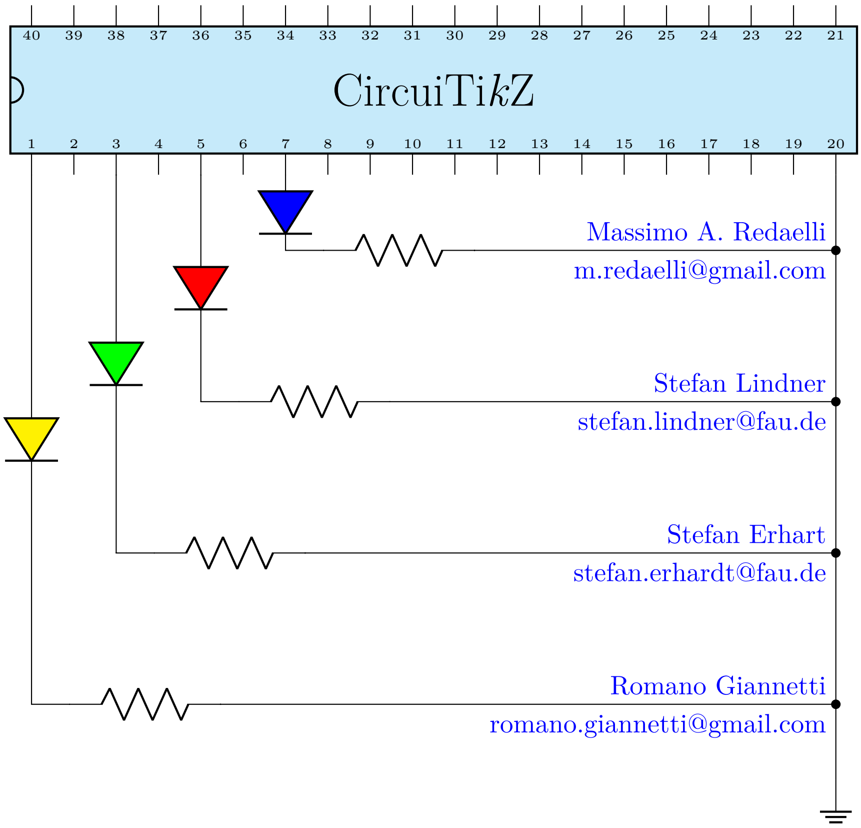

CircuiTi*k*Z

version git:471eade (2019/06/14)

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Contents

1 Introduction

1.1 About

CircuiTi*k*Z was initiated by Massimo Redaelli in 2007, who was working as a research assistant at the Polytechnic University of Milan, Italy, and needed a tool for creating exercises and exams. After he left University in 2010 the development of CircuiTi*k*Z slowed down, since LaTeX is mainly established in the academic world. In 2015 Stefan Lindner and Stefan Erhardt, both working as research assistants at the University of Erlangen-Nürnberg, Germany, joined the team and now maintain the project together with the initial author. In 2018 Romano Giannetti, full professor of Electronics at Comillas Pontifical University of Madrid, joined the team.

The use of CircuiTi*k*Z is, of course, not limited to academic teaching. The package gets widely used by engineers for typesetting electronic circuits for articles and publications all over the world.

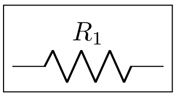
1.2 License

1.3 Loading the package

LaTeX	ConTeXt[1]
`\usepackage{circuitikz}`	`\usemodule[circuitikz]`

Ti*k*Z will be automatically loaded.

CircuiTi*k*Z commands are just Ti*k*Z commands, so a minimum usage example would be:




```
\tikz \draw (0,0) to[R=$R_1$] (2,0);
```

1.4 Installing a new version of the package.

The stable version of the package should come with your LaTeX distribution. Downloading the files from CTAN and installing them locally is, unfortunately, a distribution-dependent task and sometime not so trivial. If you search for `local texmf tree` and the name of your distribution on https://tex.stackexchange.com/ you will find a lot of hints.

Anyway, the easiest way of using whichever version of CircuiTi*k*Z is to point to the github page https://circuitikz.github.io/circuitikz/ of the project, and download the version you want. You will download a simple (biggish) file, called `circuitikz.sty`.

Now you can just put this file in your local `texmf` tree, if you have one, or simply adding it into the same directory where your main file resides, and then use

```
\usepackage[...options...]{circuitikzgit}
```

instead of `circuitikz`. This is also advantageous for "future resilience"; the authors try hard not to break backward compatibility with new versions, but sometime things happen.

[1] ConTeXt support was added mostly thanks to Mojca Miklavec and Aditya Mahajan.

1.5 Requirements

- `tikz`, version ≥ 3;
- `xstring`, not older than 2009/03/13;
- `siunitx`, if using `siunitx` option.

1.6 Incompatible packages

Ti*k*Z's own `circuit` library, which is based on CircuiTi*k*Z, (re?)defines several styles used by this library. In order to have them work together you can use the `compatibility` package option, which basically prefixes the names of all CircuiTi*k*Z `to[]` styles with an asterisk.

So, if loaded with said option, one must write `(0,0) to[*R] (2,0)` and, for transistors on a path, `(0,0) to[*Tnmos] (2,0)`, and so on (but `(0,0) node[nmos] {}`). See example at page 106.

1.7 Known bugs and limitation

CircuiTi*k*Z will **not work** correctly with global (in the main `circuitikz` environment, or in `scope` environments) *negative* scale parameters (`scale`, `xscale` or `yscale`), unless `transform shape` is also used, and even in this cases the behavior is not guaranteed. Neither it will work with angle-changing scaling (when `xscale` is different form `yscale`) and with the global `rotate` parameter.

Correcting this will need a big rewrite of the path routines, and although the authors are thinking about solving it, don't hold your breath; it will need changing a lot of interwoven code (labels, voltages, currents and so on). Contributions and help would be highly appreciated.

This same issue create a lot of problem of compatibility between CircuiTi*k*Z and the new `pic` Ti*k*Z feature, so basically don't put components into `pic`s.

1.8 Incompabilities between version

Here, we will provide a list of incompabilitys between different version of circuitikz. We will try to hold this list short, but sometimes it is easier to break with old syntax than including a lot of switches and compatibility layers. You can check the used version at your local installation using the macro `\pgfcircversion{}`.

- After v0.9.0: the parameters `tripoles/american or port/aaa`, `...bbb`, `...ccc` and `...ddd` are no longer used and are silently ignored; the same stands for `nor`, `xor`, and `xnor` ports.
- After v0.9.0: voltage and current directions/sign (plus and minus signs in case of `american voltages` and arrows in case of `european voltages` have been rationalized with a couple of new options (see details in section 4.2. The default case is still the same as v0.8.3.
- Since v0.8.2: voltage and current label directions(v<= / i<=) do NOT change the orientation of the drawn source shape anymore. Use the "invert" option to rotate the shape of the source. Furthermore, from this version on, the current label(i=) at current sources can be used independent of the regular label(l=).
- Since v0.7?: The label behaviour at mirrored bipoles has changes, this fixes the voltage drawing, but perhaps you have to adjust your label positions.
- Since v0.5.1: The parts pfet, pigfete, pigfetebulk and pigfetd are now mirrored by default. Please adjust your yscale-option to correct this.

- Since v0.5: New voltage counting direction, here exists an option to use the old behaviour

If you have older projects that show compatibility problems, you have two options:

- you can use an older version locally using the git-version and picking the correct commit from the repository (branch gh-pages) or the main GitHub site directly;
- if you are using LaTeX, the distribution has embedded several important old versions: `0.4`, `0.6`, `0.7` and `0.8.3`. To switch to use them, you simply change your `\usepackage` invocation like

```
            \usepackage[]{circuitik-0.8.3} % or circuitikz-0.4, 0.6...
```

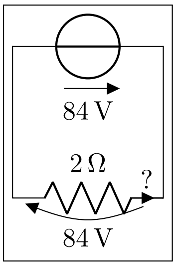
  You have to take care of the options that may have changed between versions.

1.9 Feedback

The easiest way to contact the authors is via the official Github repository: https://github.com/circuitikz/circuitikz/issues

1.10 Package options

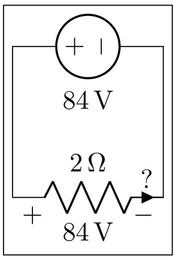
Circuit people are very opinionated about their symbols. In order to meet the individual gusto you can set a bunch of package options. The standard options are what the authors like, for example you get this:




```
\begin{circuitikz}
    \draw (0,0) to[R=2<\ohm>, i=?, v=84<\volt>] (2,0) --
    (2,2) to[V<=84<\volt>] (0,2)
    -- (0,0);
\end{circuitikz}
```

Feel free to load the package with your own cultural options:

LaTeX	ConTeXt
`\usepackage[american]{circuitikz}`	`\usemodule[circuitikz][american]`




```
\begin{circuitikz}
    \draw (0,0) to[R=2<\ohm>, i=?, v=84<\volt>] (2,0) --
    (2,2) to[V<=84<\volt>] (0,2)
    -- (0,0);
\end{circuitikz}
```

Here is the list of all the options:

- `europeanvoltages`: uses arrows to define voltages, and uses european-style voltage sources;

- straightvoltages: uses arrows to define voltages, and and uses straight voltage arrows;
- americanvoltages: uses − and + to define voltages, and uses american-style voltage sources;
- europeancurrents: uses european-style current sources;
- americancurrents: uses american-style current sources;
- europeanresistors: uses rectangular empty shape for resistors, as per european standards;
- americanresistors: uses zig-zag shape for resistors, as per american standards;
- europeaninductors: uses rectangular filled shape for inductors, as per european standards;
- americaninductors: uses "4-bumps" shape for inductors, as per american standards;
- cuteinductors: uses my personal favorite, "pig-tailed" shape for inductors;
- americanports: uses triangular logic ports, as per american standards;
- europeanports: uses rectangular logic ports, as per european standards;
- americangfsurgearrester: uses round gas filled surge arresters, as per american standards;
- europeangfsurgearrester: uses rectangular gas filled surge arresters, as per european standards;
- european: equivalent to europeancurrents, europeanvoltages, europeanresistors, europeaninductors, europeanports, europeangfsurgearrester;
- american: equivalent to americancurrents, americanvoltages, americanresistors, americaninductors, americanports, americangfsurgearrester;
- siunitx: integrates with SIunitx package. If labels, currents or voltages are of the form #1<#2> then what is shown is actually \SI{#1}{#2};
- nosiunitx: labels are not interpreted as above;
- fulldiode: the various diodes are drawn *and* filled by default, i.e. when using styles such as diode, D, sD, …Other diode styles can always be forced with e.g. Do, D-, …
- strokediode: the various diodes are drawn *and* stroke by default, i.e. when using styles such as diode, D, sD, …Other diode styles can always be forced with e.g. Do, D*, …
- emptydiode: the various diodes are drawn *but not* filled by default, i.e. when using styles such as D, sD, …Other diode styles can always be forced with e.g. Do, D-, …
- arrowmos: pmos and nmos have arrows analogous to those of pnp and npn transistors;
- noarrowmos: pmos and nmos do not have arrows analogous to those of pnp and npn transistors;
- fetbodydiode: draw the body diode of a FET;
- nofetbodydiode: do not draw the body diode of a FET;
- fetsolderdot: draw solderdot at bulk-source junction of some transistors;
- nofetsolderdot: do not draw solderdot at bulk-source junction of some transistors;
- emptypmoscircle: the circle at the gate of a pmos transistor gets not filled;
- lazymos: draws lazy nmos and pmos transistors. Chip designers with huge circuits prefer this notation;

- `straightlabels`: labels on bipoles are always printed straight up, i.e. with horizontal baseline;
- `rotatelabels`: labels on bipoles are always printed aligned along the bipole;
- `smartlabels`: labels on bipoles are rotated along the bipoles, unless the rotation is very close to multiples of 90°;
- `compatibility`: makes it possibile to load CircuiTi*k*Z and Ti*k*Z circuit library together.
- Voltage directions: until v0.8.3, there was an error in the coherence between american and european voltages styles (see section 4.2) for the batteries. This has been fixed, but to guarantee backward compatibility and to avoid nasty surprises, the fix is available with new options:
  - `oldvoltagedirection`: Use old way of voltage direction having a difference between european and american direction, with wrong default labelling for batteries;
  - `nooldvoltagedirection`: The standard from 0.5 onward, utilize the (German?) standard of voltage arrows in the direction of electric fields (without fixing batteries);
  - `RPvoltages` (meaning Rising Potential voltages): the arrow is in direction of rising potential, like in `oldvoltagedirections`, but batteries and current sources are fixed to follow the passive/active standard;
  - `EFvoltages` (meaning Electric Field voltages): the arrow is in direction of the electric field, like in `nooldvoltagedirections`, but batteries are fixed;

  If none of these option are given, the package will default to `nooldvoltagedirections`, but will give a warning. The behavior is also selectable circuit by circuit with the `voltage dir` style.
- `betterproportions`[2]: nicer proportions of transistors in comparision to resistors;

The old options in the singular (like `american voltage`) are still available for compatibility, but are discouraged.

Loading the package with no options is equivalent to the following options: `[nofetsolderdot, europeancurrents, europeanvoltages, americanports, americanresistors, cuteinductors, europeangfsurgearrester, nosiunitx, noarrowmos, smartlabels, nocompatibility]`.

In ConTEXt the options are similarly specified: `current= european|american`, `voltage= european|american`, `resistor= american|european`, `inductor= cute|american|european`, `logic= american|european`, `siunitx= true|false`, `arrowmos= false|true`.

2 Tutorials

To draw a circuit, you have to load the `circuitikz` package; this can be done with

```
\usepackage[siunitx, RPvoltages]{circuitikz}
```

somewhere in your document preamble. It will load automatically the needed packages if not already done before.

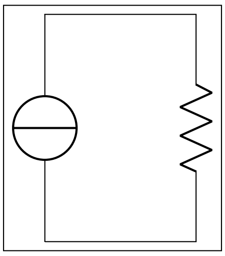
[2]May change in the future!

2.1 Getting started with CircuiTi*k*Z: a current shunt

Let's say we want to prepare a circuit to teach how a current shunt works; the idea is to draw a current generator, a couple of resistors in parallel, and the indication of currents and voltages for the discussion.

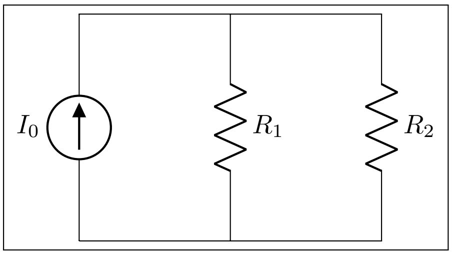
A circuit in CircuiTi*k*Zis drawn into a `circuitikz` environment (which is really an alias for `tikzpicture`). In this first example we will use absolute coordinates. The electrical components can be divided in two main categories: the one that are bipoles and are placed along a path (also known as `to`-style component, for their usage), and components that are nodes and can have any number of poles or connections.

Let's start with the first type of component, and build a basic mesh:



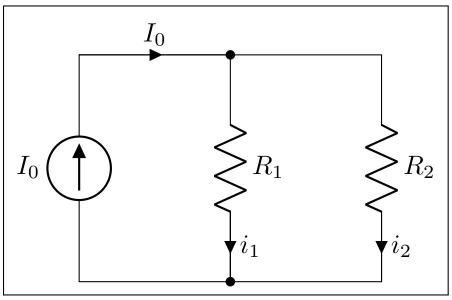
```
\begin{circuitikz}[]
    \draw (0,0) to[isource] (0,3) -- (2,3)
    to[R] (2,0) -- (0,0);
\end{circuitikz}
```

The symbol for the current source can surprise somebody; this is actually the european-style symbol, and the type of symbol chosen reflects the default options of the package (see section 1.10). Let's change the style for now (the author of the tutorial, Romano, is European - but he has always used American-style circuits, so …); and while we're at it, let's add the other branch and some labels.



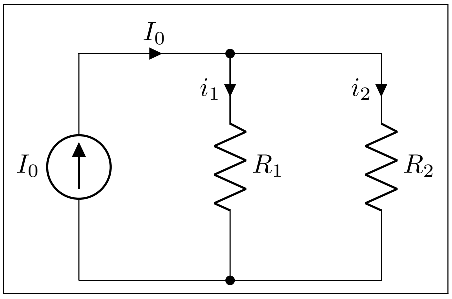

```
\begin{circuitikz}[american]
    \draw (0,0) to[isource, l=$I_0$] (0,3) --
         (2,3)
    to[R=$R_1$] (2,0) -- (0,0);
    \draw (2,3) -- (4,3) to[R=$R_2$]
         (4,0) -- (2,0);
\end{circuitikz}
```

You can use a single path or multiple path when drawing your circuit, it's just a question of style (but be aware that closing path could be non-trivial, see section 4.11), and you can use standard Ti*k*Z lines (`--`, `|-` or similar) for the wires. Nonetheless, sometime using the CircuiTi*k*Z specific `short` component for the wires can be useful, because then we can add labels and nodes at it, like for example in the following circuit.



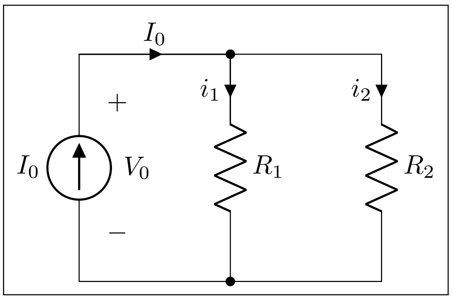

```
\begin{circuitikz}[american]
    \draw (0,0) to[isource, l=$I_0$] (0,3)
    to[short, -*, i=$I_0$] (2,3)
    to[R=$R_1$, i=$i_1$] (2,0) -- (0,0);
    \draw (2,3) -- (4,3)
    to[R=$R_2$, i=$i_2$]
    (4,0) to[short, -*] (2,0);
\end{circuitikz}
```

One of the problems with this circuit is that we would like to have the current in a different position, such as for example on the upper side of the resistors, so that Kirchoff's Current Law at the node is better shown to students. No problem; as you can see in section 4.2 you can use the position specifier `<>^_}` after the key `i`:



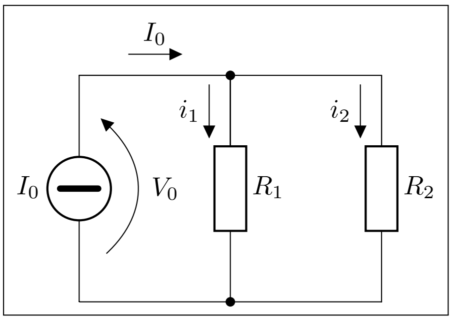

```
\begin{circuitikz}[american]
    \draw (0,0) to[isource, l=$I_0$] (0,3)
    to[short, -*, i=$I_0$] (2,3)
    to[R=$R_1$, i>_=$i_1$] (2,0) -- (0,0);
    \draw (2,3) -- (4,3)
    to[R=$R_2$, i>_=$i_2$]
    (4,0) to[short, -*] (2,0);
\end{circuitikz}
```

Finally, we would like to add voltages indication for carrying out the current formulas; as the default position of the voltage signs seems a bit cramped to me, I am adding the `voltage shift` parameter to make a bit more space for it...



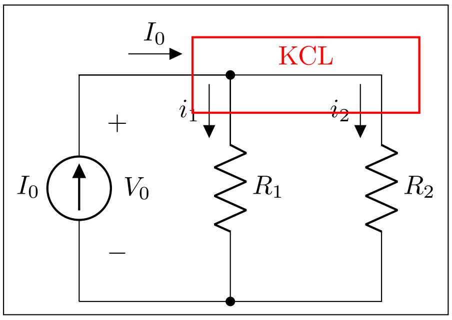

```
\begin{circuitikz}[american, voltage shift=0.5]
    \draw (0,0) to[isource, l=$I_0$, v=$V_0$] (0,3)
    to[short, -*, i=$I_0$] (2,3)
    to[R=$R_1$, i>_=$i_1$] (2,0) -- (0,0);
    \draw (2,3) -- (4,3)
    to[R=$R_2$, i>_=$i_2$]
    (4,0) to[short, -*] (2,0);
\end{circuitikz}
```

Et voilá!. Remember that this is still LaTeX, which means that you have done a description of your circuit, which is, in a lot of way, independent of the visualization of it. If you ever have to adapt the circuit to, say, a journal that force European style and flows instead of currents, you just change a couple of things and you have what seems a completely different diagram:




```
\begin{circuitikz}[european, voltage shift=0.5]
    \draw (0,0) to[isourceC, l=$I_0$, v=$V_0$] (0,3)
    to[short, -*, f=$I_0$] (2,3)
    to[R=$R_1$, f>_=$i_1$] (2,0) -- (0,0);
    \draw (2,3) -- (4,3)
    to[R=$R_2$, f>_=$i_2$]
    (4,0) to[short, -*] (2,0);
\end{circuitikz}
```

And finally, this is still Ti*k*Z, so that you can freely mix other graphics element to the circuit.




```
\begin{circuitikz}[american, voltage shift=0.5]
   \draw (0,0) to[isource, l=$I_0$, v=$V_0$] (0,3)
   to[short, -*, f=$I_0$] (2,3)
   to[R=$R_1$, f>_=$i_1$] (2,0) -- (0,0);
   \draw (2,3) -- (4,3)
   to[R=$R_2$, f>_=$i_2$]
   (4,0) to[short, -*] (2,0);
   \draw[red, thick] (1.5,2.5) rectangle (4.5,3.5)
   node[pos=0.5, above]{KCL};
\end{circuitikz}
```

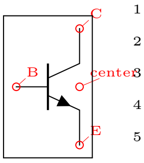
2.2 A more complex tutorial: circuits, Romano style.

The idea is to draw a two-stage amplifier for a lesson, or exercise, on the different qualities of BJT and MOSFET transistors. Notice that this is a more "personal" tutorial, showing a way to draw circuits that is, in the author's opinion, highly reusable and easy to do. The idea is using relative coordinates and named nodes as much as possible, so that changes in the circuit are easily done by changing keys numbers of position, and crucially, each block is reusable in other diagrams.

First of all, let's define a handy function to show the position of nodes:

```
\def\coord(#1){coordinate(#1)}
\def\coord(#1){node[circle, red, draw, inner sep=1pt,pin={[red, overlay, inner sep=0.5pt, font=\tiny, pin distance=0.1cm, pin edge={red, overlay,}]45:#1}](#1){}}
```

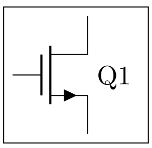
The idea is that you can use `\coord()` instead of `coordinate()` in paths, and that will draw sort of *markers* showing them. For example:




```
\begin{circuitikz}[american,]
   \draw (0,0) node[npn](Q){};
   \path (Q.center) \coord(center)
   (Q.B) \coord(B) (Q.C) \coord(C)
   (Q.E) \coord(E);
\end{circuitikz}
```

After the circuit is drawn, simply commenting out the second definition of `\coord` will hide all the markers.

So let's start with the first stage transistor; given that my preferred way of drawing a MOSFET is with arrows, I'll start with the command `\ctikzset{tripoles/mos style/arrows}`:

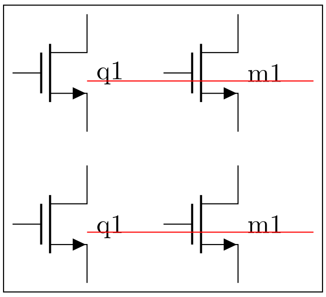



```
\begin{circuitikz}[american,]
\ctikzset{tripoles/mos style/arrows}
\def\killdepth#1{{\raisebox{0pt}[\height][0pt]{#1}}}
   \draw (0,0) node[nmos](Q1){};
   \draw (Q1.center) node[right]{\killdepth{Q1}};
\end{circuitikz}
```

Another thing I like to modify with respect to the standard is the position of the arrows in transistors, which are normally in the middle the symbol. Using the following settings will move the arrows to the start or end of the corresponding pin.

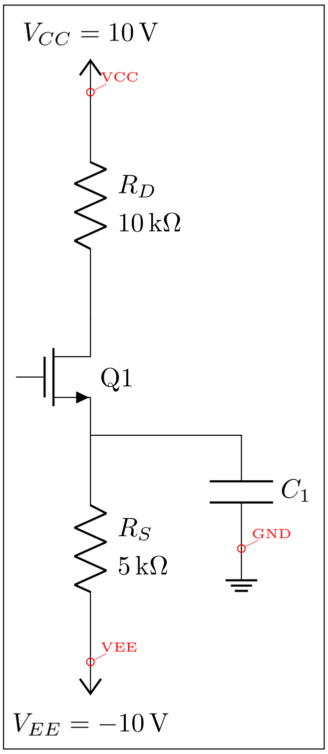
```
\ctikzset{tripoles/mos style/arrows,
tripoles/npn/arrow pos=0.8,
tripoles/pnp/arrow pos=0.8,
tripoles/nmos/arrow pos=0.8,
tripoles/pmos/arrow pos=0.6, }
```

The tricky thing about `\killdepth{}` macro is finnicky details; I do not like the standard position of labels on transistors (which is near the collector/drain) so I plot the label at the right of the `center` anchor. Without the `\killdepth` macro, the labels of different transistor will be adjusted so that the center of the box is at the `center` anchor, and as an effect, labels with descenders (like Q) will have a different baseline than labels without. You can see this here (it's really subtle):



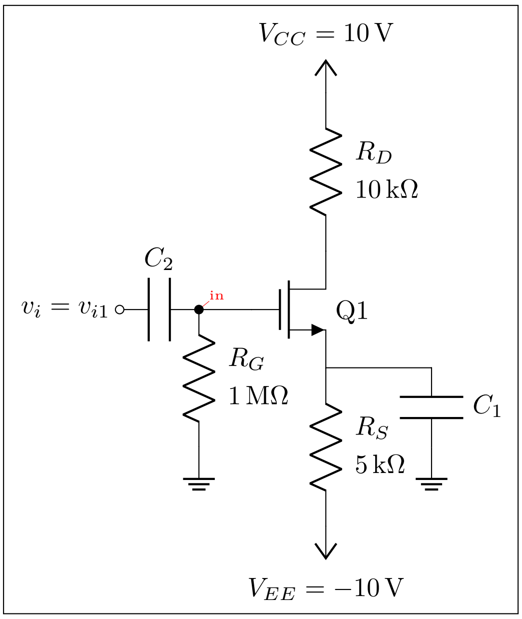

```
\begin{circuitikz}[american,]
\draw (0,0) node[nmos](Q1){} ++(2,0) node[nmos](M1){};
\draw (Q1.center) node[right]{q1};
\draw (M1.center) node[right]{m1};
\draw [red] (Q1.center) ++(0,-0.7ex) -- ++(3,0);
\draw (0,-2)node[nmos](Q1){} ++(2,0) node[nmos](M1){};
\draw (Q1.center) node[right]{\killdepth{q1}};
\draw (M1.center) node[right]{\killdepth{m1}};
\draw [red] (Q1.center) ++(0,-0.7ex) -- ++(3,0);
\end{circuitikz}
```

We will start connecting the first transistor with the power supply with a couple of resistors. Notice that I am naming the nodes `GND`, `VCC` and `VEE`, so that I can use the coordinates to have all the supply rails at the same vertical position (more on this later).




```
\begin{circuitikz}[american,]
    \draw (0,0) node[nmos,](Q1){};
    \draw (Q1.center) node[right]{\killdepth{Q1}};
    \draw (Q1.S) to[R, l2^=$R_S$ and \SI{5}{k\ohm}] ++(0,-3)
       node[vee](VEE){$V_{EE}=\SI{-10}{V}$};
    \draw (Q1.D) to[R, l2_=$R_D$ and \SI{10}{k\ohm}] ++(0,3)
       node[vcc](VCC){$V_{CC}=\SI{10}{V}$};
    \draw (Q1.S) to[short] ++(2,0) to[C=$C_1$] ++(0,-1.5) node[ground](GND){};
    \path (GND) \coord(GND) (VCC) \coord(VCC)
       (VEE) \coord(VEE);
\end{circuitikz}
```

After that, let's add the input part. I will use a named node here, to refer to it to add the input source. Notice how the ground node is positioned: the coordinate `(in |- GND)` is the point with the horizontal coordinate of `(in)` and the horizontal one of `(GND)`, lining it up with the ground of the capacitor C_1.



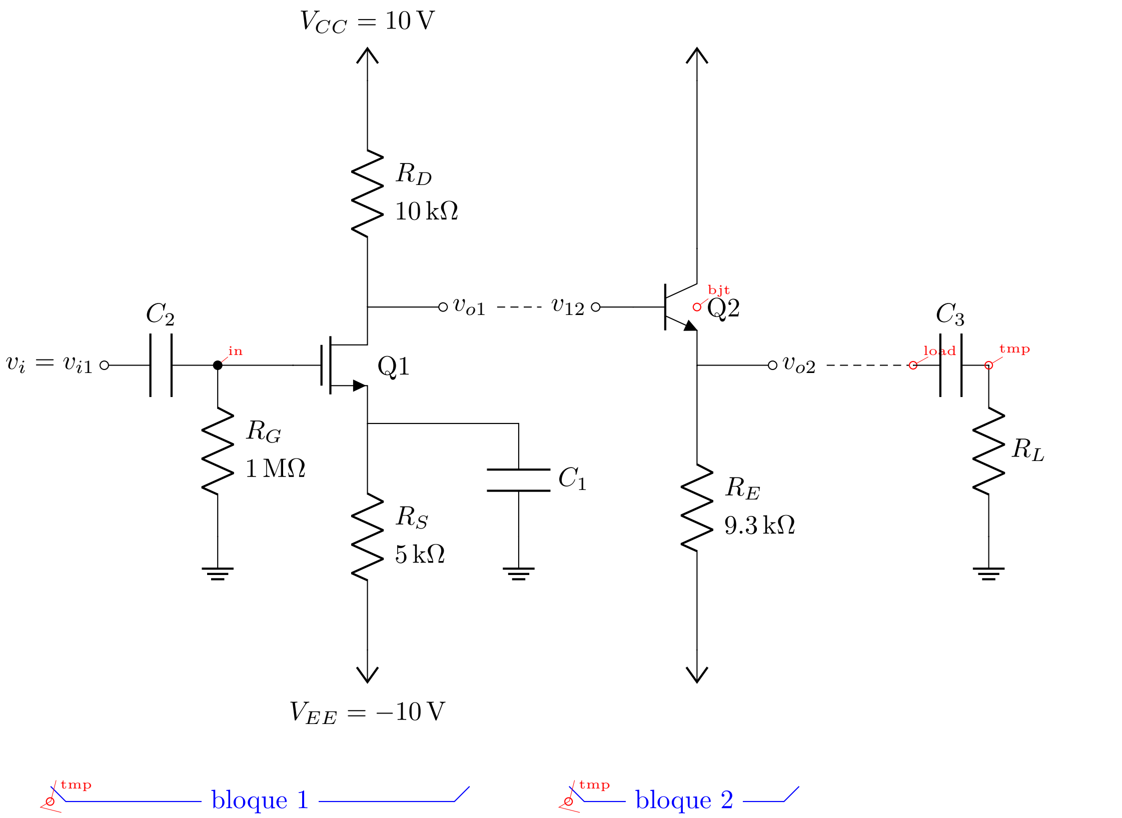

```
\begin{circuitikz}[american, scale=0.7]
    \draw (0,0) node[nmos,](Q1){};
    \draw (Q1.center) node[right]
        {\killdepth{Q1}};
    \draw (Q1.S) to[R, l2^=$R_S$ and \SI{5}{k\ohm}] ++(0,-3)
        node[vee](VEE){$V_{EE}=\SI{-10}{V}$};
    \draw (Q1.D) to[R, l2_=$R_D$ and \SI{10}{k\ohm}] ++(0,3)
        node[vcc](VCC){$V_{CC}=\SI{10}{V}$};
    \draw (Q1.S) to[short] ++(2,0) to[C=$C_1$] ++(0,-1.5) node[ground](GND){};
    \draw (Q1.G) to[short] ++(-1,0)
        \coord (in) to[R, l2^=$R_G$ and \SI{1}{M\ohm}]
        (in |- GND) node[ground]{};
    \draw (in) to[C, l_=$C_2$,*-o] ++(-1.5,0) node[left](vi1){$v_i=v_{i1}$};
\end{circuitikz}
```

Notice that the only absolute coordinate here is the first one, `(0,0)`; so the elements are connected with relative movements and can be moved by just changing one number (for example, changing the `to[C=$C_1$] ++(0,-1.5)` will move *all* the grounds down).

This is the final circuit, with the nodes still marked:

```
\tikzset{blockdef/.style={%
    {Straight Barb[harpoon, reversed, right, length=0.2cm]}-{Straight Barb[harpoon, reversed, left, length=0.2cm]},
    blue, %densely dotted,
}}
\def\killdepth#1{{\raisebox{0pt}[\height][0pt]{#1}}}
\def\coord(#1){coordinate(#1)}
\def\coord(#1){node[circle, red, draw, inner sep=1pt,pin={[red, overlay, inner sep=0.5pt, font=\tiny, pin distance=0.1cm, pin edge={red, overlay,}]45:#1}](#1){}}
\begin{circuitikz}[american, ]
    \draw (0,0) node[nmos,](Q1){};
    \draw (Q1.center) node[right]{\killdepth{Q1}};
    \draw (Q1.S) to[R, l2^=$R_S$ and \SI{5}{k\ohm}] ++(0,-3) node[vee](VEE){$V_{EE}=\SI{-10}{V}$}; %define VEE level
    \draw (Q1.S) to[short] ++(2,0) to[C=$C_1$] ++(0,-1.5) node[ground](GND){};
    \draw (Q1.G) to[short] ++(-1,0) \coord (in) to[R, l2^=$R_G$ and \SI{1}{M\ohm}] (in |- GND) node[ground]{};
    \draw (in) to[C, l_=$C_2$,*-o] ++(-1.5,0) node[left](vi1){$v_i=v_{i1}$};
    \draw (Q1.D) to[R, l2_=$R_D$ and \SI{10}{k\ohm}] ++(0,3) node[vcc](VCC){$V_{CC}=\SI{10}{V}$};
    \draw (Q1.D) to[short, -o] ++(1,0) node[right](vo1){$v_{o1}$};
    %
    \path (vo1) -- ++(3,0) \coord(bjt);
    %
```

```
    \draw (bjt) node[npn, ](Q2){};
    \draw (Q2.center) node[right]{\killdepth{Q2}};
    \draw (Q2.B) to[short, -o] ++(-0.5,0) node[left](vi2){$v_{12}$};
    \draw (Q2.E) to[R,l2^=$R_E$ and \SI{9.3}{k\ohm}] (Q2.E |- VEE) node[vee]{};
    \draw (Q2.E) to[short, -o] ++(1,0) node[right](vo2){$v_{o2}$};
    \draw (Q2.C) to[short] (Q2.C |- VCC) node[vcc]{};
    %
    \path (vo2) ++(1.5,0) \coord(load);
    \draw (load) to[C=$C_3$] ++(1,0) \coord(tmp) to[R=$R_L$] (tmp |- GND) node[ground]{};
    \draw [densely dashed] (vo2) -- (load);
    %
    \draw [densely dashed] (vo1) -- (vi2);
    %
    \draw [blockdef](vi1|-VEE) ++(0,-2) \coord(tmp)
         -- node[midway, fill=white]{bloque 1} (vo1|- tmp);
         \draw [blockdef] (vi2|-VEE) ++(0,-2) \coord(tmp)
         -- node[midway, fill=white]{bloque 2} (vo2|- tmp);

\end{circuitikz}
```



3 The components

Components in CircuiTi*k*Z come in two forms: path-style, to be used in `to` path specifications, and node-style, which will be instantiated by a `node` specification.

