

# The intcalc package

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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  $\text{\TeX}$ . 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  $\text{\TeX}$ , 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 choosen.

## 1.2 Conditions

### 1.2.1 Preconditions

- Arguments can be anything that  $\text{\TeX}$  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  $\varepsilon$ -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  $\varepsilon$ -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, Mod

`\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:

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

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

### 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 `\*package`

### 2.1 Reload check and package identification

Reload check, especially if the package is not used with  $\text{\LaTeX}$ .

```
2 \begingroup\catcode61\catcode48\catcode32=10\relax%
3 \catcode13=5 % ^^M
4 \endlinechar=13 %
5 \catcode35=6 % #
6 \catcode39=12 % '
7 \catcode44=12 % ,
8 \catcode45=12 % -
9 \catcode46=12 % .
10 \catcode58=12 % :
11 \catcode64=11 % @
12 \catcode123=1 % {
13 \catcode125=2 % }
```

```

14 \expandafter\let\expandafter\x\csname ver@intcalc.sty\endcsname
15 \ifx\x\relax % plain-TeX, first loading
16 \else
17   \def\empty{}%
18   \ifx\x\empty % LaTeX, first loading,
19     % variable is initialized, but \ProvidesPackage not yet seen
20   \else
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   \aftergroup\endinput
30 \fi
31 \fi
32 \endgroup%

```

Package identification:

```

33 \begingroup\catcode61\catcode48\catcode32=10\relax%
34 \catcode13=5 % ^^M
35 \endlinechar=13 %
36 \catcode35=6 % #
37 \catcode39=12 % '
38 \catcode40=12 % (
39 \catcode41=12 % )
40 \catcode44=12 % ,
41 \catcode45=12 % -
42 \catcode46=12 % .
43 \catcode47=12 % /
44 \catcode58=12 % :
45 \catcode64=11 % @
46 \catcode91=12 % [
47 \catcode93=12 % ]
48 \catcode123=1 % {
49 \catcode125=2 % }
50 \expandafter\ifx\csname ProvidesPackage\endcsname\relax
51   \def\x#1#2#3[#4]{\endgroup
52     \immediate\write-1{Package: #3 #4}%
53     \xdef#1{#4}%
54   }%
55 \else
56   \def\x#1#2[#3]{\endgroup
57     #2[#{#3}]%
58     \ifx#1\@undefined
59       \xdef#1{#3}%
60     \fi
61     \ifx#1\relax
62       \xdef#1{#3}%
63     \fi
64   }%
65 \fi
66 \expandafter\x\csname ver@intcalc.sty\endcsname
67 \ProvidesPackage{intcalc}%
68 [2007/09/27 v1.1 Expandable integer calculations (H0)]%

```

## 2.2 Catcodes

```

69 \begingroup\catcode61\catcode48\catcode32=10\relax%
70 \catcode13=5 % ^^M
71 \endlinechar=13 %

```

```

72 \catcode123=1 % {
73 \catcode125=2 % }
74 \catcode64=11 % @
75 \def\x{\endgroup
76 \expandafter\edef\csname InCa@AtEnd\endcsname{%
77 \endlinechar=\the\endlinechar\relax
78 \catcode13=\the\catcode13\relax
79 \catcode32=\the\catcode32\relax
80 \catcode35=\the\catcode35\relax
81 \catcode61=\the\catcode61\relax
82 \catcode64=\the\catcode64\relax
83 \catcode123=\the\catcode123\relax
84 \catcode125=\the\catcode125\relax
85 }%
86 }%
87 \x\catcode61\catcode48\catcode32=10\relax%
88 \catcode13=5 % ^^M
89 \endlinechar=13 %
90 \catcode35=6 % #
91 \catcode64=11 % @
92 \catcode123=1 % {
93 \catcode125=2 % }
94 \def\TMP@EnsureCode#1#2{%
95 \edef\InCa@AtEnd{%
96 \InCa@AtEnd
97 \catcode#1=\the\catcode#1\relax
98 }%
99 \catcode#1=#2\relax
100 }
101 \TMP@EnsureCode{33}{12}% !
102 \TMP@EnsureCode{40}{12}% (
103 \TMP@EnsureCode{41}{12}% )
104 \TMP@EnsureCode{42}{12}% *
105 \TMP@EnsureCode{43}{12}% +
106 \TMP@EnsureCode{45}{12}% -
107 \TMP@EnsureCode{47}{12}% /
108 \TMP@EnsureCode{58}{11}% : (letter!)
109 \TMP@EnsureCode{60}{12}% <
110 \TMP@EnsureCode{62}{12}% >
111 \TMP@EnsureCode{63}{14}% ? (comment!)
112 \edef\InCa@AtEnd{\InCa@AtEnd\noexpand\endinput}
113 \begingroup\expandafter\expandafter\expandafter\endgroup
114 \expandafter\ifx\csname InCa@TestMode\endcsname\relax
115 \else
116 \catcode63=9 % ? (ignore)
117 \fi
118 ? \let\InCa@@TestMode\InCa@TestMode

```

## 2.3 Macros independent of $\epsilon$ -TeX

### 2.3.1 Abs, Sgn

\InCa@Abs

```

119 \def\InCa@Abs#1#2!{%
120 \ifx#1-%
121 #2%
122 \else
123 #1#2%
124 \fi
125 }

```

\InCa@Sgn

```

126 \def\InCa@Sgn#1#2!{%

```

```

127 \ifx#1-%
128   -1%
129 \else
130   \ifx#10%
131     0%
132   \else
133     1%
134   \fi
135 \fi
136 }

```

### 2.3.2 Min, Max, Cmp

\InCa@Min

```

137 \def\InCa@Min#1!#2!{%
138   \ifnum#1<#2 %
139     #1%
140   \else
141     #2%
142   \fi
143 }

```

\InCa@Max

```

144 \def\InCa@Max#1!#2!{%
145   \ifnum#1>#2 %
146     #1%
147   \else
148     #2%
149   \fi
150 }

```

\InCa@Cmp

```

151 \def\InCa@Cmp#1!#2!{%
152   \ifnum#1=#2 %
153     0%
154   \else
155     \ifnum#1<#2 %
156       -%
157     \fi
158     1%
159   \fi
160 }

```

### 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.

```

161 \def\InCa@Fac#1!{%
162   \ifcase#1 1% 0!
163   \or 1% 1!
164   \or 2% 2!
165   \or 6% 3!
166   \or 24% 4!
167   \or 120% 5!
168   \or 720% 6!
169   \or 5040% 7!
170   \or 40320% 8!
171   \or 362880% 9!
172   \or 3628800% 10!
173   \or 39916800% 11!
174   \or 479001600% 12!

```

```

175 \else
176   \ifnum#1<\z@
177     0\IntCalcError:FacNegative%
178   \else
179     0\IntCalcError:FacOverflow%
180   \fi
181 \fi
182 }

```

## 2.4 Implementation based on $\varepsilon$ -TeX

Only `\numexpr` is used from  $\varepsilon$ -TeX.

```

183 \begingroup\expandafter\expandafter\expandafter\endgroup
184 \expandafter\ifx\csname numexpr\endcsname\relax
185 \else

```

### 2.4.1 Num

`\intcalcNum`

```

186 \def\intcalcNum#1{%
187   \the\numexpr#1\relax
188 }%

```

### 2.4.2 Inv, Abs, Sgn

`\intcalcInv`

```

189 \def\intcalcInv#1{%
190   \number-\intcalcNum{#1} %
191 }%

```

`\intcalcAbs`

```

192 \def\intcalcAbs#1{%
193   \number\expandafter\InCa@Abs\the\numexpr#1! %
194 }%

```

`\intcalcSgn`

```

195 \def\intcalcSgn#1{%
196   \number\expandafter\InCa@Sgn\the\numexpr#1! %
197 }%

```

### 2.4.3 Min, Max, Cmp

`\intcalcMin`

```

198 \def\intcalcMin#1#2{%
199   \number\expandafter\InCa@Min
200   \the\numexpr#1\expandafter!%
201   \the\numexpr#2! %
202 }%

```

`\intcalcMax`

```

203 \def\intcalcMax#1#2{%
204   \number\expandafter\InCa@Max
205   \the\numexpr#1\expandafter!%
206   \the\numexpr#2! %
207 }%

```

`\intcalcCmp`

```

208 \def\intcalcCmp#1#2{%
209   \number\expandafter\InCa@Cmp
210   \the\numexpr#1\expandafter!\the\numexpr#2! %
211 }%

```

#### 2.4.4 Inc, Dec

```
\intcalcInc
212 \def\intcalcInc#1{%
213   \the\numexpr#1+1\relax
214 }%

\intcalcDec
215 \def\intcalcDec#1{%
216   \the\numexpr#1-1\relax
217 }%

\IntCalcInc
218 \def\IntCalcInc#1!{%
219   \the\numexpr#1+1\relax
220 }%

\IntCalcDec
221 \def\IntCalcDec#1!{%
222   \the\numexpr#1-1\relax
223 }%
```

#### 2.4.5 Add, Sub

```
\intcalcAdd
224 \def\intcalcAdd#1#2{%
225   \the\numexpr#1+(#2)\relax
226 }%

\intcalcSub
227 \def\intcalcSub#1#2{%
228   \the\numexpr#1-(#2)\relax
229 }%

\IntCalcAdd
230 \def\IntCalcAdd#1!#2!{%
231   \the\numexpr#1+#2\relax
232 }%

\IntCalcSub
233 \def\IntCalcSub#1!#2!{%
234   \the\numexpr#1-#2\relax
235 }%
```

#### 2.4.6 Shl, Shr

```
\intcalcShl
236 \def\intcalcShl#1{%
237   \the\numexpr(#1)*2\relax
238 }%

\intcalcShr
239 \def\intcalcShr#1{%
240   \number\expandafter\InCa@Shr\the\numexpr#1! %
241 }%

\IntCalcShl
242 \def\IntCalcShl#1!{%
243   \the\numexpr#1*2\relax
244 }%
```

```

\IntCalcShr
245 \def\IntCalcShr#1!{%
246 \the\numexpr\ifodd#1 (#1-1)\else#1\fi/2\relax
247 }%

\InCa@Shr
248 \def\InCa@Shr#1#2!{%
249 \ifx#1-%
250 -\InCa@Shr#2!%
251 \else
252 \ifodd#1#2 %
253 \the\numexpr(#1#2-1)/2\relax
254 \else
255 \the\numexpr#1#2/2\relax
256 \fi
257 \fi
258 }%

```

#### 2.4.7 Mul, Sqr, Fac

```

\intcalcMul
259 \def\intcalcMul#1#2{%
260 \the\numexpr(#1)*(#2)\relax
261 }%

\IntCalcMul
262 \def\IntCalcMul#1!#2!{%
263 \the\numexpr#1*#2\relax
264 }%

\intcalcSqr
265 \def\intcalcSqr#1{%
266 \number\expandafter\InCa@Sqr\the\numexpr#1! %
267 }%

\InCa@Sqr
268 \def\InCa@Sqr#1!{%
269 \the\numexpr#1*#1\relax
270 }%

\intcalcFac
271 \def\intcalcFac#1{%
272 \number\expandafter\InCa@Fac\the\numexpr#1! %
273 }%

```

#### 2.4.8 Pow

```

\intcalcPow
274 \def\intcalcPow#1#2{%
275 \number\expandafter\InCa@Pow
276 \the\numexpr#1\expandafter!%
277 \the\numexpr#2! %
278 }%

\InCa@Pow
279 \def\InCa@Pow#1#2!#3#4!{%
280 \ifcase#3#4 % power = 0
281 1%
282 \or % power = 1
283 #1#2%

```

```

284 \or % power = 2
285 \the\numexpr#1#2*#1#2\relax
286 \else
287 \ifcase#1#2 % basis = 0, power <> 0
288 0%
289 \ifx#3-% power < 0
290 0\IntCalcError:DivisionByZero%
291 \fi
292 \or
293 1% basis = 1
294 \else
295 \ifnum#1#2=\m@ne % basis = -1
296 \ifodd#3#4 %
297 -%
298 \fi
299 1%
300 \else % |basis| > 1
301 \ifx#3-% power < 0
302 0%
303 \else % power > 2
304 \InCa@PowRec#1#2!#3#4!1!%
305 \fi
306 \fi
307 \fi
308 \fi
309 }%

\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
}

310 \def\InCa@PowRec#1!#2!#3!{%
311 \ifnum#2=\@ne
312 \the\numexpr#1*#3\relax
313 \else
314 \ifodd#2 %
315 \expandafter\InCa@PowRec
316 \the\numexpr#1*#1\expandafter!%
317 \the\numexpr(#2-1)/2\expandafter!%
318 \the\numexpr#1*#3\expandafter\expandafter\expandafter!%
319 \else
320 \expandafter\InCa@PowRec
321 \the\numexpr#1*#1\expandafter!%
322 \the\numexpr(#2-1)/2\expandafter!%
323 \number#3\expandafter\expandafter\expandafter!%
324 \fi
325 \fi
326 }%

```

#### 2.4.9 Div, Mod

$\TeX$ 's `\divide` truncates,  $\varepsilon\text{-}\TeX$ 's `\numexpr` rounds the result of a division. The rounding method is called “Symmetric Arithmetic Rounding” or “Round-Half-Up”

(“Kaufmännisches Runden” in German):

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

Macro `\intcalcDiv` follows  $\text{T}_{\text{E}}\text{X}$  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`

```
327 \def\intcalcDiv#1#2{%
328   \number\expandafter\InCa@Div
329   \the\numexpr#1\expandafter!%
330   \the\numexpr#2! %
331 }%
```

`\InCa@Div`

```
332 \def\InCa@Div#1!#2!{%
333   \ifcase#2 %
334     0\IntCalcError:DivisionByZero%
335   \else
336     \ifcase#1 %
337       0%
338     \else
339       \expandafter\InCa@@Div
340       \romannumeral 0%
341       \ifnum#1<\z@
342         \expandafter-\number-#1%
343       \else
344         \expandafter+\number#1%
345       \fi
346       \expandafter!%
347       \romannumeral 0%
348       \ifnum#2<\z@
349         \expandafter-\number-#2%
350       \else
351         \expandafter+\number#2%
352       \fi
353     !%
354   \fi
355 \fi
356 }%
```

