

# **A RISC-V Processor Components CircuiTikZ Library**

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# 1 Introduction

## 1.1 Motivation

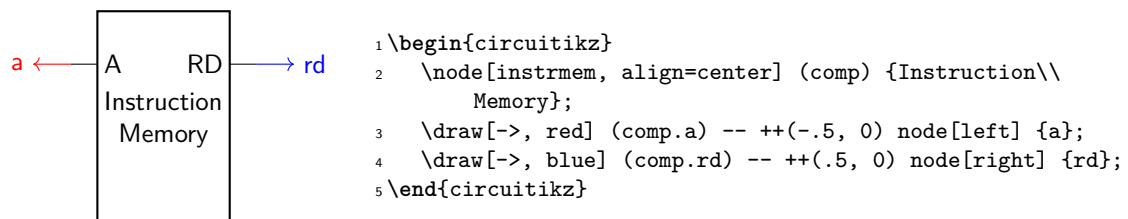
This CircuiTikZ library offers some components to efficiently draw RISC-V processors in  $\text{\LaTeX}$ . The library was designed with the goal of resembling the RISC-V processor schematics as presented in ‘Digital Design and Computer Architecture: RISC-V Edition’ by Sarah L. Harris and David Harris.

## 1.2 Usage

To use the predefined components, you must include the library `riscvproc`. Your preamble should look like this:

```
...  
\usepackage{tikz}  
\usepackage{circuitikz}  
\usetikzlibrary{riscvproc}  
...
```

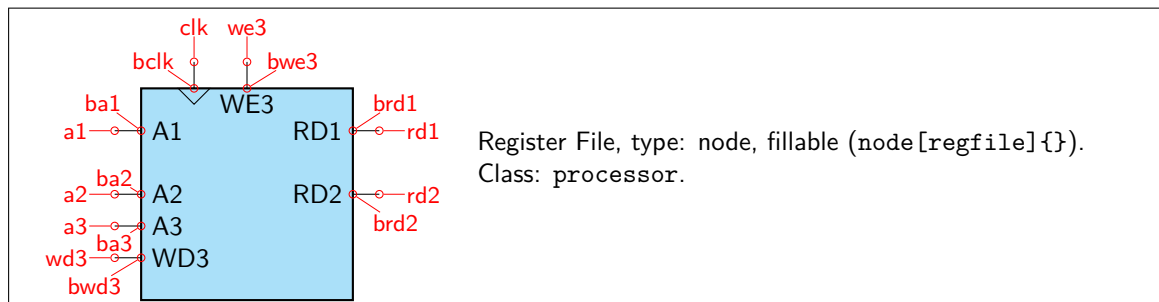
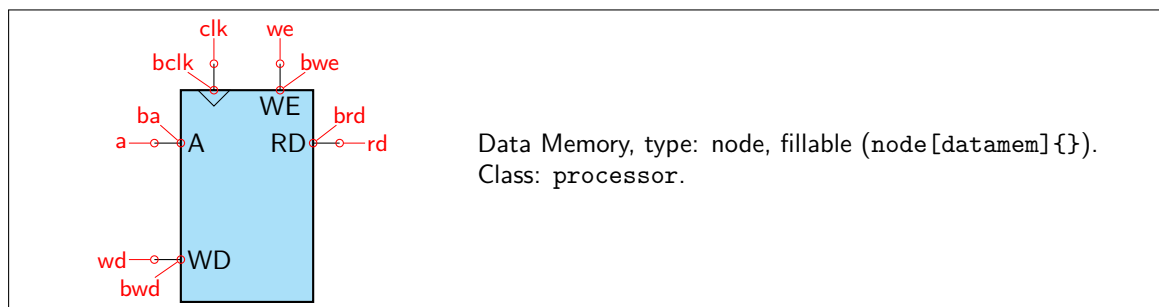
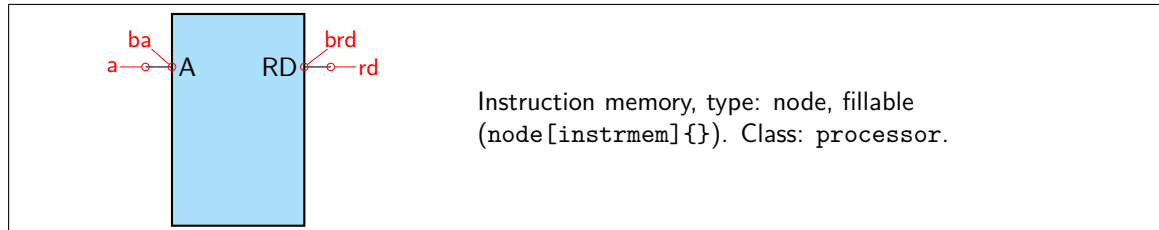
Components are then available in `circuitikz` environments:



