Components and Examples of tikzircuit

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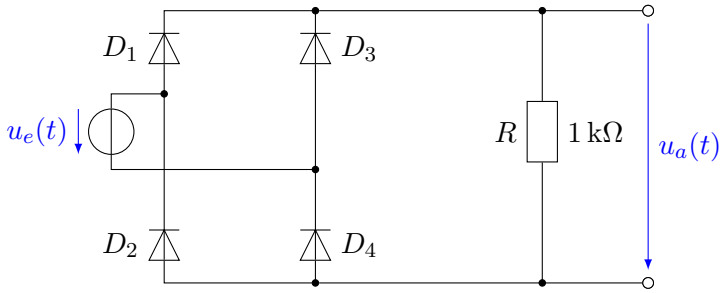
1 Introductory Examples

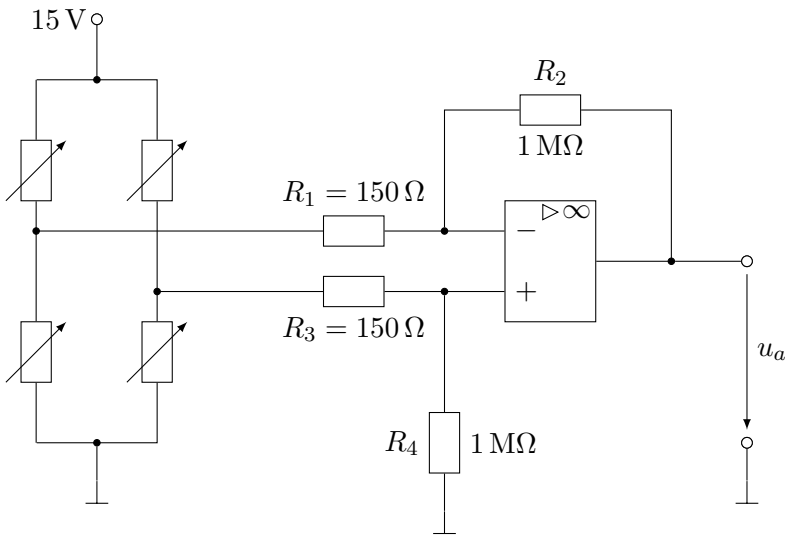
1.1 Bridge Rectifier




```
\begin{tikzpicture}
  \renewcommand{\voltagecolor}{blue}
  \voltagesourceNS{Uin}{(0.3,0)}{left}{$u_e(t)$}
  \diodeSN{diodeOne}{(1,1.3)}{left}{$D_{1}$}
  \diodeSN{diodeThree}{(3,1.3)}{right}{$D_{3}$}
  \diodeSN{diodeTwo}{(1,-1.3)}{left}{$D_{2}$}
  \diodeSN{diodeFour}{(3,-1.3)}{right}{$D_{4}$}
  \draw (UinN) -- ++(0,0.2) node (UinHelpOne) {} -- (UinHelpOne -|
      diodeOneA) \junction{UinOne};
  \draw (UinS) -- ++(0,-0.2) node (UinHelpTwo) {} -- (UinHelpTwo -|
      diodeThreeA) \junction{UinTwo};
  \draw (diodeOneA) -- (diodeTwoC) (diodeThreeA) -- (diodeFourC);

  \draw (diodeThreeC) -- ++(0,0.3) \junction{jThree} -| (diodeOneC);
  \draw (diodeFourA) -- ++(0,-0.3) \junction{jFour} -| (diodeTwoA);
  \resistorNS{resistor}{(6,0)}{$R$}{\SI{1}{\kilo\ohm}}
  \draw (jThree) -| (resistorN);
  \draw (jFour) -| (resistorS);
  \draw (jThree -| resistor) \junction{jrN} -- ++(1.4,0)
      \terminal{tuOutPlus};
  \draw (jFour -| resistor) \junction{jrS} -- (jFour -| tuOutPlus)
      \terminal{tuOutMinus};
  \voltagearrow{(tuOutPlus)}{(tuOutMinus)}{right,midway}{$u_{a}(t)$}
\end{tikzpicture}
```

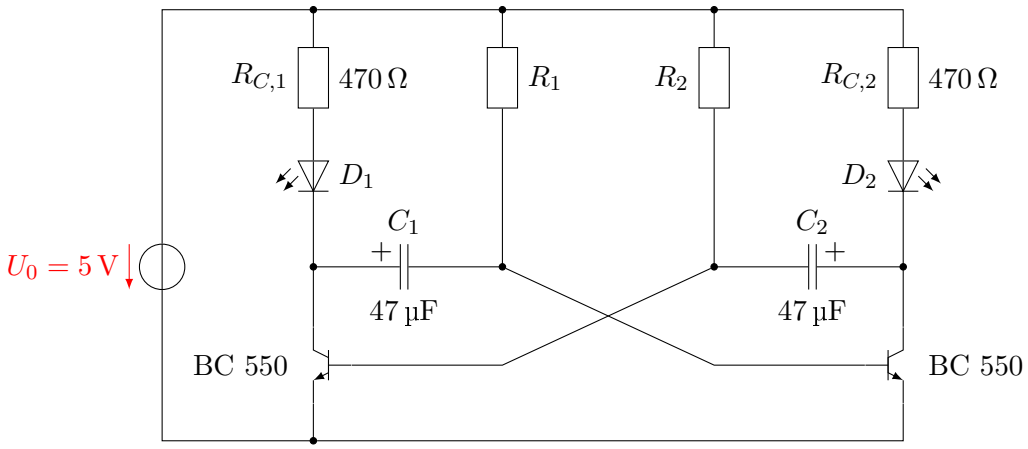
1.2 Strain Gauges Bridge




```
\begin{tikzpicture}
  \renewcommand{\voltagecolor}{black}
  \opampNormInv{op}{(0,0)}
  \resistorWE{rOne}{(opInMinus)++(-2,0)}{$R_{1}=\SI{150}{\ohm}$}{}
  \resistorWE{rThree}{(opInPlus-|rOne)}{}{$R_{3} = \SI{150}{\ohm}$}
  \resistorWE{rTwo}{(op)++(0,2)}{$R_{2}$}{$\SI{1}{\mega\ohm}$}
  \draw (rOneE) -- (opInMinus) \mjunction{jopInMinus};
  \draw (rThreeE) -- (opInPlus) \mjunction{jopInPlus};
  \resistorNS{rFour}{(jopInPlus)++(0,-2)}{$R_{4}$}{$\SI{1}{\mega\ohm}$}
  \path (op) ++(-6,0) \cnode{dms};
  \foreach \x/\y/\name in {-0.8/1.2/One, -0.8/-1.2/Two, 0.8/1.2/Three,
                           0.8/-1.2/Four}{%
      \resistorNS{dms\name}{(dms)++(\x,\y)}{$ $}{$ $}
      \draw[-latex] (dms)++(\x,\y) ++(-0.4,-0.4) -- ++(0.8,0.8);
  }
  \draw (dmsOneN) -- ++(0,0.8) \cnode{foo};
  \draw (dmsThreeN) -- (dmsThree|-foo) -- (foo) \mjunction{jdmsN};
  \draw (jdmsN) -- ++(0,0.8) \terminal{tudmsPlus} node [left] {\SI{15}{\volt}};
  \draw (dmsTwoS) -- ++(0,-0.8) \cnode{foo};
  \draw (dmsFourS) -- (dmsFour|-foo) -- (foo) \mjunction{jdmsS};
  \draw (jdmsS) -- ++(0,-0.5) \cnode{gnddms};
  \gnd{(gnddms)}
  \draw (dmsOneS) -- (dmsTwoN) (rOneW) -- (rOne-|dmsOne) \junction{jLeft};
  \draw (dmsThreeS) -- (dmsFourN);
  \draw (rThreeW) -- (rThree-|dmsThree) \junction{jRight};
  \draw (jopInPlus) -- (rFourN) (rFourS) -- ++(0,-0.5) \cnode{gndRFour};
  \gnd{(gndRFour)}
  \draw (jopInMinus) |- (rTwoW);
```

```
  \draw (opOut) -- ++(1,0) \junction{jopOut} |- (rTwoE);
  \draw (jopOut) -- ++(1,0) \terminal{tuaPlus};
  \draw (tuaPlus|-gnddms) \cnode{gndOut} -- ++(0,0.5) \terminal{tuaMinus};
  \gnd{(gndOut)}
  \voltagearrow{(tuaPlus)}{(tuaMinus)}{right}{$u_{a}$}
\end{tikzpicture}
```