`\IntCalcDiv`

```
357 \def\InCa@Temp#1{%
358   \def\IntCalcDiv##1!##2!{%
359     \number
360     \ifcase##2 %
361       0\IntCalcError:DivisionByZero%
362     \else
363       \ifcase##1 %
364         0%
365       \else
366         \the\numexpr(##1-(##2-1)/2)/##2\relax
367       \fi
368     \fi
369     #1%
370   }%
371 }%
372 \InCa@Temp{ }%
```

```

\InCa@@Div
373 \def\InCa@@Div#1#2!#3#4!{%
374   #1#3%
375   \the\numexpr(#2-(#4-1)/2)/#4\relax
376 }%

\intcalcMod
377 \def\intcalcMod#1#2{%
378   \number\expandafter\InCa@Mod
379   \the\numexpr#1\expandafter!%
380   \the\numexpr#2! %
381 }%

\InCa@Mod
382 \def\InCa@Mod#1!#2!{%
383   \ifcase#2 %
384     0\IntCalcError:DivisionByZero%
385   \else
386     \ifcase#1 %
387       0%
388     \else
389       \expandafter\InCa@@Mod
390       \romannumeral 0%
391       \ifnum#1<\z@
392         \expandafter-\number-#1%
393       \else
394         \expandafter+\number#1%
395       \fi
396       \expandafter!%
397       \romannumeral 0%
398       \ifnum#2<\z@
399         \expandafter-\number-#2%
400       \else
401         \expandafter+\number#2%
402       \fi
403       !%
404     \fi
405   \fi
406 }%

\IntCalcMod
407 \def\InCa@Temp#1{%
408   \def\IntCalcMod##1!##2!{%
409     \number
410     \ifcase##2 %
411       0\IntCalcError:DivisionByZero%
412     \else
413       \ifcase##1 %
414         0%
415       \else
416         \the\numexpr##1-(##1-(##2-1)/2)/##2*##2\relax
417       \fi
418     \fi
419     #1%
420   }%
421 }%
422 \InCa@Temp{ }%

\InCa@@Mod
423 \def\InCa@@Mod#1#2!#3#4!{%
424   \if#3+%
```

```

425     \if#1+%
426     \the\numexpr#2-\InCa@@Div+#2!+#4!*\#4\relax
427   \else
428     \expandafter\InCa@ModX
429     \the\numexpr-#2+\InCa@@Div+#2!+#4!*\#4!#4!%
430   \fi
431 \else
432   -%
433   \if#1+%
434     \expandafter\InCa@ModX
435     \the\numexpr-#2+\InCa@@Div+#2!+#4!*\#4!#4!%
436   \else
437     \the\numexpr#2-\InCa@@Div+#2!+#4!*\#4\relax
438   \fi
439 \fi
440 }%

```

\InCa@ModX

```

441 \def\InCa@ModX#1!#2!{%
442   \ifcase#1 %
443     0%
444   \else
445     \the\numexpr#1+#2\relax
446   \fi
447 }%

448 \expandafter\InCa@AtEnd
449 \fi%

```

## 2.5 Implementation without $\epsilon$ -TeX

### 2.5.1 Num

\intcalcNum

```

450 \def\intcalcNum#1{%
451   \number\expandafter\InCa@FirstOfOne\number#1! %
452 }

```

### 2.5.2 Inv, Abs, Sgn

\intcalcInv

```

453 \def\intcalcInv#1{%
454   \number\expandafter\InCa@FirstOfOne\number-#1! %
455 }

```

\InCa@FirstOfOne

```

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

```

\intcalcAbs

```

457 \def\intcalcAbs#1{%
458   \number\expandafter\InCa@Abs\number#1! %
459 }

```

\intcalcSgn

```

460 \def\intcalcSgn#1{%
461   \number\expandafter\InCa@Sgn\number#1! %
462 }

```

### 2.5.3 Min, Max, Cmp

```
\intcalcMin
463 \def\intcalcMin#1#2{%
464   \number\expandafter\InCa@Min
465   \number\number#1\expandafter!\number#2! %
466 }

\intcalcMax
467 \def\intcalcMax#1#2{%
468   \number\expandafter\InCa@Max
469   \number\number#1\expandafter!\number#2! %
470 }

\intcalcCmp
471 \def\intcalcCmp#1#2{%
472   \number\expandafter\InCa@Cmp
473   \number\number#1\expandafter!\number#2! %
474 }%
```

### 2.5.4 Inc, Dec

```
\intcalcInc
475 \def\intcalcInc#1{%
476   \number\expandafter\InCa@IncSwitch\number#1! %
477 }

\InCa@IncSwitch
478 \def\InCa@IncSwitch#1#2!{%
479   \ifx#1-%
480     -%
481     \csname InCa@Empty%
482     \InCa@Dec#2!%
483   \else
484     \csname InCa@Empty%
485     \InCa@Inc#1#2!%
486   \fi
487 }

\intcalcDec
488 \def\intcalcDec#1{%
489   \number\expandafter\InCa@DecSwitch\number#1! %
490 }

\InCa@DecSwitch
491 \def\InCa@DecSwitch#1#2!{%
492   \ifx#1-%
493     -%
494     \csname InCa@Empty%
495     \expandafter\InCa@Inc#2!%
496   \else
497     \ifx#10%
498       -1%
499     \else
500       \csname InCa@Empty%
501       \InCa@Dec#1#2!%
502     \fi
503   \fi
504 }
```

\IntCalcInc

```
505 \def\IntCalcInc#1!{%  
506   \number\csname InCa@Empty\InCa@Inc#1! %  
507 }
```

\IntCalcDec

```
508 \def\IntCalcDec#1!{%  
509   \number\csname InCa@Empty\InCa@Dec#1! %  
510 }
```

\InCa@Inc

```
511 \def\InCa@Inc#1#2{%  
512   \ifx#2!%  
513     \csname InCa@IncDigit#1\endcsname1%  
514   \else  
515     \csname InCa@IncDigit#1%  
516     \expandafter\InCa@Inc\expandafter#2%  
517   \fi  
518 }
```

\InCa@IncDigit[0-8]

```
519 \def\InCa@Temp#1#2{%  
520   \expandafter\def\csname InCa@IncDigit#1\endcsname##1{%  
521     \endcsname  
522     0%  
523     \ifcase##1 %  
524       #1%  
525     \else  
526       #2%  
527     \fi  
528   }%  
529 }  
530 \InCa@Temp 01  
531 \InCa@Temp 12  
532 \InCa@Temp 23  
533 \InCa@Temp 34  
534 \InCa@Temp 45  
535 \InCa@Temp 56  
536 \InCa@Temp 67  
537 \InCa@Temp 78  
538 \InCa@Temp 89
```

\InCa@IncDigit9

```
539 \expandafter\def\csname InCa@IncDigit9\endcsname#1{%  
540   \expandafter\endcsname  
541   \ifcase#1 %  
542     09%  
543   \else  
544     10%  
545   \fi  
546 }
```

\InCa@Dec

```
547 \def\InCa@Dec#1#2{%  
548   \ifx#2!%  
549     \csname InCa@DecDigit#1\endcsname1%  
550   \else  
551     \csname InCa@DecDigit#1%  
552     \expandafter\InCa@Dec\expandafter#2%  
553   \fi  
554 }
```

\InCa@DecDigit[1-9]

```

555 \def\InCa@Temp#1#2{%
556   \expandafter\def\csname InCa@DecDigit#1\endcsname##1{%
557     \endcsname
558     0%
559     \ifcase##1 %
560       #1%
561     \else
562       #2%
563     \fi
564   }%
565 }
566 \InCa@Temp 98
567 \InCa@Temp 87
568 \InCa@Temp 76
569 \InCa@Temp 65
570 \InCa@Temp 54
571 \InCa@Temp 43
572 \InCa@Temp 32
573 \InCa@Temp 21
574 \InCa@Temp 10

```

\InCa@DecDigit0

```

575 \expandafter\def\csname InCa@DecDigit0\endcsname#1{%
576   \expandafter\endcsname
577   \ifcase#1 %
578     00%
579   \else
580     19%
581   \fi
582 }

```

## 2.5.5 Add, Sub

\intcalcAdd

```

583 \def\intcalcAdd#1#2{%
584   \number
585   \expandafter\InCa@AddSwitch
586   \number\number#1\expandafter!%
587   \number#2! %
588 }

```

\intcalcSub

```

589 \def\intcalcSub#1#2{%
590   \number
591   \expandafter\InCa@AddSwitch
592   \number\number#1\expandafter!%
593   \number-\number#2! %
594 }

```

\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( $y, x$ )   |

```

595 \def\InCa@AddSwitch#1!#2!{%
596   \ifnum#1<\z@
597     \ifnum#2<\z@
598       -%
599       \ifnum#1<#2 %
600         \expandafter\InCa@Add\number-#1\expandafter!%
601         \@gobble#2!%
602       \else
603         \expandafter\InCa@Add\number-#2\expandafter!%
604         \@gobble#1!%
605       \fi
606     \else
607       \ifnum-#1>#2 %
608         -%
609         \expandafter\InCa@Sub\@gobble#1!#2!%
610       \else
611         \expandafter\InCa@Sub\number#2\expandafter!%
612         \@gobble#1!%
613       \fi
614     \fi
615   \else
616     \ifnum#2<\z@
617       \ifnum#1>-#2 %
618         \expandafter\InCa@Sub\number#1\expandafter!%
619         \@gobble#2!%
620       \else
621         -%
622         \expandafter\InCa@Sub\@gobble#2!#1!%
623       \fi
624     \else
625       \ifnum#1>#2 %
626         \InCa@Add#1!#2!%
627       \else
628         \InCa@Add#2!#1!%
629       \fi
630     \fi
631   \fi
632 }

\IntCalcAdd

633 \def\IntCalcAdd#1!#2!{%
634   \number\InCa@Add#1!#2! %
635 }

\IntCalcSub

636 \def\IntCalcSub#1!#2!{%
637   \number\InCa@Sub#1!#2! %
638 }

\InCa@Space

639 \begingroup
640   \def\x#1{\endgroup
641     \let\InCa@Space= #1%
642   }%
643   \x{ }

\InCa@Add

644 \def\InCa@Add#1!#2!{%
645   \ifcase#2 %
646     #1%
647   \else
648     \InCa@@Add#1!#2!00000000\InCa@Space

```

```

649  \fi
650 }

\InCa@Sub

651 \def\InCa@Sub#1!#2!{%
652  \ifnum#1=#2 %
653    0%
654  \else
655    \InCa@@Sub#1!#2!00000000\InCa@Space
656  \fi
657 }

\InCa@@Add

658 \def\InCa@@Add#1!#2#3!{%
659  \ifx\InCa@Empty#3\InCa@Empty
660    \@ReturnAfterElseFi{%
661      \InCa@@@Add!!#1!#2%
662    }%
663  \else
664    \@ReturnAfterFi{%
665      \InCa@@Add#1!#3!#2%
666    }%
667  \fi
668 }

\InCa@@Sub

669 \def\InCa@@Sub#1!#2#3!{%
670  \ifx\InCa@Empty#3\InCa@Empty
671    \@ReturnAfterElseFi{%
672      \InCa@@@Sub!!#1!#2%
673    }%
674  \else
675    \@ReturnAfterFi{%
676      \InCa@@Sub#1!#3!#2%
677    }%
678  \fi
679 }

\InCa@@@Add

680 \def\InCa@@@Add#1!#2!#3#4!#5{%
681  \ifx\InCa@Empty#4\InCa@Empty
682    \csname InCa@Empty%
683      \@ReturnAfterElseFi{%
684        \InCa@ProcessAdd#1#3!#5#2%
685      }%
686    \else
687      \@ReturnAfterFi{%
688        \InCa@@@Add#1#3!#5#2!#4!%
689      }%
690    \fi
691 }

\InCa@@@Sub

692 \def\InCa@@@Sub#1!#2!#3#4!#5{%
693  \ifx\InCa@Empty#4\InCa@Empty
694    \csname @gobble%
695      \@ReturnAfterElseFi{%
696        \InCa@ProcessSub#1#3!#5#2%
697      }%
698    \else
699      \@ReturnAfterFi{%

```

```

700      \InCa@@@Sub#1#3!#5#2!#4!%
701    }%
702  \fi
703 }

```

\InCa@ProcessAdd

```

704 \def\InCa@ProcessAdd#1#2!#3#4{%
705   \ifx\InCa@Empty#2\InCa@Empty
706     \csname InCa@AddDigit#1\endcsname#3%
707     \romannumeral0#4%
708   \else
709     \csname InCa@AddDigit#1\csname InCa@DigitCarry#3%
710       \@ReturnAfterFi{%
711         \InCa@ProcessAdd#2!#4%
712       }%
713   \fi
714 }

```

\InCa@ProcessSub

```

715 \def\InCa@ProcessSub#1#2!#3#4{%
716   \ifx\InCa@Empty#2\InCa@Empty
717     \csname InCa@SubDigit#1\endcsname#3%
718     \romannumeral0#4%
719   \else
720     \csname InCa@SubDigit#1\csname InCa@DigitCarry#3%
721       \@ReturnAfterFi{%
722         \InCa@ProcessSub#2!#4%
723       }%
724   \fi
725 }

```

\InCa@DigitCarry[0-9]

```

726 \def\InCa@Temp#1#2{%
727   \expandafter\def\csname InCa@DigitCarry#1\endcsname##1{%
728     \ifcase##1 %
729       \endcsname#1%
730     \else
731       \endcsname#2%
732     \fi
733   }%
734 }
735 \InCa@Temp 01
736 \InCa@Temp 12
737 \InCa@Temp 23
738 \InCa@Temp 34
739 \InCa@Temp 45
740 \InCa@Temp 56
741 \InCa@Temp 67
742 \InCa@Temp 78
743 \InCa@Temp 89
744 \InCa@Temp 9{{10}}

```

\InCa@AddDigit0

```

745 \expandafter\def\csname InCa@AddDigit0\endcsname#1{%
746   \ifnum#1>9 %
747     \endcsname10%
748   \else
749     \endcsname0#1%
750   \fi
751 }