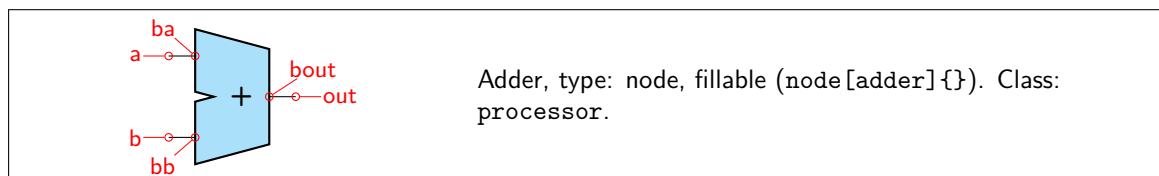
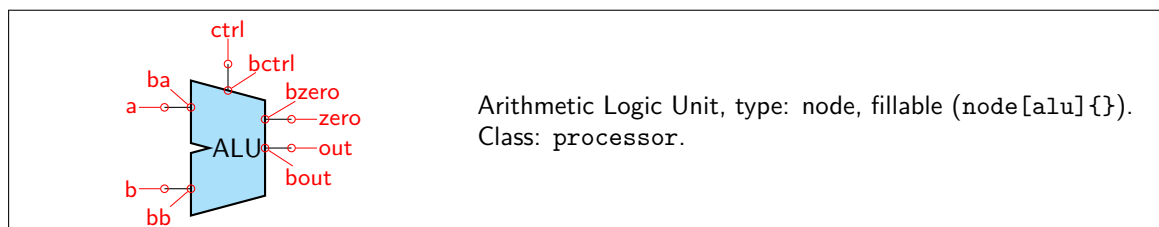
```
1\begin{circuitikz}  
2  \node[instrmem, align=center] (comp) {Instruction\\  
    Memory};  
3  \draw[->, red] (comp.a) -- ++(-.5, 0) node[left] {a};  
4  \draw[->, blue] (comp.rd) -- ++(.5, 0) node[right] {rd};  
5\end{circuitikz}
```

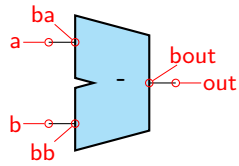
## 2 Component List

### 2.1 Memory Components



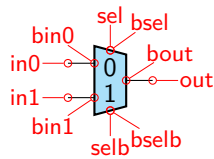
### 2.2 Arithmetic Components



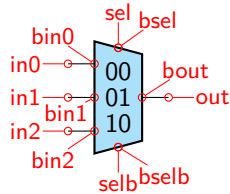


Subtractor, type: node, fillable (node[subtr]{}). Class: processor.

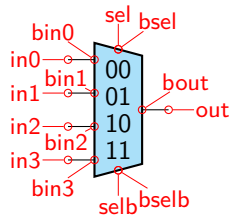
## 2.3 Multiplexers



Multiplexer, type: node, fillable (node[mux]{}). Class: processor.

