RISC-V Documentation Template

Version 0.01, 06/2021: Pre-release version

Table of Contents

Preamble

This is the preamble, which can contain contributor information and should contain the Creative Commons Attribution statement below.

For this book example, I have copied information directly from several Web sites that are hosted by asciidoctor.org and devoted to providing Asciidoc/Asciidoctor documentation, and have authored some explanations. Graphics used are either explicitly available for free, are property of RISC-V International, or were created using Wavedrom.

Preface

The following is a preface for this document and should be replaced with a preface for your document.

This document demonstrates the use of AsciiDoc for RISC-V specifications, with the goal of capturing information that will result in effective and efficient collaboration throughout the community.

AsciiDoc is the most feature-rich of the popular lightweight markup languages based on Markdown. Most of the markup that you will need is simple, and much is similar to what you use for git-flavored Markdown.

It's helpful to think of AsciiDoc as Markdown grown up. People in tech often have impulses to re-invent markdown with a brand new lightweight markup language of their own. As appealing as that idea can be, it is inherently flawed. Publishing, like music, can have simple forms, but when fully featured is quite complex. Everyone who has attempted to build upon Markdown to create a simple and feature-rich publishing solution faces the same reality.

RISC-V specifications require the use of AsciiDoc markup and the Asciidoctor toolchain with advanced publishing features that are provided by several add-ons. The templates in this repo are here to allow you to jump in with a hands-on approach and build a PDF using the example files.

Because AsciiDoc is gaining in popularity, there are opportunities contributors to the AsciiDoc specification while it is still being developed. You might want to view what Dan Allen and Sarah White are doing. Along with a growing open source community, they support both AsciiDoc and the Asciidoctor toolchain. Feel free to find out about the working group, the specification under development, the toolchain and its various plugins, and other projects that make use of AsciiDoc.

Chapter 1. A few basics

Asciidoc is fully documented, and its documentation is actively maintained. This document contains some information on asciidoc markup to get you started.

For details and additional options:

- Asciidoc/asciidoctor writers' guide: asciidoctor.org/docs/asciidoc-writers-guide/
- Asciidoc quick reference: asciidoctor.org/docs/asciidoc-syntax-quick-reference/
- Asciidoctor user manual: asciidoctor.org/docs/user-manual/

In addition, you have the option of asking questions in the asciidoctor discussion list:

As is true of any complex process, asciidoc/asciidoctor has some quirks. Please be certain to make use of these templates because they provide you with files that will result in fully featured pdf output.

Best practice is to test the pdf build frequently to ensure that you have not accidentally introduced something that breaks the build.

PDFs require the use of Ruby 2.7.2.

1.1. Headers

In asciidoc you cannot jump directly from a Head 1 to a Head 3 or 4. Your headers must appear in numerical sequence from Head 1 to Head 2, and onward. If you skip over a header in the sequence, asciidoctor throws an error.

```
= Title head (book or report title)

[colophon]
= Colophon head (in frontmatter, used for preface)

[[chapter_title]]
== Head 1 (chapter)

=== Head 2 (section)

==== Head 3 (subsection)

===== Head 4 (sub-subsection)

[appendix]
== Appendix title

[index]
Index
```

Settings in the header file trigger auto-generation of Appendix prefixes and of the Index (among other things).

1.2. Code Blocks

Asciidoc/asciidoctor supports code blocks with syntax highlighting for many languages. You can use either periods or dashes to indicate code blocks, and use macros to indicate that the block contains code in the specified language, as in the following example:

```
[source,python]
....
mono-spaced code block
add a1,a2,a3; # do an ADD
....
```

renders as follows:

```
mono-spaced code block
add a1,a2,a3; # do an ADD
```

1.3. Hyperlinks and cross references

Asciidoctor automates some linking as follows:

- Asciidoctor recognizes hyperlinks to Web pages and shortens them for readability.
- Asciidoctor automatically creates an anchor for every section and discrete heading.

To create highlighted links, use the pattern in the following example:

```
https://asciidoctor.org[Asciidoctor]
```

You can set attributes for your external links

Use macros for cross references (links within a document) as in the following example:

```
Section <<Index markers>> describes how index markers work.
```

This renders as:

Section Section 3.4 describes how index markers work.

1.4. Stem content

The `:stem: latexmath` setting makes use of asciidoctor-mathematical for asciidoctor-pdf output.