```

\InCa@AddDigit[1-9]

```
752 \def\InCa@Temp#1#2#3{%
753   \expandafter\def\csname InCa@AddDigit#1\endcsname##1{%
754     \ifnum##1>#2 %
755       \endcsname 1%
756     \else
757       \endcsname 0%
758     \fi
759     \ifcase##1 #1% 0
760     #3%
761     \else #1% 10
762     \fi
763   }%
764 }
765 \InCa@Temp 18{%
766   \or 2% 1
767   \or 3% 2
768   \or 4% 3
769   \or 5% 4
770   \or 6% 5
771   \or 7% 6
772   \or 8% 7
773   \or 9% 8
774   \or 0% 9
775 }%
776 \InCa@Temp 27{%
777   \or 3% 1
778   \or 4% 2
779   \or 5% 3
780   \or 6% 4
781   \or 7% 5
782   \or 8% 6
783   \or 9% 7
784   \or 0% 8
785   \or 1% 9
786 }%
787 \InCa@Temp 36{%
788   \or 4% 1
789   \or 5% 2
790   \or 6% 3
791   \or 7% 4
792   \or 8% 5
793   \or 9% 6
794   \or 0% 7
795   \or 1% 8
796   \or 2% 9
797 }%
798 \InCa@Temp 45{%
799   \or 5% 1
800   \or 6% 2
801   \or 7% 3
802   \or 8% 4
803   \or 9% 5
804   \or 0% 6
805   \or 1% 7
806   \or 2% 8
807   \or 3% 9
808 }%
809 \InCa@Temp 54{%
810   \or 6% 1
811   \or 7% 2
812   \or 8% 3
```

```

813 \or 9% 4
814 \or 0% 5
815 \or 1% 6
816 \or 2% 7
817 \or 3% 8
818 \or 4% 9
819 }%
820 \InCa@Temp 63{%
821 \or 7% 1
822 \or 8% 2
823 \or 9% 3
824 \or 0% 4
825 \or 1% 5
826 \or 2% 6
827 \or 3% 7
828 \or 4% 8
829 \or 5% 9
830 }%
831 \InCa@Temp 72{%
832 \or 8% 1
833 \or 9% 2
834 \or 0% 3
835 \or 1% 4
836 \or 2% 5
837 \or 3% 6
838 \or 4% 7
839 \or 5% 8
840 \or 6% 9
841 }%
842 \InCa@Temp 81{%
843 \or 9% 1
844 \or 0% 2
845 \or 1% 3
846 \or 2% 4
847 \or 3% 5
848 \or 4% 6
849 \or 5% 7
850 \or 6% 8
851 \or 7% 9
852 }%
853 \InCa@Temp 90{%
854 \or 0% 1
855 \or 1% 2
856 \or 2% 3
857 \or 3% 4
858 \or 4% 5
859 \or 5% 6
860 \or 6% 7
861 \or 7% 8
862 \or 8% 9
863 }%

```

\InCa@SubDigit[0-9]

```

864 \def\InCa@Temp#1#2{%
865 \expandafter\def\csname InCa@SubDigit#1\endcsname##1{%
866 \ifnum##1>#1 %
867 \endcsname 1%
868 \else
869 \endcsname 0%
870 \fi
871 \ifcase##1 #1% 0
872 #2%
873 \else #1% 10

```

```

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

```

```

936 \or 1% 4
937 \or 0% 5
938 \or 9% 6
939 \or 8% 7
940 \or 7% 8
941 \or 6% 9
942 }
943 \InCa@Temp 6{%
944 \or 5% 1
945 \or 4% 2
946 \or 3% 3
947 \or 2% 4
948 \or 1% 5
949 \or 0% 6
950 \or 9% 7
951 \or 8% 8
952 \or 7% 9
953 }
954 \InCa@Temp 7{%
955 \or 6% 1
956 \or 5% 2
957 \or 4% 3
958 \or 3% 4
959 \or 2% 5
960 \or 1% 6
961 \or 0% 7
962 \or 9% 8
963 \or 8% 9
964 }
965 \InCa@Temp 8{%
966 \or 7% 1
967 \or 6% 2
968 \or 5% 3
969 \or 4% 4
970 \or 3% 5
971 \or 2% 6
972 \or 1% 7
973 \or 0% 8
974 \or 9% 9
975 }
976 \InCa@Temp 9{%
977 \or 8% 1
978 \or 7% 2
979 \or 6% 3
980 \or 5% 4
981 \or 4% 5
982 \or 3% 6
983 \or 2% 7
984 \or 1% 8
985 \or 0% 9
986 }

```

## 2.5.6 Shl, Shr

\intcalShl

```

987 \def\intcalShl#1{%
988 \number\expandafter\InCa@ShlSwitch\number#1! %
989 }

```

\InCa@ShlSwitch

```

990 \def\InCa@ShlSwitch#1#2!{%
991 \ifx#1-%

```

```

992     -\csname InCa@Empty%
993     \InCa@Shl#2!%
994 \else
995     \csname InCa@Empty%
996     \InCa@Shl#1#2!%
997 \fi
998 }

\IntCalcShl

999 \def\IntCalcShl#1!{%
1000 \number
1001 \csname InCa@Empty%
1002 \InCa@Shl#1! %
1003 }

\IntCal@ShlDigit

1004 \def\InCa@Shl#1#2{%
1005 \ifx#2!%
1006     \csname InCa@ShlDigit#1\endcsname0%
1007 \else
1008     \csname InCa@ShlDigit#1%
1009     \@ReturnAfterFi{%
1010     \InCa@Shl#2%
1011     }%
1012 \fi
1013 }

\InCa@ShlDigit0

1014 \expandafter\def\csname InCa@ShlDigit0\endcsname{%
1015 \endcsname0%
1016 }

\InCa@ShlDigit[1-9]

1017 \def\InCa@Temp#1#2#3#4#5{%
1018 \expandafter\def\csname InCa@ShlDigit#1\endcsname##1{%
1019 \expandafter\endcsname
1020 \ifcase##1 %
1021     #2#3%
1022 \else
1023     #4#5%
1024 \fi
1025 }%
1026 }
1027 \InCa@Temp 10203
1028 \InCa@Temp 20405
1029 \InCa@Temp 30607
1030 \InCa@Temp 40809
1031 \InCa@Temp 51011
1032 \InCa@Temp 61213
1033 \InCa@Temp 71415
1034 \InCa@Temp 81617
1035 \InCa@Temp 91819

\intcalcShr

1036 \def\intcalcShr#1{%
1037 \number\expandafter\InCa@ShrSwitch\number#1! %
1038 }

\InCa@ShrSwitch

1039 \def\InCa@ShrSwitch#1#2!{%
1040 \ifx#1-%

```

```

1041     -\InCa@Shr#2!%
1042 \else
1043     \InCa@Shr#1#2!%
1044 \fi
1045 }

\IntCalcShr

1046 \def\IntCalcShr#1!{%
1047     \number\InCa@Shr#1! %
1048 }

\InCa@Shr

1049 \def\InCa@Shr#1#2{%
1050     \InCa@ShrDigit#1!%
1051     \ifx#2!%
1052     \else
1053         \@ReturnAfterFi{%
1054             \ifodd#1 %
1055                 \@ReturnAfterElseFi{%
1056                     \InCa@Shr{1#2}%
1057                 }%
1058             \else
1059                 \expandafter\InCa@Shr\expandafter#2%
1060             \fi
1061         }%
1062     \fi
1063 }

1064 \def\InCa@ShrDigit#1!{%
1065     \ifcase#1 0% 0
1066     \or 0% 1
1067     \or 1% 2
1068     \or 1% 3
1069     \or 2% 4
1070     \or 2% 5
1071     \or 3% 6
1072     \or 3% 7
1073     \or 4% 8
1074     \or 4% 9
1075     \or 5% 10
1076     \or 5% 11
1077     \or 6% 12
1078     \or 6% 13
1079     \or 7% 14
1080     \or 7% 15
1081     \or 8% 16
1082     \or 8% 17
1083     \or 9% 18
1084     \or 9% 19
1085     \fi
1086 }

```

### 2.5.7 \InCa@Tim

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

```

1087 \def\InCa@Temp#1{%
1088     \def\InCa@Tim##1##2{%
1089         \number
1090         \ifcase##2 % 0
1091             0%
1092         \or % 1
1093             ##1%

```

```

1094         \else % 2-9
1095             \csname InCa@Empty%
1096             \InCa@ProcessTim##2##1!%
1097         \fi
1098     #1%
1099 }%
1100 }
1101 \InCa@Temp{ }

\InCa@ProcessTim
1102 \def\InCa@ProcessTim#1#2#3{%
1103     \ifx#3!%
1104         \csname InCa@TimDigit#2\endcsname#10%
1105     \else
1106         \csname InCa@TimDigit#2\csname InCa@Param#1%
1107         \@ReturnAfterFi{%
1108             \InCa@ProcessTim#1#3%
1109         }%
1110     \fi
1111 }

\InCa@Param[0-9]
1112 \def\InCa@Temp#1{%
1113     \expandafter\def\csname InCa@Param#1\endcsname{%
1114         \endcsname#1%
1115     }%
1116 }
1117 \InCa@Temp 0%
1118 \InCa@Temp 1%
1119 \InCa@Temp 2%
1120 \InCa@Temp 3%
1121 \InCa@Temp 4%
1122 \InCa@Temp 5%
1123 \InCa@Temp 6%
1124 \InCa@Temp 7%
1125 \InCa@Temp 8%
1126 \InCa@Temp 9%

\InCa@TimDigit0
1127 \expandafter\def\csname InCa@TimDigit0\endcsname#1#2{%
1128     \endcsname
1129     0#2%
1130 }

\InCa@TimDigit1
1131 \expandafter\def\csname InCa@TimDigit1\endcsname#1#2{%
1132     \ifcase#2 %
1133         \endcsname 0#1%
1134     \else
1135         \csname InCa@AddDigit#1\endcsname #2%
1136     \fi
1137 }

\InCa@TimDigit[2-9]
1138 \def\InCa@Temp#1#2{%
1139     \expandafter\def\csname InCa@TimDigit#1\endcsname##1{%
1140         \expandafter\InCa@TimDigitCarry
1141         \number
1142         \ifcase##1 0% 0
1143             #2%
1144         \fi

```

```

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

```

```

1207 \or 28% 4
1208 \or 35% 5
1209 \or 42% 6
1210 \or 49% 7
1211 \or 56% 8
1212 \or 63% 9
1213 }
1214 \InCa@Temp 8{%
1215 \or 8% 1
1216 \or 16% 2
1217 \or 24% 3
1218 \or 32% 4
1219 \or 40% 5
1220 \or 48% 6
1221 \or 56% 7
1222 \or 64% 8
1223 \or 72% 9
1224 }
1225 \InCa@Temp 9{%
1226 \or 9% 1
1227 \or 18% 2
1228 \or 27% 3
1229 \or 36% 4
1230 \or 45% 5
1231 \or 54% 6
1232 \or 63% 7
1233 \or 72% 8
1234 \or 81% 9
1235 }

```

\InCa@TimDigitCarry

```

1236 \def\InCa@TimDigitCarry#1!{%
1237 \ifnum#1<10 %
1238 \csname InCa@AddDigit#1\expandafter\endcsname
1239 \else
1240 \@ReturnAfterFi{%
1241 \InCa@@TimDigitCarry#1!%
1242 }%
1243 \fi
1244 }

```

\InCa@@TimDigitCarry

```

1245 \def\InCa@@TimDigitCarry#1#2!#3{%
1246 \csname InCa@DigitCarry#1%
1247 \csname InCa@AddDigit#2\endcsname #3%
1248 }

```

## 2.5.8 Mul

\intcalcMul

```

1249 \def\intcalcMul#1#2{%
1250 \number
1251 \expandafter\InCa@MulSwitch
1252 \number\number#1\expandafter!%
1253 \number#2! %
1254 }

```

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

|         |         |          |   |               |
|---------|---------|----------|---|---------------|
| $x < 0$ | $y < 0$ | $x < y$  | + | $Mul(-x, -y)$ |
|         |         | else     |   | $Mul(-y, -x)$ |
|         | else    | $-x > y$ | - | $Mul(-x, y)$  |
|         |         | else     |   | $Mul(y, -x)$  |
| else    | $y < 0$ | $x > -y$ | - | $Mul(x, -y)$  |
|         |         | else     |   | $Mul(-y, x)$  |
|         | else    | $x > y$  | + | $Mul(x, y)$   |
|         |         | else     |   | $Mul(y, x)$   |

```

1255 \def\InCa@MulSwitch#1!#2!{%
1256   \ifnum#1<\z@
1257     \ifnum#2<\z@
1258       \ifnum#1<#2 %
1259         \expandafter\InCa@Mul\number-#1\expandafter!%
1260         \@gobble#2!%
1261       \else
1262         \expandafter\InCa@Mul\number-#2\expandafter!%
1263         \@gobble#1!%
1264       \fi
1265     \else
1266       -%
1267       \ifnum-#1>#2 %
1268         \expandafter\InCa@Mul\@gobble#1!#2!%
1269       \else
1270         \expandafter\InCa@Mul\number#2\expandafter!%
1271         \@gobble#1!%
1272       \fi
1273     \fi
1274   \else
1275     \ifnum#2<\z@
1276       -%
1277       \ifnum#1>-#2 %
1278         \expandafter\InCa@Mul\number#1\expandafter!%
1279         \@gobble#2!%
1280       \else
1281         \expandafter\InCa@Mul\@gobble#2!#1!%
1282       \fi
1283     \else
1284       \ifnum#1>#2 %
1285         \InCa@Mul#1!#2!%
1286       \else
1287         \InCa@Mul#2!#1!%
1288       \fi
1289     \fi
1290   \fi
1291 }

```

\IntCalcMul

```

1292 \def\IntCalcMul#1!#2!{%
1293   \number\InCa@Mul#1!#2! %
1294 }

```

\InCa@Mul

```

1295 \def\InCa@Mul#1!#2!{%
1296   \ifcase#2 %
1297     0%
1298   \or
1299     #1%
1300   \or
1301     \csname InCa@Empty%
1302     \expandafter\InCa@Shl#1!%

