

The intcalc package

Heiko Oberdiek
<oberdiek@uni-freiburg.de>

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Abstract

This package provides expandable arithmetic operations with integers.

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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 $\varepsilon\text{-}\text{\TeX}$ is detected then the macros are implemented using its features (`\numexpr`). Otherwise the slower implementation without $\varepsilon\text{-}\text{\TeX}$'s help is chosen.

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 additional 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:

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

1.4.1 Num

`\intcalcNum {⟨x⟩}`

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.

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

`\intcalcAbs {⟨x⟩}`

Macro `\intcalcAbs` returns the absolute value of integer $\langle x \rangle$.

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

`\intcalcSgn {⟨x⟩}`

Macro `\intcalcSgn` encodes the sign of $\langle x \rangle$ as number.

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

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.

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

`\intcalcMax {⟨x⟩} {⟨y⟩}`

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

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

`\intcalcCmp {⟨x⟩} {⟨y⟩}`

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

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

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 $\langle x \rangle$ by one.

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

`\intcalcDec {<x>}`

Macro `\intcalcDec` decrements $\langle x \rangle$ by one.

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

`\intcalcAdd {<x>} {<y>}`

Macro `\intcalcAdd` adds the two numbers.

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

`\intcalcSub {<x>} {<y>}`

Macro `\intcalcSub` calculates the difference.

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

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.

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

`\intcalcShr {<x>}`

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

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

1.4.6 Mul, Sqr, Fac, Pow

`\intcalcMul {<x>} {<y>}`

Macro `\intcalcMul` calculates the product of $\langle x \rangle$ and $\langle y \rangle$.

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

`\intcalcSqr {⟨x⟩}`

Macro `\intcalcSqr` returns the square product.

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

`\intcalcFac {⟨x⟩}`

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

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

$$(0! = 1)$$

`\intcalcPow Mx My`

Macro `\intcalcPow` calculates the value of $\langle x \rangle$ to the power of $\langle y \rangle$. The error “division by zero” is thrown if $\langle x \rangle$ is zero and $\langle y \rangle$ is negative. permitted:

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

$$(0^0 = 1)$$

1.4.7 Div, Mul

`\intcalcDiv {⟨x⟩} {⟨y⟩}`

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

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

`\intcalcMod {⟨x⟩} {⟨y⟩}`

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

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

The result ranges:

$$\begin{aligned} -|y| < \text{Mod}(x, y) \leq 0 & \quad \text{for } y < 0 \\ 0 \leq \text{Mod}(x, y) < y & \quad \text{for } y \geq 0 \end{aligned}$$

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 $\langle number \rangle$!`

Incrementation, range: 0..2147483646.

`\IntCalcDec $\langle number \rangle$!`

Decrementation, range: 1..2147483647.

`\IntCalcAdd $\langle number A \rangle$! $\langle number B \rangle$!`

Addition, $A \geq B$.

`\IntCalcSub $\langle number A \rangle$! $\langle number B \rangle$!`

Subtraction, $A \geq B$.

`\IntCalcShl $\langle number \rangle$!`

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

`\IntCalcShr $\langle number \rangle$!`

Right shift (integer division by two).

`\IntCalcMul $\langle number A \rangle$! $\langle number B \rangle$!`

Multiplication, $A \geq B$.

`\IntCalcDiv $\langle number A \rangle$! $\langle number B \rangle$!`

Division operation.

`\IntCalcMod $\langle number A \rangle$! $\langle number B \rangle$!`

Modulo operation.

2 Implementation

1 `$\langle *package \rangle$`

2.1 Reload check and package identification

Reload check, especially if the package is not used with L^AT_EX.

```
2 \begingroup
3 \catcode44 12 % ,
4 \catcode45 12 % -
5 \catcode46 12 % .
6 \catcode58 12 % :
7 \catcode64 11 % @
8 \catcode123 1 % {
9 \catcode125 2 % }
10 \expandafter\let\expandafter\x\csname ver@intcalc.sty\endcsname
11 \ifx\x\relax % plain-TEX, first loading
12 \else
13 \def\empty{}%
```

```

14 \ifx\x\empty % LaTeX, first loading,
15 % variable is initialized, but \ProvidesPackage not yet seen
16 \else
17 \catcode35 6 % #
18 \expandafter\ifx\csname PackageInfo\endcsname\relax
19 \def\x#1#2{%
20 \immediate\write-1{Package #1 Info: #2.}%
21 }%
22 \else
23 \def\x#1#2{\PackageInfo{#1}{#2, stopped}}%
24 \fi
25 \x{intcalc}{The package is already loaded}%
26 \aftergroup\endinput
27 \fi
28 \fi
29 \endgroup

```

Package identification:

```

30 \begingroup
31 \catcode35 6 % #
32 \catcode40 12 % (
33 \catcode41 12 % )
34 \catcode44 12 % ,
35 \catcode45 12 % -
36 \catcode46 12 % .
37 \catcode47 12 % /
38 \catcode58 12 % :
39 \catcode64 11 % @
40 \catcode91 12 % [
41 \catcode93 12 % ]
42 \catcode123 1 % {
43 \catcode125 2 % }
44 \expandafter\ifx\csname ProvidesPackage\endcsname\relax
45 \def\x#1#2#3[#4]{\endgroup
46 \immediate\write-1{Package: #3 #4}%
47 \xdef#1{#4}%
48 }%
49 \else
50 \def\x#1#2[#3]{\endgroup
51 #2[#3]}%
52 \ifx#1\@undefined
53 \xdef#1{#3}%
54 \fi
55 \ifx#1\relax
56 \xdef#1{#3}%
57 \fi
58 }%
59 \fi
60 \expandafter\x\csname ver@intcalc.sty\endcsname
61 \ProvidesPackage{intcalc}%
62 [2007/09/27 v1.1 Expandable integer calculations (H0)]

```

2.2 Catcodes

```

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

```



```

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

```

2.3 Macros independent of ε -TeX

2.3.1 Abs, Sgn

\InCa@Abs

```

104 \def\InCa@Abs#1#2!{%
105   \ifx#1-%
106     #2%
107   \else
108     #1#2%
109   \fi
110 }

```

\InCa@Sgn

```

111 \def\InCa@Sgn#1#2!{%
112   \ifx#1-%
113     -1%
114   \else
115     \ifx#10%
116       0%
117     \else
118       1%
119     \fi
120   \fi
121 }

```

2.3.2 Min, Max, Cmp

\InCa@Min

```

122 \def\InCa@Min#1!#2!{%
123   \ifnum#1<#2 %
124     #1%
125   \else
126     #2%
127   \fi
128 }

\InCa@Max

129 \def\InCa@Max#1!#2!{%
130   \ifnum#1>#2 %
131     #1%
132   \else
133     #2%
134   \fi
135 }

\InCa@Cmp

136 \def\InCa@Cmp#1!#2!{%
137   \ifnum#1=#2 %
138     0%
139   \else
140     \ifnum#1<#2 %
141       -%
142     \fi
143     1%
144   \fi
145 }

```

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.

```

146 \def\InCa@Fac#1!{%
147   \ifcase#1 1% 0!
148   \or 1% 1!
149   \or 2% 2!
150   \or 6% 3!
151   \or 24% 4!
152   \or 120% 5!
153   \or 720% 6!
154   \or 5040% 7!
155   \or 40320% 8!
156   \or 362880% 9!
157   \or 3628800% 10!
158   \or 39916800% 11!
159   \or 479001600% 12!
160   \else
161     \ifnum#1<\z@
162       0\IntCalcError:FacNegative%
163     \else
164       0\IntCalcError:FacOverflow%
165     \fi
166   \fi
167 }

```

2.4 Implementation based on ε -TeX

Only `\numexpr` is used from ε -TeX.

```

168 \begingroup\expandafter\expandafter\expandafter\endgroup
169 \expandafter\ifx\csname numexpr\endcsname\relax
170 \else

```

2.4.1 Num

\intcalcNum

```
171 \def\intcalcNum#1{%
172   \the\numexpr#1\relax
173 }%
```

2.4.2 Inv, Abs, Sgn

\intcalcInv

```
174 \def\intcalcInv#1{%
175   \number-\intcalcNum{#1} %
176 }%
```

\intcalcAbs

```
177 \def\intcalcAbs#1{%
178   \number\expandafter\InCa@Abs\the\numexpr#1! %
179 }%
```

\intcalcSgn

```
180 \def\intcalcSgn#1{%
181   \number\expandafter\InCa@Sgn\the\numexpr#1! %
182 }%
```

2.4.3 Min, Max, Cmp

\intcalcMin

```
183 \def\intcalcMin#1#2{%
184   \number\expandafter\InCa@Min
185   \the\numexpr#1\expandafter!%
186   \the\numexpr#2! %
187 }%
```

\intcalcMax

```
188 \def\intcalcMax#1#2{%
189   \number\expandafter\InCa@Max
190   \the\numexpr#1\expandafter!%
191   \the\numexpr#2! %
192 }%
```

\intcalcCmp

```
193 \def\intcalcCmp#1#2{%
194   \number\expandafter\InCa@Cmp
195   \the\numexpr#1\expandafter!\the\numexpr#2! %
196 }%
```

2.4.4 Inc, Dec

\intcalcInc

```
197 \def\intcalcInc#1{%
198   \the\numexpr#1+1\relax
199 }%
```

\intcalcDec

```
200 \def\intcalcDec#1{%
201   \the\numexpr#1-1\relax
202 }%
```

\IntCalcInc

```
203 \def\IntCalcInc#1!{%
204   \the\numexpr#1+1\relax
205 }%
```

\IntCalcDec

```
206 \def\IntCalcDec#1!{%
207   \the\numexpr#1-1\relax
208 }%
```

2.4.5 Add, Sub

\intcalcAdd

```
209 \def\intcalcAdd#1#2{%
210   \the\numexpr#1+(#2)\relax
211 }%
```

\intcalcSub

```
212 \def\intcalcSub#1#2{%
213   \the\numexpr#1-(#2)\relax
214 }%
```

\IntCalcAdd

```
215 \def\IntCalcAdd#1!#2!{%
216   \the\numexpr#1+#2\relax
217 }%
```

\IntCalcSub

```
218 \def\IntCalcSub#1!#2!{%
219   \the\numexpr#1-#2\relax
220 }%
```

2.4.6 Shl, Shr

\intcalcShl

```
221 \def\intcalcShl#1{%
222   \the\numexpr(#1)*2\relax
223 }%
```

\intcalcShr

```
224 \def\intcalcShr#1{%
225   \number\expandafter\InCa@Shr\the\numexpr#1! %
226 }%
```

\IntCalcShl

```
227 \def\IntCalcShl#1!{%
228   \the\numexpr#1*2\relax
229 }%
```

\IntCalcShr

```
230 \def\IntCalcShr#1!{%
231   \the\numexpr\ifodd#1 (#1-1)\else#1\fi/2\relax
232 }%
```

\InCa@Shr

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

```

237     \ifodd#1#2 %
238     \the\numexpr(#1#2-1)/2\relax
239     \else
240     \the\numexpr#1#2/2\relax
241     \fi
242     \fi
243 }%

```

2.4.7 Mul, Sqr, Fac

\intcalcMul

```

244 \def\intcalcMul#1#2{%
245     \the\numexpr(#1)*(#2)\relax
246 }%

```

\IntCalcMul

```

247 \def\IntCalcMul#1!#2!{%
248     \the\numexpr#1*#2\relax
249 }%

```

\intcalcSqr

```

250 \def\intcalcSqr#1{%
251     \number\expandafter\InCa@Sqr\the\numexpr#1! %
252 }%

```

\InCa@Sqr

```

253 \def\InCa@Sqr#1!{%
254     \the\numexpr#1*#1\relax
255 }%

```

\intcalcFac

```

256 \def\intcalcFac#1{%
257     \number\expandafter\InCa@Fac\the\numexpr#1! %
258 }%

