onlitteral_mul_f\romannumeral`&&\XINT_expr_onlitteral_seq_a {}}%
1618 \def\XINT_expr_onlitteral_mul_f #1#2{\xint_c_xviii `{opxmul}#2)\relax #1}%

```

##### 10.42.1 \XINT\_expr\_func\_opxadd, \XINT\_flexpr\_func\_opxadd, \XINT\_iexpr\_func\_opxadd and same for mul

modified 1.2c.

```

1619 \def\XINT_expr_func_opxadd #1#2{\XINT_allexpr_opx \xintbareeval {\xintAdd 0}}%
1620 \def\XINT_flexpr_func_opxadd #1#2{\XINT_allexpr_opx \xintbarefloateval {\XINTinFloatAdd 0}}%
1621 \def\XINT_iexpr_func_opxadd #1#2{\XINT_allexpr_opx \xintbareiieval {\xintiiAdd 0}}%
1622 \def\XINT_expr_func_opxmul #1#2{\XINT_allexpr_opx \xintbareeval {\xintMul 1}}%
1623 \def\XINT_flexpr_func_opxmul #1#2{\XINT_allexpr_opx \xintbarefloateval {\XINTinFloatMul 1}}%
1624 \def\XINT_iexpr_func_opxmul #1#2{\XINT_allexpr_opx \xintbareiieval {\xintiiMul 1}}%

```



#1=bareval etc, #2={Add0} ou {Mul1}, #3=liste encapsulée, #4=la variable, #5=expression

```
1625 \def\XINT_allexpr_opx #1#2#3#4#5%
1626 {%
1627   \expandafter\XINT_expr_getop
1628   \csname.=\romannumeral`&&\expandafter\XINT_expr_op:_a
1629     \romannumeral`&&\XINT_expr_unlock #3!{#1#5\relax !#4}{#2}\endcsname
1630 }%
1631 \def\XINT_expr_op:_a #1!#2#3{\XINT_expr_op:_b #3{#2}#1,^,}%

```

#2 in \XINT\_expr\_op:\_b is the partial result of computation so far, not locked. A noop with have #4=, and #5 the next item which we need to recover. No need to be very efficient for that in op:\_noop. In op:\_d, #4 is \xintAdd or similar.

```
1632 \def\XINT_expr_op:_b #1#2#3#4#5,{%
1633   \if ,#4\xint_dothis\XINT_expr_op:_noop\fi
1634   \if ^#4\xint_dothis\XINT_expr_op:_end\fi
1635   \xint_orthat{\expandafter\XINT_expr_op:_c}\csname.=#4#5\endcsname {#3}#1{#2}%
1636 }%
1637 \def\XINT_expr_op:_c #1#2#3#4{\expandafter\XINT_expr_op:_d\romannumeral0#2#1#3{#4}{#2}}%
1638 \def\XINT_expr_op:_d #1!#2#3#4#5%
1639   {\expandafter\XINT_expr_op:_b\expandafter #4\expandafter
1640     {\romannumeral`&&#4{\XINT_expr_unlock#1}{#5}}}%

```

The replacement text had `expr_seq:_b` rather than `expr_op:_b` due to a left-over from copy-paste. This made add and mul fail with an empty range for the variable (or "nil" in the list of values). Fixed in 1.2h.

```
1641 \def\XINT_expr_op:_noop\csname.=,#1\endcsname #2#3#4{\XINT_expr_op:_b #3{#4}{#2}#1,}%
1642 \def\XINT_expr_op:_end \csname.=^{\endcsname #1#2#3{#3}%

```

## 10.43 subs

Got simpler with 1.2c as now the dummy variable fetches an already encapsulated value, which is anyhow the form in which we get it.

```
1643 \def\XINT_expr_onlitteral_subs
1644   {\expandafter\XINT_expr_onlitteral_subs_f\romannumeral`&&\XINT_expr_onlitteral_seq_a {}}%
1645 \def\XINT_expr_onlitteral_subs_f #1#2{\xint_c_xviii `{subx}#2)\relax #1}%
1646 \def\XINT_expr_func_subx #1#2{\XINT_allexpr_subx \xintbareeval }%
1647 \def\XINT_flexpr_func_subx #1#2{\XINT_allexpr_subx \xintbarefloateval}%
1648 \def\XINT_iexpr_func_subx #1#2{\XINT_allexpr_subx \xintbareiieval}%
1649 \def\XINT_allexpr_subx #1#2#3#4% #2 is the value to assign to the dummy variable
1650 {% #3 is the dummy variable, #4 is the expression to evaluate
1651   \expandafter\expandafter\expandafter\XINT_expr_getop
1652   \expandafter\XINT_expr_subx:_end\romannumeral0#1#4\relax !#3#2%
1653 }%
1654 \def\XINT_expr_subx:_end #1!#2#3{#1}%

```

## 10.44 rseq

10.44.1	\XINT_expr_rseqx	.....	321
10.44.2	\XINT_expr_rseqy	.....	321
10.44.3	\XINT_expr_rseq:_a etc...	.....	321



10.44.4 `\XINT_expr_rseq:_A` etc... 322

When `func_rseq` has its turn, initial segment has been scanned by `oparen`, the `;` mimicking the rôle of a closing parenthesis, and stopping further expansion. Notice that the `;` is discovered during standard parsing mode, it may be for example `{;}` or arise from expansion as `rseq` does not use a delimited macro to locate it.

Here and in `rrseq` and `iter`, 1.2c adds also use of `\xintthebareeval`, etc...

```
1655 \def\XINT_expr_func_rseq {\XINT_allexpr_rseq \xintbareeval \xintthebareeval }%
1656 \def\XINT_flexpr_func_rseq {\XINT_allexpr_rseq \xintbarefloateval \xintthebarefloateval }%
1657 \def\XINT_iexpr_func_rseq {\XINT_allexpr_rseq \xintbareiieval \xintthebareiieval }%
1658 \def\XINT_allexpr_rseq #1#2#3%
1659 {%
1660   \expandafter\XINT_expr_rseqx\expandafter #1\expandafter#2\expandafter
1661   #3\romannumeral`&&\XINT_expr_onlitteral_seq_a }%
1662 }%
```

10.44.1 `\XINT_expr_rseqx`

The `(#5)` is for `++` mechanism which must have its closing parenthesis.

```
1663 \def\XINT_expr_rseqx #1#2#3#4#5%
1664 {%
1665   \expandafter\XINT_expr_rseqy\romannumeral0#1(#5)\relax #3#4#2%
1666 }%
```

10.44.2 `\XINT_expr_rseqy`

`#1=valeurs pour variable (locked)`, `#2=toutes les valeurs initiales (csv,locked)`, `#3=variable`, `#4=expr`, `#5=\xintthebareeval ou \xintthebarefloateval ou \xintthebareiieval`

```
1667 \def\XINT_expr_rseqy #1#2#3#4#5%
1668 {%
1669   \expandafter \XINT_expr_getop
1670   \csname .=\XINT_expr_unlock #2%
1671   \expandafter\XINT_expr_rseq:_aa
1672   \romannumeral`&&\XINT_expr_unlock #1!{#5#4\relax !#3}#2\endcsname
1673 }%
1674 \def\XINT_expr_rseq:_aa #1{\if +#1\expandafter\XINT_expr_rseq:_A\else
1675   \expandafter\XINT_expr_rseq:_a\fi #1}%

```

10.44.3 `\XINT_expr_rseq:_a` etc...

```
1676 \def\XINT_expr_rseq:_a #1!#2#3{\XINT_expr_rseq:_b {#3}{#2}#1,^,%}
1677 \def\XINT_expr_rseq:_b #1#2#3#4,{%
1678   \if ,#3\xint_dothis\XINT_expr_rseq:_noop\fi
1679   \if ^#3\xint_dothis\XINT_expr_rseq:_end\fi
1680   \xint_orthat{\expandafter\XINT_expr_rseq:_c}\csname .=#3#4\endcsname
1681   {#1}{#2}%
1682 }%
1683 \def\XINT_expr_rseq:_noop\csname .=#1\endcsname #2#3{\XINT_expr_rseq:_b {#2}{#3}#1,%}
1684 \def\XINT_expr_rseq:_end \csname .=#1\endcsname #1#2{%}
1685 \def\XINT_expr_rseq:_c #1#2#3%
```

```

1686   {\expandafter\XINT_expr_rseq:_d\romannumeral`&&@#3#1~#2{#3}}%
1687 \def\XINT_expr_rseq:_d #1{%
1688   \if ^#1\xint_dothis\XINT_expr_rseq:_abort\fi
1689   \if ?#1\xint_dothis\XINT_expr_rseq:_break\fi
1690   \if !#1\xint_dothis\XINT_expr_rseq:_omit\fi
1691   \xint_orthat{\XINT_expr_rseq:_goon #1}}%
1692 \def\XINT_expr_rseq:_goon #1!#2#3~#4#5{,#1\expandafter\XINT_expr_rseq:_b
1693   \romannumeral0\XINT_expr_lockit {#1}{#5}}%
1694 \def\XINT_expr_rseq:_omit #1!#2#3~{\XINT_expr_rseq:_b }%
1695 \def\XINT_expr_rseq:_abort #1!#2#3~#4#5#6^,{,}%
1696 \def\XINT_expr_rseq:_break #1!#2#3~#4#5#6^,{,#1}%

```

#### 10.44.4 \XINT\_expr\_rseq:\_A etc...

n++ for rseq. With 1.2c dummy variables pick a single token.

```

1697 \def\XINT_expr_rseq:_A +#1!#2#3{\XINT_expr_rseq:_D #1#3{#2}}%
1698 \def\XINT_expr_rseq:_D #1#2#3%
1699   {\expandafter\XINT_expr_rseq:_E\romannumeral`&&@#3#1~#2{#3}}%
1700 \def\XINT_expr_rseq:_E #1{\if #1^\xint_dothis\XINT_expr_rseq:_Abort\fi
1701   \if #1?\xint_dothis\XINT_expr_rseq:_Break\fi
1702   \if #1!\xint_dothis\XINT_expr_rseq:_Omit\fi
1703   \xint_orthat{\XINT_expr_rseq:_Goon #1}}%
1704 \def\XINT_expr_rseq:_Goon #1!#2#3~#4#5%
1705   {,#1\expandafter\XINT_expr_rseq:_D
1706     \csname.=\the\numexpr \XINT_expr_unlock#3+\xint_c_i\expandafter\endcsname
1707     \romannumeral0\XINT_expr_lockit{#1}{#5}}%
1708 \def\XINT_expr_rseq:_Omit #1!#2#3~%#4#5%
1709   {\expandafter\XINT_expr_rseq:_D
1710     \csname.=\the\numexpr \XINT_expr_unlock#3+\xint_c_i\endcsname }%
1711 \def\XINT_expr_rseq:_Abort #1!#2#3~#4#5{,%
1712 \def\XINT_expr_rseq:_Break #1!#2#3~#4#5{,#1}%

```

#### 10.45 iter

10.45.1	\XINT_expr_iterx	...	323
10.45.2	\XINT_expr_itory	...	323
10.45.3	\XINT_expr_iter:_a etc...	...	323
10.45.4	\XINT_expr_iter:_A etc...	...	323

Prior to 1.2g, the iter keyword was what is now called iterr, analogous with rrseq. Somehow I forgot an iter functioning like rseq with the sole difference of printing only the last iteration. Both rseq and iter work well with list selectors, as @ refers to the whole comma separated sequence of the initial values. I have thus deliberately done the backwards incompatible renaming of iter to iterr, and the new iter.

```

1713 \def\XINT_expr_func_iter {\XINT_allexpr_iter \xintbareeval \xintthebareeval }%
1714 \def\XINT_flexpr_func_iter {\XINT_allexpr_iter \xintbarefloateval \xintthebarefloateval }%
1715 \def\XINT_iexpr_func_iter {\XINT_allexpr_iter \xintbareiieval \xintthebareiieval }%
1716 \def\XINT_allexpr_iter #1#2#3%
1717 {%
1718   \expandafter\XINT_expr_iterx\expandafter #1\expandafter#2\expandafter
1719   #3\romannumeral`&&\XINT_expr_onlitteral_seq_a {}%
1720 }%

```

### 10.45.1 `\XINT_expr_iterx`

The (#5) is for ++ mechanism which must have its closing parenthesis.

```
1721 \def\XINT_expr_iterx #1#2#3#4#5%
1722 {%
1723   \expandafter\XINT_expr_itery\romannumeral0#1(#5)\relax #3#4#2%
1724 }%
```

### 10.45.2 `\XINT_expr_itery`

#1=valeurs pour variable (locked), #2=toutes les valeurs initiales (csv,locked), #3=variable, #4=expr, #5=\xintthebareeval ou \xintthebarefloateval ou \xintthebareiieval

```
1725 \def\XINT_expr_itery #1#2#3#4#5%
1726 {%
1727   \expandafter \XINT_expr_getop
1728   \csname .=%
1729   \expandafter\XINT_expr_iter:_aa
1730   \romannumeral`&&@\XINT_expr_unlock #1!{#5#4\relax !#3}#2\endcsname
1731 }%
1732 \def\XINT_expr_iter:_aa #1{ \if +#1\expandafter\XINT_expr_iter:_A\else
1733   \expandafter\XINT_expr_iter:_a\fi #1}%

```

### 10.45.3 `\XINT_expr_iter:_a` etc...