```

```

1303 \else
1304 \ifnum#2<10 %
1305 \InCa@Tim{#1}#2%
1306 \else
1307 \InCa@ProcessMul!#2!#1!%
1308 \fi
1309 \fi
1310 }

\InCa@Mul
1311 \def\InCa@ProcessMul#1!#2#3!#4!{%
1312 \ifx\InCa@Empty#3\InCa@Empty
1313 \expandafter\InCa@Add\number
1314 #10\expandafter\expandafter\expandafter!%
1315 \InCa@Tim{#4}#2!%
1316 \else
1317 \ifx\InCa@Empty#1\InCa@Empty
1318 \expandafter\expandafter\expandafter\InCa@ProcessMul
1319 \InCa@Tim{#4}#2!%
1320 #3!#4!%
1321 \else
1322 \expandafter\InCa@ProcessMul\number
1323 \expandafter\InCa@Add\number%
1324 #10\expandafter\expandafter\expandafter!%
1325 \InCa@Tim{#4}#2!%
1326 #3!#4!%
1327 \fi
1328 \fi
1329 }

```

### 2.5.9 Sqr, Fac

```

\intcalcSqr
1330 \def\intcalcSqr#1{%
1331 \number\expandafter\InCa@Sqr\number#1! %
1332 }

```

```

\InCa@Sqr
1333 \def\InCa@Sqr#1#2!{%
1334 \ifx#1-%
1335 \InCa@Mul#2!#2!%
1336 \else
1337 \InCa@Mul#1#2!#1#2!%
1338 \fi
1339 }

```

```

\intcalcFac
1340 \def\intcalcFac#1{%
1341 \number\expandafter\InCa@Fac\number#1! %
1342 }

```

### 2.5.10 Pow

```

\intcalcPow
1343 \def\intcalcPow#1#2{%
1344 \number\expandafter\InCa@Pow
1345 \number\number#1\expandafter!%
1346 \number#2! %
1347 }

```

```

\InCa@Pow
1348 \def\InCa@Pow#1#2!#3#4!{%
1349   \ifcase#3#4 % power = 0
1350     1%
1351   \or % power = 1
1352     #1#2%
1353   \or % power = 2
1354     \ifx#1-%
1355       \InCa@Mul#2!#2!%
1356     \else
1357       \InCa@Mul#1#2!#1#2!%
1358     \fi
1359   \else
1360     \ifcase#1#2 % basis = 0, power <> 0
1361       0%
1362     \ifx#3-% power < 0
1363       0\IntCalcError:DivisionByZero%
1364     \fi
1365   \or
1366     1% basis = 1
1367   \else
1368     \ifnum#1#2=\m@ne % basis = -1
1369       \ifodd#3#4 %
1370         -%
1371       \fi
1372       1%
1373     \else % |basis| > 1
1374       \ifx#3-% power < 0
1375         0%
1376       \else % power > 2
1377         \ifx#1-% basis < 0
1378           \ifodd#3#4 %
1379             -%
1380           \fi
1381           \InCa@PowRec#2!#3#4!1!%
1382         \else
1383           \InCa@PowRec#1#2!#3#4!1!%
1384         \fi
1385       \fi
1386     \fi
1387   \fi
1388 \fi
1389 }

\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
}

1390 \def\InCa@PowRec#1!#2!#3!{%
1391   \ifnum#2=\@ne
1392     \ifnum#1>#3 %
1393       \InCa@Mul#1!#3!%

```

```

1394     \else
1395         \InCa@Mul#3!#1!%
1396     \fi
1397 \else
1398     \expandafter\InCa@PowRec
1399     \number\InCa@Mul#1!#1!\expandafter!%
1400     \number\intcalcShr{#2}\expandafter!%
1401     \number
1402     \ifodd#2 %
1403         \ifnum#1>#3 %
1404             \InCa@Mul#1!#3!%
1405         \else
1406             \InCa@Mul#3!#1!%
1407         \fi
1408     \else
1409         #3%
1410     \fi
1411     \expandafter!%
1412 \fi
1413 }

```

### 2.5.11 Div

\intcalcDiv

```

1414 \def\intcalcDiv#1#2{%
1415     \number\expandafter\InCa@Div
1416     \number\number#1\expandafter!%
1417     \number#2! %
1418 }

```

\InCa@Div

```

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

```

\IntCalcDiv

```

1432 \def\InCa@Temp#1{%
1433     \def\IntCalcDiv##1!##2!{%
1434         \number
1435         \ifcase##2 %
1436             0\IntCalcError:DivisionByZero%
1437         \else
1438             \ifcase##1 %
1439                 0%
1440             \else
1441                 \InCa@@Div##1!##2!%
1442             \fi
1443         \fi
1444         #1%
1445     }%
1446 }
1447 \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    | + | $\text{Div}(x, y)$   |

```

1448 \def\InCa@DivSwitch#1!#2!{%
1449   \ifnum#1<\z@
1450     \ifnum#2<\z@
1451       \expandafter\InCa@@Div\number-#1\expandafter!%
1452       \@gobble#2!%
1453     \else
1454       -%
1455       \expandafter\InCa@@Div\@gobble#1!#2!%
1456     \fi
1457   \else
1458     \ifnum#2<\z@
1459       -%
1460       \expandafter\InCa@@Div\number#1\expandafter!%
1461       \@gobble#2!%
1462     \else
1463       \InCa@@Div#1!#2!%
1464     \fi
1465   \fi
1466 }
```

\InCa@@Div

```

1467 \def\InCa@@Div#1!#2!{%
1468   \ifnum#1>#2 %
1469     \ifcase#2 % 0 already caught
1470 ?     \IntCalcError:ThisCannotHappen%
1471     \or % 1
1472       #1%
1473     \or % 2
1474       \InCa@Shr#1!%
1475     \else
1476       \InCa@DivStart!#1!#2!#2!%
1477     \fi
1478   \else
1479     \ifnum#1=#2 %
1480       1%
1481     \else
1482       0%
1483     \fi
1484   \fi
1485 }
```

\InCa@DivStart

```

1486 \def\InCa@DivStart#1!#2#3!#4#5{%
1487   \ifx#5!%
1488     \@ReturnAfterElseFi{%
1489       \InCa@DivStartI{#1#2}#3=!%
1490     }%
1491   \else
1492     \@ReturnAfterFi{%
1493       \InCa@DivStart{#1#2}!#3!#5%
1494     }%
1495   \fi
1496 }
```

\InCa@StartI

```

1497 \def\InCa@DivStartI#1!#2!{%
1498   \expandafter\InCa@DivStartII
1499   \number#2\expandafter\expandafter\expandafter!%
1500   \intcalcShl{#2}!%
1501   #1!%
1502 }

\InCa@StartII

1503 \def\InCa@DivStartII#1!#2!{%
1504   \expandafter\InCa@DivStartIII
1505   \number#1\expandafter!%
1506   \number#2\expandafter\expandafter\expandafter!%
1507   \intcalcShl{#2}!%
1508 }

\InCa@StartIII

1509 \def\InCa@DivStartIII#1!#2!#3!{%
1510   \expandafter\InCa@DivStartIV
1511   \number#1\expandafter!%
1512   \number#2\expandafter!%
1513   \number#3\expandafter!%
1514   \number\InCa@Add#3!#2!\expandafter\expandafter\expandafter!%
1515   \intcalcShl{#3}!%
1516 }

\InCa@StartIV

1517 \def\InCa@DivStartIV#1!#2!#3!#4!#5!#6!{%
1518   \InCa@ProcessDiv#6!#1!#2!#3!#4!#5!/%
1519 }

\InCa@ProcessDiv

1520 \def\InCa@ProcessDiv#1#2#3!#4!#5!#6!#7!#8!#9/{%
1521   #9%
1522   \ifnum#1<#4 % 0
1523     0%
1524     \ifx#2=%
1525     \else
1526       \InCa@ProcessDiv{#1#2}#3!#4!#5!#6!#7!#8!%
1527     \fi
1528   \else % 1-9
1529     \ifnum#1<#5 % 1
1530       1%
1531       \ifx#2=%
1532       \else
1533         \expandafter\InCa@ProcessDiv\expandafter{%
1534           \number\InCa@Sub#1!#4!%
1535           #2%
1536         }#3!#4!#5!#6!#7!#8!%
1537       \fi
1538     \else % 2-9
1539       \ifnum#1<#7 % 2 3 4 5
1540       \ifnum#1<#6 % 2 3
1541         \@ReturnAfterElseFi{%
1542           \expandafter\InCa@@ProcessDiv
1543           \number\InCa@Sub#1!#5!%
1544           23%
1545         }%
1546       \else % 4 5
1547         \@ReturnAfterFi{%
1548           \expandafter\InCa@@ProcessDiv
1549           \number\InCa@Sub#1!#6!%
1550           45%

```

```

1551     }%
1552     \fi
1553     #2#3!#4!#5!#6!#7!#8!%
1554     \else % 6 7 8 9
1555         \ifnum#1<#8 % 6 7
1556             \@ReturnAfterElseFi{%
1557                 \expandafter\InCa@@ProcessDiv
1558                 \number\InCa@Sub#1!#7!!%
1559                 67%
1560             }%
1561         \else % 8 9
1562             \@ReturnAfterFi{%
1563                 \expandafter\InCa@@ProcessDiv
1564                 \number\InCa@Sub#1!#8!!%
1565                 89%
1566             }%
1567         \fi
1568         #2#3!#4!#5!#6!#7!#8!%
1569     \fi
1570 \fi
1571 \fi
1572 \ifx#2=%
1573     \expandafter\@gobble
1574 \fi
1575 /%
1576 }

```

\InCa@@ProcessDiv

```

1577 \def\InCa@@ProcessDiv#1!#2#3#4#5!#6!{%
1578     \ifnum#1<#6 %
1579         #2%
1580         \@ReturnAfterElseFi{%
1581             \ifx#4=%
1582                 \expandafter\InCa@CleanupIV
1583             \else
1584                 \@ReturnAfterFi{%
1585                     \InCa@ProcessDiv{#1#4}#5!#6!%
1586                 }%
1587             \fi
1588         }%
1589     \else
1590         #3%
1591         \@ReturnAfterFi{%
1592             \ifx#4=%
1593                 \expandafter\InCa@CleanupIV
1594             \else
1595                 \@ReturnAfterFi{%
1596                     \expandafter\InCa@ProcessDiv\expandafter{%
1597                         \number\InCa@Sub#1!#6! %
1598                         #4%
1599                     }#5!#6!%
1600                 }%
1601             \fi
1602         }%
1603     \fi
1604 }

```

\InCa@CleanupIV

```

1605 \def\InCa@CleanupIV#1!#2!#3!#4!{}

```

### 2.5.12 Mod

\intcalcMod

```

1606 \def\intcalcMod#1#2{%
1607   \number\expandafter\InCa@Mod
1608   \number\number#1\expandafter!%
1609   \number#2! %
1610 }

```

\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

```

```

1611 \def\InCa@Mod#1!#2!{%
1612   \ifcase#2 %
1613     0\IntCalcError:DivisionByZero%
1614   \else
1615     \ifnum#2<\z@
1616       -%
1617       \expandafter\InCa@Mod
1618       \number-#1\expandafter!%
1619       \number-#2!%
1620   \else
1621     \ifcase#1 %
1622       0%
1623     \else
1624       \ifcase#2 % 0 already caught
1625 ?     \IntCalcError:ThisCannotHappen%
1626       \or % 1
1627         0%
1628       \or % 2
1629         \ifodd#1 1\else 0\fi
1630     \else
1631       \ifnum#1<\z@
1632         \expandafter\InCa@ModShift
1633         \number-%
1634         \expandafter\InCa@Sub
1635         \number\@gobble#1\expandafter!%
1636         \number\intcalcMul{#2}{%
1637           \expandafter\InCa@Div\@gobble#1!#2!%
1638         }!%
1639         !#2!%
1640     \else
1641       \expandafter\InCa@Sub\number#1\expandafter!%
1642       \number\intcalcMul{#2}{\InCa@Div#1!#2!}%
1643     \fi
1644   \fi
1645 \fi
1646 \fi
1647 \fi
1648 }

```

\IntCalcMod

```

1649 \def\InCa@Temp#1{%
1650   \def\IntCalcMod##1!##2!{%

```

```

1651 \number
1652 \ifcase##2 %
1653 0\IntCalcError:DivisionByZero%
1654 \else
1655 \ifcase##1 %
1656 0%
1657 \else
1658 \ifcase##2 % 0 already caught
1659 ? \IntCalcError:ThisCannotHappen
1660 \or % 1
1661 0%
1662 \or % 2
1663 \ifodd ##1 1\else 0\fi
1664 \else
1665 \expandafter\InCa@Sub\number##1\expandafter!%
1666 \number\intcalcMul{##2}{\InCa@Div##1!##2!}%
1667 \fi
1668 \fi
1669 \fi
1670 #1%
1671 }%
1672 }
1673 \InCa@Temp{ }%

```

\InCa@ModShift

```

1674 \def\InCa@ModShift#1!#2!{%
1675 \ifnum#1<\z@
1676 \expandafter\InCa@Sub\number#2\expandafter!%
1677 \@gobble#1!%
1678 \else
1679 #1%
1680 \fi
1681 }

```

### 2.5.13 Help macros

\InCa@Empty

```

1682 \def\InCa@Empty{}

```

\@gobble

```

1683 \expandafter\ifx\csname @gobble\endcsname\relax
1684 \long\def\@gobble#1{}%
1685 \fi

```

\@ReturnAfterFi

```

1686 \long\def\@ReturnAfterFi#1\fi{\fi#1}%

```

\@ReturnAfterElseFi

```

1687 \long\def\@ReturnAfterElseFi#1\else#2\fi{\fi#1}%
1688 \InCa@AtEnd%
1689 </package>