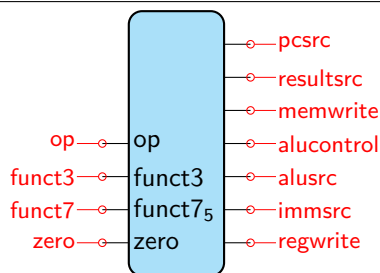


Multiplexer with 3 inputs, type: node, fillable (node[3mux]{}). Class: processor.

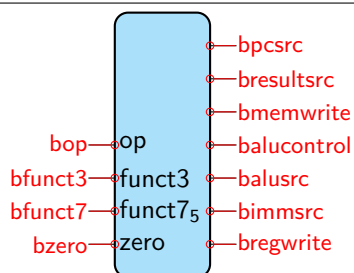


Multiplexer with 4 inputs, type: node, fillable (node[4mux]{}). Class: processor.

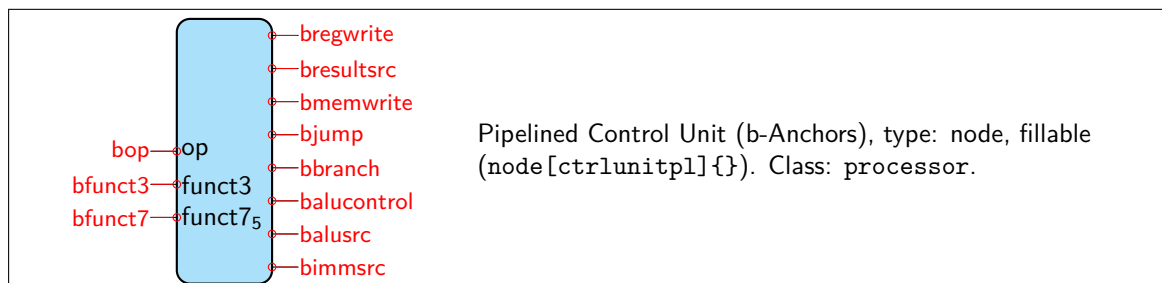
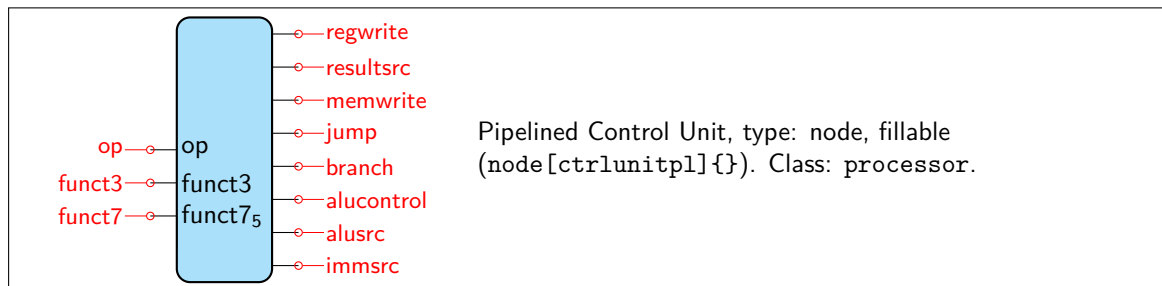
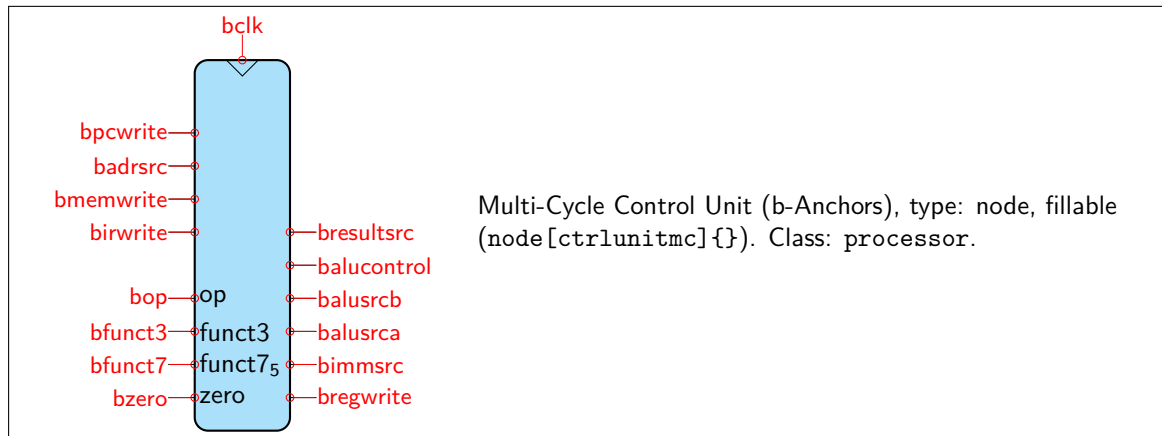
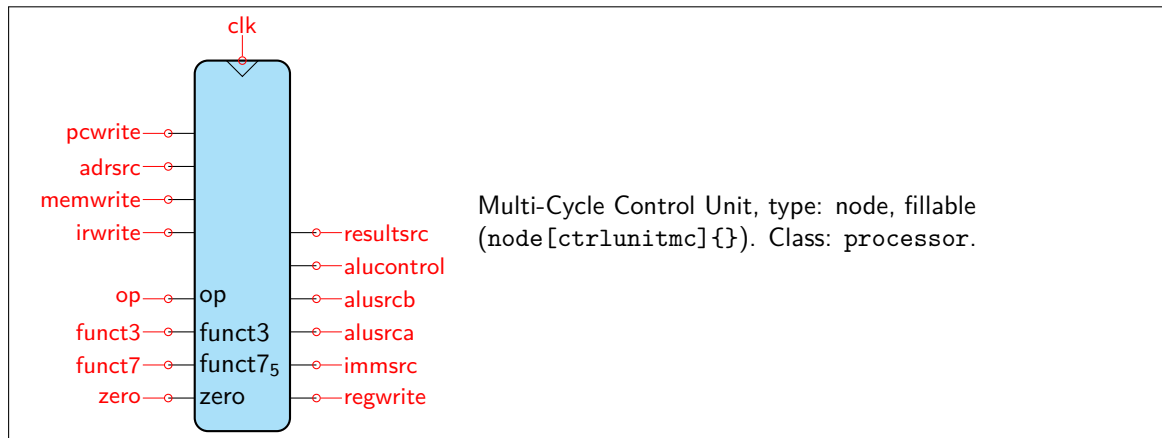
## 2.4 Control Units



