

# MFPIC Quick Reference

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This information was prepared for version 1.09 of mfpic.

## Preamble commands

|  |   |
|--|---|
| Load mfpic package (L <sup>A</sup> T <sub>E</sub> X) | <code>\usepackage[<i>options</i>]{mfpic}</code>   |
| Options  | <code>metafont   metapost, mplabels, overlaylabels, centeredcaptions, raggedcaptions, clip, truebbox, draft, final, nowrite, mfpreadlog</code>  |
| Load mfpic; activate options (plainT <sub>E</sub> X) | <code>\input mfpic. \usemetafont   \usemetapost, \usemplabels, \overlaylabels \usecenteredcaptions, \useraggedcaptions, \clipmfpic, \settruebbox, \mfpicdraft, \mfpicfinal, \mfpicnowrite, \mfpreadlog</code> |
| Turn off some options                                | <code>\nomplabels, \nooverlaylabels, \nocenteredcaptions, \noraggedcaptions, \noclipmfpic, \nottruebbox</code>  |
| Set up/close the output file                         | <code>\opengraphsfile{<i>base name</i>}...\closegraphsfile</code>   |

## The mfpic environment

|  |  |
|--|--|
| Start an mfpic figure                      | <code>\mfpic[<i>xscale</i>][<i>yscale</i>]{<i>x<sub>min</sub></i>}{<i>x<sub>max</sub></i>}{<i>y<sub>min</sub></i>}{<i>y<sub>max</sub></i>}{<i>mfpic commands</i>}</code><br><code>\endmfpic</code> |
| L <sup>A</sup> T <sub>E</sub> X (optional) | <code>\begin{mfpic} ≡ \mfpic, \end{mfpic} ≡ \endmfpic</code>   |

## Dimensions (lengths)

| <i>Purpose; where used:</i>   | <i>Name and default value:</i>    |
|---|-----------------------------------|
| Unit of length; <code>\mfpic</code>   | <code>\mfpicunit, 1pt</code>      |
| Size of a symbol; <code>\point</code> , <code>\plot</code> , and <code>\plotsymbol</code> | <code>\pointsize, 2pt</code>      |
| Darkness of shading; <code>\shade</code>  | <code>\shadespace, 1pt</code>     |
| Space between dots; <code>\polkadot</code>  | <code>\polkadotspace, 10pt</code> |
| Space between hatch lines; hatching macros  | <code>\hatchspace, 3pt</code>     |
| Size of arrowhead; <code>\arrow</code>  | <code>\headlen, 3pt</code>        |
| Size of x-, y-axis arrowhead; xy-axes macros  | <code>\axisheadlen, 5pt</code>    |
| Size of border axis arrowhead; side axis macros   | <code>\sideheadlen, 0pt</code>    |
| Size of marks on axes; axis marks   | <code>\hashlen, 4pt</code>        |
| Size of dashes; <code>\dashed</code>  | <code>\dashlen, 4pt</code>        |
| Space between dashes; <code>\dashed</code>  | <code>\dashspace, 4pt</code>      |
| Size of dots; <code>\dotted</code>  | <code>\dotsize, 0.5pt</code>      |
| Space between dots; <code>\dotted</code>  | <code>\dotspace, 3pt</code>       |
| Space between symbols; <code>\plot</code>   | <code>\symbolspace, 5pt</code>    |

The following commands are used to change the size of some dimension parameters:

| <i>Purpose (default):</i>                | <i>Command:</i>                        |
|--|--|
| Set diameter of drawing pen (0.5pt)      | <code>\penwd{<i>dimen</i>}</code>      |
| Set diameter of shading dots (0.5pt)     | <code>\shadewd{<i>dimen</i>}</code>    |
| Set diameter of polkadot (5pt)           | <code>\polkadotwd{<i>dimen</i>}</code> |
| Set diameter of hatching pen (0.5pt)     | <code>\hatchwd{<i>dimen</i>}</code>    |
| Multiply <code>\shadespace</code> by 1.2 | <code>\lightershade</code>             |
| Divide <code>\shadespace</code> by 1.2   | <code>\darkershade</code>              |