```

## 3 Test

### 3.1 Catcode checks for loading

```

1690 <*test1>
1691 \catcode'\{=1 %
1692 \catcode'\}=2 %

```

```

1693 \catcode'\#=6 %
1694 \catcode'\@=11 %
1695 \expandafter\ifx\csname count@\endcsname\relax
1696 \countdef\count@=255 %
1697 \fi
1698 \expandafter\ifx\csname @gobble\endcsname\relax
1699 \long\def\@gobble#1{%
1700 \fi
1701 \expandafter\ifx\csname @firstofone\endcsname\relax
1702 \long\def\@firstofone#1{#1}%
1703 \fi
1704 \expandafter\ifx\csname loop\endcsname\relax
1705 \expandafter\@firstofone
1706 \else
1707 \expandafter\@gobble
1708 \fi
1709 {%
1710 \def\loop#1\repeat{%
1711 \def\body{#1}%
1712 \iterate
1713 }%
1714 \def\iterate{%
1715 \body
1716 \let\next\iterate
1717 \else
1718 \let\next\relax
1719 \fi
1720 \next
1721 }%
1722 \let\repeat=\fi
1723 }%
1724 \def\RestoreCatcodes{}
1725 \count@=0 %
1726 \loop
1727 \edef\RestoreCatcodes{%
1728 \RestoreCatcodes
1729 \catcode\the\count@=\the\catcode\count@\relax
1730 }%
1731 \ifnum\count@<255 %
1732 \advance\count@ 1 %
1733 \repeat
1734
1735 \def\RangeCatcodeInvalid#1#2{%
1736 \count@=#1\relax
1737 \loop
1738 \catcode\count@=15 %
1739 \ifnum\count@<#2\relax
1740 \advance\count@ 1 %
1741 \repeat
1742 }
1743 \def\RangeCatcodeCheck#1#2#3{%
1744 \count@=#1\relax
1745 \loop
1746 \ifnum#3=\catcode\count@
1747 \else
1748 \errmessage{%
1749 Character \the\count@\space
1750 with wrong catcode \the\catcode\count@\space
1751 instead of \number#3%
1752 }%
1753 \fi
1754 \ifnum\count@<#2\relax

```

```

1755 \advance\count@ 1 %
1756 \repeat
1757 }
1758 \def\space{ }
1759 \expandafter\ifx\csname LoadCommand\endcsname\relax
1760 \def\LoadCommand{\input intcalc.sty\relax}%
1761 \fi
1762 \def\Test{%
1763 \RangeCatcodeInvalid{0}{47}%
1764 \RangeCatcodeInvalid{58}{64}%
1765 \RangeCatcodeInvalid{91}{96}%
1766 \RangeCatcodeInvalid{123}{255}%
1767 \catcode'\@=12 %
1768 \catcode'\=0 %
1769 \catcode'\%=14 %
1770 \LoadCommand
1771 \RangeCatcodeCheck{0}{36}{15}%
1772 \RangeCatcodeCheck{37}{37}{14}%
1773 \RangeCatcodeCheck{38}{47}{15}%
1774 \RangeCatcodeCheck{48}{57}{12}%
1775 \RangeCatcodeCheck{58}{63}{15}%
1776 \RangeCatcodeCheck{64}{64}{12}%
1777 \RangeCatcodeCheck{65}{90}{11}%
1778 \RangeCatcodeCheck{91}{91}{15}%
1779 \RangeCatcodeCheck{92}{92}{0}%
1780 \RangeCatcodeCheck{93}{96}{15}%
1781 \RangeCatcodeCheck{97}{122}{11}%
1782 \RangeCatcodeCheck{123}{255}{15}%
1783 \RestoreCatcodes
1784 }
1785 \Test
1786 \csname @@end\endcsname
1787 \end
1788 </test1>

```

## 3.2 Macro tests

### 3.2.1 Preamble with test macro definitions

```

1789 <*test2 | test4>
1790 \NeedsTeXFormat{LaTeX2e}
1791 \nofiles
1792 \documentclass{article}
1793 <noetex> \let\SavedNumexpr\numexpr
1794 <noetex> \let\numexpr\UNDEFINED
1795 \makeatletter
1796 \chardef\InCa@TestMode=1 %
1797 \makeatother
1798 \usepackage{intcalc}[2007/09/27]
1799 <noetex> \let\numexpr\SavedNumexpr
1800 \usepackage{qstest}
1801 \IncludeTests{*}
1802 \LogTests{log}{*}{*}
1803 </test2 | test4>
1804 <*test2>
1805 \newcommand*{\TestSpaceAtEnd}[1]{%
1806 <noetex> \let\SavedNumexpr\numexpr
1807 <noetex> \let\numexpr\UNDEFINED
1808 \edef\resultA{#1}%
1809 \edef\resultB{#1}%
1810 <noetex> \let\numexpr\SavedNumexpr
1811 \Expect*{\resultA\space}*{\resultB}%
1812 }

```

```

1813 \newcommand*{\TestResult}[2]{%
1814   \noetex \let\SavedNumexpr\numexpr
1815   \noetex \let\numexpr\UNDEFINED
1816   \edef\result{#1}%
1817   \noetex \let\numexpr\SavedNumexpr
1818   \Expect*{\result}{#2}%
1819 }
1820 \newcommand*{\TestResultTwoExpansions}[2]{%
1821   \noetex
1822   \begingroup
1823     \let\numexpr\UNDEFINED
1824     \expandafter\expandafter\expandafter
1825     \endgroup
1826   \noetex
1827   \expandafter\expandafter\expandafter\Expect
1828   \expandafter\expandafter\expandafter{#1}{#2}%
1829 }
1830 \newcount\TestCount
1831 \etex\newcommand*{\TestArg}[1]{\numexpr#1\relax}
1832 \noetex\newcommand*{\TestArg}[1]{#1}
1833 \newcommand*{\TestTeXDivide}[2]{%
1834   \TestCount=\TestArg{#1}\relax
1835   \divide\TestCount by \TestArg{#2}\relax
1836   \Expect*{\intcalcdDiv{#1}{#2}}*{\the\TestCount}%
1837 }
1838 \newcommand*{\Test}[2]{%
1839   \TestResult{#1}{#2}%
1840   \TestResultTwoExpansions{#1}{#2}%
1841   \TestSpaceAtEnd{#1}%
1842 }
1843 \newcommand*{\TestExch}[2]{\Test{#2}{#1}}
1844 \newcommand*{\TestInv}[2]{%
1845   \Test{\intcalcInv{#1}}{#2}%
1846 }
1847 \newcommand*{\TestNum}[2]{%
1848   \Test{\intcalcNum{#1}}{#2}%
1849 }
1850 \newcommand*{\TestAbs}[2]{%
1851   \Test{\intcalcAbs{#1}}{#2}%
1852 }
1853 \newcommand*{\TestSgn}[2]{%
1854   \Test{\intcalcSgn{#1}}{#2}%
1855 }
1856 \newcommand*{\TestMin}[3]{%
1857   \Test{\intcalcMin{#1}{#2}}{#3}%
1858 }
1859 \newcommand*{\TestMax}[3]{%
1860   \Test{\intcalcMax{#1}{#2}}{#3}%
1861 }
1862 \newcommand*{\TestCmp}[3]{%
1863   \Test{\intcalcCmp{#1}{#2}}{#3}%
1864 }
1865 \newcommand*{\TestInc}[2]{%
1866   \Test{\intcalcInc{#1}}{#2}%
1867   \ifnum\intcalcNum{#1}>-1 %
1868     \edef\x{%
1869       \noexpand\Test{%
1870         \noexpand\IntCalcInc\intcalcNum{#1}!%
1871       }{#2}%
1872     }%
1873     \x
1874   \fi

```

```

1875 }
1876 \newcommand*{\TestDec}[2]{%
1877   \Test{\intcalcDec{#1}}{#2}%
1878   \ifnum\intcalcNum{#1}>0 %
1879     \edef\x{%
1880       \noexpand\Test{%
1881         \noexpand\IntCalcDec\intcalcNum{#1}!%
1882       }{#2}%
1883     }%
1884     \x
1885   \fi
1886 }
1887 \newcommand*{\TestAdd}[3]{%
1888   \Test{\intcalcAdd{#1}{#2}}{#3}%
1889   \ifnum\intcalcNum{#1}>0 %
1890     \ifnum\intcalcNum{#2}> 0 %
1891       \ifnum\intcalcCmp{#1}{#2}>0 %
1892         \edef\x{%
1893           \noexpand\Test{%
1894             \noexpand\IntCalcAdd
1895               \intcalcNum{#1}!\intcalcNum{#2}!%
1896             }{#3}%
1897           }%
1898           \x
1899         \else
1900           \edef\x{%
1901             \noexpand\Test{%
1902               \noexpand\IntCalcAdd
1903                 \intcalcNum{#2}!\intcalcNum{#1}!%
1904             }{#3}%
1905           }%
1906           \x
1907         \fi
1908       \fi
1909     \fi
1910 }
1911 \newcommand*{\TestSub}[3]{%
1912   \Test{\intcalcSub{#1}{#2}}{#3}%
1913   \ifnum\intcalcNum{#1}>0 %
1914     \ifnum\intcalcNum{#2}> 0 %
1915       \ifnum\intcalcCmp{#1}{#2}>0 %
1916         \edef\x{%
1917           \noexpand\Test{%
1918             \noexpand\IntCalcSub
1919               \intcalcNum{#1}!\intcalcNum{#2}!%
1920             }{#3}%
1921           }%
1922           \x
1923         \fi
1924       \fi
1925     \fi
1926 }
1927 \newcommand*{\TestShl}[2]{%
1928   \Test{\intcalcShl{#1}}{#2}%
1929   \edef\x{%
1930     \noexpand\Test{%
1931       \noexpand\IntCalcShl\intcalcAbs{#1}!%
1932     }{\intcalcAbs{#2}}%
1933   }%
1934   \x
1935 }
1936 \newcommand*{\TestShr}[2]{%

```

```

1937 \Test{\intcalcShr{#1}{#2}%
1938 \edef\x{%
1939     \noexpand\Test{%
1940         \noexpand\IntCalcShr\intcalcAbs{#1}!%
1941     }\intcalcAbs{#2}}%
1942 }%
1943 \x
1944 }
1945 \newcommand*\TestMul}[3]{%
1946     \Test{\intcalcMul{#1}{#2}}{#3}%
1947 \edef\x{%
1948     \noexpand\Test{%
1949         \noexpand\IntCalcMul\intcalcAbs{#1}!\intcalcAbs{#2}!%
1950     }\intcalcAbs{#3}}%
1951 }%
1952 \x
1953 }
1954 \newcommand*\TestSqr}[2]{%
1955     \Test{\intcalcSqr{#1}{#2}%
1956 }
1957 \newcommand*\TestFac}[2]{%
1958     \expandafter\TestExch\expandafter{\the\numexpr#2}\intcalcFac{#1}}%
1959 }
1960 \newcommand*\TestPow}[3]{%
1961     \Test{\intcalcPow{#1}{#2}}{#3}%
1962 }
1963 \newcommand*\TestDiv}[3]{%
1964     \Test{\intcalcDiv{#1}{#2}}{#3}%
1965     \TestTeXDivide{#1}{#2}%
1966 \edef\x{%
1967     \noexpand\Test{%
1968         \noexpand\IntCalcDiv\intcalcAbs{#1}!\intcalcAbs{#2}!%
1969     }\intcalcAbs{#3}}%
1970 }%
1971 }
1972 \newcommand*\TestMod}[3]{%
1973     \Test{\intcalcMod{#1}{#2}}{#3}%
1974     \ifcase\ifcase\intcalcSgn{#1} 0%
1975         \or
1976         \ifcase\intcalcSgn{#2} 1%
1977         \or 0%
1978         \else 1%
1979         \fi
1980     \else
1981         \ifcase\intcalcSgn{#2} 1%
1982         \or 1%
1983         \else 0%
1984         \fi
1985     \fi\relax
1986 \edef\x{%
1987     \noexpand\Test{%
1988         \noexpand\IntCalcMod
1989         \intcalcAbs{#1}!\intcalcAbs{#2}!%
1990     }\intcalcAbs{#3}}%
1991 }%
1992 \x
1993 \fi
1994 }
1995 </test2>

```

### 3.2.2 Time

```

1996 <*test2>
1997 \begingroup\expandafter\expandafter\expandafter\endgroup

```

```

1998 \expandafter\ifx\csname pdfresettimer\endcsname\relax
1999 \else
2000   \makeatletter
2001   \newcount\SummaryTime
2002   \newcount\TestTime
2003   \SummaryTime=\z@
2004   \newcommand*\PrintTime}[2]{%
2005     \typeout{%
2006       [Time #1: \strip@pt\dimexpr\number#2sp\relax\space s]%
2007     }%
2008   }%
2009   \newcommand*\StartTime#[1]{%
2010     \renewcommand*\TimeDescription}{#1}%
2011     \pdfresettimer
2012   }%
2013   \newcommand*\TimeDescription{}%
2014   \newcommand*\StopTime{}%
2015   \TestTime=\pdfelapsedtime
2016   \global\advance\SummaryTime\TestTime
2017   \PrintTime\TimeDescription\TestTime
2018 }%
2019 \let\saved@qstest\qstest
2020 \let\saved@endqstest\endqstest
2021 \def\qstest#1#2{%
2022   \saved@qstest{#1}{#2}%
2023   \StartTime{#1}%
2024 }%
2025 \def\endqstest{%
2026   \StopTime
2027   \saved@endqstest
2028 }%
2029 \AtEndDocument{%
2030   \PrintTime{summary}\SummaryTime
2031 }%
2032 \makeatother
2033 \fi
2034 </test2>

```

### 3.2.3 Test 4: additional mod/div operations

```

2035 <*test4>
2036 \newcommand*\TestDo}[2]{%
2037   \ifcase\numexpr#2\relax
2038   \else
2039     \edef\temp{\intcalcMod{#1}{#2}}%
2040     \Expect*{%
2041       \the\numexpr
2042       \intcalcMul{%
2043         \intcalcDiv{\intcalcAbs{#1}}{\intcalcAbs{#2}}%
2044       }\intcalcAbs{#2}}%
2045       +\intcalcMod{\intcalcAbs{#1}}{\intcalcAbs{#2}}\relax
2046     }*\the\numexpr\intcalcAbs{#1}\relax}%
2047   \fi
2048 }
2049 \newcommand*\TestOne}[2]{%
2050   \TestDo{#1}{#1}%
2051 }
2052 \newcommand*\TestTwo}[3]{%
2053   \TestDo{#1}{#2}%
2054   \TestDo{#2}{#1}%
2055 }
2056 \let\TestNum\TestOne
2057 \let\TestInv\TestOne
2058 \let\TestAbs\TestOne