```

2.4.8 Pow

\intcalcPow

```

259 \def\intcalcPow#1#2{%
260     \number\expandafter\InCa@Pow
261     \the\numexpr#1\expandafter!%
262     \the\numexpr#2! %
263 }%

```

\InCa@Pow

```

264 \def\InCa@Pow#1#2!#3#4!{%
265     \ifcase#3#4 % power = 0
266     1%
267     \or % power = 1
268     #1#2%
269     \or % power = 2
270     \the\numexpr#1#2*#1#2\relax
271     \else
272     \ifcase#1#2 % basis = 0, power <> 0
273     0%
274     \ifx#3-% power < 0
275     0\IntCalcError:DivisionByZero%
276     \fi
277     \or
278     1% basis = 1

```

```

279     \else
280     \ifnum#1#2=\m@ne % basis = -1
281     \ifodd#3#4 %
282     -%
283     \fi
284     1%
285     \else % |basis| > 1
286     \ifx#3-% power < 0
287     0%
288     \else % power > 2
289     \InCa@PowRec#1#2!#3#4!1!%
290     \fi
291     \fi
292     \fi
293     \fi
294 }%

\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
}

295 \def\InCa@PowRec#1!#2!#3!{%
296     \ifnum#2=\@ne
297     \the\numexpr#1*#3\relax
298     \else
299     \ifodd#2 %
300     \expandafter\InCa@PowRec
301     \the\numexpr#1*#1\expandafter!%
302     \the\numexpr(#2-1)/2\expandafter!%
303     \the\numexpr#1*#3\expandafter\expandafter\expandafter!%
304     \else
305     \expandafter\InCa@PowRec
306     \the\numexpr#1*#1\expandafter!%
307     \the\numexpr(#2-1)/2\expandafter!%
308     \number#3\expandafter\expandafter\expandafter!%
309     \fi
310     \fi
311 }%

```

2.4.9 Div, Mod

$\mathrm{T}_{\mathrm{E}}\mathrm{X}$'s `\divide` truncates, $\varepsilon\text{-}\mathrm{T}_{\mathrm{E}}\mathrm{X}$'s `\numexpr` rounds the result of a division. The rounding method is called “Symmetric Arithmetic Rounding” or “Round-Half-Up” (“Kaufmännisches Runden” in German):

$$\begin{aligned}
 1 &= 3 \text{ divide } 2 = 1.5 = \text{numexpr } 3/2 = 2 \\
 -1 &= -3 \text{ divide } 2 = -1.5 = \text{numexpr } -3/2 = -2
 \end{aligned}$$

Macro `\intcalcDiv` follows $\mathrm{T}_{\mathrm{E}}\mathrm{X}$ and truncates. The calculation is done by the following formula:

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

The operator ‘/’ is `\numexpr`'s division.

```

\intcalcDiv
312 \def\intcalcDiv#1#2{%
313 \number\expandafter\InCa@Div
314 \the\numexpr#1\expandafter!%
315 \the\numexpr#2! %
316 }%

\InCa@Div
317 \def\InCa@Div#1!#2!{%
318 \ifcase#2 %
319 0\IntCalcError:DivisionByZero%
320 \else
321 \ifcase#1 %
322 0%
323 \else
324 \expandafter\InCa@@Div
325 \romannumeral 0%
326 \ifnum#1<\z@
327 \expandafter-\number-#1%
328 \else
329 \expandafter+\number#1%
330 \fi
331 \expandafter!%
332 \romannumeral 0%
333 \ifnum#2<\z@
334 \expandafter-\number-#2%
335 \else
336 \expandafter+\number#2%
337 \fi
338 !%
339 \fi
340 \fi
341 }%

\IntCalcDiv
342 \def\InCa@Temp#1{%
343 \def\IntCalcDiv##1!##2!{%
344 \number
345 \ifcase##2 %
346 0\IntCalcError:DivisionByZero%
347 \else
348 \ifcase##1 %
349 0%
350 \else
351 \the\numexpr(##1-(##2-1)/2)/##2\relax
352 \fi
353 \fi
354 #1%
355 }%
356 }%
357 \InCa@Temp{ }%

\InCa@@Div
358 \def\InCa@@Div#1#2!#3#4!{%
359 #1#3%
360 \the\numexpr(#2-(#4-1)/2)/#4\relax
361 }%

\intcalcMod
362 \def\intcalcMod#1#2{%
363 \number\expandafter\InCa@Mod

```

```

364     \the\numexpr#1\expandafter!%
365     \the\numexpr#2! %
366 }%

\InCa@Mod

367 \def\InCa@Mod#1!#2!{%
368     \ifcase#2 %
369         0\IntCalcError:DivisionByZero%
370     \else
371         \ifcase#1 %
372             0%
373         \else
374             \expandafter\InCa@@Mod
375             \romannumeral 0%
376             \ifnum#1<\z@
377                 \expandafter-\number-#1%
378             \else
379                 \expandafter+\number#1%
380             \fi
381             \expandafter!%
382             \romannumeral 0%
383             \ifnum#2<\z@
384                 \expandafter-\number-#2%
385             \else
386                 \expandafter+\number#2%
387             \fi
388             !%
389         \fi
390     \fi
391 }%

\IntCalcMod

392 \def\InCa@Temp#1{%
393     \def\IntCalcMod##1!##2!{%
394         \number
395         \ifcase##2 %
396             0\IntCalcError:DivisionByZero%
397         \else
398             \ifcase##1 %
399                 0%
400             \else
401                 \the\numexpr##1-(##1-(##2-1)/2)/##2*##2\relax
402             \fi
403         \fi
404         #1%
405     }%
406 }%
407 \InCa@Temp{ }%

\InCa@@Mod

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

```



```

420      \the\numexpr-#2+\InCa@Div+#2!+#4!*\#4!\#4!%
421      \else
422      \the\numexpr#2-\InCa@Div+#2!+#4!*\#4\relax
423      \fi
424      \fi
425      }%

\InCa@ModX

426 \def\InCa@ModX#1!#2!{%
427   \ifcase#1 %
428     0%
429   \else
430     \the\numexpr#1+#2\relax
431   \fi
432   }%

433 \InCa@AtEnd
434 \expandafter\endinput
435 \fi

```

2.5 Implementation without ε -TeX

2.5.1 Num

```

\intcalcNum

436 \def\intcalcNum#1{%
437   \number\expandafter\InCa@FirstOfOne\number#1! %
438 }

```

2.5.2 Inv, Abs, Sgn

```

\intcalcInv

439 \def\intcalcInv#1{%
440   \number\expandafter\InCa@FirstOfOne\number-#1! %
441 }

\InCa@FirstOfOne

442 \def\InCa@FirstOfOne#1!{#1}

\intcalcAbs

443 \def\intcalcAbs#1{%
444   \number\expandafter\InCa@Abs\number#1! %
445 }

\intcalcSgn

446 \def\intcalcSgn#1{%
447   \number\expandafter\InCa@Sgn\number#1! %
448 }

```

2.5.3 Min, Max, Cmp

```

\intcalcMin

449 \def\intcalcMin#1#2{%
450   \number\expandafter\InCa@Min
451   \number\number#1\expandafter!\number#2! %
452 }

\intcalcMax

453 \def\intcalcMax#1#2{%
454   \number\expandafter\InCa@Max
455   \number\number#1\expandafter!\number#2! %
456 }

```

\intcalcCmp

```
457 \def\intcalcCmp#1#2{%
458   \number\expandafter\InCa@Cmp
459   \number\number#1\expandafter!\number#2! %
460 }%
```

2.5.4 Inc, Dec

\intcalcInc

```
461 \def\intcalcInc#1{%
462   \number\expandafter\InCa@IncSwitch\number#1! %
463 }
```

\InCa@IncSwitch

```
464 \def\InCa@IncSwitch#1#2!{%
465   \ifx#1-%
466     -%
467     \csname InCa@Empty%
468     \InCa@Dec#2!%
469   \else
470     \csname InCa@Empty%
471     \InCa@Inc#1#2!%
472   \fi
473 }
```

\intcalcDec

```
474 \def\intcalcDec#1{%
475   \number\expandafter\InCa@DecSwitch\number#1! %
476 }
```

\InCa@DecSwitch

```
477 \def\InCa@DecSwitch#1#2!{%
478   \ifx#1-%
479     -%
480     \csname InCa@Empty%
481     \expandafter\InCa@Inc#2!%
482   \else
483     \ifx#10%
484       -1%
485     \else
486       \csname InCa@Empty%
487       \InCa@Dec#1#2!%
488     \fi
489   \fi
490 }
```

\IntCalcInc

```
491 \def\IntCalcInc#1!{%
492   \number\csname InCa@Empty\InCa@Inc#1! %
493 }
```

\IntCalcDec

```
494 \def\IntCalcDec#1!{%
495   \number\csname InCa@Empty\InCa@Dec#1! %
496 }
```

\InCa@Inc

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

```

500 \else
501 \csname InCa@IncDigit#1%
502 \expandafter\InCa@Inc\expandafter#2%
503 \fi
504 }

\InCa@IncDigit[0-8]

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

\InCa@IncDigit9

525 \expandafter\def\csname InCa@IncDigit9\endcsname#1{%
526 \expandafter\endcsname
527 \ifcase#1 %
528 09%
529 \else
530 10%
531 \fi
532 }

\InCa@Dec

533 \def\InCa@Dec#1#2{%
534 \ifx#2!%
535 \csname InCa@DecDigit#1\endcsname1%
536 \else
537 \csname InCa@DecDigit#1%
538 \expandafter\InCa@Dec\expandafter#2%
539 \fi
540 }

\InCa@DecDigit[1-9]

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

```

```

554 \InCa@Temp 76
555 \InCa@Temp 65
556 \InCa@Temp 54
557 \InCa@Temp 43
558 \InCa@Temp 32
559 \InCa@Temp 21
560 \InCa@Temp 10

```

\InCa@DecDigit0

```

561 \expandafter\def\csname InCa@DecDigit0\endcsname#1{%
562   \expandafter\endcsname
563   \ifcase#1 %
564     00%
565   \else
566     19%
567   \fi
568 }

```

2.5.5 Add, Sub

\intcalcAdd

```

569 \def\intcalcAdd#1#2{%
570   \number
571   \expandafter\InCa@AddSwitch
572   \number\number#1\expandafter!%
573   \number#2! %
574 }

```

\intcalcSub

```

575 \def\intcalcSub#1#2{%
576   \number
577   \expandafter\InCa@AddSwitch
578   \number\number#1\expandafter!%
579   \number-\number#2! %
580 }

```

\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-.

