

# The **xfp** package

## Floating Point Unit

The L<sup>A</sup>T<sub>E</sub>X3 Project\*

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This package provides a L<sup>A</sup>T<sub>E</sub>X 2<sub>ε</sub> document-level interface to the L<sup>A</sup>T<sub>E</sub>X3 floating point unit (part of `expl3`). It also provides a parallel integer expression interface for convenience.

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**`\fpeval`** ★

The expandable command `\fpeval` takes as its argument a floating point expression and produces a result using the normal rules of mathematics. As this command is expandable it can be used where T<sub>E</sub>X requires a number and for example within a low-level `\edef` operation to give a purely numerical result.

Briefly, the floating point expressions may comprise:

- Basic arithmetic: addition  $x + y$ , subtraction  $x - y$ , multiplication  $x * y$ , division  $x / y$ , square root  $\sqrt{x}$ , and parentheses.
- Comparison operators:  $x < y$ ,  $x <= y$ ,  $x >? y$ ,  $x != y$  *etc.*
- Boolean logic: `sign`  $\text{sign } x$ , negation `!` $x$ , conjunction  $x \&\& y$ , disjunction  $x || y$ , ternary operator  $x ? y : z$ .
- Exponentials: `exp`  $x$ , `ln`  $x$ ,  $x^y$ .
- Integer factorial: `fact`  $x$ .
- Trigonometry: `sin`  $x$ , `cos`  $x$ , `tan`  $x$ , `cot`  $x$ , `sec`  $x$ , `csc`  $x$  expecting their arguments in radians, and `sind`  $x$ , `cosd`  $x$ , `tand`  $x$ , `cotd`  $x$ , `secd`  $x$ , `cscd`  $x$  expecting their arguments in degrees.
- Inverse trigonometric functions: `asin`  $x$ , `acos`  $x$ , `atan`  $x$ , `acot`  $x$ , `asec`  $x$ , `acsc`  $x$  giving a result in radians, and `asind`  $x$ , `acosd`  $x$ , `atand`  $x$ , `acotd`  $x$ , `asecd`  $x$ , `acscd`  $x$  giving a result in degrees.
- Extrema:  $\max(x_1, x_2, \dots)$ ,  $\min(x_1, x_2, \dots)$ ,  $\text{abs}(x)$ .
- Rounding functions, controlled by two optional values,  $n$  (number of places, 0 by default) and  $t$  (behavior on a tie, `NaN` by default):
  - `trunc`( $x, n$ ) rounds towards zero,
  - `floor`( $x, n$ ) rounds towards  $-\infty$ ,

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- $\text{ceil}(x, n)$  rounds towards  $+\infty$ ,
- $\text{round}(x, n, t)$  rounds to the closest value, with ties rounded to an even value by default, towards zero if  $t = 0$ , towards  $+\infty$  if  $t > 0$  and towards  $-\infty$  if  $t < 0$ .

- Random numbers: `rand()`, `randint(m, n)`.
- Constants: `pi`, `deg` (one degree in radians).
- Dimensions, automatically expressed in points, *e.g.*, `pc` is 12.
- Automatic conversion (no need for `\number`) of integer, dimension, and skip variables to floating points numbers, expressing dimensions in points and ignoring the stretch and shrink components of skips.
- Tuples:  $(x_1, \dots, x_n)$  that can be added together, multiplied or divided by a floating point number, and nested.

An example of use could be the following.

`\LaTeX{}` can now compute:  $\$ \frac{\sin(3.5)}{2} + 2 \cdot 10^{-3} = \text{fpeval}\{\sin(3.5)/2 + 2\text{e-}3\} \$$ .

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## `\inteval` ★

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The expandable command `\inteval` takes as its argument an integer expression and produces a result using the normal rules of mathematics. The operations recognised are `+`, `-`, `*` and `/` plus parentheses. Division occurs with *rounding*, and ties are rounded away from zero. As this command is expandable it can be used where  $\text{T}_{\text{E}}\text{X}$  requires a number and for example within a low-level `\edef` operation to give a purely numerical result.

An example of use could be the following.

`\LaTeX{}` can now compute: The sum of the numbers is  $\$ \inteval\{1 + 2 + 3\} \$$ .

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