```

```

2059 \let\TestSgn\TestOne
2060 \let\TestMin\TestTwo
2061 \let\TestMax\TestTwo
2062 \let\TestCmp\TestTwo
2063 \let\TestInc\TestOne
2064 \let\TestDec\TestOne
2065 \let\TestAdd\TestTwo
2066 \let\TestSub\TestTwo
2067 \let\TestShl\TestOne
2068 \let\TestShr\TestOne
2069 \let\TestMul\TestTwo
2070 \let\TestSqr\TestOne
2071 \def\TestFac#1#2{}
2072 \let\TestPow\TestTwo
2073 \let\TestDiv\TestTwo
2074 \let\TestMod\TestTwo
2075 </test4>

```

### 3.2.4 Test sets

```

2076 <*test2 | test4>
2077 \makeatletter
2078
2079 \begin{qstest}{num}{num}%
2080   \TestNum{0}{0}%
2081   \TestNum{1}{1}%
2082   \TestNum{-1}{-1}%
2083   \TestNum{10}{10}%
2084   \TestNum{-10}{-10}%
2085   \TestNum{2147483647}{2147483647}%
2086   \TestNum{-2147483647}{-2147483647}%
2087   \TestNum{ 0 }{0}%
2088   \TestNum{ 1 }{1}%
2089   \TestNum{--1}{1}%
2090   \TestNum{ - + - + 4 }{4}%
2091   \TestNum{\z@}{0}%
2092   \TestNum{\@ne}{1}%
2093   \TestNum{\m@ne}{-1}%
2094 <*etex>
2095   \TestNum{-10+30}{20}%
2096   \TestNum{10-30}{-20}%
2097 </etex>
2098 \end{qstest}
2099
2100 \begin{qstest}{inv}{inv}%
2101   \TestInv{0}{0}%
2102   \TestInv{1}{-1}%
2103   \TestInv{-1}{1}%
2104   \TestInv{10}{-10}%
2105   \TestInv{-10}{10}%
2106   \TestInv{2147483647}{-2147483647}%
2107   \TestInv{-2147483647}{2147483647}%
2108   \TestInv{ 0 }{0}%
2109   \TestInv{ 1 }{-1}%
2110   \TestInv{--1}{-1}%
2111   \TestInv{\z@}{0}%
2112   \TestInv{\@ne}{-1}%
2113   \TestInv{\m@ne}{1}%
2114 <*etex>
2115   \TestInv{-10+30}{-20}%
2116   \TestInv{10-30}{20}%
2117 </etex>
2118 \end{qstest}
2119

```

```

2120 \begin{qstest}{abs}{abs}%
2121   \TestAbs{0}{0}%
2122   \TestAbs{1}{1}%
2123   \TestAbs{-1}{1}%
2124   \TestAbs{10}{10}%
2125   \TestAbs{-10}{10}%
2126   \TestAbs{2147483647}{2147483647}%
2127   \TestAbs{-2147483647}{2147483647}%
2128   \TestAbs{ 0 }{0}%
2129   \TestAbs{ 1 }{1}%
2130   \TestAbs{--1}{1}%
2131   \TestAbs{\z0}{0}%
2132   \TestAbs{\@ne}{1}%
2133   \TestAbs{\m@ne}{1}%
2134 \etex
2135   \TestAbs{-10+30}{20}%
2136   \TestAbs{10-30}{20}%
2137 \etex
2138 \end{qstest}
2139
2140 \begin{qstest}{sign}{sign}%
2141   \TestSgn{0}{0}%
2142   \TestSgn{1}{1}%
2143   \TestSgn{-1}{-1}%
2144   \TestSgn{10}{1}%
2145   \TestSgn{-10}{-1}%
2146   \TestSgn{2147483647}{1}%
2147   \TestSgn{-2147483647}{-1}%
2148   \TestSgn{ 0 }{0}%
2149   \TestSgn{ 2 }{1}%
2150   \TestSgn{ -2 }{-1}%
2151   \TestSgn{--2}{1}%
2152   \TestSgn{\z0}{0}%
2153   \TestSgn{\@ne}{1}%
2154   \TestSgn{\m@ne}{-1}%
2155 \etex
2156   \TestSgn{-10+30}{1}%
2157   \TestSgn{10-30}{-1}%
2158 \etex
2159 \end{qstest}
2160
2161 \begin{qstest}{min}{min}%
2162   \TestMin{0}{1}{0}%
2163   \TestMin{1}{0}{0}%
2164   \TestMin{-10}{-20}{-20}%
2165   \TestMin{ 1 }{ 2 }{1}%
2166   \TestMin{ 2 }{ 1 }{1}%
2167   \TestMin{1}{1}{1}%
2168   \TestMin{\z0}{\@ne}{0}%
2169   \TestMin{\@ne}{\m@ne}{-1}%
2170 \etex
2171   \TestMin{1+2}{3+4}{3}%
2172 \etex
2173 \end{qstest}
2174
2175 \begin{qstest}{max}{max}%
2176   \TestMax{0}{1}{1}%
2177   \TestMax{1}{0}{1}%
2178   \TestMax{-10}{-20}{-10}%
2179   \TestMax{ 1 }{ 2 }{2}%
2180   \TestMax{ 2 }{ 1 }{2}%
2181   \TestMax{1}{1}{1}%

```

```

2182 \TestMax{\z0}{\@ne}{1}%
2183 \TestMax{\@ne}{\m@ne}{1}%
2184 <*etex>
2185 \TestMax{1+2}{3+4}{7}%
2186 </etex>
2187 \end{qstest}
2188
2189 \begin{qstest}{cmp}{cmp}%
2190 \TestCmp{0}{0}{0}%
2191 \TestCmp{-21}{17}{-1}%
2192 \TestCmp{3}{4}{-1}%
2193 \TestCmp{-10}{-10}{0}%
2194 \TestCmp{-10}{-11}{1}%
2195 \TestCmp{100}{5}{1}%
2196 \TestCmp{2147483647}{-2147483647}{1}%
2197 \TestCmp{-2147483647}{2147483647}{-1}%
2198 \TestCmp{2147483647}{2147483647}{0}%
2199 \TestCmp{\z0}{\@ne}{-1}%
2200 \TestCmp{\@ne}{\m@ne}{1}%
2201 \TestCmp{ 4 }{ 5 }{-1}%
2202 \TestCmp{ -3 }{ -7 }{1}%
2203 <*etex>
2204 \TestCmp{1+2}{3+4}{-1}%
2205 </etex>
2206 \end{qstest}
2207
2208 \begin{qstest}{fac}{fac}
2209 \TestFac{0}{1}%
2210 \TestFac{1}{1}%
2211 \TestFac{2}{2}%
2212 \TestFac{3}{2*3}%
2213 \TestFac{4}{2*3*4}%
2214 \TestFac{5}{2*3*4*5}%
2215 \TestFac{6}{2*3*4*5*6}%
2216 \TestFac{7}{2*3*4*5*6*7}%
2217 \TestFac{8}{2*3*4*5*6*7*8}%
2218 \TestFac{9}{2*3*4*5*6*7*8*9}%
2219 \TestFac{10}{2*3*4*5*6*7*8*9*10}%
2220 \TestFac{11}{2*3*4*5*6*7*8*9*10*11}%
2221 \TestFac{12}{2*3*4*5*6*7*8*9*10*11*12}%
2222 \end{qstest}
2223
2224 \begin{qstest}{inc}{inc}%
2225 \TestInc{0}{1}%
2226 \TestInc{1}{2}%
2227 \TestInc{-1}{0}%
2228 \TestInc{10}{11}%
2229 \TestInc{-10}{-9}%
2230 \TestInc{999}{1000}%
2231 \TestInc{-1000}{-999}%
2232 \TestInc{129}{130}%
2233 \TestInc{2147483646}{2147483647}%
2234 \TestInc{-2147483647}{-2147483646}%
2235 \end{qstest}
2236
2237 \begin{qstest}{dec}{dec}%
2238 \TestDec{0}{-1}%
2239 \TestDec{1}{0}%
2240 \TestDec{-1}{-2}%
2241 \TestDec{10}{9}%
2242 \TestDec{-10}{-11}%
2243 \TestDec{1000}{999}%

```

```

2244 \TestDec{-999}{-1000}%
2245 \TestDec{130}{129}%
2246 \TestDec{2147483647}{2147483646}%
2247 \TestDec{-2147483646}{-2147483647}%
2248 \end{qstest}
2249
2250 \begin{qstest}{add}{add}%
2251 \TestAdd{0}{0}{0}%
2252 \TestAdd{1}{0}{1}%
2253 \TestAdd{0}{1}{1}%
2254 \TestAdd{1}{2}{3}%
2255 \TestAdd{-1}{-1}{-2}%
2256 \TestAdd{2147483646}{1}{2147483647}%
2257 \TestAdd{-2147483647}{2147483647}{0}%
2258 \TestAdd{20}{-5}{15}%
2259 \TestAdd{-4}{-1}{-5}%
2260 \TestAdd{-1}{-4}{-5}%
2261 \TestAdd{-4}{1}{-3}%
2262 \TestAdd{-1}{4}{3}%
2263 \TestAdd{4}{-1}{3}%
2264 \TestAdd{1}{-4}{-3}%
2265 \TestAdd{-4}{-1}{-5}%
2266 \TestAdd{-1}{-4}{-5}%
2267 \TestAdd{ -4 }{ -1 }{-5}%
2268 \TestAdd{ -1 }{ -4 }{-5}%
2269 \TestAdd{ -4 }{ 1 }{-3}%
2270 \TestAdd{ -1 }{ 4 }{3}%
2271 \TestAdd{ 4 }{ -1 }{3}%
2272 \TestAdd{ 1 }{ -4 }{-3}%
2273 \TestAdd{ -4 }{ -1 }{-5}%
2274 \TestAdd{ -1 }{ -4 }{-5}%
2275 \TestAdd{876543210}{111111111}{987654321}%
2276 \TestAdd{999999999}{2}{1000000001}%
2277 (*etex)
2278 \TestAdd{100}{50+150}{300}%
2279 \TestAdd{2147483647}{10-2147483647}{10}%
2280 (/etex)
2281 \end{qstest}
2282
2283 \begin{qstest}{sub}{sub}
2284 \TestSub{0}{0}{0}%
2285 \TestSub{1}{0}{1}%
2286 \TestSub{1}{2}{-1}%
2287 \TestSub{-1}{-1}{0}%
2288 \TestSub{2147483646}{-1}{2147483647}%
2289 \TestSub{-2147483647}{-2147483647}{0}%
2290 \TestSub{-4}{-1}{-3}%
2291 \TestSub{-1}{-4}{3}%
2292 \TestSub{-4}{1}{-5}%
2293 \TestSub{-1}{4}{-5}%
2294 \TestSub{4}{-1}{5}%
2295 \TestSub{1}{-4}{5}%
2296 \TestSub{-4}{-1}{-3}%
2297 \TestSub{-1}{-4}{3}%
2298 \TestSub{ -4 }{ -1 }{-3}%
2299 \TestSub{ -1 }{ -4 }{3}%
2300 \TestSub{ -4 }{ 1 }{-5}%
2301 \TestSub{ -1 }{ 4 }{-5}%
2302 \TestSub{ 4 }{ -1 }{5}%
2303 \TestSub{ 1 }{ -4 }{5}%
2304 \TestSub{ -4 }{ -1 }{-3}%
2305 \TestSub{ -1 }{ -4 }{3}%

```

```

2306 \TestSub{1000000000}{2}{999999998}%
2307 \TestSub{987654321}{111111111}{876543210}%
2308 <*etex>
2309 \TestSub{100}{50+150}{-100}%
2310 \TestSub{2147483647}{-10+2147483647}{10}%
2311 </etex>
2312 \end{qstest}
2313
2314 \begin{qstest}{shl}{shl}
2315 \TestShl{0}{0}%
2316 \TestShl{1}{2}%
2317 \TestShl{5621}{11242}%
2318 \TestShl{1073741823}{2147483646}%
2319 \TestShl{-1}{-2}%
2320 \TestShl{-5621}{-11242}%
2321 \end{qstest}
2322
2323 \begin{qstest}{shr}{shr}
2324 \TestShr{0}{0}%
2325 \TestShr{1}{0}%
2326 \TestShr{2}{1}%
2327 \TestShr{3}{1}%
2328 \TestShr{4}{2}%
2329 \TestShr{5}{2}%
2330 \TestShr{6}{3}%
2331 \TestShr{7}{3}%
2332 \TestShr{8}{4}%
2333 \TestShr{9}{4}%
2334 \TestShr{10}{5}%
2335 \TestShr{11}{5}%
2336 \TestShr{12}{6}%
2337 \TestShr{13}{6}%
2338 \TestShr{14}{7}%
2339 \TestShr{15}{7}%
2340 \TestShr{16}{8}%
2341 \TestShr{17}{8}%
2342 \TestShr{18}{9}%
2343 \TestShr{19}{9}%
2344 \TestShr{20}{10}%
2345 \TestShr{21}{10}%
2346 \TestShr{22}{11}%
2347 \TestShr{11241}{5620}%
2348 \TestShr{73054202}{36527101}%
2349 \TestShr{2147483646}{1073741823}%
2350 \TestShr{-1}{0}%
2351 \TestShr{-2}{-1}%
2352 \TestShr{-3}{-1}%
2353 \TestShr{-11241}{-5620}%
2354 \end{qstest}
2355
2356 \begin{qstest}{mul}{mul}
2357 \TestMul{0}{0}{0}%
2358 \TestMul{1}{0}{0}%
2359 \TestMul{0}{1}{0}%
2360 \TestMul{1}{1}{1}%
2361 \TestMul{3}{1}{3}%
2362 \TestMul{1}{-3}{-3}%
2363 \TestMul{-4}{-5}{20}%
2364 \TestMul{3}{7}{21}%
2365 \TestMul{7}{3}{21}%
2366 \TestMul{3}{-7}{-21}%
2367 \TestMul{7}{-3}{-21}%