```
1734 \def\XINT_expr_iter:_a #1!#2#3{\XINT_expr_iter:_b {#3}{#2}#1,^,%}
1735 \def\XINT_expr_iter:_b #1#2#3#4,{%
1736   \if ,#3\xint_dothis\XINT_expr_iter:_noop\fi
1737   \if ^#3\xint_dothis\XINT_expr_iter:_end\fi
1738   \xint_orthat{\expandafter\XINT_expr_iter:_c}%
1739   \csname.=#3#4\endcsname {#1}{#2}%
1740 }%
1741 \def\XINT_expr_iter:_noop\csname.=#1\endcsname #2#3{\XINT_expr_iter:_b {#2}{#3}#1,%}
1742 \def\XINT_expr_iter:_end \csname.=`\endcsname #1#2{\XINT_expr:_unlock #1}%
1743 \def\XINT_expr_iter:_c #1#2#3%
1744   {\expandafter\XINT_expr_iter:_d\romannumeral`&&@#3#1~#2{#3}}%
1745 \def\XINT_expr_iter:_d #1{%
1746   \if ^#1\xint_dothis\XINT_expr_iter:_abort\fi
1747   \if ?#1\xint_dothis\XINT_expr_iter:_break\fi
1748   \if !#1\xint_dothis\XINT_expr_iter:_omit\fi
1749   \xint_orthat{\XINT_expr_iter:_goon #1}%}
1750 \def\XINT_expr_iter:_goon #1!#2#3~#4#5%
1751   {\expandafter\XINT_expr_iter:_b\romannumeral0\XINT_expr_lockit {#1}{#5}}%
1752 \def\XINT_expr_iter:_omit #1!#2#3~{\XINT_expr_iter:_b }%
1753 \def\XINT_expr_iter:_abort #1!#2#3~#4#5#6^,{\XINT_expr_unlock #4}%
1754 \def\XINT_expr_iter:_break #1!#2#3~#4#5#6^,{#1}%

```

### 10.45.4 `\XINT_expr_iter:_A` etc...

n++ for iter. With 1.2c dummy variables pick a single token.

```
1755 \def\XINT_expr_iter:_A +#1!#2#3{\XINT_expr_iter:_D #1#3{#2}}%
1756 \def\XINT_expr_iter:_D #1#2#3%
```

```

1757 {\expandafter\XINT_expr_iter:_E\romannumeral`&&@#3#1~#2{#3}}%
1758 \def\XINT_expr_iter:_E #1{\if #1^\xint_dothis\XINT_expr_iter:_Abort\fi
1759         \if #1?\xint_dothis\XINT_expr_iter:_Break\fi
1760         \if #1!\xint_dothis\XINT_expr_iter:_Omit\fi
1761         \xint_orthat{\XINT_expr_iter:_Goon #1}}%
1762 \def\XINT_expr_iter:_Goon #1!#2#3~#4#5%
1763     {\expandafter\XINT_expr_iter:_D
1764     \csname.=\the\numexpr \XINT_expr_unlock#3+\xint_c_i\expandafter\endcsname
1765     \romannumeral0\XINT_expr_lockit{#1}{#5}}%
1766 \def\XINT_expr_iter:_Omit #1!#2#3~%#4#5%
1767     {\expandafter\XINT_expr_iter:_D
1768     \csname.=\the\numexpr \XINT_expr_unlock#3+\xint_c_i\endcsname }%
1769 \def\XINT_expr_iter:_Abort #1!#2#3~#4#5{\XINT_expr:_unlock #4}%
1770 \def\XINT_expr_iter:_Break #1!#2#3~#4#5{#1}%

```

## 10.46 rrseq

10.46.1	<code>\XINT_expr_rrseqx</code> . . . . .	324
10.46.2	<code>\XINT_expr_rrseqy</code> . . . . .	324
10.46.3	<code>\XINT_expr_rrseq:_a</code> etc. . . . .	325
10.46.4	<code>\XINT_expr_rrseq:_A</code> etc. . . . .	325

When `func_rrseq` has its turn, initial segment has been scanned by `oparen`, the `;` mimicking the rôle of a closing parenthesis, and stopping further expansion.

```

1771 \def\XINT_expr_func_rrseq {\XINT_allexpr_rrseq \xintbareeval \xintthebareeval }%
1772 \def\XINT_flexpr_func_rrseq {\XINT_allexpr_rrseq \xintbarefloateval \xintthebarefloateval }%
1773 \def\XINT_iexpr_func_rrseq {\XINT_allexpr_rrseq \xintbareiieval \xintthebareiieval }%
1774 \def\XINT_allexpr_rrseq #1#2#3%
1775 {%
1776     \expandafter\XINT_expr_rrseqx\expandafter #1\expandafter#2\expandafter
1777     #3\romannumeral`&&@\XINT_expr_onlitteral_seq_a {}%
1778 }%

```

### 10.46.1 `\XINT_expr_rrseqx`

The `(#5)` is for `++` mechanism which must have its closing parenthesis.

```

1779 \def\XINT_expr_rrseqx #1#2#3#4#5%
1780 {%
1781     \expandafter\XINT_expr_rrseqy\romannumeral0#1(#5)\expandafter\relax
1782     \expandafter{\romannumeral0\xintapply \XINT_expr_lockit
1783         {\xintRevWithBraces{\xintCSVtoListNonStripped{\XINT_expr_unlock #3}}}%
1784     #3#4#2%
1785 }%

```

### 10.46.2 `\XINT_expr_rrseqy`

`#1`=valeurs pour variable (locked), `#2`=initial values (reversed, one (braced) token each) `#3`=toutes les valeurs initiales (csv,locked), `#4`=variable, `#5`=expr, `#6`=`\xintthebareeval` ou `\xintthebarefloateval` ou `\xintthebareiieval`

```

1786 \def\XINT_expr_rrseqy #1#2#3#4#5#6%

```

```

1787 {%
1788   \expandafter \XINT_expr_getop
1789   \csname .=\XINT_expr_unlock #3%
1790   \expandafter\XINT_expr_rrseq:_aa
1791       \romannumeral`&&@\XINT_expr_unlock #1!{#6#5\relax !#4}{#2}\endcsname
1792 }%
1793 \def\XINT_expr_rrseq:_aa #1{\if +#1\expandafter\XINT_expr_rrseq:_A\else
1794     \expandafter\XINT_expr_rrseq:_a\fi #1}%

```

#### 10.46.3 \XINT\_expr\_rrseq:\_a etc...

Attention que ? a catcode 3 ici et dans iter.

```

1795 \catcode`? 3
1796 \def\XINT_expr_rrseq:_a #1!#2#3{\XINT_expr_rrseq:_b {#3}{#2}#1,^,%}
1797 \def\XINT_expr_rrseq:_b #1#2#3#4,{%
1798     \if ,#3\xint_dothis\XINT_expr_rrseq:_noop\fi
1799     \if ^#3\xint_dothis\XINT_expr_rrseq:_end\fi
1800     \xint_orthat{\expandafter\XINT_expr_rrseq:_c}\csname.=#3#4\endcsname
1801     {#1}{#2}%
1802 }%
1803 \def\XINT_expr_rrseq:_noop\csname.=,#1\endcsname #2#3{\XINT_expr_rrseq:_b {#2}{#3}#1,%}
1804 \def\XINT_expr_rrseq:_end \csname.=^\endcsname #1#2{%}
1805 \def\XINT_expr_rrseq:_c #1#2#3%
1806     {\expandafter\XINT_expr_rrseq:_d\romannumeral`&&@#3#1~#2?{#3}}%
1807 \def\XINT_expr_rrseq:_d #1{%
1808     \if ^#1\xint_dothis\XINT_expr_rrseq:_abort\fi
1809     \if ?#1\xint_dothis\XINT_expr_rrseq:_break\fi
1810     \if !#1\xint_dothis\XINT_expr_rrseq:_omit\fi
1811     \xint_orthat{\XINT_expr_rrseq:_goon #1}%
1812 }%
1813 \def\XINT_expr_rrseq:_goon #1!#2#3~#4?#5{,#1\expandafter\XINT_expr_rrseq:_b\expandafter
1814     {\romannumeral0\xinttrim{-1}{\XINT_expr_lockit{#1}{#4}}{#5}}%
1815 \def\XINT_expr_rrseq:_omit #1!#2#3~{\XINT_expr_rrseq:_b }%
1816 \def\XINT_expr_rrseq:_abort #1!#2#3~#4?#5#6^,{}%
1817 \def\XINT_expr_rrseq:_break #1!#2#3~#4?#5#6^,{,#1}%

```

#### 10.46.4 \XINT\_expr\_rrseq:\_A etc...

n++ for rrseq. With 1.2C, the #1 in \XINT\_expr\_rrseq:\_A is a single token.

```

1818 \def\XINT_expr_rrseq:_A +#1!#2#3{\XINT_expr_rrseq:_D #1{#3}{#2}}%
1819 \def\XINT_expr_rrseq:_D #1#2#3%
1820     {\expandafter\XINT_expr_rrseq:_E\romannumeral`&&@#3#1~#2?{#3}}%
1821 \def\XINT_expr_rrseq:_Goon #1!#2#3~#4?#5%
1822     {,#1\expandafter\XINT_expr_rrseq:_D
1823         \csname.=\the\numexpr \XINT_expr_unlock#3+\xint_c_i\expandafter\endcsname
1824         \expandafter{\romannumeral0\xinttrim{-1}{\XINT_expr_lockit{#1}{#4}}{#5}}%
1825 \def\XINT_expr_rrseq:_Omit #1!#2#3~%#4?#5%
1826     {\expandafter\XINT_expr_rrseq:_D
1827         \csname.=\the\numexpr \XINT_expr_unlock#3+\xint_c_i\endcsname}%
1828 \def\XINT_expr_rrseq:_Abort #1!#2#3~#4?#5{%}
1829 \def\XINT_expr_rrseq:_Break #1!#2#3~#4?#5{,#1}%

```

```

1830 \def\XINT_expr_rrseq:_E #1{\if #1^\xint_dothis\XINT_expr_rrseq:_Abort\fi
1831           \if #1?\xint_dothis\XINT_expr_rrseq:_Break\fi
1832           \if #1!\xint_dothis\XINT_expr_rrseq:_Omit\fi
1833           \xint_orthat{\XINT_expr_rrseq:_Goon #1}}%

```

## 10.47 iterr

10.47.1	<code>\XINT_expr_iterrx</code>	326
10.47.2	<code>\XINT_expr_ittery</code>	326
10.47.3	<code>\XINT_expr_iterr:_a</code> etc...	326
10.47.4	<code>\XINT_expr_iterr:_A</code> etc...	327

```

1834 \def\XINT_expr_func_iterr { \XINT_allexpr_iterr \xintbareeval \xintthebareeval }%
1835 \def\XINT_flexpr_func_iterr { \XINT_allexpr_iterr \xintbarefloateval \xintthebarefloateval }%
1836 \def\XINT_iexpr_func_iterr { \XINT_allexpr_iterr \xintbareiieval \xintthebareiieval }%
1837 \def\XINT_allexpr_iterr #1#2#3%
1838 {%
1839   \expandafter\XINT_expr_iterrx\expandafter #1\expandafter #2\expandafter
1840   #3\romannumeral`&&\XINT_expr_onlitteral_seq_a {}%
1841 }%

```

### 10.47.1 `\XINT_expr_iterrx`

The (#5) is for ++ mechanism which must have its closing parenthesis.

```

1842 \def\XINT_expr_iterrx #1#2#3#4#5%
1843 {%
1844   \expandafter\XINT_expr_ittery\romannumeral0#1(#5)\expandafter\relax
1845   \expandafter{\romannumeral0\xintapply \XINT_expr_lockit
1846     {\xintRevWithBraces{\xintCSVtoListNonStripped{\XINT_expr_unlock #3}}}}%
1847   #3#4#2%
1848 }%

```

### 10.47.2 `\XINT_expr_ittery`

#1=valeurs pour variable (locked), #2=initial values (reversed, one (braced) token each) #3=toutes les valeurs initiales (csv,locked), #4=variable, #5=expr, #6=\xintbareeval ou \xintbarefloateval ou \xintbareiieval

```

1849 \def\XINT_expr_ittery #1#2#3#4#5#6%
1850 {%
1851   \expandafter \XINT_expr_getop
1852   \csname .=%
1853   \expandafter\XINT_expr_iterr:_aa
1854   \romannumeral`&&\XINT_expr_unlock #1!{#6#5\relax !#4}{#2}\endcsname
1855 }%
1856 \def\XINT_expr_iterr:_aa #1{\if +#1\expandafter\XINT_expr_iterr:_A\else
1857   \expandafter\XINT_expr_iterr:_a\fi #1}%

```

### 10.47.3 `\XINT_expr_iterr:_a` etc...