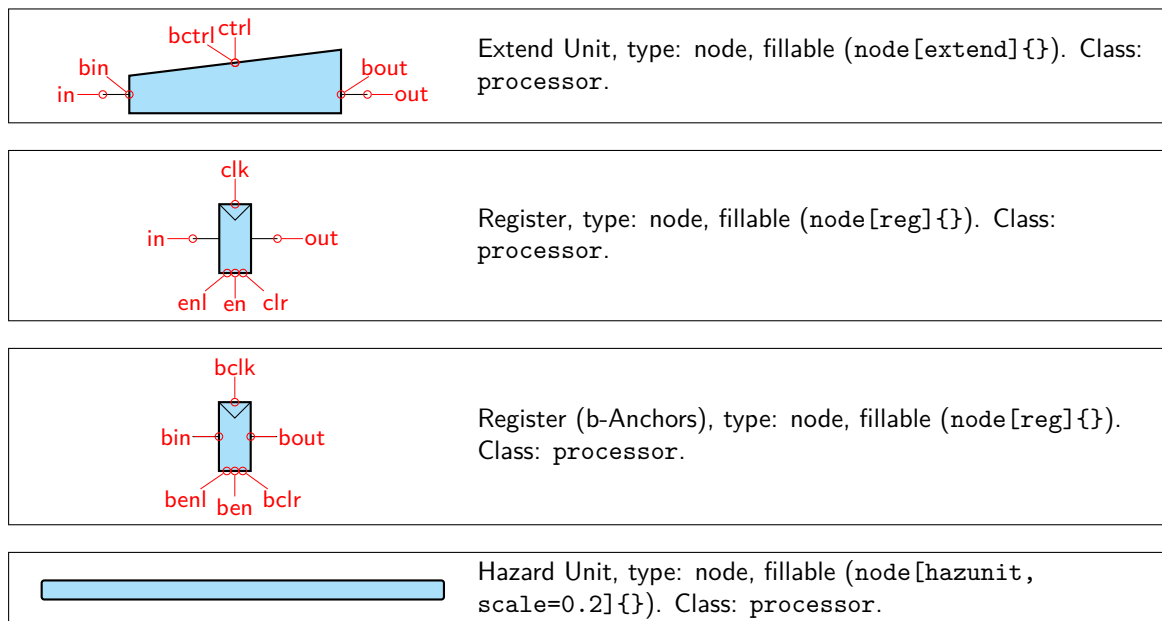
Single-Cycle Control Unit, type: node, fillable (node[ctrlunitsc]{}). Class: processor.