Asciidoctor Mathematical is a Ruby gem that uses native extensions. It has a few system prerequisites which limit installation to Linux and macOS. Please refer to the README in the RISC-V docs-templates repo for information on the asciidoctor-mathematical install.

```
[stem]
++++
sqrt(4) = 2
++++
```

$$sqrt(4) = 2$$

In some cases, you might want to make use of unicode characters. Keep in mind that asciidoctor-pdf currently only supports decimal character references. See github.com/asciidoctor/asciidoctor-pdf/issues/486

Hexadecimal unicode looks like it has problems in the pdf. This is gnarley.

Updates to asciidoctor-pdf: github.com/asciidoctor/asciidoctor-pdf

Chapter 2. Tables, symbols, and graphics

Asciidoc makes standard tables easy and also supports the creation of complex tables.

2.1. Some table examples

AsciiDoc tables can also be created directly from CSV data. Just set the format block attribute to CSV and insert CSV data inside the block delimiters directly:

```
[%header,format=csv]
|===
Artist,Track,Genre
Baauer,Harlem Shake,Hip Hop
The Lumineers,Ho Hey,Folk Rock
|===
```

The above renders as follows:

Artist	Track	Genre
Baauer	Harlem Shake	Hip Hop
The Lumineers	Ho Hey	Folk Rock

Here is an additional example of what can be done with tables:

```
[cols="e,m,^,>s",width="25%"]
|============================
|1 >s|2 |3 |4
^|5 2.2+^.^|6 .3+<.>m|7
^|8
|9 2+>|10
|============================
```

Which renders as follows:

1	**2**	3	**4**
5	6		
8			
9	10		7

Following is code for a numbered encoding table with link target.

Annotations have been added to the code to illustrate their use.

```
[#proposed-16bit-encodings-1]  ①
.proposed 16-bit encodings-1    ②
[width="100%",options=header]
|===
|15 |14 |13 |12 |11 |10 |9 |8 |7 |6 |5 |4 |3 |2 |1 |0 |instruction
3+|100|1|0|0|0 2+|field|0 |0 2+|00 | field 2+|00|mnemonic1
3+|100|1|0|0 3+|field|bit|1 3+|field 2+|00|mnemonic2
3+|110|1|0|0 3+|field|1 |0 3+|field 2+|00|mnemonic3
17+|This row spans the whole table
3+|100|1|1|1 8+|    field        2+| 00   | mnemonic4
|===
```

1. Link target.
2. Numbered table title.

Table 1. proposed 16-bit encodings-1

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0	instruction
100			1	0	0	0	field		0	0	00		field	00		mnemonic1
100			1	0	0	field			bit	1	field			00		mnemonic2
110			1	0	0	field			1	0	field			00		mnemonic3
This row spans the whole table																
100			1	1	1	field								00		mnemonic4

2.2. Unicode symbols

For pdf, some unicode symbols are buggy. There are some workarounds. The asciidcotor-pdf toolchain supports most unicode up to and including four digits, and not characters that require five or more digits. I noticed the need for a mathematical *w* and because its encoding uses an integer that is in the 5+ digit category it doesn't work.

Here are a few unicode examples from en.wikipedia.org/wiki/List_of_XML_and_HTML_character_entity_references:

As an example, ◆ is encoded as follows:

```
&#9830;
```

Table 2. Useful unicode for specifications

sym	num	name
^	94	caret
□	136	
◆	9830	name
"	0034	name
w	0077	w
∴	8756	therefore
♯	9839	sharp
ш	1096	shcy
ϖ	982	piv varpi
ω	969	omega
℘	8472	weierp wp
Σ	8721	sum
∞	8734	infin
∫	8747	integral
≠	8800	not equal to
≤	8804	le
≥	8805	ge
≈	8776	numerical approximation
D	68	mathematical D?
⇒	8658	rightwards double arrow
X	88	Latin Capital x
χ	967	Greek x
×	215	times
☑	9745	boxed checkmark
r	114	latin small letter r

Unfortunately a better checkmark is not available for asciidoctor-pdf, because anything above four digits doesn't work. The fact that encodings for moe than four digits for HTML encoding doesn't work is connected to prawn, which is used for generating the fully functional asciidoctor-pdf, and not to asciidoctor-pdf itself. Until the newer asciidoctor build that uses a different toolchain becomes fully featured, we must use a workaround.