3.1 Path-style components

The path-style components are used as shown below:

```
\begin{circuitikz}
\draw (0,0) to[#1=#2, #options] (2,0);
\end{circuitikz}
```

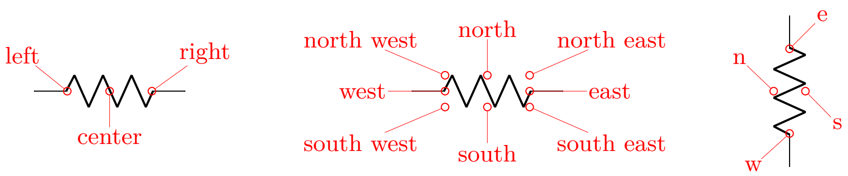
where `#1` is the name of the component, `#2` is an (optional) label, and `options` are optional labels, annotations, style specifier that will be explained in the rest of the manual.

Transistors and some other node-style components can also be placed using the syntax for bipoles. See section 3.18.2.

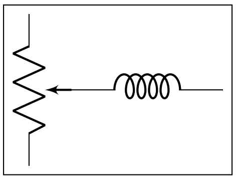
Most path-style components can be used as a node-style components; to access them, you add a `shape` to the main name of component (for example, `diodeshape`). Such a "node name" is specified in the description of each component.

3.1.1 Anchors

Normally, path-style components do not need anchors, although they have them just in case you need them. You have the basic "geographical" anchors (bipoles are defined horizontally and then rotated as needed):

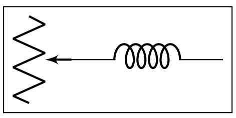


In the case of bipoles, also shortened geographical anchors exists. In the description, it will be shown when a bipole has additional anchors. To use the anchors, just give a name to the bipole element.



```
\begin{circuitikz}
    \draw (0,0) to[potentiometer, name=P, mirror] ++(0,2);
    \draw (P.wiper) to[L] ++(2,0);
\end{circuitikz}
```

Alternatively, that you can use the shape form, and then use the `left` and `right` anchors to do your connections.



```
\begin{circuitikz}
    \draw (0,0) node[potentiometershape, rotate=-90](P){};
    \draw (P.wiper) to[L] ++(2,0);
\end{circuitikz}
```

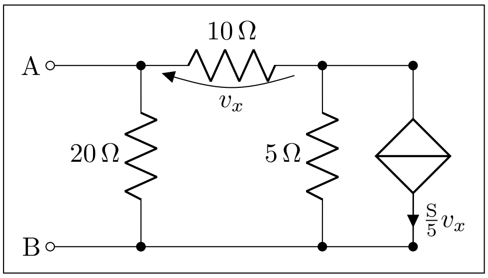
3.1.2 Customization

Pretty much all CircuiTi*k*Z relies heavily on `pgfkeys` for value handling and configuration. Indeed, at the beginning of `circuitikz.sty` and in the file `pfgcirc.define.tex` a series of key definitions can be found that modify all the graphical characteristics of the package.

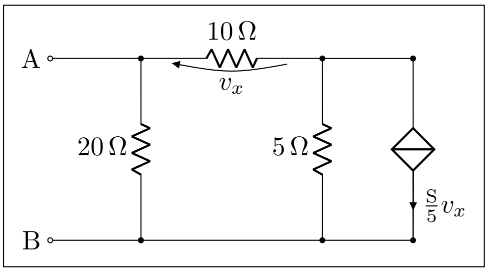
All can be varied using the `\ctikzset` command, anywhere in the code.

3.1.2.1 Components size

Perhaps the most important parameter is `bipoles/length` (default 1.4 cm), which can be interpreted as the length of a resistor (including reasonable connections): all other lengths are relative to this value. For instance:



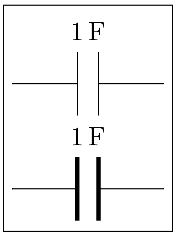

```
\ctikzset{bipoles/length=1.4cm}
\begin{circuitikz}[scale=1.2]\draw
  (0,0) node[anchor=east] {B}
        to[short, o-*] (1,0)
        to[R=20<\ohm>, *-*] (1,2)
        to[R=10<\ohm>, v=$v_x$] (3,2) -- (4,2)
        to[cI=$\frac{\si{\siemens}}{5} v_x$, *-*] (4,0) -- (3,0)
        to[R=5<\ohm>, *-*] (3,2)
  (3,0) -- (1,0)
  (1,2) to[short, -o] (0,2) node[anchor=east]{A}
;\end{circuitikz}
```




```
\ctikzset{bipoles/length=.8cm}
\begin{circuitikz}[scale=1.2]\draw
  (0,0) node[anchor=east] {B}
        to[short, o-*] (1,0)
        to[R=20<\ohm>, *-*] (1,2)
        to[R=10<\ohm>, v=$v_x$] (3,2) -- (4,2)
        to[cI=$\frac{\siemens}{5} v_x$, *-*] (4,0) -- (3,0)
        to[R=5<\ohm>, *-*] (3,2)
  (3,0) -- (1,0)
  (1,2) to[short, -o] (0,2) node[anchor=east]{A}
;\end{circuitikz}
```

3.1.2.2 Thickness of the lines (globally)

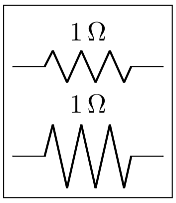
You can change the thickness of the components lines with the parameter `bipoles/thickness` (default 2). The number is relative to the thickness of the normal lines leading to the component.




```
\ctikzset{bipoles/thickness=1}
\tikz \draw (0,0) to[C=1<\farad>] (2,0); \par
\ctikzset{bipoles/thickness=4}
\tikz \draw (0,0) to[C=1<\farad>] (2,0);
```

3.1.2.3 Shape of the components (on a per-component-class basis)

The shape of the components are adjustable with a lot of parameters; in this manual we will comment the main ones, but you can look into the source files specified above to find more.

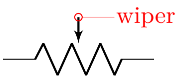



```
\tikz \draw (0,0) to[R=1<\ohm>] (2,0); \par
\ctikzset{bipoles/resistor/height=.6}
\tikz \draw (0,0) to[R=1<\ohm>] (2,0);
```

3.1.3 Descriptions

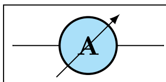
The typical entry in the component list will be like this:

`resistor`: resistor, american style, `type: path-style`, `nodename: resistorshape`. Aliases: `R`, `american resistor`.



`pR`: potentiometer, american style, `type: path-style`, `nodename: potentiometershape`. Aliases: `pR`, `american potentiometer`.

where you have all the needed information about the bipole, with also no-standard anchors. If the component can be filled it will be specified in the description. In addition, as an example, the component shown will be filled with the option `fill=cyan!30!white`:



`ammeter`: Ammeter, `type: path-style, fillable`, `nodename: ammetershape`.

3.2 Node-style components

Node-style components (monopoles, multipoles) can be drawn at a specified point with this syntax, where `#1` is the name of the component:

```
\begin{circuitikz}
    \draw (0,0) node[#1,#2] (#3) {#4};
\end{circuitikz}
```

Explanation of the parameters:
#1: component name[3] (mandatory)
#2: list of comma separated options (optional)
#3: name of an anchor (optional)
#4: text written to the text anchor of the component (optional)

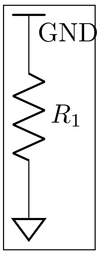
Most path-style components can be used as a node-style components; to access them, you add a `shape` to the main name of component (for example, `diodeshape`). Such a "node name" is specified in the description of each component.

> **Notice:** Nodes must have curly brackets at the end, even when empty. An optional anchor (`#3`) can be defined within round brackets to be addressed again later on. And please don't forget the semicolon to terminate the `\draw` command.

> **Also notice:** If using the `\tikzexternalize` feature, as of Ti*k*z 2.1 all pictures must end with `\end{tikzpicture}`. Thus you *cannot* use the `circuitikz` environment.
>
> Which is ok: just use the environment `tikzpicture`: everything will work there just fine.

3.2.1 Mirroring and flipping

Mirroring and flipping of node components is obtained by using the Ti*k*Z keys `xscale` and `yscale`. Notice that this parameters affect also text labels, so they need to be un-scaled by hand.



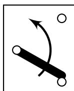

```
\begin{circuitikz}
   \draw (0,2)
      node[rground, yscale=-1] {%
      \scalebox{1}[-1]{ GND}}
      to[R=$R_1$] (0,0)
      node[sground] {};
\end{circuitikz}
```

3.2.2 Anchors

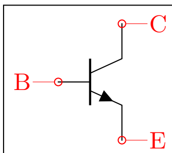
Node components anchors are variable across the various kind of components, so they will described better after each category is presented in the manual.

3.2.3 Descriptions

The typical entry in the component list will be like this:



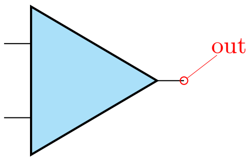
Cute spdt down with arrow, type: node (`node[cute spdt down arrow]{}`)



NPN, TYPE: NODE (`node[npn]{}`)

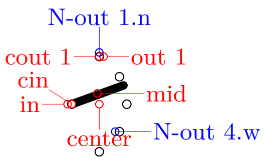
[3] For using bipoles as nodes, the name of the node is `#1shape`.

All the shapes defined by CircuiTi*k*Z. These are all `pgf` nodes, so they are usable in both `pgf` and Ti*k*Z. If the component can be filled it will be specified in the description. In addition, as an example, the component shown will be filled with the option `fill=cyan!30!white`:



Plain amplifier, type: node, fillable (`node[plain amp]{}`)

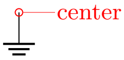
Sometime, components will expose internal (sub-)shapes that can be accessed with the syntax `<node name>-<internal node name>` (a dash is separating the node name and the internal node name); that will be shown in the description as a blue "anchor":



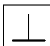
Rotary switch, type: node (`node[rotaryswitch](N){}`)

3.3 Grounds and supply voltages

For the grounds, the `center` anchor is put on the connecting point of the symbol, so that you can use them directly in a `path` specification.

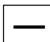


Ground, type: node (`node[ground]{}`)



Reference ground, type: node (`node[rground]{}`)

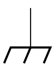
Signal ground, type: node, fillable (`node[sground]{}`)



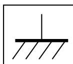
Thicker ground, type: node (`node[tground]{}`)

Noiseless ground, type: node (`node[nground]{}`)

Protective ground, type: node (`node[pground]{}`)

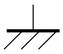


Chassis ground[4], type: node (`node[cground]{}`)



European style ground, type: node (`node[eground]{}`)

[4]These last three were contributed by Luigi «Liverpool»

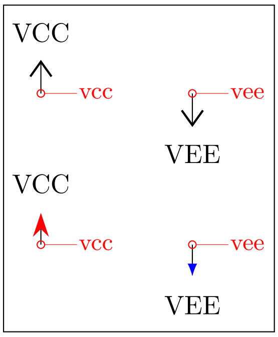
	European style ground, version 2[5], type: node (`node[eground2]{}`)

	VCC/VDD, type: node (`node[vcc]{}`)

	VEE/VSS, type: node (`node[vee]{}`)

3.3.1 Power supplies

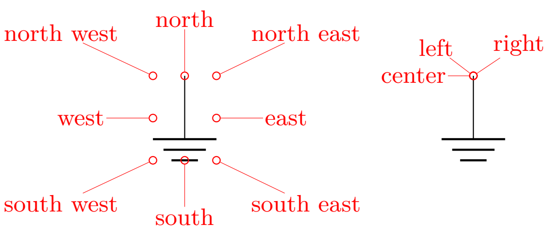
The power supplies are normally drawn with the arrows shown in the list above. You can change them using all the options of the `arrows.meta` package (see the Ti*k*Z manual for details) by changing the key `monopoles/vcc/arrow` and `monopoles/vee/arrow` (the default for both is `legacy`, which will use the old code for drawing them). Notes that the anchors are at the start of the connecting lines!



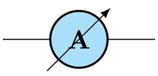

```
\begin{circuitikz}
    \def\coord(#1){\showcoord(#1)<0:0.3>}
    \draw (0,0)
    node[vcc](vcc){VCC} \coord(vcc) ++(2,0)
    node[vee](vee){VEE} \coord(vee);
    \ctikzset{monopoles/vcc/arrow={Stealth[red, width=6pt,
         length=9pt]}}
    \ctikzset{monopoles/vee/arrow={Latex[blue]}}
    \draw (0,-2)
    node[vcc](vcc){VCC} \coord(vcc) ++(2,0)
    node[vee](vee){VEE} \coord(vee);
\end{circuitikz}
```

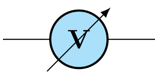
3.3.2 Grounds anchors

Anchors for grounds are a bit strange, given that they have the `center` spot at the same location than `north` and all the ground will develop “going down”:

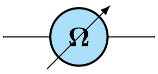


3.4 Instruments

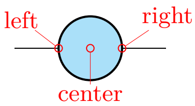
	`ammeter`: Ammeter, type: `path-style, fillable, nodename: ammetershape`.

	`voltmeter`: Voltmeter, type: `path-style, fillable, nodename: voltmetershape`.

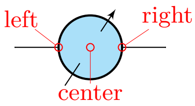
[5]These last two were contributed by `@fotesan`



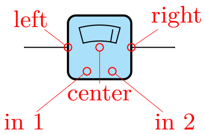
`ohmmeter`: Ohmmeter, type: `path-style, fillable,` nodename: `ohmmetershape`.



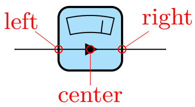
`rmeter`: Round meter (use `t=...` for the symbol), type: `path-style, fillable,` nodename: `rmetershape`.



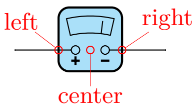
`rmeterwa`: Round meter with arrow (use `t=...` for the symbol), type: `path-style, fillable,` nodename: `rmeterwashape`.



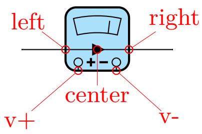
`smeter`: Square meter (use `t=...` for the symbol), type: `path-style, fillable,` nodename: `smetershape`.



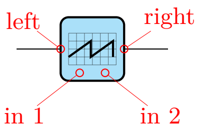
`qiprobe`: QUCS-style current probe, type: `path-style, fillable,` nodename: `qiprobeshape`.



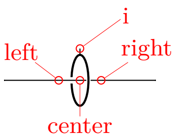
`qvprobe`: QUCS-style voltage probe, type: `path-style, fillable,` nodename: `qvprobeshape`.



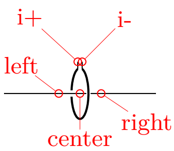
`qpprobe`: QUCS-style power probe, type: `path-style, fillable,` nodename: `qpprobeshape`.



`oscope`: Oscilloscope[6], type: `path-style, fillable,` nodename: `oscopeshape`.



`iloop`: Current loop (symbolic), type: `path-style,` nodename: `iloopshape`.

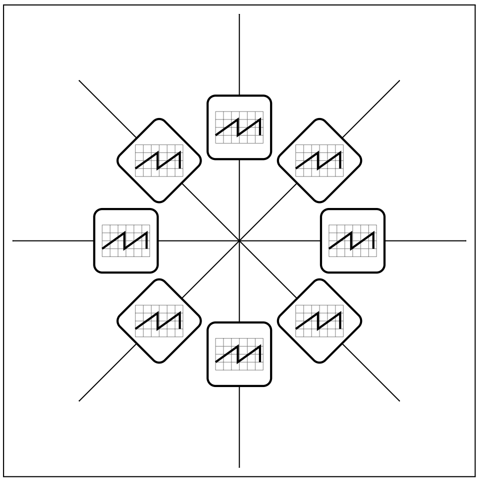


`iloop2`: Current loop (real), type: `path-style,` nodename: `iloop2shape`.

[6] Suggested by `@nobrl` on GitHub

3.4.1 Rotation-invariant elements

The `oscope` element will not rotate the "graph" shown with the component:

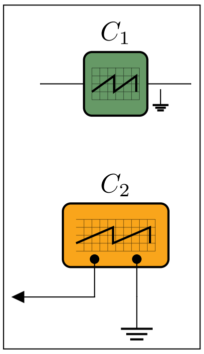


```
\begin{circuitikz}
    \foreach \a in {0,45,...,350} {
        \draw (0,0) to[oscope] (\a:3);
    }
\end{circuitikz}
```

The `rmeter`, `rmaterwa`, and `smeter` have the same behavior.

3.4.2 Instruments as node elements

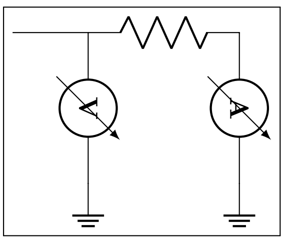
The node-style usage of the `oscope` is also interesting, using the additional `in 1` and `in 2` anchors; notice that in this case you can use the text content of the node to put labels above it. Moreover, you can change the size of the oscilloscope by changing `bipoles/oscope/width` and `bipoles/oscope/height` keys (which both default at 0.6).




```
\begin{circuitikz}
    \draw (0,1)
        to[oscope=$C_1$, fill=green!20!gray, name=O1] ++(2,0);
    \path (O1.right)
        node[ground, scale=0.5, below right=4pt]{};
    \ctikzset{bipoles/oscope/width=1.0}
    \draw (1,-1)
        node[oscopeshape, fill=yellow!20!orange](O2){$C_2$};
    \draw (O2.in 2) to[short, *-] ++(0,-0.5) node[ground]{};
    \draw (O2.in 1) to[short, *-] ++(0,-0.5)
           -- ++(-1,0) node[currarrow, xscale=-1]{};
\end{circuitikz}
```

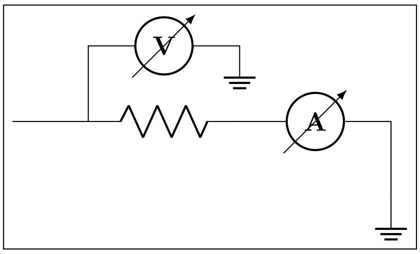
3.4.3 Measuring voltage and currents, multiple ways

This is the classical (legacy) option, with the `voltmeter` and `ammeter`. The problem is that elements are intrinsically horizontal and so they looks funny if put in vertical way.



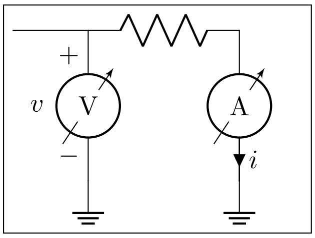
```
\begin{circuitikz}
    \draw (0,0) -- ++(1,0) to[R] ++(2,0)
    to [ammeter] ++(0,-2) node[ground]{};
    \draw (1,0) to[voltmeter] ++(0,-2)
    node[ground]{};
\end{circuitikz}
```

So the solution is often changing the structure to keep the meters in horizontal position.



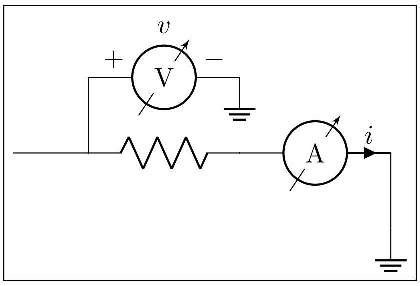

```
\begin{circuitikz}
    \draw (0,0) -- ++(1,0) to[R] ++(2,0)
    to [ammeter] ++(2,0) --
    ++(0,-1) node[ground]{};
    \draw (1,0) -- (1,1) to[voltmeter]
    ++(2,0) node[ground]{};
\end{circuitikz}
```

Since version 0.9.0 you have more options for the measuring instruments. You can use the generic `rmeterwa` (round meter with arrow), to which you can specify the internal symbol with the option `t=...` (and is fillable).



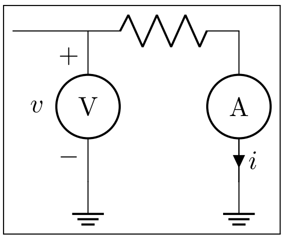

```
    \begin{circuitikz}[american]
    \draw (0,0) -- ++(1,0) to[R] ++(2,0)
    to [rmeterwa, t=A, i=$i$] ++(0,-2) node[ground]{};
    \draw (1,0) to[rmeterwa, t=V, v=$v$] ++(0,-2)
    node[ground]{};
\end{circuitikz}
```

This kind of component will keep the symbol horizontal, whatever the orientation:



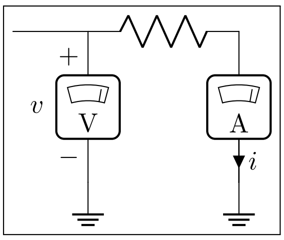

```
    \begin{circuitikz}[american]
    \draw (0,0) -- ++(1,0) to[R] ++(2,0)
    to [rmeterwa, t=A, i=$i$] ++(2,0) --
    ++(0,-1) node[ground]{};
    \draw (1,0) -- (1,1) to[rmeterwa, t=V, v^=$v$]
    ++(2,0) node[ground]{};
\end{circuitikz}
```

The plain `rmeter` is the same, without the measuring arrow:




```
\begin{circuitikz}[american]
    \draw (0,0) -- ++(1,0) to[R] ++(2,0)
    to [rmeter, t=A, i=$i$] ++(0,-2) node[ground]{};
    \draw (1,0) to[rmeter, t=V, v=$v$] ++(0,-2)
    node[ground]{};
\end{circuitikz}
```

If you prefer it, you have the option to use square meters, in order to have more visual difference from generators:

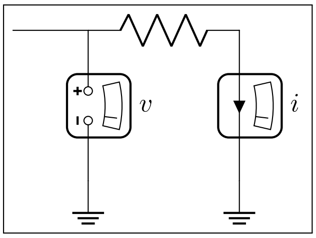



```
\begin{circuitikz}[american]
    \draw (0,0) -- ++(1,0) to[R] ++(2,0)
    to [smeter, t=A, i=$i$] ++(0,-2) node[ground]{};
    \draw (1,0) to[smeter, t=V, v=$v$] ++(0,-2)
    node[ground]{};
\end{circuitikz}
```

Another possibility is to use QUCS[7]-style probes, which have the nice property of explictly showing

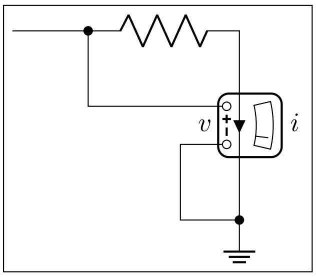
[7]QUCS is an open source circuit simulator: http://qucs.sourceforge.net/

the type of connection (in series or parallel) of the meter:



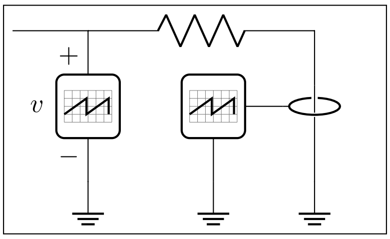

```
\begin{circuitikz}[american]
    \draw (0,0) -- ++(1,0) to[R] ++(2,0)
    to [qiprobe, l=$i$] ++(0,-2) node[ground]{};
    \draw (1,0) to[qvprobe, l=$v$] ++(0,-2)
    node[ground]{};
\end{circuitikz}
```

If you want to explicitly show a power measurement, you can use the power probe `qpprobe` and using the additional anchors `v+` and `v-` :




```
\begin{circuitikz}[american]
    \draw (0,0) to[short,-*] ++(1,0) coordinate(b)
    to[R] ++(2,0) to [qpprobe, l=$i$, a=$v$, name=P]
    ++(0,-2.5) node[ground](GND){};
    \draw (P.v-) -| ++(-0.5,-1) coordinate(a)
    to [short, -*] (a-|GND);
    \draw (P.v+) -| (b);
\end{circuitikz}
```

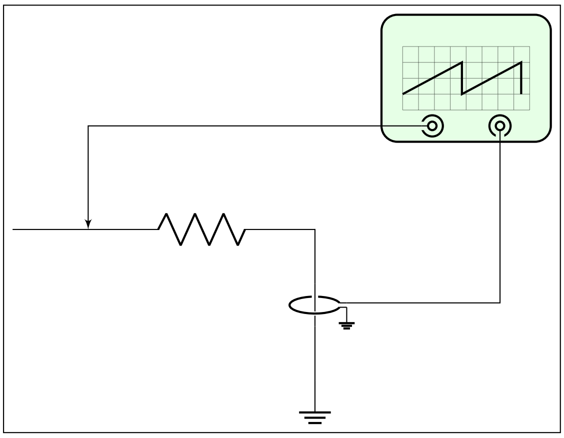
The final possibility is to use oscilloscopes. For example:



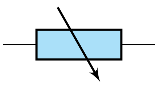
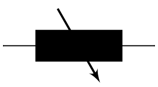
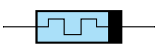

```
\begin{circuitikz}[american]
    \draw (0,0) -- ++(1,0) to[R] ++(3,0)
    to [iloop, mirror, name=I] ++(0,-2)
    node[ground] (GND){};
    \draw (1,0) to[oscope, v=$v$] ++(0,-2)
    node[ground]{};
    \draw (I.i) -- ++(-0.5,0) node[oscopeshape,
        anchor=right, name=O]{};
    \draw (O.south) -- (O.south |- GND) node[
        ground]{};
\end{circuitikz}
```

Or, if you want a more physical structure for the measurement setup:

```
\begin{circuitikz}[american]
   \draw (0,0) -- ++(1,0) to[R] ++(3,0) to [iloop2, name=I] ++(0,-2)
   node[ground] (GND){};
   \ctikzset{bipoles/oscope/width=1.6}\ctikzset{bipoles/oscope/height=1.2}
   \node [oscopeshape, fill=green!10](O) at (6,2){};
   \node [bnc, xscale=-1, anchor=zero](bnc1) at (O.in 1){};
   \node [bnc, , anchor=zero, rotate=-90](bnc2) at (O.in 2){};
   \draw [-latexslim] (bnc1.hot) -| (1,0);
   \draw (bnc2.hot) |- (I.i+);
   \draw (I.i-) node[ground, scale=0.5]{};
\end{circuitikz}
```



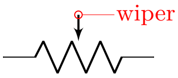
3.5 Resistive bipoles

	short: Short circuit, type: path-style, nodename: shortshape.
	open: Open circuit, type: path-style, nodename: openshape.
	**generic**: Generic (symmetric) bipole, type: path-style, fillable, nodename: genericshape.
	**tgeneric**: Tunable generic bipole, type: path-style, fillable, nodename: tgenericshape.
	**ageneric**: Generic asymmetric bipole, type: path-style, fillable, nodename: agenericshape.
	**fullgeneric**: Generic asymmetric bipole (full), type: path-style, nodename: fullgenericshape.
	**tfullgeneric**: Tunable generic bipole (full), type: path-style, nodename: tfullgenericshape.
	**memristor**: Memristor, type: path-style, fillable, nodename: memristorshape. Aliases: Mr.

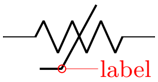
If `americanresistors` option is active (or the style `[american resistors]` is used; this is the default for the package), the resistors are displayed as follows:

`R`: Resistor, `type: path-style, nodename: resistorshape`. Aliases: `american resistor`.

`vR`: Variable resistor, `type: path-style, nodename: vresistorshape`. Aliases: `variable american resistor`.



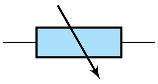
`pR`: Potentiometer, `type: path-style, nodename: potentiometershape`. Aliases: `american potentiometer`.



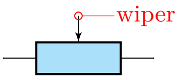
`sR`: Resisitive sensor, `type: path-style, nodename: resistivesensshape`. Aliases: `american resisitive sensor`.

If instead `europeanresistors` option is active (or the style `[european resistors]` is used), the resistors, variable resistors and potentiometers are displayed as follows:

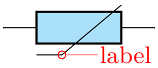
`R`: Resistor, `type: path-style, fillable, nodename: genericshape`. Aliases: `european resistor`.



`vR`: Variable resistor, `type: path-style, fillable, nodename: tgenericshape`. Aliases: `variable european resistor`.

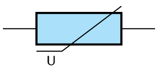


`pR`: Potentiometer, `type: path-style, fillable, nodename: genericpotentiometershape`. Aliases: `european potentiometer`.

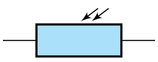


`sR`: Resistive sensor, `type: path-style, fillable, nodename: thermistorshape`. Aliases: `european resistive sensor`.

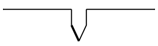
Other miscellaneous resistor-like devices:



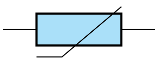
`varistor`: Varistor, `type: path-style, fillable, nodename: varistorshape`.



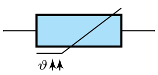
`phR`: Photoresistor, `type: path-style, fillable, nodename: photoresistorshape`. Aliases: `photoresistor`.



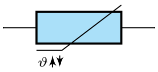
`thermocouple`: Thermocouple, `type: path-style, nodename: thermocoupleshape`.



`thR`: Thermistor, `type: path-style, fillable, nodename: thermistorshape`. Aliases: `thermistor`.



`thRp`: PTC thermistor, `type: path-style, fillable, nodename: thermistorptcshape`. Aliases: `thermistor ptc`.



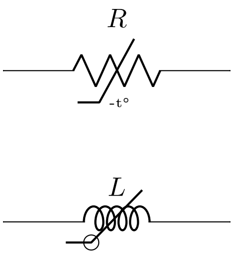
thRn: NTC thermistor, `type: path-style, fillable, nodename: thermistorntcshape`. Aliases: `thermistor ntc`.

fuse: Fuse, `type: path-style, fillable, nodename: fuseshape`.

afuse: Asymmetric fuse, `type: path-style, fillable, nodename: afuseshape`. Aliases: `asymmetric fuse`.

3.5.1 Generic sensors anchors

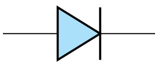
Generic sensors have an extra label to help positioning the type of dependence, if needed:



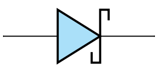

```
\begin{circuitikz}
  \draw (0,2) to[sR, l=$R$, name=mySR] ++(3,0);
  \node [font=\tiny, right] at(mySR.label) {-t\si{\degree
      }};
  \draw (0,0) to[sL, l=$L$, name=mySL] ++(3,0);
  \node [draw, circle, inner sep=2pt] at(mySL.label) {};
\end{circuitikz}
```

The anchor is positioned just on the corner of the segmented line crossing the component.

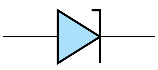
3.6 Diodes and such



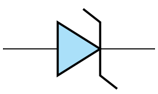
empty diode: Empty diode, `type: path-style, fillable, nodename: emptydiodeshape`. Aliases: `Do`.



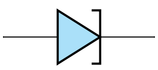
empty Schottky diode: Empty Schottky diode, `type: path-style, fillable, nodename: emptysdiodeshape`. Aliases: `sDo`.



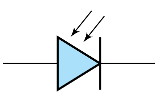
empty Zener diode: Empty Zener diode, `type: path-style, fillable, nodename: emptyzdiodeshape`. Aliases: `zDo`.



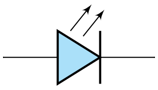
empty ZZener diode: Empty ZZener diode, `type: path-style, fillable, nodename: emptyzzdiodeshape`. Aliases: `zzDo`.



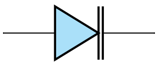
empty tunnel diode: Empty tunnel diode, `type: path-style, fillable, nodename: emptytdiodeshape`. Aliases: `tDo`.



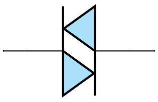
empty photodiode: Empty photodiode, `type: path-style, fillable, nodename: emptypdiodeshape`. Aliases: `pDo`.



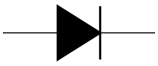
`empty led`: Empty led, `type: path-style, fillable, nodename: emptylediodeshape.` Aliases: `leDo`.



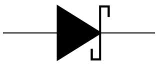
`empty varcap`: Empty varcap, `type: path-style, fillable, nodename: emptyvarcapshape.` Aliases: `VCo`.



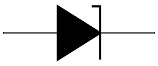
`empty bidirectionaldiode`: Empty bidirectionaldiode, `type: path-style, fillable, nodename: emptybidirectionaldiodeshape.` Aliases: `biDo`.



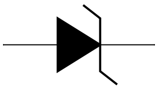
`full diode`: Full diode, `type: path-style, nodename: fulldiodeshape.` Aliases: `D*`.



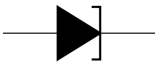
`full Schottky diode`: Full Schottky diode, `type: path-style, nodename: fullsdiodeshape.` Aliases: `sD*`.



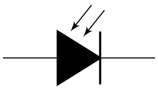
`full Zener diode`: Full Zener diode, `type: path-style, nodename: fullzdiodeshape.` Aliases: `zD*`.



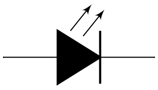
`full ZZener diode`: Full ZZener diode, `type: path-style, nodename: fullzzdiodeshape.` Aliases: `zzD*`.



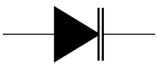
`full tunnel diode`: Full tunnel diode, `type: path-style, nodename: fulltdiodeshape.` Aliases: `tD*`.



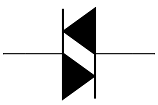
`full photodiode`: Full photodiode, `type: path-style, nodename: fullpdiodeshape.` Aliases: `pD*`.



`full led`: Full led, `type: path-style, nodename: fulllediodeshape.` Aliases: `leD*`.

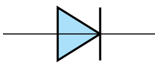


`full varcap`: Full varcap, `type: path-style, nodename: fullvarcapshape.` Aliases: `VC*`.

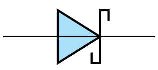


`full bidirectionaldiode`: Full bidirectionaldiode, `type: path-style, nodename: fullbidirectionaldiodeshape.` Aliases: `biD*`.

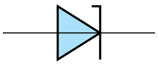
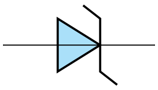
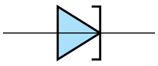
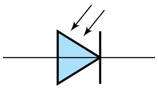
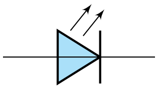
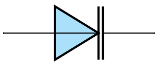
These shapes have no exact node-style counterpart, because the stroke line is built upon the empty variants:



`stroke diode`: Stroke diode, `type: path-style, fillable, nodename: emptydiodeshape.` Aliases: `D-`.

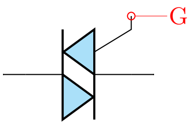
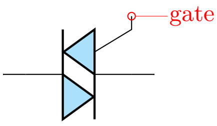
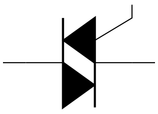
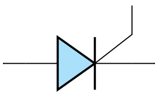
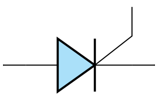
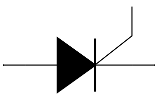


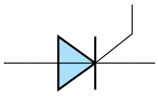
`stroke Schottky diode`: Stroke Schottky diode, `type: path-style, fillable, nodename: emptysdiodeshape.` Aliases: `sD-`.