Single-Cycle Control Unit (b-Anchors), type: node, fillable (node[ctrlunitsc]{}). Class: processor.



## 2.5 Miscellaneous Components



## 3 Keys

### 3.1 CircuiTikZ keys

The desired CircuiTikZ key can be set via `\ctikzset{processor/<key>=value}`. E.g. if one wishes to set the line width of all components to 4, the line `\ctikzset{processor/thickness=4}` would have to be included in the specific circuitikz picture. A list of all CircuiTikZ keys can be found in Table ???. A list of component families can be found in Table ???.

Key	Description	Default value
<code>scale</code>	Sets scale for all processor components.	1
<code>thickness</code>	Sets line width for all processor components.	2
<code>font</code>	Sets font family for all labels of processor components.	<code>\rmfamily</code>
<code>memory/height</code>	Sets height for all memory components.	2
<code>memory/width</code>	Sets width for all memory components except <code>regfile</code> .	1.25
<code>control/heightsc</code>	Sets height for <code>ctrlunitsc</code> .	2.5
<code>control/heightmc</code>	Sets height for <code>ctrlunitmc</code> .	3.5
<code>control/width</code>	Sets width for control components.	0.9
<code>control/radius</code>	Sets border radius for control components.	5
<code>arith/height</code>	Sets height for arithmetic components.	0.9
<code>arith/width</code>	Sets height for arithmetic components.	0.7
<code>arith/slope</code>	Sets slope for arithmetic components in degrees.	15
<code>extend/height</code>	Sets height for big side of extend components.	0.6
<code>extend/width</code>	Sets height for extend components.	2
<code>extend/slope</code>	Sets slope for extend components in degrees.	7
<code>mux/slope</code>	Sets slope for multiplexers in degrees.	15
<code>misc/smallheight</code>	Sets height for small components.	0.65
<code>misc/smallwidth</code>	Sets width for small components. Also affects the CLK input triangle.	0.3
<code>misc/leadlen</code>	Sets length for input and output leads.	0.25
<code>hazard/height</code>	Sets height for <code>hazunit</code> .	0.9
<code>hazard/width</code>	Sets width for <code>hazunit</code> .	18
<code>hazard/radius</code>	Sets border radius for <code>hazunit</code> .	5

Table 1: List of CircuiTikZ keys

Component family	Component list
memory components	<code>instrmem</code> , <code>datamem</code> , <code>regfile</code>
control components	<code>ctrlunitsc</code> , <code>ctrlunitmc</code>
arithmetic components	<code>alu</code> , <code>add</code> , <code>subtr</code>
extend components	<code>extend</code>
small components	<code>mux</code> , <code>reg</code>

