The intcalc package

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Abstract

This package provides expandable arithmetic operations with integers.

Contents

1 Documentation

1.1 Introduction

Package intcalc defines arithmetic operations that deal with integers. Integers mean numbers in TeX. The same restrictions apply, the range is limited to [-2147483647, 2147483647].

The operations have the form of macros that take one or two integers as parameter and return the integer result. The macro name is a three letter operation name prefixed by the package name, e.g. `\intcalcAdd{10}{43}` returns 53.

The macros are fully expandable, exactly two expansion steps generate the result. Therefore the operations may be used nearly everywhere in TeX, even inside `\number`, `\csname`, file names, or other expandable contexts.

The package contains two implementations of the operations. If ε-TeX is detected then the macros are implemented using its features (`\numexpr`). Otherwise the slower implementation without ε-TeX's help is choosen.

1.2 Conditions

1.2.1 Preconditions

- Arguments can be anything that TeX interprets as "number". Examples: plain numbers, count or length register, macros that expands to a number.

- The arguments are limited to the range -2147483647 until 2147483647. These numbers belong to the range. Note that some operations have additionals restrictions to the range.

- The argument may be expressions that `\numexpr` understands if ε-TeX is available.

- The resulting number must fit in the allowed range.

1.2.2 Postconditions

Additional properties of the macros apart from calculating a correct result (of course ☺):

- The macros are fully expandable. Thus they can be used inside `\edef`, `\csname`, after `\number`, for example.

- Furthermore exactly two expansion steps calculate the result.

- The number consists of one optional minus sign and one to ten digits. The first digit is larger than zero for numbers that consists of more than one digit.

  In short, the number format is exactly the same as `\number` generates. And the tokens (minus sign, digits) have catcode 12 (other).

- Call by value is simulated. First the arguments are converted to numbers. Then these numbers are used in the calculations.

  Remember that arguments may contain expensive macros or ε-TeX expressions. This strategy avoids multiple evaluations of such arguments.

1.3 Error handling

There are two kinds of errors if a precondition is violated: Some errors are detected by the macros, example: division by zero. In this cases an undefined control sequence is called and causes a TeX error message, example: `\IntCalcError:DivisionByZero`. The name of the control sequence contains the reason for the error. The TeX error may be ignored. Then the operation returns zero as result. Because the macros are supposed to work in expandible contexts. An traditional error message, however, is not expandable and would break these contexts.

If a number exceeds the range of -2147483647 until 2147483647, then TeX throws an error "Number too big" and recovers by using biggest allowed value. Example for the negative number -3000000000 is replaced by -2147483647.

1.4 Operations

Some definition equations below use the function Int that converts a real number to an integer. The number is truncated that means rounding to zero:

$$\mathrm{Int}(x) := \begin{cases} \lfloor x \rfloor & \text{if } x \geq 0 \\ \lceil x \rceil & \text{otherwise} \end{cases}$$

1.4.1 Num

$\boxed{\texttt{\textbackslash intcalcNum}\ \{\langle x \rangle\}}$

Macro `\intcalcNum` converts its argument to a normalized integer number without unnecessary leading zeros or signs. The result matches the regular expression:

```
0|-?[1-9][0-9]*
```

1.4.2 Inv, Abs, Sgn

`\intcalcInv {⟨x⟩}`

Macro `\intcalcInv` switches the sign.

$$\mathrm{Inv}(x) := -x$$

`\intcalcAbs {⟨x⟩}`

Macro `\intcalcAbs` returns the absolute value of integer $⟨x⟩$.

$$\mathrm{Abs}(x) := |x|$$

`\intcalcSgn {⟨x⟩}`

Macro `\intcalcSgn` encodes the sign of $⟨x⟩$ as number.

$$\mathrm{Sgn}(x) := \begin{cases} -1 & \text{if } x < 0 \\ 0 & \text{if } x = 0 \\ 1 & \text{if } x > 0 \end{cases}$$

These return values can easily be distinguished by `\ifcase`:

```
\ifcase\intcalcSgn{<x>}
  $x=0$
\or
  $x>0$
\else
  $x<0$
\fi
```

1.4.3 Min, Max, Cmp

`\intcalcMin {⟨x⟩} {⟨y⟩}`

Macro `\intcalcMin` returns the smaller of the two integers.

$$\mathrm{Min}(x, y) := \begin{cases} x & \text{if } x < y \\ y & \text{otherwise} \end{cases}$$

`\intcalcMax {⟨x⟩} {⟨y⟩}`

Macro `\intcalcMax` returns the larger of the two integers.

$$\mathrm{Max}(x, y) := \begin{cases} x & \text{if } x > y \\ y & \text{otherwise} \end{cases}$$

`\intcalcCmp {⟨x⟩} {⟨y⟩}`

Macro `\intcalcCmp` encodes the comparison result as number:

$$\mathrm{Cmp}(x, y) := \begin{cases} -1 & \text{if } x < y \\ 0 & \text{if } x = y \\ 1 & \text{if } x > y \end{cases}$$

These values can be distinguished by `\ifcase`:

```
\ifcase\intcalcCmp{<x>}{<y>}
  $x=y$
\or
  $x>y$
\else
  $x<y$
\fi
```

1.4.4   Inc, Dec, Add, Sub

`\intcalcInc {⟨x⟩}`

Macro `\intcalcInc` increments ⟨x⟩ by one.

$$\mathrm{Inc}(x) := x + 1$$

`\intcalcDec {⟨x⟩}`

Macro `\intcalcDec` decrements ⟨x⟩ by one.

$$\mathrm{Dec}(x) := x - 1$$

`\intcalcAdd {⟨x⟩} {⟨y⟩}`

Macro `\intcalcAdd` adds the two numbers.

$$\mathrm{Add}(x, y) := x + y$$

`\intcalcSub {⟨x⟩} {⟨y⟩}`

Macro `\intcalcSub` calculates the difference.

$$\mathrm{Sub}(x, y) := x - y$$

1.4.5   Shl, Shr

`\intcalcShl {⟨x⟩}`

Macro `\intcalcShl` implements shifting to the left that means the number is multiplied by two. Overflow is possible. The sign is preserved.

$$\mathrm{Shl}(x) := x * 2$$

`\intcalcShr {⟨x⟩}`

Macro `\intcalcShr` implements shifting to the right. That is equivalent to an integer division by two. The sign is preserved.

$$\mathrm{Shr}(x) := \mathrm{Int}(x/2)$$

1.4.6   Mul, Sqr, Fac, Pow

`\intcalcMul {⟨x⟩} {⟨y⟩}`

Macro `\intcalcMul` calculates the product of ⟨x⟩ and ⟨y⟩.

$$\mathrm{Mul}(x, y) := x * y$$

> `\intcalcSqr {⟨x⟩}`

Macro `\intcalcSqr` returns the square product.

$$\text{Sqr}(x) := x^2$$

> `\intcalcFac {⟨x⟩}`

Macro `\intcalcFac` returns the factorial of $⟨x⟩$. Negative numbers are not permitted.

$$\text{Fac}(x) := x! \qquad \text{for } x \geq 0$$

$(0! = 1)$

> `\intcalcPow Mx My`

Macro `\intcalcPow` calculates the value of $⟨x⟩$ to the power of $⟨y⟩$. The error "division by zero" is thrown if $⟨x⟩$ is zero and $⟨y⟩$ is negative. permitted:

$$\text{Pow}(x, y) := \text{Int}(x^y) \qquad \text{for } x \neq 0 \text{ or } y \geq 0$$

$(0^0 = 1)$

1.4.7 Div, Mul

> `\intcalcDiv {⟨x⟩} {⟨y⟩}`

Macro `\intcalcDiv` performs an integer division. Argument $⟨y⟩$ must not be zero.

$$\text{Div}(x, y) := \text{Int}(x/y) \qquad \text{for } y \neq 0$$

> `\intcalcMod {⟨x⟩} {⟨y⟩}`

Macro `\intcalcMod` gets the remainder of the integer division. The sign follows the divisor $⟨y⟩$. Argument $⟨y⟩$ must not be zero.

$$\text{Mod}(x, y) := x \mathbin{\%} y \qquad \text{for } y \neq 0$$

The result ranges:

$$-|y| < \text{Mod}(x, y) \leq 0 \qquad \text{for } y < 0$$
$$0 \leq \text{Mod}(x, y) < y \qquad \text{for } y \geq 0$$

1.5 Interface for programmer

If the programmer can ensure some more properties about the arguments of the operations, then the following macros are a little more efficient.

In general numbers must obey the following constraints:

- Plain number: digit tokens only, no command tokens.

- Non-negative. Signs are forbidden.

- Arguments and the result must fit in range `0..2147483647`.

- Delimited by exclamation mark. Curly braces around the number are not allowed and will break the code.

> `\IntCalcInc` ⟨*number*⟩ `!`

Incrementation, range: `0..2147483646`.

> `\IntCalcDec` ⟨*number*⟩ `!`

Decrementation, range: `1..2147483647`.

> `\IntCalcAdd` ⟨*number A*⟩ `!` ⟨*number B*⟩ `!`

Addition, $A \geq B$.

> `\IntCalcSub` ⟨*number A*⟩ `!` ⟨*number B*⟩ `!`

Subtraction, $A \geq B$.

> `\IntCalcShl` ⟨*number*⟩ `!`

Left shift (multiplication with two), range: `0..1073741823`.

> `\IntCalcShr` ⟨*number*⟩ `!`

Right shift (integer division by two).

> `\IntCalcMul` ⟨*number A*⟩ `!` ⟨*number B*⟩ `!`

Multiplication, $A \geq B$.

> `\IntCalcDiv` ⟨*number A*⟩ `!` ⟨*number B*⟩ `!`

Division operation.

> `\IntCalcMod` ⟨*number A*⟩ `!` ⟨*number B*⟩ `!`

Modulo operation.

2 Implementation

1 ⟨∗package⟩

2.1 Reload check and package identification

Reload check, especially if the package is not used with LaTeX.

```
 2 \begingroup
 3   \catcode44 12 % ,
 4   \catcode45 12 % -
 5   \catcode46 12 % .
 6   \catcode58 12 % :
 7   \catcode64 11 % @
 8   \expandafter\let\expandafter\x\csname ver@intcalc.sty\endcsname
 9   \ifcase 0%
10     \ifx\x\relax % plain
11     \else
12       \ifx\x\empty % LaTeX
13       \else
```

```
14        1%
15      \fi
16    \fi
17  \else
18    \catcode35 6 % #
19    \catcode123 1 % {
20    \catcode125 2 % }
21    \expandafter\ifx\csname PackageInfo\endcsname\relax
22      \def\x#1#2{%
23        \immediate\write-1{Package #1 Info: #2.}%
24      }%
25    \else
26      \def\x#1#2{\PackageInfo{#1}{#2, stopped}}%
27    \fi
28    \x{intcalc}{The package is already loaded}%
29    \endgroup
30    \expandafter\endinput
31  \fi
32 \endgroup
```

Package identification:

```
33 \begingroup
34  \catcode35 6 % #
35  \catcode40 12 % (
36  \catcode41 12 % )
37  \catcode44 12 % ,
38  \catcode45 12 % -
39  \catcode46 12 % .
40  \catcode47 12 % /
41  \catcode58 12 % :
42  \catcode64 11 % @
43  \catcode123 1 % {
44  \catcode125 2 % }
45  \expandafter\ifx\csname ProvidesPackage\endcsname\relax
46    \def\x#1#2#3[#4]{\endgroup
47      \immediate\write-1{Package: #3 #4}%
48      \xdef#1{#4}%
49    }%
50  \else
51    \def\x#1#2[#3]{\endgroup
52      #2[{#3}]%
53      \ifx#1\relax
54        \xdef#1{#3}%
55      \fi
56    }%
57  \fi
58 \expandafter\x\csname ver@intcalc.sty\endcsname
59 \ProvidesPackage{intcalc}%
60   [2007/09/27 v1.1 Expandable integer calculations (HO)]
```

2.2 Catcodes

```
61 \begingroup
62  \catcode123 1 % {
63  \catcode125 2 % }
64  \def\x{\endgroup
65    \expandafter\edef\csname InCa@AtEnd\endcsname{%
66      \catcode35 \the\catcode35\relax
67      \catcode64 \the\catcode64\relax
68      \catcode123 \the\catcode123\relax
69      \catcode125 \the\catcode125\relax
70    }%
71  }%
```

```
72 \x
73 \catcode35 6 % #
74 \catcode64 11 % @
75 \catcode123 1 % {
76 \catcode125 2 % }
77 \def\TMP@EnsureCode#1#2{%
78   \edef\InCa@AtEnd{%
79     \InCa@AtEnd
80     \catcode#1 \the\catcode#1\relax
81   }%
82   \catcode#1 #2\relax
83 }
84 \TMP@EnsureCode{33}{12}% !
85 \TMP@EnsureCode{40}{12}% (
86 \TMP@EnsureCode{41}{12}% )
87 \TMP@EnsureCode{42}{12}% *
88 \TMP@EnsureCode{43}{12}% +
89 \TMP@EnsureCode{45}{12}% -
90 \TMP@EnsureCode{47}{12}% /
91 \TMP@EnsureCode{58}{11}% : (letter!)
92 \TMP@EnsureCode{60}{12}% <
93 \TMP@EnsureCode{61}{12}% =
94 \TMP@EnsureCode{62}{12}% >
95 \TMP@EnsureCode{63}{14}% ? (comment!)
96 \begingroup\expandafter\expandafter\expandafter\endgroup
97 \expandafter\ifx\csname InCa@TestMode\endcsname\relax
98 \else
99   \catcode63=9 % ? (ignore)
100 \fi
101 ? \let\InCa@@TestMode\InCa@TestMode
```

2.3 Macros independent of ε-TeX

2.3.1 Abs, Sgn

\InCa@Abs

```
102 \def\InCa@Abs#1#2!{%
103   \ifx#1-%
104     #2%
105   \else
106     #1#2%
107   \fi
108 }
```

\InCa@Sgn

```
109 \def\InCa@Sgn#1#2!{%
110   \ifx#1-%
111     -1%
112   \else
113     \ifx#10%
114       0%
115     \else
116       1%
117     \fi
118   \fi
119 }
```

2.3.2 Min, Max, Cmp

\InCa@Min

```
120 \def\InCa@Min#1!#2!{%
121   \ifnum#1<#2 %
122     #1%
```

```
123    \else
124      #2%
125    \fi
126 }
```