$x < 0$	$y < 0$	$x < y$	-	$\text{Add}(-x, -y)$
		else		$\text{Add}(-y, -x)$
	else	$-x > y$	-	$\text{Sub}(-x, y)$
		else	+	$\text{Sub}(y, -x)$
else	$y < 0$	$x > -y$	+	$\text{Sub}(x, -y)$
		else	-	$\text{Sub}(-y, x)$
	else	$x > y$	+	$\text{Add}(x, y)$
		else		$\text{Add}(y, x)$

```

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

```

```

594      -%
595      \expandafter\InCa@Sub\@gobble#1!#2!%
596    \else
597      \expandafter\InCa@Sub\number#2\expandafter!%
598      \@gobble#1!%
599    \fi
600  \fi
601 \else
602   \ifnum#2<\z@
603     \ifnum#1>=#2 %
604       \expandafter\InCa@Sub\number#1\expandafter!%
605       \@gobble#2!%
606     \else
607       -%
608       \expandafter\InCa@Sub\@gobble#2!#1!%
609     \fi
610   \else
611     \ifnum#1>#2 %
612       \InCa@Add#1!#2!%
613     \else
614       \InCa@Add#2!#1!%
615     \fi
616   \fi
617 \fi
618 }

\IntCalcAdd

619 \def\IntCalcAdd#1!#2!{%
620   \number\InCa@Add#1!#2! %
621 }

\IntCalcSub

622 \def\IntCalcSub#1!#2!{%
623   \number\InCa@Sub#1!#2! %
624 }

\InCa@Space

625 \begingroup
626   \def\x#1{\endgroup
627     \let\InCa@Space= #1%
628   }%
629 \x{ }

\InCa@Add

630 \def\InCa@Add#1!#2!{%
631   \ifcase#2 %
632     #1%
633   \else
634     \InCa@@Add#1!#2!00000000\InCa@Space
635   \fi
636 }

\InCa@Sub

637 \def\InCa@Sub#1!#2!{%
638   \ifnum#1=#2 %
639     0%
640   \else
641     \InCa@@Sub#1!#2!00000000\InCa@Space
642   \fi
643 }

```

\InCa@@@Add

```
644 \def\InCa@@Add#1!#2#3!{%
645   \ifx\InCa@Empty#3\InCa@Empty
646     \@ReturnAfterElseFi{%
647       \InCa@@@Add!!#1!#2%
648     }%
649   \else
650     \@ReturnAfterFi{%
651       \InCa@@Add#1!#3!#2%
652     }%
653   \fi
654 }
```

\InCa@@@Sub

```
655 \def\InCa@@Sub#1!#2#3!{%
656   \ifx\InCa@Empty#3\InCa@Empty
657     \@ReturnAfterElseFi{%
658       \InCa@@@Sub!!#1!#2%
659     }%
660   \else
661     \@ReturnAfterFi{%
662       \InCa@@Sub#1!#3!#2%
663     }%
664   \fi
665 }
```

\InCa@@@Add

```
666 \def\InCa@@@Add#1!#2!#3#4!#5{%
667   \ifx\InCa@Empty#4\InCa@Empty
668     \csname InCa@Empty%
669       \@ReturnAfterElseFi{%
670         \InCa@ProcessAdd#1#3!#5#2%
671       }%
672   \else
673     \@ReturnAfterFi{%
674       \InCa@@@Add#1#3!#5#2!#4!%
675     }%
676   \fi
677 }
```

\InCa@@@Sub

```
678 \def\InCa@@@Sub#1!#2!#3#4!#5{%
679   \ifx\InCa@Empty#4\InCa@Empty
680     \csname @gobble%
681       \@ReturnAfterElseFi{%
682         \InCa@ProcessSub#1#3!#5#2%
683       }%
684   \else
685     \@ReturnAfterFi{%
686       \InCa@@@Sub#1#3!#5#2!#4!%
687     }%
688   \fi
689 }
```

\InCa@ProcessAdd

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

```

696     \@ReturnAfterFi{%
697     \InCa@ProcessAdd#2!#4%
698     }%
699     \fi
700 }

```

\InCa@ProcessSub

```

701 \def\InCa@ProcessSub#1#2!#3#4{%
702   \ifx\InCa@Empty#2\InCa@Empty
703     \csname InCa@SubDigit#1\endcsname#3%
704     \romannumeral0#4%
705   \else
706     \csname InCa@SubDigit#1\csname InCa@DigitCarry#3%
707     \@ReturnAfterFi{%
708     \InCa@ProcessSub#2!#4%
709     }%
710   \fi
711 }

```

\InCa@DigitCarry[0-9]

```

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

```

\InCa@AddDigit0

```

731 \expandafter\def\csname InCa@AddDigit0\endcsname#1{%
732   \ifnum#1>9 %
733     \endcsname10%
734   \else
735     \endcsname0#1%
736   \fi
737 }

```

\InCa@AddDigit[1-9]

```

738 \def\InCa@Temp#1#2#3{%
739   \expandafter\def\csname InCa@AddDigit#1\endcsname##1{%
740     \ifnum##1>#2 %
741     \endcsname 1%
742   \else
743     \endcsname 0%
744   \fi
745   \ifcase##1 #1% 0
746   #3%
747   \else #1% 10
748   \fi
749   }%

```

```

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

```



```

812 \or 2% 6
813 \or 3% 7
814 \or 4% 8
815 \or 5% 9
816 }%
817 \InCa@Temp 72{%
818 \or 8% 1
819 \or 9% 2
820 \or 0% 3
821 \or 1% 4
822 \or 2% 5
823 \or 3% 6
824 \or 4% 7
825 \or 5% 8
826 \or 6% 9
827 }%
828 \InCa@Temp 81{%
829 \or 9% 1
830 \or 0% 2
831 \or 1% 3
832 \or 2% 4
833 \or 3% 5
834 \or 4% 6
835 \or 5% 7
836 \or 6% 8
837 \or 7% 9
838 }%
839 \InCa@Temp 90{%
840 \or 0% 1
841 \or 1% 2
842 \or 2% 3
843 \or 3% 4
844 \or 4% 5
845 \or 5% 6
846 \or 6% 7
847 \or 7% 8
848 \or 8% 9
849 }%

```

\InCa@SubDigit[0-9]

```

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

```

```

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

```

```

935 \or 0% 6
936 \or 9% 7
937 \or 8% 8
938 \or 7% 9
939 }
940 \InCa@Temp 7{%
941 \or 6% 1
942 \or 5% 2
943 \or 4% 3
944 \or 3% 4
945 \or 2% 5
946 \or 1% 6
947 \or 0% 7
948 \or 9% 8
949 \or 8% 9
950 }
951 \InCa@Temp 8{%
952 \or 7% 1
953 \or 6% 2
954 \or 5% 3
955 \or 4% 4
956 \or 3% 5
957 \or 2% 6
958 \or 1% 7
959 \or 0% 8
960 \or 9% 9
961 }
962 \InCa@Temp 9{%
963 \or 8% 1
964 \or 7% 2
965 \or 6% 3
966 \or 5% 4
967 \or 4% 5
968 \or 3% 6
969 \or 2% 7
970 \or 1% 8
971 \or 0% 9
972 }

```

2.5.6 Shl, Shr

\intcalcShl

```

973 \def\intcalcShl#1{%
974 \number\expandafter\InCa@ShlSwitch\number#1! %
975 }

```

\InCa@ShlSwitch

```

976 \def\InCa@ShlSwitch#1#2!{%
977 \ifx#1-%
978 -\csname InCa@Empty%
979 \InCa@Shl#2!%
980 \else
981 \csname InCa@Empty%
982 \InCa@Shl#1#2!%
983 \fi
984 }

```

\IntCalcShl

```

985 \def\IntCalcShl#1!{%
986 \number
987 \csname InCa@Empty%
988 \InCa@Shl#1! %

```

```

989 }

\IntCal@ShlDigit

990 \def\InCa@Shl#1#2{%
991   \ifx#2!%
992     \csname InCa@ShlDigit#1\endcsname0%
993   \else
994     \csname InCa@ShlDigit#1%
995     \@ReturnAfterFi{%
996       \InCa@Shl#2%
997     }%
998   \fi
999 }

\InCa@ShlDigit0

1000 \expandafter\def\csname InCa@ShlDigit0\endcsname{%
1001   \endcsname0%
1002 }

\InCa@ShlDigit[1-9]

1003 \def\InCa@Temp#1#2#3#4#5{%
1004   \expandafter\def\csname InCa@ShlDigit#1\endcsname##1{%
1005     \expandafter\endcsname
1006     \ifcase##1 %
1007       #2#3%
1008     \else
1009       #4#5%
1010     \fi
1011   }%
1012 }
1013 \InCa@Temp 10203
1014 \InCa@Temp 20405
1015 \InCa@Temp 30607
1016 \InCa@Temp 40809
1017 \InCa@Temp 51011
1018 \InCa@Temp 61213
1019 \InCa@Temp 71415
1020 \InCa@Temp 81617
1021 \InCa@Temp 91819

\intcalcShr

1022 \def\intcalcShr#1{%
1023   \number\expandafter\InCa@ShrSwitch\number#1! %
1024 }

\InCa@ShrSwitch

1025 \def\InCa@ShrSwitch#1#2!{%
1026   \ifx#1-%
1027     -\InCa@Shr#2!%
1028   \else
1029     \InCa@Shr#1#2!%
1030   \fi
1031 }

\IntCalcShr

1032 \def\IntCalcShr#1!{%
1033   \number\InCa@Shr#1! %
1034 }

\InCa@Shr

1035 \def\InCa@Shr#1#2{%

```

```

1036 \InCa@ShrDigit#1!%
1037 \ifx#2!%
1038 \else
1039 \ReturnAfterFi{%
1040 \ifodd#1 %
1041 \ReturnAfterElseFi{%
1042 \InCa@Shr{1#2}%
1043 }%
1044 \else
1045 \expandafter\InCa@Shr\expandafter#2%
1046 \fi
1047 }%
1048 \fi
1049 }

1050 \def\InCa@ShrDigit#1!{%
1051 \ifcase#1 0% 0
1052 \or 0% 1
1053 \or 1% 2
1054 \or 1% 3
1055 \or 2% 4
1056 \or 2% 5
1057 \or 3% 6
1058 \or 3% 7
1059 \or 4% 8
1060 \or 4% 9
1061 \or 5% 10
1062 \or 5% 11
1063 \or 6% 12
1064 \or 6% 13
1065 \or 7% 14
1066 \or 7% 15
1067 \or 8% 16
1068 \or 8% 17
1069 \or 9% 18
1070 \or 9% 19
1071 \fi
1072 }

```

2.5.7 \InCa@Tim

\InCa@Tim Macro \InCa@Tim implements “Number *times* digit”.

```

1073 \def\InCa@Temp#1{%
1074 \def\InCa@Tim##1##2{%
1075 \number
1076 \ifcase##2 % 0
1077 0%
1078 \or % 1
1079 ##1%
1080 \else % 2-9
1081 \csname InCa@Empty%
1082 \InCa@ProcessTim##2##1!%
1083 \fi
1084 #1%
1085 }%
1086 }
1087 \InCa@Temp{ }

```

\InCa@ProcessTim

```

1088 \def\InCa@ProcessTim#1#2#3{%
1089 \ifx#3!%
1090 \csname InCa@TimDigit#2\endcsname#10%

```

```

1091 \else
1092 \csname InCa@TimDigit#2\csname InCa@Param#1%
1093 \@ReturnAfterFi{%
1094 \InCa@ProcessTim#1#3%
1095 }%
1096 \fi
1097 }

\InCa@Param[0-9]

1098 \def\InCa@Temp#1{%
1099 \expandafter\def\csname InCa@Param#1\endcsname{%
1100 \endcsname#1%
1101 }%
1102 }
1103 \InCa@Temp 0%
1104 \InCa@Temp 1%
1105 \InCa@Temp 2%
1106 \InCa@Temp 3%
1107 \InCa@Temp 4%
1108 \InCa@Temp 5%
1109 \InCa@Temp 6%
1110 \InCa@Temp 7%
1111 \InCa@Temp 8%
1112 \InCa@Temp 9%

\InCa@TimDigit0

1113 \expandafter\def\csname InCa@TimDigit0\endcsname#1#2{%
1114 \endcsname
1115 0#2%
1116 }

\InCa@TimDigit1

1117 \expandafter\def\csname InCa@TimDigit1\endcsname#1#2{%
1118 \ifcase#2 %
1119 \endcsname 0#1%
1120 \else
1121 \csname InCa@AddDigit#1\endcsname #2%
1122 \fi
1123 }

\InCa@TimDigit[2-9]

1124 \def\InCa@Temp#1#2{%
1125 \expandafter\def\csname InCa@TimDigit#1\endcsname##1{%
1126 \expandafter\InCa@TimDigitCarry
1127 \number
1128 \ifcase##1 0% 0
1129 #2%
1130 \fi
1131 !%
1132 }%
1133 }
1134 \InCa@Temp 2{%
1135 \or 2% 1
1136 \or 4% 2
1137 \or 6% 3
1138 \or 8% 4
1139 \or 10% 5
1140 \or 12% 6
1141 \or 14% 7
1142 \or 16% 8
1143 \or 18% 9
1144 }