Table 2: List of component families



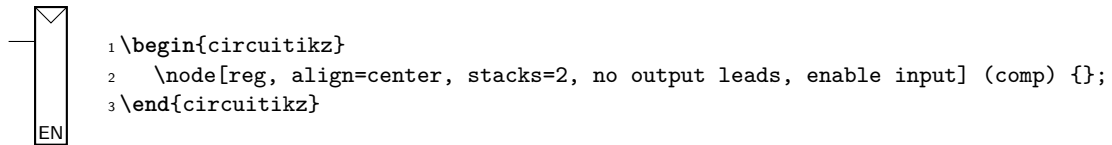


Figure 1: Passing options to a node

Key	Description	applicable to
input leads	Specifies wether to draw input leads.	all components
output leads	Specifies wether to draw output leads.	all components
leads	Specifies wether to draw leads at all.	all components
stacks	Sets height of a register in multiples of the default height, allows for stretched registers.	reg
enable input	Specifies wether to draw an enable input or not. This also gives two new anchors, en and ben.	reg
clear input	Specifies wether to draw a clear input or not. This also gives two new anchors, clr and bclr. For Usage of enable and clear inputs, use the enl and benl anchors.	reg
clock	Specifies wether to draw a clk input on a component that supports it.	all timed components

Table 3: List special node keys

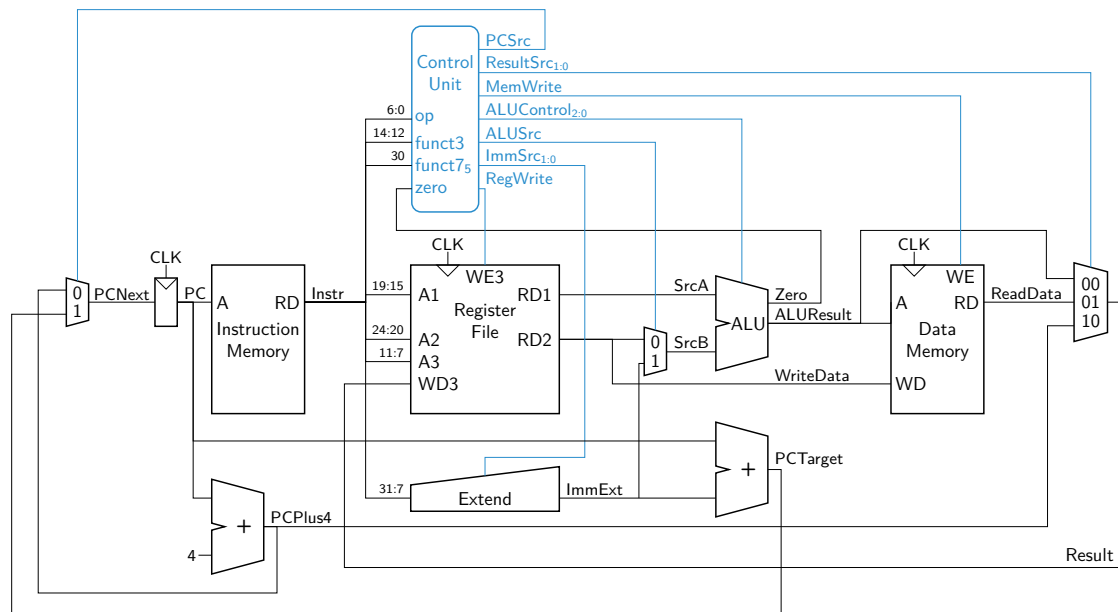
## 3.2 Special node keys

Some keys are also defined as Tikz keys and can therefore be directly passed to nodes likes shown in Figure ?? . A list of all these keys can be found in Table ?? .