	**`stroke Zener diode`**: Stroke Zener diode, `type: path-style, fillable, nodename: emptyzdiodeshape`. Aliases: `zD-`.
	**`stroke ZZener diode`**: Stroke ZZener diode, `type: path-style, fillable, nodename: emptyzzdiodeshape`. Aliases: `zzD-`.
	**`stroke tunnel diode`**: Stroke tunnel diode, `type: path-style, fillable, nodename: emptytdiodeshape`. Aliases: `tD-`.
	**`stroke photodiode`**: Stroke photodiode, `type: path-style, fillable, nodename: emptypdiodeshape`. Aliases: `pD-`.
	**`stroke led`**: Stroke led, `type: path-style, fillable, nodename: emptylediodeshape`. Aliases: `leD-`.
	**`stroke varcap`**: Stroke varcap, `type: path-style, fillable, nodename: emptyvarcapshape`. Aliases: `VC-`.

3.7 Tripole-like diodes

The following tripoles are entered with the usual command, of the form

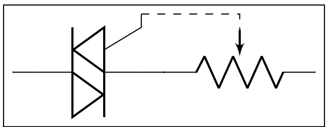
	**`triac`**: Standard triac (shape depends on package option), `type: path-style, fillable, nodename: emptytriacshape`. Aliases: `Tr`.
	**`empty triac`**: Empty triac, `type: path-style, fillable, nodename: emptytriacshape`. Aliases: `Tro`.
	**`full triac`**: Full triac, `type: path-style, nodename: fulltriacshape`. Aliases: `Tr*`.
	**`thyristor`**: Standard thyristor (shape depends on package option), `type: path-style, fillable, nodename: emptythyristorshape`. Aliases: `Ty`.
	**`empty thyristor`**: Empty thyristor, `type: path-style, fillable, nodename: emptythyristorshape`. Aliases: `Tyo`.
	**`full thyristor`**: Full thyristor, `type: path-style, nodename: fullthyristorshape`. Aliases: `Ty*`.



stroke thyristor: Stroke thyristor, type: path-style, fillable, nodename: emptythyristorshape. Aliases: Ty-.

3.7.1 Triacs anchors

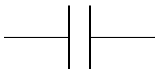
When inserting a thrystor, a triac or a potentiometer, one needs to refer to the third node-gate (gate or G) for the former two; wiper (wiper or W) for the latter one. This is done by giving a name to the bipole:



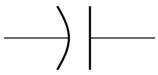
```
\begin{circuitikz} \draw
  (0,0) to[Tr, n=TRI] (2,0)
        to[pR, n=POT] (4,0);
  \draw[dashed] (TRI.G) -| (POT.wiper)
;\end{circuitikz}
```

The package options fulldiode, strokediode, and emptydiode (and the styles [full diodes], [stroke diodes], and [empty diodes]) define which shape will be used by abbreviated commands such that D, sD, zD, zzD, tD, pD, leD, VC, Ty,Tr (no stroke symbol available!).

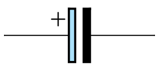
3.8 Capacitors and inductors: dynamical bipoles



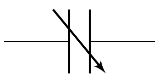
capacitor: Capacitor, type: path-style, nodename: capacitorshape. Aliases: C.



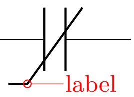
polar capacitor: Polar capacitor, type: path-style, nodename: polarcapacitorshape. Aliases: pC.



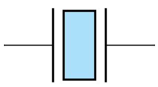
ecapacitor: Electrolytic capacitor, type: path-style, fillable, nodename: ecapacitorshape. Aliases: eC,elko.



variable capacitor: Variable capacitor, type: path-style, nodename: vcapacitorshape. Aliases: vC.

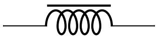
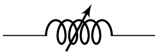
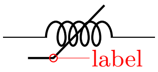


capacitive sensor: Capacitive sensor, type: path-style, nodename: capacitivesensshape. Aliases: sC.

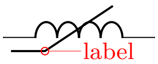


piezoelectric: Piezoelectric Element, type: path-style, fillable, nodename: piezoelectricshape. Aliases: PZ.

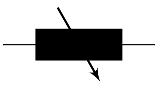
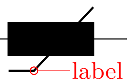
If (default behaviour) cuteinductors option is active (or the style [cute inductors] is used), the inductors are displayed as follows:

	`L`: Inductor, type: `path-style`, nodename: `cuteinductorshape`. Aliases: `cute inductor`.
	`cute choke`: Choke, type: `path-style`, nodename: `cutechokeshape`.
	`vL`: Variable inductor, type: `path-style`, nodename: `vcuteinductorshape`. Aliases: `variable cute inductor`.
	`sL`: Inductive sensor, type: `path-style`, nodename: `scuteinductorshape`. Aliases: `cute inductive sensor`.

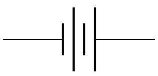
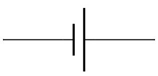
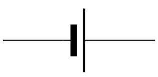
If `americaninductors` option is active (or the style `[american inductors]` is used), the inductors are displayed as follows:

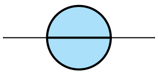
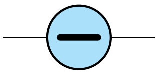
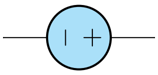
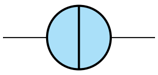
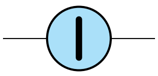
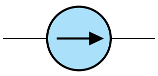
	`L`: Inductor, type: `path-style`, nodename: `americaninductorshape`. Aliases: `american inductor`.
	`vL`: Variable inductor, type: `path-style`, nodename: `vamericaninductorshape`. Aliases: `variable american inductor`.
	`sL`: Inductive sensor, type: `path-style`, nodename: `samericaninductorshape`. Aliases: `american inductive sensor`.

Finally, if `europeaninductors` option is active (or the style `[european inductors]` is used), the inductors are displayed as follows:

	`L`: Inductor, type: `path-style`, nodename: `fullgenericshape`. Aliases: `european inductor`.
	`vL`: Variable inductor, type: `path-style`, nodename: `tfullgenericshape`. Aliases: `variable european inductor`.
	`sL`: Inductive sensor, type: `path-style`, nodename: `sfullgenericshape`. Aliases: `european inductive sensor`.

3.9 Stationary sources

	`battery`: Battery, type: `path-style`, nodename: `batteryshape`.
	`battery1`: Single battery cell, type: `path-style`, nodename: `battery1shape`.
	`battery2`: Single battery cell, type: `path-style`, nodename: `battery2shape`.

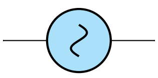
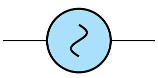
	`european voltage source`: Voltage source (european style), `type: path-style, fillable, nodename: vsourceshape`.
	`cute european voltage source`: Voltage source (cute european style), `type: path-style, fillable, nodename: vsourceCshape`. Aliases: `vsourceC, ceV`.
	`american voltage source`: Voltage source (american style), `type: path-style, fillable, nodename: vsourceAMshape`.
	`european current source`: Current source (european style), `type: path-style, fillable, nodename: isourceshape`.
	`cute european current source`: Current source (cute european style), `type: path-style, fillable, nodename: isourceCshape`. Aliases: `isourceC, ceI`.
	`american current source`: Current source (american style), `type: path-style, fillable, nodename: isourceAMshape`.

If (default behaviour) `europeancurrents` option is active (or the style `[european currents]` is used), the shorthands `current source`, `isource`, and `I` are equivalent to `european current source`. Otherwise, if `americancurrents` option is active (or the style `[american currents]` is used) they are equivalent to `american current source`.

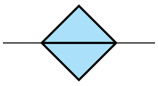
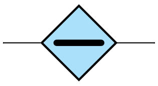
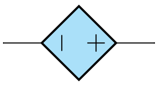
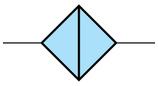
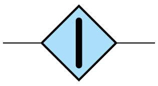
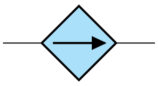
Similarly, if (default behaviour) `europeanvoltages` option is active (or the style `[european voltages]` is used), the shorthands `voltage source`, `vsource`, and `V` are equivalent to `european voltage source`. Otherwise, if `americanvoltages` option is active (or the style `[american voltages]` is used) they are equivalent to `american voltage source`.

3.10 Sinusoidal sources

Here because I was asked for them. But how do you distinguish one from the other?!

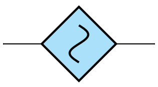
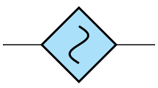
	`sinusoidal voltage source`: Sinusoidal voltage source, `type: path-style, fillable, nodename: vsourcesinshape`. Aliases: `vsourcesin, sV`.
	`sinusoidal current source`: Sinusoidal current source, `type: path-style, fillable, nodename: isourcesinshape`. Aliases: `isourcesin, sI`.

3.11 Controlled sources

	**european controlled voltage source**: Controlled voltage source (european style), `type: path-style, fillable, nodename: cvsourceshape`.
	**cute european controlled voltage source**: Voltage source (cute european style), `type: path-style, fillable, nodename: cvsourceCshape`. Aliases: `cvsourceC, cceV`.
	**american controlled voltage source**: Controlled voltage source (american style), `type: path-style, fillable, nodename: cvsourceAMshape`.
	**european controlled current source**: Controlled current source (european style), `type: path-style, fillable, nodename: cisourceshape`.
	**cute european controlled current source**: Current source (cute european style), `type: path-style, fillable, nodename: cisourceCshape`. Aliases: `cisourceC, cceI`.
	**american controlled current source**: Controlled current source (american style), `type: path-style, fillable, nodename: cisourceAMshape`.

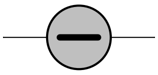
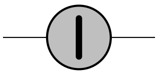
If (default behaviour) `europeancurrents` option is active (or the style `[european currents]` is used), the shorthands `controlled current source`, `cisource`, and `cI` are equivalent to `european controlled current source`. Otherwise, if `americancurrents` option is active (or the style `[american currents]` is used) they are equivalent to `american controlled current source`.

Similarly, if (default behaviour) `europeanvoltages` option is active (or the style `[european voltages]` is used), the shorthands `controlled voltage source`, `cvsource`, and `cV` are equivalent to `european controlled voltage source`. Otherwise, if `americanvoltages` option is active (or the style `[american voltages]` is used) they are equivalent to `american controlled voltage source`.

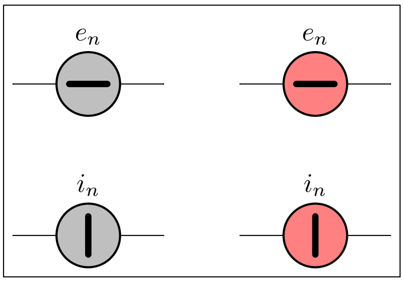
	**controlled sinusoidal voltage source**: Controlled sinusoidal voltage source, `type: path-style, fillable, nodename: cvsourcesinshape`. Aliases: `controlled vsourcesin, cvsourcesin, csV`.
	**controlled sinusoidal current source**: Controlled sinusoidal current source, `type: path-style, fillable, nodename: cisourcesinshape`. Aliases: `controlled isourcesin, cisourcesin, csI`.

3.12 Noise sources

In this case, the “direction” of the source is undefined. Noise sources are filled in gray by default, but if you choose the dashed style, they become fillable.

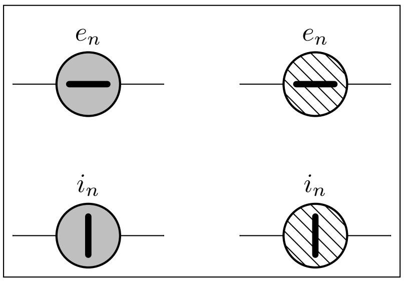
	`noise voltage source`: Sinusoidal voltage source, `type: path-style`, `nodename: vsourceNshape`. Aliases: `vsourceN`, `nV`.
	`noise current source`: Sinusoidal current source, `type: path-style`, `nodename: isourceNshape`. Aliases: `isourceN`, `nI`.

You can change the fill color with the key `circuitikz/bipoles/noise sources/fillcolor`:



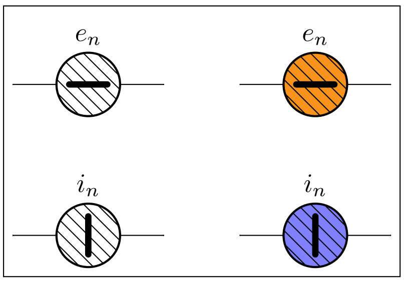

```
\begin{circuitikz}
    \draw(0,0) to [nV, l=$e_n$] ++(2,0);
    \draw(0,-2) to [nI, l=$i_n$] ++(2,0);
    \begin{scope}[circuitikz/bipoles/noise sources/fillcolor=red!50]
        \draw(3,0) to [nV, l=$e_n$] ++(2,0);
        \draw(3,-2) to [nI, l=$i_n$] ++(2,0);
    \end{scope}
\end{circuitikz}
```

If you prefer a patterned noise generator (similar to the one you draw by hand) you can use the fake color `dashed`:



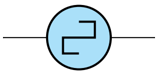
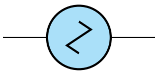
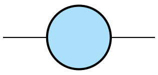
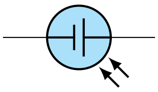
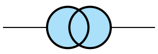
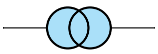

```
\begin{circuitikz}
    \draw(0,0) to [nV, l=$e_n$] ++(2,0);
    \draw(0,-2) to [nI, l=$i_n$] ++(2,0);
    \begin{scope}[circuitikz/bipoles/noise sources/fillcolor=dashed]
        \draw(3,0) to [nV, l=$e_n$] ++(2,0);
        \draw(3,-2) to [nI, l=$i_n$] ++(2,0);
    \end{scope}
\end{circuitikz}
```

Notice that if you choose the dashed style, the noise sources are fillable:

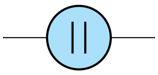
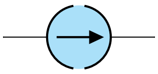



```
\begin{circuitikz}
    \ctikzset{bipoles/noise sources/fillcolor=dashed}
    \draw(0,0) to [nV, l=$e_n$] ++(2,0);
    \draw(0,-2) to [nI, l=$i_n$] ++(2,0);
    \begin{scope}
        \draw(3,0) to [nV, l=$e_n$, fill=yellow!50!red] ++(2,0);
        \draw(3,-2) to [nI, l=$i_n$, fill=blue!50!white] ++(2,0);
    \end{scope}
\end{circuitikz}
```

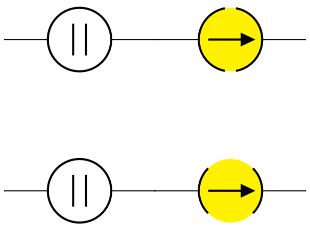
3.13 Special sources

	**`square voltage source`**: Square voltage source, `type: path-style, fillable, nodename: vsourcesquareshape`. Aliases: `vsourcesquare, sqV`.
	**`vsourcetri`**: Triangle voltage source, `type: path-style, fillable, nodename: vsourcetrishape`. Aliases: `tV`.
	**`esource`**: Empty voltage source, `type: path-style, fillable, nodename: esourceshape`.
	**`pvsource`**: Photovoltaic-voltage source, `type: path-style, fillable, nodename: pvsourceshape`.
	**`ioosource`**: Double Zero style current source, `type: path-style, fillable, nodename: oosourceshape`.
	**`voosource`**: Double Zero style voltage source, `type: path-style, fillable, nodename: oosourceshape`.

3.14 DC sources

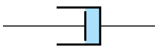
	**`dcvsource`**: DC voltage source, `type: path-style, fillable, nodename: dcvsourceshape`.
	**`dcisource`**: DC current source, `type: path-style, fillable, nodename: dcisourceshape`.

The size of the broken part of the DC current source is configurable by changing the value of `bipoles/dcisource/angle` (default 80); values must be between 0 (no circle at all, probably not useful) and 90 (full circle, again not useful).

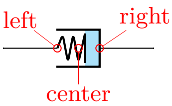


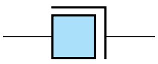
```
\begin{circuitikz}
    \draw (0,0) to[dcvsource] ++(2,0)
    to [dcisource, fill=yellow] ++(2,0) ;
    \ctikzset{bipoles/dcisource/angle=45}
    \draw (0,-2) to[dcvsource] ++(2,0)
    to [dcisource, fill=yellow] ++(2,0) ;
\end{circuitikz}
```

3.15 Mechanical Analogy

	`damper`: Mechanical Damping, `type: path-style, fillable, nodename: dampershape.`

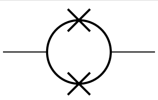
	`spring`: Mechanical Stiffness, `type: path-style, nodename: springshape.`

	`viscoe`: Mechanical viscoelastic element[8], `type: path-style, fillable, nodename: viscoeshape.`

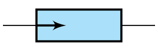
	`mass`: Mechanical Mass, `type: path-style, fillable, nodename: massshape.`

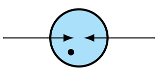
3.16 Other bipoles

Here you'll find bipoles that are not easily grouped in the categories above.

	`squid`: Squid, `type: path-style, nodename: squidshape.`

	`barrier`: Barrier, `type: path-style, nodename: barriershape.`

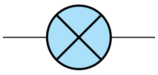
	`european gas filled surge arrester`: European gas filled surge arrester, `type: path-style, fillable, nodename: european gas filled surge arrestershape.`

	`american gas filled surge arrester`: American gas filled surge arrester, `type: path-style, fillable, nodename: american gas filled surge arrestershape.`

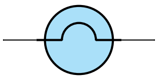
If (default behaviour) `europeangfsurgearrester` option is active (or the style `[european gas filled surge arrester]` is used), the shorthands `gas filled surge arrester` and `gf surge arrester` are equivalent to the european version of the component.

If otherwise `americangfsurgearrester` option is active (or the style `[american gas filled surge arrester]` is used), the shorthands the shorthands `gas filled surge arrester` and `gf surge arrester` are equivalent to the american version of the component.

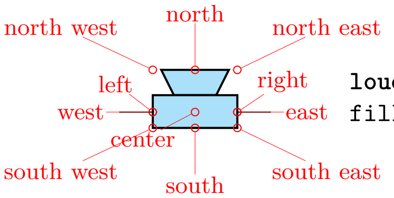
[8]Suggested by @Alex in https://tex.stackexchange.com/q/484268/38080



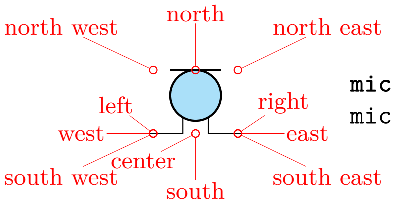
`lamp`: Lamp, `type: path-style, fillable, nodename: lampshape`.



`bulb`: Bulb, `type: path-style, fillable, nodename: bulbshape`.

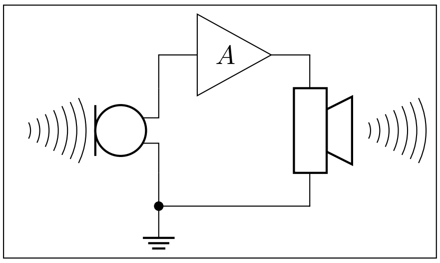


`loudspeaker`: loudspeaker, `type: path-style, fillable, nodename: loudspeakershape`.



`mic`: mic, `type: path-style, fillable, nodename: micshape`.

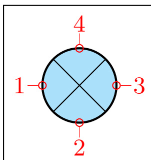
You can use microphones and loudspeakers with `waves` (see section 3.24) too:



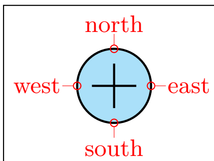

```
\begin{circuitikz}
    \draw (0,0) to[mic, name=M] ++(0,2)
    to[amp, t=$A$] ++(2,0)
    to[loudspeaker, name=L] ++(0,-2)
    to[short, -*] (0,0) node[ground]{};
    \node [waves, scale=0.7, left=5pt]
        at(M.north) {};
    \node [waves, scale=0.7, right]
        at(L.north) {};
\end{circuitikz}
```

3.17 Block diagram components

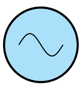
Contributed by Stefan Erhardt.



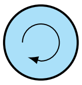
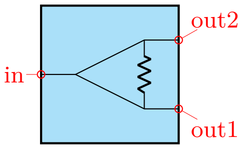
mixer, type: node, fillable (`node[mixer]{}`)

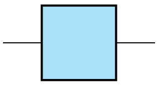
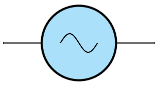
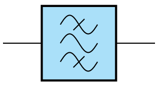
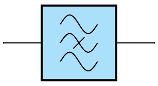
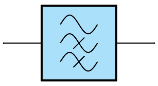
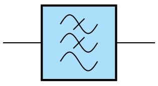
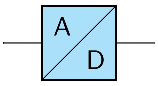
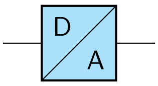
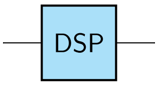
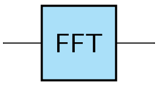
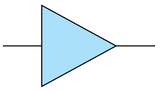
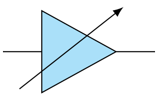


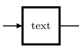
adder, type: node, fillable (`node[adder]{}`)

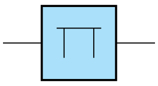
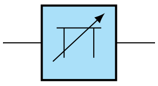
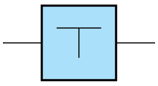
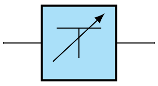
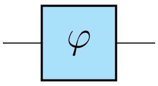
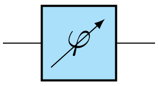
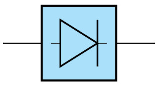


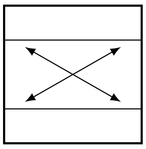
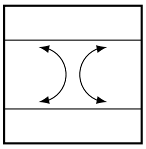
oscillator, type: node, fillable (`node[oscillator]{}`)

	circulator, type: node, fillable (`node[circulator]{}`)
	wilkinson divider, type: node, fillable (`node[wilkinson]{}`)

	**`twoport`**: generic two port[9], type: `path-style, fillable, nodename: twoportshape.`
	**`vco`**: vco, type: `path-style, fillable, nodename: vcoshape.`
	**`bandpass`**: bandpass, type: `path-style, fillable, nodename: bandpassshape.`
	**`bandstop`**: bandstop, type: `path-style, fillable, nodename: bandstopshape.`
	**`highpass`**: highpass, type: `path-style, fillable, nodename: highpassshape.`
	**`lowpass`**: lowpass, type: `path-style, fillable, nodename: lowpassshape.`
	**`adc`**: A/D converter, type: `path-style, fillable, nodename: adcshape.`
	**`dac`**: D/A converter, type: `path-style, fillable, nodename: dacshape.`
	**`dsp`**: DSP, type: `path-style, fillable, nodename: dspshape.`
	**`fft`**: FFT, type: `path-style, fillable, nodename: fftshape.`
	**`amp`**: amplifier, type: `path-style, fillable, nodename: ampshape.`
	**`vamp`**: VGA, type: `path-style, fillable, nodename: vampshape.`

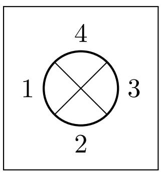
[9]To specify text to be put in the component: `twoport[t=text]`): 

	`piattenuator`: π attenuator, `type: path-style, fillable, nodename: piattenuatorshape`.
	`vpiattenuator`: var. π attenuator, `type: path-style, fillable, nodename: vpiattenuatorshape`.
	`tattenuator`: T attenuator, `type: path-style, fillable, nodename: tattenuatorshape`.
	`vtattenuator`: var. T attenuator, `type: path-style, fillable, nodename: vtattenuatorshape`.
	`phaseshifter`: phase shifter, `type: path-style, fillable, nodename: phaseshiftershape`.
	`vphaseshifter`: var. phase shifter, `type: path-style, fillable, nodename: vphaseshiftershape`.
	`detector`: detector, `type: path-style, fillable, nodename: detectorshape`.

	Coupler, type: node (`node[coupler]{}`)
	Coupler, 2, type: node (`node[coupler2]{}`)

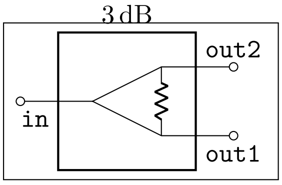
3.17.1 Blocks anchors

The ports of the mixer and adder can be addressed with numbers or `west`/`south`/`east`/`north`:



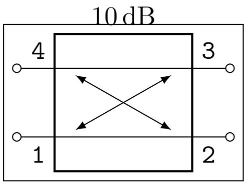

```
\begin{circuitikz} \draw
 (0,0) node[mixer] (mix) {}
 (mix.1) node[left] {1}
 (mix.2) node[below] {2}
 (mix.3) node[right] {3}
 (mix.4) node[above] {4}
;\end{circuitikz}
```

The Wilkinson divider has:

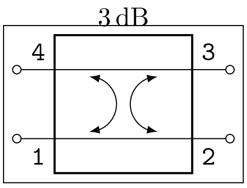



```
\begin{circuitikz} \draw
  (0,0) node[wilkinson] (w) {\SI{3}{dB}}
  (w.in) to[short,-o] ++(-0.5,0)
  (w.out1) to[short,-o] ++(0.5,0)
  (w.out2) to[short,-o] ++(0.5,0)
  (w.in) node[below left] {\texttt{in}}
  (w.out1) node[below right] {\texttt{out1}}
  (w.out2) node[above right] {\texttt{out2}}
  ;
\end{circuitikz}
```

The couplers have:




```
\begin{circuitikz} \draw
  (0,0) node[coupler] (c) {\SI{10}{dB}}
  (c.1) to[short,-o] ++(-0.5,0)
  (c.2) to[short,-o] ++(0.5,0)
  (c.3) to[short,-o] ++(0.5,0)
  (c.4) to[short,-o] ++(-0.5,0)
  (c.1) node[below left] {\texttt{1}}
  (c.2) node[below right] {\texttt{2}}
  (c.3) node[above right] {\texttt{3}}
  (c.4) node[above left] {\texttt{4}}
  ;
\end{circuitikz}
```




```
\begin{circuitikz} \draw
  (0,0) node[coupler2] (c) {\SI{3}{dB}}
  (c.1) to[short,-o] ++(-0.5,0)
  (c.2) to[short,-o] ++(0.5,0)
  (c.3) to[short,-o] ++(0.5,0)
  (c.4) to[short,-o] ++(-0.5,0)
  (c.1) node[below left] {\texttt{1}}
  (c.2) node[below right] {\texttt{2}}
  (c.3) node[above right] {\texttt{3}}
  (c.4) node[above left] {\texttt{4}}
  ;
\end{circuitikz}
```

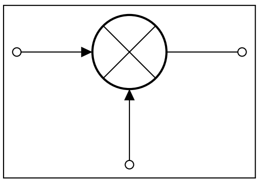
3.17.2 Blocks customization

With the option `>` you can draw an arrow to the input of the block diagram symbols.


```
\begin{circuitikz} \draw
  (0,0) to[short,o-] ++(0.3,0)
  to[lowpass,>] ++(2,0)
  to[adc,>] ++(2,0)
  to[short,-o] ++(0.3,0);
\end{circuitikz}
```

3.17.2.1 Multi ports

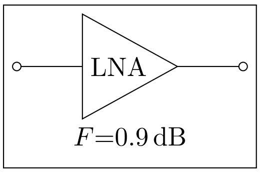
Since inputs and outputs can vary, input arrows can be placed as nodes. Note that you have to rotate the arrow on your own:



```
\begin{circuitikz} \draw
  (0,0) node[mixer] (m) {}
  (m.1) to[short,-o] ++(-1,0)
  (m.2) to[short,-o] ++(0,-1)
  (m.3) to[short,-o] ++(1,0)
  (m.1) node[inputarrow] {}
  (m.2) node[inputarrow,rotate=90] {};
\end{circuitikz}
```

3.17.2.2 Labels and custom two-port boxes

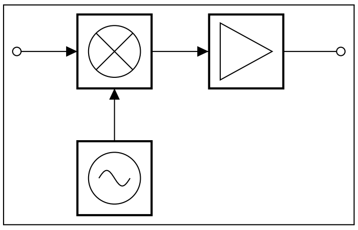
Some two-ports have the option to place a normal label (`l=`) and a inner label (`t=`).




```
\begin{circuitikz}
  \ctikzset{bipoles/amp/width=0.9}
  \draw (0,0) to[amp,t=LNA,l_=$F{=}0.9\,$dB,o-o] ++(3,0);
\end{circuitikz}
```

3.17.2.3 Box option

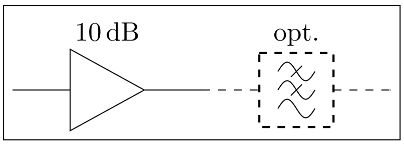
Some devices have the possibility to add a box around them. The inner symbol scales down to fit inside the box.



```
\begin{circuitikz} \draw
  (0,0) node[mixer,box,anchor=east] (m) {}
   to[amp,box,>,-o] ++(2.5,0)
  (m.west) node[inputarrow] {} to[short,-o]
     ++(-0.8,0)
  (m.south) node[inputarrow,rotate=90] {} --
   ++(0,-0.7) node[oscillator,box,anchor=north] {};
\end{circuitikz}
```

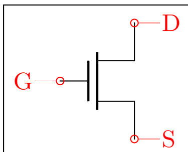
3.17.2.4 Dash optional parts

To show that a device is optional, you can dash it. The inner symbol will be kept with solid lines.

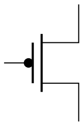



```
\begin{circuitikz}
  \draw (0,0) to[amp,l=\SI{10}{dB}] ++(2.5,0);
  \draw[dashed] (2.5,0) to[lowpass,l=opt.]
      ++(2.5,0);
\end{circuitikz}
```

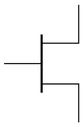
3.18 Transistors



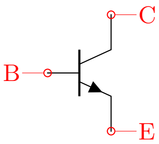
NMOS, TYPE: NODE (`node[nmos]{}`)



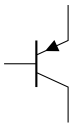
PMOS, TYPE: NODE (`node[pmos]{}`)



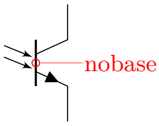
HEMT, TYPE: NODE (`node[hemt]{}`)



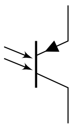
NPN, TYPE: NODE (`node[npn]{}`)



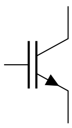
PNP, TYPE: NODE (`node[pnp]{}`)



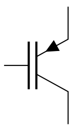
NPN, TYPE: NODE (`node[npn,photo]{}`)



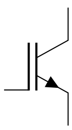
PNP, TYPE: NODE (`node[pnp,photo]{}`)



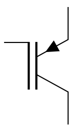
NIGBT, TYPE: NODE (`node[nigbt]{}`)



PIGBT, TYPE: NODE (`node[pigbt]{}`)

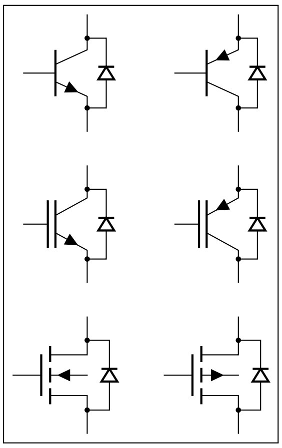


LNIGBT, TYPE: NODE (`node[Lnigbt]{}`)



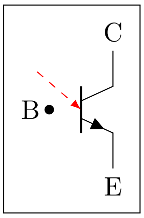
LPIGBT, TYPE: NODE (`node[Lpigbt]{}`)

For all transistors a body diode (or freewheeling diode) can automatically be drawn. Just use the global option bodydiode, or for single transistors, the tikz-option bodydiode:



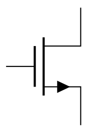
```
\begin{circuitikz}
  \draw (0,0) node[npn,bodydiode](npn){}++(2,0)node[pnp,
      bodydiode](npn){};
  \draw (0,-2) node[nigbt,bodydiode](npn){}++(2,0)node[
      pigbt,bodydiode](npn){};
  \draw (0,-4) node[nfet,bodydiode](npn){}++(2,0)node[
      pfet,bodydiode](npn){};
\end{circuitikz}
```

The Base/Gate connection of all transistors can be disabled by the options *nogate* or *nobase*, respectively. The Base/Gate anchors are floating, but there is an additional anchor "nogate"/"nobase", which can be used to point to the unconnected base:

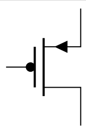



```
\begin{circuitikz}
  \draw (2,0) node[npn,nobase](npn){};
  \draw (npn.E) node[below]{E};
  \draw (npn.C) node[above]{C};
  \draw (npn.B) node[circ]{} node[left]{B};
  \draw[dashed,red,-latex] (1,0.5)--(npn.nobase);
\end{circuitikz}
```

If the option `arrowmos` is used (or after the command `\ctikzset{tripoles/mos style/arrows}` is given), this is the output:

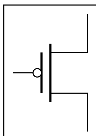


NMOS, TYPE: NODE (`node[nmos]{}`)



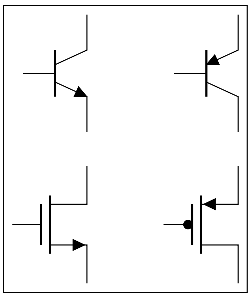
PMOS, TYPE: NODE (`node[pmos]{}`)

To draw the PMOS circle non-solid, use the option `emptycircle` or the command `\ctikzset{tripoles/pmos style/emptycircle}`.



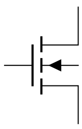
PMOS, TYPE: NODE (`node[pmos,emptycircle]{}`)

If you prefer a different position of the arrows in transistors and FETs, you can adjust them like this (it works for the other BJT-based transistors, too):

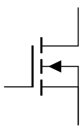


```
\begin{circuitikz}
   \ctikzset{tripoles/mos style/arrows,
   tripoles/npn/arrow pos=0.8,
   tripoles/pnp/arrow pos=0.8,
   tripoles/nmos/arrow pos=0.8,
   tripoles/pmos/arrow pos=0.6, }
  \draw (0,0) node[npn, ](npn){};
  \draw (2,0) node[pnp, ](npn){};
  \draw (0,-2) node[nmos, ](npn){};
  \draw (2,-2) node[pmos, ](npn){};
\end{circuitikz}
```

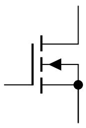
NFETs and PFETs have been incorporated based on code provided by Clemens Helfmeier and Theodor Borsche. Use the package options `fetsolderdot/nofetsolderdot` to enable/disable solderdot at some fet-transistors. Additionally, the solderdot option can be enabled/disabled for single transistors with the option "solderdot" and "nosolderdot", respectively.