1.3 Astable Multivibrator




```
\begin{tikzpicture}
  \renewcommand{\voltagecolor}{red}
  \BJTnpnNSMirror{bjtOne}{(0,0)}
  \path (bjtOne) ++(-0.2,0) node[left] {BC 550};
  \BJTnpnNS{bjtTwo}{(bjtOne)++(7.8,0)}
  \path (bjtTwo) ++(0.2,0) node [right] {BC 550};
  \ledNSW{ledOne}{(bjtOneC)++(0,1.8)}{$D_{1}$}
  \ledNSE{ledTwo}{(bjtTwoC |- ledOne)}{$D_{2}$}
  \resistorNS{rcOne}{(ledOne)++(0,1.5)}{$R_{C,1}$}{$\SI{470}{\ohm}$}
  \resistorNS{rcTwo}{(ledTwo |- rcOne)}{$R_{C,2}$}{$\SI{470}{\ohm}$}
  \capacitorWE{cOne}{(ledOne)++(1.2,-1)}{$C_{1}$}{$\SI{47}{\micro\farad}$}
  \path (cOne)++(-0.3,0.2) node {$+$};
  \resistorNS{rOne}{(rcOne)++(2.5,0)}{}{$R_{1}$}
  \resistorNS{rTwo}{(rcTwo)++(-2.5,0)}{$R_{2}$}{}
  \capacitorWE{cTwo}{(ledTwo)++(-1.2,-1)}{$C_{2}$}{$\SI{47}{\micro\farad}$}
  \path (cTwo)++(0.3,0.2) node {$+$};
  \voltagesourceNS{u}{(ledOne |- cOne)++(-2,0)}{left}{$U_{0}=\SI{5}{\volt}$}
  \draw (rcOneN) -- ++(0,0.5) \junction{jrcN} -| (uN);
  \draw (bjtOneE) -- ++(0,-0.5) \junction{jbjtE} -| (uS);
  \draw (jrcN) -| (rcTwoN);
  \draw (jbjtE) -| (bjtTwoE);
  \draw (rOneN) -- (rOne |- jrcN) \junction{jrOneN};
```

```
  \draw (rTwoN) -- (rTwo |- jrcN) \junction{jrTwoN};
  \draw (rcOneS) -- (ledOneA) (ledOneC) -- (bjtOneC);
  \draw (rcTwoS) -- (ledTwoA) (ledTwoC) -- (bjtTwoC);
  \draw (bjtOneC |- cOne) \junction{jbjtOneC} -- (cOneW);
  \draw (bjtTwoC |- cTwo) \junction{jbjtTwoC} -- (cTwoE);
  \draw (cOneE) -- (cOne -| rOne) \junction{jcOneW} -- (rOneS);
  \draw (cTwoW) -- (cTwo -| rTwo) \junction{jcTwoE} -- (rTwoS);
  \draw (jcOneW) -- (rTwo |- bjtTwo) -- (bjtTwoB);
  \draw (jcTwoE) -- (rOne |- bjtOne) -- (bjtOneB);
\end{tikzpicture}
```

2 Sources

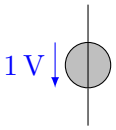
2.1 Voltage Source in North-South Orientation

```
\voltagesourceNS{name}{position}{align:left|right}{text}
```

node endings: N: north, S: south

Example:

```
\renewcommand{\voltagecolor}{blue}
\renewcommand{\fillcolor}{lightgray}
\voltagesourceNS{u}{(0,0)}{left}{\SI{1}{\volt}}
\draw (uN) -- ++(0,0.5) (uS) -- ++(0,-0.5);
```



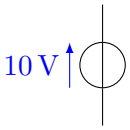
2.2 Voltage Source in South-North Orientation

```
\voltagesourceSN{name}{position}{align:left|right}{text}
```

node endings: N: north, S: south

Example:

```
\renewcommand{\voltagecolor}{blue}
\voltagesourceSN{Ua}{(0,0)}{left}{\SI{10}{\volt}}
\draw (uN) -- ++(0,0.5) (uS) -- ++(0,-0.5);
```



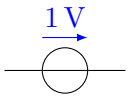
2.3 Voltage Source in West-East Orientation

```
\voltagesourceWE{name}{position}{align:above|below}{text}
```

node endings: W: west, E: east

Example:

```
\voltagesourceWE{u}{(0,0)}{above}{\SI{1}{\volt}}
\draw (uW) -- ++(-0.5,0) (uE) -- ++(0.5,0);
```



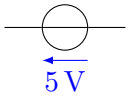
2.4 Voltage Source in East-West Orientation

```
\voltagesourceEW{name}{position}{align:above|below}{text}
```

node endings: W: west, E: east

Example:

```
\voltagesourceEW{u}{(0,0)}{below}{\SI{5}{\volt}}
\draw (uW) -- ++(-0.5,0) (uE) -- ++(0.5,0);
```



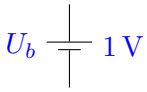
2.5 Battery in North-South Orientation

```
\batteryNS{name}{position}{left text}{right text}
```

node endings: N: north, S: south

Example:

```
\batteryNS{u}{(0,0)}{$U_{b}$}{\SI{1}{\volt}}
\draw (uN) -- ++(0,0.5) (uS) -- ++(0,-0.5);
```



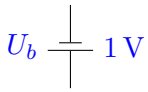
2.6 Battery in South-North Orientation

```
\batterySN{name}{position}{left text}{right text}
```

node endings: N: north, S: south

Example:

```
\batterySN{u}{(0,0)}{$U_{b}$}{\SI{1}{\volt}}
\draw (uN) -- ++(0,0.5) (uS) -- ++(0,-0.5);
```



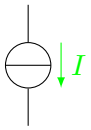
2.7 Current Source in North-South Orientation

```
\currentsourceNS{name}{position}{align:left|right}{text}
```

node endings: N: north, S: south

Example:

```
\renewcommand{\currentcolor}{green}
\currentsourceNS{i}{(0,0)}{right}{$I$}
\draw (iN) -- ++(0,0.5) (iS) -- ++(0,-0.5);
```



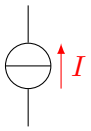
2.8 Current Source in South-North Orientation

```
\currentsourceSN{name}{position}{align:left|right}{text}
```

node endings: N: north, S: south

Example:

```
\renewcommand{\currentcolor}{red}
\currentsourceSN{i}{(0,0)}{right}{$I$}
\draw (iN) -- ++(0,0.5) (iS) -- ++(0,-0.5);
```



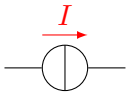
2.9 Current Source in West-East Orientation

```
\currentsourceWE{name}{position}{align:above|below}{text}
```

node endings: W: west, E: east

Example:

```
\currentsourceWE{i}{(0,0)}{above}{$I$}
\draw (iW) -- ++(-0.5,0) (iE) -- ++(0.5,0);
```