```

```

1145 \InCa@Temp 3{%
1146 \or 3% 1
1147 \or 6% 2
1148 \or 9% 3
1149 \or 12% 4
1150 \or 15% 5
1151 \or 18% 6
1152 \or 21% 7
1153 \or 24% 8
1154 \or 27% 9
1155 }
1156 \InCa@Temp 4{%
1157 \or 4% 1
1158 \or 8% 2
1159 \or 12% 3
1160 \or 16% 4
1161 \or 20% 5
1162 \or 24% 6
1163 \or 28% 7
1164 \or 32% 8
1165 \or 36% 9
1166 }
1167 \InCa@Temp 5{%
1168 \or 5% 1
1169 \or 10% 2
1170 \or 15% 3
1171 \or 20% 4
1172 \or 25% 5
1173 \or 30% 6
1174 \or 35% 7
1175 \or 40% 8
1176 \or 45% 9
1177 }
1178 \InCa@Temp 6{%
1179 \or 6% 1
1180 \or 12% 2
1181 \or 18% 3
1182 \or 24% 4
1183 \or 30% 5
1184 \or 36% 6
1185 \or 42% 7
1186 \or 48% 8
1187 \or 54% 9
1188 }
1189 \InCa@Temp 7{%
1190 \or 7% 1
1191 \or 14% 2
1192 \or 21% 3
1193 \or 28% 4
1194 \or 35% 5
1195 \or 42% 6
1196 \or 49% 7
1197 \or 56% 8
1198 \or 63% 9
1199 }
1200 \InCa@Temp 8{%
1201 \or 8% 1
1202 \or 16% 2
1203 \or 24% 3
1204 \or 32% 4
1205 \or 40% 5
1206 \or 48% 6

```

```

1207 \or 56% 7
1208 \or 64% 8
1209 \or 72% 9
1210 }
1211 \InCa@Temp 9{%
1212 \or 9% 1
1213 \or 18% 2
1214 \or 27% 3
1215 \or 36% 4
1216 \or 45% 5
1217 \or 54% 6
1218 \or 63% 7
1219 \or 72% 8
1220 \or 81% 9
1221 }

```

\InCa@TimDigitCarry

```

1222 \def\InCa@TimDigitCarry#1!{%
1223 \ifnum#1<10 %
1224 \csname InCa@AddDigit#1\expandafter\endcsname
1225 \else
1226 \@ReturnAfterFi{%
1227 \InCa@@TimDigitCarry#1!%
1228 }%
1229 \fi
1230 }

```

\InCa@@TimDigitCarry

```

1231 \def\InCa@@TimDigitCarry#1#2!#3{%
1232 \csname InCa@DigitCarry#1%
1233 \csname InCa@AddDigit#2\endcsname #3%
1234 }

```

2.5.8 Mul

\intcalcMul

```

1235 \def\intcalcMul#1#2{%
1236 \number
1237 \expandafter\InCa@MulSwitch
1238 \number\number#1\expandafter!%
1239 \number#2! %
1240 }

```

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

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

```

1241 \def\InCa@MulSwitch#1!#2!{%
1242 \ifnum#1<\z@
1243 \ifnum#2<\z@
1244 \ifnum#1<#2 %
1245 \expandafter\InCa@Mul\number-#1\expandafter!%
1246 \@gobble#2!%
1247 \else

```



```

1248     \expandafter\InCa@Mul\number-#2\expandafter!%
1249     \@gobble#1!%
1250   \fi
1251 \else
1252   -%
1253   \ifnum-#1>#2 %
1254     \expandafter\InCa@Mul\@gobble#1!#2!%
1255   \else
1256     \expandafter\InCa@Mul\number#2\expandafter!%
1257     \@gobble#1!%
1258   \fi
1259 \fi
1260 \else
1261   \ifnum#2<\z@
1262     -%
1263     \ifnum#1>-#2 %
1264       \expandafter\InCa@Mul\number#1\expandafter!%
1265       \@gobble#2!%
1266     \else
1267       \expandafter\InCa@Mul\@gobble#2!#1!%
1268     \fi
1269   \else
1270     \ifnum#1>#2 %
1271       \InCa@Mul#1!#2!%
1272     \else
1273       \InCa@Mul#2!#1!%
1274     \fi
1275   \fi
1276 \fi
1277 }

```

\IntCalcMul

```

1278 \def\IntCalcMul#1!#2!{%
1279   \number\InCa@Mul#1!#2! %
1280 }

```

\InCa@Mul

```

1281 \def\InCa@Mul#1!#2!{%
1282   \ifcase#2 %
1283     0%
1284   \or
1285     #1%
1286   \or
1287     \csname InCa@Empty%
1288       \expandafter\InCa@Shl#1!%
1289   \else
1290     \ifnum#2<10 %
1291       \InCa@Tim{#1}#2%
1292     \else
1293       \InCa@ProcessMul!#2!#1!%
1294     \fi
1295   \fi
1296 }

```

\InCa@Mul

```

1297 \def\InCa@ProcessMul#1!#2#3!#4!{%
1298   \ifx\InCa@Empty#3\InCa@Empty
1299     \expandafter\InCa@Add\number
1300     #10\expandafter\expandafter\expandafter!%
1301     \InCa@Tim{#4}#2!%
1302   \else
1303     \ifx\InCa@Empty#1\InCa@Empty

```

```

1304     \expandafter\expandafter\expandafter\InCa@ProcessMul
1305     \InCa@Tim{#4}#2!%
1306     #3!#4!%
1307   \else
1308     \expandafter\InCa@ProcessMul\number
1309     \expandafter\InCa@Add\number%
1310     #10\expandafter\expandafter\expandafter!%
1311     \InCa@Tim{#4}#2!!%
1312     #3!#4!%
1313   \fi
1314 \fi
1315 }

```

2.5.9 Sqr, Fac

\intcalcSqr

```

1316 \def\intcalcSqr#1{%
1317   \number\expandafter\InCa@Sqr\number#1! %
1318 }

```

\InCa@Sqr

```

1319 \def\InCa@Sqr#1#2!{%
1320   \ifx#1-%
1321     \InCa@Mul#2!#2!%
1322   \else
1323     \InCa@Mul#1#2!#1#2!%
1324   \fi
1325 }

```

\intcalcFac

```

1326 \def\intcalcFac#1{%
1327   \number\expandafter\InCa@Fac\number#1! %
1328 }

```

2.5.10 Pow

\intcalcPow

```

1329 \def\intcalcPow#1#2{%
1330   \number\expandafter\InCa@Pow
1331   \number\number#1\expandafter!%
1332   \number#2! %
1333 }

```

\InCa@Pow

```

1334 \def\InCa@Pow#1#2!#3#4!{%
1335   \ifcase#3#4 % power = 0
1336     1%
1337   \or % power = 1
1338     #1#2%
1339   \or % power = 2
1340     \ifx#1-%
1341       \InCa@Mul#2!#2!%
1342     \else
1343       \InCa@Mul#1#2!#1#2!%
1344     \fi
1345   \else
1346     \ifcase#1#2 % basis = 0, power <> 0
1347       0%
1348     \ifx#3-% power < 0
1349       0\IntCalcError:DivisionByZero%
1350     \fi

```

```

1351 \or
1352 1% basis = 1
1353 \else
1354 \ifnum#1#2=\m@ne % basis = -1
1355 \ifodd#3#4 %
1356 -%
1357 \fi
1358 1%
1359 \else % |basis| > 1
1360 \ifx#3-% power < 0
1361 0%
1362 \else % power > 2
1363 \ifx#1-% basis < 0
1364 \ifodd#3#4 %
1365 -%
1366 \fi
1367 \InCa@PowRec#2!#3#4!1!%
1368 \else
1369 \InCa@PowRec#1#2!#3#4!1!%
1370 \fi
1371 \fi
1372 \fi
1373 \fi
1374 \fi
1375 }

\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
}

1376 \def\InCa@PowRec#1!#2!#3!{%
1377 \ifnum#2=\@ne
1378 \ifnum#1>#3 %
1379 \InCa@Mul#1!#3!%
1380 \else
1381 \InCa@Mul#3!#1!%
1382 \fi
1383 \else
1384 \expandafter\InCa@PowRec
1385 \number\InCa@Mul#1!#1!\expandafter!%
1386 \number\intcalcShr{#2}\expandafter!%
1387 \number
1388 \ifodd#2 %
1389 \ifnum#1>#3 %
1390 \InCa@Mul#1!#3!%
1391 \else
1392 \InCa@Mul#3!#1!%
1393 \fi
1394 \else
1395 #3%
1396 \fi
1397 \expandafter!%
1398 \fi

```

1399 }

2.5.11 Div

\intcalcDiv

```
1400 \def\intcalcDiv#1#2{%
1401   \number\expandafter\InCa@Div
1402   \number\number#1\expandafter!%
1403   \number#2! %
1404 }
```

\InCa@Div

```
1405 \def\InCa@Div#1!#2!{%
1406   \ifcase#2 %
1407     0\IntCalcError:DivisionByZero%
1408   \else
1409     \ifcase#1 %
1410       0%
1411     \else
1412       \expandafter\InCa@DivSwitch
1413       \number#1\expandafter!%
1414       \number#2!%
1415     \fi
1416   \fi
1417 }
```

\IntCalcDiv

```
1418 \def\InCa@Temp#1{%
1419   \def\IntCalcDiv##1!##2!{%
1420     \number
1421     \ifcase##2 %
1422       0\IntCalcError:DivisionByZero%
1423     \else
1424       \ifcase##1 %
1425         0%
1426       \else
1427         \InCa@@Div##1!##2!%
1428       \fi
1429     \fi
1430     #1%
1431   }%
1432 }
1433 \InCa@Temp{ }%
```

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

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

```
1434 \def\InCa@DivSwitch#1!#2!{%
1435   \ifnum#1<\z@
1436     \ifnum#2<\z@
1437       \expandafter\InCa@@Div\number-#1\expandafter!%
1438       \@gobble#2!%
1439     \else
1440       -%
1441       \expandafter\InCa@@Div\@gobble#1!#2!%
1442     \fi
1443   \else
```

```

1444     \ifnum#2<\z@
1445     -%
1446     \expandafter\InCa@@Div\number#1\expandafter!%
1447     \@gobble#2!%
1448     \else
1449     \InCa@@Div#1!#2!%
1450     \fi
1451 \fi
1452 }

\InCa@@Div
1453 \def\InCa@@Div#1!#2!{%
1454     \ifnum#1>#2 %
1455     \ifcase#2 % 0 already caught
1456 ?     \IntCalcError:ThisCannotHappen%
1457     \or % 1
1458     #1%
1459     \or % 2
1460     \InCa@Shr#1!%
1461     \else
1462     \InCa@DivStart!#1!#2!#2!%
1463     \fi
1464 \else
1465     \ifnum#1=#2 %
1466     1%
1467     \else
1468     0%
1469     \fi
1470 \fi
1471 }

\InCa@DivStart
1472 \def\InCa@DivStart#1!#2#3!#4#5{%
1473     \ifx#5!%
1474     \@ReturnAfterElseFi{%
1475     \InCa@DivStartI{#1#2}#3=!%
1476     }%
1477 \else
1478     \@ReturnAfterFi{%
1479     \InCa@DivStart{#1#2}!#3!#5%
1480     }%
1481 \fi
1482 }

\InCa@StartI
1483 \def\InCa@DivStartI#1!#2!{%
1484     \expandafter\InCa@DivStartII
1485     \number#2\expandafter\expandafter\expandafter!%
1486     \intcalcShl{#2}!%
1487     #1!%
1488 }

\InCa@StartII
1489 \def\InCa@DivStartII#1!#2!{%
1490     \expandafter\InCa@DivStartIII
1491     \number#1\expandafter!%
1492     \number#2\expandafter\expandafter\expandafter!%
1493     \intcalcShl{#2}!%
1494 }

\InCa@StartIII