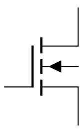
NFET, TYPE: NODE (`node[nfet]{}`)



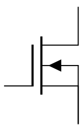
NIGFETE, TYPE: NODE (`node[nigfete]{}`)



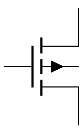
NIGFETE, TYPE: NODE (`node[nigfete,solderdot]{}`)



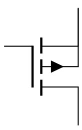
NIGFETEBULK, TYPE: NODE (`node[nigfetebulk]{}`)



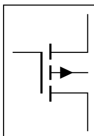
NIGFETD, TYPE: NODE (`node[nigfetd]{}`)



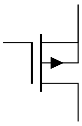
PFET, TYPE: NODE (`node[pfet]{}`)



PIGFETE, TYPE: NODE (`node[pigfete]{}`)

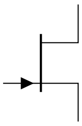


PIGFETEBULK, TYPE: NODE (`node[pigfetebulk]{}`)

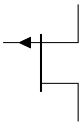


pigfetd, type: node (`node[pigfetd]{}`)

njfet and pjfet have been incorporated based on code provided by Danilo Piazzalunga:

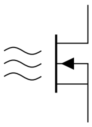


njfet, type: node (`node[njfet]{}`)



pjfet, type: node (`node[pjfet]{}`)

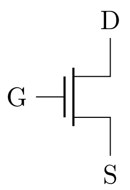
isfet



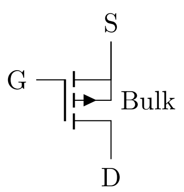
isfet, type: node (`node[isfet]{}`)

3.18.1 Transistors anchors

For nmos, pmos, nfet, nigfete, nigfetd, pfet, pigfete, and pigfetd transistors one has `base`, `gate`, `source` and `drain` anchors (which can be abbreviated with `B`, `G`, `S` and `D`):

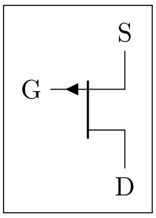



```
\begin{circuitikz} \draw
  (0,0) node[nmos] (mos) {}
  (mos.gate) node[anchor=east] {G}
  (mos.drain) node[anchor=south] {D}
  (mos.source) node[anchor=north] {S}
;\end{circuitikz}
```



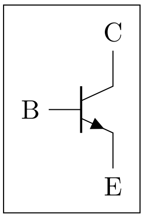

```
\begin{circuitikz} \draw
  (0,0) node[pigfete] (pigfete) {}
  (pigfete.G) node[anchor=east] {G}
  (pigfete.D) node[anchor=north] {D}
  (pigfete.S) node[anchor=south] {S}
  (pigfete.bulk) node[anchor=west] {Bulk}
;\end{circuitikz}
```

Similarly njfet and pjfet have `gate`, `source` and `drain` anchors (which can be abbreviated with `G`, `S` and `D`):

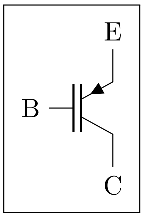



```
\begin{circuitikz} \draw
  (0,0) node[pjfet] (pjfet) {}
  (pjfet.G) node[anchor=east] {G}
  (pjfet.D) node[anchor=north] {D}
  (pjfet.S) node[anchor=south] {S}
;\end{circuitikz}
```

For NPN, PNP, NIGBT and PIGBT transistors, the anchors are `base`, `emitter` and `collector` anchors (which can be abbreviated with `B`, `E` and `C`):

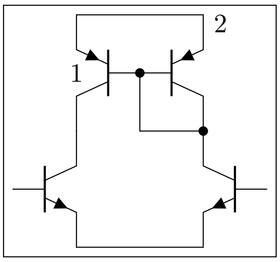



```
\begin{circuitikz} \draw
  (0,0) node[npn] (npn) {}
  (npn.base) node[anchor=east] {B}
  (npn.collector) node[anchor=south] {C}
  (npn.emitter) node[anchor=north] {E}
;\end{circuitikz}
```




```
\begin{circuitikz} \draw
  (0,0) node[pigbt] (pigbt) {}
  (pigbt.B) node[anchor=east] {B}
  (pigbt.C) node[anchor=north] {C}
  (pigbt.E) node[anchor=south] {E}
;\end{circuitikz}
```

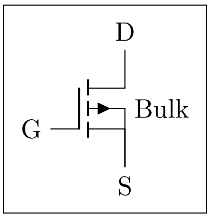
Here is one composite example (please notice that the `xscale=-1` style would also reflect the label of the transistors, so here a new node is added and its text is used, instead of that of `pnp1`):




```
\begin{circuitikz} \draw
  (0,0) node[pnp] (pnp2) {2}
  (pnp2.B) node[pnp, xscale=-1, anchor=B] (pnp1) {}
    (pnp1) node {1}
  (pnp1.C) node[npn, anchor=C] (npn1) {}
  (pnp2.C) node[npn, xscale=-1, anchor=C] (npn2) {}
  (pnp1.E) -- (pnp2.E) (npn1.E) -- (npn2.E)
  (pnp1.B) node[circ] {} |- (pnp2.C) node[circ] {}
;\end{circuitikz}
```

Notice that the text labels of transistors are somewhat buggy. It is better to se explicit anchors to set transistor's names.

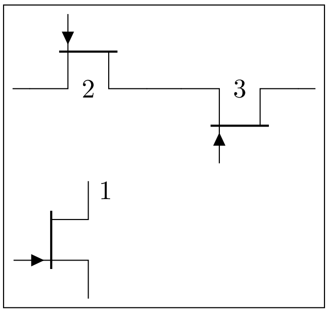
Similarly, transistors like other components can be reflected vertically:




```
\begin{circuitikz} \draw
  (0,0) node[pigfete, yscale=-1] (pigfete) {}
  (pigfete.bulk) node[anchor=west] {Bulk}
  (pigfete.G) node[anchor=east] {G}
  (pigfete.D) node[anchor=south] {D}
  (pigfete.S) node[anchor=north] {S}
;\end{circuitikz}
```

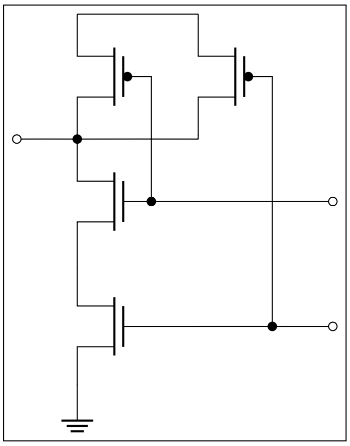
3.18.2 Transistor paths

For syntactical convenience transistors can be placed using the normal path notation used for bipoles. The transitor type can be specified by simply adding a “T” (for transistor) in front of the node name of the transistor. It will be placed with the base/gate orthogonal to the direction of the path:




```
\begin{circuitikz} \draw
 (0,0) node[njfet] {1}
 (-1,2) to[Tnjfet=2] (1,2)
   to[Tnjfet=3, mirror] (3,2);
;\end{circuitikz}
```

Access to the gate and/or base nodes can be gained by naming the transistors with the `n` or `name` path style:

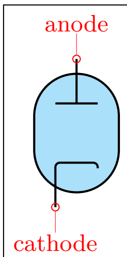


```
\begin{circuitikz} \draw[yscale=1.1, xscale=.8]
 (2,4.5) -- (0,4.5) to[Tpmos, n=p1] (0,3)
   to[Tnmos, n=n1] (0,1.5)
   to[Tnmos, n=n2] (0,0) node[ground] {}
 (2,4.5) to[Tpmos,n=p2] (2,3) to[short, -*] (0,3)
 (p1.G) -- (n1.G) to[short, *-o] ($(n1.G)+(3,0)$)
 (n2.G) ++(2,0) node[circ] {} -| (p2.G)
 (n2.G) to[short, -o] ($(n2.G)+(3,0)$)
 (0,3) to[short, -o] (-1,3)
;\end{circuitikz}
```

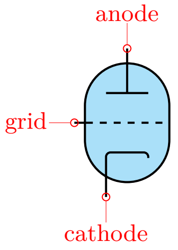
The `name` property is available also for bipoles, although this is useful mostly for triac, potentiometer and thyristor (see 3.7).

3.19 Electronic Tubes

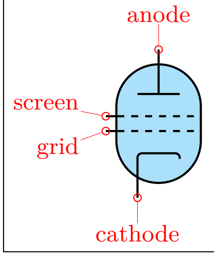
Electronic tubes, also known as vacuum tubes, control current flow between electrodes. They come in many different flavours. Contributed by J. op den Brouw (`J.E.J.opdenBrouw@hhs.nl`).



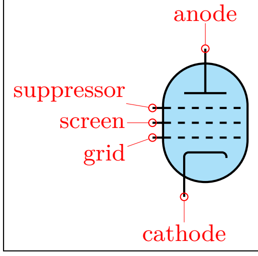
Tube Diode, type: node, fillable (`node[diodetube]{}`)



Triode, type: node, fillable (`node[triode]{}`)

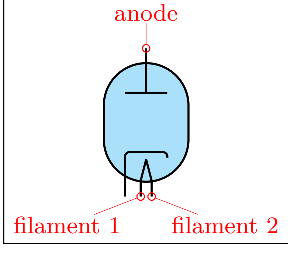


Tetrode, type: node, fillable (`node[tetrode]{}`)



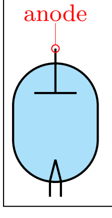
Pentode, type: node, fillable (`node[pentode]{}`)

Note that the `diodetube` is used as component name to avoid clashes with the semiconductor diode. Normally, the filament is not drawn. If you want a filament, put the `filament` option in the node description:



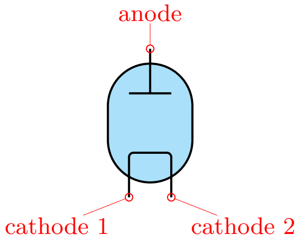
Tube Diode, type: node, fillable (`node[diodetube,filament]{}`)

Sometimes, you don't want the cathode to be drawn (but you do want the filament). Use the `nocathode` option in the node description:



Tube Diode, type: node, fillable (`node[diodetube,filament,nocathode]{}`)

If you want a full cathode to be drawn, use the `fullcathode` option in the node description. You can then use the anchors `cathode 1` and `cathode 2`.

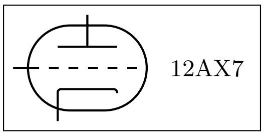


Tube Diode, type: node, fillable
(`node[diodetube,fullcathode]{}`)

These circuit elements are fully configurable, and the attributes are described below:

Key	Default value	Description
`tubes/width`	1	relative width
`tubes/height`	1.4	relative height
`tubes/tube radius`	0.40	radius of tube circle
`tubes/anode distance`	0.40	distance from center
`tubes/anode width`	0.40	width of an anode/plate
`tubes/grid protrusion`	0.25	distance from center
`tubes/grid dashes`	5	number of grid dashes
`tubes/grid separation`	0.2	separation between grids
`tubes/grid shift`	0.0	y shift of grids from center
`tubes/cathode distance`	0.40	distance from grid
`tubes/cathode width`	0.40	width of a cathode
`tubes/cathode corners`	0.06	corners of the cathode wire
`tubes/cathode right extend`	0.075	extension at the right side
`tubes/filament distance`	0.1	distance from cathode
`tubes/filament angle`	15	angle from the centerpoint

Conventionally, the model of the tube is indicated at the `east` anchor:

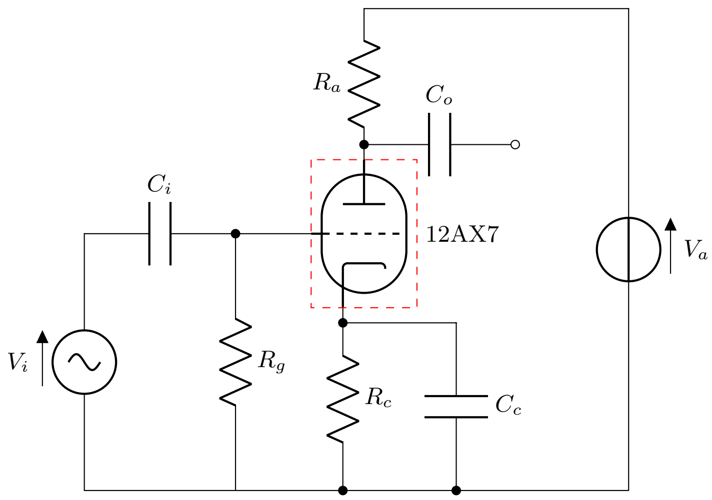


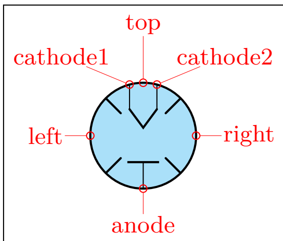

```
\ctikzset{tubes/width=1.4}
\ctikzset{tubes/height=1}

\begin{circuitikz}
\draw (0,0) node[triode] (Tri) {};
\draw (Tri.east) node[right] {12AX7};
\end{circuitikz}
```

Example triode amplifier:

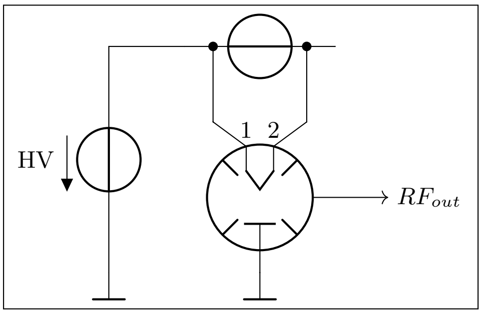
```
\begin{circuitikz}
\draw (0,0) node (start) {}
              to[sV=$V_i$] ++(0,2+\ctikzvalof{tubes/height})
              to[C=$C_i$] ++(2,0) node (Rg) {}
              to[R=$R_g$] (Rg |- start)
(Rg)          to[short,*-] ++(1,0)
              node[triode,anchor=grid] (Tri) {} ++(2,0)
(Tri.cathode) to[R=$R_c$,-*] (Tri.cathode |- start)
(Tri.anode)   to [R=$R_a$] ++(0,2)
              to [short] ++(3.5,0) node(Vatop) {}
              to [V<=$V_a$] (Vatop |- start)
              to [short] (start)
(Tri.anode)   ++(0,0.2) to[C=$C_o$,*-o] ++(2,0)
```

```
(Tri.cathode) ++(0,-0.2) to[short,*-] ++(1.5,0) node(Cctop) {}
                to[C=$C_c$,-*] (start -| Cctop)
;
\draw[red,thin,dashed] (Tri.north west) rectangle (Tri.south east);
\draw (Tri.east) node[right] {12AX7};
\end{circuitikz}
```





Magnetron, type: node, fillable (`node[magnetron]{}`)

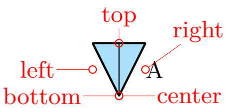



```
\begin{circuitikz}
\draw (0,-2)node[rground](gnd){} to[
    voltage source,v<={HV}]++(0,3)--++(1,0)
    to[V,n=DC]++(2,0);
\draw (2,-1) node[magnetron,scale=1](magn)
    {};
\draw (DC.left)++(-0.2,0)to [short,*-]
    ++(0,-1) to [short] (magn.cathode1);
\draw (DC.right)++(0.2,0)to [short,*-]
    ++(0,-1) to [short] (magn.cathode2);
\draw (magn.anode) to [short] (magn.anode|-
    gnd) node[rground]{};
\draw (magn.cathode1)node[above]{$1$};
\draw (magn.cathode2)node[above]{$2$};
\draw[->](magn.east) --++(1,0)node[right
    ]{$RF_{out}$};
\end{circuitikz}
```

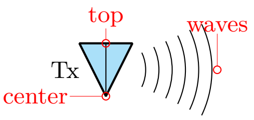
3.20 RF components

For the RF components, similarly to the grounds and supply rails, the `center` anchor is put on the connecting point of the symbol, so that you can use them directly in a `path` specification.

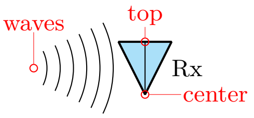
Notes that in the transmission and receiving antennas, the "waves" are outside the geographical anchors.



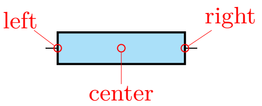
Bare Antenna, type: node, fillable (`node[bareantenna]{A}`)



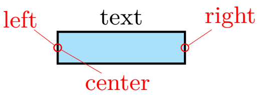
Bare TX Antenna, type: node, fillable (`node[bareTXantenna]{Tx}`)



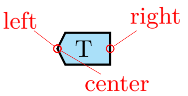
Bare RX Antenna, type: node, fillable (`node[bareRXantenna]{Rx}`)



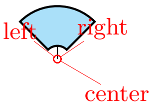
`mstline`: Microstrip transmission line[10], `type: path-style, fillable, nodename: mstlineshape.`



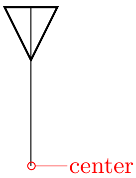
Microstrip stub, type: node, fillable (`node[mslstub]{text}`)



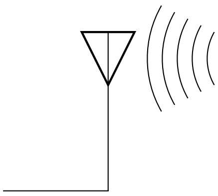
Microstrip port, type: node, fillable (`node[msport]{T}`)



Microstrip radial stub, type: node, fillable (`node[msrstub]{}`)

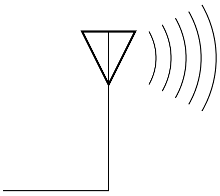
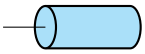


Antenna, type: node (`node[antenna]{}`)



Receiving antenna, type: node (`node[rxantenna]{}`)

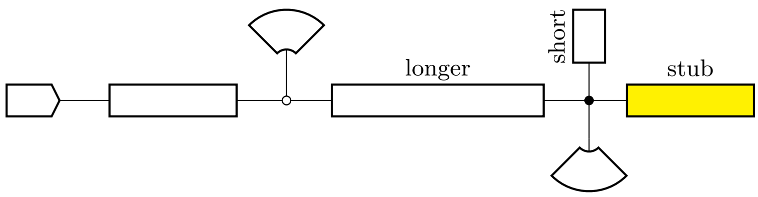
[10] This four components were suggested by `@tcpluess` on GitHub

	Transmitting antenna, type: node (`node[txantenna]{}`)
	Transmission line stub, type: node, fillable (`node[tlinestub]{}`)
	`TL`: Transmission line, `type: path-style, fillable, nodename: tlineshape.` Aliases: `transmission line, tline`.
	match, type: node (`node[match]{}`)

3.20.1 Microstrip customization

The microstrip linear components' (`mstline`, `mslstub`, `msport`) heights depend on the parameters `bipoles/mstline/height` (for the three of them, default 0.3). The widths are specified in `bipoles/mstline/width` for the first two and by `monopoles/msport/width` for the port (defaults: 1.2, 0.5).

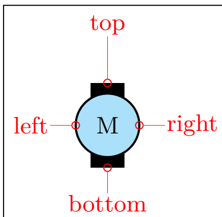
For the length parameter of the transmission line there is a shortcut in the form of the direct parameter `mstlinelen`.



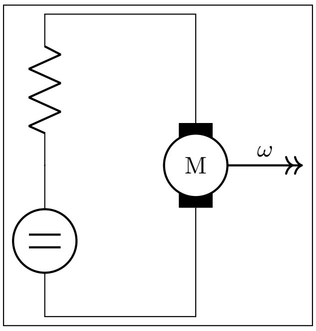

```
\begin{circuitikz}
   \draw (0,0) node[msport, right, xscale=-1]{}
   to[mstline, -o] ++(3,0) coordinate(there)
   to[mstline, mstlinelen=2, l=longer, o-*] ++(4,0)
      coordinate(here) -- ++(0.5,0) node[mslstub, fill=yellow]{stub}
      (here) -- ++(0,0.5) node[mslstub, rotate=90, mstlinelen=0.5]{short};
      \draw (there) to[short, o-] ++(0, 0.5) node[msrstub]{};
      \draw (here) -- ++(0, -0.5) node[msrstub, yscale=-1]{};
\end{circuitikz}
```

3.21 Electro-Mechanical Devices

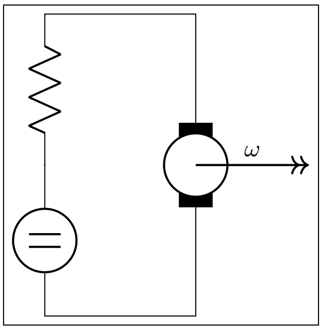
The internal part of the motor and generator are, by default, filled white (to avoid compatibility problems with older versions of the package).

	Motor, type: node, fillable (`node[elmech]{M}`)

Generator, type: node, fillable (`node[elmech]{G}`)

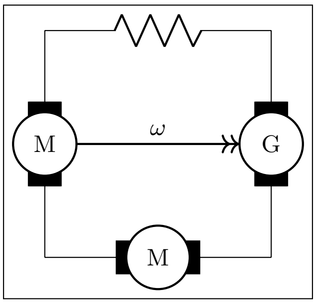



```
\begin{circuitikz}
\draw (2,0) node[elmech](motor){M};
\draw (motor.north) |-(0,2) to [R] ++(0,-2) to[
    dcvsource]++(0,-2) -| (motor.bottom);
\draw[thick,->>](motor.right)--++(1,0)node[midway,
    above]{$\omega$};
\end{circuitikz}
```




```
\begin{circuitikz}
\draw (2,0) node[elmech](motor){};
\draw (motor.north) |-(0,2) to [R] ++(0,-2) to[
    dcvsource]++(0,-2) -| (motor.bottom);
\draw[thick,->>](motor.center)--++(1.5,0)node[midway,
    above]{$\omega$};
\end{circuitikz}
```

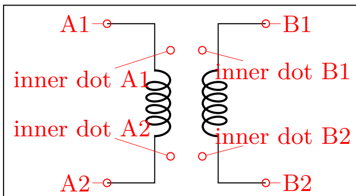
The symbols can also be used along a path, using the transistor-path-syntax(T in front of the shape name, see section 3.18.2). Don´t forget to use parameter n to name the node and get access to the anchors:



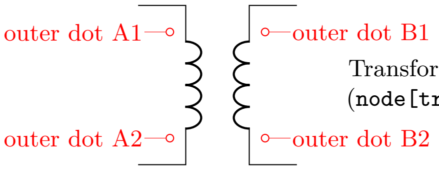

```
\begin{circuitikz}
\draw (0,0) to [Telmech=M,n=motor] ++(0,-3) to [
    Telmech=M] ++(3,0) to [Telmech=G,n=generator]
    ++(0,3) to [R] (0,0);
\draw[thick,->>](motor.left)--(generator.left)node[
    midway,above]{$\omega$};
\end{circuitikz}
```

3.22 Double bipoles (transformers)

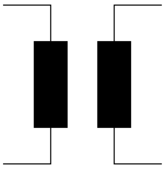
Transformers automatically use the inductor shape currently selected. These are the three possibilities:



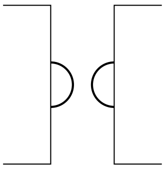
Transformer (cute inductor), type: node (`node[transformer]{}`)



Transformer (american inductor), type: node (`node[transformer]{}`)

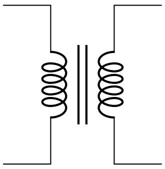


Transformer (european inductor), type: node (`node[transformer]{}`)

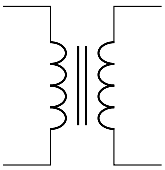


Gyrator, type: node (`node[gyrator]{}`)

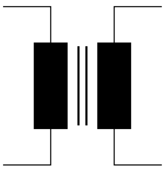
Transformers with core are also available:



Transformer core (cute inductor), type: node (`node[transformer core]{}`)



Transformer core (american inductor), type: node (`node[transformer core]{}`)

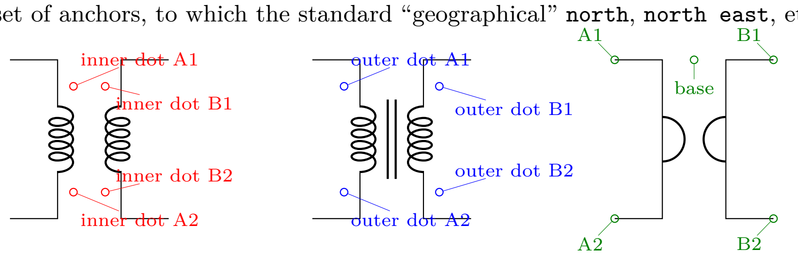


Transformer core (european inductor), type: node (`node[transformer core]{}`)

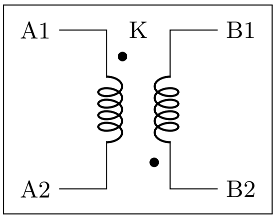
3.22.1 Double dipoles anchors

All the double bipoles/quadrupoles have the four anchors, two for each port. The first port, to the left, is port `A`, having the anchors `A1` (up) and `A2` (down); same for port `B`.

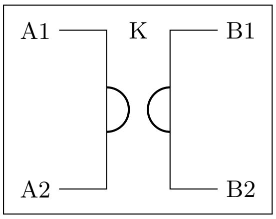
They also expose the `base` anchor, for labelling, and anchors for setting dots or signs to specify polarity. The set of anchors, to which the standard "geographical" `north`, `north east`, etc. is here:



Also, the standard “geographical” `north`, `north east`, etc. are defined. A couple of examples follow:



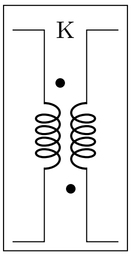

```
\begin{circuitikz} \draw
  (0,0) node[transformer] (T) {}
  (T.A1) node[anchor=east] {A1}
  (T.A2) node[anchor=east] {A2}
  (T.B1) node[anchor=west] {B1}
  (T.B2) node[anchor=west] {B2}
  (T.base) node{K}
  (T.inner dot A1) node[circ]{}
  (T.inner dot B2) node[circ]{}
;\end{circuitikz}
```




```
\begin{circuitikz} \draw
  (0,0) node[gyrator] (G) {}
  (G.A1) node[anchor=east] {A1}
  (G.A2) node[anchor=east] {A2}
  (G.B1) node[anchor=west] {B1}
  (G.B2) node[anchor=west] {B2}
  (G.base) node{K}
;\end{circuitikz}
```

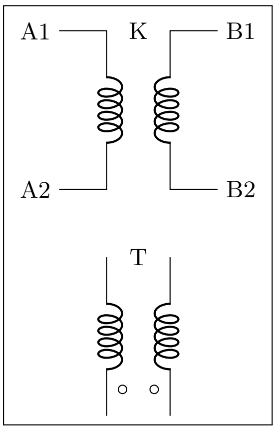
3.22.2 Double dipoles customization

You can change the aspect of a quadpole using the corresponding parameters `quadpoles/*/width` and `quadpoles/*/heigth` (substitute the star for `transformer`, `transformer core` or `gyrator`; default value is `1.5` for all). You have to be careful to not choose value that overlaps the components!



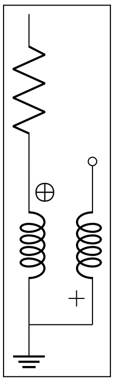

```
\begin{circuitikz}
\ctikzset{quadpoles/transformer/width=1,
    quadpoles/transformer/height=2}
  \draw (0,0) node[transformer] (T) {}
    (T.base) node{K}
    (T.inner dot A1) node[circ]{}
    (T.inner dot B2) node[circ]{};
\end{circuitikz}
```

Another very useful parameter is `quadpoles/*/inner` (default `0.4`) that determine which part of the component is the “vertical” one. So, setting that parameter to 1 will eliminate the horizontal part of the component (obviously, to maintain the general aspect ratio you need to change the width also):



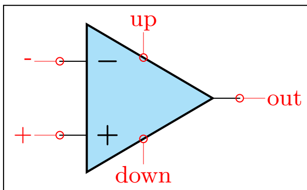

```
\begin{circuitikz}
\draw (0,0) node[transformer] (T) {}
  (T.A1) node[anchor=east] {A1}
  (T.A2) node[anchor=east] {A2}
  (T.B1) node[anchor=west] {B1}
  (T.B2) node[anchor=west] {B2}
  (T.base) node{K} ;
\ctikzset{quadpoles/transformer/inner=1, quadpoles/
    transformer/width=0.6}
\draw (0,-3) node[transformer] (P) {}
  (P.base) node{T}
  (P.inner dot A2) node[ocirc]{}
  (P.inner dot B2) node[ocirc]{};
\end{circuitikz}
```

This can be useful if you want to put seamlessly something in series with either side of the component; for simplicity, you have a style setting `quadpoles style` to toggle between the standard shape of double bipoles (called `inward`, default) and the one without horizontal leads (called `inline`):

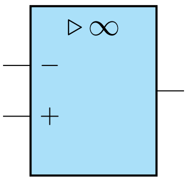


```
\begin{circuitikz}
\ctikzset{inductor=cute, quadpoles style=inline}
\draw
  (0,0) to[R] ++(0,-2)
  node[transformer, anchor=A1](T){}
  (T.A2) node[ground](GND){}
  (T.inner dot A1) node[font=\small\boldmath]{$\oplus$}
  (T.inner dot B2) node[]{$+$}
  (T.B1) node[above, ocirc]{}
  (T.B2) -- (GND);
\end{circuitikz}
```

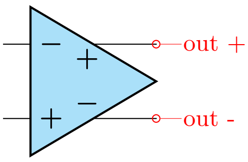
3.23 Amplifiers



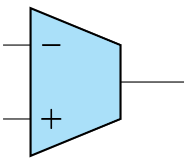
Operational amplifier, type: node, fillable (`node[op amp]{}`)



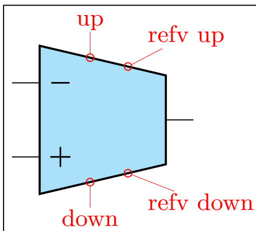
Operational amplifier compliant to DIN/EN 60617 standard, type: node, fillable (`node[en amp]{}`)



Fully differential operational amplifier[11], type: node, fillable (`node[fd op amp]{}`)

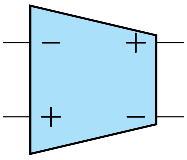
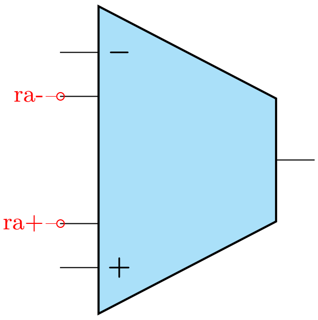
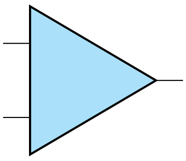
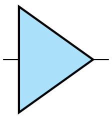


transconductance amplifier, type: node, fillable (`node[gm amp]{}`)



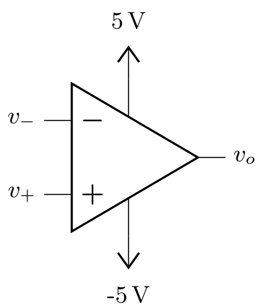
plain instrumentation amplifier, type: node, fillable (`node[inst amp]{}`)

[11]Contributed by Kristofer M. Monisit.

	Fully differential instrumentation amplifier, type: node, fillable (`node[fd inst amp]{}`)
	instrumentation amplifier with amplification resistance terminals, type: node, fillable (`node[inst amp ra]{}`)
	Plain amplifier, type: node, fillable (`node[plain amp]{}`)
	Buffer, type: node, fillable (`node[buffer]{}`)

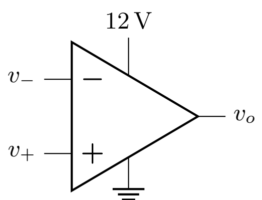
3.23.1 Amplifiers anchors

The op amp defines the inverting input (`-`), the non-inverting input (`+`) and the output (`out`) anchors:



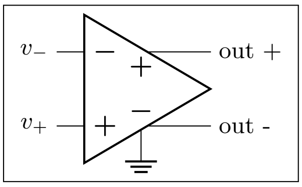

```
\begin{circuitikz} \draw
  (0,0) node[op amp] (opamp) {}
  (opamp.+) node[left] {$v_+$}
  (opamp.-) node[left] {$v_-$}
  (opamp.out) node[right] {$v_o$}
  (opamp.up) --++(0,0.5) node[vcc]{5\,\textnormal{V}}
  (opamp.down) --++(0,-0.5) node[vee]{-5\,\textnormal{V}}
;\end{circuitikz}
```

There are also two more anchors defined, `up` and `down`, for the power supplies:



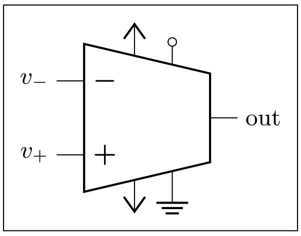

```
\begin{circuitikz} \draw
  (0,0) node[op amp] (opamp) {}
  (opamp.+) node[left] {$v_+$}
  (opamp.-) node[left] {$v_-$}
  (opamp.out) node[right] {$v_o$}
  (opamp.down) node[ground] {}
  (opamp.up) ++ (0,.5) node[above] {\SI{12}{\volt}}
    -- (opamp.up)
;\end{circuitikz}
```

The fully differential op amp defines two outputs:



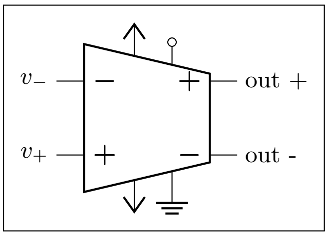

```
\begin{circuitikz} \draw
  (0,0) node[fd op amp] (opamp) {}
  (opamp.+) node[left] {$v_+$}
  (opamp.-) node[left] {$v_-$}
  (opamp.out +) node[right] {out +}
  (opamp.out -) node[right] {out -}
  (opamp.down) node[ground] {}
;\end{circuitikz}
```

The instrumentation amplifier inst amp defines also references (normally you use the ”down”, unless you are flipping the component):



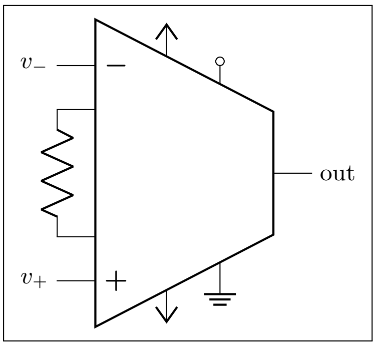

```
\begin{circuitikz} \draw
  (0,0) node[inst amp] (opamp) {}
  (opamp.+) node[left] {$v_+$}
  (opamp.-) node[left] {$v_-$}
  (opamp.out) node[right] {out}
  (opamp.up) node[vcc]{}
  (opamp.down) node[vee] {}
  (opamp.refv down) node[ground]{}
  (opamp.refv up) to[short, -o] ++(0,0.3)
;\end{circuitikz}
```

The fully diffential instrumentation amplifier inst amp defines two outputs:




```
\begin{circuitikz} \draw
  (0,0) node[fd inst amp] (opamp) {}
  (opamp.+) node[left] {$v_+$}
  (opamp.-) node[left] {$v_-$}
  (opamp.out +) node[right] {out +}
  (opamp.out -) node[right] {out -}
  (opamp.up) node[vcc]{}
  (opamp.down) node[vee] {}
  (opamp.refv down) node[ground]{}
  (opamp.refv up) to[short, -o] ++(0,0.3)
;\end{circuitikz}
```

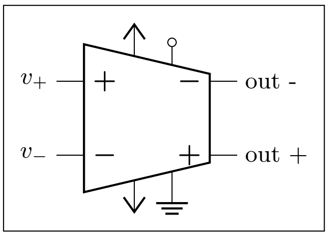
The instrumentation amplifier with resistance terminals (`inst amp ra`) defines also terminals to add an amplification resistor:




```
\begin{circuitikz} \draw
  (0,0) node[inst amp ra] (opamp) {}
  (opamp.+) node[left] {$v_+$}
  (opamp.-) node[left] {$v_-$}
  (opamp.out) node[right] {out}
  (opamp.up) node[vcc]{}
  (opamp.down) node[vee] {}
  (opamp.refv down) node[ground]{}
  (opamp.refv up) to[short, -o] ++(0,0.3)
  (opamp.ra-) to[R] (opamp.ra+)
;\end{circuitikz}
```

3.23.2 Amplifiers customization

All these amplifier have the possibility to flip input and output (if needed) polarity. You can change polarity of the input with the `noinv input down` (default) or `noinv input up` key; and the output with `noinv output up` (default) or `noinv output down` key:




```
\begin{circuitikz} \draw
  (0,0) node[fd inst amp,
    noinv input up,
    noinv output down] (opamp) {}
  (opamp.+) node[left] {$v_+$}
  (opamp.-) node[left] {$v_-$}
  (opamp.out +) node[right] {out +}
  (opamp.out -) node[right] {out -}
  (opamp.up) node[vcc]{}
  (opamp.down) node[vee] {}
  (opamp.refv down) node[ground]{}
  (opamp.refv up) to[short, -o] ++(0,0.3)
;\end{circuitikz}
```

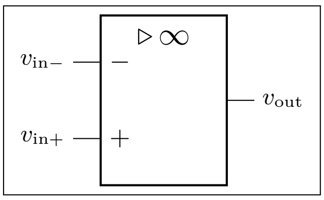
When you use the `noinv input/output ...` keys the anchors (`+`, `-`, `out +`, `out -`) will change with the effective position of the terminals. You have also the anchors `in up`, `in down`, `out up`, `out down` that will not change with the positive or negative sign.