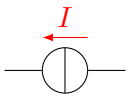
2.10 Current Source in East-West Orientation

```
\currentsourceEW{name}{position}{align:above|below}{text}
```

node endings: W: west, E: east

Example:

```
\currentsourceEW{i}{(0,0)}{above}{$I$}
\draw (iW) -- ++(-0.5,0) (iE) -- ++(0.5,0);
```



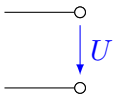
3 Voltage and Current Arrows

3.1 Voltage Arrow Between Two Nodes

```
\voltagearrow{begin}{end}{text parameters}{text}
```

Example:

```
\draw (0,1) -- (1,1) \terminal{tOne};
\draw (0,0) -- (1,0) \terminal{tTwo};
\voltagearrow{(tOne)}{(tTwo)}{right}{$U$}
```

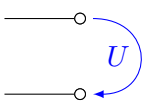


3.2 Curved Voltage Arrow Between Two Nodes

```
\voltagearrowC{begin}{end}{control option}{text parameters}{text}
```

Example:

```
\draw (0,1) -- (1,1) \terminal{tA};
\draw (0,0) -- (1,0) \terminal{tB};
\voltagearrowC{(tA)}{(tB)}{+(1,0) and +(1,0)}{left}{$U$}
```



3.3 Current Arrow in North-South Orientation

```
\currentarrowNS{position}{align:left|right}{text}
```

Example:

```
\draw (0,0) -- (0,1) \mnode{ia};
\currentarrowNS{(ia)}{left}{$I$}
```

3.4 Current Arrow in South-North Orientation

```
\currentarrowSN{position}{align:left|right}{text}
```

Example:

```
\draw (0,0) -- (0,1) \mnode{ia};
\currentarrowSN{(ia)}{left}{$I$}
```

3.5 Current Arrow in West-East Orientation

```
\currentarrowWE{position}{align:above|below}{text}
```

Example:

```
\draw (0,0) -- (1,0) \mnode{ia};
\currentarrowWE{(ia)}{above}{$I$}
```

3.6 Current Arrow in East-West Orientation

```
\currentarrowEW{position}{align:above|below}{text}
```

Example:

```
\draw (0,0) -- (1,0) \mnode{ia};
\currentarrowEW{(ia)}{above}{$I$}
```

4 Resistors, Capacitors and Inductors

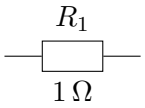
4.1 Resistor in West-East Orientation

```
\resistorWE{name}{position}{text above}{text below}
```

node endings: W: west, E: east

Example:

```
\resistorWE{r}{(0,0)}{$R_{1}$}{\SI{1}{\ohm}}
\draw (rW) -- ++(-0.5,0) (rE) -- ++(0.5,0);
```



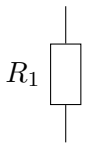
4.2 Resistor in North-South Orientation

```
\resistorWE{name}{position}{text left}{text right}
```

node endings: N: north, S: south

Example:

```
\resistorNS{r}{(0,0)}{$R_{1}$}{ }
\draw (rN) -- ++(0,0.5) (rS) -- ++(0,-0.5);
```



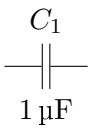
4.3 Capacitor in West-East Orientation

```
\capacitorWE{name}{position}{text above}{text below}
```

node endings: W: west, E: east

Example:

```
\capacitorWE{c}{(0,0)}{$C_{1}$}{\SI{1}{\micro\farad}}
\draw (cW) -- ++(-0.5,0) (cE) -- ++(0.5,0);
```



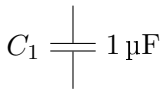
4.4 Capacitor in North-South Orientation

```
\capacitorNS{name}{position}{text left}{text right}
```

node endings: N: north, S: south

Example:

```
\capacitorNS{c}{(0,0)}{$C_{1}$}{\SI{1}{\micro\farad}}
\draw (cN) -- ++(0,0.5) (cS) -- ++(0,-0.5);
```



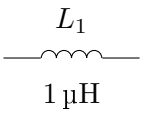
4.5 Inductor in West-East Orientation

```
\inductorWE{name}{position}{text above}{text below}
```

node endings: W: west, E: east

Example:

```
\inductorWE{l}{(0,0)}{$L_{1}$}{\SI{1}{\micro\henry}}
\draw (lW) -- ++(-0.5,0) (lE) -- ++(0.5,0);
```



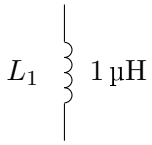
4.6 Inductor in North-South Orientation

```
\inductorNS{name}{position}{text left}{text right}
```

node endings: N: north, S: south

Example:

```
\inductorNS{l}{(0,0)}{$L_{1}$}{\SI{1}{\micro\henry}}
\draw (lN) -- ++(0,0.5) (lS) -- ++(0,-0.5);
```



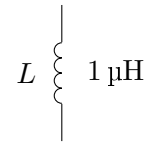
4.7 Inductor in North-South Orientation (Mirrored)

```
\inductorNS{name}{position}{text left}{text right}
```

node endings: N: north, S: south

Example:

```
\inductorNSmirror{l}{(0,0)}{$L$}{\SI{1}{\micro\henry}}
\draw (lN) -- ++(0,0.5) (lS) -- ++(0,-0.5);
```



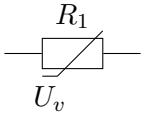
4.8 Varistor in West-East Orientation

```
\varistorWE{name}{position}{text left}{text right}{controlling voltage}
```

node endings: W: west, E: east

Example:

```
\varistorWE{r}{(0,0)}{$R_{1}$}{}{$U_{v}$}
\draw (rW) -- ++(-0.5,0) (rE) -- ++(0.5,0);
```



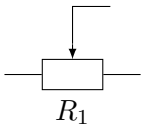
4.9 Potentiometer in West-East Orientation, North Connection

```
\potentiometerWEN{name}{position}{text}
```

node endings: W: west, E: east, N: north

Example:

```
\potentiometerWEN{p}{(0,0)}{$R_{1}$}
\draw (pW) -- ++(-0.5,0) (pE) -- ++(0.5,0);
\draw (pN) |- ++(0.5,0.5);
```



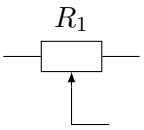
4.10 Potentiometer in West-East Orientation, South Connection

```
\potentiometerWES{name}{position}{text}
```

node endings: W: west, E: east, S: south

Example:

```
\potentiometerWES{p}{(0,0)}{$R_{1}$}
\draw (pW) -- ++(-0.5,0) (pE) -- ++(0.5,0);
\draw (pS) |- ++(0.5,-0.5);
```



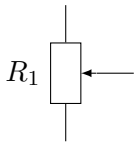
4.11 Potentiometer in North-South Orientation, East Connection

```
\potentiometerNSE{name}{position}{text}
```

node endings: N: north, S: south, E: east

Example:

```
\potentiometerNSE{p}{(0,0)}{$R_{1}$}
\draw (pS) -- ++(0,-0.5) (pN) -- ++(0,0.5);
\draw (pE) -- ++(0.5,0);
```



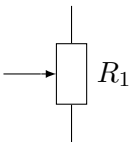
4.12 Potentiometer in North-South Orientation, West Connection

```
\potentiometerNSW{name}{position}{text}
```

node endings: N: north, S: south, W: west

Example:

```
\potentiometerNSW{p}{(0,0)}{$R_{1}$}
\draw (pS) -- ++(0,-0.5) (pN) -- ++(0,0.5);
\draw (pW) -- ++(-0.5,0);
```



5 Transformer

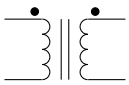
5.1 Transformer in North-South Orientation

```
\transformerNS{name}{position}
```

node endings: N: north, S: south

Example:

```
\transformerNS{tf}{(0,0)}
\draw (tfAN) -- ++(-0.5,0) (tfAS) -- ++(-0.5,0);
\draw (tfBN) -- ++( 0.5,0) (tfBS) -- ++( 0.5,0);
```