```

```

1495 \def\InCa@DivStartIII#1!#2!#3!{%
1496   \expandafter\InCa@DivStartIV
1497   \number#1\expandafter!%
1498   \number#2\expandafter!%
1499   \number#3\expandafter!%
1500   \number\InCa@Add#3!#2!\expandafter\expandafter\expandafter!%
1501   \intcalcShl{#3}!%
1502 }

```

\InCa@StartIV

```

1503 \def\InCa@DivStartIV#1!#2!#3!#4!#5!#6!{%
1504   \InCa@ProcessDiv#6!#1!#2!#3!#4!#5!/%
1505 }

```

\InCa@ProcessDiv

```

1506 \def\InCa@ProcessDiv#1#2#3!#4!#5!#6!#7!#8!#9/{%
1507   #9%
1508   \ifnum#1<#4 % 0
1509     0%
1510     \ifx#2=%
1511     \else
1512       \InCa@ProcessDiv{#1#2}#3!#4!#5!#6!#7!#8!%
1513     \fi
1514   \else % 1-9
1515     \ifnum#1<#5 % 1
1516       1%
1517       \ifx#2=%
1518       \else
1519         \expandafter\InCa@ProcessDiv\expandafter{%
1520           \number\InCa@Sub#1!#4!%
1521           #2%
1522         }#3!#4!#5!#6!#7!#8!%
1523       \fi
1524     \else % 2-9
1525       \ifnum#1<#7 % 2 3 4 5
1526       \ifnum#1<#6 % 2 3
1527         \@ReturnAfterElseFi{%
1528           \expandafter\InCa@@ProcessDiv
1529           \number\InCa@Sub#1!#5!%
1530           23%
1531         }%
1532       \else % 4 5
1533         \@ReturnAfterFi{%
1534           \expandafter\InCa@@ProcessDiv
1535           \number\InCa@Sub#1!#6!%
1536           45%
1537         }%
1538       \fi
1539       #2#3!#4!#5!#6!#7!#8!%
1540     \else % 6 7 8 9
1541       \ifnum#1<#8 % 6 7
1542         \@ReturnAfterElseFi{%
1543           \expandafter\InCa@@ProcessDiv
1544           \number\InCa@Sub#1!#7!%
1545           67%
1546         }%
1547       \else % 8 9
1548         \@ReturnAfterFi{%
1549           \expandafter\InCa@@ProcessDiv
1550           \number\InCa@Sub#1!#8!%
1551           89%
1552         }%

```

```

1553     \fi
1554     #2#3!#4!#5!#6!#7!#8!%
1555     \fi
1556     \fi
1557     \fi
1558     \ifx#2=%
1559         \expandafter\@gobble
1560     \fi
1561     /%
1562 }

```

\InCa@@ProcessDiv

```

1563 \def\InCa@@ProcessDiv#1!#2#3#4#5!#6!{%
1564     \ifnum#1<#6 %
1565         #2%
1566         \@ReturnAfterElseFi{%
1567             \ifx#4=%
1568                 \expandafter\InCa@CleanupIV
1569             \else
1570                 \@ReturnAfterFi{%
1571                     \InCa@ProcessDiv{#1#4}#5!#6!%
1572                 }%
1573             \fi
1574         }%
1575     \else
1576         #3%
1577         \@ReturnAfterFi{%
1578             \ifx#4=%
1579                 \expandafter\InCa@CleanupIV
1580             \else
1581                 \@ReturnAfterFi{%
1582                     \expandafter\InCa@ProcessDiv\expandafter{%
1583                         \number\InCa@Sub#1!#6! %
1584                         #4%
1585                     }#5!#6!%
1586                 }%
1587             \fi
1588         }%
1589     \fi
1590 }

```

\InCa@CleanupIV

```

1591 \def\InCa@CleanupIV#1!#2!#3!#4!{}

```

2.5.12 Mod

\intcalcMod

```

1592 \def\intcalcMod#1#2{%
1593     \number\expandafter\InCa@Mod
1594     \number\number#1\expandafter!%
1595     \number#2! %
1596 }

```

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

```

if      y = 0   DivisionByZero
elsif  y < 0   - Mod(-x, -y)
elsif  x = 0   0
elsif  y = 1   0
elsif  y = 2   ifodd(x) ? 1 : 0
elsif  x < 0   z ← x - (x/y) * y;   (z < 0) ? z + y : z
else        x - (x/y) * y

```

```

1597 \def\InCa@Mod#1!#2!{%
1598   \ifcase#2 %
1599     0\IntCalcError:DivisionByZero%
1600   \else
1601     \ifnum#2<\z@
1602       -%
1603       \expandafter\InCa@Mod
1604       \number-#1\expandafter!%
1605       \number-#2!%
1606     \else
1607       \ifcase#1 %
1608         0%
1609       \else
1610         \ifcase#2 % 0 already caught
1611 ?       \IntCalcError:ThisCannotHappen%
1612         \or % 1
1613         0%
1614         \or % 2
1615         \ifodd#1 1\else 0\fi
1616       \else
1617         \ifnum#1<\z@
1618         \expandafter\InCa@ModShift
1619         \number-%
1620         \expandafter\InCa@Sub
1621         \number\@gobble#1\expandafter!%
1622         \number\intcalcMul{#2}{%
1623         \expandafter\InCa@Div\@gobble#1!#2!%
1624         }!%
1625         !#2!%
1626       \else
1627         \expandafter\InCa@Sub\number#1\expandafter!%
1628         \number\intcalcMul{#2}{\InCa@Div#1!#2!}%
1629       \fi
1630     \fi
1631   \fi
1632 \fi
1633 \fi
1634 }

```

\IntCalcMod

```

1635 \def\InCa@Temp#1{%
1636   \def\IntCalcMod##1!##2!{%
1637     \number
1638     \ifcase##2 %
1639       0\IntCalcError:DivisionByZero%
1640     \else
1641       \ifcase##1 %
1642         0%
1643       \else
1644         \ifcase##2 % 0 already caught
1645 ?       \IntCalcError:ThisCannotHappen
1646         \or % 1
1647         0%
1648         \or % 2
1649         \ifodd ##1 1\else 0\fi
1650       \else
1651         \expandafter\InCa@Sub\number##1\expandafter!%
1652         \number\intcalcMul{##2}{\InCa@Div##1!##2!}%
1653       \fi
1654     \fi
1655   \fi
1656   #1%
1657 }%

```



```

1658 }
1659 \InCa@Temp{ }%

```

\InCa@ModShift

```

1660 \def\InCa@ModShift#1!#2!{%
1661   \ifnum#1<\z@
1662     \expandafter\InCa@Sub\number#2\expandafter!%
1663     \@gobble#1!%
1664   \else
1665     #1%
1666   \fi
1667 }

```

2.5.13 Help macros

\InCa@Empty

```

1668 \def\InCa@Empty{}

```

\@gobble

```

1669 \expandafter\ifx\csname \@gobble\endcsname\relax
1670   \long\def\@gobble#1{}%
1671 \fi

```

\@ReturnAfterFi

```

1672 \long\def\@ReturnAfterFi#1\fi{\fi#1}%

```

\@ReturnAfterElseFi

```

1673 \long\def\@ReturnAfterElseFi#1\else#2\fi{\fi#1}%

```

```

1674 \InCa@AtEnd

```

```

1675 </package>

```

3 Test

3.1 Catcode checks for loading

```

1676 <*test1>
1677 \catcode'\{=1 %
1678 \catcode'\}=2 %
1679 \catcode'\#=6 %
1680 \catcode'\@=11 %
1681 \expandafter\ifx\csname count@\endcsname\relax
1682   \countdef\count@=255 %
1683 \fi
1684 \expandafter\ifx\csname \@gobble\endcsname\relax
1685   \long\def\@gobble#1{}%
1686 \fi
1687 \expandafter\ifx\csname @firstofone\endcsname\relax
1688   \long\def\@firstofone#1{#1}%
1689 \fi
1690 \expandafter\ifx\csname loop\endcsname\relax
1691   \expandafter\@firstofone
1692 \else
1693   \expandafter\@gobble
1694 \fi
1695 {%
1696   \def\loop#1\repeat{%
1697     \def\body{#1}%
1698     \iterate
1699   }%

```

```

1700 \def\iterate{%
1701   \body
1702   \let\next\iterate
1703   \else
1704   \let\next\relax
1705   \fi
1706   \next
1707 }%
1708 \let\repeat=\fi
1709 }%
1710 \def\RestoreCatcodes{}
1711 \count@=0 %
1712 \loop
1713   \edef\RestoreCatcodes{%
1714     \RestoreCatcodes
1715     \catcode\the\count@=\the\catcode\count@\relax
1716   }%
1717 \ifnum\count@<255 %
1718   \advance\count@ 1 %
1719 \repeat
1720
1721 \def\RangeCatcodeInvalid#1#2{%
1722   \count@=#1\relax
1723   \loop
1724     \catcode\count@=15 %
1725   \ifnum\count@<#2\relax
1726     \advance\count@ 1 %
1727   \repeat
1728 }
1729 \expandafter\ifx\csname LoadCommand\endcsname\relax
1730 \def\LoadCommand{\input intcalc.sty\relax}%
1731 \fi
1732 \def\Test{%
1733   \RangeCatcodeInvalid{0}{47}%
1734   \RangeCatcodeInvalid{58}{64}%
1735   \RangeCatcodeInvalid{91}{96}%
1736   \RangeCatcodeInvalid{123}{255}%
1737   \catcode'\@=12 %
1738   \catcode'\=0 %
1739   \catcode'\{=1 %
1740   \catcode'\}=2 %
1741   \catcode'\#=6 %
1742   \catcode'\[=12 %
1743   \catcode'\]=12 %
1744   \catcode'\%=14 %
1745   \catcode'\ =10 %
1746   \catcode13=5 %
1747   \LoadCommand
1748   \RestoreCatcodes
1749 }
1750 \Test
1751 \csname @@end\endcsname
1752 \end
1753 </test1>

```

3.2 Macro tests

3.2.1 Preamble with test macro definitions

```

1754 <*test2 | test4>
1755 \NeedsTeXFormat{LaTeX2e}
1756 \nofiles
1757 \documentclass{article}

```

```

1758 <noetex> \let \SavedNumexpr \numexpr
1759 <noetex> \let \numexpr \UNDEFINED
1760 \makeatletter
1761 \chardef \InCa@TestMode=1 %
1762 \makeatother
1763 \usepackage{intcalc}[2007/09/27]
1764 <noetex> \let \numexpr \SavedNumexpr
1765 \usepackage{qstest}
1766 \IncludeTests{*}
1767 \LogTests{log}{*}{*}
1768 </test2 | test4>
1769 <*test2>
1770 \newcommand*{\TestSpaceAtEnd}[1]{%
1771 <noetex> \let \SavedNumexpr \numexpr
1772 <noetex> \let \numexpr \UNDEFINED
1773 \edef\resultA{#1}%
1774 \edef\resultB{#1 }%
1775 <noetex> \let \numexpr \SavedNumexpr
1776 \Expect*{\resultA\space}*{\resultB}%
1777 }
1778 \newcommand*{\TestResult}[2]{%
1779 <noetex> \let \SavedNumexpr \numexpr
1780 <noetex> \let \numexpr \UNDEFINED
1781 \edef\result{#1}%
1782 <noetex> \let \numexpr \SavedNumexpr
1783 \Expect*{\result}{#2}%
1784 }
1785 \newcommand*{\TestResultTwoExpansions}[2]{%
1786 <*noetex>
1787 \begingroup
1788 \let \numexpr \UNDEFINED
1789 \expandafter\expandafter\expandafter
1790 \endgroup
1791 </noetex>
1792 \expandafter\expandafter\expandafter\Expect
1793 \expandafter\expandafter\expandafter{#1}{#2}%
1794 }
1795 \newcount\TestCount
1796 <etex> \newcommand*{\TestArg}[1]{\numexpr#1\relax}
1797 <noetex> \newcommand*{\TestArg}[1]{#1}
1798 \newcommand*{\TestTeXDivide}[2]{%
1799 \TestCount=\TestArg{#1}\relax
1800 \divide\TestCount by \TestArg{#2}\relax
1801 \Expect*{\intcalcDiv{#1}{#2}}*{\the\TestCount}%
1802 }
1803 \newcommand*{\Test}[2]{%
1804 \TestResult{#1}{#2}%
1805 \TestResultTwoExpansions{#1}{#2}%
1806 \TestSpaceAtEnd{#1}%
1807 }
1808 \newcommand*{\TestExch}[2]{\Test{#2}{#1}}
1809 \newcommand*{\TestInv}[2]{%
1810 \Test{\intcalcInv{#1}}{#2}%
1811 }
1812 \newcommand*{\TestNum}[2]{%
1813 \Test{\intcalcNum{#1}}{#2}%
1814 }
1815 \newcommand*{\TestAbs}[2]{%
1816 \Test{\intcalcAbs{#1}}{#2}%
1817 }
1818 \newcommand*{\TestSgn}[2]{%
1819 \Test{\intcalcSgn{#1}}{#2}%