It is possible to map fonts for better substitutes to numbers for which you don't need to make use of the existing unicode mapping should the need become a priority. For example, if a perfect mathematical *w* is important, we can implement the workaround until the newer toolchain for the pdf

build is fully featured.

Table 3. Unicode identified as not working

sym	num	name
□	9084	angzarr not working
□	8921	ggg not working
□	8617	hookleftarrow not working
□	9083	not checkmark not working

2.3. Graphics

While asciidoc can render graphics in all popular formats, by far the highest quality graphics rendering is from .svg format.

WaveDrom sequence diagrams are essential to the RISC-V specifications. We are in the process of phasing in an automated process for incorporating WaveDrom diagrams into the professional quality pdf output so please stay tuned.

Asciidocdoctor-pdf enables automation of diagrams from scripts, including WaveDrom.

Even as we are using WaveDrom to simplify the creation of accurate svgs for register diagrams, the graphical elements—those for the various diagrams—add complexity to the build.

2.3.1. Automated diagramming

The asciidoctor-diagram extension supports numerous diagram types including WaveDrom diagramming (for sequence and waveform diagrams).

The requirements for building WaveDrom diagrams are specified in the docs temaplates readme.

The following json-formatted script, when added within an asciidoc block with the macro indicators `[wavedrom, svg]`, will embed the diagram output into the pdf:

```
{reg:[
    { bits:  7, name: 0x3b, attr: ['OP-32'] },
    { bits:  5, name: 'rd' },
    { bits:  3, name: 0x0, attr: ['ADD.UW'] },
    { bits:  5, name: 'rs1' },
    { bits:  5, name: 'rs2' },
    { bits:  7, name: 0x04, attr: ['ADD.UW'] },
]}
```

For the above to build into a diagram, with a figure title, you need to add the macro information and a figure title above the code block:

```
.Figure title
[wavedrom, svg]
```

Prior bug is fixed and requirements for local build added to the README. Once the required node and ruby extensions are installed, the diagrams build from asciidoc blocks

```
Figure title
[wavedrom, svg]
....
{reg:[
    { bits:  7, name: 0x3b, attr: ['OP-32'] },
    { bits:  5, name: 'rd' },
    { bits:  3, name: 0x0, attr: ['ADD.UW'] },
    { bits:  5, name: 'rs1' },
    { bits:  5, name: 'rs2' },
    { bits:  7, name: 0x04, attr: ['ADD.UW'] },
]}
....
```

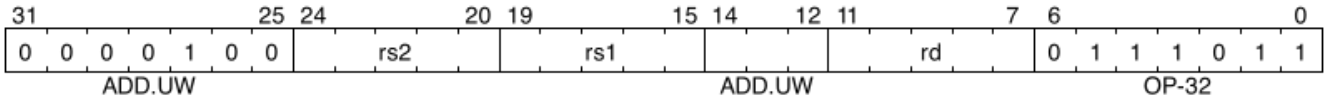


Figure 1. Figure title

You have the option of referencing a graphics file directly:

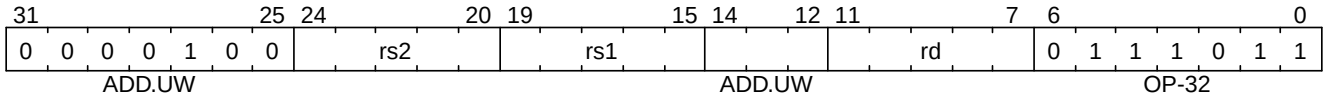


Figure 2. This example is from an svg generated prior to the build

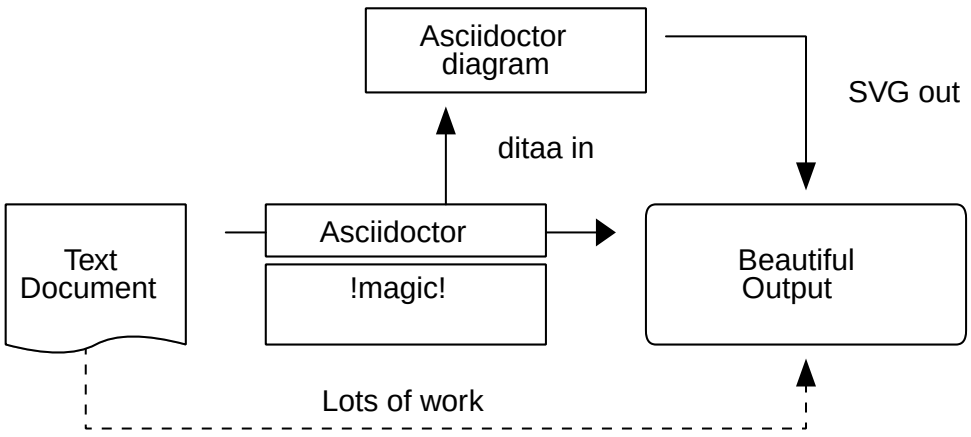
2.3.2. Additional diagram type examples

Following is source for simple ditaa diagram:

```
[ditaa,target="image-example",svg]
....

                  +-------------+
                  | Asciidoctor |-------+
                  |   diagram   |       |
                  +-------------+       | SVG out
                      ^                 |
                      | ditaa in        |
                      |                 v
 +--------+   +--------+----+    /---------------\
 |        | --+ Asciidoctor +--> |               |
 |  Text  |   +-------------+    |   Beautiful   |
 |Document|   |   !magic!   |    |    Output     |
 |     {d}|   |             |    |               |
 +---+----+   +-------------+    \---------------/
     :                                   ^
     |          Lots of work             |
     +-----------------------------------+
....
```

Which renders to:

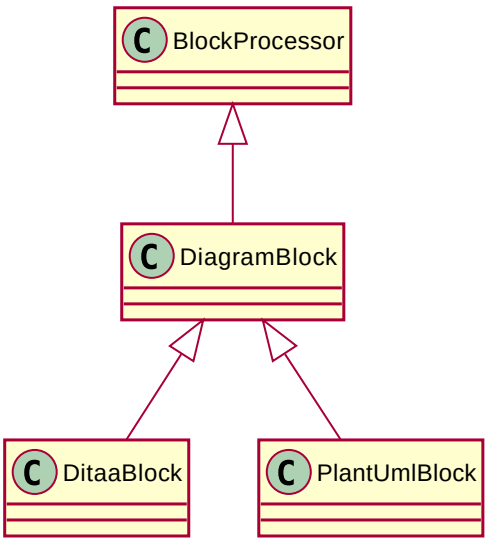


Following is source for a plantuml diagram:

```
[plantuml, diagram-classes, svg]
....
class BlockProcessor
class DiagramBlock
class DitaaBlock
class PlantUmlBlock

BlockProcessor <|-- DiagramBlock
DiagramBlock <|-- DitaaBlock
DiagramBlock <|-- PlantUmlBlock
....
```

Which renders to:



2.4. Superscipts and other mathematical notations

While not all of the RISC-V specifications make use of mathematical notations, some make frequent use of superscipts.

To indicate a superscript, enclose the string for the superscript in carets as in the following example:

```
2^8^
```

Which renders as:

2^{8}

You can indicate text in a superscript as well:

```
1234^NOTE^
```

Which renders as:

1234[NOTE]

You can make use of LaTeX notation as in the following:

```
latexmath:[$C = \alpha + \beta Y^{\gamma} + \epsilon$]
```

Which renders as:

$C = \alpha + \beta Y^{\gamma} + \epsilon$

Chapter 3. Blocks, notes and markers

RISC-V specifications are notable for their extended commentaries that explain the thinking behind various important aspects of the technologies.

In most cases, contributors should make use of admonition blocks for their commentaries.

3.1. Blocks

Asciidoctor allows for many types of blocks, as documented at docs.asciidoctor.org/asciidoc/latest/blocks/.

3.1.1. Sidebars

Sidebars provide for a form of commentary.