6 Diodes

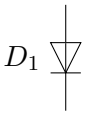
6.1 Diode In North-South Orientation

```
\diodeNS{name}{position}{align:left|right}{text}
```

node endings: A: anode, C: cathode

Example:

```
\diodeNS{d}{(0,0)}{left}{$D_{1}$}
\draw (dA) -- ++(0,0.5) (dC) -- ++(0,-0.5);
```



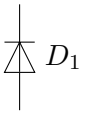
6.2 Diode in South-North Orientation

```
\diodeSN{name}{position}{align:left|right}{text}
```

node endings: A: anode, C: cathode

Example:

```
\diodeSN{d}{(0,0)}{right}{$D_{1}$}
\draw (dA) -- ++(0,-0.5) (dC) -- ++(0,0.5);
```



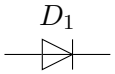
6.3 Diode in West-East Orientation

```
\diodeWE{name}{position}{align:above|below}{text}
```

node endings: A: anode, C: cathode

Example:

```
\diodeWE{d}{(0,0)}{above}{$D_{1}$}
\draw (dA) -- ++(-0.5,0) (dC) -- ++(0.5,0);
```



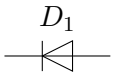
6.4 Diode in East-West Orientation

```
\diodeEW{name}{position}{align:above|below}{text}
```

node endings: A: anode, C: cathode

Example:

```
\diodeEW{d}{(0,0)}{above}{$D_{1}$}
\draw (dA) -- ++(0.5,0) (dC) -- ++(-0.5,0);
```



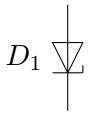
6.5 Zener Diode in North-South Orientation

```
\zDiodeNS{name}{position}{align:left|right}{text}
```

node endings: A: anode, C: cathode

Example:

```
\zDiodeNS{zd}{(0,0)}{left}{$D_{1}$}
\draw (zdA) -- ++(0,0.5) (zdC) -- ++(0,-0.5);
```



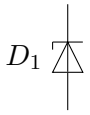
6.6 Zener Diode in South-North Orientation

```
\zDiodeSN{name}{position}{align:left|right}{text}
```

node endings: A: anode, C: cathode

Example:

```
\zDiodeSN{zd}{(0,0)}{left}{$D_{1}$}
\draw (zdA) -- ++(0,-0.5) (zdC) -- ++(0,0.5);
```



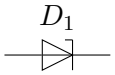
6.7 Zener Diode in West-East Orientation

```
\zDiodeWE{name}{position}{align:above|below}{text}
```

node endings: A: anode, C: cathode

Example:

```
\zDiodeWE{zd}{(0,0)}{above}{$D_{1}$}
\draw (zdA) -- ++(-0.5,0) (zdC) -- ++(0.5,0);
```



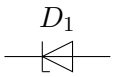
6.8 Zener Diode in East-West Orientation

```
\zDiodeEW{name}{position}{align:above|below}{text}
```

node endings: A: anode, C: cathode

Example:

```
\zDiodeEW{zd}{(0,0)}{above}{$D_{1}$}
\draw (zdA) -- ++(0.5,0) (zdC) -- ++(-0.5,0);
```



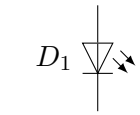
6.9 LED in North-South Orientation, Light in East Direction

```
\ledNSE{name}{position}{text}
```

node endings: A: anode, C: cathode

Example:

```
\ledNSE{led}{(0,0)}{$D_{1}$}
\draw (ledA) -- ++(0,0.5) (ledC) -- ++(0,-0.5);
```



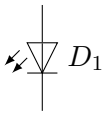
6.10 LED in North-South Orientation, Light in West Direction

```
\ledNSW{name}{position}{text}
```

node endings: A: anode, C: cathode

Example:

```
\ledNSW{led}{(0,0)}{$D_{1}$}
\draw (ledA) -- ++(0,0.5) (ledC) -- ++(0,-0.5);
```



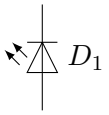
6.11 LED in South-North Orientation, Light in West Direction

```
\ledSNW{name}{position}{text}
```

node endings: A: anode, C: cathode

Example:

```
\ledSNW{led}{(0,0)}{$D_{1}$}
\draw (ledA) -- ++(0,-0.5) (ledC) -- ++(0,0.5);
```



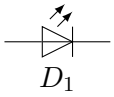
6.12 LED in West-East orientation, Light in North Direction

```
\ledWEN{name}{position}{text}
```

node endings: A: anode, C: cathode

Example:

```
\ledWEN{led}{(0,0)}{$D_{1}$}
\draw (ledA) -- ++(-0.5,0) (ledC) -- ++(0.5,0);
```



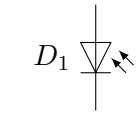
6.13 Photo Diode in North-South Orientation, Light from East

```
\photodiodeNSE{name}{position}{text}
```

node endings: A: anode, C: cathode

Example:

```
\photodiodeNSE{pd}{(0,0)}{$D_{1}$}
\draw (pdA) -- ++(0,0.5) (pdC) -- ++(0,-0.5);
```



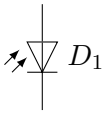
6.14 photo diode in North-South Orientation, Light from West

```
\photodiodeNSW{name}{position}{text}
```

node endings: A: anode, C: cathode

Example:

```
\photodiodeNSW{pd}{(0,0)}{$D_{1}$}
\draw (pdA) -- ++(0,0.5) (pdC) -- ++(0,-0.5);
```



7 Transistors

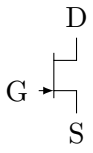
7.1 N-Channel JFET in North-South Orientation

```
\nChnJFETNS{name}{position}
```

node endings: D: drain, G: gate, S: source

Example:

```
\nChnJFETNS{jfet}{(0,0)}
\path (jfetG) node [left]{G};
\path (jfetD) node [above]{D};
\path (jfetS) node [below]{S};
```



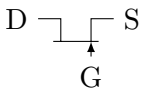
7.2 N-Channel JFET in West-East Orientation

```
\nChnJFETWE{name}{position}
```

node endings: D: drain, G: gate, S: source

Example:

```
\nChnJFETWE{jfet}{(0,0)}
\path (jfetG) node [below]{G};
\path (jfetD) node [left]{D};
\path (jfetS) node [right]{S};
```



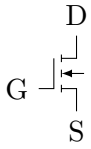
7.3 Enhancement-Mode N-Channel MOSFET in North-South Orientation

```
\NMOSFETenhNS{name}{position}
```

node endings: D: drain, G: gate, S: source, B: bulk

Example:

```
\NMOSFETenhNS{jfet}{(0,0)}
\path (jfetG) node [left]{G};
\path (jfetD) node [above]{D};
\path (jfetS) node [below]{S};
```



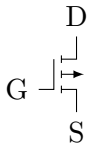
7.4 Enhancement-Mode P-Channel MOSFET in North-South Orientation

```
\PMOSFETenhNS{name}{position}
```

node endings: D: drain, G: gate, S: source, B: bulk

Example:

```
\PMOSFETenhNS{jfet}{(0,0)}
\path (jfetG) node [left]{G};
\path (jfetD) node [above]{D};
\path (jfetS) node [below]{S};
```



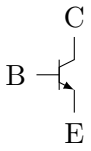
7.5 NPN Bipolar Junction Transistor in North-South Orientation

```
\BJTnpnNS{name}{position}
```

node endings: B: basis, E: emitter, C: collector

Example:

```
\BJTnpnNS{b}{(0,0)}
\path (bB) node [left]{B};
\path (bC) node [above]{C};
\path (bE) node [below]{E};
```