```

```

2368 \TestMul{-3}{7}{-21}%
2369 \TestMul{-7}{3}{-21}%
2370 \TestMul{-3}{-7}{21}%
2371 \TestMul{-7}{-3}{21}%
2372 \TestMul{12}{11}{132}%
2373 \TestMul{999}{333}{332667}%
2374 \TestMul{1000}{4321}{4321000}%
2375 \TestMul{12345}{173955}{2147474475}%
2376 \TestMul{1073741823}{2}{2147483646}%
2377 \TestMul{2}{1073741823}{2147483646}%
2378 \TestMul{-1073741823}{2}{-2147483646}%
2379 \TestMul{2}{-1073741823}{-2147483646}%
2380 \etex
2381 \TestMul{2+3}{5+7}{60}%
2382 \TestMul{2147483647}{2147483647/2147483647}{2147483647}%
2383 \etex
2384 \end{qstest}
2385
2386 \begin{qstest}{sqr}{sqr}
2387 \TestSqr{0}{0}%
2388 \TestSqr{1}{1}%
2389 \TestSqr{2}{4}%
2390 \TestSqr{3}{9}%
2391 \TestSqr{4}{16}%
2392 \TestSqr{9}{81}%
2393 \TestSqr{10}{100}%
2394 \TestSqr{46340}{2147395600}%
2395 \TestSqr{-1}{1}%
2396 \TestSqr{-2}{4}%
2397 \TestSqr{-46340}{2147395600}%
2398 \end{qstest}
2399
2400 \begin{qstest}{pow}{pow}
2401 \TestPow{-2}{0}{1}%
2402 \TestPow{-1}{0}{1}%
2403 \TestPow{0}{0}{1}%
2404 \TestPow{1}{0}{1}%
2405 \TestPow{2}{0}{1}%
2406 \TestPow{3}{0}{1}%
2407 \TestPow{-2}{1}{-2}%
2408 \TestPow{-1}{1}{-1}%
2409 \TestPow{1}{1}{1}%
2410 \TestPow{2}{1}{2}%
2411 \TestPow{3}{1}{3}%
2412 \TestPow{-2}{2}{4}%
2413 \TestPow{-1}{2}{1}%
2414 \TestPow{0}{2}{0}%
2415 \TestPow{1}{2}{1}%
2416 \TestPow{2}{2}{4}%
2417 \TestPow{3}{2}{9}%
2418 \TestPow{0}{1}{0}%
2419 \TestPow{1}{-2}{1}%
2420 \TestPow{1}{-1}{1}%
2421 \TestPow{-1}{-2}{1}%
2422 \TestPow{-1}{-1}{-1}%
2423 \TestPow{-1}{3}{-1}%
2424 \TestPow{-1}{4}{1}%
2425 \TestPow{-2}{-1}{0}%
2426 \TestPow{-2}{-2}{0}%
2427 \TestPow{2}{3}{8}%
2428 \TestPow{2}{4}{16}%
2429 \TestPow{2}{5}{32}%

```

```

2430 \TestPow{2}{6}{64}%
2431 \TestPow{2}{7}{128}%
2432 \TestPow{2}{8}{256}%
2433 \TestPow{2}{9}{512}%
2434 \TestPow{2}{10}{1024}%
2435 \TestPow{-2}{3}{-8}%
2436 \TestPow{-2}{4}{16}%
2437 \TestPow{-2}{5}{-32}%
2438 \TestPow{-2}{6}{64}%
2439 \TestPow{-2}{7}{-128}%
2440 \TestPow{-2}{8}{256}%
2441 \TestPow{-2}{9}{-512}%
2442 \TestPow{-2}{10}{1024}%
2443 \TestPow{3}{3}{27}%
2444 \TestPow{3}{4}{81}%
2445 \TestPow{3}{5}{243}%
2446 \TestPow{-3}{3}{-27}%
2447 \TestPow{-3}{4}{81}%
2448 \TestPow{-3}{5}{-243}%
2449 \TestPow{2}{30}{1073741824}%
2450 \TestPow{-3}{19}{-1162261467}%
2451 \TestPow{5}{13}{1220703125}%
2452 \TestPow{-7}{11}{-1977326743}%
2453 \end{qstest}
2454
2455 \begin{qstest}{div}{div}
2456 \TestDiv{1}{1}{1}%
2457 \TestDiv{2}{1}{2}%
2458 \TestDiv{-2}{1}{-2}%
2459 \TestDiv{2}{-1}{-2}%
2460 \TestDiv{-2}{-1}{2}%
2461 \TestDiv{15}{2}{7}%
2462 \TestDiv{-16}{2}{-8}%
2463 \TestDiv{1}{2}{0}%
2464 \TestDiv{1}{3}{0}%
2465 \TestDiv{2}{3}{0}%
2466 \TestDiv{-2}{3}{0}%
2467 \TestDiv{2}{-3}{0}%
2468 \TestDiv{-2}{-3}{0}%
2469 \TestDiv{13}{3}{4}%
2470 \TestDiv{-13}{-3}{4}%
2471 \TestDiv{-13}{3}{-4}%
2472 \TestDiv{-6}{5}{-1}%
2473 \TestDiv{-5}{5}{-1}%
2474 \TestDiv{-4}{5}{0}%
2475 \TestDiv{-3}{5}{0}%
2476 \TestDiv{-2}{5}{0}%
2477 \TestDiv{-1}{5}{0}%
2478 \TestDiv{0}{5}{0}%
2479 \TestDiv{1}{5}{0}%
2480 \TestDiv{2}{5}{0}%
2481 \TestDiv{3}{5}{0}%
2482 \TestDiv{4}{5}{0}%
2483 \TestDiv{5}{5}{1}%
2484 \TestDiv{6}{5}{1}%
2485 \TestDiv{-5}{4}{-1}%
2486 \TestDiv{-4}{4}{-1}%
2487 \TestDiv{-3}{4}{0}%
2488 \TestDiv{-2}{4}{0}%
2489 \TestDiv{-1}{4}{0}%
2490 \TestDiv{0}{4}{0}%
2491 \TestDiv{1}{4}{0}%

```

```

2492 \TestDiv{2}{4}{0}%
2493 \TestDiv{3}{4}{0}%
2494 \TestDiv{4}{4}{1}%
2495 \TestDiv{5}{4}{1}%
2496 \TestDiv{12345}{678}{18}%
2497 \TestDiv{32372}{5952}{5}%
2498 \TestDiv{284271294}{18162}{15651}%
2499 \TestDiv{217652429}{12561}{17327}%
2500 \TestDiv{462028434}{5439}{84947}%
2501 \TestDiv{2147483647}{1000}{2147483}%
2502 \TestDiv{2147483647}{-1000}{-2147483}%
2503 \TestDiv{-2147483647}{1000}{-2147483}%
2504 \TestDiv{-2147483647}{-1000}{2147483}%
2505 \end{qstest}
2506
2507 \begin{qstest}{mod}{mod}
2508 \TestMod{-6}{5}{4}%
2509 \TestMod{-5}{5}{0}%
2510 \TestMod{-4}{5}{1}%
2511 \TestMod{-3}{5}{2}%
2512 \TestMod{-2}{5}{3}%
2513 \TestMod{-1}{5}{4}%
2514 \TestMod{0}{5}{0}%
2515 \TestMod{1}{5}{1}%
2516 \TestMod{2}{5}{2}%
2517 \TestMod{3}{5}{3}%
2518 \TestMod{4}{5}{4}%
2519 \TestMod{5}{5}{0}%
2520 \TestMod{6}{5}{1}%
2521 \TestMod{-5}{4}{3}%
2522 \TestMod{-4}{4}{0}%
2523 \TestMod{-3}{4}{1}%
2524 \TestMod{-2}{4}{2}%
2525 \TestMod{-1}{4}{3}%
2526 \TestMod{0}{4}{0}%
2527 \TestMod{1}{4}{1}%
2528 \TestMod{2}{4}{2}%
2529 \TestMod{3}{4}{3}%
2530 \TestMod{4}{4}{0}%
2531 \TestMod{5}{4}{1}%
2532 \TestMod{-6}{-5}{-1}%
2533 \TestMod{-5}{-5}{0}%
2534 \TestMod{-4}{-5}{-4}%
2535 \TestMod{-3}{-5}{-3}%
2536 \TestMod{-2}{-5}{-2}%
2537 \TestMod{-1}{-5}{-1}%
2538 \TestMod{0}{-5}{0}%
2539 \TestMod{1}{-5}{-4}%
2540 \TestMod{2}{-5}{-3}%
2541 \TestMod{3}{-5}{-2}%
2542 \TestMod{4}{-5}{-1}%
2543 \TestMod{5}{-5}{0}%
2544 \TestMod{6}{-5}{-4}%
2545 \TestMod{-5}{-4}{-1}%
2546 \TestMod{-4}{-4}{0}%
2547 \TestMod{-3}{-4}{-3}%
2548 \TestMod{-2}{-4}{-2}%
2549 \TestMod{-1}{-4}{-1}%
2550 \TestMod{0}{-4}{0}%
2551 \TestMod{1}{-4}{-3}%
2552 \TestMod{2}{-4}{-2}%
2553 \TestMod{3}{-4}{-1}%

```

```

2554 \TestMod{4}{-4}{0}%
2555 \TestMod{5}{-4}{-3}%
2556 \TestMod{2147483647}{1000}{647}%
2557 \TestMod{2147483647}{-1000}{-353}%
2558 \TestMod{-2147483647}{1000}{353}%
2559 \TestMod{-2147483647}{-1000}{-647}%
2560 \TestMod{ 0 }{ 4 }{0}%
2561 \TestMod{ 1 }{ 4 }{1}%
2562 \TestMod{ -1 }{ 4 }{3}%
2563 \TestMod{ 0 }{ -4 }{0}%
2564 \TestMod{ 1 }{ -4 }{-3}%
2565 \TestMod{ -1 }{ -4 }{-1}%
2566 <*etex>
2567 \TestMod{1+2}{1+3}{3}%
2568 \TestMod{1-2}{1+3}{3}%
2569 \TestMod{1-2}{1-4}{-1}%
2570 \TestMod{1+2}{1-4}{0}%
2571 \TestMod{1+2}{1-5}{-1}%
2572 </etex>
2573 \end{qstest}
2574 </test2 | test4>
2575
2576 <*test2>
2577 \newcommand*{\TestError}[2]{%
2578   \begingroup
2579     \expandafter\def\csname IntCalcError:#1\endcsname{%
2580       \Expect*{#2}{0}%
2581       \expandafter\def\csname IntCalcError:#1\endcsname{ERROR}%
2582       \Expect*{#2}{0ERROR }%
2583     \endgroup
2584   }
2585 \begin{qstest}{error}{error}
2586 \TestError{FacNegative}{\intcalcFac{-1}}%
2587 \TestError{FacNegative}{\intcalcFac{-2147483647}}%
2588 \TestError{FacOverflow}{\intcalcFac{13}}%
2589 \TestError{FacOverflow}{\intcalcFac{2147483647}}%
2590 \TestError{DivisionByZero}{\intcalcPow{0}{-1}}%
2591 \TestError{DivisionByZero}{\intcalcDiv{1}{0}}%
2592 \TestError{DivisionByZero}{\intcalcMod{1}{0}}%
2593 \TestError{DivisionByZero}{\IntCalcDiv1!0!}%
2594 \TestError{DivisionByZero}{\IntCalcMod1!0!}%
2595 \end{qstest}
2596 </test2>
2597
2598 <*test2 | test4>
2599 \begin{document}
2600 \end{document}
2601 </test2 | test4>

```

## 4 Installation

### 4.1 Download

**Package.** This package is available on CTAN<sup>1</sup>:

[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.

<sup>1</sup><http://ftp.ctan.org/tex-archive/>

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

*TDS* refers to the standard “A Directory Structure for T<sub>E</sub>X 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 T<sub>E</sub>X:

```
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):

|                                     |  |
|-------------------------------------|--|
| <code>intcalc.sty</code>            | → <code>tex/generic/oberdiek/intcalc.sty</code>          |
| <code>intcalc.pdf</code>            | → <code>doc/latex/oberdiek/intcalc.pdf</code>            |
| <code>test/intcalc-test1.tex</code> | → <code>doc/latex/oberdiek/test/intcalc-test1.tex</code> |
| <code>test/intcalc-test2.tex</code> | → <code>doc/latex/oberdiek/test/intcalc-test2.tex</code> |
| <code>test/intcalc-test3.tex</code> | → <code>doc/latex/oberdiek/test/intcalc-test3.tex</code> |
| <code>test/intcalc-test4.tex</code> | → <code>doc/latex/oberdiek/test/intcalc-test4.tex</code> |
| <code>intcalc.dtx</code>            | → <code>source/latex/oberdiek/intcalc.dtx</code>         |

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`.

## 4.4 Refresh file name databases

If your T<sub>E</sub>X distribution (teT<sub>E</sub>X, mikT<sub>E</sub>X, ...) relies on file name databases, you must refresh these. For example, teT<sub>E</sub>X 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 L<sup>A</sup>T<sub>E</sub>X.** The .dtx chooses its action depending on the format:

**plain T<sub>E</sub>X:** Run docstrip and extract the files.

**L<sup>A</sup>T<sub>E</sub>X:** Generate the documentation.

If you insist on using L<sup>A</sup>T<sub>E</sub>X for docstrip (really, docstrip does not need L<sup>A</sup>T<sub>E</sub>X), 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 pdfL<sup>A</sup>T<sub>E</sub>X:

```
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; plain numbers refer to the code lines where the entry is used.