3.23.2.1 European-style amplifier customization

Thanks to the suggestions from David Rouvel (david.rouvel@iphc.cnrs.fr) there are several possible customization for the European-style amplifiers.

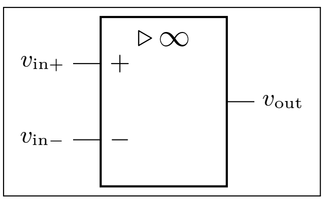
Since 0.9.0, the default appearance of the symbol has changed to be more in line with the standard; notice that to have a bigger triangle by default we should require more packages, and I fear ConTEXt compatibility; but see later on how to change it. Notice that the font used for the symbol is defined in `tripoles/en amp/font2` and that the font used for the `+` and `-` symbols is `tripoles/en amp/font`.

You can change the distances of the inputs, using `tripoles/en amp/input height` (default 0.3):



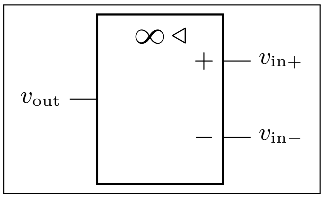

```
\begin{circuitikz}
    \ctikzset{tripoles/en amp/input height=0.45}
    \draw (0,0)node[en amp](E){}
        (E.out) node[right] {$v_{\mathrm{out}}$}
        (E.-) node[left] {$v_{\mathrm{in}-}$}
        (E.+) node[left] {$v_{\mathrm{in}+}$};
\end{circuitikz}
```

and of course the key `noinv input up` is fully functional:




```
\begin{circuitikz}
    \ctikzset{tripoles/en amp/input height=0.45}
    \draw (0,0)node[en amp, noinv input up](E){}
        (E.out) node[right] {$v_{\mathrm{out}}$}
        (E.-) node[left] {$v_{\mathrm{in}-}$}
        (E.+) node[left] {$v_{\mathrm{in}+}$};
\end{circuitikz}
```

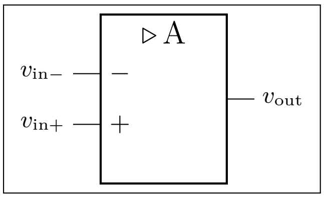
To flip the amplifier in the horizontal direction, you can use `xscale=-1` as usual:




```
\begin{circuitikz}
    \ctikzset{tripoles/en amp/input height=0.45}
    \draw (0,0)node[en amp, xscale=-1, noinv input up ](E){}
        (E.out) node[left] {$v_{\mathrm{out}}$}
        (E.-) node[right] {$v_{\mathrm{in}-}$}
        (E.+) node[right] {$v_{\mathrm{in}+}$};
\end{circuitikz}
```

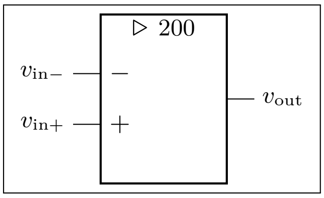
Notice that the label is fully mirrored, so check below for the generic way to change this.

You can use the new key `en amp text A` to change the infinity symbol with an A:




```
\begin{circuitikz}
    \draw (0,0)node[en amp, en amp text A](E){}
        (E.out) node[right] {$v_{\mathrm{out}}$}
        (E.-) node[left] {$v_{\mathrm{in}-}$}
        (E.+) node[left] {$v_{\mathrm{in}+}$} ;
\end{circuitikz}
```

And if you want, you can completely change the text using the key `en amp text=`, which by default is `$\mathstrut{\triangleright}\,{\infty}$`:

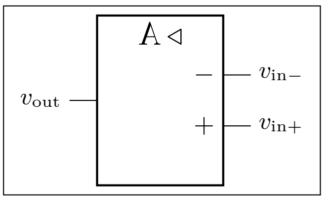



```
\begin{circuitikz}
    \draw (0,0)node[en amp, en amp text={%
            ${\triangleright}$ \small 200}](E){}
        (E.out) node[right] {$v_{\mathrm{out}}$}
        (E.-) node[left] {$v_{\mathrm{in}-}$}
        (E.+) node[left] {$v_{\mathrm{in}+}$} ;
\end{circuitikz}
```

Notice two things here: the first, that `\triangleright` is enclosed in braces to remove the default spacing it has as a binary operator, and that `en amp text A` is simply a shortcut for

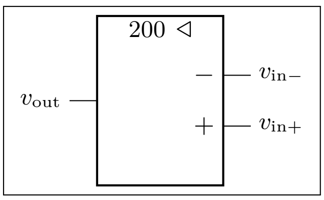
```
    en amp text={$\mathstrut{\triangleright}\,\mathrm{A}$}
```

To combine flipping with a generic label you just do:




```
\begin{circuitikz}
    \draw (0,0)node[en amp, xscale=-1, en amp text A](E){}
        (E.out) node[left] {$v_{\mathrm{out}}$}
        (E.-) node[right] {$v_{\mathrm{in}-}$}
        (E.+) node[right] {$v_{\mathrm{in}+}$} ;
\end{circuitikz}
```

But notice that the "A" is also flipped by the `xscale` parameter. So the solution in this case is to use `scalebox`, like this:



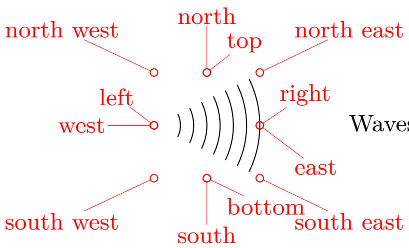
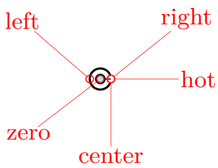

```
\begin{circuitikz}
    \draw (0,0)node[en amp, xscale=-1, en amp text={%
    ${\triangleright}$ \scalebox{-1}[1]{\small 200}}](E){}
        (E.out) node[left] {$v_{\mathrm{out}}$}
        (E.-) node[right] {$v_{\mathrm{in}-}$}
        (E.+) node[right] {$v_{\mathrm{in}+}$} ;
\end{circuitikz}
```

3.24 Support shapes and bipoles

Path style:

	`crossing`: Jumper style non-contact crossing, `type: path-style, nodename: crossingshape.` Aliases: `xing`.

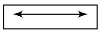
Node style:

▶	Arrows (current and voltage), type: node (`node[currarrow]{}`)
▸	Arrow to draw at its tip, useful for block diagrams., type: node (`node[inputarrow]{}`)
	Jumper-style crossing node, type: node (`node[jump crossing]{}`)
+	Plain style crossing node, type: node (`node[plain crossing]{}`)
	Waves, type: node (`node[waves]{}`)
	BNC connector, type: node, fillable (`node[bnc]{}`)

These are the so-called "bipole nodes" shapes, or poles (see section 4.6). These nodes are always filled; the "open" versions (starting with an `o`) are by default filled white, but you can override it with the `fill` parameter.

●	Connected terminal, type: node (`node[circ]{}`)
○	Unconnected terminal, type: node (`node[ocirc]{}`)
◆	Diamond-square terminal, type: node (`node[diamondpole]{}`)
◇	Open diamond-square terminal, type: node (`node[odiamondpole]{}`)
■	Square-shape terminal, type: node (`node[squarepole]{}`)
□	Open square-shape terminal, type: node (`node[osquarepole]{}`)

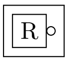
Moreover, you have the arrow tip `latexslim` which is an arrow similar to the old (in deprecated `arrows` library) `latex'` element:



```
\begin{circuitikz}[american,]
   \draw [latexslim-latexslim] (0,0) -- (1,0);
\end{circuitikz}
```

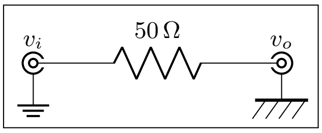
3.24.1 Terminal shapes

Since version 0.9.0, “bipole nodes” shapes have all the standard geographical anchors, so you can do things like these:



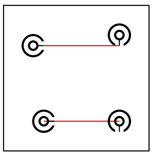

```
\begin{circuitikz}[american,]
   \draw (0,-1) node[draw](R){R};
   \draw (R.east) node[ocirc, right]{};
\end{circuitikz}
```

The BNC connector is defined so that you can easily connect it as input or output (but remember that you need to flip the text if you flip the component):




```
\begin{circuitikz}
   \draw (0,0)
   node[bnc](B1){$v_i$} to[R=\SI{50}{\ohm}] ++(3,0)
   node[bnc, xscale=-1](B2){\scalebox{-1}[1]{$v_o$}};
   \node [ground] at (B1.shield) {};
   \node [eground] at (B2.shield){};
\end{circuitikz}
```

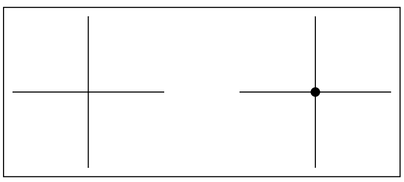
It also has a `zero` anchor if you need to rotate it about its real center.



```
\begin{circuitikz}
   \draw[thin, red] (0,0) -- ++(1,0) (0,-1) -- ++(1,0);
   \path (0,0) node[bnc]{} ++(1,0) node[bnc, rotate=-90]{};
   \path (0,-1) node[bnc, anchor=zero]{} ++(1,0) node[bnc, anchor=
       zero, rotate=-90]{};
\end{circuitikz}
```

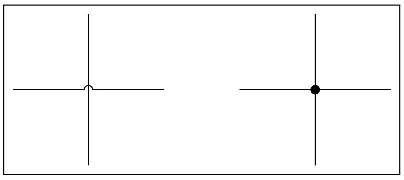
3.24.2 Crossings

All circuit-drawing standards agree that to show a crossing without electric contact, a simple crossing of the wires suffices; the electrical contact must be explicitly marked with a filled dot.



```
\begin{circuitikz}[]
\draw(1,-1) to[short] (1,1)
   (0,0) to[short] (2,0);
\draw(4,-1) to[short] (4,1)
   (3,0) to[short] (5,0)
   (4,0) node[circ]{};
\end{circuitikz}
```

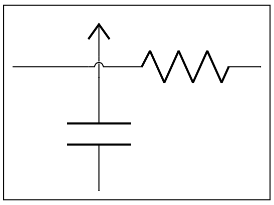
However, sometime it is advisable to mark the non-contact situation more explicitly. To this end, you can use a path-style component called `crossing`:



```
\begin{circuitikz}[]
\draw(1,-1) to[short] (1,1) (0,0) to[crossing] (2,0);
\draw(4,-1) to[short] (4,1) (3,0) to[short] (5,0)
   (4,0) node[circ]{};
\end{circuitikz}
```

That should suffice most of the time; the only problem is that the crossing jumper will be put in the center of the subpath where the `to[crossing]` is issued, so sometime a bit of trial and error is needed to position it.

For a more powerful (and elegant) way you can use the crossing nodes:



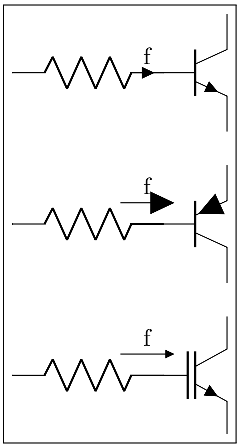
```
\begin{circuitikz}[]
   \node at (1,1)[jump crossing](X){};
   \draw (X.west) -- ++(-1,0);
   \draw (X.east) to[R] ++(2,0);
   \draw (X.north) node[vcc]{};
   \draw (X.south) to[C] ++(0,-1.5);
\end{circuitikz}
```

Notice that the `plain crossing` and the `jump crossing` have a small gap in the straight wire, to enhance the effect of crossing (as a kind of shadow).

The size of the crossing elements can be changed with the key `bipoles/crossing/size` (default 0.2).

3.24.3 Arrows size

You can use the parameter `current arrow scale` to change the size of the arrows in various components and indicators; the normal value is 16, higher numbers give smaller arrows and so on. You need to use `circuitikz/current arrow scale` if you use it into a node.



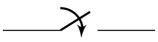
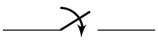
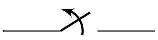
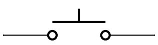
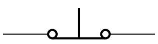
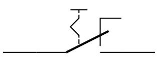

```
\begin{circuitikz}
   \draw (0,0) to[R, i=f] ++(2,0) node[npn, anchor=B]{};
   \draw (0,-2) to[R, f=f, current arrow scale=8] ++(2,0)
         node[pnp, anchor=B, circuitikz/current arrow scale=8]{};
   \draw (0,-4) to[R, f=f, current arrow scale=24] ++(2,0)
         node[nigbt, anchor=B]{};
\end{circuitikz}
```

3.25 Switches and buttons

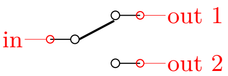
Switches and button come in to-style (the simple ones and the pushbuttons), and as nodes.

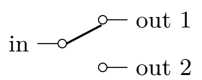
3.25.1 Traditional switches

These are all of the to-style type:

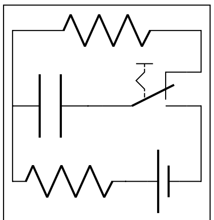
	**`switch`**: Switch, **`type`**: `path-style`, **`nodename`**: `cspstshape`. Aliases: `spst`.
	**`closing switch`**: Closing switch, **`type`**: `path-style`, **`nodename`**: `cspstshape`. Aliases: `cspst`.
	**`opening switch`**: Opening switch, **`type`**: `path-style`, **`nodename`**: `ospstshape`. Aliases: `ospst`.
	**`normal open switch`**: Normally open switch, **`type`**: `path-style`, **`nodename`**: `nosshape`. Aliases: `nos`.
	**`normal closed switch`**: Normally closed switch, **`type`**: `path-style`, **`nodename`**: `ncsshape`. Aliases: `ncs`.
	**`push button`**: Normally open push button, **`type`**: `path-style`, **`nodename`**: `pushbuttonshape`. Aliases: `normally open push button`, `nopb`.
	**`normally closed push button`**: Normally closed push button, **`type`**: `path-style`, **`nodename`**: `ncpushbuttonshape`. Aliases: `ncpb`.
	**`toggle switch`**: Toggle switch, **`type`**: `path-style`, **`nodename`**: `toggleswitchshape`.

while this is a node-style component:

	spdt, type: node (`node[spdt]{}`)




```
\begin{circuitikz} \draw
  (0,0) node[spdt] (Sw) {}
  (Sw.in) node[left] {in}
  (Sw.out 1) node[right] {out 1}
  (Sw.out 2) node[right] {out 2}
;\end{circuitikz}
```

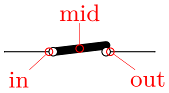
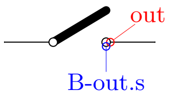
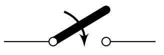


```
\begin{circuitikz} \draw
(0,0) to[C] (1,0) to[toggle switch , n=Sw] (2.5,0)
  -- (2.5,-1) to[battery1] (1.5,-1) to[R] (0,-1) -| (0,0)
 (Sw.out 2) -| (2.5, 1) to[R] (0,1) -- (0,0)
;\end{circuitikz}
```

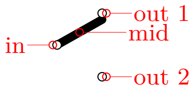
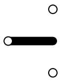
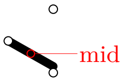
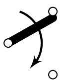
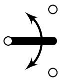
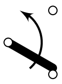
3.25.2 Cute switches

These switches have been introduced after version 0.9.0, and they come in also in to-style and in node-style, but they are size-matched so that they can be used together in a seamless way.

The path element (to-style) are:

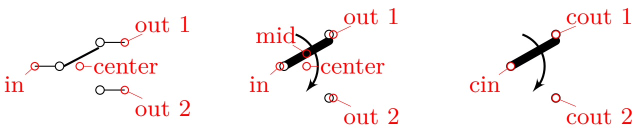
	**`cute closed switch`**: Cute closed switch, **`type:`** `path-style`, `nodename: cuteclosedswitchshape.` Aliases: `ccsw`.
	**`cute open switch`**: Cute open switch, **`type:`** `path-style`, `name=B`, `nodename: cuteopenswitchshape.` Aliases: `cosw`.
	**`cute closing switch`**: Cute closing switch, **`type:`** `path-style`, `nodename: cuteclosingswitchshape.` Aliases: `ccgsw`.
	**`cute opening switch`**: Cute opening switch, **`type:`** `path-style`, `nodename: cuteopeningswitchshape.` Aliases: `cogsw`.

while the node-style components are the single-pole, double-throw (`spdt`) ones:

	Cute spdt up, type: node (`node[cute spdt up]{}`)
	Cute spdt mid, type: node (`node[cute spdt mid]{}`)
	Cute spdt down, type: node (`node[cute spdt down]{}`)
	Cute spdt up with arrow, type: node (`node[cute spdt up arrow]{}`)
	Cute spdt mid with arrow, type: node (`node[cute spdt mid arrow]{}`)
	Cute spdt down with arrow, type: node (`node[cute spdt down arrow]{}`)

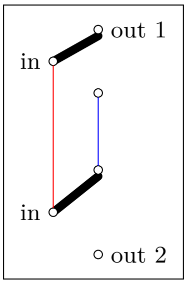
3.25.2.1 Cute switches anchors

The nodes-style switches have the following anchors:



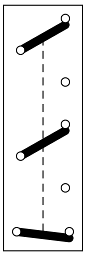
Please notice the position of the normal anchors at the border of the `ocirc` shape for the cute switches; they are thought to be compatible with an horizontal wire going out. Additionaly, you have the `cin`, `cout 1` y `cout 2` which are anchors on the center of the contacts.

For more complex situations, the contact nodes are available[12] using the syntax *name of the node*-`in`, …-`out 1` and …-`out 2`, with all their anchors.




```
\begin{circuitikz}
\draw (0,0) node[cute spdt up] (S1) {}
  (S1.in) node[left] {in}
  (S1.out 1) node[right] {out 1};
  \draw (0,-2) node[cute spdt up,
      /tikz/circuitikz/bipoles/cuteswitch/height=0.8] (S2) {}
  (S2.in) node[left] {in}
  (S2.out 2) node[right] {out 2};
  \draw [red] (S1-in.s) -- (S2-in.n);
  \draw [blue] (S1-out 2.s) -- (S2-out 1.n);
\end{circuitikz}
```

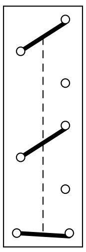
The `mid` anchor in the cute switches (both path- and node-style) can be used to combine switches to get more complex configurations:



```
\begin{circuitikz}
    \draw (0,1.4) node[cute spdt up](S1){};
    \draw (0,0) node[cute spdt up](S2){};
    \draw (0,-1) node[cuteclosedswitchshape, yscale=-1](S3){};
    \draw [densely dashed] (S1.mid)--(S2.mid)--(S3.mid);
\end{circuitikz}
```

3.25.2.2 Cute switches customization

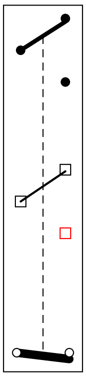
You can use the key `bipoles/cuteswitch/thickness` to decide the thickness of the switch lever. The units are the diameter of the `ocirc` connector, and the default is `1`.



```
\begin{circuitikz}
    \ctikzset{bipoles/cuteswitch/thickness=0.5}
    \draw (0,1.4) node[cute spdt up](S1){};
    \draw (0,0) node[cute spdt up](S2){};
    \draw (0,-1) node[cuteclosedswitchshape, yscale=-1](S3){};
    \draw [densely dashed] (S1.mid)--(S2.mid)--(S3.mid);
\end{circuitikz}
```

Finally, the switches are normally drawn using the `ocirc` shape, but you can change it, as in the following example, with the key `bipoles/cuteswitch/shape`. Be careful that the shape is used with its defaults (which can lead to strange results), and that the standard anchors will be correct only for `circ` and `ocirc` shapes, so you have to use the internal node syntax to connect it.

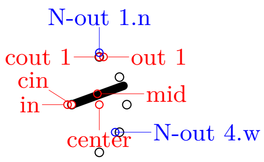
[12] Thanks to `@marmot` on tex.stackexchange.com.



```
\begin{circuitikz}
    \begin{scope}
        \ctikzset{bipoles/cuteswitch/thickness=0.5,
        bipoles/cuteswitch/shape=circ}
        \draw (0,2) node[cute spdt up](S1){};
        \ctikzset{bipoles/cuteswitch/thickness=0.25,
        bipoles/cuteswitch/shape=emptyshape}
        \draw (0,0) node[cute spdt up](S2){};
        \draw (S2.cin) node[draw, inner sep=2pt]{};
        \draw (S2.cout 1) node[draw, inner sep=2pt]{};
        \draw (S2.cout 2) node[draw=red, inner sep=2pt]{};
    \end{scope}
    \draw (0,-2) node[cuteclosedswitchshape, yscale=-1](S3){};
    \draw [densely dashed] (S1.mid)--(S2.mid)--(S3.mid);
\end{circuitikz}
```

3.25.3 Rotary switches

Rotary switches are a kind of generic multipole switches; they are implemented as a strongly customizable element (and a couple of styles to simplify its usage). The basic element is the following one, and it has the same basic anchors of the cute switches, included the access to internal nodes (shown in blue here).



Rotary switch, type: node (`node[rotaryswitch](N){}`)

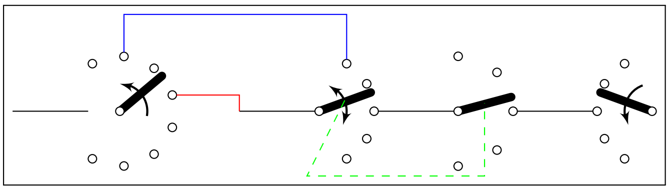
Notice that the name of the shape is `rotaryswitch`, no spaces. The default rotary switch component has 5 channels (this is set in the parameter `multipoles/rotary/channels`), spanning form $-60°$ to $60°$ (parameter `multipoles/rotary/angle`) and with the wiper at $20°$ (parameter `multipoles/rotary/wiper`).

Moreover, there are by default no arrows on the wiper; you can set this with the parameter `multipoles/rotary/arrow` which can assume the values `none`, `cw` (clockwise), `ccw` (counterclockwise) or `both`.

To simplify the usage of the component, a series of styles are defined: `rotary switch=`*<channels>* `in` *<angle>* `wiper` *<wiper angle>* (notice the space in the name of the style!). Using `rotary switch` without parameters will generate a default switch.

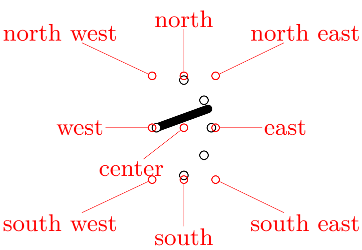
To add arrows, you can use the styles `rotary switch -` (no arrow, whatever the default), `rotary switch <-` (counterclockwise arrow), `rotary switch ->` (clockwise) and `rotary switch <->` (both).

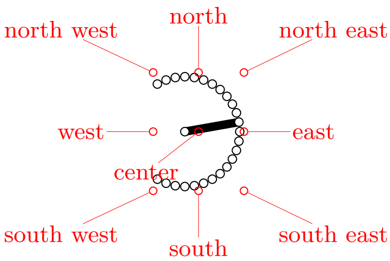
Notice that the defaults of the styles are the same as the default values of the parameters, but that if you change globally the defaults using the keys mentioned above, you only change the defaults for the "bare" component `rotaryswitch`, not for the styles.



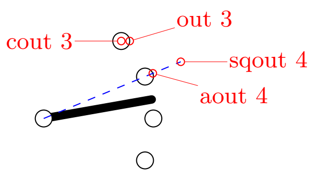
```
\begin{circuitikz}
\ctikzset{multipoles/rotary/arrow=both}
\draw (0,0) -- ++(1,0) node[rotary switch <-=8 in 120 wiper 40, anchor=in](A){};
\draw (3,0) -- ++(1,0) node[rotary switch, anchor=in](B){}; % default values
\draw[red] (A.out 4) -| (3,0);
\draw[blue] (A-out 2.n) -- ++(0,0.5) -| (B-out 1.n);
\draw (B.out 3) -- ++(1,0) node[rotary switch -=5 in 90 wiper 15, anchor=in](C){};
\draw (C.out 3) -- ++(1,0) node[rotary switch ->, xscale=-1, anchor=out 3](D){};
\draw[green, dashed] (B.mid) -- ++(-.5,-1) -| (C.mid);
\end{circuitikz}
```

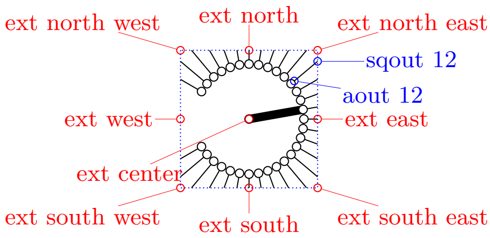
3.25.3.1 Rotary switch anchors Rotary switches anchors are basically the same as the cute switches, including access (with the `<node name>-<anchor name>` notation) to the internal connection nodes. The geographical anchors work as expected, marking the limits of the component.





In addition to the anchors they have in common with the cute switches, the rotary switch has the so called "angled" anchors and the "external square anchors". *Angled anchors*, called `aout 1`, `aout 2` and so forth, are anchors placed on the output poles at the same angle as the imaginary lines coming from the input pole; *square anchors*, called `sqout 1`..., are located on an imaginary square surrounding the rotary switch on the same line.

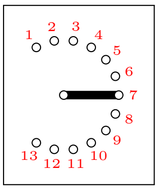




The code for the diagram at the left, above, without the markings for the anchors, is:

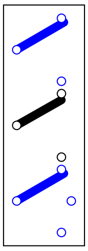
```
\begin{circuitikz}
    \draw (8,0) node[rotary switch -=31 in 150 wiper 10](D){};
    \foreach \i in {1,...,31} \draw (D.sqout \i) -- (D.aout \i);
    \draw[blue, densely dotted] (D.ext north west) rectangle (D.ext south east);
\end{circuitikz}
```

One possible application for the angled and the "on square" anchors is that you can use them to move radially from the output poles, for example for adding numbers:




```latex
\begin{circuitikz}
\draw (0,0) node[rotary switch=13 in 120 wiper 0](S){};
\foreach \i in {1,...,13} % requires "calc"
   \path ($(S.aout \i)!1ex!(S.sqout \i)$)
      node[font=\tiny\color{red}]{\i};
\end{circuitikz}
```

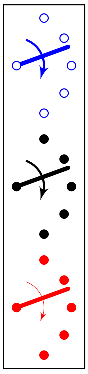
Finally, notice that the value of width for the rotary switches is taken from the one for the “cute switches” which in turn is taken from the width of traditional `spdt` switch, so that they match (notice that the “center” anchor is better centered in the rotary switch, so you have to explicitly align them).



```latex
\begin{circuitikz}
   \draw (0,0) node[color=blue, rotary switch=2 in 35 wiper 30,
      anchor=in](R){};
   \draw (0,-1) node[cute spdt up, anchor=in](C){};
   \draw (0,-2) node[color=blue, rotary switch=3 in 35 wiper 30,
      anchor=in](R){};
\end{circuitikz}
```

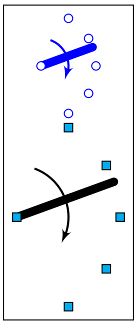
3.25.3.2 Rotary switch customization

Apart from the basic customization seen above (number of channels, etc.) you can change, as in the cute switches, the shape used by the connection points with the parameter `multipoles/rotary/shape`, and the thickness of the wiper with `multipoles/rotary/thickness`. The optional arrow has thickness equal to the standard bipole thickness `bipoles/thickness` (default 2).



```latex
\begin{circuitikz}
   \ctikzset{multipoles/rotary/thickness=0.5}
   \draw (0,1.6) node[rotary switch ->, color=blue](S1){};
   \ctikzset{multipoles/rotary/shape=circ}
   \draw (0,0) node[rotary switch ->](S2){};
   \ctikzset{bipoles/thickness=0.5}
   \draw (0,-1.6) node[rotary switch ->, color=red](S3){};
\end{circuitikz}
```

Finally, the size can be changed using the parameter `tripoles/spdt/width` (default 0.85).

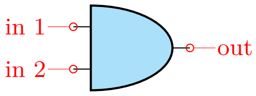


```latex
\begin{circuitikz}
   \draw (0,2) node[rotary switch ->, color=blue](S1){};
   \ctikzset{tripoles/spdt/width=1.6, fill=cyan,
      multipoles/rotary/shape=osquarepole}
   \draw (0,0) node[rotary switch ->](S2){};
\end{circuitikz}
```

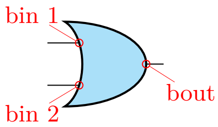
3.26 Logic gates

Logic gates, with two or more input, are supported. Albeit in principle these components are multipoles, the are considered tripoles here, for historical reasons (when they just had two inputs).

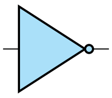
3.26.1 American Logic gates



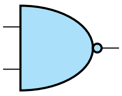
American AND port, type: node, fillable (`node[american and port]{}`)



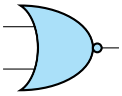
American OR port, type: node, fillable (`node[american or port]{}`)



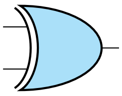
American NOT port, type: node, fillable (`node[american not port]{}`)



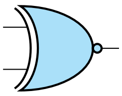
American NAND port, type: node, fillable (`node[american nand port]{}`)



American NOR port, type: node, fillable (`node[american nor port]{}`)

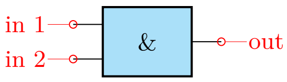


American XOR port, type: node, fillable (`node[american xor port]{}`)

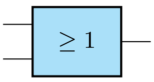


American XNOR port, type: node, fillable (`node[american xnor port]{}`)

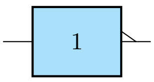
3.26.2 European Logic gates



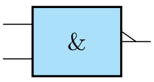
European AND port, type: node, fillable (`node[european and port]{}`)



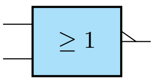
European OR port, type: node, fillable (`node[european or port]{}`)



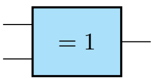
European NOT port, type: node, fillable (`node[european not port]{}`)



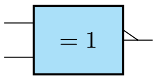
European NAND port, type: node, fillable (`node[european nand port]{}`)



European NOR port, type: node, fillable (`node[european nor port]{}`)



European XOR port, type: node, fillable (`node[european xor port]{}`)



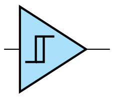
European XNOR port, type: node, fillable (`node[european xnor port]{}`)

If (default behaviour) `americanports` option is active (or the style `[american ports]` is used), the shorthands `and port`, `or port`, `not port`, `nand port`, `not port`, `xor port`, and `xnor port` are equivalent to the american version of the respective logic port.

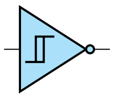
If otherwise `europeanports` option is active (or the style `[european ports]` is used), the shorthands `and port`, `or port`, `not port`, `nand port`, `not port`, `xor port`, and `xnor port` are equivalent to the european version of the respective logic port.

3.26.3 Special components

There is no "european" version of these symbols.



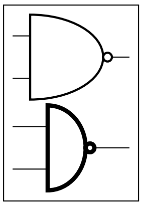
Non-Inverting SCHMITTTRIGGER, type: node, fillable (`node[schmitt]{}`)



Inverting SCHMITTTRIGGER, type: node, fillable (`node[invschmitt]{}`)

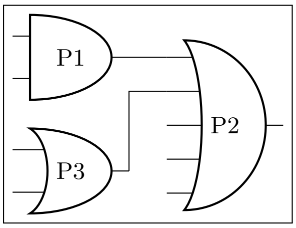
3.26.4 Logic port customization

As for most components, you can change the width and height of the ports; the thickness is given by the parameter `tripoles/thickness` (default 2):



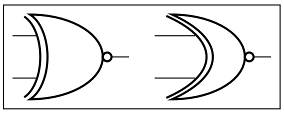
```
\tikz \draw (0,0) node[nand port] {}; \par
\ctikzset{tripoles/american nand port/input height=.2}
\ctikzset{tripoles/american nand port/port width=.4}
\ctikzset{tripoles/thickness=4}
\tikz \draw (0,0) node[nand port] {};
```

This is especially useful if you have ports with more than two inputs, which are instantiated with the parameter `number inputs` :




```
\begin{circuitikz}
\draw (0,3) node[american and port] (A) {P1};
\begin{scope}
   \ctikzset{tripoles/american or port/height=1.6}
   \draw (A.out) -- ++(0.5,0)
   node[american or port,
   number inputs=5,
   anchor=in 1] (B) {P2};
\end{scope}
\draw (0,1.5) node[american or port] (C) {P3};
\draw (C.out) |- (B.in 2);
\end{circuitikz}
```

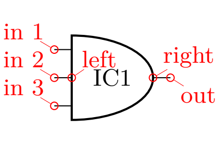
You can tweak the appearance of american “or” family (`or`, `nor`, `xor` and `xnor`) ports, too, with the parameters `inner` (how much the base circle go “into” the shape, default 0.3) and `angle` (the angle at which the base starts, default 70).