\InCa@Max

```
127 \def\InCa@Max#1!#2!{%
128    \ifnum#1>#2 %
129      #1%
130    \else
131      #2%
132    \fi
133 }
```

\InCa@Cmp

```
134 \def\InCa@Cmp#1!#2!{%
135    \ifnum#1=#2 %
136      0%
137    \else
138      \ifnum#1<#2 %
139        -%
140      \fi
141      1%
142    \fi
143 }
```

2.3.3   Fac

\InCa@Fac   It does not make much sense to calculate the faculty by an general algorithm. The allowed range of arguments is too low because of the limited integer domain.

```
144 \def\InCa@Fac#1!{%
145    \ifcase#1 1% 0!
146    \or 1% 1!
147    \or 2% 2!
148    \or 6% 3!
149    \or 24% 4!
150    \or 120% 5!
151    \or 720% 6!
152    \or 5040% 7!
153    \or 40320% 8!
154    \or 362880% 9!
155    \or 3628800% 10!
156    \or 39916800% 11!
157    \or 479001600% 12!
158    \else
159      \ifnum#1<\z@
160        0\IntCalcError:FacNegative%
161      \else
162        0\IntCalcError:FacOverflow%
163      \fi
164    \fi
165 }
```

2.4   Implementation based on ε-TeX

Only \numexpr is used from ε-TeX.

```
166 \begingroup\expandafter\expandafter\expandafter\endgroup
167 \expandafter\ifx\csname numexpr\endcsname\relax
168 \else
```

2.4.1 Num

\intcalcNum

```
169  \def\intcalcNum#1{%
170    \the\numexpr#1\relax
171  }%
```

2.4.2 Inv, Abs, Sgn

\intcalcInv

```
172  \def\intcalcInv#1{%
173    \number-\intcalcNum{#1} %
174  }%
```

\intcalcAbs

```
175  \def\intcalcAbs#1{%
176    \number\expandafter\InCa@Abs\the\numexpr#1! %
177  }%
```

\intcalcSgn

```
178  \def\intcalcSgn#1{%
179    \number\expandafter\InCa@Sgn\the\numexpr#1! %
180  }%
```

2.4.3 Min, Max, Cmp

\intcalcMin

```
181  \def\intcalcMin#1#2{%
182    \number\expandafter\InCa@Min
183    \the\numexpr#1\expandafter!%
184    \the\numexpr#2! %
185  }%
```

\intcalcMax

```
186  \def\intcalcMax#1#2{%
187    \number\expandafter\InCa@Max
188    \the\numexpr#1\expandafter!%
189    \the\numexpr#2! %
190  }%
```

\intcalcCmp

```
191  \def\intcalcCmp#1#2{%
192    \number\expandafter\InCa@Cmp
193    \the\numexpr#1\expandafter!\the\numexpr#2! %
194  }%
```

2.4.4 Inc, Dec

\intcalcInc

```
195  \def\intcalcInc#1{%
196    \the\numexpr#1+1\relax
197  }%
```

\intcalcDec

```
198  \def\intcalcDec#1{%
199    \the\numexpr#1-1\relax
200  }%
```

11

\IntCalcInc

```
201  \def\IntCalcInc#1!{%
202    \the\numexpr#1+1\relax
203  }%
```

\IntCalcDec

```
204  \def\IntCalcDec#1!{%
205    \the\numexpr#1-1\relax
206  }%
```

2.4.5 Add, Sub

\intcalcAdd

```
207  \def\intcalcAdd#1#2{%
208    \the\numexpr#1+(#2)\relax
209  }%
```

\intcalcSub

```
210  \def\intcalcSub#1#2{%
211    \the\numexpr#1-(#2)\relax
212  }%
```

\IntCalcAdd

```
213  \def\IntCalcAdd#1!#2!{%
214    \the\numexpr#1+#2\relax
215  }%
```

\IntCalcSub

```
216  \def\IntCalcSub#1!#2!{%
217    \the\numexpr#1-#2\relax
218  }%
```

2.4.6 Shl, Shr

\intcalcShl

```
219  \def\intcalcShl#1{%
220    \the\numexpr(#1)*2\relax
221  }%
```

\intcalcShr

```
222  \def\intcalcShr#1{%
223    \number\expandafter\InCa@Shr\the\numexpr#1! %
224  }%
```

\IntCalcShl

```
225  \def\IntCalcShl#1!{%
226    \the\numexpr#1*2\relax
227  }%
```

\IntCalcShr

```
228  \def\IntCalcShr#1!{%
229    \the\numexpr\ifodd#1 (#1-1)\else#1\fi/2\relax
230  }%
```

\InCa@Shr

```
231  \def\InCa@Shr#1#2!{%
232    \ifx#1-%
233      -\InCa@Shr#2!%
234    \else
```

```
235     \ifodd#1#2 %
236       \the\numexpr(#1#2-1)/2\relax
237     \else
238       \the\numexpr#1#2/2\relax
239     \fi
240   \fi
241 }%
```

2.4.7 Mul, Sqr, Fac

\intcalcMul

```
242 \def\intcalcMul#1#2{%
243   \the\numexpr(#1)*(#2)\relax
244 }%
```

\IntCalcMul

```
245 \def\IntCalcMul#1!#2!{%
246   \the\numexpr#1*#2\relax
247 }%
```

\intcalcSqr

```
248 \def\intcalcSqr#1{%
249   \number\expandafter\InCa@Sqr\the\numexpr#1! %
250 }%
```

\InCa@Sqr

```
251 \def\InCa@Sqr#1!{%
252   \the\numexpr#1*#1\relax
253 }%
```

\intcalcFac

```
254 \def\intcalcFac#1{%
255   \number\expandafter\InCa@Fac\the\numexpr#1! %
256 }%
```

2.4.8 Pow

\intcalcPow

```
257 \def\intcalcPow#1#2{%
258   \number\expandafter\InCa@Pow
259   \the\numexpr#1\expandafter!%
260   \the\numexpr#2! %
261 }%
```

\InCa@Pow

```
262 \def\InCa@Pow#1#2!#3#4!{%
263   \ifcase#3#4 % power = 0
264     1%
265   \or % power = 1
266     #1#2%
267   \or % power = 2
268     \the\numexpr#1#2*#1#2\relax
269   \else
270     \ifcase#1#2 % basis = 0, power <> 0
271       0%
272       \ifx#3-% power < 0
273         0\IntCalcError:DivisionByZero%
274       \fi
275     \or
276       1% basis = 1
```

13

```
277        \else
278          \ifnum#1#2=\m@ne % basis = -1
279            \ifodd#3#4 %
280              -%
281            \fi
282            1%
283          \else % |basis| > 1
284            \ifx#3-% power < 0
285              0%
286            \else % power > 2
287              \InCa@PowRec#1#2!#3#4!1!%
288            \fi
289          \fi
290        \fi
291      \fi
292    }%
```

\InCa@PowRec
```
              Pow(b, p) {
                PowRec(b, p, 1)
              }
              PowRec(b, p, r) {
                if p == 1 then
                  return r*b
                else
                  ifodd p then
                    return PowRec(b*b, (p-1)/2, r*b) % p div 2 = (p-1)/2
                  else
                    return PowRec(b*b, (p-1)/2, r)
                  fi
                fi
              }
```
```
293    \def\InCa@PowRec#1!#2!#3!{%
294      \ifnum#2=\@ne
295        \the\numexpr#1*#3\relax
296      \else
297        \ifodd#2 %
298          \expandafter\InCa@PowRec
299          \the\numexpr#1*#1\expandafter!%
300          \the\numexpr(#2-1)/2\expandafter!%
301          \the\numexpr#1*#3\expandafter\expandafter\expandafter!%
302        \else
303          \expandafter\InCa@PowRec
304          \the\numexpr#1*#1\expandafter!%
305          \the\numexpr(#2-1)/2\expandafter!%
306          \number#3\expandafter\expandafter\expandafter!%
307        \fi
308      \fi
309    }%
```

2.4.9 Div, Mod

TeX's \divide truncates, ε-TeX's \numexpr rounds the result of a division. The
rounding method is called "Symmetric Arithmetic Rounding" or "Round-Half-Up"
("Kaufmännisches Runden" in German):

```
  1 =  3 divide 2 =  1.5 = numexpr  3/2 =  2
 -1 = -3 divide 2 = -1.5 = numexpr -3/2 = -2
```

Macro \intcalcDiv follows TeX and truncates. The calculation is done by the
following formula:

$$\mathrm{Div}(X, Y) = (X - (Y - 1)/2)/Y \qquad \text{for } X, Y > 0 \tag{1}$$

The operator '/' is \numexpr's division.

```
310  \def\intcalcDiv#1#2{%
311    \number\expandafter\InCa@Div
312    \the\numexpr#1\expandafter!%
313    \the\numexpr#2! %
314  }%
```

```
315  \def\InCa@Div#1!#2!{%
316    \ifcase#2 %
317      0\IntCalcError:DivisionByZero%
318    \else
319      \ifcase#1 %
320        0%
321      \else
322        \expandafter\InCa@@Div
323        \romannumeral 0%
324        \ifnum#1<\z@
325          \expandafter-\number-#1%
326        \else
327          \expandafter+\number#1%
328        \fi
329        \expandafter!%
330        \romannumeral 0%
331        \ifnum#2<\z@
332          \expandafter-\number-#2%
333        \else
334          \expandafter+\number#2%
335        \fi
336        !%
337      \fi
338    \fi
339  }%
```

```
340  \def\InCa@Temp#1{%
341    \def\IntCalcDiv##1!##2!{%
342      \number
343      \ifcase##2 %
344        0\IntCalcError:DivisionByZero%
345      \else
346        \ifcase##1 %
347          0%
348        \else
349          \the\numexpr(##1-(##2-1)/2)/##2\relax
350        \fi
351      \fi
352      #1%
353    }%
354  }%
355  \InCa@Temp{ }%
```

```
356  \def\InCa@@Div#1#2!#3#4!{%
357    #1#3%
358    \the\numexpr(#2-(#4-1)/2)/#4\relax
359  }%
```

```
360  \def\intcalcMod#1#2{%
361    \number\expandafter\InCa@Mod
```

```
362     \the\numexpr#1\expandafter!%
363     \the\numexpr#2! %
364   }%
```

```
365   \def\InCa@Mod#1!#2!{%
366     \ifcase#2 %
367       0\IntCalcError:DivisionByZero%
368     \else
369       \ifcase#1 %
370         0%
371       \else
372         \expandafter\InCa@@Mod
373         \romannumeral 0%
374         \ifnum#1<\z@
375           \expandafter-\number-#1%
376         \else
377           \expandafter+\number#1%
378         \fi
379         \expandafter!%
380         \romannumeral 0%
381         \ifnum#2<\z@
382           \expandafter-\number-#2%
383         \else
384           \expandafter+\number#2%
385         \fi
386         !%
387       \fi
388     \fi
389   }%
```

```
390   \def\InCa@Temp#1{%
391     \def\IntCalcMod##1!##2!{%
392       \number
393       \ifcase##2 %
394         0\IntCalcError:DivisionByZero%
395       \else
396         \ifcase##1 %
397           0%
398         \else
399           \the\numexpr##1-(##1-(##2-1)/2)/##2*##2\relax
400         \fi
401       \fi
402       #1%
403     }%
404   }%
405   \InCa@Temp{ }%
```

```
406   \def\InCa@@Mod#1#2!#3#4!{%
407     \if#3+%
408       \if#1+%
409         \the\numexpr#2-\InCa@@Div+#2!+#4!*#4\relax
410       \else
411         \expandafter\InCa@ModX
412         \the\numexpr-#2+\InCa@@Div+#2!+#4!*#4!#4!%
413       \fi
414     \else
415       -%
416       \if#1+%
417         \expandafter\InCa@ModX
```

16

```
418        \the\numexpr-#2+\InCa@@Div+#2!+#4!*#4!#4!%
419      \else
420        \the\numexpr#2-\InCa@@Div+#2!+#4!*#4\relax
421      \fi
422    \fi
423  }%
```

\InCa@ModX

```
424  \def\InCa@ModX#1!#2!{%
425    \ifcase#1 %
426      0%
427    \else
428      \the\numexpr#1+#2\relax
429    \fi
430  }%

431  \InCa@AtEnd
432  \expandafter\endinput
433 \fi
```

2.5 Implementation without ε-TeX

2.5.1 Num

\intcalcNum

```
434 \def\intcalcNum#1{%
435   \number\expandafter\InCa@FirstOfOne\number#1! %
436 }
```

2.5.2 Inv, Abs, Sgn

\intcalcInv

```
437 \def\intcalcInv#1{%
438   \number\expandafter\InCa@FirstOfOne\number-#1! %
439 }
```

\InCa@FirstOfOne

```
440 \def\InCa@FirstOfOne#1!{#1}
```

\intcalcAbs

```
441 \def\intcalcAbs#1{%
442   \number\expandafter\InCa@Abs\number#1! %
443 }
```

\intcalcSgn

```
444 \def\intcalcSgn#1{%
445   \number\expandafter\InCa@Sgn\number#1! %
446 }
```

2.5.3 Min, Max, Cmp

\intcalcMin

```
447 \def\intcalcMin#1#2{%
448   \number\expandafter\InCa@Min
449   \number\number#1\expandafter!\number#2! %
450 }
```

\intcalcMax

```
451 \def\intcalcMax#1#2{%
452   \number\expandafter\InCa@Max
453   \number\number#1\expandafter!\number#2! %
454 }
```

\intcalcCmp

```
455 \def\intcalcCmp#1#2{%
456   \number\expandafter\InCa@Cmp
457   \number\number#1\expandafter!\number#2! %
458 }%
```

2.5.4 Inc, Dec

\intcalcInc

```
459 \def\intcalcInc#1{%
460   \number\expandafter\InCa@IncSwitch\number#1! %
461 }
```

\InCa@IncSwitch

```
462 \def\InCa@IncSwitch#1#2!{%
463   \ifx#1-%
464     -%
465     \csname InCa@Empty%
466     \InCa@Dec#2!%
467   \else
468     \csname InCa@Empty%
469     \InCa@Inc#1#2!%
470   \fi
471 }
```

\intcalcDec

```
472 \def\intcalcDec#1{%
473   \number\expandafter\InCa@DecSwitch\number#1! %
474 }
```

\InCa@DecSwitch

```
475 \def\InCa@DecSwitch#1#2!{%
476   \ifx#1-%
477     -%
478     \csname InCa@Empty%
479     \expandafter\InCa@Inc#2!%
480   \else
481     \ifx#10%
482       -1%
483     \else
484       \csname InCa@Empty%
485       \InCa@Dec#1#2!%
486     \fi
487   \fi
488 }
```