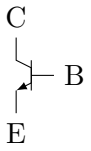
7.6 NPN Bipolar Junction Transistor in North-South Orientation (Mirrored)

```
\BJTnpnNSMirror{name}{position}
```

node endings: B: basis, E: emitter, C: collector

Example:

```
\BJTnpnNSMirror{b}{(0,0)}
\path (bB) node [right]{B};
\path (bC) node [above]{C};
\path (bE) node [below]{E};
```



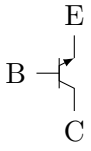
7.7 NPN Bipolar Junction Transistor in South-North Orientation

```
\BJTnpnSN{name}{position}
```

node endings: B: basis, E: emitter, C: collector

Example:

```
\BJTnpnSN{b}{(0,0)}
\path (bB) node [left]{B};
\path (bC) node [below]{C};
\path (bE) node [above]{E};
```



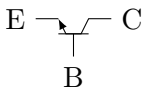
7.8 NPN Bipolar Junction Transistor in East-West Orientation

```
\BJTnpnEW{name}{position}
```

node endings: B: basis, E: emitter, C: collector

Example:

```
\BJTnpnEW{b}{(0,0)}
\path (bB) node [below]{B};
\path (bC) node [right]{C};
\path (bE) node [left]{E};
```



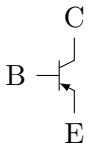
7.9 PNP Bipolar Junction Transistor in North-South Orientation

```
\BJTpnpNS{name}{position}
```

node endings: B: basis, E: emitter, C: collector

Example:

```
\BJTpnpNS{b}{(0,0)}
\path (bB) node [left]{B};
\path (bC) node [above]{C};
\path (bE) node [below]{E};
```



8 Operational Amplifiers

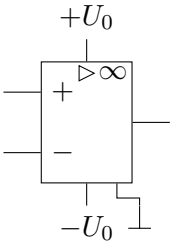
8.1 OP-AMP, Standardized Symbol

```
\opampNorm{name}{position}
```

node endings: Out: output, InMinus: n-input, InPlus: p-input, UbattPlus: positive power supply, UbattMinus: negative power supply Gnd: ground

Example:

```
\opampNorm{op}{(0,0)}
\draw (opOut) -- ++(0.5,0);
\draw (opInMinus) -- ++(-0.5,0);
\draw (opInPlus) -- ++(-0.5,0);
\draw (opUbattPlus) -- ++(0,0.3) node [above]{$+U_{0}$};
\draw (opUbattMinus) -- ++(0,-0.3) node [below]{$-U_{0}$};
\draw (opGnd) -- ++(0,-0.2) -| ++(0.3,-0.1) \cnode{gnd};
\gnd{(gnd)}
```



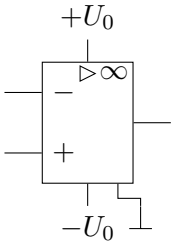
8.2 OP-AMP, Standardized Symbol, N-Input above P-Input

```
\opampNormInv{name}{position}
```

node endings: Out: output, InMinus: n-input, InPlus: p-input, UbattPlus: positive power supply, UbattMinus: negative power supply Gnd: ground

Example:

```
\opampNormInv{op}{(0,0)}
\draw (opOut) -- ++(0.5,0);
\draw (opInMinus) -- ++(-0.5,0);
\draw (opInPlus) -- ++(-0.5,0);
\draw (opUbattPlus) -- ++(0,0.3) node [above]{$+U_{0}$};
\draw (opUbattMinus) -- ++(0,-0.3) node [below]{$-U_{0}$};
\draw (opGnd) -- ++(0,-0.2) -| ++(0.3,-0.1) \cnode{gnd};
\gnd{(gnd)}
```



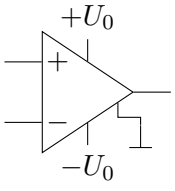
8.3 OP-AMP

```
\opamp{name}{position}
```

node endings: Out: output, InMinus: n-input, InPlus: p-input, UbattPlus: positive power supply, UbattMinus: negative power supply Gnd: ground

Example:

```
\opamp{op}{(0,0)}
\draw (opOut) -- ++(0.5,0);
\draw (opInMinus) -- ++(-0.5,0);
\draw (opInPlus) -- ++(-0.5,0);
\draw (opUbattPlus) -- ++(0,0.3) node [above]{$+U_{0}$};
\draw (opUbattMinus) -- ++(0,-0.3) node [below]{$-U_{0}$};
\draw (opGnd) -- ++(0,-0.2) -| ++(0.3,-0.1) \cnode{gnd};
\gnd{(gnd)}
```



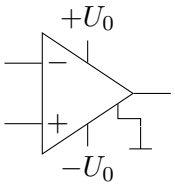
8.4 OP-AMP, N-Input above P-Input

```
\opampInv{name}{position}
```

node endings: Out: output, InMinus: n-input, InPlus: p-input, UbattPlus: positive power supply, UbattMinus: negative power supply Gnd: ground

Example:

```
\opampInv{opamp}{(0,0)}
\draw (opampOut) -- ++(0.5,0);
\draw (opInMinus) -- ++(-0.5,0);
\draw (opInPlus) -- ++(-0.5,0);
\draw (opUbattPlus) -- ++(0,0.3) node [above]{$+U_{0}$};
\draw (opUbattMinus) -- ++(0,-0.3) node [below]{$-U_{0}$};
\draw (opGnd) -- ++(0,-0.2) -| ++(0.3,-0.1) \cnode{gnd};
\gnd{(gnd)}
```



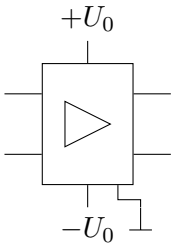
8.5 General Amplifier

```
\amplifier{name}{position}
```

node endings: OutPlus: p-output OutMinus: n-output, InMinus: n-input, InPlus: p-input, UbattPlus: positive power supply, UbattMinus: negative power supply Gnd: ground

Example:

```
\amplifier{a}{(0,0)}
\draw (aOutPlus) -- ++(0.5,0);
\draw (aOutMinus) -- ++(0.5,0);
\draw (aInMinus) -- ++(-0.5,0);
\draw (aInPlus) -- ++(-0.5,0);
\draw (aUBattPlus) -- ++(0,0.3) node [above]{$+U_{0}$};
\draw (aUBattMinus) -- ++(0,-0.3) node [below]{$-U_{0}$};
\draw (aGnd) -- ++(0,-0.2) -| ++(0.3,-0.1) \cnode{gnd};
\gnd{(gnd)}
```



9 Amplifiers

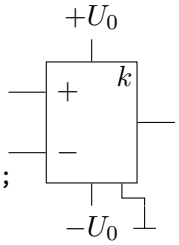
9.1 Amplifier, Standardized Symbol

```
\ampNorm{name}{position}{amplification factor}
```

node endings: Out: output, InMinus: n-input, InPlus: p-input, UbattPlus: positive power supply, UbattMinus: negative power supply Gnd: ground

Example:

```
\ampNorm{amp}{(0,0)}{$k$}
\draw (ampOut) -- ++(0.5,0);
\draw (ampInMinus) -- ++(-0.5,0);
\draw (ampInPlus) -- ++(-0.5,0);
\draw (ampUbattPlus) -- ++(0,0.3) node [above]{$+U_{0}$};
\draw (ampUbattMinus) -- ++(0,-0.3) node [below]{$-U_{0}$};
\draw (ampGnd) -- ++(0,-0.2) -| ++(0.3,-0.1) \cnode{gnd};
\gnd{(gnd)}
```