```

1858 \def\XINT_expr_iterr:_a #1!#2#3{\XINT_expr_iterr:_b {#3}{#2}#1,^,%}
1859 \def\XINT_expr_iterr:_b #1#2#3#4,{%

```

```

1860 \if ,#3\xint_dothis\xINT_expr_iterr:_noop\fi
1861 \if ^#3\xint_dothis\xINT_expr_iterr:_end\fi
1862 \xint_orthat{\expandafter\xINT_expr_iterr:_c}%
1863 \csname.=#3#4\endcsname {#1}{#2}%
1864 }%
1865 \def\xINT_expr_iterr:_noop\csname.=,#1\endcsname #2#3{\xINT_expr_iterr:_b {#2}{#3}#1,}%
1866 \def\xINT_expr_iterr:_end \csname.=^\endcsname #1#2%
1867 {\expandafter\xint_gobble_i\romannumeral0\xintapplyunbraced
1868 {\,\xINT_expr:_unlock}{\xintReverseOrder{#1\space}}}%
1869 \def\xINT_expr_iterr:_c #1#2#3%
1870 {\expandafter\xINT_expr_iterr:_d\romannumeral`&&@#3#1~#2?{#3}}%
1871 \def\xINT_expr_iterr:_d #1{%
1872 \if ^#1\xint_dothis\xINT_expr_iterr:_abort\fi
1873 \if ?#1\xint_dothis\xINT_expr_iterr:_break\fi
1874 \if !#1\xint_dothis\xINT_expr_iterr:_omit\fi
1875 \xint_orthat{\xINT_expr_iterr:_goon #1}%
1876 }%
1877 \def\xINT_expr_iterr:_goon #1!#2#3~#4?#5{\expandafter\xINT_expr_iterr:_b\expandafter
1878 {\romannumeral0\xinttrim{-1}{\xINT_expr_lockit{#1}#4}}{#5}}%
1879 \def\xINT_expr_iterr:_omit #1!#2#3~{\xINT_expr_iterr:_b }%
1880 \def\xINT_expr_iterr:_abort #1!#2#3~#4?#5#6^,%
1881 {\expandafter\xint_gobble_i\romannumeral0\xintapplyunbraced
1882 {\,\xINT_expr:_unlock}{\xintReverseOrder{#4\space}}}%
1883 \def\xINT_expr_iterr:_break #1!#2#3~#4?#5#6^,%
1884 {\expandafter\xint_gobble_iv\romannumeral0\xintapplyunbraced
1885 {\,\xINT_expr:_unlock}{\xintReverseOrder{#4\space}},#1}%
1886 \def\xINT_expr:_unlock #1{\xINT_expr_unlock #1}%

```

#### 10.47.4 \xINT\_expr\_iterr:\_A etc...

n++ for iterr. ? is of catcode 3 here.

```

1887 \def\xINT_expr_iterr:_A +#1!#2#3{\xINT_expr_iterr:_D #1{#3}{#2}}%
1888 \def\xINT_expr_iterr:_D #1#2#3%
1889 {\expandafter\xINT_expr_iterr:_E\romannumeral`&&@#3#1~#2?{#3}}%
1890 \def\xINT_expr_iterr:_Goon #1!#2#3~#4?#5%
1891 {\expandafter\xINT_expr_iterr:_D
1892 \csname.=\the\numexpr \xINT_expr_unlock#3+\xint_c_i\expandafter\endcsname
1893 \expandafter{\romannumeral0\xinttrim{-1}{\xINT_expr_lockit{#1}#4}}{#5}}%
1894 \def\xINT_expr_iterr:_Omit #1!#2#3~#4?#5%
1895 {\expandafter\xINT_expr_iterr:_D
1896 \csname.=\the\numexpr \xINT_expr_unlock#3+\xint_c_i\endcsname}%
1897 \def\xINT_expr_iterr:_Abort #1!#2#3~#4?#5%
1898 {\expandafter\xint_gobble_i\romannumeral0\xintapplyunbraced
1899 {\,\xINT_expr:_unlock}{\xintReverseOrder{#4\space}}}%
1900 \def\xINT_expr_iterr:_Break #1!#2#3~#4?#5%
1901 {\expandafter\xint_gobble_iv\romannumeral0\xintapplyunbraced
1902 {\,\xINT_expr:_unlock}{\xintReverseOrder{#4\space}},#1}%
1903 \def\xINT_expr_iterr:_E #1{\if #1^\xint_dothis\xINT_expr_iterr:_Abort\fi
1904 \if #1?\xint_dothis\xINT_expr_iterr:_Break\fi
1905 \if #1!\xint_dothis\xINT_expr_iterr:_Omit\fi
1906 \xint_orthat{\xINT_expr_iterr:_Goon #1}}%
1907 \catcode`? 11

```

## 10.48 Macros handling csv lists for functions with multiple comma separated arguments in expressions

10.48.1	<code>\xintANDof:csv</code>	328
10.48.2	<code>\xintORof:csv</code>	328
10.48.3	<code>\xintXORof:csv</code>	328
10.48.4	Generic csv routine	329
10.48.5	<code>\xintMaxof:csv, \xintiiMaxof:csv</code>	329
10.48.6	<code>\xintMinof:csv, \xintiiMinof:csv</code>	329
10.48.7	<code>\xintSum:csv, \xintiiSum:csv</code>	329
10.48.8	<code>\xintPrd:csv, \xintiiPrd:csv</code>	330
10.48.9	<code>\xintGCDof:csv, \xintLCMof:csv</code>	330
10.48.10	<code>\xintiiGCDof:csv, \xintiiLCMof:csv</code>	330
10.48.11	<code>\XINTinFloatdigits, \XINTinFloatSqrtdigits, \XINTinFloatFacdigits</code>	330
10.48.12	<code>\XINTinFloatMaxof:csv, \XINTinFloatMinof:csv</code>	330
10.48.13	<code>\XINTinFloatSum:csv, \XINTinFloatPrd:csv</code>	330

These macros are used inside `\csname...\endcsname`. These things are not initiated by a `\romannumeral` in general, but in some cases they are, especially when involved in an `\xintNewExpr`. They will then be protected against expansion and expand only later in contexts governed by an initial `\romannumeral-`0`. There each new item may need to be expanded, which would not be the case in the use for the `_func_` things.

1.2g adds (to be continued)

### 10.48.1 `\xintANDof:csv`

1.09a. For use by `\xintexpr` inside `\csname`. 1.1, je remplace `ifTrueAelseB` par `iiNotZero` pour des raisons d'optimisations.

```

1908 \def\xintANDof:csv #1{\expandafter\XINT_andof:_a\romannumeral`&&@#1,,^}%
1909 \def\XINT_andof:_a #1{\if ,#1\expandafter\XINT_andof:_e
1910     \else\expandafter\XINT_andof:_c\fi #1}%
1911 \def\XINT_andof:_c #1,{\xintiifNotZero {#1}{\XINT_andof:_a}{\XINT_andof:_no}}%
1912 \def\XINT_andof:_no #1^{0}%
1913 \def\XINT_andof:_e #1^{1}% works with empty list

```

### 10.48.2 `\xintORof:csv`

1.09a. For use by `\xintexpr`.

```

1914 \def\xintORof:csv #1{\expandafter\XINT_orof:_a\romannumeral`&&@#1,,^}%
1915 \def\XINT_orof:_a #1{\if ,#1\expandafter\XINT_orof:_e
1916     \else\expandafter\XINT_orof:_c\fi #1}%
1917 \def\XINT_orof:_c #1,{\xintiifNotZero{#1}{\XINT_orof:_yes}{\XINT_orof:_a}}%
1918 \def\XINT_orof:_yes #1^{1}%
1919 \def\XINT_orof:_e #1^{0}% works with empty list

```

### 10.48.3 `\xintXORof:csv`

1.09a. For use by `\xintexpr` (inside a `\csname...\endcsname`).

```

1920 \def\xintXORof:csv #1{\expandafter\XINT_xorof:_a\expandafter 0\romannumeral`&&@#1,,^}%
1921 \def\XINT_xorof:_a #1#2,{\XINT_xorof:_b #2,#1}%

```



```

1922 \def\XINT_xorof:_b #1{\if ,#1\expandafter\XINT_xorof:_e
1923         \else\expandafter\XINT_xorof:_c\fi #1}%
1924 \def\XINT_xorof:_c #1,#2%
1925         {\xintiifNotZero {#1}{\if #20\xint_afterfi{\XINT_xorof:_a 1}%
1926         \else\xint_afterfi{\XINT_xorof:_a 0}\fi}%
1927         {\XINT_xorof:_a #2}%
1928         }%
1929 \def\XINT_xorof:_e ,#1#2^{#1}% allows empty list (then returns 0)

```

#### 10.48.4 Generic csv routine

1.1. generic routine. up to the loss of some efficiency, especially for Sum:csv and Prod:csv, where \XINTinFloat will be done twice for each argument.

```

1930 \def\XINT_oncsv:_empty #1,^,#2{#2}%
1931 \def\XINT_oncsv:_end ^,#1#2#3#4{#1}%
1932 \def\XINT_oncsv:_a #1#2#3%
1933     {\if ,#3\expandafter\XINT_oncsv:_empty\else\expandafter\XINT_oncsv:_b\fi #1#2#3}%
1934 \def\XINT_oncsv:_b #1#2#3,%
1935     {\expandafter\XINT_oncsv:_c \expandafter{\romannumeral`&&@#2{#3}}#1#2}%
1936 \def\XINT_oncsv:_c #1#2#3#4,{\expandafter\XINT_oncsv:_d \romannumeral`&&@#4,{#1}#2#3}%
1937 \def\XINT_oncsv:_d #1%
1938     {\if ^#1\expandafter\XINT_oncsv:_end\else\expandafter\XINT_oncsv:_e\fi #1}%
1939 \def\XINT_oncsv:_e #1,#2#3#4%
1940     {\expandafter\XINT_oncsv:_c\expandafter {\romannumeral`&&@#3{#4{#1}}{#2}}#3#4}%

```

#### 10.48.5 \xintMaxof:csv, \xintiiMaxof:csv

1.09i. Rewritten for 1.1. Compatible avec liste vide donnant valeur par défaut. Pas compatible avec items manquants. ah je m'aperçois au dernier moment que je n'ai pas en effet de \xintiiMax. Je devrais le rajouter. En tout cas ici c'est uniquement pour xintiiexpr, dans il faut bien sûr ne pas faire de xintNum, donc il faut un iimax.

```

1941 \def\xintMaxof:csv #1{\expandafter\XINT_oncsv:_a\expandafter\xintmax
1942         \expandafter\xint_firstofone\romannumeral`&&@#1,^{,0/1[0]}}%
1943 \def\xintiiMaxof:csv #1{\expandafter\XINT_oncsv:_a\expandafter\xintiiimax
1944         \expandafter\xint_firstofone\romannumeral`&&@#1,^{,0}%

```

#### 10.48.6 \xintMinof:csv, \xintiiMinof:csv

1.09i. Rewritten for 1.1. For use by \xintiiexpr.

```

1945 \def\xintMinof:csv #1{\expandafter\XINT_oncsv:_a\expandafter\xintmin
1946         \expandafter\xint_firstofone\romannumeral`&&@#1,^{,0/1[0]}}%
1947 \def\xintiiMinof:csv #1{\expandafter\XINT_oncsv:_a\expandafter\xintiiimin
1948         \expandafter\xint_firstofone\romannumeral`&&@#1,^{,0}%

```

#### 10.48.7 \xintSum:csv, \xintiiSum:csv

1.09a. Rewritten for 1.1. For use by \xintexpr.

```

1949 \def\xintSum:csv #1{\expandafter\XINT_oncsv:_a\expandafter\xintadd
1950         \expandafter\xint_firstofone\romannumeral`&&@#1,^{,0/1[0]}}%
1951 \def\xintiiSum:csv #1{\expandafter\XINT_oncsv:_a\expandafter\xintiiadd
1952         \expandafter\xint_firstofone\romannumeral`&&@#1,^{,0}%

```

#### 10.48.8 `\xintPrd:csv`, `\xintiiPrd:csv`

1.09a. Rewritten for 1.1. For use by `\xintexpr`.

```
1953 \def\xintPrd:csv #1{\expandafter\XINT_onscv:_a\expandafter\xintmul
1954         \expandafter\xint_firstofone\romannumeral`&&@#1,^,{1/1[0]}}}%
1955 \def\xintiiPrd:csv #1{\expandafter\XINT_onscv:_a\expandafter\xintiimul
1956         \expandafter\xint_firstofone\romannumeral`&&@#1,^,1}%

```

#### 10.48.9 `\xintGCDof:csv`, `\xintLCMof:csv`

1.09a. Rewritten for 1.1. For use by `\xintexpr`. Expansion réinstaurée pour besoins de `xintNewExpr` de version 1.1

```
1957 \def\xintGCDof:csv #1{\expandafter\XINT_onscv:_a\expandafter\xintgcd
1958         \expandafter\xint_firstofone\romannumeral`&&@#1,^,1}%
1959 \def\xintLCMof:csv #1{\expandafter\XINT_onscv:_a\expandafter\xintlcm
1960         \expandafter\xint_firstofone\romannumeral`&&@#1,^,0}%

```

#### 10.48.10 `\xintiiGCDof:csv`, `\xintiiLCMof:csv`

1.1a pour `\xintiiexpr`. Ces histoires de ii sont pénibles à la fin.