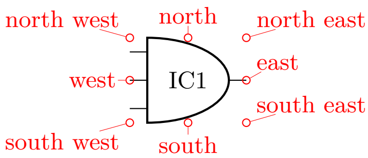


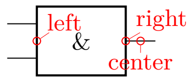
```
\tikz \draw (0,0) node[xnor port] {};
\ctikzset{tripoles/american xnor port/inner=.7}
\ctikzset{tripoles/american xnor port/angle=40}
\tikz \draw (0,0) node[xnor port] {};
```

3.26.5 Logic port anchors

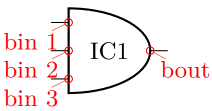
These are the anchors for logic ports:

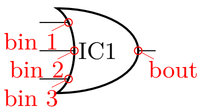


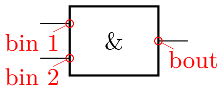




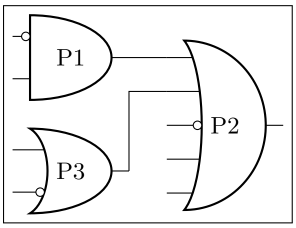
You have also “border pin anchors”:





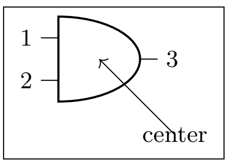


These anchors are especially useful if you want to negate inputs:

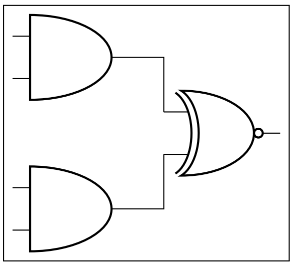



```
\begin{circuitikz}
\draw (0,3) node[american and port] (A) {P1};
\node at (A.bin 1) [ocirc, left]{} ;
\begin{scope}
    \ctikzset{tripoles/american or port/height=1.6}
    \draw (A.out) -- ++(0.5,0) node[american or port,
    number inputs=5, anchor=in 1] (B) {P2};
    \node at (B.bin 3) [ocirc, left]{} ;
\end{scope}
\draw (0,1.5) node[american or port] (C) {P3};
\node at (C.bin 2) [ocirc, left]{} ;
\draw (C.out) |- (B.in 2);
\end{circuitikz}
```

As you can see, the `center` anchor is (for historic reasons) not in the center at all. You can fix this with the command `\ctikzset{logic ports origin=center}`:

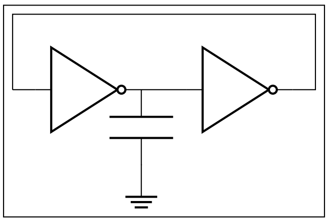



```
\begin{circuitikz}
\ctikzset{logic ports origin=center}
\draw (0,0) node[and port] (myand) {}
  (myand.in 1) node[anchor=east] {1}
  (myand.in 2) node[anchor=east] {2}
  (myand.out) node[anchor=west] {3};
\draw[<-] (myand.center) -- ++(1,-1)
   node{center};
\end{circuitikz}
```



```
\begin{circuitikz} \draw
  (0,2) node[and port] (myand1) {}
  (0,0) node[and port] (myand2) {}
  (2,1) node[xnor port] (myxnor) {}
  (myand1.out) -| (myxnor.in 1)
  (myand2.out) -| (myxnor.in 2)
;\end{circuitikz}
```

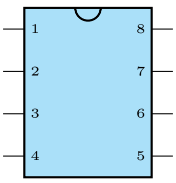
In the case of NOT, there are only `in` and `out` (although for compatibility reasons `in 1` is still defined and equal to `in`):



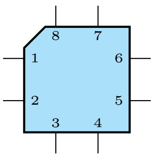
```
\begin{circuitikz} \draw
  (1,0) node[not port] (not1) {}
  (3,0) node[not port] (not2) {}
  (0,0) -- (not1.in)
  (not2.in) -- (not1.out)
  ++(0,-1) node[ground] {} to[C] (not1.out)
  (not2.out) -| (4,1) -| (0,0)
;\end{circuitikz}
```

3.27 Chips (integrated circuits)

`CircuiTikZ` supports two types of variable-pin chips: DIP (Dual-in-Line Package) and QFP (Quad-Flat Package).



Dual-in-Line Package chip, type: node, fillable
(`node[dipchip]{}`)



Quad-Flat Package chip, type: node, fillable
(`node[qfpchip]{}`)

3.27.1 DIP and QFP chips customization

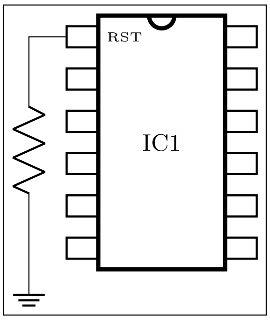
You can customize the DIP chip with the keys `multipoles/dipchip/width` (default 1.2) and `multipoles/dipchip/pin spacing` (default 0.4) that are expressed in fraction of basic lengths (see section 3.1.2). The height of the chip will be equal to half the numbers of pins multiplied by the spacing, plus one spacing for the borders. For the QFP chips, you can only chose the pin spacing with `multipoles/qfpchip/pin spacing` key.

The pins of the chip can be "hidden" (that is, just a spot in the border, optionally marked with a number) or "stick out" with a thin lead by setting `multipoles/external pins width` greater than 0 (default value is 0.2, so you'll have leads as shown above). Moreover, you can transform the thin lead into a pad by setting the key `multipoles/external pad fraction` to something different form 0 (default is 0); the value expresses the fraction of the pin spacing space that the pad will use on both sides of the pin.

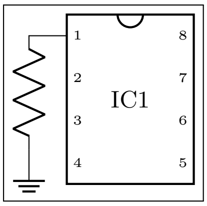
The number of pins is settable with the key `num pins`. **Please notice** that the number of pins **must** be *even* for `dipchips` and *multiple of 4* for `qfpchips`, otherwise havoc will ensue.

You can, if you want, avoid printing the numbers of the pin with `hide numbers` (default `show numbers`) if you prefer positioning them yourself (see the next section for the anchors you can use). The font used for the pins is adjustable with the key `multipoles/font` (default `\tiny`) For special use you can suppress the orientation mark with the key `no topmark` (default `topmark`).

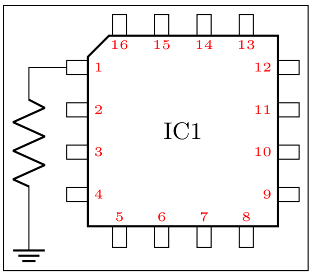
The line thickness of the main shape is controlled by `multipoles/thickness` (default 2) and the one of the external pins/pads with `multipoles/external pins thickness` (default 1).




```
\begin{circuitikz}
    \ctikzset{multipoles/thickness=4}
    \ctikzset{multipoles/external pins thickness=2}
    \draw (0,0) node[dipchip,
      num pins=12,
      hide numbers,
      external pins width=0.3,
      external pad fraction=4 ](C){IC1};
    \draw (C.pin 1) -- ++(-0.5,0) to[R]
      ++(0,-3) node[ground]{};
      \node [right, font=\tiny]
      at (C.bpin 1) {RST};
\end{circuitikz}
```




```
\begin{circuitikz}
    \draw (0,0) node[dipchip,
      num pins=8,
      external pins width=0.0](C){IC1};
    \draw (C.pin 1) -- ++(-0.5,0) to[R]
      ++(0,-1.5) node[ground]{};
\end{circuitikz}
```

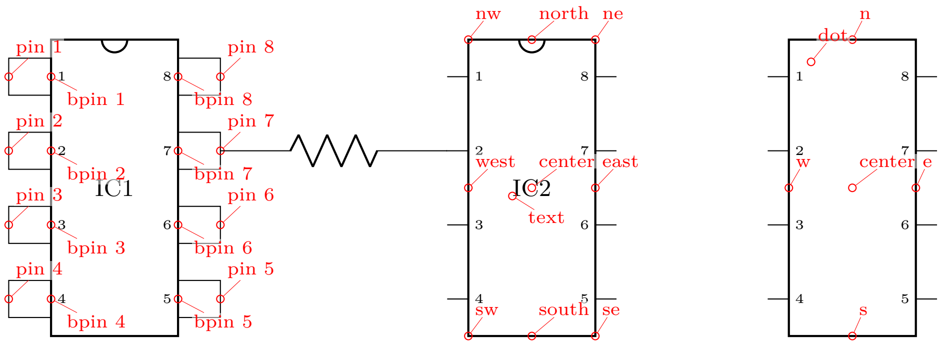



```
\begin{circuitikz}
    \ctikzset{multipoles/font={\color{red}\tiny}}
    \draw (0,0) node[qfpchip,
      num pins=16,
      external pad fraction=6](C){IC1};
    \draw (C.pin 1) -- ++(-0.5,0) to[R]
      ++(0,-2) node[ground]{};
\end{circuitikz}
```

3.27.2 Chips anchors

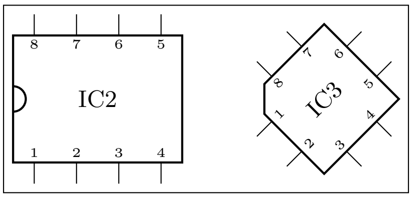
Chips have anchors on pins and global anchors for the main shape. The pin anchors to be used to connect wires to the chip are called `pin 1`, `pin 2` , ..., with just one space between `pin` and the number. Border pin anchors (`bpin 1`...) are always on the box border, and can be used to add numbers or whatever markings are needed. Obviously, in case of `multipoles/external pins width` equal to zero, border and normal pin anchors will coincide.

Additionally, you have geometrical anchors on the chip "box", see the following figure. The nodes are available with the full name (like `north`) and with the short abbreviations `n`, `nw`, `w`.... The `dot` anchor is useful to add a personalized marker if you use the `no topmark` key.



3.27.3 Chips rotation

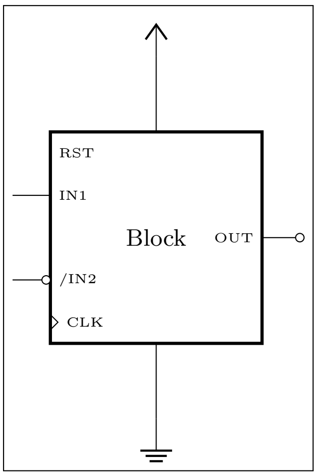
You can rotate chips, and normally the pin numbers are kept straight (option `straight numbers`, which is the default), but you can rotate them if you like with `rotated numbers`. Notice that the main label has to be (counter-) rotated manually in this case.




```
\begin{circuitikz}
    \draw (0,0) node[dipchip,
        rotate=90]{%
        \rotatebox{-90}{IC2}};
    \draw (3,0) node[qfpchip,
        rotated numbers,
        rotate=45]{IC3};
\end{circuitikz}
```

3.27.4 Chip special usage

You can use chips to have special, personalized blocks. Look at the following example, which is easily put into a macro.



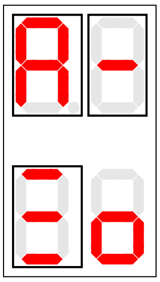

```
\begin{circuitikz}
    \ctikzset{multipoles/thickness=3}
    \ctikzset{multipoles/dipchip/width=2}
    \draw (0,0) node[dipchip,
        num pins=10, hide numbers, no topmark,
        external pins width=0](C){Block};
    \node [right, font=\tiny] at (C.bpin 1) {RST};
    \node [right, font=\tiny] at (C.bpin 2) {IN1};
    \node [right, font=\tiny] at (C.bpin 4) {/IN2};
    \node [left, font=\tiny] at (C.bpin 8) {OUT};
    \draw (C.bpin 2) -- ++(-0.5,0) coordinate(extpin);
    \node [ocirc, anchor=0](notin2) at (C.bpin 4) {};
    \draw (notin2.180) -- (C.bpin 4 -| extpin);
    \draw (C.bpin 8) to[short,-o] ++(0.5,0);
    \draw (C.bpin 5) ++(0,0.1) -- ++(0.1,-0.1)
        node[right, font=\tiny]{CLK} -- ++(-0.1,-0.1);
    \draw (C.n) -- ++(0,1) node[vcc]{};
    \draw (C.s) -- ++(0,-1) node[ground]{};
\end{circuitikz}
```

3.28 Seven segment displays

	Seven segment display, type: node, fillable (node[bare7seg]{})

The seven segment display lets you show values as if they were displayed in a classical seven segment display.[13]

The main "bare" component is the one shown above, but for simplicity a couple of style interfaces are defined:



```
\begin{circuitikz}
    \draw (0,0) node[seven segment val=A dot off box on]{};
    \draw (1,0) node[seven segment val=- dot none box on]{};
    \draw (0,-2) node[seven segment bits=1001001 dot empty box on
        ]{};
    \draw (1,-2) node[seven segment bits=0011101 dot none box off
        ]{};
\end{circuitikz}
```

There are two main configuration methods. The first one is `seven segment val`, which will take an hexadecimal number or value and display it: the possible values are `0,...,15`, plus `A, B, C, D, E, F` (or lowercase) and the symbol `-` (minus).

The other interface is `seven segment bits`, where you specify seven bits saying which segment must be on (please never specify a different number of bits, it will throw a very obscure error); you can see in the anchors the name of each segment.

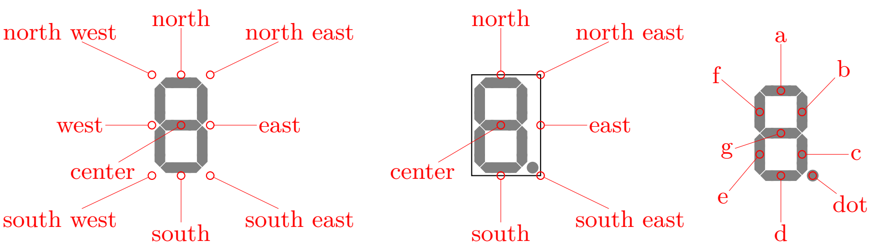
The option `dot` specifies if you want a decimal dot or not. The key `none` will remove the dot and the space it would take; `empty` will not show the dot at all but reserve the space, and `on` or `off` will show the dot in the corresponding state.

The option `box` (can be `on` or `off`) simply toggles the drawing of the external box. You can separate it from the display with the key `seven seg/box sep` (default `1pt`), and it will use the thickness specified in `multipoles/thickness` (The same as the chips).

You can use these option with the "bare" object `bare7seg` and the keys `seven seg/bits` (default `0000000`), `seven seg/dot` (default `none`) and `seven seg/box` (default `off`); there is no option equivalent to the `val` interface.

3.28.1 Seven segments anchors

These are the anchors for the seven segment displays; notice that when the `dot` parameter is not `none`, the cell is a bit wider at the right side.



[13] This component has been loosely inspired by the package `SevenSeg` by Germain Gondor, 2009, see TEXexample.net.

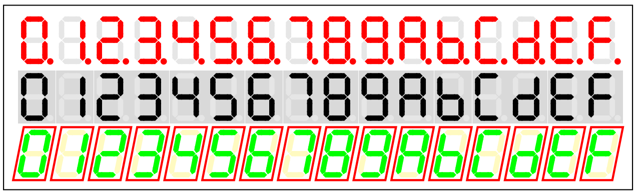
3.28.2 Seven segments customization

You can change several parameters to adjust the displays:

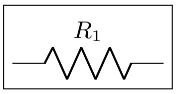
```
\ctikzset{seven seg/width/.initial=0.4}% relative to \pgf@circ@Rlen
\ctikzset{seven seg/thickness/.initial=4pt}% segment thickness
\ctikzset{seven seg/segment sep/.initial=0.2pt}% gap between segments
\ctikzset{seven seg/box sep/.initial=1pt}% external box gap
\ctikzset{seven seg/color on/.initial=red}% color for segment "on"
\ctikzset{seven seg/color off/.initial=gray!20!white} % ...and "off"
```

A couple of examples following:

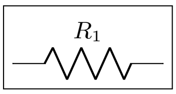
```
\begin{circuitikz}[scale=0.5]
\ctikzset{seven seg/width=0.2, seven seg/thickness=2pt}
\foreach \i in {0,...,15} \path (\i,0)
   node[seven segment val=\i dot on box off]{};
\ctikzset{seven seg/color on=black}
\foreach \i in {0,...,15} \path (\i,-1.5)
   node[seven segment val=\i dot off box off, fill=gray!30!white]{};
\ctikzset{seven seg/color on=green, seven seg/color off=yellow!30}
\foreach \i in {0,...,15} \path[color=red] (\i,-3)
   node[seven segment val=\i dot none box on, xslant=0.2]{};
\end{circuitikz}
```



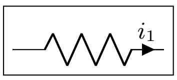
4 Labels and similar annotations



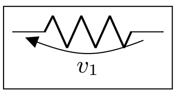

```
\begin{circuitikz}
   \draw (0,0) to[R, l=$R_1$] (2,0);
\end{circuitikz}
```



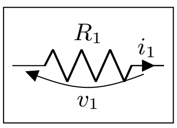

```
\begin{circuitikz}
   \draw (0,0) to[R=$R_1$] (2,0);
\end{circuitikz}
```



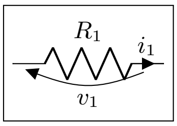

```
\begin{circuitikz}
   \draw (0,0) to[R, i=$i_1$] (2,0);
\end{circuitikz}
```




```
\begin{circuitikz}
   \draw (0,0) to[R, v=$v_1$] (2,0);
\end{circuitikz}
```

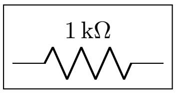



```
\begin{circuitikz}
   \draw (0,0) to[R=$R_1$, i=$i_1$, v=$v_1$] (2,0);
\end{circuitikz}
```




```
\begin{circuitikz}
  \draw (0,0) to[R=$R_1$, i=$i_1$, v=$v_1$] (2,0);
\end{circuitikz}
```

Long names/styles for the bipoles can be used:

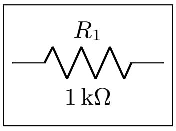



```
\begin{circuitikz}\draw
 (0,0) to[resistor=1<\kilo\ohm>] (2,0)
;\end{circuitikz}
```

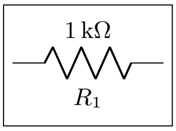
4.1 Labels and Annotations

Since Version 0.7, beside the original label (l) option, there is a new option to place a second label, called annotation (a) at each bipole. Up to now this is a beta-test and there can be problems. For example, up to now this option is not compatible with the concurrent use of voltage labels.

The position of (a) and (l) labels can be adjusted with _ and ^, respectively.

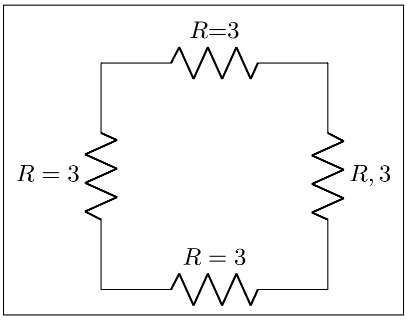



```
\begin{circuitikz}
  \draw (0,0) to[R, l=$R_1$,a=1<\kilo\ohm>] (2,0);
\end{circuitikz}
```



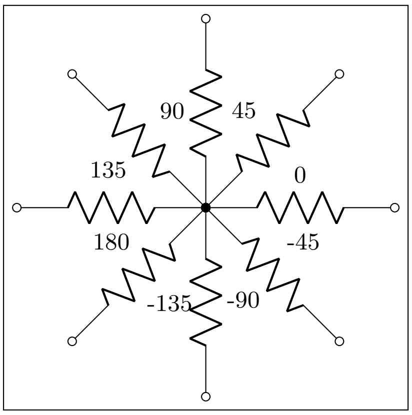

```
\begin{circuitikz}
  \draw (0,0) to[R, l_=$R_1$,a^=1<\kilo\ohm>] (2,0);
\end{circuitikz}
```

Caveat: notice that the way in which `circuitikz` processes the options, there will be problems if the label (or annotation, voltage, or current) contains one of the characters = (equal) or , (comma), giving unexpected errors and wrong output. These two characters must be protected to the option parser using an `\mbox` command, or redefining the characters with a TeX `\def`:

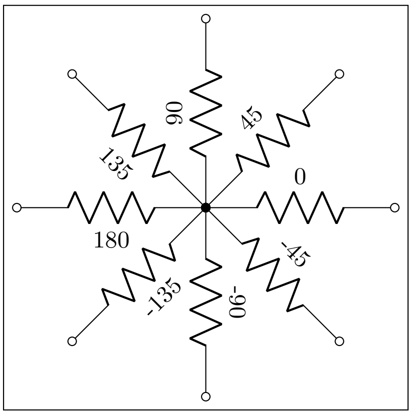



```
\def\eq{=}
\begin{circuitikz}
    % the following will fail:
    % \draw (0,0) to[R, l={$R=3$}] (3,0);
    \draw (0,0) to[R, l=\mbox{$R=3$}] (3,0);
    \draw (0,0) to[R, l=$R\eq3$] (0,3);
    \draw (3,3) to[R, l=\mbox{$R,3$}] (3,0);
    % this works, but it has wrong spacing
    \draw (0,3) to[R, l=$R{=}3$] (3,3);
\end{circuitikz}
```

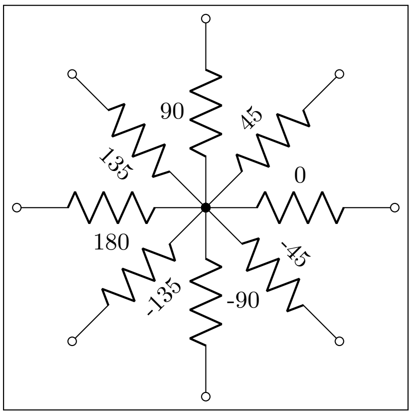
The default orientation of labels is controlled by the options `smartlabels`, `rotatelabels` and `straightlabels` (or the corresponding `label/align` keys). Here are examples to see the differences:




```
\begin{circuitikz}
\ctikzset{label/align = straight}
\def\DIR{0,45,90,135,180,-90,-45,-135}
\foreach \i in \DIR {
  \draw (0,0) to[R=\i, *-o] (\i:2.5);
}
\end{circuitikz}
```

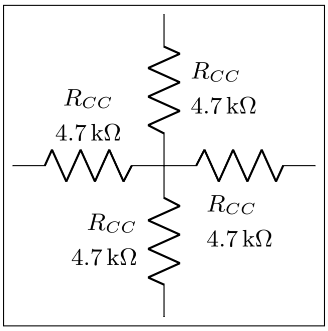



```
\begin{circuitikz}
\ctikzset{label/align = rotate}
\def\DIR{0,45,90,135,180,-90,-45,-135}
\foreach \i in \DIR {
  \draw (0,0) to[R=\i, *-o] (\i:2.5);
}
\end{circuitikz}
```

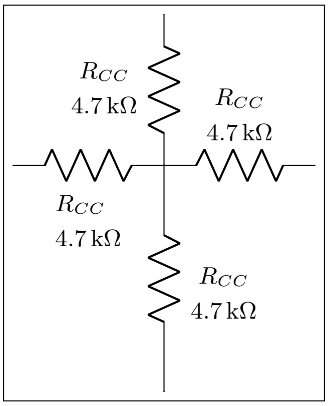



```
\begin{circuitikz}
\ctikzset{label/align = smart}
\def\DIR{0,45,90,135,180,-90,-45,-135}
\foreach \i in \DIR {
  \draw (0,0) to[R=\i, *-o] (\i:2.5);
}
\end{circuitikz}
```

You also can use stacked (two lines) labels. The example should be self-explanatory: the two lines are specified as `l2=`*line1* `and` *line2*. You can use the keys `l2 halign` to control horizontal position (`l`eft, `c`enter, `r`ight) and `l2 valign` to control the vertical one (`b`ottom, `c`center, `t`op).




```
\begin{circuitikz}[ american, ]
    %
    % default is l2 halign=l, l2 valign=c
    %
    \draw (0,0) to[R, l2_=$R_{CC}$ and \SI{4.7}{k\ohm},   , l2 valign=t] (2,0);
    \draw (0,0) to[R, l2_=$R_{CC}$ and \SI{4.7}{k\ohm},   ,          ] (0,2);
    \draw (0,0) to[R, l2_=$R_{CC}$ and \SI{4.7}{k\ohm}, l2 halign=c, l2 valign=b] (-2,0);
    \draw (0,0) to[R, l2_=$R_{CC}$ and \SI{4.7}{k\ohm}, l2 halign=r, l2 valign=c] (0, -2);
\end{circuitikz}
```




```
\begin{circuitikz}[ american, ]
    \draw (0,0) to[R, l2^=$R_{CC}$ and \SI{4.7}{k\ohm}, l2 halign=c, l2 valign=b] (2,0);
    \draw (0,0) to[R, l2^=$R_{CC}$ and \SI{4.7}{k\ohm}, l2 halign=c, ] (0,2);
    \draw (0,0) to[R, l2^=$R_{CC}$ and \SI{4.7}{k\ohm},   , l2 valign=t] (-2,0);
    \draw (0,0) to[R, l2^=$R_{CC}$ and \SI{4.7}{k\ohm}, l2 halign=c, l2 valign=t](0, -3);
\end{circuitikz}
```

4.2 Currents and voltages

The default direction/sign for currents and voltages in the components is, unfortunately, not standard, and can change across country and sometime across different authors. This unfortunate situation created a bit of confusion in `circuitikz` across the versions, with several incompatible changes starting from version 0.5. From version 0.9.0 onward, the maintainers agreed a new policy for the directions of bipoles' voltages and currents, depending on 4 different possible options:

- `oldvoltagedirection`, or the key style `voltage dir=old`: Use old way of voltage direction having a difference between european and american direction, with wrong default labelling for batteries (it was the default before version 0.5);
- `nooldvoltagedirection`, or the key style `voltage dir=noold`: The standard from version 0.5 onward, utilize the (German?) standard of voltage arrows in the direction of electric fields (without fixing batteries);
- `RPvoltages` (meaning Rising Potential voltages), or the key style `voltage dir=RP`: the arrow is in direction of rising potential, like in `oldvoltagedirections`, but batteries and current sources are fixed so that they follow the passive/active standard: the default direction of `v` and `i` are chosen so that, when both values are positive:
  - in passive component, the element is *dissipating power*;
  - in active components (generators), the element is *generating power*.
- `EFvoltages` (meaning Electric Field voltages), or the key style `voltage dir=EF`: the arrow is in direction of the electric field, like in `nooldvoltagedirections`, but batteries are fixed;

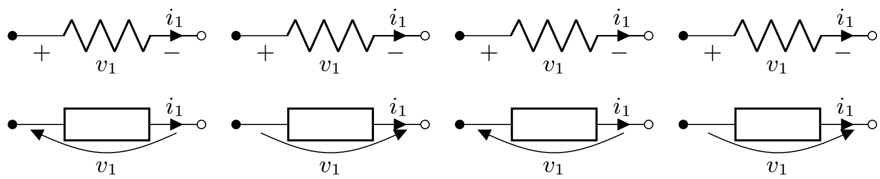
The standard direction of currents, flows and voltages are changed by these options; notice that the default drops in case of passive and active elements is normally different. Take care that in the case of `noold` and `EFvoltages` also the currents can switch directions. It is much easier to understand the several behaviors by looking at the following examples, that have been generated by the code:

```
\foreach\element in {R, C, D, battery2, V, I, sV, cV, cI}{%
   \noindent\ttfamily
   \begin{tabular}{p{2cm}}
      \element \\ american \\[15pt]
      \element \\ european \\
   \end{tabular}
   \foreach\mode in {old, noold, RP, EF} {
      \begin{tabular}{@{}l@{}}
         \multicolumn{1}{c}{voltage dir} \\
         \multicolumn{1}{c}{dir=\mode} \\[4pt]
         \begin{tikzpicture}[
            american, voltage dir=\mode,
            ]
            \draw (0,0) to[\element, *-o, v=$v_1$, i=$i_1$, ] (2.5,0);
         \end{tikzpicture}\\
         \begin{tikzpicture}[
            european, voltage dir=\mode,
            ]
            \draw (0,0) to[\element, *-o, v=$v_1$, i=$i_1$, ] (2.5,0);
         \end{tikzpicture}
      \end{tabular}
      \medskip
   }
   \par
}
```

	voltage dir dir=old	voltage dir dir=noold	voltage dir dir=RP	voltage dir dir=EF

R
american

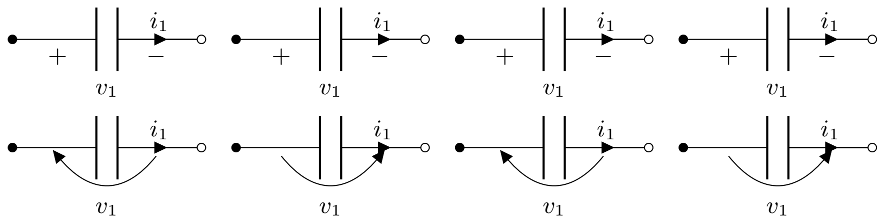
R
european



	voltage dir dir=old	voltage dir dir=noold	voltage dir dir=RP	voltage dir dir=EF

C
american

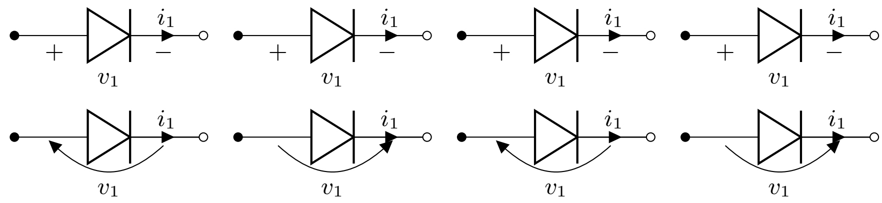
C
european



voltage dir dir=old · voltage dir dir=noold · voltage dir dir=RP · voltage dir dir=EF

D american

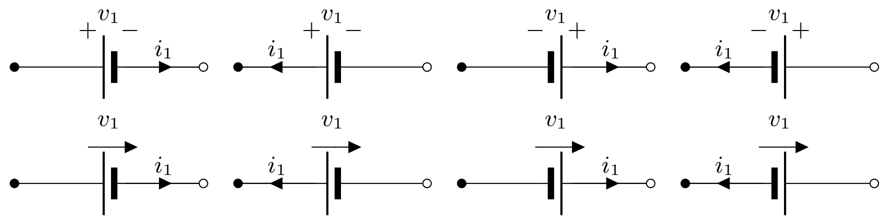
D european



voltage dir dir=old · voltage dir dir=noold · voltage dir dir=RP · voltage dir dir=EF

battery2 american

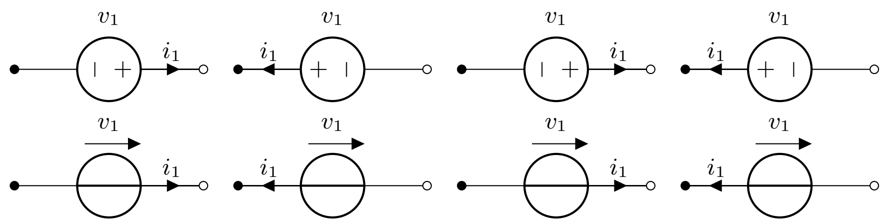
battery2 european



voltage dir dir=old · voltage dir dir=noold · voltage dir dir=RP · voltage dir dir=EF

V american

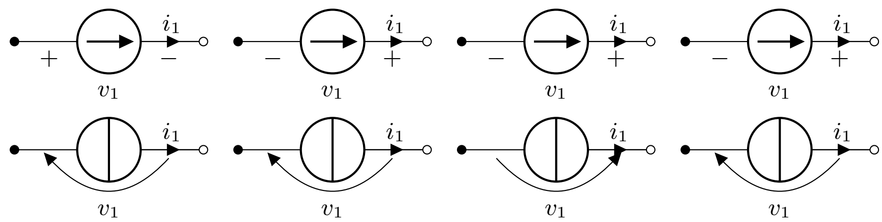
V european



voltage dir dir=old · voltage dir dir=noold · voltage dir dir=RP · voltage dir dir=EF

I american

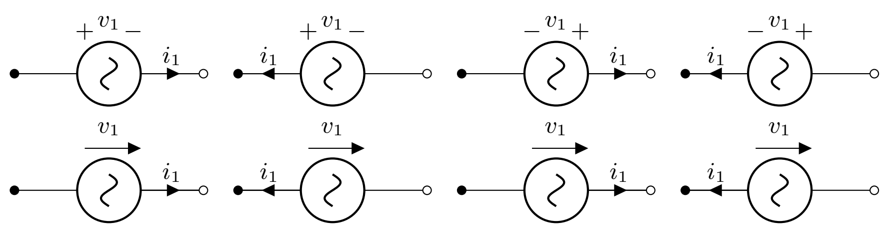
I european

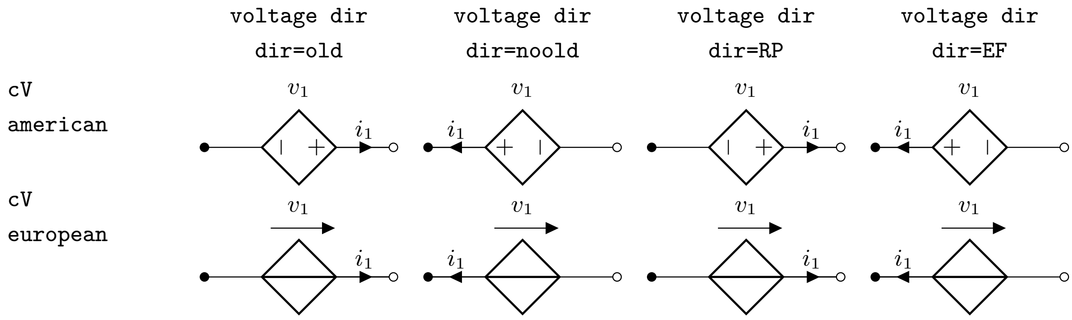


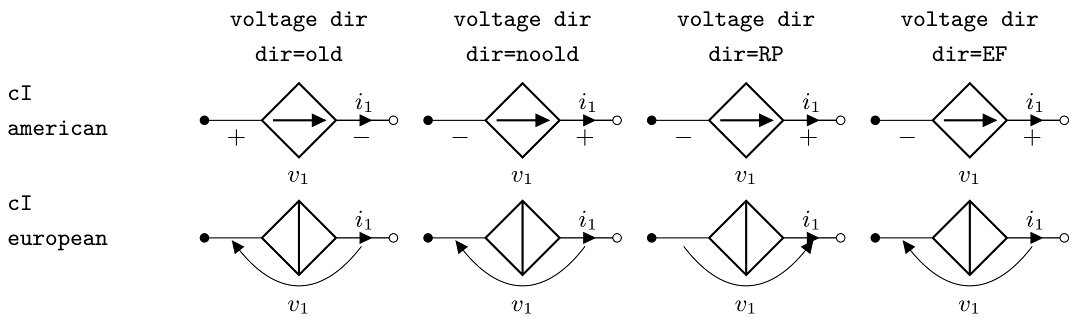
voltage dir dir=old · voltage dir dir=noold · voltage dir dir=RP · voltage dir dir=EF

sV american

sV european





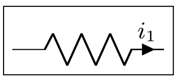


Obviously, you normally use just one between current and flows, but anyway you can change direction of the voltages, currents and flows using the complete keys `i_>`, `i^<`, `i>_`, `i>^`, as shown in the following examples.

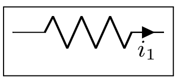
This manual has been typeset with the option `RPvoltages`.

4.3 Currents

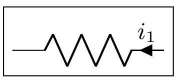
Inline (along the wire) currents are selected with `i_>`, `i^<`, `i>_`, `i>^`, and various simplification; the default position and direction is obtained with the key `i=...`.