\IntCalcInc

```
489 \def\IntCalcInc#1!{%
490   \number\csname InCa@Empty\InCa@Inc#1! %
491 }
```

\IntCalcDec

```
492 \def\IntCalcDec#1!{%
493   \number\csname InCa@Empty\InCa@Dec#1! %
494 }
```

\InCa@Inc

```
495 \def\InCa@Inc#1#2{%
496   \ifx#2!%
497     \csname InCa@IncDigit#1\endcsname1%
```

```
498     \else
499       \csname InCa@IncDigit#1%
500       \expandafter\InCa@Inc\expandafter#2%
501     \fi
502 }
```

`\InCa@IncDigit[0-8]`

```
503 \def\InCa@Temp#1#2{%
504   \expandafter\def\csname InCa@IncDigit#1\endcsname##1{%
505     \endcsname
506     0%
507     \ifcase##1 %
508       #1%
509     \else
510       #2%
511     \fi
512   }%
513 }
514 \InCa@Temp 01
515 \InCa@Temp 12
516 \InCa@Temp 23
517 \InCa@Temp 34
518 \InCa@Temp 45
519 \InCa@Temp 56
520 \InCa@Temp 67
521 \InCa@Temp 78
522 \InCa@Temp 89
```

`\InCa@IncDigit9`

```
523 \expandafter\def\csname InCa@IncDigit9\endcsname#1{%
524   \expandafter\endcsname
525   \ifcase#1 %
526     09%
527   \else
528     10%
529   \fi
530 }
```

`\InCa@Dec`

```
531 \def\InCa@Dec#1#2{%
532   \ifx#2!%
533     \csname InCa@DecDigit#1\endcsname1%
534   \else
535     \csname InCa@DecDigit#1%
536     \expandafter\InCa@Dec\expandafter#2%
537   \fi
538 }
```

`\InCa@DecDigit[1-9]`

```
539 \def\InCa@Temp#1#2{%
540   \expandafter\def\csname InCa@DecDigit#1\endcsname##1{%
541     \endcsname
542     0%
543     \ifcase##1 %
544       #1%
545     \else
546       #2%
547     \fi
548   }%
549 }
550 \InCa@Temp 98
551 \InCa@Temp 87
```

```
552 \InCa@Temp 76
553 \InCa@Temp 65
554 \InCa@Temp 54
555 \InCa@Temp 43
556 \InCa@Temp 32
557 \InCa@Temp 21
558 \InCa@Temp 10
```

\InCa@DecDigit0

```
559 \expandafter\def\csname InCa@DecDigit0\endcsname#1{%
560   \expandafter\endcsname
561   \ifcase#1 %
562     00%
563   \else
564     19%
565   \fi
566 }
```

2.5.5 Add, Sub

\intcalcAdd

```
567 \def\intcalcAdd#1#2{%
568   \number
569     \expandafter\InCa@AddSwitch
570     \number\number#1\expandafter!%
571     \number#2! %
572 }
```

\intcalcSub

```
573 \def\intcalcSub#1#2{%
574   \number
575     \expandafter\InCa@AddSwitch
576     \number\number#1\expandafter!%
577     \number-\number#2! %
578 }
```

\InCa@AddSwitch Decision table for \InCa@AddSwitch. The sign of negative numbers can be removed by a simple \@gobble instead of the more expensive \number-.

$x < 0$	$y < 0$	$x < y$	$-$	Add$(-x, -y)$
		else		Add$(-y, -x)$
	else	$-x > y$	$-$	Sub$(-x, y)$
		else	$+$	Sub$(y, -x)$
else	$y < 0$	$x > -y$	$+$	Sub$(x, -y)$
		else	$-$	Sub$(-y, x)$
	else	$x > y$	$+$	Add(x, y)
		else		Add(y, x)

```
579 \def\InCa@AddSwitch#1!#2!{%
580   \ifnum#1<\z@
581     \ifnum#2<\z@
582       -%
583       \ifnum#1<#2 %
584         \expandafter\InCa@Add\number-#1\expandafter!%
585         \@gobble#2!%
586       \else
587         \expandafter\InCa@Add\number-#2\expandafter!%
588         \@gobble#1!%
589       \fi
590     \else
591       \ifnum-#1>#2 %
```

```
592        -%
593        \expandafter\InCa@Sub\@gobble#1!#2!%
594      \else
595        \expandafter\InCa@Sub\number#2\expandafter!%
596        \@gobble#1!%
597      \fi
598    \fi
599  \else
600    \ifnum#2<\z@
601      \ifnum#1>-#2 %
602        \expandafter\InCa@Sub\number#1\expandafter!%
603        \@gobble#2!%
604      \else
605        -%
606        \expandafter\InCa@Sub\@gobble#2!#1!%
607      \fi
608    \else
609      \ifnum#1>#2 %
610        \InCa@Add#1!#2!%
611      \else
612        \InCa@Add#2!#1!%
613      \fi
614    \fi
615  \fi
616 }
```

\IntCalcAdd

```
617 \def\IntCalcAdd#1!#2!{%
618   \number\InCa@Add#1!#2! %
619 }
```

\IntCalcSub

```
620 \def\IntCalcSub#1!#2!{%
621   \number\InCa@Sub#1!#2! %
622 }
```

\InCa@Space

```
623 \begingroup
624   \def\x#1{\endgroup
625     \let\InCa@Space= #1%
626   }%
627 \x{ }
```

\InCa@Add

```
628 \def\InCa@Add#1!#2!{%
629   \ifcase#2 %
630     #1%
631   \else
632     \InCa@@Add#1!#2!000000000\InCa@Space
633   \fi
634 }
```

\InCa@Sub

```
635 \def\InCa@Sub#1!#2!{%
636   \ifnum#1=#2 %
637     0%
638   \else
639     \InCa@@Sub#1!#2!000000000\InCa@Space
640   \fi
641 }
```

21

\InCa@@Add

```
642 \def\InCa@@Add#1!#2#3!{%
643   \ifx\InCa@Empty#3\InCa@Empty
644     \@ReturnAfterElseFi{%
645       \InCa@@@Add!!#1!#2%
646     }%
647   \else
648     \@ReturnAfterFi{%
649       \InCa@@Add#1!#3!#2%
650     }%
651   \fi
652 }
```

\InCa@@Sub

```
653 \def\InCa@@Sub#1!#2#3!{%
654   \ifx\InCa@Empty#3\InCa@Empty
655     \@ReturnAfterElseFi{%
656       \InCa@@@Sub!!#1!#2%
657     }%
658   \else
659     \@ReturnAfterFi{%
660       \InCa@@Sub#1!#3!#2%
661     }%
662   \fi
663 }
```

\InCa@@@Add

```
664 \def\InCa@@@Add#1!#2!#3#4!#5{%
665   \ifx\InCa@Empty#4\InCa@Empty
666     \csname InCa@Empty%
667     \@ReturnAfterElseFi{%
668       \InCa@ProcessAdd#1#3!#5#2%
669     }%
670   \else
671     \@ReturnAfterFi{%
672       \InCa@@@Add#1#3!#5#2!#4!%
673     }%
674   \fi
675 }
```

\InCa@@@Sub

```
676 \def\InCa@@@Sub#1!#2!#3#4!#5{%
677   \ifx\InCa@Empty#4\InCa@Empty
678     \csname @gobble%
679     \@ReturnAfterElseFi{%
680       \InCa@ProcessSub#1#3!#5#2%
681     }%
682   \else
683     \@ReturnAfterFi{%
684       \InCa@@@Sub#1#3!#5#2!#4!%
685     }%
686   \fi
687 }
```

\InCa@ProcessAdd

```
688 \def\InCa@ProcessAdd#1#2!#3#4{%
689   \ifx\InCa@Empty#2\InCa@Empty
690     \csname InCa@AddDigit#1\endcsname#3%
691     \romannumeral0#4%
692   \else
693     \csname InCa@AddDigit#1\csname InCa@DigitCarry#3%
```

```
694    \@ReturnAfterFi{%
695      \InCa@ProcessAdd#2!#4%
696    }%
697   \fi
698 }
```

\InCa@ProcessSub

```
699 \def\InCa@ProcessSub#1#2!#3#4{%
700   \ifx\InCa@Empty#2\InCa@Empty
701     \csname InCa@SubDigit#1\endcsname#3%
702     \romannumeral0#4%
703   \else
704     \csname InCa@SubDigit#1\csname InCa@DigitCarry#3%
705     \@ReturnAfterFi{%
706       \InCa@ProcessSub#2!#4%
707     }%
708   \fi
709 }
```

\InCa@DigitCarry[0-9]

```
710 \def\InCa@Temp#1#2{%
711   \expandafter\def\csname InCa@DigitCarry#1\endcsname##1{%
712     \ifcase##1 %
713       \endcsname#1%
714     \else
715       \endcsname#2%
716     \fi
717   }%
718 }
719 \InCa@Temp 01
720 \InCa@Temp 12
721 \InCa@Temp 23
722 \InCa@Temp 34
723 \InCa@Temp 45
724 \InCa@Temp 56
725 \InCa@Temp 67
726 \InCa@Temp 78
727 \InCa@Temp 89
728 \InCa@Temp 9{{10}}
```

\InCa@AddDigit0

```
729 \expandafter\def\csname InCa@AddDigit0\endcsname#1{%
730   \ifnum#1>9 %
731     \endcsname10%
732   \else
733     \endcsname0#1%
734   \fi
735 }
```

\InCa@AddDigit[1-9]

```
736 \def\InCa@Temp#1#2#3{%
737   \expandafter\def\csname InCa@AddDigit#1\endcsname##1{%
738     \ifnum##1>#2 %
739       \endcsname 1%
740     \else
741       \endcsname 0%
742     \fi
743     \ifcase##1 #1% 0
744     #3%
745     \else #1% 10
746     \fi
747   }%
```

```
748 }
749 \InCa@Temp 18{%
750     \or 2% 1
751     \or 3% 2
752     \or 4% 3
753     \or 5% 4
754     \or 6% 5
755     \or 7% 6
756     \or 8% 7
757     \or 9% 8
758     \or 0% 9
759 }%
760 \InCa@Temp 27{%
761     \or 3% 1
762     \or 4% 2
763     \or 5% 3
764     \or 6% 4
765     \or 7% 5
766     \or 8% 6
767     \or 9% 7
768     \or 0% 8
769     \or 1% 9
770 }%
771 \InCa@Temp 36{%
772     \or 4% 1
773     \or 5% 2
774     \or 6% 3
775     \or 7% 4
776     \or 8% 5
777     \or 9% 6
778     \or 0% 7
779     \or 1% 8
780     \or 2% 9
781 }%
782 \InCa@Temp 45{%
783     \or 5% 1
784     \or 6% 2
785     \or 7% 3
786     \or 8% 4
787     \or 9% 5
788     \or 0% 6
789     \or 1% 7
790     \or 2% 8
791     \or 3% 9
792 }%
793 \InCa@Temp 54{%
794     \or 6% 1
795     \or 7% 2
796     \or 8% 3
797     \or 9% 4
798     \or 0% 5
799     \or 1% 6
800     \or 2% 7
801     \or 3% 8
802     \or 4% 9
803 }%
804 \InCa@Temp 63{%
805     \or 7% 1
806     \or 8% 2
807     \or 9% 3
808     \or 0% 4
809     \or 1% 5
```

```
810    \or 2% 6
811    \or 3% 7
812    \or 4% 8
813    \or 5% 9
814 }%
815 \InCa@Temp 72{%
816    \or 8% 1
817    \or 9% 2
818    \or 0% 3
819    \or 1% 4
820    \or 2% 5
821    \or 3% 6
822    \or 4% 7
823    \or 5% 8
824    \or 6% 9
825 }%
826 \InCa@Temp 81{%
827    \or 9% 1
828    \or 0% 2
829    \or 1% 3
830    \or 2% 4
831    \or 3% 5
832    \or 4% 6
833    \or 5% 7
834    \or 6% 8
835    \or 7% 9
836 }%
837 \InCa@Temp 90{%
838    \or 0% 1
839    \or 1% 2
840    \or 2% 3
841    \or 3% 4
842    \or 4% 5
843    \or 5% 6
844    \or 6% 7
845    \or 7% 8
846    \or 8% 9
847 }%
```

`\InCa@SubDigit[0-9]`

```
848 \def\InCa@Temp#1#2{%
849    \expandafter\def\csname InCa@SubDigit#1\endcsname##1{%
850      \ifnum##1>#1 %
851        \endcsname 1%
852      \else
853        \endcsname 0%
854      \fi
855      \ifcase##1 #1% 0
856      #2%
857      \else #1% 10
858      \fi
859    }%
860 }
861 \InCa@Temp 0{%
862    \or 9% 1
863    \or 8% 2
864    \or 7% 3
865    \or 6% 4
866    \or 5% 5
867    \or 4% 6
868    \or 3% 7
869    \or 2% 8
870    \or 1% 9
```

25

```
871 }
872 \InCa@Temp 1{%
873     \or 0% 1
874     \or 9% 2
875     \or 8% 3
876     \or 7% 4
877     \or 6% 5
878     \or 5% 6
879     \or 4% 7
880     \or 3% 8
881     \or 2% 9
882 }
883 \InCa@Temp 2{%
884     \or 1% 1
885     \or 0% 2
886     \or 9% 3
887     \or 8% 4
888     \or 7% 5
889     \or 6% 6
890     \or 5% 7
891     \or 4% 8
892     \or 3% 9
893 }
894 \InCa@Temp 3{%
895     \or 2% 1
896     \or 1% 2
897     \or 0% 3
898     \or 9% 4
899     \or 8% 5
900     \or 7% 6
901     \or 6% 7
902     \or 5% 8
903     \or 4% 9
904 }
905 \InCa@Temp 4{%
906     \or 3% 1
907     \or 2% 2
908     \or 1% 3
909     \or 0% 4
910     \or 9% 5
911     \or 8% 6
912     \or 7% 7
913     \or 6% 8
914     \or 5% 9
915 }
916 \InCa@Temp 5{%
917     \or 4% 1
918     \or 3% 2
919     \or 2% 3
920     \or 1% 4
921     \or 0% 5
922     \or 9% 6
923     \or 8% 7
924     \or 7% 8
925     \or 6% 9
926 }
927 \InCa@Temp 6{%
928     \or 5% 1
929     \or 4% 2
930     \or 3% 3
931     \or 2% 4
932     \or 1% 5
```

```
933    \or 0% 6
934    \or 9% 7
935    \or 8% 8
936    \or 7% 9
937 }
938 \InCa@Temp 7{%
939    \or 6% 1
940    \or 5% 2
941    \or 4% 3
942    \or 3% 4
943    \or 2% 5
944    \or 1% 6
945    \or 0% 7
946    \or 9% 8
947    \or 8% 9
948 }
949 \InCa@Temp 8{%
950    \or 7% 1
951    \or 6% 2
952    \or 5% 3
953    \or 4% 4
954    \or 3% 5
955    \or 2% 6
956    \or 1% 7
957    \or 0% 8
958    \or 9% 9
959 }
960 \InCa@Temp 9{%
961    \or 8% 1
962    \or 7% 2
963    \or 6% 3
964    \or 5% 4
965    \or 4% 5
966    \or 3% 6
967    \or 2% 7
968    \or 1% 8
969    \or 0% 9
970 }
```