```
1961 \def\xintiiGCDof:csv #1{\expandafter\XINT_onscv:_a\expandafter\xintiigcd
1962         \expandafter\xint_firstofone\romannumeral`&&@#1,^,1}%
1963 \def\xintiiLCMof:csv #1{\expandafter\XINT_onscv:_a\expandafter\xintiilcm
1964         \expandafter\xint_firstofone\romannumeral`&&@#1,^,0}%

```

#### 10.48.11 `\XINTinFloatdigits`, `\XINTinFloatSqrtdigits`, `\XINTinFloatFacdigits`

for `\xintNewExpr` matters, mainly.

```
1965 \def\XINTinFloatdigits {\XINTinFloat [\XINTdigits]]}%
1966 \def\XINTinFloatSqrtdigits {\XINTinFloatSqrt[\XINTdigits]]}%
1967 \def\XINTinFloatFacdigits {\XINTinFloatFac [\XINTdigits]]}%

```

#### 10.48.12 `\XINTinFloatMaxof:csv`, `\XINTinFloatMinof:csv`

1.09a. Rewritten for 1.1. For use by `\xintfloatexpr`. Name changed in 1.09h

```
1968 \def\XINTinFloatMaxof:csv #1{\expandafter\XINT_onscv:_a\expandafter\xintmax
1969         \expandafter\XINTinFloatdigits\romannumeral`&&@#1,^,{0[0]}}}%
1970 \def\XINTinFloatMinof:csv #1{\expandafter\XINT_onscv:_a\expandafter\xintmin
1971         \expandafter\XINTinFloatdigits\romannumeral`&&@#1,^,{0[0]}}}%

```

#### 10.48.13 `\XINTinFloatSum:csv`, `\XINTinFloatPrd:csv`

1.09a. Rewritten for 1.1. For use by `\xintfloatexpr`.

```
1972 \def\XINTinFloatSum:csv #1{\expandafter\XINT_onscv:_a\expandafter\XINTinfloatadd
1973         \expandafter\XINTinFloatdigits\romannumeral`&&@#1,^,{0[0]}}}%
1974 \def\XINTinFloatPrd:csv #1{\expandafter\XINT_onscv:_a\expandafter\XINTinfloatmul
1975         \expandafter\XINTinFloatdigits\romannumeral`&&@#1,^,{1[0]}}}%

```

## 10.49 The num, reduce, abs, sgn, frac, floor, ceil, sqr, sqrt, sqrtr, float, round, trunc, mod, quo, rem, gcd, lcm, max, min, `+`, `\*`, `?`, `!`, not, all, any, xor, if, ifsgn, even, odd, first, last, len, reversed, factorial and binomial functions

```

1976 \def\XINT_expr_twoargs #1,#2,{\{#1\}{#2}}%
1977 \def\XINT_expr_argadopt #1,#2,#3.#4#5%
1978 {%
1979   \if\relax#3\relax\expandafter\xint_firstoftwo\else
1980     \expandafter\xint_secondoftwo\fi
1981   {#4}{#5[\xintNum {#2}]}{#1}%
1982 }%
1983 \def\XINT_expr_oneortwo #1#2#3,#4,#5.%
1984 {%
1985   \if\relax#5\relax\expandafter\xint_firstoftwo\else
1986     \expandafter\xint_secondoftwo\fi
1987   {#1{0}}{#2{\xintNum {#4}}}{#3}%
1988 }%
1989 \def\XINT_iexpr_oneortwo #1#2,#3,#4.%
1990 {%
1991   \if\relax#4\relax\expandafter\xint_firstoftwo\else
1992     \expandafter\xint_secondoftwo\fi
1993   {#1{0}}{#1{#3}}{#2}%
1994 }%
1995 \def\XINT_expr_func_num #1#2#3%
1996   {\expandafter #1\expandafter #2\csname.=\xintNum {\XINT_expr_unlock #3}\endcsname }%
1997 \let\XINT_flexpr_func_num\XINT_expr_func_num
1998 \let\XINT_iexpr_func_num\XINT_expr_func_num
1999 % [0] added Oct 25. For interaction with SPRaw::csv
2000 \def\XINT_expr_func_reduce #1#2#3%
2001   {\expandafter #1\expandafter #2\csname.=\xintIrr {\XINT_expr_unlock #3}[0]\endcsname }%
2002 \let\XINT_flexpr_func_reduce\XINT_expr_func_reduce
2003 % no \XINT_iexpr_func_reduce
2004 \def\XINT_expr_func_abs #1#2#3%
2005   {\expandafter #1\expandafter #2\csname.=\xintAbs {\XINT_expr_unlock #3}\endcsname }%
2006 \let\XINT_flexpr_func_abs\XINT_expr_func_abs
2007 \def\XINT_iexpr_func_abs #1#2#3%
2008   {\expandafter #1\expandafter #2\csname.=\xintiiAbs {\XINT_expr_unlock #3}\endcsname }%
2009 \def\XINT_expr_func_sgn #1#2#3%
2010   {\expandafter #1\expandafter #2\csname.=\xintSgn {\XINT_expr_unlock #3}\endcsname }%
2011 \let\XINT_flexpr_func_sgn\XINT_expr_func_sgn
2012 \def\XINT_iexpr_func_sgn #1#2#3%
2013   {\expandafter #1\expandafter #2\csname.=\xintiiSgn {\XINT_expr_unlock #3}\endcsname }%
2014 \def\XINT_expr_func_frac #1#2#3%
2015   {\expandafter #1\expandafter #2\csname.=\xintTFrac {\XINT_expr_unlock #3}\endcsname }%
2016 \def\XINT_flexpr_func_frac #1#2#3{\expandafter #1\expandafter #2\csname
2017   .=\XINTinFloatFracdigits {\XINT_expr_unlock #3}\endcsname }%

no \XINT_iexpr_func_frac

2018 \def\XINT_expr_func_floor #1#2#3%
2019   {\expandafter #1\expandafter #2\csname .=\xintFloor {\XINT_expr_unlock #3}\endcsname }%
2020 \let\XINT_flexpr_func_floor\XINT_expr_func_floor

```

The floor and ceil functions in *\xintiexpr* require `protect(a/b)` or, better, `\qfrac(a/b)`; else the / will be executed first and do an integer rounded division.

```

2021 \def\xINT_iiexpr_func_floor #1#2#3%
2022 {%
2023   \expandafter #1\expandafter #2\csname.=\xintiFloor {\XINT_expr_unlock #3}\endcsname }%
2024 \def\xINT_expr_func_ceil #1#2#3%
2025   {\expandafter #1\expandafter #2\csname .=\xintCeil {\XINT_expr_unlock #3}\endcsname }%
2026 \let\xINT_flexpr_func_ceil\xINT_expr_func_ceil
2027 \def\xINT_iiexpr_func_ceil #1#2#3%
2028 {%
2029   \expandafter #1\expandafter #2\csname.=\xintiCeil {\XINT_expr_unlock #3}\endcsname }%
2030 \def\xINT_expr_func_sqr #1#2#3%
2031   {\expandafter #1\expandafter #2\csname.=\xintSqr {\XINT_expr_unlock #3}\endcsname }%
2032 \def\xINT_flexpr_func_sqr #1#2#3%
2033 {%
2034   \expandafter #1\expandafter #2\csname
2035     .=\XINTinFloatMul{\XINT_expr_unlock #3}{\XINT_expr_unlock #3}\endcsname
2036 }%
2037 \def\xINT_expr_func_factorial #1#2#3%
2038 {%
2039   \expandafter #1\expandafter #2\csname .=%
2040     \expandafter\xINT_expr_argandopt
2041     \romannumeral`&&\XINT_expr_unlock#3,,.\xintiFac\xINTinFloatFac
2042     \endcsname
2043 }%
2044 \def\xINT_flexpr_func_factorial #1#2#3%
2045 {%
2046   \expandafter #1\expandafter #2\csname .=%
2047     \expandafter\xINT_expr_argandopt
2048     \romannumeral`&&\XINT_expr_unlock#3,,.\XINTinFloatFacdigits\xINTinFloatFac
2049     \endcsname
2050 }%
2051 \def\xINT_iiexpr_func_factorial #1#2#3%
2052 {%
2053   \expandafter #1\expandafter #2\csname.=\xintiiFac{\XINT_expr_unlock #3}\endcsname
2054 }%
2055 \def\xINT_iiexpr_func_sqr #1#2#3%
2056   {\expandafter #1\expandafter #2\csname.=\xintiiSqr {\XINT_expr_unlock #3}\endcsname }%
2057 \def\xINT_expr_func_sqrt #1#2#3%
2058 {%
2059   \expandafter #1\expandafter #2\csname .=%
2060     \expandafter\xINT_expr_argandopt
2061     \romannumeral`&&\XINT_expr_unlock#3,,.\XINTinFloatSqrtdigits\xINTinFloatSqrt
2062     \endcsname
2063 }%
2064 \let\xINT_flexpr_func_sqrt\xINT_expr_func_sqrt
2065 \def\xINT_iiexpr_func_sqrt #1#2#3%
2066   {\expandafter #1\expandafter #2\csname.=\xintiiSqrt {\XINT_expr_unlock #3}\endcsname }%
2067 \def\xINT_iiexpr_func_sqrtr #1#2#3%
2068   {\expandafter #1\expandafter #2\csname.=\xintiiSqrtr {\XINT_expr_unlock #3}\endcsname }%
2069 \def\xINT_expr_func_round #1#2#3%
2070 {%

```

```

2071 \expandafter #1\expandafter #2\csname .=%
2072 \expandafter\XINT_expr_oneortwo
2073 \expandafter\xintiRound\expandafter\xintRound
2074 \romannumeral`&&\XINT_expr_unlock #3,,.\endcsname
2075 }%
2076 \let\XINT_flexpr_func_round\XINT_expr_func_round
2077 \def\XINT_iiexpr_func_round #1#2#3%
2078 {%
2079 \expandafter #1\expandafter #2\csname .=%
2080 \expandafter\XINT_iiexpr_oneortwo\expandafter\xintiRound
2081 \romannumeral`&&\XINT_expr_unlock #3,,.\endcsname
2082 }%
2083 \def\XINT_expr_func_trunc #1#2#3%
2084 {%
2085 \expandafter #1\expandafter #2\csname .=%
2086 \expandafter\XINT_expr_oneortwo
2087 \expandafter\xintiTrunc\expandafter\xintTrunc
2088 \romannumeral`&&\XINT_expr_unlock #3,,.\endcsname
2089 }%
2090 \let\XINT_flexpr_func_trunc\XINT_expr_func_trunc
2091 \def\XINT_iiexpr_func_trunc #1#2#3%
2092 {%
2093 \expandafter #1\expandafter #2\csname .=%
2094 \expandafter\XINT_iiexpr_oneortwo\expandafter\xintiTrunc
2095 \romannumeral`&&\XINT_expr_unlock #3,,.\endcsname
2096 }%
2097 \def\XINT_expr_func_float #1#2#3%
2098 {%
2099 \expandafter #1\expandafter #2\csname .=%
2100 \expandafter\XINT_expr_argandopt
2101 \romannumeral`&&\XINT_expr_unlock #3,,.\XINTinFloatdigits\XINTinFloat
2102 \endcsname
2103 }%
2104 \let\XINT_flexpr_func_float\XINT_expr_func_float
2105 % \XINT_iiexpr_func_float not defined
2106 \def\XINT_expr_func_mod #1#2#3%
2107 {%
2108 \expandafter #1\expandafter #2\csname .=%
2109 \expandafter\expandafter\expandafter\xintMod
2110 \expandafter\XINT_expr_twoargs
2111 \romannumeral`&&\XINT_expr_unlock #3,\endcsname
2112 }%
2113 \def\XINT_flexpr_func_mod #1#2#3%
2114 {%
2115 \expandafter #1\expandafter #2\csname .=%
2116 \expandafter\XINTinFloatMod
2117 \romannumeral`&&\expandafter\XINT_expr_twoargs
2118 \romannumeral`&&\XINT_expr_unlock #3,\endcsname
2119 }%
2120 \def\XINT_iiexpr_func_mod #1#2#3%
2121 {%
2122 \expandafter #1\expandafter #2\csname .=%

```

```

2123 \expandafter\expandafter\expandafter\xintiMod
2124 \expandafter\XINT_expr_twoargs
2125 \romannumeral`&&\XINT_expr_unlock #3,\endcsname
2126 }%
2127 \def\XINT_expr_func_binomial #1#2#3%
2128 {%
2129 \expandafter #1\expandafter #2\csname .=%
2130 \expandafter\expandafter\expandafter\xintiBinomial
2131 \expandafter\XINT_expr_twoargs
2132 \romannumeral`&&\XINT_expr_unlock #3,\endcsname
2133 }%
2134 \def\XINT_flexpr_func_binomial #1#2#3%
2135 {%
2136 \expandafter #1\expandafter #2\csname .=%
2137 \expandafter\expandafter\expandafter\XINTinFloatBinomial
2138 \expandafter\XINT_expr_twoargs
2139 \romannumeral`&&\XINT_expr_unlock #3,\endcsname
2140 }%
2141 \def\XINT_iiexpr_func_binomial #1#2#3%
2142 {%
2143 \expandafter #1\expandafter #2\csname .=%
2144 \expandafter\expandafter\expandafter\xintiBinomial
2145 \expandafter\XINT_expr_twoargs
2146 \romannumeral`&&\XINT_expr_unlock #3,\endcsname
2147 }%
2148 \def\XINT_expr_func_pfactorial #1#2#3%
2149 {%
2150 \expandafter #1\expandafter #2\csname .=%
2151 \expandafter\expandafter\expandafter\xintiPFactorial
2152 \expandafter\XINT_expr_twoargs
2153 \romannumeral`&&\XINT_expr_unlock #3,\endcsname
2154 }%
2155 \def\XINT_flexpr_func_pfactorial #1#2#3%
2156 {%
2157 \expandafter #1\expandafter #2\csname .=%
2158 \expandafter\expandafter\expandafter\XINTinFloatPFactorial
2159 \expandafter\XINT_expr_twoargs
2160 \romannumeral`&&\XINT_expr_unlock #3,\endcsname
2161 }%
2162 \def\XINT_iiexpr_func_pfactorial #1#2#3%
2163 {%
2164 \expandafter #1\expandafter #2\csname .=%
2165 \expandafter\expandafter\expandafter\xintiPFactorial
2166 \expandafter\XINT_expr_twoargs
2167 \romannumeral`&&\XINT_expr_unlock #3,\endcsname
2168 }%
2169 \def\XINT_expr_func_quo #1#2#3%
2170 {%
2171 \expandafter #1\expandafter #2\csname .=%
2172 \expandafter\expandafter\expandafter\xintiQuo
2173 \expandafter\XINT_expr_twoargs
2174 \romannumeral`&&\XINT_expr_unlock #3,\endcsname

```