```

```

1820 }
1821 \newcommand*{\TestMin}[3]{%
1822   \Test{\intcalcMin{#1}{#2}}{#3}%
1823 }
1824 \newcommand*{\TestMax}[3]{%
1825   \Test{\intcalcMax{#1}{#2}}{#3}%
1826 }
1827 \newcommand*{\TestCmp}[3]{%
1828   \Test{\intcalcCmp{#1}{#2}}{#3}%
1829 }
1830 \newcommand*{\TestInc}[2]{%
1831   \Test{\intcalcInc{#1}}{#2}%
1832   \ifnum\intcalcNum{#1}>-1 %
1833     \edef\x{%
1834       \noexpand\Test{%
1835         \noexpand\IntCalcInc\intcalcNum{#1}!%
1836       }{#2}%
1837     }%
1838     \x
1839   \fi
1840 }
1841 \newcommand*{\TestDec}[2]{%
1842   \Test{\intcalcDec{#1}}{#2}%
1843   \ifnum\intcalcNum{#1}>0 %
1844     \edef\x{%
1845       \noexpand\Test{%
1846         \noexpand\IntCalcDec\intcalcNum{#1}!%
1847       }{#2}%
1848     }%
1849     \x
1850   \fi
1851 }
1852 \newcommand*{\TestAdd}[3]{%
1853   \Test{\intcalcAdd{#1}{#2}}{#3}%
1854   \ifnum\intcalcNum{#1}>0 %
1855     \ifnum\intcalcNum{#2}> 0 %
1856       \ifnum\intcalcCmp{#1}{#2}>0 %
1857         \edef\x{%
1858           \noexpand\Test{%
1859             \noexpand\IntCalcAdd
1860             \intcalcNum{#1}!\intcalcNum{#2}!%
1861           }{#3}%
1862         }%
1863         \x
1864       \else
1865         \edef\x{%
1866           \noexpand\Test{%
1867             \noexpand\IntCalcAdd
1868             \intcalcNum{#2}!\intcalcNum{#1}!%
1869           }{#3}%
1870         }%
1871         \x
1872       \fi
1873     \fi
1874   \fi
1875 }
1876 \newcommand*{\TestSub}[3]{%
1877   \Test{\intcalcSub{#1}{#2}}{#3}%
1878   \ifnum\intcalcNum{#1}>0 %
1879     \ifnum\intcalcNum{#2}> 0 %
1880       \ifnum\intcalcCmp{#1}{#2}>0 %
1881         \edef\x{%

```

```

1882         \noexpand\Test{%
1883         \noexpand\IntCalcSub
1884         \intcalcNum{#1}!\intcalcNum{#2}!%
1885         }{#3}%
1886     }%
1887     \x
1888     \fi
1889     \fi
1890 \fi
1891 }
1892 \newcommand*\TestShl}[2]{%
1893 \Test{\intcalcShl{#1}}{#2}%
1894 \edef\x{%
1895     \noexpand\Test{%
1896     \noexpand\IntCalcShl\intcalcAbs{#1}!%
1897     }{\intcalcAbs{#2}}%
1898 }%
1899 \x
1900 }
1901 \newcommand*\TestShr}[2]{%
1902 \Test{\intcalcShr{#1}}{#2}%
1903 \edef\x{%
1904     \noexpand\Test{%
1905     \noexpand\IntCalcShr\intcalcAbs{#1}!%
1906     }{\intcalcAbs{#2}}%
1907 }%
1908 \x
1909 }
1910 \newcommand*\TestMul}[3]{%
1911 \Test{\intcalcMul{#1}{#2}}{#3}%
1912 \edef\x{%
1913     \noexpand\Test{%
1914     \noexpand\IntCalcMul\intcalcAbs{#1}!\intcalcAbs{#2}!%
1915     }{\intcalcAbs{#3}}%
1916 }%
1917 \x
1918 }
1919 \newcommand*\TestSqr}[2]{%
1920 \Test{\intcalcSqr{#1}}{#2}%
1921 }
1922 \newcommand*\TestFac}[2]{%
1923 \expandafter\TestExch\expandafter{\the\numexpr#2}{\intcalcFac{#1}}%
1924 }
1925 \newcommand*\TestPow}[3]{%
1926 \Test{\intcalcPow{#1}{#2}}{#3}%
1927 }
1928 \newcommand*\TestDiv}[3]{%
1929 \Test{\intcalcDiv{#1}{#2}}{#3}%
1930 \TestTeXDivide{#1}{#2}%
1931 \edef\x{%
1932     \noexpand\Test{%
1933     \noexpand\IntCalcDiv\intcalcAbs{#1}!\intcalcAbs{#2}!%
1934     }{\intcalcAbs{#3}}%
1935 }%
1936 }
1937 \newcommand*\TestMod}[3]{%
1938 \Test{\intcalcMod{#1}{#2}}{#3}%
1939 \ifcase\ifcase\intcalcSgn{#1} 0%
1940     \or
1941     \ifcase\intcalcSgn{#2} 1%
1942     \or 0%
1943     \else 1%

```

```

1944         \fi
1945     \else
1946         \ifcase\intcalcSgn{#2} 1%
1947         \or 1%
1948         \else 0%
1949         \fi
1950     \fi\relax
1951 \edef\x{%
1952     \noexpand\Test{%
1953         \noexpand\IntCalcMod
1954         \intcalcAbs{#1}!\intcalcAbs{#2}!%
1955     }\intcalcAbs{#3}}%
1956 }%
1957 \x
1958 \fi
1959 }
1960 </test2>

```

3.2.2 Time

```

1961 <*test2>
1962 \begingroup\expandafter\expandafter\expandafter\endgroup
1963 \expandafter\ifx\csname pdfresettimer\endcsname\relax
1964 \else
1965     \makeatletter
1966     \newcount\SummaryTime
1967     \newcount\TestTime
1968     \SummaryTime=\z@
1969     \newcommand*\PrintTime}[2]{%
1970         \typeout{%
1971             [Time #1: \strip@pt\dimexpr\number#2sp\relax\space s]%
1972         }%
1973     }%
1974     \newcommand*\StartTime#[1]{%
1975         \renewcommand*\TimeDescription}{#1}%
1976         \pdfresettimer
1977     }%
1978     \newcommand*\TimeDescription{}%
1979     \newcommand*\StopTime{%
1980         \TestTime=\pdfelapsedtime
1981         \global\advance\SummaryTime\TestTime
1982         \PrintTime\TimeDescription\TestTime
1983     }%
1984     \let\saved@qstest\qstest
1985     \let\saved@endqstest\endqstest
1986     \def\qstest#1#2{%
1987         \saved@qstest{#1}{#2}%
1988         \StartTime{#1}%
1989     }%
1990     \def\endqstest{%
1991         \StopTime
1992         \saved@endqstest
1993     }%
1994     \AtEndDocument{%
1995         \PrintTime{summary}\SummaryTime
1996     }%
1997     \makeatother
1998 \fi
1999 </test2>

```

3.2.3 Test 4: additional mod/div operations

```

2000 <*test4>
2001 \newcommand*\TestDo}[2]{%
2002     \ifcase\numexpr#2\relax

```

```

2003 \else
2004   \edef\temp{\intcalcMod{#1}{#2}}%
2005   \Expect*{%
2006     \the\numexpr
2007     \intcalcMul{%
2008       \intcalcDiv{\intcalcAbs{#1}}{\intcalcAbs{#2}}}%
2009     }{\intcalcAbs{#2}}}%
2010   +\intcalcMod{\intcalcAbs{#1}}{\intcalcAbs{#2}}\relax
2011   }*{\the\numexpr\intcalcAbs{#1}\relax}%
2012 \fi
2013 }
2014 \newcommand*{\TestOne}[2]{%
2015   \TestDo{#1}{#1}%
2016 }
2017 \newcommand*{\TestTwo}[3]{%
2018   \TestDo{#1}{#2}%
2019   \TestDo{#2}{#1}%
2020 }
2021 \let\TestNum\TestOne
2022 \let\TestInv\TestOne
2023 \let\TestAbs\TestOne
2024 \let\TestSgn\TestOne
2025 \let\TestMin\TestTwo
2026 \let\TestMax\TestTwo
2027 \let\TestCmp\TestTwo
2028 \let\TestInc\TestOne
2029 \let\TestDec\TestOne
2030 \let\TestAdd\TestTwo
2031 \let\TestSub\TestTwo
2032 \let\TestShl\TestOne
2033 \let\TestShr\TestOne
2034 \let\TestMul\TestTwo
2035 \let\TestSqr\TestOne
2036 \def\TestFac#1#2{}
2037 \let\TestPow\TestTwo
2038 \let\TestDiv\TestTwo
2039 \let\TestMod\TestTwo
2040 \end{test4}

```

3.2.4 Test sets

```

2041 \test2 | test4)
2042 \makeatletter
2043
2044 \begin{qstest}{num}{num}%
2045   \TestNum{0}{0}%
2046   \TestNum{1}{1}%
2047   \TestNum{-1}{-1}%
2048   \TestNum{10}{10}%
2049   \TestNum{-10}{-10}%
2050   \TestNum{2147483647}{2147483647}%
2051   \TestNum{-2147483647}{-2147483647}%
2052   \TestNum{ 0 }{0}%
2053   \TestNum{ 1 }{1}%
2054   \TestNum{--1}{1}%
2055   \TestNum{ - + - + 4 }{4}%
2056   \TestNum{\z@}{0}%
2057   \TestNum{\@ne}{1}%
2058   \TestNum{\m@ne}{-1}%
2059 \etex
2060   \TestNum{-10+30}{20}%
2061   \TestNum{10-30}{-20}%
2062 \etex
2063 \end{qstest}