## Colors

|  |  |
|--|--|
| Set color for curves                     | <code>\drawcolor{<i>color</i>}</code>                                    |
| Set color for fills                      | <code>\fillcolor{<i>color</i>}</code>                                    |
| Set color for points, symbols            | <code>\pointcolor{<i>color</i>}</code>                                   |
| Set color for hatching                   | <code>\hatchcolor{<i>color</i>}</code>                                   |
| Set color for arrowheads                 | <code>\headcolor{<i>color</i>}</code>                                    |
| Set color for tlabels                    | <code>\tlabelcolor{<i>color</i>}</code>                                  |
| Set color used by <code>\gc clear</code> | <code>\backgroundcolor{<i>color</i>}</code>                              |
| L <sup>A</sup> T <sub>E</sub> X syntax   | <code>\drawcolor[<i>model</i>]{<i>clr spec</i>}, etc.</code>             |
| Define a color name                      | <code>\mfpdefinecolor{<i>name</i>}{<i>model</i>}{<i>clr spec</i>}</code> |

## Common geometric figures

Drawing commands that operate on a variable length list in braces may be followed by `\datafile{filename}` instead of the list.

### Points

|  |   |
|--|---|
| Place a symbol at given point(s)                   | <code>\plotsymbol[<i>size</i>]{<i>name</i>}{(<i>x<sub>0</sub></i>,<i>y<sub>0</sub></i>),(<i>x<sub>1</sub></i>,<i>y<sub>1</sub></i>),...}</code> |
| Available symbol names                             | Triangle, Square, Circle, Diamond, Star, SolidTriangle, SolidSquare, SolidCircle, SolidDiamond, SolidStar, Plus, Cross, Asterisk                |
| Points (filled or unfilled circles)                | <code>\point[<i>size</i>]{(<i>x<sub>0</sub></i>,<i>y<sub>0</sub></i>),(<i>x<sub>1</sub></i>,<i>y<sub>1</sub></i>),...}</code>                   |
| Force filled/open circles in <code>\point</code> : | <code>\pointfilltrue/\pointfillfalse</code>   |

### Lines

|  |  |
|--|--|
| Connect points with lines              | <code>\polyline{(<i>x<sub>0</sub></i>,<i>y<sub>0</sub></i>),(<i>x<sub>1</sub></i>,<i>y<sub>1</sub></i>),...}</code> , or <code>(\lines)</code> |
| Closed polygon                         | <code>\polygon{(<i>x<sub>0</sub></i>,<i>y<sub>0</sub></i>),(<i>x<sub>1</sub></i>,<i>y<sub>1</sub></i>),...}</code>                             |
| Concatenate vectors                    | <code>\turtle{<i>initialpoint</i>},(<i>v<sub>1</sub></i>),(<i>v<sub>2</sub></i>),...}</code>   |
| Rectangle (upright) with given corners | <code>\rect{(<i>x<sub>0</sub></i>,<i>y<sub>0</sub></i>),(<i>x<sub>1</sub></i>,<i>y<sub>1</sub></i>)}</code>                                    |

