The `fp` package

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Abstract

Fixed point arithmetic for TEX with numbers ranging from
−9999999999999999.99999999999999999
to +9999999999999999.99999999999999999

Contents

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1 Usage:

- LaTeX 2_ε:
  `\usepackage[<options>]fp`
  where the following options are known:

  `[nomessages]`: don't print messages about the functions that are just computed.

  `[debug]`: print debug messages (mainly for `\FPupn`).

- LaTeX2.09:
  `include lfp.sty` in the document preamble, i.e.
  `\documentstyle[...,lfp,...]...`

- TeX:
  `\input fp.tex`

- MsDos/Windows Users:
  It may be necessary to rename some files such that they just have a length of eight characters (plus a three character suffix). The following renaming examples works for emtex:

Original name	Name for emtex
`defpattern.sty`	`defpaern.sty`
`fp-addons.sty`	`fp-adons.sty`
`fp-random.sty`	`fp-radom.sty`

2 Basic functions:

- **\FPset#1#2**: Defines a variable that you can later print.
- **\FPprint#1**: Prints the value of a variable.

  Example:

```
\FPset\x{2} %sets x=2
$x=\x$.\\ %prints x=2          x = 2.
$x=\FPprint\x$.\\              x = 2.
x=\x.\\                        x=2.
x=\FPprint\x .                 x=2.
```

- The following commands are very straightforward:
  `binary and unary operations:`

```
\FPadd#1#2#3 % #1 := #2+#3
\FPdiv#1#2#3 % #1 := #2/#3
\FPmul#1#2#3 % #1 := #2*#3
\FPsub#1#2#3 % #1 := #2-#3
\FPabs#1#2 % #1 := abs(#2)
```

```
\FPneg#1#2 % #1 := -#2
\FPmin#1#2#3 % #1 = min(#2,#3)
\FPmax#1#2#3 % #1 = max(#2,#3)
```

binary and unary relations:

```
\FPiflt#1#2...\else...\fi % #1 < #2 ?
\FPifeq#1#2...\else...\fi % #1 = #2 ?
\FPifgt#1#2...\else...\fi % #1 > #2 ?
\FPifneg#1 ...\else...\fi % #1 <  0 ?
\FPifpos#1 ...\else...\fi % #1 >= 0 ?
\FPifzero#1...\else...\fi % #1 =  0 ?
\FPifint#1 ...\else...\fi % #1 is integer ?
%repeat last test
\ifFPtest  ...\else...\fi % repeat last test
```

Trigonometric functions (Note: only accepts float numbers for the input variables):

```
\FPpi  % 3.141592653589793238
\FPsin#1#2 % #1 := sin(#2)
\FPcos#1#2  % #1 := cos(#2)
\FPsincos#1#2#3 % #1 := sin(#3), #2 := cos(#3)
\FPtan#1#2 % #1 := tan(#2)
\FPcot#1#2  % #1 := cot(#2)
\FPtancot#1#2#3  % #1 := tan(#3), #2 := cot(#3)
\FParcsin#1#2 % #1 := arcsin(#2)
\FParccos#1#2      % #1 := arccos(#2)
\FParcsincos#1#2#3   % #1 := arcsin(#3), #2 := arccos(#3)
\FParctan#1#2  % #1 := arctan(#2)
\FParccot#1#2  % #1 := arccot(#2)
\FParctancot#1#2#3 % #1 := arctan(#3), #2 := arccot(#3)
```

Examples:

```
\FPset\x{-1}
\FPset\y{2}
\FPadd\xay\x\y
\FPmin\xoy\x\y
$x=\x, y=\y$ \\
\FPifgt\xay\y $x+y>y$.
\else $x+y<y$.\fi \\ \\ \\
The result $x+y$
\FPifint\xay  is an integer.
\else is not an integer.
\fi\\ \\
$\min(x,y)=\xoy$.
```

$x = -1, y = 2$

$x + y < y$.

The result $x + y$ is an integer.

$\min(x, y) = -1$.

- Solving equations:

```
\FPlsolve#1#2#3
% #1 := x with #2*x+#3=0
\FPqsolve#1#2#3#4#5
% #1,#2 := x with #3*x^2+#4*x+#5 = 0
\FPcsolve#1#2#3#4#5#6#7
% #1,#2,#3 := x with #4*x^3+#5*x^2+#6*x+#7 = 0
\FPqqsolve#1#2#3#4#5#6#7#8#9
% #1,#2,#3,#4 := x with #5*x^4+#6*x^3+#7*x^2+#8*x+#9 = 0
```

Example:

```
\FPset\ca{-4}
\FPset\cb{2}
\FPlsolve\res\ca\cb
The root for
$\ca x+\cb=0$ is\\
$x=\res$.
```

The root for $-4x + 2 = 0$ is
$x = 0.500000000000000000$.