```

```

2064
2065 \begin{qstest}{inv}{inv}%
2066 \TestInv{0}{0}%
2067 \TestInv{1}{-1}%
2068 \TestInv{-1}{1}%
2069 \TestInv{10}{-10}%
2070 \TestInv{-10}{10}%
2071 \TestInv{2147483647}{-2147483647}%
2072 \TestInv{-2147483647}{2147483647}%
2073 \TestInv{ 0 }{0}%
2074 \TestInv{ 1 }{-1}%
2075 \TestInv{--1}{-1}%
2076 \TestInv{\z0}{0}%
2077 \TestInv{\@ne}{-1}%
2078 \TestInv{\m@ne}{1}%
2079 \etex
2080 \TestInv{-10+30}{-20}%
2081 \TestInv{10-30}{20}%
2082 \etex
2083 \end{qstest}
2084
2085 \begin{qstest}{abs}{abs}%
2086 \TestAbs{0}{0}%
2087 \TestAbs{1}{1}%
2088 \TestAbs{-1}{1}%
2089 \TestAbs{10}{10}%
2090 \TestAbs{-10}{10}%
2091 \TestAbs{2147483647}{2147483647}%
2092 \TestAbs{-2147483647}{2147483647}%
2093 \TestAbs{ 0 }{0}%
2094 \TestAbs{ 1 }{1}%
2095 \TestAbs{--1}{1}%
2096 \TestAbs{\z0}{0}%
2097 \TestAbs{\@ne}{1}%
2098 \TestAbs{\m@ne}{1}%
2099 \etex
2100 \TestAbs{-10+30}{20}%
2101 \TestAbs{10-30}{20}%
2102 \etex
2103 \end{qstest}
2104
2105 \begin{qstest}{sign}{sign}%
2106 \TestSgn{0}{0}%
2107 \TestSgn{1}{1}%
2108 \TestSgn{-1}{-1}%
2109 \TestSgn{10}{1}%
2110 \TestSgn{-10}{-1}%
2111 \TestSgn{2147483647}{1}%
2112 \TestSgn{-2147483647}{-1}%
2113 \TestSgn{ 0 }{0}%
2114 \TestSgn{ 2 }{1}%
2115 \TestSgn{ -2 }{-1}%
2116 \TestSgn{--2}{1}%
2117 \TestSgn{\z0}{0}%
2118 \TestSgn{\@ne}{1}%
2119 \TestSgn{\m@ne}{-1}%
2120 \etex
2121 \TestSgn{-10+30}{1}%
2122 \TestSgn{10-30}{-1}%
2123 \etex
2124 \end{qstest}
2125

```



```

2126 \begin{qstest}{min}{min}%
2127   \TestMin{0}{1}{0}%
2128   \TestMin{1}{0}{0}%
2129   \TestMin{-10}{-20}{-20}%
2130   \TestMin{ 1 }{ 2 }{1}%
2131   \TestMin{ 2 }{ 1 }{1}%
2132   \TestMin{1}{1}{1}%
2133   \TestMin{\z@}{\@ne}{0}%
2134   \TestMin{\@ne}{\m@ne}{-1}%
2135 \etex
2136   \TestMin{1+2}{3+4}{3}%
2137 \etex
2138 \end{qstest}
2139
2140 \begin{qstest}{max}{max}%
2141   \TestMax{0}{1}{1}%
2142   \TestMax{1}{0}{1}%
2143   \TestMax{-10}{-20}{-10}%
2144   \TestMax{ 1 }{ 2 }{2}%
2145   \TestMax{ 2 }{ 1 }{2}%
2146   \TestMax{1}{1}{1}%
2147   \TestMax{\z@}{\@ne}{1}%
2148   \TestMax{\@ne}{\m@ne}{1}%
2149 \etex
2150   \TestMax{1+2}{3+4}{7}%
2151 \etex
2152 \end{qstest}
2153
2154 \begin{qstest}{cmp}{cmp}%
2155   \TestCmp{0}{0}{0}%
2156   \TestCmp{-21}{17}{-1}%
2157   \TestCmp{3}{4}{-1}%
2158   \TestCmp{-10}{-10}{0}%
2159   \TestCmp{-10}{-11}{1}%
2160   \TestCmp{100}{5}{1}%
2161   \TestCmp{2147483647}{-2147483647}{1}%
2162   \TestCmp{-2147483647}{2147483647}{-1}%
2163   \TestCmp{2147483647}{2147483647}{0}%
2164   \TestCmp{\z@}{\@ne}{-1}%
2165   \TestCmp{\@ne}{\m@ne}{1}%
2166   \TestCmp{ 4 }{ 5 }{-1}%
2167   \TestCmp{ -3 }{ -7 }{1}%
2168 \etex
2169   \TestCmp{1+2}{3+4}{-1}%
2170 \etex
2171 \end{qstest}
2172
2173 \begin{qstest}{fac}{fac}
2174   \TestFac{0}{1}%
2175   \TestFac{1}{1}%
2176   \TestFac{2}{2}%
2177   \TestFac{3}{2*3}%
2178   \TestFac{4}{2*3*4}%
2179   \TestFac{5}{2*3*4*5}%
2180   \TestFac{6}{2*3*4*5*6}%
2181   \TestFac{7}{2*3*4*5*6*7}%
2182   \TestFac{8}{2*3*4*5*6*7*8}%
2183   \TestFac{9}{2*3*4*5*6*7*8*9}%
2184   \TestFac{10}{2*3*4*5*6*7*8*9*10}%
2185   \TestFac{11}{2*3*4*5*6*7*8*9*10*11}%
2186   \TestFac{12}{2*3*4*5*6*7*8*9*10*11*12}%
2187 \end{qstest}

```

```

2188
2189 \begin{qstest}{inc}{inc}%
2190   \TestInc{0}{1}%
2191   \TestInc{1}{2}%
2192   \TestInc{-1}{0}%
2193   \TestInc{10}{11}%
2194   \TestInc{-10}{-9}%
2195   \TestInc{999}{1000}%
2196   \TestInc{-1000}{-999}%
2197   \TestInc{129}{130}%
2198   \TestInc{2147483646}{2147483647}%
2199   \TestInc{-2147483647}{-2147483646}%
2200 \end{qstest}
2201
2202 \begin{qstest}{dec}{dec}%
2203   \TestDec{0}{-1}%
2204   \TestDec{1}{0}%
2205   \TestDec{-1}{-2}%
2206   \TestDec{10}{9}%
2207   \TestDec{-10}{-11}%
2208   \TestDec{1000}{999}%
2209   \TestDec{-999}{-1000}%
2210   \TestDec{130}{129}%
2211   \TestDec{2147483647}{2147483646}%
2212   \TestDec{-2147483646}{-2147483647}%
2213 \end{qstest}
2214
2215 \begin{qstest}{add}{add}%
2216   \TestAdd{0}{0}{0}%
2217   \TestAdd{1}{0}{1}%
2218   \TestAdd{0}{1}{1}%
2219   \TestAdd{1}{2}{3}%
2220   \TestAdd{-1}{-1}{-2}%
2221   \TestAdd{2147483646}{1}{2147483647}%
2222   \TestAdd{-2147483647}{2147483647}{0}%
2223   \TestAdd{20}{-5}{15}%
2224   \TestAdd{-4}{-1}{-5}%
2225   \TestAdd{-1}{-4}{-5}%
2226   \TestAdd{-4}{1}{-3}%
2227   \TestAdd{-1}{4}{3}%
2228   \TestAdd{4}{-1}{3}%
2229   \TestAdd{1}{-4}{-3}%
2230   \TestAdd{-4}{-1}{-5}%
2231   \TestAdd{-1}{-4}{-5}%
2232   \TestAdd{ -4 }{ -1 }{-5}%
2233   \TestAdd{ -1 }{ -4 }{-5}%
2234   \TestAdd{ -4 }{ 1 }{-3}%
2235   \TestAdd{ -1 }{ 4 }{3}%
2236   \TestAdd{ 4 }{ -1 }{3}%
2237   \TestAdd{ 1 }{ -4 }{-3}%
2238   \TestAdd{ -4 }{ -1 }{-5}%
2239   \TestAdd{ -1 }{ -4 }{-5}%
2240   \TestAdd{876543210}{111111111}{987654321}%
2241   \TestAdd{999999999}{2}{1000000001}%
2242 \etex
2243   \TestAdd{100}{50+150}{300}%
2244   \TestAdd{2147483647}{10-2147483647}{10}%
2245 \etex
2246 \end{qstest}
2247
2248 \begin{qstest}{sub}{sub}
2249   \TestSub{0}{0}{0}%

```

```

2250 \TestSub{1}{0}{1}%
2251 \TestSub{1}{2}{-1}%
2252 \TestSub{-1}{-1}{0}%
2253 \TestSub{2147483646}{-1}{2147483647}%
2254 \TestSub{-2147483647}{-2147483647}{0}%
2255 \TestSub{-4}{-1}{-3}%
2256 \TestSub{-1}{-4}{3}%
2257 \TestSub{-4}{1}{-5}%
2258 \TestSub{-1}{4}{-5}%
2259 \TestSub{4}{-1}{5}%
2260 \TestSub{1}{-4}{5}%
2261 \TestSub{-4}{-1}{-3}%
2262 \TestSub{-1}{-4}{3}%
2263 \TestSub{ -4 }{ -1 }{-3}%
2264 \TestSub{ -1 }{ -4 }{3}%
2265 \TestSub{ -4 }{ 1 }{-5}%
2266 \TestSub{ -1 }{ 4 }{-5}%
2267 \TestSub{ 4 }{ -1 }{5}%
2268 \TestSub{ 1 }{ -4 }{5}%
2269 \TestSub{ -4 }{ -1 }{-3}%
2270 \TestSub{ -1 }{ -4 }{3}%
2271 \TestSub{1000000000}{2}{999999998}%
2272 \TestSub{987654321}{111111111}{876543210}%
2273 \*etex
2274 \TestSub{100}{50+150}{-100}%
2275 \TestSub{2147483647}{-10+2147483647}{10}%
2276 \*etex
2277 \end{qstest}
2278
2279 \begin{qstest}{shl}{shl}
2280 \TestShl{0}{0}%
2281 \TestShl{1}{2}%
2282 \TestShl{5621}{11242}%
2283 \TestShl{1073741823}{2147483646}%
2284 \TestShl{-1}{-2}%
2285 \TestShl{-5621}{-11242}%
2286 \end{qstest}
2287
2288 \begin{qstest}{shr}{shr}
2289 \TestShr{0}{0}%
2290 \TestShr{1}{0}%
2291 \TestShr{2}{1}%
2292 \TestShr{3}{1}%
2293 \TestShr{4}{2}%
2294 \TestShr{5}{2}%
2295 \TestShr{6}{3}%
2296 \TestShr{7}{3}%
2297 \TestShr{8}{4}%
2298 \TestShr{9}{4}%
2299 \TestShr{10}{5}%
2300 \TestShr{11}{5}%
2301 \TestShr{12}{6}%
2302 \TestShr{13}{6}%
2303 \TestShr{14}{7}%
2304 \TestShr{15}{7}%
2305 \TestShr{16}{8}%
2306 \TestShr{17}{8}%
2307 \TestShr{18}{9}%
2308 \TestShr{19}{9}%
2309 \TestShr{20}{10}%
2310 \TestShr{21}{10}%
2311 \TestShr{22}{11}%

```

```

2312 \TestShr{11241}{5620}%
2313 \TestShr{73054202}{36527101}%
2314 \TestShr{2147483646}{1073741823}%
2315 \TestShr{-1}{0}%
2316 \TestShr{-2}{-1}%
2317 \TestShr{-3}{-1}%
2318 \TestShr{-11241}{-5620}%
2319 \end{qstest}
2320
2321 \begin{qstest}{mul}{mul}
2322 \TestMul{0}{0}{0}%
2323 \TestMul{1}{0}{0}%
2324 \TestMul{0}{1}{0}%
2325 \TestMul{1}{1}{1}%
2326 \TestMul{3}{1}{3}%
2327 \TestMul{1}{-3}{-3}%
2328 \TestMul{-4}{-5}{20}%
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{-3}{-7}{21}%
2336 \TestMul{-7}{-3}{21}%
2337 \TestMul{12}{11}{132}%
2338 \TestMul{999}{333}{332667}%
2339 \TestMul{1000}{4321}{4321000}%
2340 \TestMul{12345}{173955}{2147474475}%
2341 \TestMul{1073741823}{2}{2147483646}%
2342 \TestMul{2}{1073741823}{2147483646}%
2343 \TestMul{-1073741823}{2}{-2147483646}%
2344 \TestMul{2}{-1073741823}{-2147483646}%
2345 \etex
2346 \TestMul{2+3}{5+7}{60}%
2347 \TestMul{2147483647}{2147483647/2147483647}{2147483647}%
2348 \etex
2349 \end{qstest}
2350
2351 \begin{qstest}{sqr}{sqr}
2352 \TestSqr{0}{0}%
2353 \TestSqr{1}{1}%
2354 \TestSqr{2}{4}%
2355 \TestSqr{3}{9}%
2356 \TestSqr{4}{16}%
2357 \TestSqr{9}{81}%
2358 \TestSqr{10}{100}%
2359 \TestSqr{46340}{2147395600}%
2360 \TestSqr{-1}{1}%
2361 \TestSqr{-2}{4}%
2362 \TestSqr{-46340}{2147395600}%
2363 \end{qstest}
2364
2365 \begin{qstest}{pow}{pow}
2366 \TestPow{-2}{0}{1}%
2367 \TestPow{-1}{0}{1}%
2368 \TestPow{0}{0}{1}%
2369 \TestPow{1}{0}{1}%
2370 \TestPow{2}{0}{1}%
2371 \TestPow{3}{0}{1}%
2372 \TestPow{-2}{1}{-2}%
2373 \TestPow{-1}{1}{-1}%