```

2175 }%
2176 \let\XINT_flexpr_func_quo\XINT_expr_func_quo
2177 \def\XINT_iiexpr_func_quo #1#2#3%
2178 {%
2179     \expandafter #1\expandafter #2\csname .=%
2180     \expandafter\expandafter\expandafter\xintiiQuo
2181     \expandafter\XINT_expr_twoargs
2182     \romannumeral`&&\XINT_expr_unlock #3,\endcsname
2183 }%
2184 \def\XINT_expr_func_rem #1#2#3%
2185 {%
2186     \expandafter #1\expandafter #2\csname .=%
2187     \expandafter\expandafter\expandafter\xintiRem
2188     \expandafter\XINT_expr_twoargs
2189     \romannumeral`&&\XINT_expr_unlock #3,\endcsname
2190 }%
2191 \let\XINT_flexpr_func_rem\XINT_expr_func_rem
2192 \def\XINT_iiexpr_func_rem #1#2#3%
2193 {%
2194     \expandafter #1\expandafter #2\csname .=%
2195     \expandafter\expandafter\expandafter\xintiRem
2196     \expandafter\XINT_expr_twoargs
2197     \romannumeral`&&\XINT_expr_unlock #3,\endcsname
2198 }%
2199 \def\XINT_expr_func_gcd #1#2#3%
2200     {\expandafter #1\expandafter #2\csname
2201         .=\xintGCDoF:csv{\XINT_expr_unlock #3}\endcsname }%
2202 \let\XINT_flexpr_func_gcd\XINT_expr_func_gcd
2203 \def\XINT_iiexpr_func_gcd #1#2#3%
2204     {\expandafter #1\expandafter #2\csname
2205         .=\xintiiGCDoF:csv{\XINT_expr_unlock #3}\endcsname }%
2206 \def\XINT_expr_func_lcm #1#2#3%
2207     {\expandafter #1\expandafter #2\csname
2208         .=\xintLCMoF:csv{\XINT_expr_unlock #3}\endcsname }%
2209 \let\XINT_flexpr_func_lcm\XINT_expr_func_lcm
2210 \def\XINT_iiexpr_func_lcm #1#2#3%
2211     {\expandafter #1\expandafter #2\csname
2212         .=\xintiiLCMoF:csv{\XINT_expr_unlock #3}\endcsname }%
2213 \def\XINT_expr_func_max #1#2#3%
2214     {\expandafter #1\expandafter #2\csname
2215         .=\xintMaxoF:csv{\XINT_expr_unlock #3}\endcsname }%
2216 \def\XINT_iiexpr_func_max #1#2#3%
2217     {\expandafter #1\expandafter #2\csname
2218         .=\xintiiMaxoF:csv{\XINT_expr_unlock #3}\endcsname }%
2219 \def\XINT_flexpr_func_max #1#2#3%
2220     {\expandafter #1\expandafter #2\csname
2221         .=\XINTinFloatMaxoF:csv{\XINT_expr_unlock #3}\endcsname }%
2222 \def\XINT_expr_func_min #1#2#3%
2223     {\expandafter #1\expandafter #2\csname
2224         .=\xintMinof:csv{\XINT_expr_unlock #3}\endcsname }%
2225 \def\XINT_iiexpr_func_min #1#2#3%
2226     {\expandafter #1\expandafter #2\csname

```



```

2227 .=\xintiiMinof:csv{\XINT_expr_unlock #3}\endcsname }%
2228 \def\XINT_flexpr_func_min #1#2#3%
2229   {\expandafter #1\expandafter #2\csname
2230     .=\XINTinFloatMinof:csv{\XINT_expr_unlock #3}\endcsname }%
2231 \expandafter\def\csname XINT_expr_func_+\endcsname #1#2#3%
2232   {\expandafter #1\expandafter #2\csname
2233     .=\xintSum:csv{\XINT_expr_unlock #3}\endcsname }%
2234 \expandafter\def\csname XINT_flexpr_func_+\endcsname #1#2#3%
2235   {\expandafter #1\expandafter #2\csname
2236     .=\XINTinFloatSum:csv{\XINT_expr_unlock #3}\endcsname }%
2237 \expandafter\def\csname XINT_iiexpr_func_+\endcsname #1#2#3%
2238   {\expandafter #1\expandafter #2\csname
2239     .=\xintiiSum:csv{\XINT_expr_unlock #3}\endcsname }%
2240 \expandafter\def\csname XINT_expr_func_*\endcsname #1#2#3%
2241   {\expandafter #1\expandafter #2\csname
2242     .=\xintPrd:csv{\XINT_expr_unlock #3}\endcsname }%
2243 \expandafter\def\csname XINT_flexpr_func_*\endcsname #1#2#3%
2244   {\expandafter #1\expandafter #2\csname
2245     .=\XINTinFloatPrd:csv{\XINT_expr_unlock #3}\endcsname }%
2246 \expandafter\def\csname XINT_iiexpr_func_*\endcsname #1#2#3%
2247   {\expandafter #1\expandafter #2\csname
2248     .=\xintiiPrd:csv{\XINT_expr_unlock #3}\endcsname }%
2249 \def\XINT_expr_func_? #1#2#3%
2250   {\expandafter #1\expandafter #2\csname
2251     .=\xintiiIsNotZero {\XINT_expr_unlock #3}\endcsname }%
2252 \let\XINT_flexpr_func_? \XINT_expr_func_?
2253 \let\XINT_iiexpr_func_? \XINT_expr_func_?
2254 \def\XINT_expr_func_! #1#2#3%
2255   {\expandafter #1\expandafter #2\csname .=\xintiiIsZero {\XINT_expr_unlock #3}\endcsname }%
2256 \let\XINT_flexpr_func_! \XINT_expr_func_!
2257 \let\XINT_iiexpr_func_! \XINT_expr_func_!
2258 \def\XINT_expr_func_not #1#2#3%
2259   {\expandafter #1\expandafter #2\csname .=\xintiiIsZero {\XINT_expr_unlock #3}\endcsname }%
2260 \let\XINT_flexpr_func_not \XINT_expr_func_not
2261 \let\XINT_iiexpr_func_not \XINT_expr_func_not
2262 \def\XINT_expr_func_all #1#2#3%
2263   {\expandafter #1\expandafter #2\csname
2264     .=\xintANDof:csv{\XINT_expr_unlock #3}\endcsname }%
2265 \let\XINT_flexpr_func_all\XINT_expr_func_all
2266 \let\XINT_iiexpr_func_all\XINT_expr_func_all
2267 \def\XINT_expr_func_any #1#2#3%
2268   {\expandafter #1\expandafter #2\csname
2269     .=\xintORof:csv{\XINT_expr_unlock #3}\endcsname }%
2270 \let\XINT_flexpr_func_any\XINT_expr_func_any
2271 \let\XINT_iiexpr_func_any\XINT_expr_func_any
2272 \def\XINT_expr_func_xor #1#2#3%
2273   {\expandafter #1\expandafter #2\csname
2274     .=\xintXORof:csv{\XINT_expr_unlock #3}\endcsname }%
2275 \let\XINT_flexpr_func_xor\XINT_expr_func_xor
2276 \let\XINT_iiexpr_func_xor\XINT_expr_func_xor
2277 \def\xintifNotZero: #1,#2,#3,{\xintiiifNotZero{#1}{#2}{#3}}%
2278 \def\XINT_expr_func_if #1#2#3%

```



```

2279     {\expandafter #1\expandafter #2\csname
2280       .=\expandafter\xintifNotZero:\romannumeral`&&\XINT_expr_unlock #3,\endcsname }%
2281 \let\XINT_flexpr_func_if\XINT_expr_func_if
2282 \let\XINT_iiexpr_func_if\XINT_expr_func_if
2283 \def\xintifSgn: #1,#2,#3,#4,{\xintiifSgn{#1}{#2}{#3}{#4}}%
2284 \def\XINT_expr_func_ifsgn #1#2#3%
2285 {%
2286   \expandafter #1\expandafter #2\csname
2287     .=\expandafter\xintifSgn:\romannumeral`&&\XINT_expr_unlock #3,\endcsname
2288 }%
2289 \let\XINT_flexpr_func_ifsgn\XINT_expr_func_ifsgn
2290 \let\XINT_iiexpr_func_ifsgn\XINT_expr_func_ifsgn
2291 \def\XINT_expr_func_len #1#2#3%
2292   {\expandafter#1\expandafter#2%
2293     \csname.\xintLength:f:csv {\XINT_expr_unlock#3}\endcsname }%
2294 \let\XINT_flexpr_func_len \XINT_expr_func_len
2295 \let\XINT_iiexpr_func_len \XINT_expr_func_len

```

1.2k has `\xintFirstItem:f:csv` for improved `\xintNewExpr` compatibility.

```

2296 \def\XINT_expr_func_first #1#2#3%
2297   {\expandafter #1\expandafter #2\csname.=%
2298     \xintFirstItem:f:csv{\XINT_expr_unlock #3}\endcsname}%
2299 \let\XINT_flexpr_func_first\XINT_expr_func_first
2300 \let\XINT_iiexpr_func_first\XINT_expr_func_first

```

1.2k has `\xintLastItem:f:csv` for efficiency and improved `\xintNewExpr` compatibility.

```

2301 \def\XINT_expr_func_last #1#2#3%
2302   {\expandafter #1\expandafter #2\csname.=%
2303     \xintLastItem:f:csv{\XINT_expr_unlock #3}\endcsname}%
2304 \let\XINT_flexpr_func_last\XINT_expr_func_last
2305 \let\XINT_iiexpr_func_last\XINT_expr_func_last
2306 \def\XINT_expr_func_odd #1#2#3%
2307   {\expandafter #1\expandafter #2\csname.\xintOdd{\XINT_expr_unlock #3}\endcsname}%
2308 \let\XINT_flexpr_func_odd\XINT_expr_func_odd
2309 \def\XINT_iiexpr_func_odd #1#2#3%
2310   {\expandafter #1\expandafter #2\csname.\xintiiOdd{\XINT_expr_unlock #3}\endcsname}%
2311 \def\XINT_expr_func_even #1#2#3%
2312   {\expandafter #1\expandafter #2\csname.\xintEven{\XINT_expr_unlock #3}\endcsname}%
2313 \let\XINT_flexpr_func_even\XINT_expr_func_even
2314 \def\XINT_iiexpr_func_even #1#2#3%
2315   {\expandafter #1\expandafter #2\csname.\xintiiEven{\XINT_expr_unlock #3}\endcsname}%
2316 \def\XINT_expr_func_nuple #1#2#3%
2317   {\expandafter #1\expandafter #2\csname .=\XINT_expr_unlock #3\endcsname }%
2318 \let\XINT_flexpr_func_nuple\XINT_expr_func_nuple
2319 \let\XINT_iiexpr_func_nuple\XINT_expr_func_nuple

```

1.2c I hesitated but left the function "reversed" from 1.1 with this name, not "reverse". But the inner not public macro got renamed into `\xintReverse::csv`. 1.2g opts for the name `\xintReverse:f:csv`, and rewrites it for direct handling of csv lists. 2016/03/17.

```

2320 \def\XINT_expr_func_reversed #1#2#3%
2321   {\expandafter #1\expandafter #2\csname .=%

```

```

2322      \xintReverse:f:csv {\XINT_expr_unlock #3}\endcsname }%
2323 \let\XINT_flexpr_func_reversed\XINT_expr_func_reversed
2324 \let\XINT_iiexpr_func_reversed\XINT_expr_func_reversed

```

## 10.50 f-expandable versions of the `\xintSeqB:f:csv` and alike routines, for `\xintNewExpr`

10.50.1	<code>\xintSeqB:f:csv</code>	338
10.50.2	<code>\xintiiSeqB:f:csv</code>	338
10.50.3	<code>\XINTinFloatSeqB:f:csv</code>	339

### 10.50.1 `\xintSeqB:f:csv`

Produces in f-expandable way. If the step is zero, gives empty result except if start and end coincide.

