

# MFPIC Quick Reference

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This information was prepared for version 1.04 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 (plainL <sup>A</sup> T <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, \notruebbox</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>}</code> <code>{<i>mfpic commands</i>}</code> <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>\gclear</code>	<code>\backgroundcolor{<i>color</i>}</code>
L <sup>A</sup> T <sub>E</sub> X syntax	<code>\drawcolor[<i>model</i>]{<i>clrspec</i>}</code> , etc.
Define a color name	<code>\mfpdefinecolor{<i>name</i>}{<i>model</i>}{<i>clrspec</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>, y<sub>0</sub>)</i>, <i>(x<sub>1</sub>, 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>, y<sub>0</sub>)</i>, <i>(x<sub>1</sub>, 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>, y<sub>0</sub>)</i>, <i>(x<sub>1</sub>, y<sub>1</sub>)</i>, ...}</code> , or <code>(\lines)</code>
Closed polygon	<code>\polygon{<i>(x<sub>0</sub>, y<sub>0</sub>)</i>, <i>(x<sub>1</sub>, 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>, y<sub>0</sub>)</i>, <i>(x<sub>1</sub>, 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>, y<sub>0</sub>)</i>, <i>(x<sub>1</sub>, y<sub>1</sub>)</i>, <i>(x<sub>2</sub>, 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>, y<sub>0</sub>)</i>, <i>(x<sub>1</sub>, 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>, y<sub>0</sub>)</i>, <i>(x<sub>1</sub>, y<sub>1</sub>)</i>, <i>(x<sub>2</sub>, 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>, y<sub>0</sub>)</i>, <i>(x<sub>1</sub>, y<sub>1</sub>)</i>, <i>(angle)</i>}</code>

Ellipse, center  $(x_0, y_0)$ , radii  $\langle r_x \rangle$ ,  $\langle r_y \rangle$ , angle  $\langle \theta \rangle$  `\ellipse[(θ)]{(x0, y0), (rx), (ry)}`

## 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>, y<sub>0</sub>)</i>, <i>(x<sub>1</sub>, 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>, <math>\Delta x</math>}{<i>f(x)</i>}</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>, <math>\Delta t</math>}{<i>(x(t), y(t))</i>}</code>
Graph of $r = f(\theta)$	<code>\plrfcn[<i>(spec)</i>]{<i>θ<sub>min</sub></i>, <i>θ<sub>max</sub></i>, <math>\Delta \theta</math>}{<i>f(t)</i>}</code>
Interpolate with a smooth <i>function</i>	<code>\fncurve[<i>(tension)</i>]{<i>(x<sub>0</sub>, y<sub>0</sub>)</i>, <i>(x<sub>1</sub>, 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[⟨tension⟩]{⟨x<sub>1</sub>, y<sub>1</sub>⟩, ⟨x<sub>2</sub>, y<sub>2</sub>⟩, ...}</code>
Circular sector (pie slice)	<code>\sector{⟨center⟩, ⟨radius⟩, ⟨θ<sub>1</sub>⟩, ⟨θ<sub>2</sub>⟩}</code>
Region between two functions	<code>\btwnfcn[⟨spec⟩]{⟨x<sub>min</sub>, x<sub>max</sub>, Δx⟩{⟨f(x)⟩}{⟨g(x)⟩}</code>
Region in polar coordinates	<code>\plrregion[⟨spec⟩]{⟨θ<sub>min</sub>, θ<sub>max</sub>, Δθ⟩{⟨f(t)⟩}</code>
Curves surrounding text	<code>\labelrect[⟨radius⟩](⟨x⟩, ⟨y⟩){⟨text⟩}</code> <code>\labeloval[⟨mult⟩](⟨x⟩, ⟨y⟩){⟨text⟩}</code> <code>\labelellipse[⟨ratio⟩](⟨x⟩, ⟨y⟩){⟨text⟩}</code> ⟨radius⟩: round corners. ⟨mult⟩: stretch horizontally. ⟨ratio⟩: width/height of ellipse

## Prefix macros

### Drawing curves

Dashed path	<code>\dashed[⟨length⟩, ⟨gap⟩]...</code>
Dotted path	<code>\dotted[⟨size⟩, ⟨gap⟩]...</code>
Trace a path with symbols	<code>\plot[⟨size⟩, ⟨gap⟩]{⟨symbol⟩}...</code>
Generalized dashes	<code>\gendashed{⟨patname⟩}...</code>
Define a named dash pattern	<code>\dashpattern{⟨patname⟩}{⟨len<sub>1</sub>⟩, ⟨len<sub>2</sub>⟩, ..., ⟨len<sub>2n</sub>⟩}</code>
Place a symbol at all nodes	<code>\plotnodes[⟨size⟩]{⟨symbol⟩}...</code>
Solid curve	<code>\draw[⟨color⟩]...</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[⟨color⟩]...</code>
Unfill	<code>\gclear...</code>
Hatched fills	<code>\thatch[⟨space⟩, ⟨angle⟩][⟨color⟩]...</code> ⟨angle⟩ = 45 deg <code>\rhatch[⟨space⟩][⟨color⟩]...</code> ⟨angle⟩ = -45 deg <code>\lhatch[⟨space⟩][⟨color⟩]...</code> crosshatching <code>\xhatch[⟨space⟩][⟨color⟩]...</code> <code>\hatch = \xhatch</code>
Shading	<code>\shade[⟨space⟩]...</code>
Polkadot fill	<code>\polkadot[⟨space⟩]...</code>
Fill with copies of a tile	<code>\tess{⟨tile⟩}...</code> Define a tile* <code>\tile{⟨name⟩, ⟨unit⟩, ⟨width⟩, ⟨height⟩, ⟨clip⟩}</code> <code>⟨drawing commands⟩ \endtile</code>

\* Creates a mini-mfpic, clipped if `⟨clip⟩ = true`.