10 Logic Gates

10.1 Inversion Symbol for Logic Gates Outputs

```
\NOTcircle{name}{position}
```

Example:

```
\draw (0,0) -- (0,1);
\NOTcircle{n}{(0,0.5)}
```

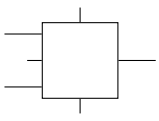
10.2 Logic Gate Symbol, IEC Standard

```
\LogicGateIEC{name}{position}
```

node endings: In: input, Out: output, InN: north input, InS: south input, N: north, S: south

Example:

```
\LogicGateIEC{g}{(0,0)}
\draw (gIn) -- ++(-0.2,0);
\draw (gOut) -- ++(0.5,0);
\draw (gInN) -- ++(-0.5,0);
\draw (gInS) -- ++(-0.5,0);
\draw (gN) -- ++(0,0.2);
\draw (gS) -- ++(0,-0.2);
```



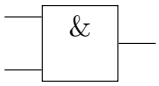
10.3 Logic AND Gate Symbol

```
\GateAND{name}{position}
```

node endings: In: input, Out: output, InN: north input, InS: south input, N: north, S: south

Example:

```
\GateAND{g}{(0,0)}
\draw (gOut) -- ++(0.5,0);
\draw (gInN) -- ++(-0.5,0);
\draw (gInS) -- ++(-0.5,0);
```



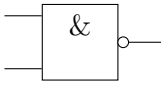
10.4 Logic NAND Gate Symbol

```
\GateNAND{name}{position}
```

node endings: In: input, Out: output, InN: north input, InS: south input, N: north, S: south

Example:

```
\GateNAND{g}{(0,0)}
\draw (gOut) -- ++(0.5,0);
\draw (gInN) -- ++(-0.5,0);
\draw (gInS) -- ++(-0.5,0);
```



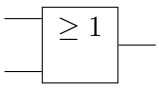
10.5 Logic OR Gate Symbol

```
\GateOR{name}{position}
```

node endings: In: input, Out: output, InN: north input, InS: south input, N: north, S: south

Example:

```
\GateOR{g}{(0,0)}
\draw (gOut) -- ++(0.5,0);
\draw (gInN) -- ++(-0.5,0);
\draw (gInS) -- ++(-0.5,0);
```



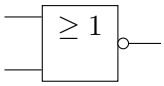
10.6 Logic NOR Gate Symbol

```
\GateNOR{name}{position}
```

node endings: In: input, Out: output, InN: north input, InS: south input, N: north, S: south

Example:

```
\GateNOR{g}{(0,0)}
\draw (gOut) -- ++(0.5,0);
\draw (gInN) -- ++(-0.5,0);
\draw (gInS) -- ++(-0.5,0);
```



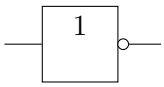
10.7 Logic NOT Gate Symbol

```
\GateNOT{name}{position}
```

node endings: In: input, Out: output, InN: north input, InS: south input, N: north, S: south

Example:

```
\GateNOT{g}{(0,0)}
\draw (gOut) -- ++(0.5,0);
\draw (gIn) -- ++(-0.5,0);
```



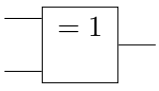
10.8 Logic XOR Gate Symbol

```
\GateXOR{name}{position}
```

node endings: In: input, Out: output, InN: north input, InS: south input, N: north, S: south

Example:

```
\GateXOR{g}{(0,0)}
\draw (gOut) -- ++(0.5,0);
\draw (gInN) -- ++(-0.5,0);
\draw (gInS) -- ++(-0.5,0);
```



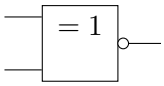
10.9 Logic XNOR Gate Symbol

```
\GateXNOR{name}{position}
```

node endings: In: input, Out: output, InN: north input, InS: south input, N: north, S: south

Example:

```
\GateXNOR{g}{(0,0)}
\draw (gOut) -- ++(0.5,0);
\draw (gInN) -- ++(-0.5,0);
\draw (gInS) -- ++(-0.5,0);
```



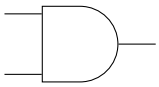
10.10 Logic AND Gate, ANSI Symbol

```
\ANSIGateAND{name}{position}
```

node endings: Out: output, InN: north input, InS: south input, N: north, S: south

Example:

```
\ANSIGateAND{g}{(0,0)}
\draw (gOut) -- ++(0.5,0);
\draw (gInN) -- ++(-0.5,0);
\draw (gInS) -- ++(-0.5,0);
```



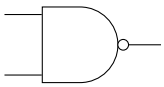
10.11 Logic NAND Gate, ANSI Symbol

```
\ANSIGateNAND{name}{position}
```

node endings: Out: output, InN: north input, InS: south input, N: north, S: south

Example:

```
\ANSIGateNAND{g}{(0,0)}
\draw (gOut) -- ++(0.5,0);
\draw (gInN) -- ++(-0.5,0);
\draw (gInS) -- ++(-0.5,0);
```



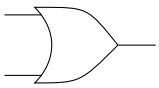
10.12 Logic OR Gate, ANSI Symbol

```
\ANSIGateOR{name}{position}
```

node endings: Out: output, InN: north input, InS: south input, N: north, S: south

Example:

```
\ANSIGateOR{g}{(0,0)}
\draw (gOut) -- ++(0.5,0);
\draw (gInN) -- ++(-0.5,0);
\draw (gInS) -- ++(-0.5,0);
```



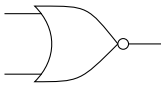
10.13 Logic NOR Gate, ANSI Symbol

```
\ANSIGateNOR{name}{position}
```

node endings: Out: output, InN: north input, InS: south input, N: north, S: south

Example:

```
\ANSIGateNOR{g}{(0,0)}
\draw (gOut) -- ++(0.5,0);
\draw (gInN) -- ++(-0.5,0);
\draw (gInS) -- ++(-0.5,0);
```



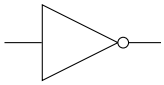
10.14 Logic NOT Gate, ANSI Symbol

```
\ANSIGateNOT{name}{position}
```

node endings: Out: output, In: input, N: north, S: south

Example:

```
\ANSIGateNOT{g}{(0,0)}
\draw (gOut) -- ++(0.5,0);
\draw (gIn) -- ++(-0.5,0);
```



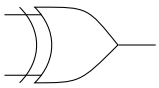
10.15 Logic XOR Gate, ANSI Symbol

```
\ANSIGateXOR{name}{position}
```

node endings: Out: output, InN: north input, InS: south input, N: north, S: south

Example:

```
\ANSIGateXOR{g}{(0,0)}
\draw (gOut) -- ++(0.5,0);
\draw (gInN) -- ++(-0.5,0);
\draw (gInS) -- ++(-0.5,0);
```



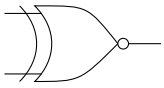
10.16 Logic XNOR Gate, ANSI Symbol

```
\ANSIGateXNOR{name}{position}
```

node endings: Out: output, InN: north input, InS: south input, N: north, S: south

Example:

```
\ANSIGateXNOR{g}{(0,0)}
\draw (gOut) -- ++(0.5,0);
\draw (gInN) -- ++(-0.5,0);
\draw (gInS) -- ++(-0.5,0);
```



11 Flip-Flops

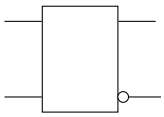
11.1 General Flip-Flop Symbol

```
\FlipFlop{name}{position}
```

node endings: OutN: north output, OutS: south output InN: north input, InS: south input, N: north, S: south W: middle input

Example:

```
\FlipFlop{ff}{(0,0)}
\draw (ffInN) -- ++(-0.5,0) (ffInS) -- ++(-0.5,0);
\draw (ffOutN) -- ++(0.5,0) (ffOutS) -- ++(0.5,0);
```