```

2325 \def\xintSeqB:f:csv #1#2%
2326   {\expandafter\XINT_seqb:f:csv \expandafter{\romannumeral0\xintra{#2}}{#1}}%
2327 \def\XINT_seqb:f:csv #1#2{\expandafter\XINT_seqb:f:csv_a\romannumeral`&&@#2#1!}%
2328 \def\XINT_seqb:f:csv_a #1#2;#3;#4!{%
2329   \expandafter\xint_gobble_i\romannumeral`&&@%
2330   \xintifCmp {#3}{#4}\XINT_seqb:f:csv_bl\XINT_seqb:f:csv_be\XINT_seqb:f:csv_bg
2331   #1{#3}{#4}{#2}}%
2332 \def\XINT_seqb:f:csv_be #1#2#3#4#5{,#2}%
2333 \def\XINT_seqb:f:csv_bl #1{\if #1p\expandafter\XINT_seqb:f:csv_pa\else
2334   \xint_afterfi{\expandafter,\xint_gobble_iv}\fi }%
2335 \def\XINT_seqb:f:csv_pa #1#2#3#4{\expandafter\XINT_seqb:f:csv_p\expandafter
2336   {\romannumeral0\xintadd{#4}{#1}}{#2}{#3,#1}{#4}}%
2337 \def\XINT_seqb:f:csv_p #1#2%
2338   {%
2339   \xintifCmp {#1}{#2}\XINT_seqb:f:csv_pa\XINT_seqb:f:csv_pb\XINT_seqb:f:csv_pc
2340   {#1}{#2}%
2341   }%
2342 \def\XINT_seqb:f:csv_pb #1#2#3#4{#3,#1}%
2343 \def\XINT_seqb:f:csv_pc #1#2#3#4{#3}%
2344 \def\XINT_seqb:f:csv_bg #1{\if #1n\expandafter\XINT_seqb:f:csv_na\else
2345   \xint_afterfi{\expandafter,\xint_gobble_iv}\fi }%
2346 \def\XINT_seqb:f:csv_na #1#2#3#4{\expandafter\XINT_seqb:f:csv_n\expandafter
2347   {\romannumeral0\xintadd{#4}{#1}}{#2}{#3,#1}{#4}}%
2348 \def\XINT_seqb:f:csv_n #1#2%
2349   {%
2350   \xintifCmp {#1}{#2}\XINT_seqb:f:csv_nc\XINT_seqb:f:csv_nb\XINT_seqb:f:csv_na
2351   {#1}{#2}%
2352   }%
2353 \def\XINT_seqb:f:csv_nb #1#2#3#4{#3,#1}%
2354 \def\XINT_seqb:f:csv_nc #1#2#3#4{#3}%

```

### 10.50.2 `\xintiiSeqB:f:csv`

Produces in f-expandable way. If the step is zero, gives empty result except if start and end coincide.

2015/11/11. I correct a typo dating back to release 1.1 (2014/10/29): the macro name had a "b" rather than "B", hence was not functional (causing \xintNewIIEExpr to fail on inputs such as #1..[1]..#2).

```

2355 \def\xintiSeqB:f:csv #1#2%
2356   {\expandafter\XINT_iiseqb:f:csv \expandafter{\romannumeral`&&@#2}{#1}}%
2357 \def\XINT_iiseqb:f:csv #1#2{\expandafter\XINT_iiseqb:f:csv_a\romannumeral`&&@#2#1!}%
2358 \def\XINT_iiseqb:f:csv_a #1#2;#3;#4!{%
2359   \expandafter\xint_gobble_i\romannumeral`&&@%
2360   \xintSgnFork{\XINT_Cmp {#3}{#4}}%
2361     \XINT_iiseqb:f:csv_bl\XINT_seqb:f:csv_be\XINT_iiseqb:f:csv_bg
2362     #1{#3}{#4}{#2}}%
2363 \def\XINT_iiseqb:f:csv_bl #1{\if #1p\expandafter\XINT_iiseqb:f:csv_pa\else
2364   \xint_afterfi{\expandafter,\xint_gobble_iv}\fi }%
2365 \def\XINT_iiseqb:f:csv_pa #1#2#3#4{\expandafter\XINT_iiseqb:f:csv_p\expandafter
2366   {\romannumeral0\xintiiadd{#4}{#1}}{#2}{#3,#1}{#4}}%
2367 \def\XINT_iiseqb:f:csv_p #1#2%
2368 {%
2369   \xintSgnFork{\XINT_Cmp {#1}{#2}}%
2370   \XINT_iiseqb:f:csv_pa\XINT_iiseqb:f:csv_pb\XINT_iiseqb:f:csv_pc {#1}{#2}%
2371 }%
2372 \def\XINT_iiseqb:f:csv_pb #1#2#3#4{#3,#1}%
2373 \def\XINT_iiseqb:f:csv_pc #1#2#3#4{#3}%
2374 \def\XINT_iiseqb:f:csv_bg #1{\if #1n\expandafter\XINT_iiseqb:f:csv_na\else
2375   \xint_afterfi{\expandafter,\xint_gobble_iv}\fi }%
2376 \def\XINT_iiseqb:f:csv_na #1#2#3#4{\expandafter\XINT_iiseqb:f:csv_n\expandafter
2377   {\romannumeral0\xintiiadd{#4}{#1}}{#2}{#3,#1}{#4}}%
2378 \def\XINT_iiseqb:f:csv_n #1#2%
2379 {%
2380   \xintSgnFork{\XINT_Cmp {#1}{#2}}%
2381   \XINT_seqb:f:csv_nc\XINT_seqb:f:csv_nb\XINT_iiseqb:f:csv_na {#1}{#2}%
2382 }%

```

### 10.50.3 \XINTinFloatSeqB:f:csv

Produces in f-expandable way. If the step is zero, gives empty result except if start and end coincide. This is all for \xintNewExpr.

```

2383 \def\XINTinFloatSeqB:f:csv #1#2{\expandafter\XINT_flseqb:f:csv \expandafter
2384   {\romannumeral0\XINTinfloat [\XINTdigits]{#2}}{#1}}%
2385 \def\XINT_flseqb:f:csv #1#2{\expandafter\XINT_flseqb:f:csv_a\romannumeral`&&@#2#1!}%
2386 \def\XINT_flseqb:f:csv_a #1#2;#3;#4!{%
2387   \expandafter\xint_gobble_i\romannumeral`&&@%
2388   \xintifCmp {#3}{#4}\XINT_flseqb:f:csv_bl\XINT_seqb:f:csv_be\XINT_flseqb:f:csv_bg
2389   #1{#3}{#4}{#2}}%
2390 \def\XINT_flseqb:f:csv_bl #1{\if #1p\expandafter\XINT_flseqb:f:csv_pa\else
2391   \xint_afterfi{\expandafter,\xint_gobble_iv}\fi }%
2392 \def\XINT_flseqb:f:csv_pa #1#2#3#4{\expandafter\XINT_flseqb:f:csv_p\expandafter
2393   {\romannumeral0\XINTinfloatadd{#4}{#1}}{#2}{#3,#1}{#4}}%
2394 \def\XINT_flseqb:f:csv_p #1#2%
2395 {%
2396   \xintifCmp {#1}{#2}%
2397   \XINT_flseqb:f:csv_pa\XINT_flseqb:f:csv_pb\XINT_flseqb:f:csv_pc {#1}{#2}%

```

```

2398 }%
2399 \def\XINT_flseqb:f:csv_pb #1#2#3#4{#3,#1}%
2400 \def\XINT_flseqb:f:csv_pc #1#2#3#4{#3}%
2401 \def\XINT_flseqb:f:csv_bg #1{\if #1n\expandafter\XINT_flseqb:f:csv_na\else
2402     \xint_afterfi{\expandafter,\xint_gobble_iv}\fi }%
2403 \def\XINT_flseqb:f:csv_na #1#2#3#4{\expandafter\XINT_flseqb:f:csv_n\expandafter
2404     {\romannumeral0\XINTinfloatadd{#4}{#1}}{#2}{#3,#1}{#4}}%
2405 \def\XINT_flseqb:f:csv_n #1#2%
2406 {%
2407     \xintifCmp {#1}{#2}%
2408     \XINT_seqb:f:csv_nc\XINT_seqb:f:csv_nb\XINT_flseqb:f:csv_na {#1}{#2}%
2409 }%

```

## 10.51 User defined functions: *\xintdeffunc*, *\xintdefiifunc*, *\xintdeffloatfunc*

1.2c (November 11-12, 2015). It is possible to overload a variable name with a function name (and conversely). The function interpretation will be used only if followed by an opening parenthesis, disabling the tacit multiplication usually applied to variables. Crazy things such as  $\text{add}(f(f), f=1..10)$  are possible if there is a function "f". Or we can use "e" both for an exponential function and the Euler constant.

2015/11/13: function candidates names first completely expanded, then detokenized and cleaned of spaces.

2015/11/21: no more *\detokenize* on the function names. Also I use  $\#1(\#2)\#3:=\#4$  rather than  $\#1(\#2):=\#3$ . Ah, rather  $\#1(\#2)\#3=\#4$ , then I don't have to worry about active :.

2016/02/22: 1.2f la macro associée à la fonction ne débute plus par un *\romannumeral*, de toute façon est pour emploi dans *\csname.. \endcsname*.

2016/03/08: 1.2f allows comma separated expressions; until then the user had to use explicit parentheses *\xintdeffunc foo(x,...):=(..., ..., ...)\relax*.

```

2410 \catcode`: 12
2411 \def\XINT_tmpa #1#2#3#4%
2412 {%
2413     \def #1##1(##2)##3=##4;{%
2414         \edef\XINT_expr_tmpa {##1}%
2415         \edef\XINT_expr_tmpa {\xint_zapspace_o \XINT_expr_tmpa}%
2416         \def\XINT_expr_tmppb {0}%
2417         \def\XINT_expr_tmppc {(##4)}%
2418         \xintFor ####1 in {##2} \do
2419             {\edef\XINT_expr_tmppb {\the\numexpr\XINT_expr_tmppb+\xint_c_i}%
2420             \edef\XINT_expr_tmppc {subs(\unexpanded\expandafter{\XINT_expr_tmppc},%
2421                 ####1=#####\XINT_expr_tmppb)}}%
2422     }%
2423     \expandafter#3\csname XINT_#2_userfunc_\XINT_expr_tmpa\endcsname
2424         [\XINT_expr_tmppb]{\XINT_expr_tmppc}%
2425     \expandafter\XINT_expr_defuserfunc
2426     \csname XINT_#2_func_\XINT_expr_tmpa\expandafter\endcsname
2427     \csname XINT_#2_userfunc_\XINT_expr_tmpa\endcsname
2428     \ifxintverbose\xintMessage {\xintexpr}{Info}
2429         {Function \XINT_expr_tmpa\space for \string\xint #4 parser
2430         associated to \string\XINT_#2_userfunc_\XINT_expr_tmpa\space
2431         with meaning \expandafter\meaning
2432         \csname XINT_#2_userfunc_\XINT_expr_tmpa\endcsname}%
2433     \fi

```

```

2434 }%
2435 }%
2436 \catcode`: 11
2437 \XINT_tmpa\xintdeffunc {expr} \XINT_NewFunc {expr}%
2438 \XINT_tmpa\xintdefiifunc {iiexpr}\XINT_NewIIFunc {iiexpr}%
2439 \XINT_tmpa\xintdeffloatfunc{flexpr}\XINT_NewFloatFunc{floatexpr}%
2440 \def\XINT_expr_defuserfunc #1#2{%
2441   \def #1##1##2##3{\expandafter ##1\expandafter ##2%
2442     \csname .=\expandafter #2\romannumeral`&&@\XINT_expr_unlock ##3,\endcsname
2443   }%
2444 }%

```

## 10.52 \xintNewFunction

1.2h (2016/11/20). Syntax is `\xintNewFunction{<name>}[nb of arguments]{expression with #1, #2,... as in \xintNewExpr}`. This defines a function for all three parsers but the expression parsing is delayed until function execution. Hence the expression admits all constructs, contrarily to `\xintNewExpr` or `\xintdeffunc`.