### Circles, arcs and ellipses

|   |  |
|---|--|
| Circles   |  |
| polar form (default):   | <code>\circle[p]{<i>center</i>},(<i>radius</i>)}</code>  |
| three-point form:   | <code>\circle[t]{(<i>x<sub>0</sub></i>,<i>y<sub>0</sub></i>),(<i>x<sub>1</sub></i>,<i>y<sub>1</sub></i>),(<i>x<sub>2</sub></i>,<i>y<sub>2</sub></i>)}</code> |
| center-point form:  | <code>\circle[c]{<i>center</i>},(<i>point</i>)}</code>   |
| point-sweep form:   | <code>\circle[s]{(<i>x<sub>0</sub></i>,<i>y<sub>0</sub></i>),(<i>x<sub>1</sub></i>,<i>y<sub>1</sub></i>),<i>angle</i>}</code>                                |
| Arcs  |  |
| polar form:   | <code>\arc[p]{<i>center</i>},(<i>θ<sub>1</sub></i>),(<i>θ<sub>2</sub></i>),(<i>radius</i>)}</code>   |
| three-point form:   | <code>\arc[t]{(<i>x<sub>0</sub></i>,<i>y<sub>0</sub></i>),(<i>x<sub>1</sub></i>,<i>y<sub>1</sub></i>),(<i>x<sub>2</sub></i>,<i>y<sub>2</sub></i>)}</code>    |
| center-point-angle form:  | <code>\arc[c]{<i>center</i>},(<i>point</i>),<i>angle</i>}</code>   |
| point-sweep form (default):   | <code>\arc[s]{(<i>x<sub>0</sub></i>,<i>y<sub>0</sub></i>),(<i>x<sub>1</sub></i>,<i>y<sub>1</sub></i>),<i>angle</i>}</code>                                   |
| Ellipse, center ( <i>x<sub>0</sub></i> , <i>y<sub>0</sub></i> ), radii <i>r<sub>x</sub></i> , <i>r<sub>y</sub></i> , angle <i>θ</i> | <code>\ellipse[<i>θ</i>]{(<i>x<sub>0</sub></i>,<i>y<sub>0</sub></i>),(<i>r<sub>x</sub></i>),(<i>r<sub>y</sub></i>)}</code>                                   |

## General curves

A *spec* can be **p** (for polyline) or **s** (for smooth) followed by a number for the tension.

|   |   |
|---|---|
| Smooth curve through points                       | <code>\curve[<i>tension</i>]{(<i>x<sub>0</sub></i>,<i>y<sub>0</sub></i>),(<i>x<sub>1</sub></i>,<i>y<sub>1</sub></i>),...}</code>    |
| Graph of $y = f(x)$                               | <code>\function[<i>spec</i>]{<i>x<sub>min</sub></i>,<i>x<sub>max</sub></i>,<i>Δx</i>}{<i>f</i>(<b>x</b>)}</code>                    |
| Graph of parametric curve $(x(t), y(t))$          | <code>\parafcn[<i>spec</i>]{<i>t<sub>min</sub></i>,<i>t<sub>max</sub></i>,<i>Δt</i>}{<i>x</i>(<b>t</b>), <i>y</i>(<b>t</b>)}</code> |
| Graph of $r = f(θ)$                               | <code>\plrfcn[<i>spec</i>]{<i>θ<sub>min</sub></i>,<i>θ<sub>max</sub></i>,<i>Δθ</i>}{<i>f</i>(<b>t</b>)}</code>                      |
| Interpolate with a smooth <i>function</i>         | <code>\fcncurve[<i>tension</i>]{(<i>x<sub>0</sub></i>,<i>y<sub>0</sub></i>),(<i>x<sub>1</sub></i>,<i>y<sub>1</sub></i>),...}</code> |
| Curve from data in a file                         | <code>\datafile[<i>spec</i>]{<i>file</i>}</code>  |
| Set how <code>\datafile</code> processes a line   | <code>\using{<i>read_pattern</i>}{<i>write_pattern</i>}</code>  |
| Default is <code>\using{#1 #2 #3}{(#1,#2)}</code> |   |

## Regions

Curves are not necessarily ‘closed’ even if the start and end are the same. The following are closed (can be filled), as are `\rect`, `\polygon`, `\circle`, and `\ellipse`.