2.5.6   Shl, Shr

\intcalcShl

```
971 \def\intcalcShl#1{%
972    \number\expandafter\InCa@ShlSwitch\number#1! %
973 }
```

\InCa@ShlSwitch

```
974 \def\InCa@ShlSwitch#1#2!{%
975    \ifx#1-%
976      -\csname InCa@Empty%
977      \InCa@Shl#2!%
978    \else
979      \csname InCa@Empty%
980      \InCa@Shl#1#2!%
981    \fi
982 }
```

\IntCalcShl

```
983 \def\IntCalcShl#1!{%
984    \number
985    \csname InCa@Empty%
986    \InCa@Shl#1! %
```

```
987 }
```

\IntCal@ShlDigit

```
988 \def\InCa@Shl#1#2{%
989   \ifx#2!%
990     \csname InCa@ShlDigit#1\endcsname0%
991   \else
992     \csname InCa@ShlDigit#1%
993     \@ReturnAfterFi{%
994       \InCa@Shl#2%
995     }%
996   \fi
997 }
```

\InCa@ShlDigit0

```
998 \expandafter\def\csname InCa@ShlDigit0\endcsname{%
999   \endcsname0%
1000 }
```

\InCa@ShlDigit[1-9]

```
1001 \def\InCa@Temp#1#2#3#4#5{%
1002   \expandafter\def\csname InCa@ShlDigit#1\endcsname##1{%
1003     \expandafter\endcsname
1004     \ifcase##1 %
1005       #2#3%
1006     \else
1007       #4#5%
1008     \fi
1009   }%
1010 }
1011 \InCa@Temp 10203
1012 \InCa@Temp 20405
1013 \InCa@Temp 30607
1014 \InCa@Temp 40809
1015 \InCa@Temp 51011
1016 \InCa@Temp 61213
1017 \InCa@Temp 71415
1018 \InCa@Temp 81617
1019 \InCa@Temp 91819
```

\intcalcShr

```
1020 \def\intcalcShr#1{%
1021   \number\expandafter\InCa@ShrSwitch\number#1! %
1022 }
```

\InCa@ShrSwitch

```
1023 \def\InCa@ShrSwitch#1#2!{%
1024   \ifx#1-%
1025     -\InCa@Shr#2!%
1026   \else
1027     \InCa@Shr#1#2!%
1028   \fi
1029 }
```

\IntCalcShr

```
1030 \def\IntCalcShr#1!{%
1031   \number\InCa@Shr#1! %
1032 }
```

\InCa@Shr

```
1033 \def\InCa@Shr#1#2{%
```

```
1034    \InCa@ShrDigit#1!%
1035    \ifx#2!%
1036    \else
1037      \@ReturnAfterFi{%
1038        \ifodd#1 %
1039          \@ReturnAfterElseFi{%
1040            \InCa@Shr{1#2}%
1041          }%
1042        \else
1043          \expandafter\InCa@Shr\expandafter#2%
1044        \fi
1045      }%
1046    \fi
1047 }

1048 \def\InCa@ShrDigit#1!{%
1049    \ifcase#1 0% 0
1050    \or 0% 1
1051    \or 1% 2
1052    \or 1% 3
1053    \or 2% 4
1054    \or 2% 5
1055    \or 3% 6
1056    \or 3% 7
1057    \or 4% 8
1058    \or 4% 9
1059    \or 5% 10
1060    \or 5% 11
1061    \or 6% 12
1062    \or 6% 13
1063    \or 7% 14
1064    \or 7% 15
1065    \or 8% 16
1066    \or 8% 17
1067    \or 9% 18
1068    \or 9% 19
1069    \fi
1070 }
```

2.5.7 \InCa@Tim

\InCa@Tim   Macro \InCa@Tim implements "Number *tim*es digit".

```
1071 \def\InCa@Temp#1{%
1072    \def\InCa@Tim##1##2{%
1073      \number
1074        \ifcase##2 % 0
1075          0%
1076        \or % 1
1077          ##1%
1078        \else % 2-9
1079          \csname InCa@Empty%
1080          \InCa@ProcessTim##2##1!%
1081        \fi
1082      #1%
1083    }%
1084 }
1085 \InCa@Temp{ }
```

\InCa@ProcessTim

```
1086 \def\InCa@ProcessTim#1#2#3{%
1087    \ifx#3!%
1088      \csname InCa@TimDigit#2\endcsname#10%
```

29

```
1089     \else
1090       \csname InCa@TimDigit#2\csname InCa@Param#1%
1091       \@ReturnAfterFi{%
1092         \InCa@ProcessTim#1#3%
1093       }%
1094     \fi
1095 }
```

\InCa@Param[0-9]

```
1096 \def\InCa@Temp#1{%
1097   \expandafter\def\csname InCa@Param#1\endcsname{%
1098     \endcsname#1%
1099   }%
1100 }
1101 \InCa@Temp 0%
1102 \InCa@Temp 1%
1103 \InCa@Temp 2%
1104 \InCa@Temp 3%
1105 \InCa@Temp 4%
1106 \InCa@Temp 5%
1107 \InCa@Temp 6%
1108 \InCa@Temp 7%
1109 \InCa@Temp 8%
1110 \InCa@Temp 9%
```

\InCa@TimDigit0

```
1111 \expandafter\def\csname InCa@TimDigit0\endcsname#1#2{%
1112   \endcsname
1113   0#2%
1114 }
```

\InCa@TimDigit1

```
1115 \expandafter\def\csname InCa@TimDigit1\endcsname#1#2{%
1116   \ifcase#2 %
1117     \endcsname 0#1%
1118   \else
1119     \csname InCa@AddDigit#1\endcsname #2%
1120   \fi
1121 }
```

\InCa@TimDigit[2-9]

```
1122 \def\InCa@Temp#1#2{%
1123   \expandafter\def\csname InCa@TimDigit#1\endcsname##1{%
1124     \expandafter\InCa@TimDigitCarry
1125     \number
1126       \ifcase##1 0% 0
1127       #2%
1128       \fi
1129     !%
1130   }%
1131 }
1132 \InCa@Temp 2{%
1133   \or  2% 1
1134   \or  4% 2
1135   \or  6% 3
1136   \or  8% 4
1137   \or 10% 5
1138   \or 12% 6
1139   \or 14% 7
1140   \or 16% 8
1141   \or 18% 9
1142 }
```

```
1143 \InCa@Temp 3{%
1144    \or  3% 1
1145    \or  6% 2
1146    \or  9% 3
1147    \or 12% 4
1148    \or 15% 5
1149    \or 18% 6
1150    \or 21% 7
1151    \or 24% 8
1152    \or 27% 9
1153 }
1154 \InCa@Temp 4{%
1155    \or  4% 1
1156    \or  8% 2
1157    \or 12% 3
1158    \or 16% 4
1159    \or 20% 5
1160    \or 24% 6
1161    \or 28% 7
1162    \or 32% 8
1163    \or 36% 9
1164 }
1165 \InCa@Temp 5{%
1166    \or  5% 1
1167    \or 10% 2
1168    \or 15% 3
1169    \or 20% 4
1170    \or 25% 5
1171    \or 30% 6
1172    \or 35% 7
1173    \or 40% 8
1174    \or 45% 9
1175 }
1176 \InCa@Temp 6{%
1177    \or  6% 1
1178    \or 12% 2
1179    \or 18% 3
1180    \or 24% 4
1181    \or 30% 5
1182    \or 36% 6
1183    \or 42% 7
1184    \or 48% 8
1185    \or 54% 9
1186 }
1187 \InCa@Temp 7{%
1188    \or  7% 1
1189    \or 14% 2
1190    \or 21% 3
1191    \or 28% 4
1192    \or 35% 5
1193    \or 42% 6
1194    \or 49% 7
1195    \or 56% 8
1196    \or 63% 9
1197 }
1198 \InCa@Temp 8{%
1199    \or  8% 1
1200    \or 16% 2
1201    \or 24% 3
1202    \or 32% 4
1203    \or 40% 5
1204    \or 48% 6
```

```
1205    \or 56% 7
1206    \or 64% 8
1207    \or 72% 9
1208 }
1209 \InCa@Temp 9{%
1210    \or  9% 1
1211    \or 18% 2
1212    \or 27% 3
1213    \or 36% 4
1214    \or 45% 5
1215    \or 54% 6
1216    \or 63% 7
1217    \or 72% 8
1218    \or 81% 9
1219 }
```

\InCa@TimDigitCarry

```
1220 \def\InCa@TimDigitCarry#1!{%
1221    \ifnum#1<10 %
1222      \csname InCa@AddDigit#1\expandafter\endcsname
1223    \else
1224      \@ReturnAfterFi{%
1225        \InCa@@TimDigitCarry#1!%
1226      }%
1227    \fi
1228 }
```

\InCa@@TimDigitCarry

```
1229 \def\InCa@@TimDigitCarry#1#2!#3{%
1230    \csname InCa@DigitCarry#1%
1231    \csname InCa@AddDigit#2\endcsname #3%
1232 }
```

2.5.8   Mul

\intcalcMul

```
1233 \def\intcalcMul#1#2{%
1234    \number
1235      \expandafter\InCa@MulSwitch
1236      \number\number#1\expandafter!%
1237      \number#2! %
1238 }
```

\InCa@MulSwitch   Decision table for \InCa@MulSwitch.

$x < 0$	$y < 0$	$x < y$	$+$	$\mathrm{Mul}(-x, -y)$
		else		$\mathrm{Mul}(-y, -x)$
	else	$-x > y$	$-$	$\mathrm{Mul}(-x, y)$
		else		$\mathrm{Mul}(y, -x)$
else	$y < 0$	$x > -y$	$-$	$\mathrm{Mul}(x, -y)$
		else		$\mathrm{Mul}(-y, x)$
	else	$x > y$	$+$	$\mathrm{Mul}(x, y)$
		else		$\mathrm{Mul}(y, x)$

```
1239 \def\InCa@MulSwitch#1!#2!{%
1240    \ifnum#1<\z@
1241      \ifnum#2<\z@
1242        \ifnum#1<#2 %
1243          \expandafter\InCa@Mul\number-#1\expandafter!%
1244          \@gobble#2!%
1245        \else
```

```
1246        \expandafter\InCa@Mul\number-#2\expandafter!%
1247        \@gobble#1!%
1248      \fi
1249    \else
1250      -%
1251      \ifnum-#1>#2 %
1252        \expandafter\InCa@Mul\@gobble#1!#2!%
1253      \else
1254        \expandafter\InCa@Mul\number#2\expandafter!%
1255        \@gobble#1!%
1256      \fi
1257    \fi
1258  \else
1259    \ifnum#2<\z@
1260      -%
1261      \ifnum#1>-#2 %
1262        \expandafter\InCa@Mul\number#1\expandafter!%
1263        \@gobble#2!%
1264      \else
1265        \expandafter\InCa@Mul\@gobble#2!#1!%
1266      \fi
1267    \else
1268      \ifnum#1>#2 %
1269        \InCa@Mul#1!#2!%
1270      \else
1271        \InCa@Mul#2!#1!%
1272      \fi
1273    \fi
1274  \fi
1275 }
```

\IntCalcMul

```
1276 \def\IntCalcMul#1!#2!{%
1277   \number\InCa@Mul#1!#2! %
1278 }
```

\InCa@Mul

```
1279 \def\InCa@Mul#1!#2!{%
1280   \ifcase#2 %
1281     0%
1282   \or
1283     #1%
1284   \or
1285     \csname InCa@Empty%
1286     \expandafter\InCa@Shl#1!%
1287   \else
1288     \ifnum#2<10 %
1289       \InCa@Tim{#1}#2%
1290     \else
1291       \InCa@ProcessMul!#2!#1!%
1292     \fi
1293   \fi
1294 }
```

\InCa@Mul

```
1295 \def\InCa@ProcessMul#1!#2#3!#4!{%
1296   \ifx\InCa@Empty#3\InCa@Empty
1297     \expandafter\InCa@Add\number
1298     #10\expandafter\expandafter\expandafter!%
1299     \InCa@Tim{#4}#2!%
1300   \else
1301     \ifx\InCa@Empty#1\InCa@Empty
```

33

```
1302      \expandafter\expandafter\expandafter\InCa@ProcessMul
1303      \InCa@Tim{#4}#2!%
1304      #3!#4!%
1305    \else
1306      \expandafter\InCa@ProcessMul\number
1307      \expandafter\InCa@Add\number%
1308      #10\expandafter\expandafter\expandafter!%
1309      \InCa@Tim{#4}#2!!%
1310      #3!#4!%
1311    \fi
1312  \fi
1313 }
```

2.5.9 Sqr, Fac

\intcalcSqr

```
1314 \def\intcalcSqr#1{%
1315   \number\expandafter\InCa@Sqr\number#1! %
1316 }
```

\InCa@Sqr

```
1317 \def\InCa@Sqr#1#2!{%
1318   \ifx#1-%
1319     \InCa@Mul#2!#2!%
1320   \else
1321     \InCa@Mul#1#2!#1#2!%
1322   \fi
1323 }
```

\intcalcFac

```
1324 \def\intcalcFac#1{%
1325   \number\expandafter\InCa@Fac\number#1! %
1326 }
```

2.5.10 Pow

\intcalcPow

```
1327 \def\intcalcPow#1#2{%
1328   \number\expandafter\InCa@Pow
1329   \number\number#1\expandafter!%
1330   \number#2! %
1331 }
```