```

2445 \def\XINT_expr_wrapit #1{\expandafter\XINT_expr_wrap\csname.=#1\endcsname}%
2446 \def\xintNewFunction #1#2[#3]#4%
2447 {%
2448   \edef\XINT_expr_tmpa {#1}%
2449   \edef\XINT_expr_tmpa {\xint_zapspaces_o \XINT_expr_tmpa}%
2450   \def\XINT_expr_tmpb ##1##2##3##4##5##6##7##8##9{#4}%
2451   \begingroup
2452     \ifcase #3\relax
2453       \toks0{,}%
2454     \or \toks0{##1,}%
2455     \or \toks0{##1,##2,}%
2456     \or \toks0{##1,##2,##3,}%
2457     \or \toks0{##1,##2,##3,##4,}%
2458     \or \toks0{##1,##2,##3,##4,##5,}%
2459     \or \toks0{##1,##2,##3,##4,##5,##6,}%
2460     \or \toks0{##1,##2,##3,##4,##5,##6,##7,}%
2461     \or \toks0{##1,##2,##3,##4,##5,##6,##7,##8,}%
2462     \else \toks0{##1,##2,##3,##4,##5,##6,##7,##8,##9,}%
2463     \fi
2464     \expandafter
2465   \endgroup
2466   \expandafter
2467   \def\csname XINT_expr_macrofunc_\XINT_expr_tmpa\expandafter\endcsname
2468   \the\toks0\expandafter{\XINT_expr_tmpb
2469     {\XINT_expr_wrapit{##1}}{\XINT_expr_wrapit{##2}}{\XINT_expr_wrapit{##3}}}%
2470     {\XINT_expr_wrapit{##4}}{\XINT_expr_wrapit{##5}}{\XINT_expr_wrapit{##6}}}%
2471     {\XINT_expr_wrapit{##7}}{\XINT_expr_wrapit{##8}}{\XINT_expr_wrapit{##9}}}%
2472   \expandafter\XINT_expr_newfunction
2473   \csname XINT_expr_func_\XINT_expr_tmpa\expandafter\endcsname
2474   \csname XINT_expr_macrofunc_\XINT_expr_tmpa\endcsname\xintbareeval
2475   \expandafter\XINT_expr_newfunction
2476   \csname XINT_iiexpr_func_\XINT_expr_tmpa\expandafter\endcsname
2477   \csname XINT_expr_macrofunc_\XINT_expr_tmpa\endcsname\xintbareiieval
2478   \expandafter\XINT_expr_newfunction

```

```

2479 \csname XINT_flexpr_func_\XINT_expr_tmpa\expandafter\endcsname
2480 \csname XINT_expr_macrofunc_\XINT_expr_tmpa\endcsname\xintbarefloateval
2481 \ifxintverbose
2482 \xintMessage {xintexpr}{Info}
2483 {Function \XINT_expr_tmpa\space for the expression parsers is
2484 associated to \string\XINT_expr_macrofunc_\XINT_expr_tmpa\space
2485 with meaning \expandafter\meaning
2486 \csname XINT_expr_macrofunc_\XINT_expr_tmpa\endcsname}%
2487 \fi
2488 }%
2489 \def\XINT_expr_newfunction #1#2#3%
2490 {%
2491 \def#1##1##2##3{\expandafter ##1\expandafter ##2\romannumeral`&&@%
2492 #3\expandafter#2\romannumeral`&&@\XINT_expr_unlock##3,\relax}%
2493 }%

```

### 10.53 \xintNewExpr, \xintNewIExpr, \xintNewFloatExpr, \xintNewIIExpr

10.53.1	\xintApply::csv . . . . .	342
10.53.2	\xintApply:::csv . . . . .	343
10.53.3	\XINT_expr_RApply::csv, \XINT_expr_LApply::csv, \XINT_expr_RLApply:::csv . .	343
10.53.4	Mysterious stuff . . . . .	343
10.53.5	\xintNewExpr, ..., at last. . . . .	346

There was an `\xintNewExpr` already in 1.07 from May 2013, which was modified in September 2013 to work with the `#` macro parameter character, and then refactored into a more powerful version in June 2014 for 1.1 release of 2014/10/28. List handling causes special challenges, addressed by `\xintApply::csv`, `\xintApply:::csv`, ... next.

Comments finally added 2015/12/11 (with later edits):

The whole point is to expand completely macros when they have only numerical arguments and to inhibit this expansion if not. This is done in a recursive way: the catcode 12 `~` is used to register a macro name whose expansion must be inhibited. Any argument itself starting with such a `~` will force use of `~` for the macro which receives it.

In this context the catcode 12 `$` is used to signal a "virtual list" argument. It triggers insertion of `\xintApply::csv` or `\xintApply:::csv` for delayed handling later. This succeeds into handling inputs such as `[#1..[#2]..#3][#4:#5]...`

A final `\scantokens` converts the `"~"` prefixed names into real control sequences.

For this whole mechanism we need to have everything expressed using exclusively f-expandable macros. We avoid `\csname... \endcsname` like construct, but if absolutely needed perhaps we will do it ultimately.

For the iterating loops `seq`, `iter`, etc..., and dummy variables, we have no macros to our disposal to handle the case where the list of indices is not explicit. Moreover `omit`, `abort`, `break` can not work with non numerical data. Thus the whole mechanism is currently not applicable to them. It does work when the macro parameters (or variables for `\xintdeffunc`) do not intervene in the list of values to iterate over. But we can not delay expansion of dummy variables.

#### 10.53.1 \xintApply::csv

```

2494 \def\xintApply::csv #1#2%
2495 {\expandafter\XINT_applyon::_a\expandafter {\romannumeral`&&@#2}{#1}}%
2496 \def\XINT_applyon::_a #1#2{\XINT_applyon::_b {#2}{#1},}%
2497 \def\XINT_applyon::_b #1#2#3,{\expandafter\XINT_applyon::_c \romannumeral`&&@#3,{#1}{#2}}%

```

```

2498 \def\XINT_applyon::_c #1{\if #1,\expandafter\XINT_applyon::_end
2499         \else\expandafter\XINT_applyon::_d\fi #1}%
2500 \def\XINT_applyon::_d #1,#2{\expandafter\XINT_applyon::_e\romannumeral`&&@#2{#1},{#2}}%
2501 \def\XINT_applyon::_e #1,#2#3{\XINT_applyon::_b {#2}{#3}, #1}%
2502 \def\XINT_applyon::_end #1,#2#3{\xint_secondoftwo #3}%

```

### 10.53.2 \xintApply:::csv

```

2503 \def\xintApply:::csv #1#2#3%
2504     {\expandafter\XINT_applyon::_a\expandafter{\romannumeral`&&@#2{#1}{#3}}%
2505 \def\XINT_applyon::_a #1#2#3{\XINT_applyon::_b {#2}{#3}{#1},,}%
2506 \def\XINT_applyon::_b #1#2#3#4,%
2507     {\expandafter\XINT_applyon::_c \romannumeral`&&@#4,{#1}{#2}{#3}}%
2508 \def\XINT_applyon::_c #1{\if #1,\expandafter\XINT_applyon::_end
2509         \else\expandafter\XINT_applyon::_d\fi #1}%
2510 \def\XINT_applyon::_d #1,#2#3%
2511     {\expandafter\XINT_applyon::_e\expandafter
2512         {\romannumeral`&&\xintApply:::csv {#2{#1}}{#3}}{#2}{#3}}%
2513 \def\XINT_applyon::_e #1,#2#3#4{\XINT_applyon::_b {#2}{#3}{#4}, #1}%
2514 \def\XINT_applyon::_end #1,#2#3#4{\xint_secondoftwo #4}%

```

### 10.53.3 \XINT\_expr\_RApply:::csv, \XINT\_expr\_LApply:::csv, \XINT\_expr\_RLApply:::csv

The #1 in `_Rapply` will start with a `~`. No risk of glueing to previous `~expandafter` during the `\scantokens`.

Attention here and next `~` has catcode 12 and not 3 like elsewhere in *xintexpr*.

```

2515 \catcode`~ 12
2516 \def\XINT_expr_RApply:::csv #1#2#3#4%
2517     {\xintApply:::csv{~expandafter#1~xint_exchangetwo_keepbraces{#4}}{#3}}%
2518 \def\XINT_expr_LApply:::csv #1#2#3#4{\xintApply:::csv{#1{#3}}{#4}}%
2519 \def\XINT_expr_RLApply:::csv #1#2{\xintApply:::csv{#1}}%

```

### 10.53.4 Mysterious stuff

`~` and `$` of catcode 12 in what follows.

```

2520 \catcode`$ 12 % $
2521 \def\XINT_xptwo_getab_b #1#2!#3%
2522     {\expandafter\XINT_xptwo_getab_c\romannumeral`&&@#3!#1{#1#2}}%
2523 \def\XINT_xptwo_getab_c #1#2!#3#4#5#6{#1#3{#5}{#6}{#1#2}{#4}}%
2524 \def\xint_ddfork #1$$$#2#3\krof {#2}% $$
2525 \def\XINT_NEfork #1#2{\xint_ddfork
2526         #1#2\XINT_expr_RLApply:::csv
2527         #1$\XINT_expr_RApply:::csv% $
2528         $#2\XINT_expr_LApply:::csv% $
2529         $$\XINT_NEfork_nn #1#2}% $$
2530         \krof }%
2531 \def\XINT_NEfork_nn #1#2#3#4{%
2532     \if #1##\xint_dothis{#3}\fi
2533     \if #1~\xint_dothis{#3}\fi
2534     \if #2##\xint_dothis{#3}\fi
2535     \if #2~\xint_dothis{#3}\fi
2536     \xint_orthat {\csname #4NE\endcsname }%
2537     }%

```



```

2538 \def\XINT_NEfork_one #1#2!#3#4#5#6{%
2539   \if ###1\xint_dothis {#3}\fi
2540   \if ~#1\xint_dothis {#3}\fi
2541   \if $#1\xint_dothis {\xintApply::csv{#3#5}}\fi %$
2542   \xint_orthat {\csname #4NE\endcsname #6}{#1#2}%
2543 }%
2544 \toks0 {}%
2545 \xintFor #1 in
2546   {DivTrunc,Mod,Round,Trunc,iRound,iTrunc,iQuo,iRem,
2547    iiDivTrunc,iiDivRound,iiMod,iiQuo,iiRem,%
2548    Lt,Gt,Eq,LtorEq,GtorEq,Neq,%
2549    iiLt,iiGt,iiEq,iiLtorEq,iiGtorEq,iiNeq,%
2550    Add,Sub,Mul,Div,Pow,E,%
2551    iiAdd,iiSub,iiMul,iiPow,iiE,%
2552    AND,OR,XOR,%
2553    SeqA::csv,iiSeqA::csv}\do
2554 {\toks0
2555  \expandafter{\the\toks0% no space!
2556  \expandafter\let\csname xint#1NE\expandafter\endcsname\csname xint#1\expandafter
2557  \endcsname\expandafter\def\csname xint#1\endcsname #####1####2{%
2558    \expandafter\XINT_NEfork
2559    \romannumeral`&&@\expandafter\XINT_xptwo_getab_b
2560    \romannumeral`&&@####2!{####1}{~xint#1}{xint#1}}}%
2561 }%
2562 }%
2563 % cela aurait-il un sens d'ajouter Raw et iNum (à cause de qint, qfrac,
2564 % qfloat?). Pas le temps d'y réfléchir. Je ne fais rien.
2565 \xintFor #1 in {Num,Irr,Abs,iiAbs,Sgn,iiSgn,TFrac,Floor,iFloor,Ceil,iCeil,%
2566   Sqr,iiSqr,iiSqrt,iiSqrtR,iiIsZero,iiIsNotZero,iiifNotZero,iiifSgn,%
2567   Odd,Even,iiOdd,iiEven,Opp,iiOpp,iiifZero,iFac,iBinomial,%
2568   iPFactorial,iiFac,iiBinomial,iiPFactorial,Bool,Toggle}\do
2569 {\toks0 \expandafter{\the\toks0%
2570   \expandafter\let\csname xint#1NE\expandafter\endcsname\csname
2571   xint#1\expandafter
2572   \endcsname\expandafter\def\csname xint#1\endcsname #####1{%
2573     \expandafter\XINT_NEfork_one\romannumeral`&&@####1!{~xint#1}{xint#1}{}}}%
2574 }%
2575 }%
2576 \toks0
2577 \expandafter{\the\toks0
2578 \let\XINTinFloatFacNE\XINTinFloatFac
2579 \def\XINTinFloatFac ##1{%
2580   \expandafter\XINT_NEfork_one
2581   \romannumeral`&&@##1!{~XINTinFloatFac}{XINTinFloatFac}{}}}%
2582 }%
2583 \xintFor #1 in {Add,Sub,Mul,Div,Binomial,PFactorial,PowerH,E,Mod,SeqA::csv}\do
2584 {\toks0
2585   \expandafter{\the\toks0%
2586   \expandafter\let\csname XINTinFloat#1NE\expandafter\endcsname
2587   \csname XINTinFloat#1\expandafter\endcsname
2588   \expandafter\def\csname XINTinFloat#1\endcsname #####1####2{%
2589     \expandafter\XINT_NEfork

```



```

2590      \romannumeral`&&@\expandafter\XINT_xptwo_getab_b
2591      \romannumeral`&&@###2!{###1}{~XINTinFloat#1}{XINTinFloat#1}}%
2592  }%
2593 }%
2594 \xintFor #1 in {XINTinFloatdigits,XINTinFloatFracdigits,XINTinFloatSqrtdigits,XINTinFloatFacdigits}\do
2595 {\toks0
2596  \expandafter{\the\toks0%
2597  \expandafter\let\csname #1NE\expandafter\endcsname\csname #1\expandafter
2598  \endcsname\expandafter\def\csname #1\endcsname ###1{\expandafter
2599    \XINT_NEfork_one\romannumeral`&&@###1!{~#1}{#1}{}}}%
2600  }%
2601 }%
2602 \xintFor #1 in {xintSeq::csv,xintiiSeq::csv,XINTinFloatSeq::csv}\do
2603 {\toks0
2604  \expandafter{\the\toks0% no space
2605  \expandafter\let\csname #1NE\expandafter\endcsname\csname #1\expandafter
2606  \endcsname\expandafter\def\csname #1\endcsname ###1####2{%
2607    \expandafter\XINT_NEfork
2608    \romannumeral`&&@\expandafter\XINT_xptwo_getab_b
2609    \romannumeral`&&@###2!{###1}{$noexpand$#1}{#1}}}%
2610  }%
2611 }%
2612 \xintFor #1 in {xintSeqB,xintiiSeqB,XINTinFloatSeqB}\do
2613 {\toks0
2614  \expandafter{\the\toks0% no space
2615  \expandafter\let\csname #1::csvNE\expandafter\endcsname\csname #1::csv\expandafter
2616  \endcsname\expandafter\def\csname #1::csv\endcsname ###1####2{%
2617    \expandafter\XINT_NEfork
2618    \romannumeral`&&@\expandafter\XINT_xptwo_getab_b
2619    \romannumeral`&&@###2!{###1}{$noexpand$#1:f:csv}{#1::csv}}}%
2620  }%
2621 }%
2622 \toks0
2623  \expandafter{\the\toks0
2624  \let\XINTinFloatNE\XINTinFloat
2625  \def\XINTinFloat [##1]##2{% not ultimately general, but got tired
2626    \expandafter\XINT_NEfork_one
2627    \romannumeral`&&@###2!{~XINTinFloat[##1]}{XINTinFloat}{}[##1]]}%
2628  \let\XINTinFloatSqrtNE\XINTinFloatSqrt
2629  \def\XINTinFloatSqrt [##1]##2{%
2630    \expandafter\XINT_NEfork_one
2631    \romannumeral`&&@###2!{~XINTinFloatSqrt[##1]}{XINTinFloatSqrt}{}[##1]]}%
2632  \let\XINTinFloatFacNE\XINTinFloatFac
2633  \def\XINTinFloatFac [##1]##2{%
2634    \expandafter\XINT_NEfork_one
2635    \romannumeral`&&@###2!{~XINTinFloatFac[##1]}{XINTinFloatFac}{}[##1]]}%
2636 }%

\XINTNewExpr has difficulties with handling lists, hence all these macros are set-up to simply not
attempt to do anything immediately, they will not try to check if the list is completely explicit.