|                                   |   |
|-----------------------------------|---|
| Closed curve through given points | <code>\cyclic[<math>\langle tension \rangle</math>]{<math>(x_1, y_1), (x_2, y_2), \dots</math>}</code>  |
| Circular sector (pie slice)       | <code>\sector{<math>\langle center \rangle</math>,<math>\langle radius \rangle</math>,<math>\langle \theta_1 \rangle</math>,<math>\langle \theta_2 \rangle</math>}</code>   |
| Region between two functions      | <code>\btwnfcn[<math>\langle spec \rangle</math>]{<math>x_{\min}, x_{\max}, \Delta x</math>}{<math>f(x)</math>}{<math>g(x)</math>}</code>   |
| Region in polar coordinates       | <code>\plrregion[<math>\langle spec \rangle</math>]{<math>\theta_{\min}, \theta_{\max}, \Delta \theta</math>}{<math>f(t)</math>}</code>   |
| Curves surrounding text           | <code>\tlabelrect[<math>\langle radius \rangle</math>]{<math>\langle x \rangle</math>,<math>\langle y \rangle</math>}{<math>\langle text \rangle</math>}</code><br><code>\tlabeloval[<math>\langle mult \rangle</math>]{<math>\langle x \rangle</math>,<math>\langle y \rangle</math>}{<math>\langle text \rangle</math>}</code><br><code>\tlabelellipse[<math>\langle ratio \rangle</math>]{<math>\langle x \rangle</math>,<math>\langle y \rangle</math>}{<math>\langle text \rangle</math>}</code><br>$\langle radius \rangle$ : round corners. $\langle mult \rangle$ : stretch horizontally. $\langle ratio \rangle$ : width/height of ellipse |

## Prefix macros

### Drawing curves

|                             |  |
|-----------------------------|--|
| Dashed path                 | <code>\dashed[<math>\langle length \rangle</math>,<math>\langle gap \rangle</math>]</code> ...   |
| Dotted path                 | <code>\dotted[<math>\langle size \rangle</math>,<math>\langle gap \rangle</math>]</code> ...   |
| Trace a path with symbols   | <code>\plot[<math>\langle size \rangle</math>,<math>\langle gap \rangle</math>]{<math>\langle symbol \rangle</math>}</code> ...  |
| Generalized dashes          | <code>\gendashed{<math>\langle patname \rangle</math>}</code> ...  |
| Define a named dash pattern | <code>\dashpattern{<math>\langle patname \rangle</math>}{<math>\langle len_1 \rangle</math>,<math>\langle len_2 \rangle</math>,...,<math>\langle len_{2n} \rangle</math>}</code> |
| Place a symbol at all nodes | <code>\plotnodes[<math>\langle size \rangle</math>]{<math>\langle symbol \rangle</math>}</code> ...  |
| Solid curve                 | <code>\draw[<math>\langle color \rangle</math>]</code> ...   |

### Closing a curve

These turn any path into a ‘closed’ path (result can then be filled).

|  |                          |
|--|--------------------------|
| Close with a straight line,                          | <code>\lclosed...</code> |
| Close with a smooth join, like <code>\cycle</code> , | <code>\sclosed...</code> |
| Close letting METAFONT choose                        | <code>\bclosed...</code> |

### Filling closed curves

These filling prefixes turn off automatic drawing of the curve.

|                                   |   |
|-----------------------------------|---|
| Solid fill                        | <code>\gfill[<math>\langle color \rangle</math>]</code> ...   |
| Unfill                            | <code>\gclear...</code>   |
| Hatched fills                     | <code>\thatch[<math>\langle space \rangle</math>,<math>\langle angle \rangle</math>][<math>\langle color \rangle</math>]</code> ...   |
| $\langle angle \rangle = 45$ deg  | <code>\rhatch[<math>\langle space \rangle</math>][<math>\langle color \rangle</math>]</code> ...  |
| $\langle angle \rangle = -45$ deg | <code>\lhatch[<math>\langle space \rangle</math>][<math>\langle color \rangle</math>]</code> ...  |
| crosshatching                     | <code>\xhatch[<math>\langle space \rangle</math>][<math>\langle color \rangle</math>]</code> ...  |
|                                   | <code>\hatch = \xhatch</code>   |
| Shading                           | <code>\shade[<math>\langle space \rangle</math>]</code> ...   |
| Gradients <sup>†</sup>            | <code>\gradient{<math>\langle clr \rangle</math>,<math>\langle width \rangle</math>,<math>\langle angle \rangle</math>}</code> ...  |
|                                   | <code>\areagradient{<math>\langle clr \rangle</math>,<math>\langle h-wd \rangle</math>,<math>\langle v-wd \rangle</math>}</code> ...  |
|                                   | <code>\radialgradient{<math>\langle clr \rangle</math>,<math>\langle wd \rangle</math>,<math>\langle center \rangle</math>}</code> ...  |
| Polkadot fill                     | <code>\polkadot[<math>\langle space \rangle</math>]</code> ...  |
| Fill with copies of a tile        | <code>\tess{<math>\langle tile \rangle</math>}</code> ...   |
| Define a tile*                    | <code>\tile{<math>\langle name \rangle</math>,<math>\langle unit \rangle</math>,<math>\langle width \rangle</math>,<math>\langle height \rangle</math>,<math>\langle clip \rangle</math>}</code><br><code><math>\langle drawing commands \rangle</math> \endtile</code> |