| Symbols             |   |   |
|---------------------|---|---|
| \#                  | 1693                                      | \@ReturnAfterFi . . . . . 664, 675, 687, 699, 710, 721, |
| \%                  | 1769                                      | 1009, 1053, 1107, 1240, 1492,                           |
| \@                  | 1694, 1767                                | 1547, 1562, 1584, 1591, 1595, <u>1686</u>               |
| \@ReturnAfterElseFi |   | \@firstofone . . . . . 1702, 1705                       |
|                     | 660, 671, 683, 695,                       | \@gobble 601, 604, 609, 612, 619, 622,                  |
|                     | 1055, 1488, 1541, 1556, 1580, <u>1687</u> | 1260, 1263, 1268, 1271, 1279,                           |

|  |  |
|--|--|
| 1281, 1452, 1455, 1461, 1573,<br>1635, 1637, 1677, <u>1683</u> , 1699, 1707  | 753, 755, 757, 865, 867, 869,<br>1006, 1014, 1015, 1018, 1019,<br>1104, 1113, 1114, 1127, 1128,<br>1131, 1133, 1135, 1139, 1238,<br>1247, 1683, 1695, 1698, 1701,<br>1704, 1759, 1786, 1998, 2579, 2581  |
| \@ne 311, 1391, 2092, 2112, 2132, 2153,<br>2168, 2169, 2182, 2183, 2199, 2200  | \endinput ..... 29, 112  |
| \@undefined ..... 58   | \endlinechar ..... 4, 35, 71, 77, 89   |
| \\ ..... 1768  | \endqstest ..... 2020, 2025  |
| \{ ..... 1691  | \errmessage ..... 1748   |
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| <code>\nofiles</code> . . . . .        | 1791                               |  |
| <code>\number</code> . . . . .         | 190, 193,                          |  |
|  | 196, 199, 204, 209, 240, 266,      |  |
|  | 272, 275, 323, 328, 342, 344,      |  |
|  | 349, 351, 359, 378, 392, 394,      |  |
|  | 399, 401, 409, 451, 454, 458,      |  |
|  | 461, 464, 465, 468, 469, 472,      |  |
|  | 473, 476, 489, 506, 509, 584,      |  |
|  | 586, 587, 590, 592, 593, 600,      |  |
|  | 603, 611, 618, 634, 637, 988,      |  |
|  | 1000, 1037, 1047, 1089, 1141,      |  |
|  | 1250, 1252, 1253, 1259, 1262,      |  |
|  | 1270, 1278, 1293, 1313, 1322,      |  |
|  | 1323, 1331, 1341, 1344, 1345,      |  |
|  | 1346, 1399, 1400, 1401, 1415,      |  |
|  | 1416, 1417, 1427, 1428, 1434,      |  |
|  | 1451, 1460, 1499, 1505, 1506,      |  |
|  | 1511, 1512, 1513, 1514, 1534,      |  |
|  | 1543, 1549, 1558, 1564, 1597,      |  |
|  | 1607, 1608, 1609, 1618, 1619,      |  |
|  | 1633, 1635, 1636, 1641, 1642,      |  |
|  | 1651, 1665, 1666, 1676, 1751, 2006 |  |
| <code>\numexpr</code> . . .            | 187, 193, 196, 200, 201,           |  |
|  | 205, 206, 210, 213, 216, 219,      |  |
|  | 222, 225, 228, 231, 234, 237,      |  |
|  | 240, 243, 246, 253, 255, 260,      |  |
|  | 263, 266, 269, 272, 276, 277,      |  |
|  | 285, 312, 316, 317, 318, 321,      |  |
|  |                                    |  |
|  |                                    | <code>\RangeCatcodeCheck</code> . . .                |
|  |                                    | 1743, 1771,  |
|  |                                    | 1772, 1773, 1774, 1775, 1776,                        |
|  |                                    | 1777, 1778, 1779, 1780, 1781, 1782                   |
|  |                                    | <code>\RangeCatcodeInvalid</code> . . . . .          |
|  |                                    | 1735, 1763, 1764, 1765, 1766                         |
|  |                                    | <code>\renewcommand</code> . . . . .                 |
|  |                                    | 2010   |
|  |                                    | <code>\repeat</code> . . .                           |
|  |                                    | 1710, 1722, 1733, 1741, 1756                         |
|  |                                    | <code>\RestoreCatcodes</code> 1724, 1727, 1728, 1783 |
|  |                                    | <code>\result</code> . . . . .                       |
|  |                                    | 1816, 1818   |
|  |                                    | <code>\resultA</code> . . . . .                      |
|  |                                    | 1808, 1811   |
|  |                                    | <code>\resultB</code> . . . . .                      |
|  |                                    | 1809, 1811   |
|  |                                    | <code>\romannumeral</code> . . . . .                 |
|  |                                    | 340, 347, 390, 397, 707, 718                         |
|  |                                    | <b>S</b>   |
|  |                                    | <code>\saved@endqstest</code> . . . . .              |
|  |                                    | 2020, 2027   |
|  |                                    | <code>\saved@qstest</code> . . . . .                 |
|  |                                    | 2019, 2022   |
|  |                                    | <code>\SavedNumexpr</code> . . . . .                 |
|  |                                    | 1793, 1799, 1806, 1810, 1814, 1817                   |
|  |                                    | <code>\space</code> . . .                            |
|  |                                    | 1749, 1750, 1758, 1811, 2006                         |
|  |                                    | <code>\StartTime</code> . . . . .                    |
|  |                                    | 2009, 2023   |
|  |                                    | <code>\StopTime</code> . . . . .                     |
|  |                                    | 2014, 2026   |
|  |                                    | <code>\strip@pt</code> . . . . .                     |
|  |                                    | 2006   |
|  |                                    | <code>\SummaryTime</code> . . .                      |
|  |                                    | 2001, 2003, 2016, 2030                               |
|  |                                    | <b>T</b>   |
|  |                                    | <code>\temp</code> . . . . .                         |
|  |                                    | 2039   |
|  |                                    | <code>\Test</code> . . . . .                         |
|  |                                    | 1762,  |
|  |                                    | 1785, 1838, 1843, 1845, 1848,                        |
|  |                                    | 1851, 1854, 1857, 1860, 1863,                        |
|  |                                    | 1866, 1869, 1877, 1880, 1888,                        |
|  |                                    | 1893, 1901, 1912, 1917, 1928,                        |
|  |                                    | 1930, 1937, 1939, 1946, 1948,                        |
|  |                                    | 1955, 1961, 1964, 1967, 1973, 1987                   |
|  |                                    | <code>\TestAbs</code> . . . . .                      |
|  |                                    | 1850,  |
|  |                                    | 2058, 2121, 2122, 2123, 2124,                        |
|  |                                    | 2125, 2126, 2127, 2128, 2129,                        |
|  |                                    | 2130, 2131, 2132, 2133, 2135, 2136                   |
|  |                                    | <code>\TestAdd</code> . . .                          |
|  |                                    | 1887, 2065, 2251, 2252,                              |
|  |                                    | 2253, 2254, 2255, 2256, 2257,                        |
|  |                                    | 2258, 2259, 2260, 2261, 2262,                        |
|  |                                    | 2263, 2264, 2265, 2266, 2267,                        |
|  |                                    | 2268, 2269, 2270, 2271, 2272,                        |
|  |                                    | 2273, 2274, 2275, 2276, 2278, 2279                   |
|  |                                    | <code>\TestArg</code> . . . . .                      |
|  |                                    | 1831, 1832, 1834, 1835                               |

|                         |   |  |  |
|-------------------------|---|--|--|
| <code>\TestCmp</code>   | 1862, 2062, 2190, 2191, 2192,<br>2193, 2194, 2195, 2196, 2197,<br>2198, 2199, 2200, 2201, 2202, 2204  | 2407, 2408, 2409, 2410, 2411,<br>2412, 2413, 2414, 2415, 2416,<br>2417, 2418, 2419, 2420, 2421,<br>2422, 2423, 2424, 2425, 2426,<br>2427, 2428, 2429, 2430, 2431,<br>2432, 2433, 2434, 2435, 2436,<br>2437, 2438, 2439, 2440, 2441,<br>2442, 2443, 2444, 2445, 2446,<br>2447, 2448, 2449, 2450, 2451, 2452 |  |
| <code>\TestCount</code> | .... 1830, 1834, 1835, 1836   | <code>\TestResult</code>   | ..... 1813, 1839   |
| <code>\TestDec</code>   | ..... 1876,<br>2064, 2238, 2239, 2240, 2241,<br>2242, 2243, 2244, 2245, 2246, 2247  | <code>\TestResultTwoExpansions</code>  | . 1820, 1840   |
| <code>\TestDiv</code>   | 1963, 2073, 2456, 2457, 2458,<br>2459, 2460, 2461, 2462, 2463,<br>2464, 2465, 2466, 2467, 2468,<br>2469, 2470, 2471, 2472, 2473,<br>2474, 2475, 2476, 2477, 2478,<br>2479, 2480, 2481, 2482, 2483,<br>2484, 2485, 2486, 2487, 2488,<br>2489, 2490, 2491, 2492, 2493,<br>2494, 2495, 2496, 2497, 2498,<br>2499, 2500, 2501, 2502, 2503, 2504   | <code>\TestSgn</code>  | ..... 1853, 2059,<br>2141, 2142, 2143, 2144, 2145,<br>2146, 2147, 2148, 2149, 2150,<br>2151, 2152, 2153, 2154, 2156, 2157  |
| <code>\TestDo</code>    | ..... 2036, 2050, 2053, 2054  | <code>\TestShl</code>  | ..... 1927, 2067,<br>2315, 2316, 2317, 2318, 2319, 2320  |
| <code>\TestError</code> | 2577, 2586, 2587, 2588,<br>2589, 2590, 2591, 2592, 2593, 2594   | <code>\TestShr</code>  | ..... 1936,<br>2068, 2324, 2325, 2326, 2327,<br>2328, 2329, 2330, 2331, 2332,<br>2333, 2334, 2335, 2336, 2337,<br>2338, 2339, 2340, 2341, 2342,<br>2343, 2344, 2345, 2346, 2347,<br>2348, 2349, 2350, 2351, 2352, 2353   |
| <code>\TestExch</code>  | ..... 1843, 1958  | <code>\TestSpaceAtEnd</code>   | ..... 1805, 1841   |
| <code>\TestFac</code>   | .. 1957, 2071, 2209, 2210,<br>2211, 2212, 2213, 2214, 2215,<br>2216, 2217, 2218, 2219, 2220, 2221   | <code>\TestSqr</code>  | ..... 1954, 2070,<br>2387, 2388, 2389, 2390, 2391,<br>2392, 2393, 2394, 2395, 2396, 2397   |
| <code>\TestInc</code>   | ..... 1865,<br>2063, 2225, 2226, 2227, 2228,<br>2229, 2230, 2231, 2232, 2233, 2234  | <code>\TestSub</code>  | ..... 1911, 2066,<br>2284, 2285, 2286, 2287, 2288,<br>2289, 2290, 2291, 2292, 2293,<br>2294, 2295, 2296, 2297, 2298,<br>2299, 2300, 2301, 2302, 2303,<br>2304, 2305, 2306, 2307, 2309, 2310  |
| <code>\TestInv</code>   | ..... 1844,<br>2057, 2101, 2102, 2103, 2104,<br>2105, 2106, 2107, 2108, 2109,<br>2110, 2111, 2112, 2113, 2115, 2116   | <code>\TestTeXDivide</code>  | ..... 1833, 1965   |
| <code>\TestMax</code>   | 1859, 2061, 2176, 2177, 2178,<br>2179, 2180, 2181, 2182, 2183, 2185   | <code>\TestTime</code>   | ..... 2002, 2015, 2016, 2017   |
| <code>\TestMin</code>   | 1856, 2060, 2162, 2163, 2164,<br>2165, 2166, 2167, 2168, 2169, 2171   | <code>\TestTwo</code>  | .. 2052, 2060, 2061, 2062,<br>2065, 2066, 2069, 2072, 2073, 2074   |
| <code>\TestMod</code>   | .. 1972, 2074, 2508, 2509,<br>2510, 2511, 2512, 2513, 2514,<br>2515, 2516, 2517, 2518, 2519,<br>2520, 2521, 2522, 2523, 2524,<br>2525, 2526, 2527, 2528, 2529,<br>2530, 2531, 2532, 2533, 2534,<br>2535, 2536, 2537, 2538, 2539,<br>2540, 2541, 2542, 2543, 2544,<br>2545, 2546, 2547, 2548, 2549,<br>2550, 2551, 2552, 2553, 2554,<br>2555, 2556, 2557, 2558, 2559,<br>2560, 2561, 2562, 2563, 2564,<br>2565, 2567, 2568, 2569, 2570, 2571 | <code>\the</code>  | ..... 77, 78,<br>79, 80, 81, 82, 83, 84, 97, 187,<br>193, 196, 200, 201, 205, 206,<br>210, 213, 216, 219, 222, 225,<br>228, 231, 234, 237, 240, 243,<br>246, 253, 255, 260, 263, 266,<br>269, 272, 276, 277, 285, 312,<br>316, 317, 318, 321, 322, 329,<br>330, 366, 375, 379, 380, 416,<br>426, 429, 435, 437, 445, 1729,<br>1749, 1750, 1836, 1958, 2041, 2046 |
| <code>\TestMul</code>   | ..... 1945,<br>2069, 2357, 2358, 2359, 2360,<br>2361, 2362, 2363, 2364, 2365,<br>2366, 2367, 2368, 2369, 2370,<br>2371, 2372, 2373, 2374, 2375,<br>2376, 2377, 2378, 2379, 2381, 2382   | <code>\TimeDescription</code>  | ... 2010, 2013, 2017   |
| <code>\TestNum</code>   | ..... 1847, 2056,<br>2080, 2081, 2082, 2083, 2084,<br>2085, 2086, 2087, 2088, 2089,<br>2090, 2091, 2092, 2093, 2095, 2096   | <code>\TMP@EnsureCode</code>   | .....<br>..... 94, 101, 102, 103, 104,<br>105, 106, 107, 108, 109, 110, 111  |
| <code>\TestOne</code>   | .. 2049, 2056, 2057, 2058,<br>2059, 2063, 2064, 2067, 2068, 2070  | <code>\typeout</code>  | ..... 2005   |
| <code>\TestPow</code>   | ..... 1960, 2072, 2401,<br>2402, 2403, 2404, 2405, 2406,  |  |  |

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|--------------------------|-----------------------------|
| <code>\UNDEFINED</code>  | .... 1794, 1807, 1815, 1823 |
| <code>\usepackage</code> | ..... 1798, 1800            |

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|                     |              |
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| <code>\write</code> | ..... 23, 52 |
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|                          |                             |
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| <code>\UNDEFINED</code>  | .... 1794, 1807, 1815, 1823 |
| <code>\usepackage</code> | ..... 1798, 1800            |

## W

|                     |              |
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| <code>\write</code> | ..... 23, 52 |
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|    | <b>X</b>   | <b>Z</b>   |
|----|--|--|
| \x | 14, 15, 18, 22, 26, 28, 51, 56, 66, 75,<br>87, 640, 643, 1868, 1873, 1879,<br>1884, 1892, 1898, 1900, 1906,<br>1916, 1922, 1929, 1934, 1938,<br>1943, 1947, 1952, 1966, 1986, 1992 | \z@ . . . . . 176, 341, 348,<br>391, 398, 596, 597, 616, 1256,<br>1257, 1275, 1449, 1450, 1458,<br>1615, 1631, 1675, 2003, 2091,<br>2111, 2131, 2152, 2168, 2182, 2199 |