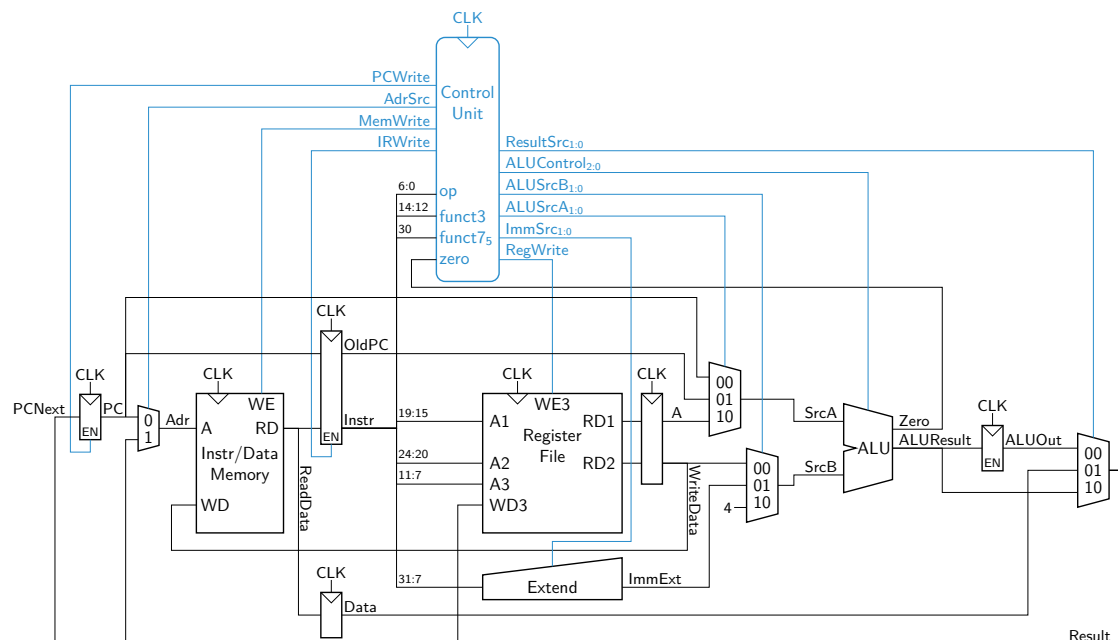
More keys might be added in future.