\InCa@Pow

```
1332 \def\InCa@Pow#1#2!#3#4!{%
1333   \ifcase#3#4 % power = 0
1334     1%
1335   \or % power = 1
1336     #1#2%
1337   \or % power = 2
1338     \ifx#1-%
1339       \InCa@Mul#2!#2!%
1340     \else
1341       \InCa@Mul#1#2!#1#2!%
1342     \fi
1343   \else
1344     \ifcase#1#2 % basis = 0, power <> 0
1345       0%
1346       \ifx#3-% power < 0
1347         0\IntCalcError:DivisionByZero%
1348       \fi
```

```
1349      \or
1350        1% basis = 1
1351      \else
1352        \ifnum#1#2=\m@ne % basis = -1
1353          \ifodd#3#4 %
1354            -%
1355          \fi
1356          1%
1357        \else % |basis| > 1
1358          \ifx#3-% power < 0
1359            0%
1360          \else % power > 2
1361            \ifx#1-% basis < 0
1362              \ifodd#3#4 %
1363                -%
1364              \fi
1365              \InCa@PowRec#2!#3#4!1!%
1366            \else
1367              \InCa@PowRec#1#2!#3#4!1!%
1368            \fi
1369          \fi
1370        \fi
1371      \fi
1372    \fi
1373 }
```

\InCa@PowRec

```
Pow(b, p) {
  PowRec(b, p, 1)
}
PowRec(b, p, r) {
  if p == 1 then
    return r
  else
    ifodd p then
      return PowRec(b*b, p div 2, r*b) % p div 2 = (p-1)/2
    else
      return PowRec(b*b, p div 2, r)
    fi
  fi
}
```

```
1374 \def\InCa@PowRec#1!#2!#3!{%
1375   \ifnum#2=\@ne
1376     \ifnum#1>#3 %
1377       \InCa@Mul#1!#3!%
1378     \else
1379       \InCa@Mul#3!#1!%
1380     \fi
1381   \else
1382     \expandafter\InCa@PowRec
1383     \number\InCa@Mul#1!#1!\expandafter!%
1384     \number\intcalcShr{#2}\expandafter!%
1385     \number
1386     \ifodd#2 %
1387       \ifnum#1>#3 %
1388         \InCa@Mul#1!#3!%
1389       \else
1390         \InCa@Mul#3!#1!%
1391       \fi
1392     \else
1393       #3%
1394     \fi
1395     \expandafter!%
1396   \fi
```

```
1397 }
```

2.5.11 Div

\intcalcDiv

```
1398 \def\intcalcDiv#1#2{%
1399   \number\expandafter\InCa@Div
1400   \number\number#1\expandafter!%
1401   \number#2! %
1402 }
```

\InCa@Div

```
1403 \def\InCa@Div#1!#2!{%
1404   \ifcase#2 %
1405     0\IntCalcError:DivisionByZero%
1406   \else
1407     \ifcase#1 %
1408       0%
1409     \else
1410       \expandafter\InCa@DivSwitch
1411       \number#1\expandafter!%
1412       \number#2!%
1413     \fi
1414   \fi
1415 }
```

\IntCalcDiv

```
1416 \def\InCa@Temp#1{%
1417   \def\IntCalcDiv##1!##2!{%
1418     \number
1419     \ifcase##2 %
1420       0\IntCalcError:DivisionByZero%
1421     \else
1422       \ifcase##1 %
1423         0%
1424       \else
1425         \InCa@@Div##1!##2!%
1426       \fi
1427     \fi
1428     #1%
1429   }%
1430 }
1431 \InCa@Temp{ }%
```

\InCa@DivSwitch Decision table for \InCa@DivSwitch.

$x < 0$	$y < 0$	$+$	$\mathrm{Div}(-x, -y)$
	else	$-$	$\mathrm{Div}(-x, y)$
else	$y < 0$	$-$	$\mathrm{Div}(x, -y)$
	else	$+$	$\mathrm{Div}(x, y)$

```
1432 \def\InCa@DivSwitch#1!#2!{%
1433   \ifnum#1<\z@
1434     \ifnum#2<\z@
1435       \expandafter\InCa@@Div\number-#1\expandafter!%
1436       \@gobble#2!%
1437     \else
1438       -%
1439       \expandafter\InCa@@Div\@gobble#1!#2!%
1440     \fi
1441   \else
```

```
                    1442  \ifnum#2<\z@
                    1443    -%
                    1444    \expandafter\InCa@@Div\number#1\expandafter!%
                    1445    \@gobble#2!%
                    1446  \else
                    1447    \InCa@@Div#1!#2!%
                    1448  \fi
                    1449  \fi
                    1450 }

\InCa@@Div
                    1451 \def\InCa@@Div#1!#2!{%
                    1452  \ifnum#1>#2 %
                    1453    \ifcase#2 % 0 already catched
                    1454 ?    \IntCalcError:ThisCannotHappen%
                    1455    \or % 1
                    1456      #1%
                    1457    \or % 2
                    1458      \InCa@Shr#1!%
                    1459    \else
                    1460      \InCa@DivStart!#1!#2!#2!%
                    1461    \fi
                    1462  \else
                    1463    \ifnum#1=#2 %
                    1464      1%
                    1465    \else
                    1466      0%
                    1467    \fi
                    1468  \fi
                    1469 }

\InCa@DivStart
                    1470 \def\InCa@DivStart#1!#2#3!#4#5{%
                    1471  \ifx#5!%
                    1472    \@ReturnAfterElseFi{%
                    1473      \InCa@DivStartI{#1#2}#3=!%
                    1474    }%
                    1475  \else
                    1476    \@ReturnAfterFi{%
                    1477      \InCa@DivStart{#1#2}!#3!#5%
                    1478    }%
                    1479  \fi
                    1480 }

\InCa@StartI
                    1481 \def\InCa@DivStartI#1!#2!{%
                    1482  \expandafter\InCa@DivStartII
                    1483  \number#2\expandafter\expandafter\expandafter!%
                    1484  \intcalcShl{#2}!%
                    1485  #1!%
                    1486 }

\InCa@StartII
                    1487 \def\InCa@DivStartII#1!#2!{%
                    1488  \expandafter\InCa@DivStartIII
                    1489  \number#1\expandafter!%
                    1490  \number#2\expandafter\expandafter\expandafter!%
                    1491  \intcalcShl{#2}!%
                    1492 }

\InCa@StartIII
```

```
1493 \def\InCa@DivStartIII#1!#2!#3!{%
1494   \expandafter\InCa@DivStartIV
1495   \number#1\expandafter!%
1496   \number#2\expandafter!%
1497   \number#3\expandafter!%
1498   \number\InCa@Add#3!#2!\expandafter\expandafter\expandafter!%
1499   \intcalcShl{#3}!%
1500 }
```

```
1501 \def\InCa@DivStartIV#1!#2!#3!#4!#5!#6!{%
1502   \InCa@ProcessDiv#6!#1!#2!#3!#4!#5!/%
1503 }
```

```
1504 \def\InCa@ProcessDiv#1#2#3!#4!#5!#6!#7!#8!#9/{%
1505   #9%
1506   \ifnum#1<#4 % 0
1507     0%
1508     \ifx#2=%
1509     \else
1510       \InCa@ProcessDiv{#1#2}#3!#4!#5!#6!#7!#8!%
1511     \fi
1512   \else % 1-9
1513     \ifnum#1<#5 % 1
1514       1%
1515       \ifx#2=%
1516       \else
1517         \expandafter\InCa@ProcessDiv\expandafter{%
1518           \number\InCa@Sub#1!#4!%
1519           #2%
1520         }#3!#4!#5!#6!#7!#8!%
1521       \fi
1522     \else % 2-9
1523       \ifnum#1<#7 % 2 3 4 5
1524         \ifnum#1<#6 % 2 3
1525           \@ReturnAfterElseFi{%
1526             \expandafter\InCa@@ProcessDiv
1527             \number\InCa@Sub#1!#5!!%
1528             23%
1529           }%
1530         \else % 4 5
1531           \@ReturnAfterFi{%
1532             \expandafter\InCa@@ProcessDiv
1533             \number\InCa@Sub#1!#6!!%
1534             45%
1535           }%
1536         \fi
1537         #2#3!#4!#5!#6!#7!#8!%
1538       \else % 6 7 8 9
1539         \ifnum#1<#8 % 6 7
1540           \@ReturnAfterElseFi{%
1541             \expandafter\InCa@@ProcessDiv
1542             \number\InCa@Sub#1!#7!!%
1543             67%
1544           }%
1545         \else % 8 9
1546           \@ReturnAfterFi{%
1547             \expandafter\InCa@@ProcessDiv
1548             \number\InCa@Sub#1!#8!!%
1549             89%
1550           }%
```

```
1551        \fi
1552        #2#3!#4!#5!#6!#7!#8!%
1553      \fi
1554    \fi
1555  \fi
1556  \ifx#2=%
1557    \expandafter\@gobble
1558  \fi
1559  /%
1560 }
```

\InCa@@ProcessDiv

```
1561 \def\InCa@@ProcessDiv#1!#2#3#4#5!#6!{%
1562  \ifnum#1<#6 %
1563    #2%
1564    \@ReturnAfterElseFi{%
1565      \ifx#4=%
1566        \expandafter\InCa@CleanupIV
1567      \else
1568        \@ReturnAfterFi{%
1569          \InCa@ProcessDiv{#1#4}#5!#6!%
1570        }%
1571      \fi
1572    }%
1573  \else
1574    #3%
1575    \@ReturnAfterFi{%
1576      \ifx#4=%
1577        \expandafter\InCa@CleanupIV
1578      \else
1579        \@ReturnAfterFi{%
1580          \expandafter\InCa@ProcessDiv\expandafter{%
1581            \number\InCa@Sub#1!#6! %
1582            #4%
1583          }#5!#6!%
1584        }%
1585      \fi
1586    }%
1587  \fi
1588 }
```

\InCa@CleanupIV

```
1589 \def\InCa@CleanupIV#1!#2!#3!#4!{}
```

2.5.12 Mod

\intcalcMod

```
1590 \def\intcalcMod#1#2{%
1591  \number\expandafter\InCa@Mod
1592  \number\number#1\expandafter!%
1593  \number#2! %
1594 }
```

\intcalc@Mod   Pseudocode/decision table for \intcalc@Mod.

if	$y = 0$	DivisionByZero
elsif	$y < 0$	$-\operatorname{Mod}(-x, -y)$
elsif	$x = 0$	0
elsif	$y = 1$	0
elsif	$y = 2$	ifodd(x) ? $1 : 0$
elsif	$x < 0$	$z \leftarrow x - (x/y) * y; \quad (z < 0) ? z + y : z$
else		$x - (x/y) * y$

39

```
1595 \def\InCa@Mod#1!#2!{%
1596   \ifcase#2 %
1597     0\IntCalcError:DivisionByZero%
1598   \else
1599     \ifnum#2<\z@
1600       -%
1601       \expandafter\InCa@Mod
1602       \number-#1\expandafter!%
1603       \number-#2!%
1604     \else
1605       \ifcase#1 %
1606         0%
1607       \else
1608         \ifcase#2 % 0 already catched
1609 ?         \IntCalcError:ThisCannotHappen%
1610         \or % 1
1611           0%
1612         \or % 2
1613           \ifodd#1 1\else 0\fi
1614         \else
1615           \ifnum#1<\z@
1616             \expandafter\InCa@ModShift
1617             \number-%
1618               \expandafter\InCa@Sub
1619               \number\@gobble#1\expandafter!%
1620               \number\intcalcMul{#2}{%
1621                 \expandafter\InCa@Div\@gobble#1!#2!%
1622               }!%
1623             !#2!%
1624           \else
1625             \expandafter\InCa@Sub\number#1\expandafter!%
1626             \number\intcalcMul{#2}{\InCa@Div#1!#2!}!%
1627           \fi
1628         \fi
1629       \fi
1630     \fi
1631   \fi
1632 }
```

\IntCalcMod

```
1633 \def\InCa@Temp#1{%
1634   \def\IntCalcMod##1!##2!{%
1635     \number
1636     \ifcase##2 %
1637       0\IntCalcError:DivisionByZero%
1638     \else
1639       \ifcase##1 %
1640         0%
1641       \else
1642         \ifcase##2 % 0 already catched
1643 ?         \IntCalcError:ThisCannotHappen
1644         \or % 1
1645           0%
1646         \or % 2
1647           \ifodd ##1 1\else 0\fi
1648         \else
1649           \expandafter\InCa@Sub\number##1\expandafter!%
1650           \number\intcalcMul{##2}{\InCa@Div##1!##2!}!%
1651         \fi
1652       \fi
1653     \fi
1654     #1%
1655   }%
```

```
1656 }
1657 \InCa@Temp{ }%
```

```
1658 \def\InCa@ModShift#1!#2!{%
1659   \ifnum#1<\z@
1660     \expandafter\InCa@Sub\number#2\expandafter!%
1661     \@gobble#1!%
1662   \else
1663     #1%
1664   \fi
1665 }
```

2.5.13 Help macros

```
1666 \def\InCa@Empty{}
```

```
1667 \expandafter\ifx\csname @gobble\endcsname\relax
1668   \long\def\@gobble#1{}%
1669 \fi
```

```
1670 \long\def\@ReturnAfterFi#1\fi{\fi#1}%
```

```
1671 \long\def\@ReturnAfterElseFi#1\else#2\fi{\fi#1}%
```

```
1672 \InCa@AtEnd
1673 ⟨/package⟩
```