2637 \xintFor #1 in {ANDof,ORof,XORof,iiMaxof,iiMinof,iiSum,iiPrd,
2638                GCDof,LCMof,Sum,Prd,Maxof,Minof,

```

```

2639             Reverse:f,FirstItem:f,LastItem:f}\do
2640 {\toks0
2641   \expandafter{\the\toks0\expandafter\def\csname xint#1:csv\endcsname {\~xint#1:csv}}%
2642 }%
2643 \xintFor #1 in
2644   {XINTinFloatMaxof,XINTinFloatMinof,XINTinFloatSum,XINTinFloatPrd}\do
2645 {\toks0
2646   \expandafter{\the\toks0\expandafter\def\csname #1:csv\endcsname {\~#1:csv}}%
2647 }%

~xintListSel:f:csv must have space after it, the reason being in that \XINT_expr_until:_b in-
serts a : to signal Python slice type or argument hence this : would end up following immediately
~xintListSel:f:csv and scantokens will get confused after that. Since 1.2j there is initially
\xintListSel:x:csv.

2648 \toks0 \expandafter{\the\toks0
2649           \def\xintListSel:x:csv {\~xintListSel:f:csv }%
2650 }%
2651 \odef\XINT_expr_redefinmacros {\the\toks0}%
2652 \def\XINT_expr_redefineprints
2653 {%
2654   \def\XINT_flexpr_noopt
2655     {\expandafter\XINT_flexpr_withopt_b\expandafter-\romannumeral0\xintbarefloateval }%
2656   \def\XINT_flexpr_withopt_b ##1##2%
2657     {\expandafter\XINT_flexpr_wrap\csname .;##1.=\XINT_expr_unlock ##2\endcsname }%
2658   \def\XINT_expr_unlock_sp ##1.;##2##3.==##4!%
2659     {\if -##2\expandafter\xint_firstoftwo\else\expandafter\xint_secondoftwo\fi
2660      \XINTdigits{\##2##3}{\##4}}%
2661   \def\XINT_expr_print      ##1{\expandafter\xintSPRaw::csv\expandafter
2662     {\romannumeral`&&\XINT_expr_unlock ##1}}%
2663   \def\XINT_iexpr_print    ##1{\expandafter\xintCSV::csv\expandafter
2664     {\romannumeral`&&\XINT_expr_unlock ##1}}%
2665   \def\XINT_boolexpr_print ##1{\expandafter\xintIsTrue::csv\expandafter
2666     {\romannumeral`&&\XINT_expr_unlock ##1}}%

2667   \def\xintCSV::csv      {\~xintCSV::csv }%
2668   \def\xintSPRaw::csv    {\~xintSPRaw::csv }%
2669   \def\xintPFloat::csv   {\~xintPFloat::csv }%
2670   \def\xintIsTrue::csv   {\~xintIsTrue::csv }%
2671   \def\xintRound::csv    {\~xintRound::csv }%
2672 }%
2673 \toks0 {}%

```

### 10.53.5 \xintNewExpr, ..., at last.

1.2c modifications to accomodate \XINT\_expr\_deffunc\_newexpr etc..

1.2f adds token \XINT\_newexpr\_clean to be able to have a different \XINT\_newfunc\_clean

```

2674 \def\xintNewExpr      {\XINT_NewExpr{\XINT_expr_redefineprints\xint_firstofone
2675                                     \xinttheexpr\XINT_newexpr_clean}%
2676 \def\xintNewFloatExpr{\XINT_NewExpr{\XINT_expr_redefineprints\xint_firstofone
2677                                     \xintthefloatexpr\XINT_newexpr_clean}%
2678 \def\xintNewIExpr     {\XINT_NewExpr{\XINT_expr_redefineprints\xint_firstofone
2679                                     \xinttheiexpr\XINT_newexpr_clean}%

```

```

2680 \def\xintNewIIEExpr    {\XINT_NewExpr{\XINT_expr_redefineprints\xint_firstofone
2681                                \xinttheiexpr\XINT_newexpr_clean}%
2682 \def\xintNewBoolExpr {\XINT_NewExpr{\XINT_expr_redefineprints\xint_firstofone
2683                                \xinttheboolexpr\XINT_newexpr_clean}%
2684 \def\XINT_newexpr_clean #1>{\noexpand\romannumeral`&&@}%

```

1.2c for `\xintdeffunc`, `\xintdefiifunc`, `\xintdeffloatfunc`.

```

2685 \def\XINT_NewFunc
2686 {\XINT_NewExpr,{\xint_gobble_i\xintthebareeval    \XINT_newfunc_clean }%
2687 \def\XINT_NewFloatFunc
2688 {\XINT_NewExpr,{\xint_gobble_i\xintthebarefloateval\XINT_newfunc_clean }%
2689 \def\XINT_NewIIFunc
2690 {\XINT_NewExpr,{\xint_gobble_i\xintthebareiieval    \XINT_newfunc_clean }%
2691 \def\XINT_newfunc_clean #1>{}}%

```

1.2c adds optional logging. For this needed to pass to `_NewExpr_a` the macro name as parameter. And `_NewExpr` itself receives two new parameters to treat both `\xintNewExpr` and `\xintdeffunc`.

Up to and including 1.2c the definition was global. Starting with 1.2d it is done locally.

```

2692 \def\XINT_NewExpr #1#2#3#4#5#6#7[#8]%
2693 {%
2694   \begingroup
2695     \ifcase #8\relax
2696       \toks0 {\endgroup\def#6}%
2697     \or \toks0 {\endgroup\def#6##1#1}%
2698     \or \toks0 {\endgroup\def#6##1#1##2#1}%
2699     \or \toks0 {\endgroup\def#6##1#1##2#1##3#1}%
2700     \or \toks0 {\endgroup\def#6##1#1##2#1##3#1##4#1}%
2701     \or \toks0 {\endgroup\def#6##1#1##2#1##3#1##4#1##5#1}%
2702     \or \toks0 {\endgroup\def#6##1#1##2#1##3#1##4#1##5#1##6#1}%
2703     \or \toks0 {\endgroup\def#6##1#1##2#1##3#1##4#1##5#1##6#1##7#1}%
2704     \or \toks0 {\endgroup\def#6##1#1##2#1##3#1##4#1##5#1##6#1##7#1##8#1}%
2705     \or \toks0 {\endgroup\def#6##1#1##2#1##3#1##4#1##5#1##6#1##7#1##8#1##9#1}%
2706     \fi
2707     \xintexprSafeCatcodes
2708     \XINT_expr_redefinmacros
2709     #2%
2710     \XINT_NewExpr_a #3#4#5#6%
2711   }%

```

For the 1.2a release I replaced all `\romannumeral-`0` by a fancier `\romannumeral`&&@` (with & of catcode 7). I got lucky here that it worked, despite @ being of catcode comment (anyhow `\input xintexpr.sty` would not have compiled if not, and I would have realized immediately). But to be honest I wouldn't have been 100% sure beforehand that &&@ worked also with @ comment character. I now know.

1.2d's `\xintNewExpr` makes a local definition. In earlier releases, the definition was global.

```

2712 \catcode`~ 13 \catcode`@ 14 \catcode`\% 6 \catcode`# 12 \catcode`$ 11 @ $
2713 \def\XINT_NewExpr_a %1%2%3%4%5@
2714 {@
2715   \def\XINT_tmpa %1%2%3%4%5%6%7%8%9{%5}@
2716   \def~{$\noexpand$}@
2717   \catcode`: 11 \catcode`_ 11

```

```

2718 \catcode`# 12 \catcode`~ 13 \escapechar 126
2719 \endlinechar -1 \everyeof {\noexpand }@
2720 \edef\XINT_tmpb
2721 {\scantokens\expandafter
2722 {\romannumeral`&&\expandafter%2\XINT_tmpa {#1}{#2}{#3}{#4}{#5}{#6}{#7}{#8}{#9}\relax}@
2723 }@
2724 \escapechar 92 \catcode`# 6 \catcode`$ 0 @ $
2725 \edef\XINT_tmpa %%1%%2%%3%%4%%5%%6%%7%%8%%9@
2726 {\scantokens\expandafter{\expandafter%3\meaning\XINT_tmpb}}@
2727 \the\toks0\expandafter{\XINT_tmpa{%%1}{%%2}{%%3}{%%4}{%%5}{%%6}{%%7}{%%8}{%%9}}@
2728 %1{\ifxintverbose
2729 \xintMessage{xintexpr}{Info}@
2730 {\string%4\space now with meaning \meaning%4}@
2731 \fi}@
2732 }@
2733 \catcode`% 14
2734 \let\xintexprRestoreCatcodes\empty
2735 \def\xintexprSafeCatcodes
2736 {%
2737 \edef\xintexprRestoreCatcodes {%
2738 \catcode59=\the\catcode59 % ;
2739 \catcode34=\the\catcode34 % "
2740 \catcode63=\the\catcode63 % ?
2741 \catcode124=\the\catcode124 % |
2742 \catcode38=\the\catcode38 % &
2743 \catcode33=\the\catcode33 % !
2744 \catcode93=\the\catcode93 % ]
2745 \catcode91=\the\catcode91 % [
2746 \catcode94=\the\catcode94 % ^
2747 \catcode95=\the\catcode95 % _
2748 \catcode47=\the\catcode47 % /
2749 \catcode41=\the\catcode41 % )
2750 \catcode40=\the\catcode40 % (
2751 \catcode42=\the\catcode42 % *
2752 \catcode43=\the\catcode43 % +
2753 \catcode62=\the\catcode62 % >
2754 \catcode60=\the\catcode60 % <
2755 \catcode58=\the\catcode58 % :
2756 \catcode46=\the\catcode46 % .
2757 \catcode45=\the\catcode45 % -
2758 \catcode44=\the\catcode44 % ,
2759 \catcode61=\the\catcode61 % =
2760 \catcode32=\the\catcode32\relax % space
2761 }%
2762 \catcode59=12 % ;
2763 \catcode34=12 % "
2764 \catcode63=12 % ?
2765 \catcode124=12 % |
2766 \catcode38=4 % &
2767 \catcode33=12 % !
2768 \catcode93=12 % ]
2769 \catcode91=12 % [

```

```

2770      \catcode94=7   % ^
2771      \catcode95=8   % _
2772      \catcode47=12  % /
2773      \catcode41=12  % )
2774      \catcode40=12  % (
2775      \catcode42=12  % *
2776      \catcode43=12  % +
2777      \catcode62=12  % >
2778      \catcode60=12  % <
2779      \catcode58=12  % :
2780      \catcode46=12  % .
2781      \catcode45=12  % -
2782      \catcode44=12  % ,
2783      \catcode61=12  % =
2784      \catcode32=10  % space
2785 }%
2786 \let\XINT_tmpa\relax \let\XINT_tmpb\relax \let\XINT_tmppc\relax
2787 \XINT_restorecatcodes_endinput%

xintkernel: 496. Total number of code lines: 13788. (but 3126 lines among them
xinttools:1423. start either with {% or with }%.)
xintcore:2210. Each package starts with circa 50 lines dealing with cat-
xint:1536. codes, package identification and reloading management,
xintbinhex: 495. also for Plain TEX. Version 1.2n of 2017/08/06.
xintgcd: 425.
xintfrac:3001.
xintseries: 386.
xintcfrc:1029.
xintexpr:2787.

```