<sup>†</sup>  $\langle clr \rangle$  is a function that returns a color for parameter(s) in (0,1).

\* Creates a mini-mfpic, clipped if  $\langle clip \rangle = \text{true}$ .

### Storing and reusing a path

|                       |  |
|-----------------------|--|
| Store a path          | <code>\store{<math>\langle name \rangle</math>}</code> ... |
| reusing a stored path | <code>\mfobj{<math>\langle name \rangle</math>}</code>     |

## Subpaths

|                                |   |
|--------------------------------|---|
| Subpath by fractions of length | <code>\partpath{<math>\langle frac1 \rangle</math>,<math>\langle frac2 \rangle</math>}</code> ...   |
| Subpath by node numbers        | <code>\subpath{<math>\langle m \rangle</math>,<math>\langle n \rangle</math>}</code> ...  |
| Cutting by another path        | <code>\cutoffafter{<math>\langle obj \rangle</math>}</code> ..., <code>\cutoffbefore{<math>\langle obj \rangle</math>}</code> ...<br>$\langle obj \rangle$ is a name created with <code>\store</code> |
| Trim the ends of a path        | <code>\trimpath{<math>\langle dim1 \rangle</math>,<math>\langle dim2 \rangle</math>}</code> ...   |

### Modifying a curve

|                                    |  |
|------------------------------------|--|
| Add arrowhead to the end           | <code>\arrow[<math>l \langle length \rangle</math>][<math>r \langle angle \rangle</math>][<math>b \langle backset \rangle</math>][<math>c \langle color \rangle</math>]</code> ... |
| Define arrowhead shape             | <code>\headshape{<math>\langle ratio \rangle</math>}{<math>\langle tension \rangle</math>}{<math>\langle filled \rangle</math>}</code>   |
| Reverse a curve                    | <code>\reverse...</code>   |
| Double arrow                       | <code>\arrow\reverse\arrow...</code>   |
| Rotate around a point              | <code>\rotatepath{<math>(x_0, y_0)</math>,<math>\langle angle \rangle</math>}</code> ...   |
| Reflect about a line               | <code>\reflectpath{<math>(x_0, y_0)</math>,<math>(x_1, y_1)</math>}</code> ...   |
| Shift                              | <code>\shiftpath{<math>\langle dx, dy \rangle</math>}</code> ...   |
| Scale around a point               | <code>\scalepath{<math>(x_0, y_0)</math>,<math>\langle scale \rangle</math>}</code> ...  |
| xscale about line $x = x_0$        | <code>\xscalepath{<math>x_0</math>,<math>\langle scale \rangle</math>}</code> ...  |
| yscale about line $y = y_0$        | <code>\yscalepath{<math>y_0</math>,<math>\langle scale \rangle</math>}</code> ...  |
| slant, pivoting on line $y = y_0$  | <code>\slantpath{<math>y_0</math>,<math>\langle slant \rangle</math>}</code> ...   |
| yslant, pivoting on line $x = x_0$ | <code>\yslantpath{<math>x_0</math>,<math>\langle slant \rangle</math>}</code> ...  |
| Swap x and y                       | <code>\xyswappath...</code>  |