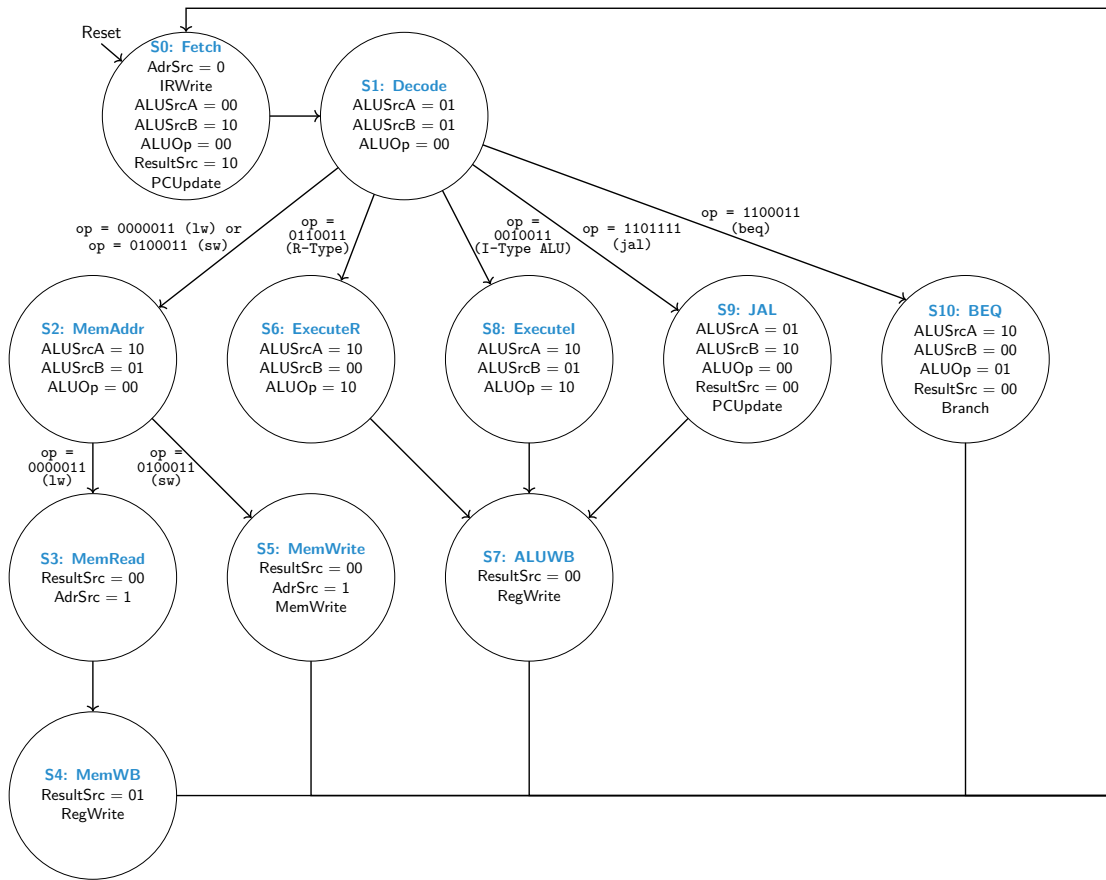
## 4 Examples

### 4.1 Single-Cycle RISC-V Processor

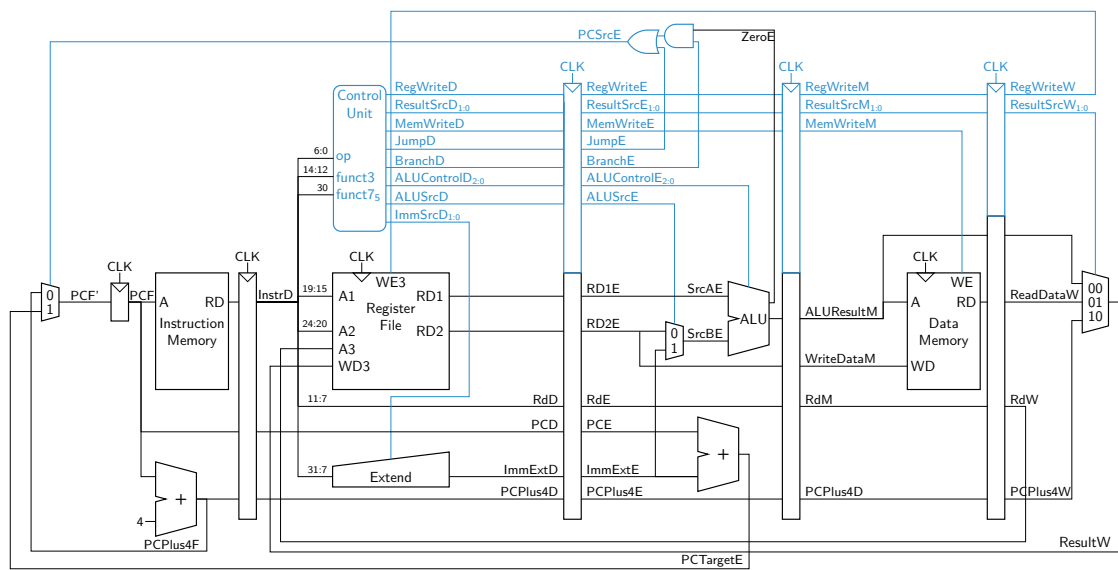


### 4.2 Multi-Cycle RISC-V Processor





### 4.3 Pipelined RISC-V Processor



## 4.4 Pipelined RISC-V Processor with Hazard Unit