3 Test

3.1 Catcode checks for loading

```
1674 ⟨*test1⟩
```

```
1675 \catcode`\{=1 %
1676 \catcode`\}=2 %
1677 \catcode`\#=6 %
1678 \catcode`\@=11 %
1679 \expandafter\ifx\csname count@\endcsname\relax
1680   \countdef\count@=255 %
1681 \fi
1682 \expandafter\ifx\csname @gobble\endcsname\relax
1683   \long\def\@gobble#1{}%
1684 \fi
1685 \expandafter\ifx\csname @firstofone\endcsname\relax
1686   \long\def\@firstofone#1{#1}%
1687 \fi
1688 \expandafter\ifx\csname loop\endcsname\relax
1689   \expandafter\@firstofone
1690 \else
1691   \expandafter\@gobble
1692 \fi
1693 {%
1694   \def\loop#1\repeat{%
1695     \def\body{#1}%
1696     \iterate
1697   }%
```

```
1698  \def\iterate{%
1699    \body
1700      \let\next\iterate
1701    \else
1702      \let\next\relax
1703    \fi
1704    \next
1705  }%
1706  \let\repeat=\fi
1707 }%
1708 \def\RestoreCatcodes{}
1709 \count@=0 %
1710 \loop
1711   \edef\RestoreCatcodes{%
1712     \RestoreCatcodes
1713     \catcode\the\count@=\the\catcode\count@\relax
1714   }%
1715 \ifnum\count@<255 %
1716   \advance\count@ 1 %
1717 \repeat
1718
1719 \def\RangeCatcodeInvalid#1#2{%
1720   \count@=#1\relax
1721   \loop
1722     \catcode\count@=15 %
1723   \ifnum\count@<#2\relax
1724     \advance\count@ 1 %
1725   \repeat
1726 }
1727 \expandafter\ifx\csname LoadCommand\endcsname\relax
1728   \def\LoadCommand{\input intcalc.sty\relax}%
1729 \fi
1730 \def\Test{%
1731   \RangeCatcodeInvalid{0}{47}%
1732   \RangeCatcodeInvalid{58}{64}%
1733   \RangeCatcodeInvalid{91}{96}%
1734   \RangeCatcodeInvalid{123}{255}%
1735   \catcode'\@=12 %
1736   \catcode'\\=0 %
1737   \catcode'\{=1 %
1738   \catcode'\}=2 %
1739   \catcode'\#=6 %
1740   \catcode'\[=12 %
1741   \catcode'\]=12 %
1742   \catcode'\%=14 %
1743   \catcode'\ =10 %
1744   \catcode13=5 %
1745   \LoadCommand
1746   \RestoreCatcodes
1747 }
1748 \Test
1749 \csname @@end\endcsname
1750 \end
1751 ⟨/test1⟩
```

3.2 Macro tests

3.2.1 Preamble with test macro definitions

```
1752 ⟨∗test2 | test4⟩
1753 \NeedsTeXFormat{LaTeX2e}
1754 \nofiles
1755 \documentclass{article}
```

```
1756 ⟨noetex⟩ \let\SavedNumexpr\numexpr
1757 ⟨noetex⟩ \let\numexpr\UNDEFINED
1758 \makeatletter
1759 \chardef\InCa@TestMode=1 %
1760 \makeatother
1761 \usepackage{intcalc}[2007/09/27]
1762 ⟨noetex⟩ \let\numexpr\SavedNumexpr
1763 \usepackage{qstest}
1764 \IncludeTests{*}
1765 \LogTests{log}{*}{*}
1766 ⟨/test2 | test4⟩
1767 ⟨*test2⟩
1768 \newcommand*{\TestSpaceAtEnd}[1]{%
1769 ⟨noetex⟩   \let\SavedNumexpr\numexpr
1770 ⟨noetex⟩   \let\numexpr\UNDEFINED
1771   \edef\resultA{#1}%
1772   \edef\resultB{#1 }%
1773 ⟨noetex⟩   \let\numexpr\SavedNumexpr
1774   \Expect*{\resultA\space}*{\resultB}%
1775 }
1776 \newcommand*{\TestResult}[2]{%
1777 ⟨noetex⟩   \let\SavedNumexpr\numexpr
1778 ⟨noetex⟩   \let\numexpr\UNDEFINED
1779   \edef\result{#1}%
1780 ⟨noetex⟩   \let\numexpr\SavedNumexpr
1781   \Expect*{\result}{#2}%
1782 }
1783 \newcommand*{\TestResultTwoExpansions}[2]{%
1784 ⟨*noetex⟩
1785   \begingroup
1786     \let\numexpr\UNDEFINED
1787     \expandafter\expandafter\expandafter
1788   \endgroup
1789 ⟨/noetex⟩
1790   \expandafter\expandafter\expandafter\Expect
1791   \expandafter\expandafter\expandafter{#1}{#2}%
1792 }
1793 \newcount\TestCount
1794 ⟨etex⟩\newcommand*{\TestArg}[1]{\numexpr#1\relax}
1795 ⟨noetex⟩\newcommand*{\TestArg}[1]{#1}
1796 \newcommand*{\TestTeXDivide}[2]{%
1797   \TestCount=\TestArg{#1}\relax
1798   \divide\TestCount by \TestArg{#2}\relax
1799   \Expect*{\intcalcDiv{#1}{#2}}*{\the\TestCount}%
1800 }
1801 \newcommand*{\Test}[2]{%
1802   \TestResult{#1}{#2}%
1803   \TestResultTwoExpansions{#1}{#2}%
1804   \TestSpaceAtEnd{#1}%
1805 }
1806 \newcommand*{\TestExch}[2]{\Test{#2}{#1}}
1807 \newcommand*{\TestInv}[2]{%
1808   \Test{\intcalcInv{#1}}{#2}%
1809 }
1810 \newcommand*{\TestNum}[2]{%
1811   \Test{\intcalcNum{#1}}{#2}%
1812 }
1813 \newcommand*{\TestAbs}[2]{%
1814   \Test{\intcalcAbs{#1}}{#2}%
1815 }
1816 \newcommand*{\TestSgn}[2]{%
1817   \Test{\intcalcSgn{#1}}{#2}%
```

```
1818 }
1819 \newcommand*{\TestMin}[3]{%
1820   \Test{\intcalcMin{#1}{#2}}{#3}%
1821 }
1822 \newcommand*{\TestMax}[3]{%
1823   \Test{\intcalcMax{#1}{#2}}{#3}%
1824 }
1825 \newcommand*{\TestCmp}[3]{%
1826   \Test{\intcalcCmp{#1}{#2}}{#3}%
1827 }
1828 \newcommand*{\TestInc}[2]{%
1829   \Test{\intcalcInc{#1}}{#2}%
1830   \ifnum\intcalcNum{#1}>-1 %
1831     \edef\x{%
1832       \noexpand\Test{%
1833         \noexpand\IntCalcInc\intcalcNum{#1}!%
1834       }{#2}%
1835     }%
1836     \x
1837   \fi
1838 }
1839 \newcommand*{\TestDec}[2]{%
1840   \Test{\intcalcDec{#1}}{#2}%
1841   \ifnum\intcalcNum{#1}>0 %
1842     \edef\x{%
1843       \noexpand\Test{%
1844         \noexpand\IntCalcDec\intcalcNum{#1}!%
1845       }{#2}%
1846     }%
1847     \x
1848   \fi
1849 }
1850 \newcommand*{\TestAdd}[3]{%
1851   \Test{\intcalcAdd{#1}{#2}}{#3}%
1852   \ifnum\intcalcNum{#1}>0 %
1853     \ifnum\intcalcNum{#2}> 0 %
1854       \ifnum\intcalcCmp{#1}{#2}>0 %
1855         \edef\x{%
1856           \noexpand\Test{%
1857             \noexpand\IntCalcAdd
1858             \intcalcNum{#1}!\intcalcNum{#2}!%
1859           }{#3}%
1860         }%
1861         \x
1862       \else
1863         \edef\x{%
1864           \noexpand\Test{%
1865             \noexpand\IntCalcAdd
1866             \intcalcNum{#2}!\intcalcNum{#1}!%
1867           }{#3}%
1868         }%
1869         \x
1870       \fi
1871     \fi
1872   \fi
1873 }
1874 \newcommand*{\TestSub}[3]{%
1875   \Test{\intcalcSub{#1}{#2}}{#3}%
1876   \ifnum\intcalcNum{#1}>0 %
1877     \ifnum\intcalcNum{#2}> 0 %
1878       \ifnum\intcalcCmp{#1}{#2}>0 %
1879         \edef\x{%
```

```
1880          \noexpand\Test{%
1881            \noexpand\IntCalcSub
1882            \intcalcNum{#1}!\intcalcNum{#2}!%
1883          }{#3}%
1884        }%
1885        \x
1886      \fi
1887    \fi
1888  \fi
1889 }
1890 \newcommand*{\TestShl}[2]{%
1891  \Test{\intcalcShl{#1}}{#2}%
1892  \edef\x{%
1893    \noexpand\Test{%
1894      \noexpand\IntCalcShl\intcalcAbs{#1}!%
1895    }{\intcalcAbs{#2}}%
1896  }%
1897  \x
1898 }
1899 \newcommand*{\TestShr}[2]{%
1900  \Test{\intcalcShr{#1}}{#2}%
1901  \edef\x{%
1902    \noexpand\Test{%
1903      \noexpand\IntCalcShr\intcalcAbs{#1}!%
1904    }{\intcalcAbs{#2}}%
1905  }%
1906  \x
1907 }
1908 \newcommand*{\TestMul}[3]{%
1909  \Test{\intcalcMul{#1}{#2}}{#3}%
1910  \edef\x{%
1911    \noexpand\Test{%
1912      \noexpand\IntCalcMul\intcalcAbs{#1}!\intcalcAbs{#2}!%
1913    }{\intcalcAbs{#3}}%
1914  }%
1915  \x
1916 }
1917 \newcommand*{\TestSqr}[2]{%
1918  \Test{\intcalcSqr{#1}}{#2}%
1919 }
1920 \newcommand*{\TestFac}[2]{%
1921  \expandafter\TestExch\expandafter{\the\numexpr#2}{\intcalcFac{#1}}%
1922 }
1923 \newcommand*{\TestPow}[3]{%
1924  \Test{\intcalcPow{#1}{#2}}{#3}%
1925 }
1926 \newcommand*{\TestDiv}[3]{%
1927  \Test{\intcalcDiv{#1}{#2}}{#3}%
1928  \TestTeXDivide{#1}{#2}%
1929  \edef\x{%
1930    \noexpand\Test{%
1931      \noexpand\IntCalcDiv\intcalcAbs{#1}!\intcalcAbs{#2}!%
1932    }{\intcalcAbs{#3}}%
1933  }%
1934 }
1935 \newcommand*{\TestMod}[3]{%
1936  \Test{\intcalcMod{#1}{#2}}{#3}%
1937  \ifcase\ifcase\intcalcSgn{#1} 0%
1938      \or
1939        \ifcase\intcalcSgn{#2} 1%
1940        \or 0%
1941        \else 1%
```

```
1942            \fi
1943          \else
1944            \ifcase\intcalcSgn{#2} 1%
1945            \or 1%
1946            \else 0%
1947            \fi
1948          \fi\relax
1949        \edef\x{%
1950          \noexpand\Test{%
1951            \noexpand\IntCalcMod
1952            \intcalcAbs{#1}!\intcalcAbs{#2}!%
1953          }{\intcalcAbs{#3}}%
1954        }%
1955        \x
1956      \fi
1957 }
1958 ⟨/test2⟩
```

3.2.2 Time

```
1959 ⟨∗test2⟩
1960 \begingroup\expandafter\expandafter\expandafter\endgroup
1961 \expandafter\ifx\csname pdfresettimer\endcsname\relax
1962 \else
1963   \makeatletter
1964   \newcount\SummaryTime
1965   \newcount\TestTime
1966   \SummaryTime=\z@
1967   \newcommand*{\PrintTime}[2]{%
1968     \typeout{%
1969       [Time #1: \strip@pt\dimexpr\number#2sp\relax\space s]%
1970     }%
1971   }%
1972   \newcommand*{\StartTime}[1]{%
1973     \renewcommand*{\TimeDescription}{#1}%
1974     \pdfresettimer
1975   }%
1976   \newcommand*{\TimeDescription}{}%
1977   \newcommand*{\StopTime}{%
1978     \TestTime=\pdfelapsedtime
1979     \global\advance\SummaryTime\TestTime
1980     \PrintTime\TimeDescription\TestTime
1981   }%
1982   \let\saved@qstest\qstest
1983   \let\saved@endqstest\endqstest
1984   \def\qstest#1#2{%
1985     \saved@qstest{#1}{#2}%
1986     \StartTime{#1}%
1987   }%
1988   \def\endqstest{%
1989     \StopTime
1990     \saved@endqstest
1991   }%
1992   \AtEndDocument{%
1993     \PrintTime{summary}\SummaryTime
1994   }%
1995   \makeatother
1996 \fi
1997 ⟨/test2⟩
```

3.2.3 Test 4: additional mod/div operations

```
1998 ⟨∗test4⟩
1999 \newcommand*{\TestDo}[2]{%
2000   \ifcase\numexpr#2\relax
```

```
2001   \else
2002     \edef\temp{\intcalcMod{#1}{#2}}%
2003     \Expect*{%
2004       \the\numexpr
2005       \intcalcMul{%
2006         \intcalcDiv{\intcalcAbs{#1}}{\intcalcAbs{#2}}%
2007       }{\intcalcAbs{#2}}%
2008       +\intcalcMod{\intcalcAbs{#1}}{\intcalcAbs{#2}}\relax
2009     }*{\the\numexpr\intcalcAbs{#1}\relax}%
2010   \fi
2011 }
2012 \newcommand*{\TestOne}[2]{%
2013   \TestDo{#1}{#1}%
2014 }
2015 \newcommand*{\TestTwo}[3]{%
2016   \TestDo{#1}{#2}%
2017   \TestDo{#2}{#1}%
2018 }
2019 \let\TestNum\TestOne
2020 \let\TestInv\TestOne
2021 \let\TestAbs\TestOne
2022 \let\TestSgn\TestOne
2023 \let\TestMin\TestTwo
2024 \let\TestMax\TestTwo
2025 \let\TestCmp\TestTwo
2026 \let\TestInc\TestOne
2027 \let\TestDec\TestOne
2028 \let\TestAdd\TestTwo
2029 \let\TestSub\TestTwo
2030 \let\TestShl\TestOne
2031 \let\TestShr\TestOne
2032 \let\TestMul\TestTwo
2033 \let\TestSqr\TestOne
2034 \def\TestFac#1#2{}
2035 \let\TestPow\TestTwo
2036 \let\TestDiv\TestTwo
2037 \let\TestMod\TestTwo
2038 ⟨/test4⟩
```

3.2.4   Test sets

```
2039 ⟨*test2 | test4⟩
2040 \makeatletter
2041
2042 \begin{qstest}{num}{num}%
2043   \TestNum{0}{0}%
2044   \TestNum{1}{1}%
2045   \TestNum{-1}{-1}%
2046   \TestNum{10}{10}%
2047   \TestNum{-10}{-10}%
2048   \TestNum{2147483647}{2147483647}%
2049   \TestNum{-2147483647}{-2147483647}%
2050   \TestNum{ 0 }{0}%
2051   \TestNum{ 1 }{1}%
2052   \TestNum{--1}{1}%
2053   \TestNum{ - + - + 4 }{4}%
2054   \TestNum{\z@}{0}%
2055   \TestNum{\@ne}{1}%
2056   \TestNum{\m@ne}{-1}%
2057 ⟨*etex⟩
2058   \TestNum{-10+30}{20}%
2059   \TestNum{10-30}{-20}%
2060 ⟨/etex⟩
2061 \end{qstest}
```