```

```

2374 \TestPow{1}{1}{1}%
2375 \TestPow{2}{1}{2}%
2376 \TestPow{3}{1}{3}%
2377 \TestPow{-2}{2}{4}%
2378 \TestPow{-1}{2}{1}%
2379 \TestPow{0}{2}{0}%
2380 \TestPow{1}{2}{1}%
2381 \TestPow{2}{2}{4}%
2382 \TestPow{3}{2}{9}%
2383 \TestPow{0}{1}{0}%
2384 \TestPow{1}{-2}{1}%
2385 \TestPow{1}{-1}{1}%
2386 \TestPow{-1}{-2}{1}%
2387 \TestPow{-1}{-1}{-1}%
2388 \TestPow{-1}{3}{-1}%
2389 \TestPow{-1}{4}{1}%
2390 \TestPow{-2}{-1}{0}%
2391 \TestPow{-2}{-2}{0}%
2392 \TestPow{2}{3}{8}%
2393 \TestPow{2}{4}{16}%
2394 \TestPow{2}{5}{32}%
2395 \TestPow{2}{6}{64}%
2396 \TestPow{2}{7}{128}%
2397 \TestPow{2}{8}{256}%
2398 \TestPow{2}{9}{512}%
2399 \TestPow{2}{10}{1024}%
2400 \TestPow{-2}{3}{-8}%
2401 \TestPow{-2}{4}{16}%
2402 \TestPow{-2}{5}{-32}%
2403 \TestPow{-2}{6}{64}%
2404 \TestPow{-2}{7}{-128}%
2405 \TestPow{-2}{8}{256}%
2406 \TestPow{-2}{9}{-512}%
2407 \TestPow{-2}{10}{1024}%
2408 \TestPow{3}{3}{27}%
2409 \TestPow{3}{4}{81}%
2410 \TestPow{3}{5}{243}%
2411 \TestPow{-3}{3}{-27}%
2412 \TestPow{-3}{4}{81}%
2413 \TestPow{-3}{5}{-243}%
2414 \TestPow{2}{30}{1073741824}%
2415 \TestPow{-3}{19}{-1162261467}%
2416 \TestPow{5}{13}{1220703125}%
2417 \TestPow{-7}{11}{-1977326743}%
2418 \end{qstest}
2419
2420 \begin{qstest}{div}{div}
2421 \TestDiv{1}{1}{1}%
2422 \TestDiv{2}{1}{2}%
2423 \TestDiv{-2}{1}{-2}%
2424 \TestDiv{2}{-1}{-2}%
2425 \TestDiv{-2}{-1}{2}%
2426 \TestDiv{15}{2}{7}%
2427 \TestDiv{-16}{2}{-8}%
2428 \TestDiv{1}{2}{0}%
2429 \TestDiv{1}{3}{0}%
2430 \TestDiv{2}{3}{0}%
2431 \TestDiv{-2}{3}{0}%
2432 \TestDiv{2}{-3}{0}%
2433 \TestDiv{-2}{-3}{0}%
2434 \TestDiv{13}{3}{4}%
2435 \TestDiv{-13}{-3}{4}%

```

```

2436 \TestDiv{-13}{3}{-4}%
2437 \TestDiv{-6}{5}{-1}%
2438 \TestDiv{-5}{5}{-1}%
2439 \TestDiv{-4}{5}{0}%
2440 \TestDiv{-3}{5}{0}%
2441 \TestDiv{-2}{5}{0}%
2442 \TestDiv{-1}{5}{0}%
2443 \TestDiv{0}{5}{0}%
2444 \TestDiv{1}{5}{0}%
2445 \TestDiv{2}{5}{0}%
2446 \TestDiv{3}{5}{0}%
2447 \TestDiv{4}{5}{0}%
2448 \TestDiv{5}{5}{1}%
2449 \TestDiv{6}{5}{1}%
2450 \TestDiv{-5}{4}{-1}%
2451 \TestDiv{-4}{4}{-1}%
2452 \TestDiv{-3}{4}{0}%
2453 \TestDiv{-2}{4}{0}%
2454 \TestDiv{-1}{4}{0}%
2455 \TestDiv{0}{4}{0}%
2456 \TestDiv{1}{4}{0}%
2457 \TestDiv{2}{4}{0}%
2458 \TestDiv{3}{4}{0}%
2459 \TestDiv{4}{4}{1}%
2460 \TestDiv{5}{4}{1}%
2461 \TestDiv{12345}{678}{18}%
2462 \TestDiv{32372}{5952}{5}%
2463 \TestDiv{284271294}{18162}{15651}%
2464 \TestDiv{217652429}{12561}{17327}%
2465 \TestDiv{462028434}{5439}{84947}%
2466 \TestDiv{2147483647}{1000}{2147483}%
2467 \TestDiv{2147483647}{-1000}{-2147483}%
2468 \TestDiv{-2147483647}{1000}{-2147483}%
2469 \TestDiv{-2147483647}{-1000}{2147483}%
2470 \end{qstest}
2471
2472 \begin{qstest}{mod}{mod}
2473 \TestMod{-6}{5}{4}%
2474 \TestMod{-5}{5}{0}%
2475 \TestMod{-4}{5}{1}%
2476 \TestMod{-3}{5}{2}%
2477 \TestMod{-2}{5}{3}%
2478 \TestMod{-1}{5}{4}%
2479 \TestMod{0}{5}{0}%
2480 \TestMod{1}{5}{1}%
2481 \TestMod{2}{5}{2}%
2482 \TestMod{3}{5}{3}%
2483 \TestMod{4}{5}{4}%
2484 \TestMod{5}{5}{0}%
2485 \TestMod{6}{5}{1}%
2486 \TestMod{-5}{4}{3}%
2487 \TestMod{-4}{4}{0}%
2488 \TestMod{-3}{4}{1}%
2489 \TestMod{-2}{4}{2}%
2490 \TestMod{-1}{4}{3}%
2491 \TestMod{0}{4}{0}%
2492 \TestMod{1}{4}{1}%
2493 \TestMod{2}{4}{2}%
2494 \TestMod{3}{4}{3}%
2495 \TestMod{4}{4}{0}%
2496 \TestMod{5}{4}{1}%
2497 \TestMod{-6}{-5}{-1}%

```

```

2498 \TestMod{-5}{-5}{0}%
2499 \TestMod{-4}{-5}{-4}%
2500 \TestMod{-3}{-5}{-3}%
2501 \TestMod{-2}{-5}{-2}%
2502 \TestMod{-1}{-5}{-1}%
2503 \TestMod{0}{-5}{0}%
2504 \TestMod{1}{-5}{-4}%
2505 \TestMod{2}{-5}{-3}%
2506 \TestMod{3}{-5}{-2}%
2507 \TestMod{4}{-5}{-1}%
2508 \TestMod{5}{-5}{0}%
2509 \TestMod{6}{-5}{-4}%
2510 \TestMod{-5}{-4}{-1}%
2511 \TestMod{-4}{-4}{0}%
2512 \TestMod{-3}{-4}{-3}%
2513 \TestMod{-2}{-4}{-2}%
2514 \TestMod{-1}{-4}{-1}%
2515 \TestMod{0}{-4}{0}%
2516 \TestMod{1}{-4}{-3}%
2517 \TestMod{2}{-4}{-2}%
2518 \TestMod{3}{-4}{-1}%
2519 \TestMod{4}{-4}{0}%
2520 \TestMod{5}{-4}{-3}%
2521 \TestMod{2147483647}{1000}{647}%
2522 \TestMod{2147483647}{-1000}{-353}%
2523 \TestMod{-2147483647}{1000}{353}%
2524 \TestMod{-2147483647}{-1000}{-647}%
2525 \TestMod{ 0 }{ 4 }{0}%
2526 \TestMod{ 1 }{ 4 }{1}%
2527 \TestMod{ -1 }{ 4 }{3}%
2528 \TestMod{ 0 }{ -4 }{0}%
2529 \TestMod{ 1 }{ -4 }{-3}%
2530 \TestMod{ -1 }{ -4 }{-1}%
2531 \langle *etex \rangle
2532 \TestMod{1+2}{1+3}{3}%
2533 \TestMod{1-2}{1+3}{3}%
2534 \TestMod{1-2}{1-4}{-1}%
2535 \TestMod{1+2}{1-4}{0}%
2536 \TestMod{1+2}{1-5}{-1}%
2537 \langle /etex \rangle
2538 \end{qstest}
2539 \langle /test2 | test4 \rangle
2540
2541 \langle *test2 \rangle
2542 \newcommand*{\TestError}[2]{%
2543 \begin{group}
2544 \expandafter\def\csname IntCalcError:#1\endcsname{%
2545 \Expect*{#2}{0}%
2546 \expandafter\def\csname IntCalcError:#1\endcsname{ERROR}%
2547 \Expect*{#2}{0ERROR }%
2548 \end{group}
2549 }
2550 \begin{qstest}{error}{error}
2551 \TestError{FacNegative}{\intcalcFac{-1}}%
2552 \TestError{FacNegative}{\intcalcFac{-2147483647}}%
2553 \TestError{FacOverflow}{\intcalcFac{13}}%
2554 \TestError{FacOverflow}{\intcalcFac{2147483647}}%
2555 \TestError{DivisionByZero}{\intcalcPow{0}{-1}}%
2556 \TestError{DivisionByZero}{\intcalcDiv{1}{0}}%
2557 \TestError{DivisionByZero}{\intcalcMod{1}{0}}%
2558 \TestError{DivisionByZero}{\IntCalcDiv1!0!}%
2559 \TestError{DivisionByZero}{\IntCalcMod1!0!}%

```

```

2560 \end{qstest}
2561 </test2>
2562
2563 <*test2 | test4>
2564 \begin{document}
2565 \end{document}
2566 </test2 | test4>

```

4 Installation

4.1 Download

Package. This package is available on CTAN¹:

[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<http://ftp.ctan.org/tex-archive/>

4.4 Refresh file name databases

If your \TeX distribution (te \TeX , mik \TeX , ...) relies on file name databases, you must refresh these. For example, te \TeX users run `texhash` or `mktextlsr`.

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 pdf \LaTeX :

```
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

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\InCa@Abs	<u>104</u> , 178, 444	\InCa@ShlDigit[1-9]	<u>1003</u>
\InCa@Add	586, 589, 612, 614, 620, <u>630</u> , 1299, 1309, 1500	\InCa@ShlSwitch	974, <u>976</u>
\InCa@AddDigit0	<u>731</u>	\InCa@Shr	225, 233, 1027, 1029, 1033, <u>1035</u> , 1460
\InCa@AddDigit[1-9]	<u>738</u>	\InCa@ShrDigit	1036, 1050
\InCa@AddSwitch	571, 577, <u>581</u>	\InCa@ShrSwitch	1023, <u>1025</u>
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\InCa@Dec	468, 487, 495, <u>533</u>	\InCa@StartII	<u>1489</u>
\InCa@DecDigit0	<u>561</u>	\InCa@StartIII	<u>1495</u>
\InCa@DecDigit[1-9]	<u>541</u>	\InCa@StartIV	<u>1503</u>
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