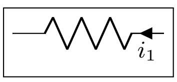

```
\begin{circuitikz}
  \draw (0,0) to[R, i^>=$i_1$] (2,0);
\end{circuitikz}
```



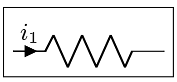

```
\begin{circuitikz}
  \draw (0,0) to[R, i_>=$i_1$] (2,0);
\end{circuitikz}
```



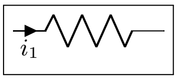

```
\begin{circuitikz}
  \draw (0,0) to[R, i^<=$i_1$] (2,0);
\end{circuitikz}
```



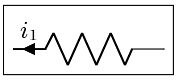

```
\begin{circuitikz}
  \draw (0,0) to[R, i_<=$i_1$] (2,0);
\end{circuitikz}
```



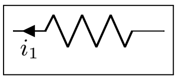

```
\begin{circuitikz}
  \draw (0,0) to[R, i>^=$i_1$] (2,0);
\end{circuitikz}
```




```
\begin{circuitikz}
  \draw (0,0) to[R, i>_=$i_1$] (2,0);
\end{circuitikz}
```

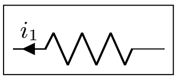



```
\begin{circuitikz}
  \draw (0,0) to[R, i<^=$i_1$] (2,0);
\end{circuitikz}
```

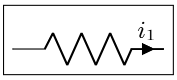



```
\begin{circuitikz}
  \draw (0,0) to[R, i<_=$i_1$] (2,0);
\end{circuitikz}
```

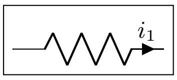
Also:



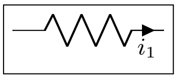

```
\begin{circuitikz}
  \draw (0,0) to[R, i<=$i_1$] (2,0);
\end{circuitikz}
```



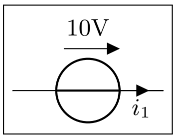

```
\begin{circuitikz}
  \draw (0,0) to[R, i>=$i_1$] (2,0);
\end{circuitikz}
```



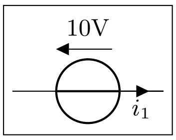

```
\begin{circuitikz}
  \draw (0,0) to[R, i^=$i_1$] (2,0);
\end{circuitikz}
```



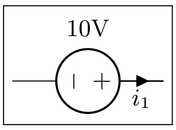

```
\begin{circuitikz}
  \draw (0,0) to[R, i_=$i_1$] (2,0);
\end{circuitikz}
```



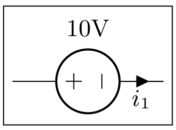

```
\begin{circuitikz}
  \draw (0,0) to[V=10V, i_=$i_1$] (2,0);
\end{circuitikz}
```



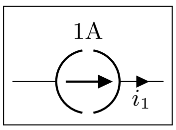

```
\begin{circuitikz}
  \draw (0,0) to[V<=10V, i_=$i_1$] (2,0);
\end{circuitikz}
```



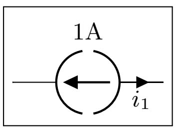

```
\begin{circuitikz}[american]
  \draw (0,0) to[V=10V, i_=$i_1$] (2,0);
\end{circuitikz}
```




```
\begin{circuitikz}[american]
  \draw (0,0) to[V=10V,invert, i_=$i_1$] (2,0);
\end{circuitikz}
```




```
\begin{circuitikz}[american]
  \draw (0,0) to[dcisource=1A, i_=$i_1$] (2,0);
\end{circuitikz}
```

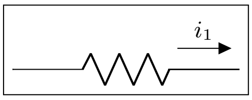



```
\begin{circuitikz}[american]
  \draw (0,0) to[dcisource=1A,invert, i_=$i_1$] (2,0);
\end{circuitikz}
```

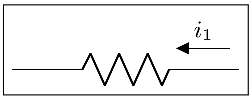
4.4 Flows

As an alternative for the current arrows, you can also use the following flows. They can also be used to indicate thermal or power flows. The syntax is pretty the same as for currents.

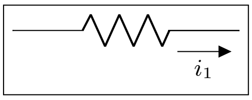
This is a new beta feature since version 0.8.3; therefore, please provide bug reports or hints to optimize this feature regarding placement and appearance! This means that the appearance may change in the future!



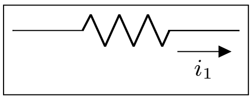

```
\begin{circuitikz}
  \draw (0,0) to[R, f=$i_1$] (3,0);
\end{circuitikz}
```



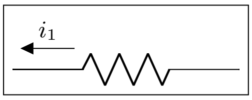

```
\begin{circuitikz}
  \draw (0,0) to[R, f<=$i_1$] (3,0);
\end{circuitikz}
```



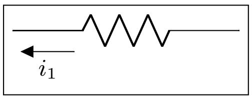

```
\begin{circuitikz}
  \draw (0,0) to[R, f_=$i_1$] (3,0);
\end{circuitikz}
```



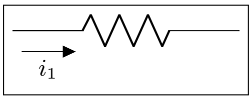

```
\begin{circuitikz}
  \draw (0,0) to[R, f_>=$i_1$] (3,0);
\end{circuitikz}
```




```
\begin{circuitikz}
  \draw (0,0) to[R, f<^=$i_1$] (3,0);
\end{circuitikz}
```




```
\begin{circuitikz}
  \draw (0,0) to[R, f<_=$i_1$] (3,0);
\end{circuitikz}
```



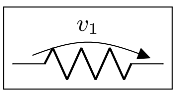

```
\begin{circuitikz}
  \draw (0,0) to[R, f>_=$i_1$] (3,0);
\end{circuitikz}
```

4.5 Voltages

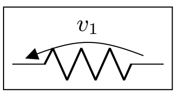
See introduction note at Currents (chapter 4.2, page 78)!

4.5.1 European style

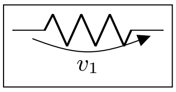
The default, with arrows. Use option `europeanvoltage` or style `[european voltages]`.



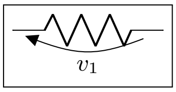

```
\begin{circuitikz}[european voltages]
  \draw (0,0) to[R, v^>=$v_1$] (2,0);
\end{circuitikz}
```



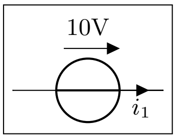

```
\begin{circuitikz}[european voltages]
  \draw (0,0) to[R, v^<=$v_1$] (2,0);
\end{circuitikz}
```



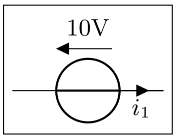

```
\begin{circuitikz}[european voltages]
  \draw (0,0) to[R, v_>=$v_1$] (2,0);
\end{circuitikz}
```



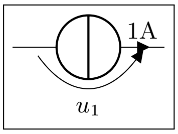

```
\begin{circuitikz}[european voltages]
  \draw (0,0) to[R, v_<=$v_1$] (2,0);
\end{circuitikz}
```



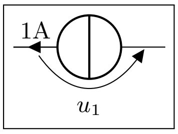

```
\begin{circuitikz}
  \draw (0,0) to[V=10V, i_=$i_1$] (2,0);
\end{circuitikz}
```



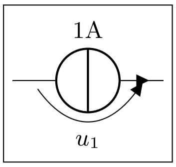

```
\begin{circuitikz}
  \draw (0,0) to[V<=10V, i_=$i_1$] (2,0);
\end{circuitikz}
```



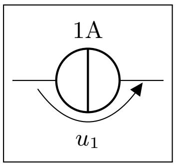

```
\begin{circuitikz}
  \draw (0,0) to[I=1A, v_=$u_1$] (2,0);
\end{circuitikz}
```



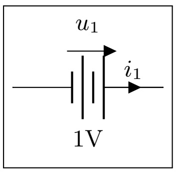

```
\begin{circuitikz}
  \draw (0,0) to[I<=1A, v_=$u_1$] (2,0);
\end{circuitikz}
```




```
\begin{circuitikz}
  \draw (0,0) to[I=$~$,l=1A, v_=$u_1$] (2,0);
\end{circuitikz}
```



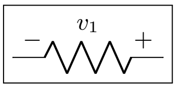

```
\begin{circuitikz}
  \draw (0,0) to[I,l=1A, v_=$u_1$] (2,0);
\end{circuitikz}
```



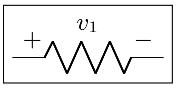

```
\begin{circuitikz}
  \draw (0,0) to[battery,l_=1V, v=$u_1$, i=$i_1$] (2,0);
\end{circuitikz}
```

4.5.2 American style

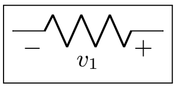
Use option `americanvoltage` or set `[american voltages]`.



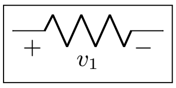

```
\begin{circuitikz}[american voltages]
  \draw (0,0) to[R, v^>=$v_1$] (2,0);
\end{circuitikz}
```



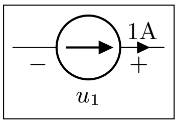

```
\begin{circuitikz}[american voltages]
  \draw (0,0) to[R, v^<=$v_1$] (2,0);
\end{circuitikz}
```



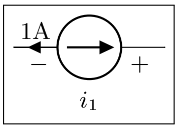

```
\begin{circuitikz}[american voltages]
  \draw (0,0) to[R, v_>=$v_1$] (2,0);
\end{circuitikz}
```




```
\begin{circuitikz}[american voltages]
  \draw (0,0) to[R, v_<=$v_1$] (2,0);
\end{circuitikz}
```



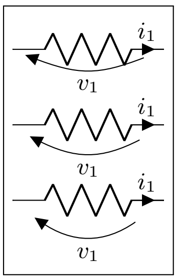

```
\begin{circuitikz}[american]
  \draw (0,0) to[I=1A, v_=$u_1$] (2,0);
\end{circuitikz}
```



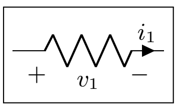

```
\begin{circuitikz}[american]
  \draw (0,0) to[I<=1A, v_=$i_1$] (2,0);
\end{circuitikz}
```

4.5.3 Voltage position

It is possible to move away the arrows and the plus or minus signs with the key `voltages shift` (default value is `0`, which gives the standard position):

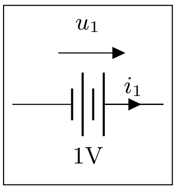



```
\begin{circuitikz}[]
  \draw (0,0) to[R, v=$v_1$, i=$i_1$] (2,0);
  \draw (0,-1) to[R, v=$v_1$, i=$i_1$,
    voltage shift=0.5] (2,-1);
  \draw (0,-2) to[R, v=$v_1$, i=$i_1$,
    voltage shift=1.0, ] (2,-2);
\end{circuitikz}
```

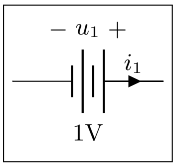



```
\begin{circuitikz}[american voltages, voltage shift=0.5]
  \draw (0,0) to[R, v=$v_1$, i=$i_1$] (2,0);
\end{circuitikz}
```

Notes that `american voltage` also affects batteries.



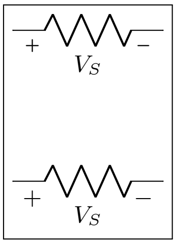

```
  \begin{circuitikz}[voltage shift=0.5]
  \draw (0,0) to[battery,l_=1V, v=$u_1$, i=$i_1$] (2,0);
\end{circuitikz}
```




```
\begin{circuitikz}[american voltages, voltage shift=0.5]
  \draw (0,0) to[battery,l_=1V, v=$u_1$, i=$i_1$] (2,0);
\end{circuitikz}
```

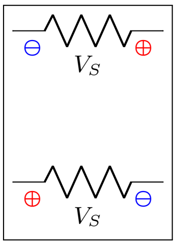
4.5.4 American voltages customization

Since 0.9.0, you can change the font[14] used by the `american voltages` style, by setting to something different from nothing the key `voltage/american font` (default: nothing, using the current font) style:



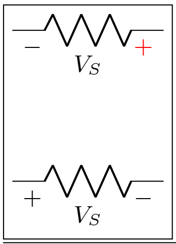

```
\begin{circuitikz}[american]
    \begin{scope}
        \ctikzset{voltage/american font=\tiny\boldmath}
        \draw (0,0) to[R,v=$V_S$] ++(2,0);
    \end{scope}
    \draw (0,-2) to[R,v=$V_S$] ++(2,0);
\end{circuitikz}
```

Also, if you want to change the symbols (sometime just the + sign is drawn, for example, or for highlighting something), using the keys `voltage/american plus` and `voltage/american minus` (default `$+$` and `$-$`).




```
\begin{circuitikz}[american]
    \ctikzset{voltage/american font=\scriptsize\boldmath}
    \ctikzset{voltage/american plus=\textcolor{red}{$\oplus$}}
    \ctikzset{voltage/american minus=\textcolor{blue}{$\ominus$}}
    \draw (0,0) to[R,v_>=$V_S$] ++(2,0);
    \draw (0,-2) to[R,v_<=$V_S$] ++(2,0);
\end{circuitikz}
```

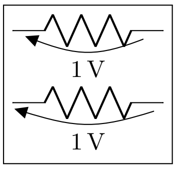
This could be especially useful if you define a style, to use like this:



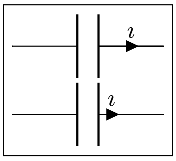

```
\tikzset{red plus/.style={
    circuitikz/voltage/american plus=\textcolor{red}{$+$},
}}
\begin{circuitikz}[american]
    \draw (0,0) to[R,v_>=$V_S$, red plus] ++(2,0);
    \draw (0,-2) to[R,v_<=$V_S$] ++(2,0);
\end{circuitikz}
```

[14]There where a bug before, noticed by the user `dzereb` on tex.stackexchange.com which made the symbols using different fonts in a basically random way. In the same page, user `campa` found the problem. Thanks!

4.5.5 Global properties of voltages and currents

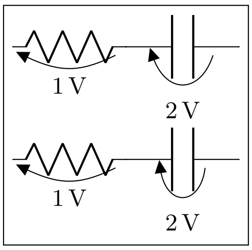



```
\tikz \draw (0,0) to[R, v=1<\volt>] (2,0); \par
\ctikzset{voltage/distance from node=.1}
\tikz \draw (0,0) to[R, v=1<\volt>] (2,0);
```




```
\tikz \draw (0,0) to[C, i=$\imath$] (2,0); \par
\ctikzset{current/distance = .2}
\tikz \draw (0,0) to[C, i=$\imath$] (2,0);
```

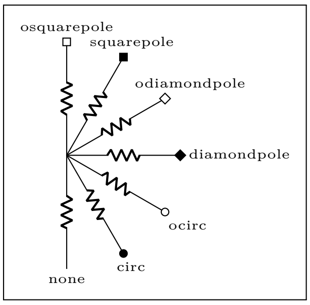
However, you can override the properties `voltage/distance from node`[15], `voltage/bump b`[16] and `voltage/european label di` on a per-component basis, in order to fine-tune the voltages:




```
\tikz \draw (0,0) to[R, v=1<\volt>] (1.5,0)
      to[C, v=2<\volt>] (3,0); \par
\ctikzset{bipoles/capacitor/voltage/%
    distance from node/.initial=.7}
\tikz \draw (0,0) to[R, v=1<\volt>] (1.5,0)
      to[C, v=2<\volt>] (3,0); \par
```

4.6 Nodes (also called poles)

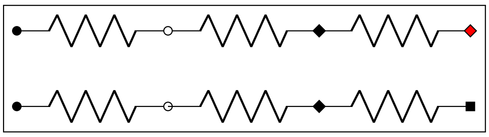
You can add nodes to the bipoles, positioned at the coordinates surrounding the component. The general style to use is `bipole nodes={start}{stop}`, where `start` and `stop` are the nodes — to be chosen between `none`, `circ`, `ocirc`, `squarepole`, `osquarepole`, `diamondpole`, `odiamondpole` and `rectfill`[18] (see section 3.24).




```
\begin{circuitikz}
   \ctikzset{bipoles/length=.5cm, nodes width=0.1}%small
        components, big nodes
   \foreach \a/\p [evaluate=\a as \b using (\a+180)] in
   {-90/none, -60/circ, -30/ocirc, 0/diamondpole, 30/
        odiamondpole, 60/squarepole, 90/osquarepole}
      \draw (0,0) to[R, bipole nodes={none}{\p}] ++(\a:1.5)
          node[font=\tiny, anchor=\b]{\p};
\end{circuitikz}
```

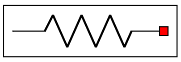
These bipole nodes are added after the path is drawn, as every node in Ti*k*Z — this is the reason why they are always filled (with the main color the normal nodes, with white the open ones), in order to “hide” the wire below. You can override the fill color if you want; but notice that if you draw things in two different paths, you will have “strange” results; notice that in the second line of resistors the second wire is starting from the center of the white `ocirc` of the previous path.

[15] That is, how distant from the initial and final points of the path the arrow starts and ends.
[16] Controlling how high the bump of the arrow is — how curved it is.
[17] Controlling how distant from the bipole the voltage label will be.
[18] You can use other shapes too, but at your own risk…Moreover, notice that `none` is not really a node, just a special word used to say “do not put any node here”.



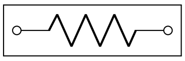
```
\begin{circuitikz}
   \draw (0,0) to[R, *-o] ++(2,0) to[R, -d] ++(2,0)
      to[R, bipole nodes={diamondpole}{odiamondpole, fill=red}] ++(2,0);
   \draw (0,-1) to[R, *-o] ++(2,0) ;
   \draw (2,-1) to[R, -d] ++(2,0) to[R, bipole nodes={none}{squarepole}] ++(2,0);
\end{circuitikz}
```

You can define shortcuts for the `bipole bodes` you use most; for example if you want a shortcut for a bipole with open square node in red in the right side you can:

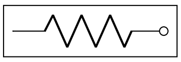


```
\begin{circuitikz}
   \ctikzset{-s/.style = {bipole nodes={none}{osquarepole, fill=red}}}
   \draw (0,0) to[R, -s] ++(2,0);
\end{circuitikz}
```

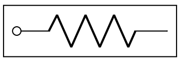
There are several predefined shorthand as the above; in the following pages you can see all of them.



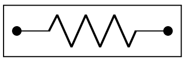
```
\begin{circuitikz}
  \draw (0,0) to[R, o-o] (2,0);
\end{circuitikz}
```



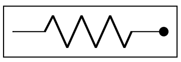
```
\begin{circuitikz}
  \draw (0,0) to[R, -o] (2,0);
\end{circuitikz}
```



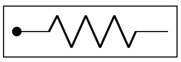
```
\begin{circuitikz}
  \draw (0,0) to[R, o-] (2,0);
\end{circuitikz}
```



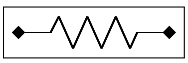
```
\begin{circuitikz}
  \draw (0,0) to[R, *-*] (2,0);
\end{circuitikz}
```



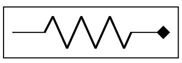
```
\begin{circuitikz}
  \draw (0,0) to[R, -*] (2,0);
\end{circuitikz}
```



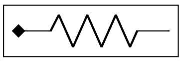
```
\begin{circuitikz}
  \draw (0,0) to[R, *-] (2,0);
\end{circuitikz}
```



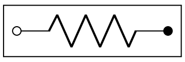
```
\begin{circuitikz}
  \draw (0,0) to[R, d-d] (2,0);
\end{circuitikz}
```



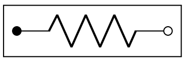
```
\begin{circuitikz}
  \draw (0,0) to[R, -d] (2,0);
\end{circuitikz}
```



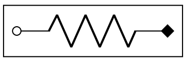
```
\begin{circuitikz}
  \draw (0,0) to[R, d-] (2,0);
\end{circuitikz}
```



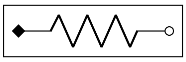
```
\begin{circuitikz}
  \draw (0,0) to[R, o-*] (2,0);
\end{circuitikz}
```



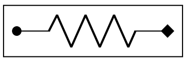
```
\begin{circuitikz}
  \draw (0,0) to[R, *-o] (2,0);
\end{circuitikz}
```



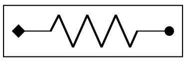
```
\begin{circuitikz}
  \draw (0,0) to[R, o-d] (2,0);
\end{circuitikz}
```



```
\begin{circuitikz}
  \draw (0,0) to[R, d-o] (2,0);
\end{circuitikz}
```



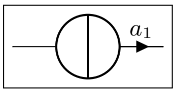
```
\begin{circuitikz}
  \draw (0,0) to[R, *-d] (2,0);
\end{circuitikz}
```



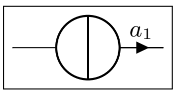
```
\begin{circuitikz}
  \draw (0,0) to[R, d-*] (2,0);
\end{circuitikz}
```

4.7 Special components

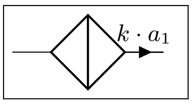
For some components label, current and voltage behave as one would expect:



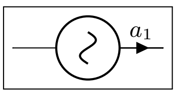

```
\begin{circuitikz}
  \draw (0,0) to[I=$a_1$] (2,0);
\end{circuitikz}
```



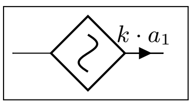

```
\begin{circuitikz}
  \draw (0,0) to[I, i=$a_1$] (2,0);
\end{circuitikz}
```




```
\begin{circuitikz}
  \draw (0,0) to[cI=$k\cdot a_1$] (2,0);
\end{circuitikz}
```

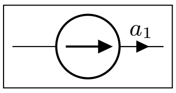



```
\begin{circuitikz}
  \draw (0,0) to[sI=$a_1$] (2,0);
\end{circuitikz}
```

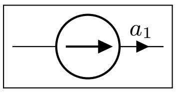



```
\begin{circuitikz}
  \draw (0,0) to[csI=$k\cdot a_1$] (2,0);
\end{circuitikz}
```

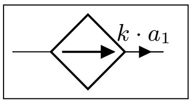
The following results from using the option `americancurrent` or using the style `[american currents]`.



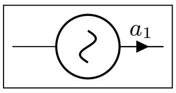

```
\begin{circuitikz}[american currents]
  \draw (0,0) to[I=$a_1$] (2,0);
\end{circuitikz}
```



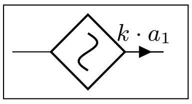

```
\begin{circuitikz}[american currents]
  \draw (0,0) to[I, i=$a_1$] (2,0);
\end{circuitikz}
```




```
\begin{circuitikz}[american currents]
  \draw (0,0) to[cI=$k\cdot a_1$] (2,0);
\end{circuitikz}
```

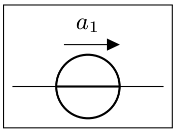



```
\begin{circuitikz}[american currents]
  \draw (0,0) to[sI=$a_1$] (2,0);
\end{circuitikz}
```

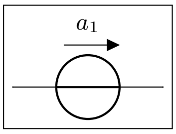



```
\begin{circuitikz}[american currents]
  \draw (0,0) to[csI=$k\cdot a_1$] (2,0);
\end{circuitikz}
```

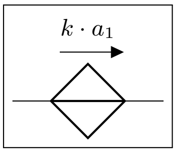
The same holds for voltage sources:



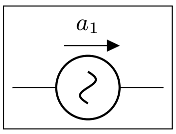

```
\begin{circuitikz}
  \draw (0,0) to[V=$a_1$] (2,0);
\end{circuitikz}
```



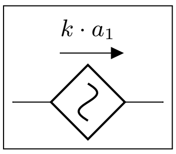

```
\begin{circuitikz}
  \draw (0,0) to[V, v=$a_1$] (2,0);
\end{circuitikz}
```




```
\begin{circuitikz}
  \draw (0,0) to[cV=$k\cdot a_1$] (2,0);
\end{circuitikz}
```

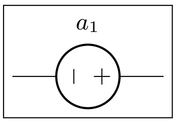



```
\begin{circuitikz}
  \draw (0,0) to[sV=$a_1$] (2,0);
\end{circuitikz}
```

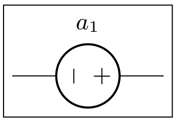



```
\begin{circuitikz}
  \draw (0,0) to[csV=$k\cdot a_1$] (2,0);
\end{circuitikz}
```

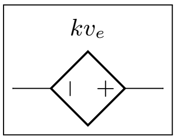
The following results from using the option `americanvoltage` or the style `[american voltages]`.



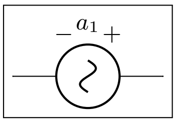

```
\begin{circuitikz}[american voltages]
  \draw (0,0) to[V=$a_1$] (2,0);
\end{circuitikz}
```



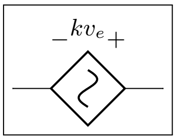

```
\begin{circuitikz}[american voltages]
  \draw (0,0) to[V, v=$a_1$] (2,0);
\end{circuitikz}
```




```
\begin{circuitikz}[american voltages]
  \draw (0,0) to[cV=$k v_e$] (2,0);
\end{circuitikz}
```



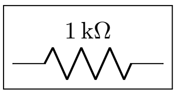

```
\begin{circuitikz}[american voltages]
  \draw (0,0) to[sV=$a_1$] (2,0);
\end{circuitikz}
```



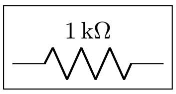

```
\begin{circuitikz}[american voltages]
  \draw (0,0) to[csV=$k v_e$] (2,0);
\end{circuitikz}
```

4.8 Integration with siunitx

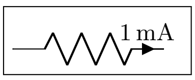
If the option `siunitx` is active (and *not* in ConTEXt), then the following are equivalent:



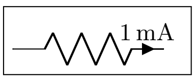

```
\begin{circuitikz}
  \draw (0,0) to[R, l=1<\kilo\ohm>] (2,0);
\end{circuitikz}
```



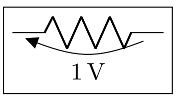

```
\begin{circuitikz}
  \draw (0,0) to[R, l=$\SI{1}{\kilo\ohm}$] (2,0);
\end{circuitikz}
```



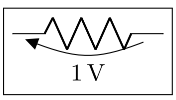

```
\begin{circuitikz}
  \draw (0,0) to[R, i=1<\milli\ampere>] (2,0);
\end{circuitikz}
```




```
\begin{circuitikz}
  \draw (0,0) to[R, i=$\SI{1}{\milli\ampere}$] (2,0);
\end{circuitikz}
```



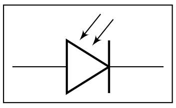

```
\begin{circuitikz}
  \draw (0,0) to[R, v=1<\volt>] (2,0);
\end{circuitikz}
```



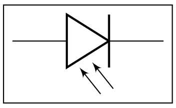

```
\begin{circuitikz}
  \draw (0,0) to[R, v=$\SI{1}{\volt}$] (2,0);
\end{circuitikz}
```

4.9 Mirroring and Inverting

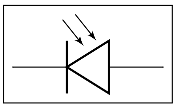
Bipole paths can also mirrored and inverted (or reverted) to change the drawing direction.



```
\begin{circuitikz}
  \draw (0,0) to[pD] (2,0);
\end{circuitikz}
```

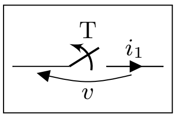


```
\begin{circuitikz}
  \draw (0,0) to[pD, mirror] (2,0);
\end{circuitikz}
```

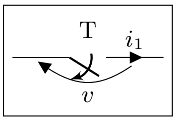


```
\begin{circuitikz}
  \draw (0,0) to[pD, invert] (2,0);
\end{circuitikz}
```

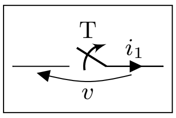
Placing labels, currents and voltages works also, please note, that mirroring and inverting does not influence the positioning of labels and voltages. Labels are by default above/right of the bipole and voltages below/left, respectively.



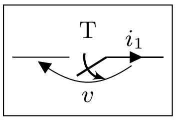

```
\begin{circuitikz}
  \draw (0,0) to[ospst=T, i=$i_1$, v=$v$] (2,0);
\end{circuitikz}
```




```
\begin{circuitikz}
  \draw (0,0) to[ospst=T, mirror, i=$i_1$, v=$v$] (2,0);
\end{circuitikz}
```

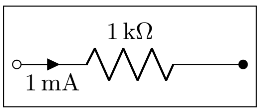



```
\begin{circuitikz}
  \draw (0,0) to[ospst=T, invert, i=$i_1$, v=$v$] (2,0);
\end{circuitikz}
```

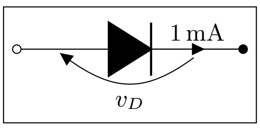



```
\begin{circuitikz}
  \draw (0,0) to[ospst=T,mirror,invert, i=$i_1$, v=$v$] (2,0);
\end{circuitikz}
```

4.10 Putting them together



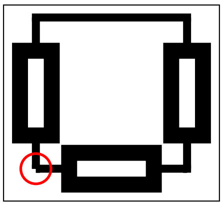

```
\begin{circuitikz}
  \draw (0,0) to[R=1<\kilo\ohm>,
     i>_=1<\milli\ampere>, o-*] (3,0);
\end{circuitikz}
```




```
\begin{circuitikz}
  \draw (0,0) to[D*, v=$v_D$,
     i=1<\milli\ampere>, o-*] (3,0);
\end{circuitikz}
```

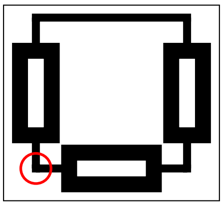
4.11 Line joins between Path Components

Line joins should be calculated correctly - if they are on the same path, and the path is not closed. For example, the following path is not closed correctly (–*cycle* does not work here!):



```
\begin{tikzpicture}[line width=3pt,european]
\draw (0,0) to[R]++(2,0)to[R]++(0,2)
   --++(-2,0)to[R]++(0,-2);
\draw[red,line width=1pt] circle(2mm);
\end{tikzpicture}
```

To correct the line ending, there are support shapes to fill the missing rectangle. They can be used like the support shapes (*,o,d) using a dot (.) on one or both ends of a component (have a look at the last resistor in this example:



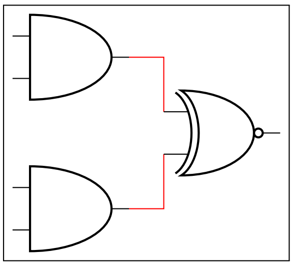
```
\begin{tikzpicture}[line width=3pt,european]
\draw (0,0) to[R]++(2,0)to[R]++(0,2)
   --++(-2,0)to[R,-.]++(0,-2);
\draw[red,line width=1pt] circle(2mm);
\end{tikzpicture}
```

5 Colors

5.1 Shape colors

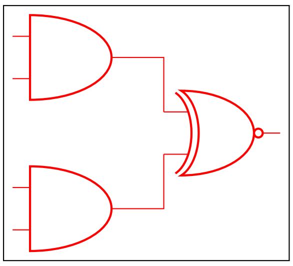
The color of the components is stored in the key `\circuitikzbasekey/color`. CircuiTi*k*Z tries to follow the color set in Ti*k*Z, although sometimes it fails. If you change color in the picture, please do not use just the color name as a style, like `[red]`, but rather assign the style `[color=red]`.

Compare for instance



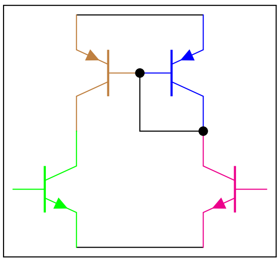
```
\begin{circuitikz} \draw[red]
  (0,2) node[and port] (myand1) {}
  (0,0) node[and port] (myand2) {}
  (2,1) node[xnor port] (myxnor) {}
  (myand1.out) -| (myxnor.in 1)
  (myand2.out) -| (myxnor.in 2)
;\end{circuitikz}
```

and



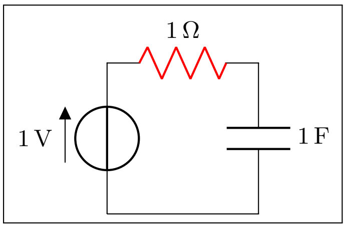
```
\begin{circuitikz} \draw[color=red]
  (0,2) node[and port] (myand1) {}
  (0,0) node[and port] (myand2) {}
  (2,1) node[xnor port] (myxnor) {}
  (myand1.out) -| (myxnor.in 1)
  (myand2.out) -| (myxnor.in 2)
;\end{circuitikz}
```

One can of course change the color *in medias res*:



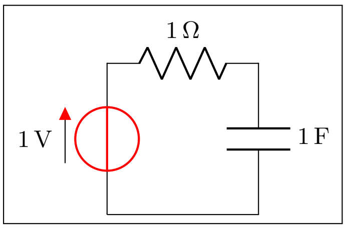
```
\begin{circuitikz} \draw
  (0,0) node[pnp, color=blue] (pnp2) {}
  (pnp2.B) node[pnp, xscale=-1, anchor=B, color=brown] (pnp1) {}
  (pnp1.C) node[npn, anchor=C, color=green] (npn1) {}
  (pnp2.C) node[npn, xscale=-1, anchor=C, color=magenta] (npn2) {}
  (pnp1.E) -- (pnp2.E) (npn1.E) -- (npn2.E)
  (pnp1.B) node[circ] {} |- (pnp2.C) node[circ] {}
;\end{circuitikz}
```

The all-in-one stream of bipoles poses some challanges, as only the actual body of the bipole, and not the connecting lines, will be rendered in the specified color. Also, please notice the curly braces around the `to`:



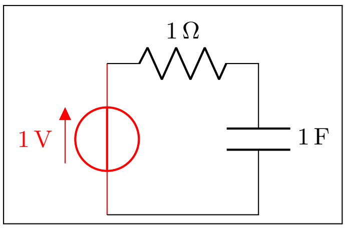

```
\begin{circuitikz} \draw
  (0,0) to[V=1<\volt>] (0,2)
      { to[R=1<\ohm>, color=red] (2,2) }
        to[C=1<\farad>] (2,0) -- (0,0)
;\end{circuitikz}
```

Which, for some bipoles, can be frustrating:




```
\begin{circuitikz} \draw
  (0,0){to[V=1<\volt>, color=red] (0,2) }
        to[R=1<\ohm>] (2,2)
        to[C=1<\farad>] (2,0) -- (0,0)
;\end{circuitikz}
```

The only way out is to specify different paths:

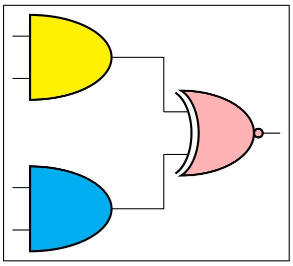



```
\begin{circuitikz} \draw[color=red]
  (0,0) to[V=1<\volt>, color=red] (0,2);
  \draw (0,2) to[R=1<\ohm>] (2,2)
        to[C=1<\farad>] (2,0) -- (0,0)
;\end{circuitikz}
```

And yes: this is a bug and *not* a feature...

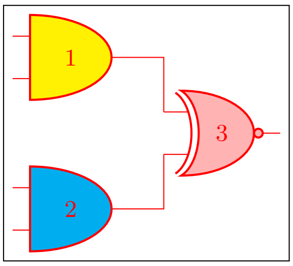
5.2 Fill colors

Since version 0.9.0, you can also fill most shapes with a color (the manual specifies which ones are fillable or not). The syntax is quite intuitive:



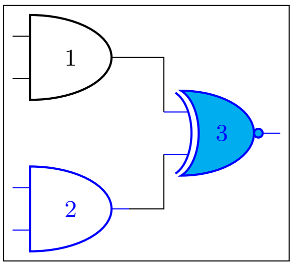
```
\begin{circuitikz} \draw
    (0,2) node[and port, fill=yellow] (myand1) {}
    (0,0) node[and port, fill=cyan] (myand2) {}
    (2,1) node[xnor port,fill=red!30!white] (myxnor) {}
  (myand1.out) -| (myxnor.in 1)
  (myand2.out) -| (myxnor.in 2)
;\end{circuitikz}
```

You can combine shape colors with fill colors, too, but you should use the `draw` color option style for this:



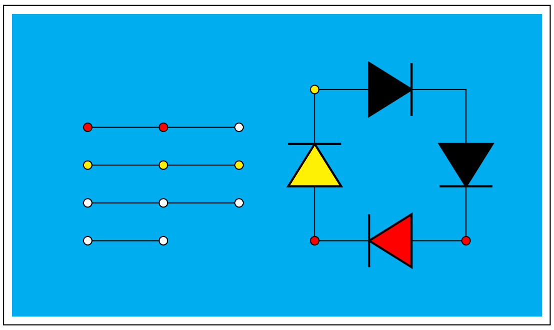

```
\begin{circuitikz} \draw[color=red]
    (0,2) node[and port, fill=yellow] (myand1) {1}
    (0,0) node[and port, fill=cyan] (myand2) {2}
    (2,1) node[xnor port,fill=red!30!white] (myxnor) {3}
  (myand1.out) -| (myxnor.in 1)
  (myand2.out) -| (myxnor.in 2)
;\end{circuitikz}
```

This is because, as you can see from the following example in port `2`, you can't specify both a fill and a color in the node (yes, it's a bug too, but it's quite complex to solve given the current circuitTi*k*Z architecture). a workaround is shown in port `3`:




```
\begin{circuitikz} \draw
  (0,2) node[and port, color=black] (myand1) {1}
  (0,0) node[and port, color=blue, fill=cyan] (myand2)
      {2}
  (2,1) {[color=blue] node[xnor port, fill=cyan] (myxnor
      ) {3}}
  (myand1.out) -| (myxnor.in 1)
  (myand2.out) -| (myxnor.in 2)
;\end{circuitikz}
```

Notice also that the connection point are always filled, although the color *tries* to follow the color of the filling of the component:



```
\begin{circuitikz}
    \fill[cyan] (0,3.0) rectangle (7,7);
    \draw [fill=yellow, ] (4,4) to [D,o-o] ++(0,2) to[D*, fill=yellow] ++(2,0)
    to[D*] ++(0,-2) to[D, fill=red, o-o] ++(-2,0);
    \draw (1,4) node[ocirc]{} -- ++(1,0) node[ocirc]{};
    \draw (1,4.5) to[short, o-o] ++(1,0) to[short, -o] ++(1,0);
    \draw[fill=yellow] (1,5) to[short, o-o] ++(1,0) to[short, -o] ++(1,0);
    \draw (1,5.5) to[short, fill=red, o-o] ++(1,0) to[short, -o] ++(1,0);
\end{circuitikz}
```

6 FAQ

Q: When using `\tikzexternalize` I get the following error:

```
! Emergency stop.
```

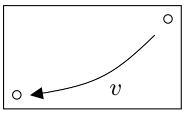
A: The Ti*k*Z manual states:

> Furthermore, the library assumes that all LaTeX pictures are ended with `\end{tikzpicture}`.