47

```
2062
2063 \begin{qstest}{inv}{inv}%
2064   \TestInv{0}{0}%
2065   \TestInv{1}{-1}%
2066   \TestInv{-1}{1}%
2067   \TestInv{10}{-10}%
2068   \TestInv{-10}{10}%
2069   \TestInv{2147483647}{-2147483647}%
2070   \TestInv{-2147483647}{2147483647}%
2071   \TestInv{ 0 }{0}%
2072   \TestInv{ 1 }{-1}%
2073   \TestInv{--1}{-1}%
2074   \TestInv{\z@}{0}%
2075   \TestInv{\@ne}{-1}%
2076   \TestInv{\m@ne}{1}%
2077 ⟨∗etex⟩
2078   \TestInv{-10+30}{-20}%
2079   \TestInv{10-30}{20}%
2080 ⟨/etex⟩
2081 \end{qstest}
2082
2083 \begin{qstest}{abs}{abs}%
2084   \TestAbs{0}{0}%
2085   \TestAbs{1}{1}%
2086   \TestAbs{-1}{1}%
2087   \TestAbs{10}{10}%
2088   \TestAbs{-10}{10}%
2089   \TestAbs{2147483647}{2147483647}%
2090   \TestAbs{-2147483647}{2147483647}%
2091   \TestAbs{ 0 }{0}%
2092   \TestAbs{ 1 }{1}%
2093   \TestAbs{--1}{1}%
2094   \TestAbs{\z@}{0}%
2095   \TestAbs{\@ne}{1}%
2096   \TestAbs{\m@ne}{1}%
2097 ⟨∗etex⟩
2098   \TestAbs{-10+30}{20}%
2099   \TestAbs{10-30}{20}%
2100 ⟨/etex⟩
2101 \end{qstest}
2102
2103 \begin{qstest}{sign}{sign}%
2104   \TestSgn{0}{0}%
2105   \TestSgn{1}{1}%
2106   \TestSgn{-1}{-1}%
2107   \TestSgn{10}{1}%
2108   \TestSgn{-10}{-1}%
2109   \TestSgn{2147483647}{1}%
2110   \TestSgn{-2147483647}{-1}%
2111   \TestSgn{ 0 }{0}%
2112   \TestSgn{ 2 }{1}%
2113   \TestSgn{ -2 }{-1}%
2114   \TestSgn{--2}{1}%
2115   \TestSgn{\z@}{0}%
2116   \TestSgn{\@ne}{1}%
2117   \TestSgn{\m@ne}{-1}%
2118 ⟨∗etex⟩
2119   \TestSgn{-10+30}{1}%
2120   \TestSgn{10-30}{-1}%
2121 ⟨/etex⟩
2122 \end{qstest}
2123
```

```
2124 \begin{qstest}{min}{min}%
2125   \TestMin{0}{1}{0}%
2126   \TestMin{1}{0}{0}%
2127   \TestMin{-10}{-20}{-20}%
2128   \TestMin{ 1 }{ 2 }{1}%
2129   \TestMin{ 2 }{ 1 }{1}%
2130   \TestMin{1}{1}{1}%
2131   \TestMin{\z@}{\@ne}{0}%
2132   \TestMin{\@ne}{\m@ne}{-1}%
2133 ⟨∗etex⟩
2134   \TestMin{1+2}{3+4}{3}%
2135 ⟨/etex⟩
2136 \end{qstest}
2137
2138 \begin{qstest}{max}{max}%
2139   \TestMax{0}{1}{1}%
2140   \TestMax{1}{0}{1}%
2141   \TestMax{-10}{-20}{-10}%
2142   \TestMax{ 1 }{ 2 }{2}%
2143   \TestMax{ 2 }{ 1 }{2}%
2144   \TestMax{1}{1}{1}%
2145   \TestMax{\z@}{\@ne}{1}%
2146   \TestMax{\@ne}{\m@ne}{1}%
2147 ⟨∗etex⟩
2148   \TestMax{1+2}{3+4}{7}%
2149 ⟨/etex⟩
2150 \end{qstest}
2151
2152 \begin{qstest}{cmp}{cmp}%
2153   \TestCmp{0}{0}{0}%
2154   \TestCmp{-21}{17}{-1}%
2155   \TestCmp{3}{4}{-1}%
2156   \TestCmp{-10}{-10}{0}%
2157   \TestCmp{-10}{-11}{1}%
2158   \TestCmp{100}{5}{1}%
2159   \TestCmp{2147483647}{-2147483647}{1}%
2160   \TestCmp{-2147483647}{2147483647}{-1}%
2161   \TestCmp{2147483647}{2147483647}{0}%
2162   \TestCmp{\z@}{\@ne}{-1}%
2163   \TestCmp{\@ne}{\m@ne}{1}%
2164   \TestCmp{ 4 }{ 5 }{-1}%
2165   \TestCmp{ -3 }{ -7 }{1}%
2166 ⟨∗etex⟩
2167   \TestCmp{1+2}{3+4}{-1}%
2168 ⟨/etex⟩
2169 \end{qstest}
2170
2171 \begin{qstest}{fac}{fac}
2172   \TestFac{0}{1}%
2173   \TestFac{1}{1}%
2174   \TestFac{2}{2}%
2175   \TestFac{3}{2*3}%
2176   \TestFac{4}{2*3*4}%
2177   \TestFac{5}{2*3*4*5}%
2178   \TestFac{6}{2*3*4*5*6}%
2179   \TestFac{7}{2*3*4*5*6*7}%
2180   \TestFac{8}{2*3*4*5*6*7*8}%
2181   \TestFac{9}{2*3*4*5*6*7*8*9}%
2182   \TestFac{10}{2*3*4*5*6*7*8*9*10}%
2183   \TestFac{11}{2*3*4*5*6*7*8*9*10*11}%
2184   \TestFac{12}{2*3*4*5*6*7*8*9*10*11*12}%
2185 \end{qstest}
```

```
2186
2187 \begin{qstest}{inc}{inc}%
2188   \TestInc{0}{1}%
2189   \TestInc{1}{2}%
2190   \TestInc{-1}{0}%
2191   \TestInc{10}{11}%
2192   \TestInc{-10}{-9}%
2193   \TestInc{999}{1000}%
2194   \TestInc{-1000}{-999}%
2195   \TestInc{129}{130}%
2196   \TestInc{2147483646}{2147483647}%
2197   \TestInc{-2147483647}{-2147483646}%
2198 \end{qstest}
2199
2200 \begin{qstest}{dec}{dec}%
2201   \TestDec{0}{-1}%
2202   \TestDec{1}{0}%
2203   \TestDec{-1}{-2}%
2204   \TestDec{10}{9}%
2205   \TestDec{-10}{-11}%
2206   \TestDec{1000}{999}%
2207   \TestDec{-999}{-1000}%
2208   \TestDec{130}{129}%
2209   \TestDec{2147483647}{2147483646}%
2210   \TestDec{-2147483646}{-2147483647}%
2211 \end{qstest}
2212
2213 \begin{qstest}{add}{add}%
2214   \TestAdd{0}{0}{0}%
2215   \TestAdd{1}{0}{1}%
2216   \TestAdd{0}{1}{1}%
2217   \TestAdd{1}{2}{3}%
2218   \TestAdd{-1}{-1}{-2}%
2219   \TestAdd{2147483646}{1}{2147483647}%
2220   \TestAdd{-2147483647}{2147483647}{0}%
2221   \TestAdd{20}{-5}{15}%
2222   \TestAdd{-4}{-1}{-5}%
2223   \TestAdd{-1}{-4}{-5}%
2224   \TestAdd{-4}{1}{-3}%
2225   \TestAdd{-1}{4}{3}%
2226   \TestAdd{4}{-1}{3}%
2227   \TestAdd{1}{-4}{-3}%
2228   \TestAdd{-4}{-1}{-5}%
2229   \TestAdd{-1}{-4}{-5}%
2230   \TestAdd{ -4 }{ -1 }{-5}%
2231   \TestAdd{ -1 }{ -4 }{-5}%
2232   \TestAdd{ -4 }{ 1 }{-3}%
2233   \TestAdd{ -1 }{ 4 }{3}%
2234   \TestAdd{ 4 }{ -1 }{3}%
2235   \TestAdd{ 1 }{ -4 }{-3}%
2236   \TestAdd{ -4 }{ -1 }{-5}%
2237   \TestAdd{ -1 }{ -4 }{-5}%
2238   \TestAdd{876543210}{111111111}{987654321}%
2239   \TestAdd{999999999}{2}{1000000001}%
2240 ⟨*etex⟩
2241   \TestAdd{100}{50+150}{300}%
2242   \TestAdd{2147483647}{10-2147483647}{10}%
2243 ⟨/etex⟩
2244 \end{qstest}
2245
2246 \begin{qstest}{sub}{sub}
2247   \TestSub{0}{0}{0}%
```

```
2248    \TestSub{1}{0}{1}%
2249    \TestSub{1}{2}{-1}%
2250    \TestSub{-1}{-1}{0}%
2251    \TestSub{2147483646}{-1}{2147483647}%
2252    \TestSub{-2147483647}{-2147483647}{0}%
2253    \TestSub{-4}{-1}{-3}%
2254    \TestSub{-1}{-4}{3}%
2255    \TestSub{-4}{1}{-5}%
2256    \TestSub{-1}{4}{-5}%
2257    \TestSub{4}{-1}{5}%
2258    \TestSub{1}{-4}{5}%
2259    \TestSub{-4}{-1}{-3}%
2260    \TestSub{-1}{-4}{3}%
2261    \TestSub{ -4 }{ -1 }{-3}%
2262    \TestSub{ -1 }{ -4 }{3}%
2263    \TestSub{ -4 }{ 1 }{-5}%
2264    \TestSub{ -1 }{ 4 }{-5}%
2265    \TestSub{ 4 }{ -1 }{5}%
2266    \TestSub{ 1 }{ -4 }{5}%
2267    \TestSub{ -4 }{ -1 }{-3}%
2268    \TestSub{ -1 }{ -4 }{3}%
2269    \TestSub{1000000000}{2}{999999998}%
2270    \TestSub{987654321}{111111111}{876543210}%
2271 ⟨*etex⟩
2272    \TestSub{100}{50+150}{-100}%
2273    \TestSub{2147483647}{-10+2147483647}{10}%
2274 ⟨/etex⟩
2275 \end{qstest}
2276
2277 \begin{qstest}{shl}{shl}
2278    \TestShl{0}{0}%
2279    \TestShl{1}{2}%
2280    \TestShl{5621}{11242}%
2281    \TestShl{1073741823}{2147483646}%
2282    \TestShl{-1}{-2}%
2283    \TestShl{-5621}{-11242}%
2284 \end{qstest}
2285
2286 \begin{qstest}{shr}{shr}
2287    \TestShr{0}{0}%
2288    \TestShr{1}{0}%
2289    \TestShr{2}{1}%
2290    \TestShr{3}{1}%
2291    \TestShr{4}{2}%
2292    \TestShr{5}{2}%
2293    \TestShr{6}{3}%
2294    \TestShr{7}{3}%
2295    \TestShr{8}{4}%
2296    \TestShr{9}{4}%
2297    \TestShr{10}{5}%
2298    \TestShr{11}{5}%
2299    \TestShr{12}{6}%
2300    \TestShr{13}{6}%
2301    \TestShr{14}{7}%
2302    \TestShr{15}{7}%
2303    \TestShr{16}{8}%
2304    \TestShr{17}{8}%
2305    \TestShr{18}{9}%
2306    \TestShr{19}{9}%
2307    \TestShr{20}{10}%
2308    \TestShr{21}{10}%
2309    \TestShr{22}{11}%
```

```
2310   \TestShr{11241}{5620}%
2311   \TestShr{73054202}{36527101}%
2312   \TestShr{2147483646}{1073741823}%
2313   \TestShr{-1}{0}%
2314   \TestShr{-2}{-1}%
2315   \TestShr{-3}{-1}%
2316   \TestShr{-11241}{-5620}%
2317 \end{qstest}
2318
2319 \begin{qstest}{mul}{mul}
2320   \TestMul{0}{0}{0}%
2321   \TestMul{1}{0}{0}%
2322   \TestMul{0}{1}{0}%
2323   \TestMul{1}{1}{1}%
2324   \TestMul{3}{1}{3}%
2325   \TestMul{1}{-3}{-3}%
2326   \TestMul{-4}{-5}{20}%
2327   \TestMul{3}{7}{21}%
2328   \TestMul{7}{3}{21}%
2329   \TestMul{3}{-7}{-21}%
2330   \TestMul{7}{-3}{-21}%
2331   \TestMul{-3}{7}{-21}%
2332   \TestMul{-7}{3}{-21}%
2333   \TestMul{-3}{-7}{21}%
2334   \TestMul{-7}{-3}{21}%
2335   \TestMul{12}{11}{132}%
2336   \TestMul{999}{333}{332667}%
2337   \TestMul{1000}{4321}{4321000}%
2338   \TestMul{12345}{173955}{2147474475}%
2339   \TestMul{1073741823}{2}{2147483646}%
2340   \TestMul{2}{1073741823}{2147483646}%
2341   \TestMul{-1073741823}{2}{-2147483646}%
2342   \TestMul{2}{-1073741823}{-2147483646}%
2343 ⟨*etex⟩
2344   \TestMul{2+3}{5+7}{60}%
2345   \TestMul{2147483647}{2147483647/2147483647}{2147483647}%
2346 ⟨/etex⟩
2347 \end{qstest}
2348
2349 \begin{qstest}{sqr}{sqr}
2350   \TestSqr{0}{0}%
2351   \TestSqr{1}{1}%
2352   \TestSqr{2}{4}%
2353   \TestSqr{3}{9}%
2354   \TestSqr{4}{16}%
2355   \TestSqr{9}{81}%
2356   \TestSqr{10}{100}%
2357   \TestSqr{46340}{2147395600}%
2358   \TestSqr{-1}{1}%
2359   \TestSqr{-2}{4}%
2360   \TestSqr{-46340}{2147395600}%
2361 \end{qstest}
2362
2363 \begin{qstest}{pow}{pow}
2364   \TestPow{-2}{0}{1}%
2365   \TestPow{-1}{0}{1}%
2366   \TestPow{0}{0}{1}%
2367   \TestPow{1}{0}{1}%
2368   \TestPow{2}{0}{1}%
2369   \TestPow{3}{0}{1}%
2370   \TestPow{-2}{1}{-2}%
2371   \TestPow{-1}{1}{-1}%
```

```
2372    \TestPow{1}{1}{1}%
2373    \TestPow{2}{1}{2}%
2374    \TestPow{3}{1}{3}%
2375    \TestPow{-2}{2}{4}%
2376    \TestPow{-1}{2}{1}%
2377    \TestPow{0}{2}{0}%
2378    \TestPow{1}{2}{1}%
2379    \TestPow{2}{2}{4}%
2380    \TestPow{3}{2}{9}%
2381    \TestPow{0}{1}{0}%
2382    \TestPow{1}{-2}{1}%
2383    \TestPow{1}{-1}{1}%
2384    \TestPow{-1}{-2}{1}%
2385    \TestPow{-1}{-1}{-1}%
2386    \TestPow{-1}{3}{-1}%
2387    \TestPow{-1}{4}{1}%
2388    \TestPow{-2}{-1}{0}%
2389    \TestPow{-2}{-2}{0}%
2390    \TestPow{2}{3}{8}%
2391    \TestPow{2}{4}{16}%
2392    \TestPow{2}{5}{32}%
2393    \TestPow{2}{6}{64}%
2394    \TestPow{2}{7}{128}%
2395    \TestPow{2}{8}{256}%
2396    \TestPow{2}{9}{512}%
2397    \TestPow{2}{10}{1024}%
2398    \TestPow{-2}{3}{-8}%
2399    \TestPow{-2}{4}{16}%
2400    \TestPow{-2}{5}{-32}%
2401    \TestPow{-2}{6}{64}%
2402    \TestPow{-2}{7}{-128}%
2403    \TestPow{-2}{8}{256}%
2404    \TestPow{-2}{9}{-512}%
2405    \TestPow{-2}{10}{1024}%
2406    \TestPow{3}{3}{27}%
2407    \TestPow{3}{4}{81}%
2408    \TestPow{3}{5}{243}%
2409    \TestPow{-3}{3}{-27}%
2410    \TestPow{-3}{4}{81}%
2411    \TestPow{-3}{5}{-243}%
2412    \TestPow{2}{30}{1073741824}%
2413    \TestPow{-3}{19}{-1162261467}%
2414    \TestPow{5}{13}{1220703125}%
2415    \TestPow{-7}{11}{-1977326743}%
2416 \end{qstest}
2417
2418 \begin{qstest}{div}{div}
2419    \TestDiv{1}{1}{1}%
2420    \TestDiv{2}{1}{2}%
2421    \TestDiv{-2}{1}{-2}%
2422    \TestDiv{2}{-1}{-2}%
2423    \TestDiv{-2}{-1}{2}%
2424    \TestDiv{15}{2}{7}%
2425    \TestDiv{-16}{2}{-8}%
2426    \TestDiv{1}{2}{0}%
2427    \TestDiv{1}{3}{0}%
2428    \TestDiv{2}{3}{0}%
2429    \TestDiv{-2}{3}{0}%
2430    \TestDiv{2}{-3}{0}%
2431    \TestDiv{-2}{-3}{0}%
2432    \TestDiv{13}{3}{4}%
2433    \TestDiv{-13}{-3}{4}%
```

```
2434    \TestDiv{-13}{3}{-4}%
2435    \TestDiv{-6}{5}{-1}%
2436    \TestDiv{-5}{5}{-1}%
2437    \TestDiv{-4}{5}{0}%
2438    \TestDiv{-3}{5}{0}%
2439    \TestDiv{-2}{5}{0}%
2440    \TestDiv{-1}{5}{0}%
2441    \TestDiv{0}{5}{0}%
2442    \TestDiv{1}{5}{0}%
2443    \TestDiv{2}{5}{0}%
2444    \TestDiv{3}{5}{0}%
2445    \TestDiv{4}{5}{0}%
2446    \TestDiv{5}{5}{1}%
2447    \TestDiv{6}{5}{1}%
2448    \TestDiv{-5}{4}{-1}%
2449    \TestDiv{-4}{4}{-1}%
2450    \TestDiv{-3}{4}{0}%
2451    \TestDiv{-2}{4}{0}%
2452    \TestDiv{-1}{4}{0}%
2453    \TestDiv{0}{4}{0}%
2454    \TestDiv{1}{4}{0}%
2455    \TestDiv{2}{4}{0}%
2456    \TestDiv{3}{4}{0}%
2457    \TestDiv{4}{4}{1}%
2458    \TestDiv{5}{4}{1}%
2459    \TestDiv{12345}{678}{18}%
2460    \TestDiv{32372}{5952}{5}%
2461    \TestDiv{284271294}{18162}{15651}%
2462    \TestDiv{217652429}{12561}{17327}%
2463    \TestDiv{462028434}{5439}{84947}%
2464    \TestDiv{2147483647}{1000}{2147483}%
2465    \TestDiv{2147483647}{-1000}{-2147483}%
2466    \TestDiv{-2147483647}{1000}{-2147483}%
2467    \TestDiv{-2147483647}{-1000}{2147483}%
2468  \end{qstest}
2469
2470  \begin{qstest}{mod}{mod}
2471    \TestMod{-6}{5}{4}%
2472    \TestMod{-5}{5}{0}%
2473    \TestMod{-4}{5}{1}%
2474    \TestMod{-3}{5}{2}%
2475    \TestMod{-2}{5}{3}%
2476    \TestMod{-1}{5}{4}%
2477    \TestMod{0}{5}{0}%
2478    \TestMod{1}{5}{1}%
2479    \TestMod{2}{5}{2}%
2480    \TestMod{3}{5}{3}%
2481    \TestMod{4}{5}{4}%
2482    \TestMod{5}{5}{0}%
2483    \TestMod{6}{5}{1}%
2484    \TestMod{-5}{4}{3}%
2485    \TestMod{-4}{4}{0}%
2486    \TestMod{-3}{4}{1}%
2487    \TestMod{-2}{4}{2}%
2488    \TestMod{-1}{4}{3}%
2489    \TestMod{0}{4}{0}%
2490    \TestMod{1}{4}{1}%
2491    \TestMod{2}{4}{2}%
2492    \TestMod{3}{4}{3}%
2493    \TestMod{4}{4}{0}%
2494    \TestMod{5}{4}{1}%
2495    \TestMod{-6}{-5}{-1}%
```

```
2496    \TestMod{-5}{-5}{0}%
2497    \TestMod{-4}{-5}{-4}%
2498    \TestMod{-3}{-5}{-3}%
2499    \TestMod{-2}{-5}{-2}%
2500    \TestMod{-1}{-5}{-1}%
2501    \TestMod{0}{-5}{0}%
2502    \TestMod{1}{-5}{-4}%
2503    \TestMod{2}{-5}{-3}%
2504    \TestMod{3}{-5}{-2}%
2505    \TestMod{4}{-5}{-1}%
2506    \TestMod{5}{-5}{0}%
2507    \TestMod{6}{-5}{-4}%
2508    \TestMod{-5}{-4}{-1}%
2509    \TestMod{-4}{-4}{0}%
2510    \TestMod{-3}{-4}{-3}%
2511    \TestMod{-2}{-4}{-2}%
2512    \TestMod{-1}{-4}{-1}%
2513    \TestMod{0}{-4}{0}%
2514    \TestMod{1}{-4}{-3}%
2515    \TestMod{2}{-4}{-2}%
2516    \TestMod{3}{-4}{-1}%
2517    \TestMod{4}{-4}{0}%
2518    \TestMod{5}{-4}{-3}%
2519    \TestMod{2147483647}{1000}{647}%
2520    \TestMod{2147483647}{-1000}{-353}%
2521    \TestMod{-2147483647}{1000}{353}%
2522    \TestMod{-2147483647}{-1000}{-647}%
2523    \TestMod{ 0 }{ 4 }{0}%
2524    \TestMod{ 1 }{ 4 }{1}%
2525    \TestMod{ -1 }{ 4 }{3}%
2526    \TestMod{ 0 }{ -4 }{0}%
2527    \TestMod{ 1 }{ -4 }{-3}%
2528    \TestMod{ -1 }{ -4 }{-1}%
2529 ⟨*etex⟩
2530    \TestMod{1+2}{1+3}{3}%
2531    \TestMod{1-2}{1+3}{3}%
2532    \TestMod{1-2}{1-4}{-1}%
2533    \TestMod{1+2}{1-4}{0}%
2534    \TestMod{1+2}{1-5}{-1}%
2535 ⟨/etex⟩
2536 \end{qstest}
2537 ⟨/test2 | test4⟩
2538
2539 ⟨*test2⟩
2540 \newcommand*{\TestError}[2]{%
2541    \begingroup
2542      \expandafter\def\csname IntCalcError:#1\endcsname{}%
2543      \Expect*{#2}{0}%
2544      \expandafter\def\csname IntCalcError:#1\endcsname{ERROR}%
2545      \Expect*{#2}{0ERROR }%
2546    \endgroup
2547 }
2548 \begin{qstest}{error}{error}
2549    \TestError{FacNegative}{\intcalcFac{-1}}%
2550    \TestError{FacNegative}{\intcalcFac{-2147483647}}%
2551    \TestError{FacOverflow}{\intcalcFac{13}}%
2552    \TestError{FacOverflow}{\intcalcFac{2147483647}}%
2553    \TestError{DivisionByZero}{\intcalcPow{0}{-1}}%
2554    \TestError{DivisionByZero}{\intcalcDiv{1}{0}}%
2555    \TestError{DivisionByZero}{\intcalcMod{1}{0}}%
2556    \TestError{DivisionByZero}{\IntCalcDiv1!0!}%
2557    \TestError{DivisionByZero}{\IntCalcMod1!0!}%
```

```
2558 \end{qstest}
2559 ⟨/test2⟩
2560
2561 ⟨*test2 | test4⟩
2562 \begin{document}
2563 \end{document}
2564 ⟨/test2 | test4⟩
```