## Axes

|                               |  |
|-------------------------------|--|
| Draw x- and/or y-axes         | <code>\axes[<math>\langle headlen \rangle</math>], \xaxis[<math>\langle headlen \rangle</math>], \yaxis[<math>\langle headlen \rangle</math>]</code>   |
| Draw various axes             | <code>\axis[<math>\langle headlen \rangle</math>]{<math>\langle axis \rangle</math>}</code> , $\langle axis \rangle$ is one of x, y, l, b, r, or t.  |
| Draw many axes                | <code>\doaxes[<math>\langle headlen \rangle</math>]{<math>\langle list \rangle</math>}</code> , $\langle list \rangle$ of letters, no commas.  |
| Shift border axis inward      | <code>\axismargin{<math>\langle axis \rangle</math>}{<math>\langle amt \rangle</math>}</code> , $\langle amt \rangle$ is in graph units.   |
| Add hashmarks to axes         | <code>\axismarks{<math>\langle axis \rangle</math>}[<math>\langle len \rangle</math>]{<math>c_1, c_2, \dots</math>}, <math>c_j</math> are positions.<br/>Abbrev. by <code>\xmarks</code> for <code>\axismarks{x}</code>, etc.</code> |
| Change position of hash marks | <code>\setaxismarks{<math>\langle axis \rangle</math>}{<math>\langle pos \rangle</math>}</code> $\langle pos \rangle$ is one of inside, outside, centered, ontop, onbottom, onleft, or onright.                                      |

## Miscellaneous

|  |   |
|--|---|
| Text labels  | <code>\tlabel[<math>\langle pos \rangle \langle \theta \rangle</math>]{<math>\langle x \rangle</math>,<math>\langle y \rangle</math>}{<math>\langle \text{\TeX } text \rangle</math>}</code><br><code>\tlabels{<math>\langle args_1 \rangle</math><math>\langle args_2 \rangle</math>...}</code><br><code>\axislabels{<math>\langle axis \rangle</math>}[<math>\langle pos \rangle \langle \theta \rangle</math>]{<math>\langle txt_1 \rangle \langle n_1 \rangle</math>,<math>\langle txt_2 \rangle \langle n_2 \rangle</math>,...}</code><br>$\langle pos \rangle$ is a two-letter sequence, $\langle \theta \rangle$ the angle* of rotation in degrees; $\langle args_j \rangle$ is an entire set of arguments as in <code>\tlabel</code> ;<br>$\langle axis \rangle$ is a letter, $\langle txt_j \rangle$ is label, $\langle n_j \rangle$ is coordinate on axis |
| Clipping to a path                                       | <code>\gclip...</code>  |
| Polar conversion   | <code>\plr{<math>\langle r_0, \theta_0 \rangle</math>,<math>\langle r_1, \theta_1 \rangle</math>,...}</code>  |
| Connect paths  | <code>\connect <math>\langle path1 \rangle</math> <math>\langle path2 \rangle</math> ... \endconnect</code>   |
| Draw many curves from one datafile                       | <code>\plotdata[<math>\langle spec \rangle</math>]{<math>\langle file \rangle</math>}</code> , $\langle spec \rangle$ is p or s $\langle num \rangle$ where $\langle num \rangle$ is the (optional) tension in the smooth curve   |
| Set how <code>\plotdata</code> draws curves <sup>†</sup> | <code>\dashedlines</code> (different dash patterns)<br><code>\coloredlines</code> (different colors, METAPOST only)<br><code>\pointedlines</code> (different symbols, like <code>\plot</code> )<br><code>\datapointsonly</code> (different symbols, like <code>\plotnodes</code> )  |

\* The angle is optional, and ignored unless option `mplabels` is in effect.

<sup>†</sup> `\plotdata` also respects the `\using` setting (see `\datafile` in section **General curves**).