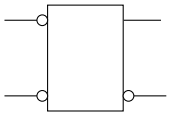
11.2 General Flip-Flop Symbol for Negative Logic

```
\FlipFlopNegLogic{name}{position}
```

node endings: OutN: north output, OutS: south output InN: north input, InS: south input, N: north, S: south W: middle input

Example:

```
\FlipFlopNegLogic{ff}{(0,0)}
\draw (ffInN) -- ++(-0.5,0) (ffInS) -- ++(-0.5,0);
\draw (ffOutN) -- ++(0.5,0) (ffOutS) -- ++(0.5,0);
```



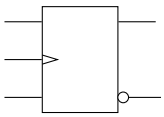
11.3 Flip-Flop Changing on Rising Edge

```
\FlipFlopRisingEdge{name}{position}
```

node endings: OutN: north output, OutS: south output InN: north input, InS: south input, N: north, S: south W: middle input

Example:

```
\FlipFlopRisingEdge{ff}{(0,0)}
\draw (ffInN) -- ++(-0.5,0) (ffInS) -- ++(-0.5,0);
\draw (ffW) -- ++(-0.5,0);
\draw (ffOutN) -- ++(0.5,0) (ffOutS) -- ++(0.5,0);
```



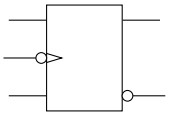
11.4 Flip-Flop Changing on Falling Edge

```
\FlipFlopFallingEdge{name}{position}
```

node endings: OutN: north output, OutS: south output InN: north input, InS: south input, N: north, S: south W: middle input

Example:

```
\FlipFlopFallingEdge{ff}{(0,0)}
\draw (ffInN) -- ++(-0.5,0) (ffInS) -- ++(-0.5,0);
\draw (ffInC) -- ++(-0.5,0);
\draw (ffOutN) -- ++(0.5,0) (ffOutS) -- ++(0.5,0);
```



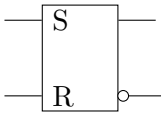
11.5 RS Flip-Flop

```
\RSFlipFlop{name}{position}
```

node endings: OutN: north output, OutS: south output InN: north input, InS: south input, N: north, S: south W: middle input

Example:

```
\RSFlipFlop{ff}{(0,0)}
\draw (ffInN) -- ++(-0.5,0) (ffInS) -- ++(-0.5,0);
\draw (ffOutN) -- ++(0.5,0) (ffOutS) -- ++(0.5,0);
```



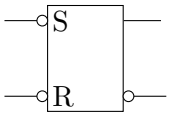
11.6 RS NAND Flip-Flop (Negative Logic)

```
\RSNANDFlipFlop{name}{position}
```

node endings: OutN: north output, OutS: south output InN: north input, InS: south input, N: north, S: south W: middle input

Example:

```
\RSNANDFlipFlop{ff}{(0,0)}
\draw (ffInN) -- ++(-0.5,0) (ffInS) -- ++(-0.5,0);
\draw (ffOutN) -- ++(0.5,0) (ffOutS) -- ++(0.5,0);
```



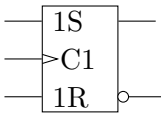
11.7 RS Flip-Flop Changing on Rising Edge

```
\RSFlipFlopRisingEdge{name}{position}
```

node endings: OutN: north output, OutS: south output InN: north input, InS: south input, N: north, S: south W: middle input

Example:

```
\RSFlipFlopRisingEdge{ff}{(0,0)}
\draw (ffInN) -- ++(-0.5,0) (ffInS) -- ++(-0.5,0);
\draw (ffW) -- ++(-0.5,0);
\draw (ffOutN) -- ++(0.5,0) (ffOutS) -- ++(0.5,0);
```



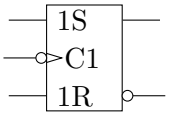
11.8 RS Flip-Flop Changing on Falling Edge

```
\RSFlipFlopFallingEdge{name}{position}
```

node endings: OutN: north output, OutS: south output InN: north input, InS: south input, N: north, S: south W: middle input

Example:

```
\RSFlipFlopFallingEdge{ff}{(0,0)}
\draw (ffInN) -- ++(-0.5,0) (ffInS) -- ++(-0.5,0);
\draw (ffInC) -- ++(-0.5,0);
\draw (ffOutN) -- ++(0.5,0) (ffOutS) -- ++(0.5,0);
```



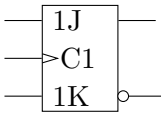
11.9 JK Flip-Flop Changing on Rising Edge

```
\JKFlipFlopRisingEdge{name}{position}
```

node endings: OutN: north output, OutS: south output InN: north input, InS: south input, N: north, S: south W: middle input

Example:

```
\JKFlipFlopRisingEdge{ff}{(0,0)}
\draw (ffInN) -- ++(-0.5,0) (ffInS) -- ++(-0.5,0);
\draw (ffW) -- ++(-0.5,0);
\draw (ffOutN) -- ++(0.5,0) (ffOutS) -- ++(0.5,0);
```



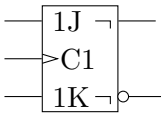
11.10 JK Master-Slave Flip-Flop

```
\JKMSFlipFlop{name}{position}
```

node endings: OutN: north output, OutS: south output InN: north input, InS: south input, N: north, S: south W: middle input

Example:

```
\JKMSFlipFlop{ff}{(0,0)}
\draw (ffInN) -- ++(-0.5,0) (ffInS) -- ++(-0.5,0);
\draw (ffW) -- ++(-0.5,0);
\draw (ffOutN) -- ++(0.5,0) (ffOutS) -- ++(0.5,0);
```



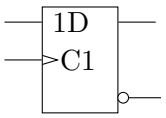
11.11 D Flip-Flop Changing on Rising Edge

```
\DFlipFlopRisingEdge{name}{position}
```

node endings: OutN: north output, OutS: south output InN: north input, InS: south input, N: north, S: south W: middle input

Example:

```
\DFlipFlopRisingEdge{ff}{(0,0)}
\draw (ffInN) -- ++(-0.5,0);
\draw (ffW) -- ++(-0.5,0);
\draw (ffOutN) -- ++(0.5,0) (ffOutS) -- ++(0.5,0);
```



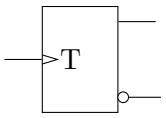
11.12 T Flip-Flop Changing on Rising Edge

```
\TFlipFlopRisingEdge{name}{position}
```

node endings: OutN: north output, OutS: south output InN: north input, InS: south input, N: north, S: south W: middle input

Example:

```
\TFlipFlopRisingEdge{ff}{(0,0)}
\draw (ffW) -- ++(-0.5,0);
\draw (ffOutN) -- ++(0.5,0) (ffOutS) -- ++(0.5,0);
```



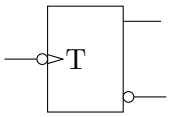
11.13 T Flip-Flop Changing on Falling Edge

```
\TFlipFlopFallingEdge{name}{position}
```

node endings: OutN: north output, OutS: south output InN: north input, InS: south input, N: north, S: south W: middle input

Example:

```
\TFlipFlopFallingEdge{ff}{(0,0)}
\draw (ffInC) -- ++(-0.5,0);
\draw (ffOutN) -- ++(0.5,0) (ffOutS) -- ++(0.5,0);
```



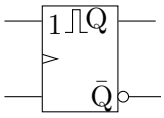
11.14 Monoflop

```
\Monoflop{name}{position}
```

node endings: OutN: north output, OutS: south output InN: north input, InS: south input, N: north, S: south W: middle input

Example:

```
\Monoflop{ff}{(0,0)}
\draw (ffInN) -- ++(-0.5,0) (ffInS) -- ++(-0.5,0);
\draw (ffOutN) -- ++(0.5,0) (ffOutS) -- ++(0.5,0);
```