- Evaluate expressions:

  ```
  \FPeval#1#2
  % #1 := eval(#2) where eval evaluates the expression #2
  ```

  Example:

  ```
  \edef\x{11}
  \FPeval\resulta{\x/2}
  \FPeval{resultb}{clip(neg(x)/2)}
  resulta = \resulta .\\
  resultb = \resultb .\\\\
  \FPeval\resulta{round(resulta:3)}
  round(resulta:3) = \resulta.
  ```

  resulta = 5.500000000000000000.
  resultb = -5.5.
  round(resulta:3) = 5.500.

  Attentions:

  – The `#1` variable can be written as either "`\resulta`" or "`{resulta}`", but not "`\resulta{}`" in the above example.

  – When referring to variables in the expression `#2`, one can use "`\x`" or "`\x{}`", or simply "`x`" in the above example.

  – The unary prefix operation "`-`" is not known, therefore one should use the function `neg()` instead.

  – All the results from `\FPeval` are real numbers so rounding may be necessary.

  Known operations:

+	-	*	/	abs	neg
pow	root	exp	ln	min	max
e	pi				
round	trunc	clip			
sin	cos	tan	cot		
arcsin	arccos	arctan	arccot		

  Most of the operations are self-explanatory. A few notes here:

`pow(#1,#2)`	returns #2 to the power of #1
`root(#1,#2)`	returns the $\#1^{th}$ root of #2
`exp(#1)`	returns e (defined below) to the power of #1
`ln(#1)`	returns ln(#1) (base e)
`min(#1,#2)`	returns minimum of #1 and #2
`e`	returns $e = 2.718281828459045235$
`pi`	returns $\pi = 3.141592653589793238$
`round(#1:#2)`	round #1 to #2 decimal places
`trunc(#1:#2)`	truncate #1 to #2 decimal places
`clip(#1)`	remove all the trailing "0"s in #1
`sin(#1)`	sin of #1 in rad. Similarly for others
`arcsin(#1)`	arcsin of #1

- Evaluate upn-expressions:

```
\FPupn#1#2  % #1 := eval(#2) where eval evaluates the
upn-expression #2
```

Known operations:
+,add,-,sub,*,mul,/,div,abs,neg,min,max, round,trunc,clip,e,exp,ln,pow,root,pi,sin,cos, sincos,tan,cot,tancot,arcsin,arccos,arcsincos, arctan,arccot,arctancot,pop,swap,copy

where

`pop`: removes the top element
`swap`: exchanges the first two elements
`copy`: copies the top element

Examples:

```
\FPupn\result{17 2.5 + 17.5 - 2 1 + * 2 swap /}
is equivalent to
\result := ((17.5 - (17 + 2.5)) * (2 + 1)) / 2
and evaluates to
\def\result{-3.000000000000000000}
Afterwards the macro call
\FPupn\result{\result{} -1 * 0.2 + sin 2 round}
^^ the "{}" is necessary!
is equivalent to
\result := round_2(sin((\result * -1) + 0.2))
and evaluates to
\def\result{-0.06}
Example 2:
As "result" is an abbreviation of "\result{}" you may
write
\FPupn{result}{17 2.5 + 17.5 - 2 1 + * 2 swap /}
and
```

```
\FPupn{result}{result -1 * 0.2 + sin 2 round}
instead leading to the same results.
```

This is even true for other macro names using e.g. "`x`" for "`\x{}`" and so on. But be careful with it. We may introduce new constants in further versions overwriting these abbreviations.

3 Known bugs:

- Does not work with multido.sty/multido.tex

  Reason:
  multido uses the same macro names `\FPadd` and `\FPsub`

  Recommended Solution:
  Patch `multido.tex`, i.e. apply the following substitutions:
  `FPadd -> mdo@FPadd`
  `FPsub -> mdo@FPsub`

- Incompatibility with french style of babel.
  This only affects macros using the colon (:)

  Recommended Solution:
  Load the fp-package before babel with french style
  Other Possible Solution:
  Use `\catcode`\:=12` after loading babel with french style

- Others:
  Currently not known, but, though we do not, we could give a warranty of their existence ...

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