4 Installation

4.1 Download

Package.   This package is available on CTAN[1]:

CTAN:macros/latex/contrib/oberdiek/intcalc.dtx The source file.

CTAN:macros/latex/contrib/oberdiek/intcalc.pdf Documentation.

Bundle.   All the packages of the bundle 'oberdiek' are also available in a TDS compliant ZIP archive. There the packages are already unpacked and the documentation files are generated. The files and directories obey the TDS standard.

CTAN:install/macros/latex/contrib/oberdiek.tds.zip

TDS refers to the standard "A Directory Structure for TeX Files" (CTAN:tds/tds.pdf). Directories with `texmf` in their name are usually organized this way.

4.2 Bundle installation

Unpacking.   Unpack the `oberdiek.tds.zip` in the TDS tree (also known as `texmf` tree) of your choice. Example (linux):

```
unzip oberdiek.tds.zip -d ~/texmf
```

Script installation.   Check the directory `TDS:scripts/oberdiek/` for scripts that need further installation steps. Package **attachfile2** comes with the Perl script `pdfatfi.pl` that should be installed in such a way that it can be called as `pdfatfi`. Example (linux):

```
chmod +x scripts/oberdiek/pdfatfi.pl
cp scripts/oberdiek/pdfatfi.pl /usr/local/bin/
```

4.3 Package installation

Unpacking.   The `.dtx` file is a self-extracting **docstrip** archive. The files are extracted by running the `.dtx` through plain-TeX:

```
tex intcalc.dtx
```

TDS.   Now the different files must be moved into the different directories in your installation TDS tree (also known as `texmf` tree):

```
intcalc.sty           → tex/generic/oberdiek/intcalc.sty
intcalc.pdf           → doc/latex/oberdiek/intcalc.pdf
test/intcalc-test1.tex → doc/latex/oberdiek/test/intcalc-test1.tex
test/intcalc-test2.tex → doc/latex/oberdiek/test/intcalc-test2.tex
test/intcalc-test3.tex → doc/latex/oberdiek/test/intcalc-test3.tex
test/intcalc-test4.tex → doc/latex/oberdiek/test/intcalc-test4.tex
intcalc.dtx           → source/latex/oberdiek/intcalc.dtx
```

If you have a `docstrip.cfg` that configures and enables **docstrip**'s TDS installing feature, then some files can already be in the right place, see the documentation of **docstrip**.

---

[1] ftp://ftp.ctan.org/tex-archive/

4.4 Refresh file name databases

If your TeX distribution (teTeX, mikTeX, ...) relies on file name databases, you must refresh these. For example, teTeX users run `texhash` or `mktexlsr`.

4.5 Some details for the interested

Attached source. The PDF documentation on CTAN also includes the `.dtx` source file. It can be extracted by AcrobatReader 6 or higher. Another option is `pdftk`, e.g. unpack the file into the current directory:

```
pdftk intcalc.pdf unpack_files output .
```

Unpacking with LaTeX. The `.dtx` chooses its action depending on the format:

plain-TeX: Run `docstrip` and extract the files.

LaTeX: Generate the documentation.

If you insist on using LaTeX for `docstrip` (really, `docstrip` does not need LaTeX), then inform the autodetect routine about your intention:

```
latex \let\install=y\input{intcalc.dtx}
```

Do not forget to quote the argument according to the demands of your shell.

Generating the documentation. You can use both the `.dtx` or the `.drv` to generate the documentation. The process can be configured by the configuration file `ltxdoc.cfg`. For instance, put this line into this file, if you want to have A4 as paper format:

```
\PassOptionsToClass{a4paper}{article}
```

An example follows how to generate the documentation with pdfLaTeX:

```
pdflatex intcalc.dtx
makeindex -s gind.ist intcalc.idx
pdflatex intcalc.dtx
makeindex -s gind.ist intcalc.idx
pdflatex intcalc.dtx
```

5 History

[2007/09/09 v1.0]

- First version.

[2007/09/27 v1.1]

- `\intcalcNum` added.

- `\intcalcShl` and `\intcalcShr` allow negative numbers. The sign is preserved.

- Reuse `\@gobble` instead of own macro `\IntCalc@Gobble`.

- Small fixes.

- Shorter internal prefix.

- Some programmer's interface.

6 Index

Numbers written in italic refer to the page where the corresponding entry is described; numbers underlined refer to the code line of the definition; numbers in roman refer to the code lines where the entry is used.