### Storing and reusing a path

Store a path	<code>\store{⟨name⟩}...</code>
reusing a stored path	<code>\mfobj{⟨name⟩}</code>

### Subpaths

Subpath by fractions of length	<code>\partpath{⟨frac1⟩, ⟨frac2⟩}...</code>
Subpath by node numbers	<code>\subpath{⟨m⟩, ⟨n⟩}...</code>

Cutting by another path	<code>\cutoffafter{⟨obj⟩}..., \cutoffbefore{⟨obj⟩}...</code> ⟨obj⟩ is a name created with <code>\store</code>
Trim the ends of a path	<code>\trimpath{⟨dim1⟩, ⟨dim2⟩}...</code>

### Modifying a curve

Add arrowhead to the end	<code>\arrow[⟨length⟩][⟨angle⟩][b{⟨backset⟩}][c{⟨color⟩}]...</code>
Define arrowhead shape	<code>\headshape{⟨ratio⟩}{⟨tension⟩}{⟨filled⟩}</code>
Reverse a curve	<code>\reverse...</code>
Double arrow	<code>\arrow\reverse\arrow...</code>
Rotate around a point	<code>\rotatepath{⟨x<sub>0</sub>, y<sub>0</sub>⟩, ⟨angle⟩}...</code>
Reflect about a line	<code>\reflectpath{⟨x<sub>0</sub>, y<sub>0</sub>⟩, ⟨x<sub>1</sub>, y<sub>1</sub>⟩}...</code>
Shift	<code>\shiftpath{⟨dx, dy⟩}...</code>
Scale around a point	<code>\scalepath{⟨x<sub>0</sub>, y<sub>0</sub>⟩, ⟨scale⟩}...</code>
xscale about line $x = x_0$	<code>\xscalepath{x<sub>0</sub>, ⟨scale⟩}...</code>
yscale about line $y = y_0$	<code>\yscalepath{y<sub>0</sub>, ⟨scale⟩}...</code>
slant, pivoting on line $y = y_0$	<code>\slantpath{y<sub>0</sub>, ⟨slant⟩}...</code>
yslant, pivoting on line $x = x_0$	<code>\yslantpath{x<sub>0</sub>, ⟨slant⟩}...</code>
Swap x and y	<code>\xyswappath...</code>

## Axes

Draw x- and/or y-axes	<code>\axes[⟨headlen⟩], \xaxis[⟨headlen⟩], \yaxis[⟨headlen⟩]</code>
Draw various axes	<code>\axis[⟨headlen⟩]{⟨axis⟩}</code> , ⟨axis⟩ is one of x, y, l, b, r, or t.
Draw many axes	<code>\doaxes[⟨headlen⟩]{⟨list⟩}</code> , ⟨list⟩ of letters, no commas.
Shift border axis inward	<code>\axismargin{⟨axis⟩}{⟨amt⟩}</code> , ⟨amt⟩ is in graph units.
Add hashmarks to axes	<code>\axismarks{⟨axis⟩}[⟨len⟩][c<sub>1</sub>, c<sub>2</sub>, ...]</code> , c <sub>j</sub> are positions. Abbrev. by <code>\xmarks</code> for <code>\axismarks{x}</code> , etc.
Change position of hash marks	<code>\setaxismarks{⟨axis⟩}{⟨pos⟩}</code> ⟨pos⟩ is one of inside, outside, centered, ontop, onbottom, onleft, or onright.

## Miscellaneous

Text labels	<code>\tlabel[⟨pos⟩(θ)](⟨x⟩, ⟨y⟩){⟨T<sub>EX</sub> text⟩}</code> <code>\tlabels{⟨args<sub>1</sub>⟩(⟨args<sub>2</sub>⟩)...</code> <code>\axislabels{⟨axis⟩}[⟨pos⟩(θ)]{⟨{t<sub>xt1}⟩(n<sub>1</sub>)⟩, ⟨{t<sub>xt2}⟩(n<sub>2</sub>)⟩, ...}</sub></sub></code> ⟨pos⟩ is a two-letter sequence, (θ) the angle* of rotation in degrees; ⟨args <sub>j</sub> ⟩ is an entire set of arguments as in <code>\tlabel</code> ; ⟨axis⟩ is a letter, ⟨t <sub>xt<sub>j</sub>⟩⟩ is label, ⟨n<sub>j</sub>⟩ is coordinate on axis</sub>
Clipping to a path	<code>\gclip...</code>
Polar conversion	<code>\plr{(r<sub>0</sub>, θ<sub>0</sub>), (r<sub>1</sub>, θ<sub>1</sub>), ...}</code>
Connect paths	<code>\connect ⟨path1⟩ ⟨path2⟩ ... \endconnect</code>
Draw many curves from one datafile	<code>\plotdata[⟨spec⟩]{⟨file⟩}</code> , ⟨spec⟩ is p or s⟨num⟩ where ⟨num⟩ is the (optional) tension in the smooth curve
Set how <code>\plotdata</code> draws curves <sup>†</sup>	<code>\dashedlines</code> (different dash patterns) <code>\coloredlines</code> (different colors, METAFONT only) <code>\pointedlines</code> (different symbols, like <code>\plot</code> ) <code>\datapointonly</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**).