11.15 Switch, West-East Direction

```
\switchWE{name}{position}
```

node endings: W: west, E: east, N: north connection

Example:

```
\switchWE{s}{(0,0)}
\draw (sW) -- ++(-0.5,0) (sE) -- ++(0.5,0);
```

11.16 Closed Switch, West-East Direction

```
\switchClosedWE{name}{position}
```

node endings: W: west, E: east, N: north connection

Example:

```
\switchClosedWE{s}{(0,0)}
\draw (sW) -- ++(-0.5,0) (sE) -- ++(0.5,0);
```


11.17 Switch, East-West Direction

```
\switchEW{name}{position}
```

node endings: W: west, E: east, N: north connection

Example:

```
\switchEW{s}{(0,0)}
\draw (sW) -- ++(-0.5,0) (sE) -- ++(0.5,0);
```

11.18 Closed Switch, East-West Direction

```
\switchClosedEW{name}{position}
```

node endings: W: west, E: east, N: north connection

Example:

```
\switchClosedEW{s}{(0,0)}
\draw (sW) -- ++(-0.5,0) (sE) -- ++(0.5,0);
```


11.19 Switch, South-North Direction

```
\switchSN{name}{position}
```

node endings: S: south, N: north, W: west connection

Example:

```
\switchSN{s}{(0,0)}
\draw (sS) -- ++(0,-0.5) (sN) -- ++(0,0.5);
```

11.20 Closed Switch, South-North Direction

```
\switchClosedSN{name}{position}
```

node endings: S: south, N: north, W: west connection

Example:

```
\switchClosedSN{s}{(0,0)}
\draw (sS) -- ++(0,-0.5) (sN) -- ++(0,0.5);
```

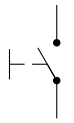

11.21 Pushbutton, South-North Direction

```
\pushbuttonSN{name}{position}
```

node endings: S: south, N: north, W: west connection

Example:

```
\pushbuttonSN{b}{(0,0)}
\draw (bS) -- ++(0,-0.5) (bN) -- ++(0,0.5);
```



12 Miscellaneous

12.1 Ground as Symbol

```
\gnd{position}
```

Example:

```
\draw (0,0) -- (1,0) \junction{gnd};
\gnd{(gnd)}
```

12.2 Ground as Continued Drawing

```
\gndNow
```

Example:

```
\draw (0,0) -- (1,0) \junction{foo} \gndNow;
```

12.3 Connecting Terminal

```
\terminal{name}
```

node endings: Con: use terminal as connector (no space when wired)

Example:

```
\renewcommand{\fillcolor}{white}
\draw (0,0) -- ++(1,0) \terminal{t};
```

12.4 Junction (Black Filled Circle)

```
\junction{name}
```

Example:

```
\draw (0,0) -- (1,0);
\draw (0.5,0) \junction{j} -- ++(0,-0.5);
```

12.5 Junction in the Middle of a Path

```
\junction{name}
```

Example:

```
\draw (0,0) -- (1,0) \mjunction{j} (j) -- ++(1,0);
```


12.6 Connection Node (for Referencing, not Visible)

```
\cnode{name}
```

Example:

```
\draw (0,0) -- (0.5,0) \cnode{c} -- (0.5,0.5);
\draw (c) -- ++(0,-0.5);
```

12.7 Midway Connection Node

```
\mnode{name}
```

Example:

```
\draw (0,0) -- (1,0) \mnode{m};
\draw (m) -- ++(0,-0.5);
```

12.8 Invisible Node with Terminal Node Properties (Used with Voltage Arrows)

```
\node{name}
```

Example:

```
\draw (0,0) -- ++(1,0) \tnode{t};
```

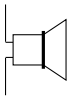

12.9 Speaker

```
\speakerWE{name}{position}
```

node endings: N: north, S: south,

Example:

```
\speakerWE{sp}{(0,0)}
\draw (spN) -- ++(0,0.5) (spS) -- ++(0,-0.5);
```



12.10 Bulb

```
\bulb{name}{position}
```

node endings: N: north, S: south, W: west, E: east

Example:

```
\bulb{b}{(0,0)}
\draw (bN) -- ++(0,0.5) (bS) -- ++(0,-0.5);
```

12.11 Multimeter (Circle for Voltmeter or Ammeter)

```
\multimeter{name}{position}{letter}
```

node endings: N: north, S: south, W: west, E: east

Example:

```
\multimeter{m}{(0,0)}{M}
\draw (mN) -- ++(0,0.5) (mS) -- ++(0,-0.5);
```

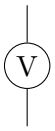
12.12 Voltmeter

```
\voltmeter{name}{position}
```

node endings: N: north, S: south, W: west, E: east

Example:

```
\voltmeter{v}{(0,0)}
\draw (vN) -- ++(0,0.5) (vS) -- ++(0,-0.5);
```



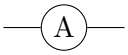
12.13 Ammeter

```
\ammeter{name}{position}
```

node endings: N: north, S: south, W: west, E: east

Example:

```
\ammeter{a}{(0,0)}
\draw (vW) -- ++(-0.5,0) (vE) -- ++(0.5,0);
```



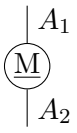
12.14 Brushless DC Electric Motor

```
\BLDCMotor{name}{position}{pin1}{pin2}
```

node endings: N: north, S: south, W: west, E: east

Example:

```
\BLDCMotor{motor}{(0,0)}{$A_1$}{$A_2$}
\draw (motorN) -- ++(0,0.5);
\draw (motorS) -- ++(0,-0.5);
```



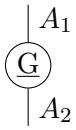
12.15 Brushless DC Electric Generator

```
\BLDCGenerator{name}{position}{pin1}{pin2}
```

node endings: N: north, S: south, W: west, E: east

Example:

```
\BLDCGenerator{gen}{(0,0)}{$A_1$}{$A_2$}
\draw (genN) -- ++(0,0.5);
\draw (genS) -- ++(0,-0.5);
```



12.16 Brushes for Electric Motors and Generators

```
\brushes{position}
```

Only usful in combination with motors or generators.

Example:

```
\brushes{(0,0)}
```

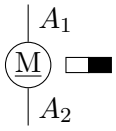
12.17 Brushless DC Electric Motor with Permanent Magnet

```
\permanentMagnetBLDCMotor{name}{position}{pin1}{pin2}
```

node endings: N: north, S: south, W: west, E: east

Example:

```
\permanentMagnetBLDCMotor{motor}{(0,0)}{$A_1$}{$A_2$}
\draw (motorN) -- ++(0,0.5);
\draw (motorS) -- ++(0,-0.5);
```



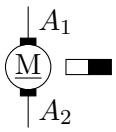
12.18 DC Electric Motor with Permanent Magnet

```
\permanentMagnetDCMotor{name}{position}{pin1}{pin2}
```

node endings: N: north, S: south, W: west, E: east

Example:

```
\permanentMagnetDCMotor{motor}{(0,0)}{$A_1$}{$A_2$}
\draw (motorN) -- ++(0,0.5);
\draw (motorS) -- ++(0,-0.5);
```



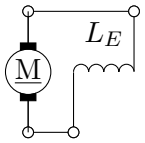
12.19 Shunt DC Electric Motor

```
\shuntDCMotor{name}{position}
```

node endings: N: north, S: south, W: west, E: east

Example:

```
\shuntDCMotor{motor}{(0,0)}
\draw (motorN) -- ++(0,0.5);
\draw (motorS) -- ++(0,-0.5);
```



12.20 Series DC Electric Motor

```
\seriesDCMotor{name}{position}
```

node endings: N: north, S: south, W: west, E: east

Example:

```
\seriesDCMotor{motor}{(0,0)}
\draw (motorN) -- ++(0,0.5);
\draw (motorS) -- ++(0,-0.5);
```