Just substitute every occurrence of the environment `circuitikz` with `tikzpicture`. They are actually pretty much the same.

Q: How do I draw the voltage between two nodes?

A: Between any two nodes there is an open circuit!




```
\begin{circuitikz} \draw
 node[ocirc] (A) at (0,0) {}
 node[ocirc] (B) at (2,1) {}
 (A) to[open, v=$v$] (B)
;\end{circuitikz}
```

Q: I cannot write `to[R = $R_1=12V$]` nor `to[ospst = open, 3s]`: I get errors.

A: It is a limitation of the parser.

Use `\def{\eq}{=}` `to[R = $R_1\eq 12V$]` and `to[ospst = open{,} 3s]` instead; see caveat in section 4.1.

Q: I tried to change the direction of the y axis with `yscale=-1`, but the circuit is completely messed up.

A: Yes, it's a known bug (or misfeature, or limitation). See section 1.7. Don't do that.

Q: I tried to put a diode in a `pic`, but it's coming out badly rotated.

A: Yes, it's a known bug (or misfeature, or limitation). See section 1.7. CircuiTi*k*Z is not compatible with `pics` at this point.

7 Defining new components

Per me si va ne la città dolente,
per me si va ne l'etterno dolore,
per me si va tra la perduta gente.
...
Lasciate ogne speranza, voi ch'intrate.[19]

Big fat warning: this material is reserved to TEX-hackers; do not delve into this if you have no familiarity with (at least) a bit of core TEX programming and to the basic Ti*k*Z layer. You have been warned.

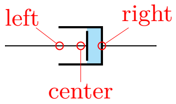
7.1 Suggested setup

The suggested way to start working on a new component is to use the utilities of the CircuiTi*k*Z manual for checking and testing your device. Basically, find (or download) the source code of the last version of CircuiTi*k*Z and find the file `ctikzmanutils.sty`; copy it in your directory and prepare a file like this:

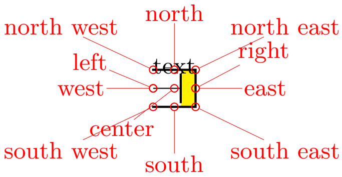
```
\documentclass[a4paper, titlepage]{article}
\usepackage{a4wide} %smaller borders
\usepackage[utf8]{inputenc}
\usepackage[T1]{fontenc}
\parindent=0pt
\parskip=4pt plus 6pt minus 2pt
\usepackage[siunitx, RPvoltages]{circuitikz}
\usepackage{ctikzmanutils}
\makeatletter
%% Test things here
% defines

% components

% paths
\makeatother

\begin{document}

\circuitdescbip*{damper}{Mechanical damping}{}(left/135/0.2, right/45/0.2,
    center/-90/0.3)

\geolrcoord{dampershape, fill=yellow}

\begin{LTXexample}[varwidth]
\begin{circuitikz}
    \draw (0,0) to[R] ++(2,0)
    to[damper] ++(2,0);
\end{circuitikz}
\end{LTXexample}
\end{document}
```

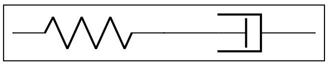
This will compile to something like this (in this case, we are using a couple of existing components to check everything is ok):

[19] https://classicsincontext.wordpress.com/2010/02/28/canto-iii-per-me-si-va-ne-la-citta-dolente/



`damper`: Mechanical damping, type: `path-style, fillable, nodename: dampershape`.





```
\begin{circuitikz}
    \draw (0,0) to[R] ++(2,0)
    to[damper] ++(2,0);
\end{circuitikz}
```

The command `circuitdescbip*` is used to show the component description (you can check the definition and the usage looking at `ctikzmanutils.sty` file, and the `\geolrcoord` is used to show the main anchors (geographical plus `left` and `right`) of the component.

From now on, you can add the new commands for the component between the `\makeatletter` and `\makeatother` commands and, modifying the example, check the results.

7.2 Path-style component

Let's define for example a path style component, like the one suggested by the user `@alex` on tex.stackexchange.com. The component will be a mix of the `damper` and the `spring` components already present.

The first step is to check if we can use the definition already existing for similar elements (for coherence of size) or if we need to define new ones; for this you have to check the file `pgfcirc.defines.tex`: we find

```
    \ctikzset{bipoles/spring/height/.initial=.5}
    \ctikzset{bipoles/spring/width/.initial=.5}
    \ctikzset{bipoles/damper/height/.initial=.35}
    \ctikzset{bipoles/damper/length/.initial=.3}
    \ctikzset{bipoles/damper/width/.initial=.4}
```

We will use them; at this stage you can decide to add other parameters if you need them. (Notice, however, than although flexibility is good, these parameters should be described in the manual, otherwise they're as good as a fixed number in the code).

To define the new component we will look into `pgfcircbipoles.tex` and we will copy, for example, the definition of the damper into our code, just changing the name:

```
%% mechanical resistor - damper
\pgfcircdeclarebipole
{}                                 % extra anchors
{\ctikzvalof{bipoles/damper/height}} % depth (under the path line)
{viscoe}                           % name
{\ctikzvalof{bipoles/damper/height}} % height (above the path line)
{\ctikzvalof{bipoles/damper/width}} % width
{ % draw the bipole
    \pgfpathrectanglecorners{\pgfpoint{\ctikzvalof{bipoles/damper/length}\
        pgf@circ@res@right}{\pgf@circ@res@down}}{\pgfpoint{\pgf@circ@res@right
        }{\pgf@circ@res@up}}
    \pgf@circ@maybefill

    % line into the damper
```

```
    \pgfpathmoveto{\pgfpoint{\pgf@circ@res@left}{\pgf@circ@res@zero}}
    \pgfpathlineto{\pgfpoint{\ctikzvalof{bipoles/damper/length}\pgf@circ@res@right}
        {\pgf@circ@res@zero}}
    \pgfusepath{stroke}

    % damper box
    \pgfsetlinewidth{\pgfkeysvalueof{/tikz/circuitikz/bipoles/thickness}\pgfstartlinewidth}
    \pgfpathmoveto{\pgfpoint{\pgf@circ@res@left}{\pgf@circ@res@down}}
    \pgfpathlineto{\pgfpoint{\pgf@circ@res@right}{\pgf@circ@res@down}}
    \pgfpathlineto{\pgfpoint{\pgf@circ@res@right}{\pgf@circ@res@up}}
    \pgfpathlineto{\pgfpoint{\pgf@circ@res@left}{\pgf@circ@res@up}}

    \pgfsetrectcap
    \pgfsetmiterjoin
    \pgfusepath{stroke}

    % damper vertical element
    \pgfpathmoveto{\pgfpoint{\ctikzvalof{bipoles/damper/length}\pgf@circ@res@right}
        {.8\pgf@circ@res@down}}
    \pgfpathlineto{\pgfpoint{\ctikzvalof{bipoles/damper/length}\pgf@circ@res@right}
        {.8\pgf@circ@res@up}}
    \pgfsetbuttcap
    \pgfusepath{stroke}
}
```

This command will define a shape that is named `viscoeshape`, with all the correct geographical anchors based on the depth, height and width defined in the parameters of `\pgfcircdeclarebipole`. This is not sufficient for using the element in a `to[]` path command; you need to "activate" it with (this commands are normally in `pgfcircpath.tex`):

```
\def\pgf@circ@viscoe@path#1{\pgf@circ@bipole@path{viscoe}{#1}}
\compattikzset{viscoe/.style = {\circuitikzbasekey,
      /tikz/to path=\pgf@circ@dviscoe@path, l=#1}}
```

And now you can show it with:

```
\circuitdescbip*{viscoe}{Mechanical viscoelastic element\footnotemark}{}(left/135/0.2, right/45/0.2, center/-90/0.3)

\geolrcoord{viscoeshape, fill=yellow}

\begin{LTXexample}[varwidth]
\begin{circuitikz}
    \draw (0,0) to[spring] ++(2,0)
    to[viscoe] ++(2,0);
\end{circuitikz}
\end{LTXexample}
```

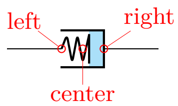
Obviously, at first you you just have a component that is the same as the one you copied with another name. It is now just a matter of modifying it so that it has the desired shape; in the example above you can already see the new symbol after the changes.

When doing the drawing, the `\pgfcircdeclarebipole` will setup the lengths `\pgf@circ@res@right` and `\pgf@circ@res@up` as the x-y coordinates of the upper right corner, and `\pgf@circ@res@left` and `\pgf@circ@res@down` as the x-y coordinates of the lower left corner of your shape. The `center` coordinate is usually at $(0pt, 0pt)$.

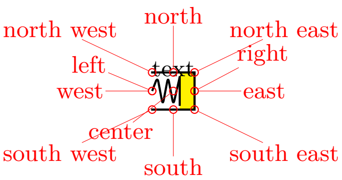
Looking at the implementation of the `spring` element, a possible implementation is changing the lines between lines 12 and 16 with:

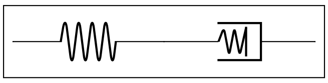
```
% spring into the damper
\pgfscope
    \pgfpathmoveto{\pgfpoint{\pgf@circ@res@left}{\pgf@circ@res@zero}}
    \pgfsetlinewidth{\pgfkeysvalueof{/tikz/circuitikz/bipoles/thickness}\
        pgfstartlinewidth}
    \pgfsetcornersarced{\pgfpoint{.25\pgf@circ@res@up}{.25\pgf@circ@res@up}}
    \pgfpathlineto{\pgfpoint{.75\pgf@circ@res@left}{.75\pgf@circ@res@up}}
    \pgfpathlineto{\pgfpoint{.5\pgf@circ@res@left}{-.75\pgf@circ@res@up}}
    \pgfpathlineto{\pgfpoint{.25\pgf@circ@res@left}{.75\pgf@circ@res@up}}
    \pgfpathlineto{\pgfpoint{0pt}{-.75\pgf@circ@res@up}}
    \pgfpathlineto{\pgfpoint{\ctikzvalof{bipoles/damper/length}\
        pgf@circ@res@right}{.75\pgf@circ@res@up}}
    \pgfusepath{stroke}
\endpgfscope
```

which leads to:



`viscoe`: Mechanical viscoelastic element, `type: path-style, fillable, nodename: viscoeshape`.





```
\begin{circuitikz}
    \draw (0,0) to[spring] ++(2,0)
    to[viscoe] ++(2,0);
\end{circuitikz}
```

As a final note, notice that the `viscoe` element is already added to the standard package.

7.3 Node-style component

Adding a node-style component is much more straightforward. Just define it by following examples in, for example, `pgfcirctripoles.tex` or the other files; be careful that you should define all the geographical anchors of the shape if you want that the Ti*k*Z positioning options (like `left`, `above`, etc.) behave correctly with your component.

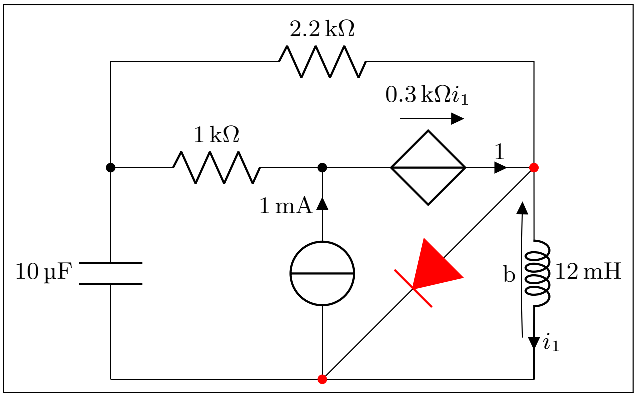
7.3.1 Finishing your work

Once you have a satisfactory element, you should

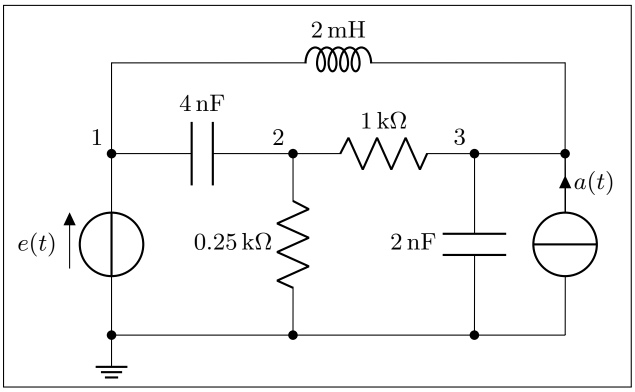
- Clean up your code;
- write a piece of documentation explaining its use, with an example;
- Propose the element for inclusion in the GitHub page of the project (you will have to license this as explained in that page, of course).

The best way of contributing is forking the project, adding your component in the correct files, modifying the manual and creating a pull request for the developers to merge. Anyway, if this is a problem, just open an issue and someone (when they have time...) will answer.

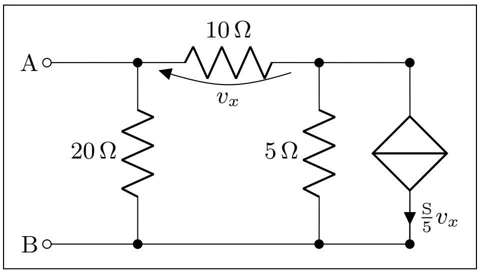
8 Examples



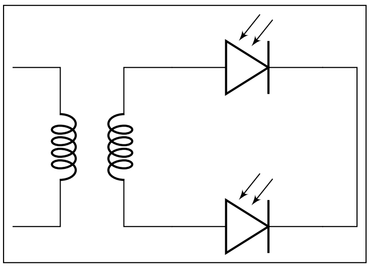

```
\begin{circuitikz}[scale=1.4]\draw
  (0,0) to[C, l=10<\micro\farad>] (0,2) -- (0,3)
        to[R, l=2.2<\kilo\ohm>] (4,3) -- (4,2)
        to[L, l=12<\milli\henry>, i=$i_1$,v=b] (4,0) -- (0,0)
  (4,2) { to[D*, *-*, color=red] (2,0) }
  (0,2) to[R, l=1<\kilo\ohm>, *-] (2,2)
        to[cV, i=1,v=$\SI{.3}{\kilo\ohm} i_1$] (4,2)
  (2,0) to[I, i=1<\milli\ampere>, -*] (2,2)
;\end{circuitikz}
```



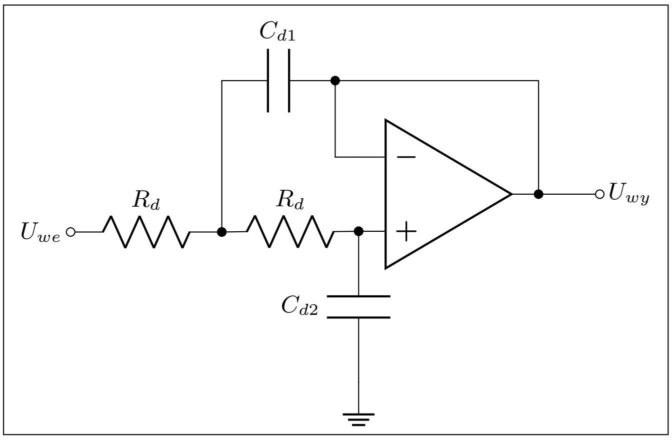

```
\begin{circuitikz}[scale=1.2]\draw
 (0,0) node[ground] {}
      to[V=$e(t)$, *-*] (0,2) to[C=4<\nano\farad>] (2,2)
      to[R, l_=.25<\kilo\ohm>, *-*] (2,0)
 (2,2) to[R=1<\kilo\ohm>] (4,2)
      to[C, l_=2<\nano\farad>, *-*] (4,0)
 (5,0) to[I, i_=$a(t)$, -*] (5,2) -- (4,2)
 (0,0) -- (5,0)
 (0,2) -- (0,3) to[L, l=2<\milli\henry>] (5,3) -- (5,2)

{[anchor=south east] (0,2) node {1} (2,2) node {2} (4,2) node {3}}
;\end{circuitikz}
```



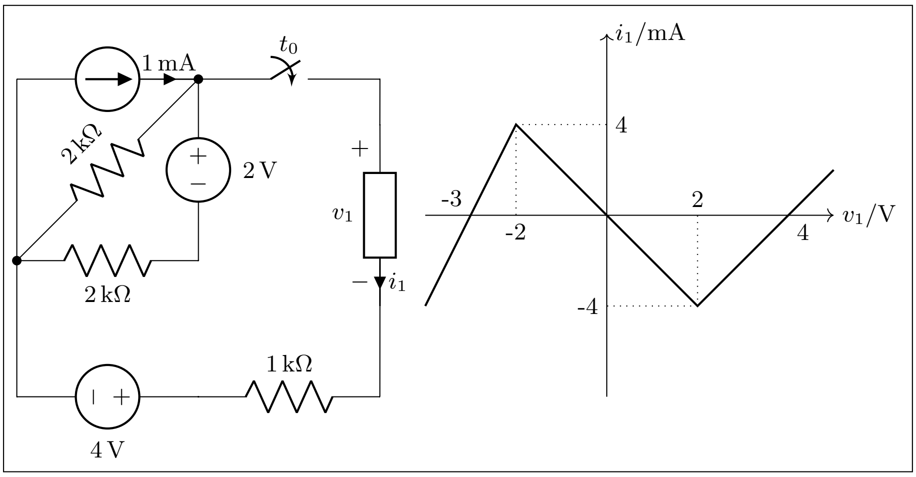

```
\begin{circuitikz}[scale=1.2]\draw
 (0,0) node[anchor=east] {B}
      to[short, o-*] (1,0)
      to[R=20<\ohm>, *-*] (1,2)
      to[R=10<\ohm>, v=$v_x$] (3,2) -- (4,2)
      to[cI=$\frac{\siemens}{5} v_x$, *-*] (4,0) -- (3,0)
      to[R=5<\ohm>, *-*] (3,2)
 (3,0) -- (1,0)
 (1,2) to[short, -o] (0,2) node[anchor=east]{A}
;\end{circuitikz}
```



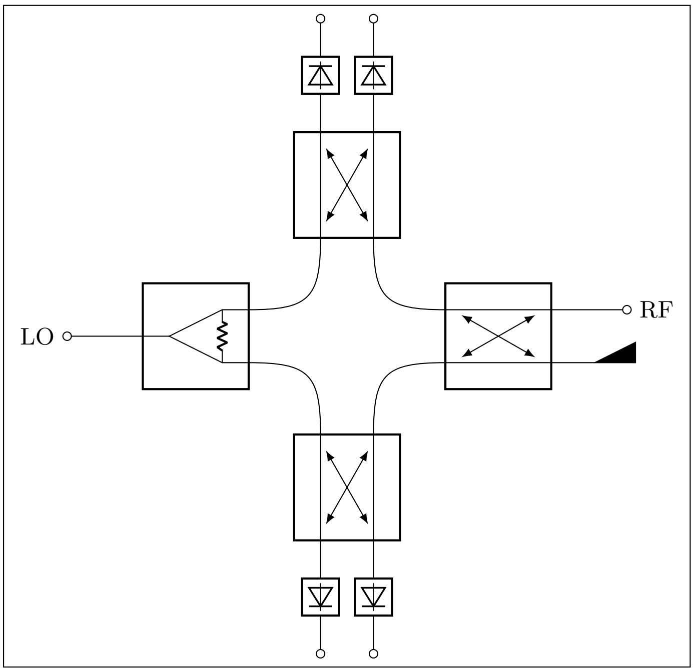
```
\begin{circuitikz}[scale=1]\draw
  (0,0) node[transformer] (T) {}
  (T.B2) to[pD] ($(T.B2)+(2,0)$) -| (3.5, -1)
  (T.B1) to[pD] ($(T.B1)+(2,0)$) -| (3.5, -1)
;\end{circuitikz}
```



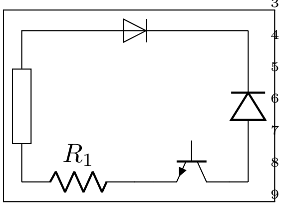

```
\begin{circuitikz}[scale=1]\draw
   (5,.5) node [op amp] (opamp) {}
   (0,0) node [left] {$U_{we}$} to [R, l=$R_d$, o-*] (2,0)
   to [R, l=$R_d$, *-*] (opamp.+)
   to [C, l_=$C_{d2}$, *-] ($(opamp.+)+(0,-2)$) node [ground] {}
   (opamp.out) |- (3.5,2) to [C, l_=$C_{d1}$, *-] (2,2) to [short] (2,0)
   (opamp.-) -| (3.5,2)
   (opamp.out) to [short, *-o] (7,.5) node [right] {$U_{wy}$}
;\end{circuitikz}
```




```
\begin{circuitikz}[scale=1.2, american]\draw
 (0,2) to[I=1<\milli\ampere>] (2,2)
      to[R, l_=2<\kilo\ohm>, *-*] (0,0)
      to[R, l_=2<\kilo\ohm>] (2,0)
      to[V, v_=2<\volt>] (2,2)
      to[cspst, l=$t_0$] (4,2) -- (4,1.5)
      to [generic, i=$i_1$, v=$v_1$] (4,-.5) -- (4,-1.5)
 (0,2) -- (0,-1.5) to[V, v_=4<\volt>] (2,-1.5)
      to [R, l=1<\kilo\ohm>] (4,-1.5);

  \begin{scope}[xshift=6.5cm, yshift=.5cm]
   \draw [->] (-2,0) -- (2.5,0) node[anchor=west] {$v_1/\volt$};
   \draw [->] (0,-2) -- (0,2) node[anchor=west] {$i_1/\SI{}{\milli\ampere}$} ;
   \draw (-1,0) node[anchor=north] {-2} (1,0) node[anchor=south] {2}
        (0,1) node[anchor=west] {4} (0,-1) node[anchor=east] {-4}
        (2,0) node[anchor=north west] {4}
        (-1.5,0) node[anchor=south east] {-3};
   \draw [thick] (-2,-1) -- (-1,1) -- (1,-1) -- (2,0) -- (2.5,.5);
   \draw [dotted] (-1,1) -- (-1,0) (1,-1) -- (1,0)
        (-1,1) -- (0,1) (1,-1) -- (0,-1);
  \end{scope}
\end{circuitikz}
```




```
\begin{circuitikz}[scale=1]
    \ctikzset{bipoles/detector/width=.35}
    \ctikzset{quadpoles/coupler/width=1}
    \ctikzset{quadpoles/coupler/height=1}
    \ctikzset{tripoles/wilkinson/width=1}
    \ctikzset{tripoles/wilkinson/height=1}
    %\draw[help lines,red,thin,dotted] (0,-5) grid (5,5);
    \draw
    (-2,0) node[wilkinson](w1){}
    (2,0) node[coupler] (c1) {}
    (0,2) node[coupler,rotate=90] (c2) {}
    (0,-2) node[coupler,rotate=90] (c3) {}
    (w1.out1) .. controls ++(0.8,0) and ++(0,0.8) .. (c3.3)
    (w1.out2) .. controls ++(0.8,0) and ++(0,-0.8) .. (c2.4)
    (c1.1) .. controls ++(-0.8,0) and ++(0,0.8) .. (c3.2)
    (c1.4) .. controls ++(-0.8,0) and ++(0,-0.8) .. (c2.1)
    (w1.in) to[short,-o] ++(-1,0)
    (w1.in) node[left=30] {LO}
    (c1.2) node[match,yscale=1] {}
    (c1.3) to[short,-o] ++(1,0)
    (c1.3) node[right=30] {RF}
    (c2.3) to[detector,-o] ++(0,1.5)
    (c2.2) to[detector,-o] ++(0,1.5)
    (c3.1) to[detector,-o] ++(0,-1.5)
    (c3.4) to[detector,-o] ++(0,-1.5)
    ;
\end{circuitikz}
```




```
\documentclass{standalone}

\usepackage{tikz}
\usetikzlibrary{circuits.ee.IEC}
\usetikzlibrary{positioning}

\usepackage[compatibility]{circuitikzgit}
\ctikzset{bipoles/length=.9cm}

\begin{document}
 \begin{tikzpicture}[circuit ee IEC]
  \draw (0,0) to [resistor={name=R}] (0,2)
   to[diode={name=D}] (3,2);
  \draw (0,0) to[*R=$R_1$] (1.5,0) to[*Tnpn] (3,0)
    to[*D](3,2);
 \end{tikzpicture}
\end{document}
```

9 Changelog

The major changes among the different circuitikz versions are listed here. See https://github.com/circuitikz/circuitikz/commits for a full list of changes.

- Version git (0.9.1, unreleased)
  - Bumped the version to 0.9.1 so it's clearly different in log from the released one.
  - Added old LaTeX versions for 0.8.3, 0.7, 0.6 and 0.4
  - Added the option to have inline transformers and gyrators
  - Added rotary switches
  - Added more configurable bipole nodes and more shapes
  - Added 7-segment displays
  - Added vacuum tubes by J. op den Brouw
  - Made the open shape of dcisources configurable
  - Made the arrows on vcc and vee configurable
  - Fixed anchors of diamondpole nodes
  - Fixed a bug (#205) about unstable anchors in the chip components
  - Fixed a regression in label placement for some values of scaling
  - Fixed problems with cute switches anchors
- Version 0.9.0 (2019-05-10)
  - Added Romano Giannetti as contributor
  - Added a CONTRIBUTING file
  - Added options for solving the voltage direction problems.
  - Adjusted ground symbols to better match ISO standard, added new symbols
  - Added new sources (cute european versions, noise sources)
  - Added new types of amplifiers, and option to flip inputs and outputs
  - Added bidirectional diodes (diac) thanks to Andre Lucas Chinazzo
  - Added L,R,C sensors (with european, american and cute variants)
  - Added stacked labels (thanks to the original work by Claudio Fiandrino)

- Make the position of voltage symbols adjustable
- Make the position of arrows in FETs and BJTs adjustable
- Added chips (DIP, QFP) with a generic number of pins
- Added special anchors for transformers (and fixed the wrong center anchor)
- Changed the logical port implementation to multiple inputs (thanks to John Kormylo) with border anchors.
- Added several symbols: bulb, new switches, new antennas, loudspeaker, microphone, coaxial connector, viscoelastic element
- Make most components fillable
- Added the oscilloscope component and several new instruments
- Added viscoelastic element
- Added a manual section on how to define new components
- Fixed american voltage symbols and allow to customize them
- Fixed placement of straightlabels in several cases
- Fixed a bug about straightlabels (thanks to @fotesan)
- Fixed labels spacing so that they are independent on scale factor
- Fixed the position of text labels in amplifiers

• Version 0.8.3 (2017-05-28)
  - Removed unwanted lines at to-paths if the starting point is a node without a explicit anchor.
  - Fixed scaling option, now all parts are scaled by bipoles/length
  - Surge arrester appears no more if a to path is used without []-options
  - Fixed current placement now possible with paths at an angle of around 280°
  - Fixed voltage placement now possible with paths at an angle of around 280°
  - Fixed label and annotation placement (at some angles position not changable)
  - Adjustable default distance for straight-voltages: 'bipoles/voltage/straight label distance'
  - Added Symbol for bandstop filter
  - New annotation type to show flows using f=... like currents, can be used for thermal, power or current flows

• Version 0.8.2 (2017-05-01)
  - Fixes pgfkeys error using alternatively specified mixed colors(see pgfplots manual section "4.7.5 Colors")
  - Added new switches "ncs" and "nos"
  - Reworked arrows at spst-switches
  - Fixed direction of controlled american voltage source
  - "v<=" and "i<=" do not rotate the sources anymore(see them as "counting direction indication", this can be different then the shape orientation); Use the option "invert" to change the direction of the source/apperance of the shape.
  - current label "i=" can now be used independent of the regular label "l=" at current sources
  - rewrite of current arrow placement. Current arrows can now also be rotated on zero-length paths
  - New DIN/EN compliant operational amplifier symbol "en amp"

• Version 0.8.1 (2017-03-25)
  - Fixed unwanted line through components if target coordinate is a name of a node
  - Fixed position of labels with subscript letters.

  - Absolute distance calculation in terms of ex at rotated labels
  - Fixed label for transistor paths (no label drawn)

- Version 0.8 (2017-03-08)
  - Allow use of voltage label at a [short]
  - Correct line joins between path components (to[...])
  - New Pole-shape .-. to fill perpendicular joins
  - Fixed direction of controlled american current source
  - Fixed incorrect scaling of magnetron
  - Fixed: Number of american inductor coils not adjustable
  - Fixed Battery Symbols and added new battery2 symbol
  - Added non-inverting Schmitttrigger

- Version 0.7 (2016-09-08)
  - Added second annotation label, showing, e.g., the value of an component
  - Added new symbol: magnetron
  - Fixed name conflict of diamond shape with tikz.shapes package
  - Fixed varcap symbol at small scalings
  - New packet-option "straightvoltages, to draw straight(no curved) voltage arrows
  - New option "invert" to revert the node direction at paths
  - Fixed american voltage label at special sources and battery
  - Fixed/rotated battery symbol(longer lines by default positive voltage)
  - New symbol Schmitttrigger

- Version 0.6 (2016-06-06)
  - Added Mechanical Symbols (damper,mass,spring)
  - Added new connection style diamond, use (d-d)
  - Added new sources voosource and ioosource (double zero-style)
  - All diode can now drawn in a stroked way, just use globel option "strokediode" or stroke instead of full/empty, or D-. Use this option for compliance with DIN standard EN-60617
  - Improved Shape of Diodes:tunnel diode, Zener diode, schottky diode (bit longer lines at cathode)
  - Reworked igbt: New anchors G,gate and new L-shaped form Lnigbt, Lpigbt
  - Improved shape of all fet-transistors and mirrored p-chan fets as default, as pnp, pmos, pfet are already. This means a backward-incompatibility, but smaller code, because p-channels mosfet are by default in the correct direction(source at top). Just remove the 'yscale=-1' from your p-chan fets at old pictures.

- Version 0.5 (2016-04-24)
  - new option boxed and dashed for hf-symbols
  - new option solderdot to enable/disable solderdot at source port of some fets
  - new parts: photovoltaic source, piezo crystal, electrolytic capacitor, electromechanical device(motor, generator)
  - corrected voltage and current direction(option to use old behaviour)
  - option to show body diode at fet transistors

- Version 0.4
  - minor improvements to documentation

- comply with TDS
- merge high frequency symbols by Stefan Erhardt
- added switch (not opening nor closing)
- added solder dot in some transistors
- improved ConTeXt compatibility

- Version 0.3.1
  - different management of color…
  - fixed typo in documentation
  - fixed an error in the angle computation in voltage and current routines
  - fixed problem with label size when scaling a tikz picture
  - added gas filled surge arrester
  - added compatibility option to work with Tikz's own circuit library
  - fixed infinite in arctan computation
- Version 0.3.0
  - fixed gate node for a few transistors
  - added mixer
  - added fully differential op amp (by Kristofer M. Monisit)
  - now general settings for the drawing of voltage can be overridden for specific components
  - made arrows more homogeneous (either the current one, or latex' bt pgf)
  - added the single battery cell
  - added fuse and asymmetric fuse
  - added toggle switch
  - added varistor, photoresistor, thermocouple, push button
  - added thermistor, thermistor ptc, thermistor ptc
  - fixed misalignment of voltage label in vertical bipoles with names
  - added isfet
  - added noiseless, protective, chassis, signal and reference grounds (Luigi «Liverpool»)
- Version 0.2.4
  - added square voltage source (contributed by Alistair Kwan)
  - added buffer and plain amplifier (contributed by Danilo Piazzalunga)
  - added squid and barrier (contributed by Cor Molenaar)
  - added antenna and transmission line symbols contributed by Leonardo Azzinnari
  - added the changeover switch spdt (suggestion of Fabio Maria Antoniali)
  - rename of context.tex and context.pdf (thanks to Karl Berry)
  - updated the email address
  - in documentation, fixed wrong (non-standard) labelling of the axis in an example (thanks to prof. Claudio Beccaria)
  - fixed scaling inconsistencies in quadrupoles
  - fixed division by zero error on certain vertical paths
  - introduced options straighlabels, rotatelabels, smartlabels
- Version 0.2.3
  - fixed compatibility problem with label option from tikz

- Fixed resizing problem for shape ground
- Variable capacitor
- polarized capacitor
- ConTeXt support (read the manual!)
- nfet, nigfete, nigfetd, pfet, pigfete, pigfetd (contribution of Clemens Helfmeier and Theodor Borsche)
- njfet, pjfet (contribution of Danilo Piazzalunga)
- pigbt, nigbt
- *backward incompatibility* potentiometer is now the standard resistor-with-arrow-in-the-middle; the old potentiometer is now known as variable resistor (or vR), similarly to variable inductor and variable capacitor
- triac, thyristor, memristor
- new property "name" for bipoles
- fixed voltage problem for batteries in american voltage mode
- european logic gates
- *backward incompatibility* new american standard inductor. Old american inductor now called "cute inductor"
- *backward incompatibility* transformer now linked with the chosen type of inductor, and version with core, too. Similarly for variable inductor
- *backward incompatibility* styles for selecting shape variants now end are in the plural to avoid conflict with paths
- new placing option for some tripoles (mostly transistors)
- mirror path style

• Version 0.2.2 - 20090520

  - Added the shape for lamps.
  - Added options `europeanresistor`, `europeaninductor`, `americanresistor` and `americaninductor`, with corresponding styles.
  - FIXED: error in transistor arrow positioning and direction under negative `xscale` and `yscale`.

• Version 0.2.1 - 20090503

  - Op-amps added
  - added options arrowmos and noarrowmos, to add arrows to pmos and nmos

• Version 0.2 - 20090417 First public release on CTAN

  - *Backward incompatibility*: labels ending with `:`*angle* are not parsed for positioning anymore.
  - Full use of Ti*k*Z keyval features.
  - White background is not filled anymore: now the network can be drawn on a background picture as well.
  - Several new components added (logical ports, transistors, double bipoles, ...).
  - Color support.
  - Integration with {`siunitx`}.
  - `Voltage, american style.`
  - `Better code, perhaps. General cleanup at the very least.`

• Version 0.1 - 2007-10-29 First public release

Index of the components