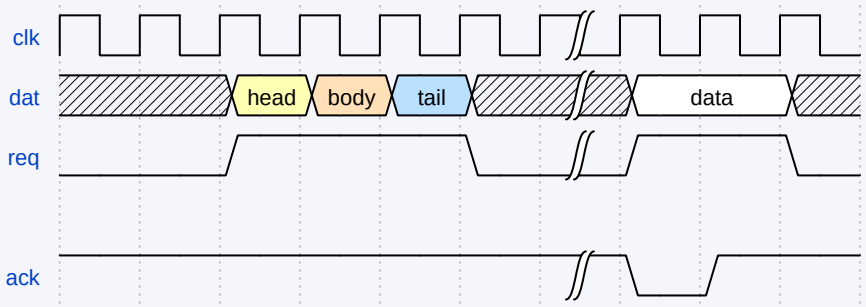
```
****
This is content in a sidebar block.

image:example-3.svg[]

This is more content in the sidebar block.
****
```

This renders as follows:

This is content in a sidebar block.



This is more content in the sidebar block.

You can add a title, along with any kind of content. Best practice for many of the "commentaries" in the LaTeX source that elucidate the decisionmaking process is to convert to this format with the `TIP` icon that illustrates a conversation or discussion, as in the following example:

```
.Optional Title
****
Sidebars are used to visually separate auxiliary bits of content
that supplement the main text.

TIP: They can contain any type of content, including admonitions like this, and
code examples like the following.

.Source code block in a sidebar
[source,js]
```

const { expect, expectCalledWith, heredoc } = require('../test/test-utils')

```
****
```

The above renders as:

Optional Title

Sidebars are used to visually separate auxiliary bits of content that supplement the main text.

They can contain any type of content, including admonitions like this, and code examples like the following.

Listing 1. Source code block in a sidebar

```
const { expect, expectCalledWith, heredoc } = require('../test/test-utils')
```

3.1.2. Admonition blocks

Five kinds of standard admonition blocks are available in asciidoc and these can be mapped to either default or custom icons.

```
[NOTE]
====
This is an example of an admonition block.

Unlike an admonition paragraph, it may contain any AsciiDoc content.
The style can be any one of the admonition labels:

* NOTE
* TIP
* WARNING
* CAUTION
* IMPORTANT
====
```

This renders as:

This is an example of an admonition block.

Unlike an admonition paragraph, it may contain any AsciiDoc content. The style can be any one of the admonition labels:

- NOTE
- TIP
- WARNING
- CAUTION
- IMPORTANT

For a single paragraph admonition, simply use a double colon:

```
NOTE: Note content.
```

which renders as:

Note content.

Alternate octicons:

- alert-24
- comment-discussion-24
- flame-24
- info-24
- pencil-24
- question-24
- sheild-24

- squirrel-24
- zap-24

Another example of an admonition block:

```
[IMPORTANT]
.Feeding the Werewolves
====
While werewolves are hardy community members, keep in mind the following dietary
concerns:

. They are allergic to cinnamon.
. More than two glasses of orange juice in 24 hours makes them howl in harmony
with alarms and sirens.
. Celery makes them sad.
====
```

Rendered:

Feeding the Werewolves

While werewolves are hardy community members, keep in mind the following dietary concerns:

1. They are allergic to cinnamon.
2. More than two glasses of orange juice in 24 hours makes them howl in harmony with alarms and sirens.
3. Celery makes them sad.

github.com/asciidoctor/asciidoctor-pdf/blob/master/docs/theming-guide.adoc#key-prefix-admonition-icon

The default admonition icons don't look right for RISC-V specification, and alternate icons and colors have been set in risc-v_spec-pdf.yml. and will be considered.

Current icons, edited to tone down color:

note

tip

warning

caution

important

Table 4. Customized colors for icons

Icon	default	customized
NOTE	19407c	6489b3
TIP	111111	5g27ag
WARNING	bf6900	9c4d4b
CAUTION	bf3400	c99a2c
IMPORTANT	bf0000	b58f5b

3.1.3. Code blocks

AsciiDoc enables code blocks that support syntax highlighting.

For example, preceding a block with a macro `[source,json]` enables `json` syntax highlighting:

```
{
    "weather": {
        "city":        "Zurich",
        "temperature":       25,
    }
}
```

3.2. Change bars

Change indicators within text files are exceedlingly useful and also can be equally complex to implement. Please consider the fact that much of the software programming for Git revolves around handling various kinds of change indicators.

In exploring possbile implementation of change bars for RISC-V, we have looked for a solution that is as simple as possible while maximizing value with respect to the time invested in implementing, maintaining, and using the tools and procedures.

The suggested solution makes use of:

- an AsciiDoc `role`.
- modifiction of two files in the Ruby gem with code snippets (see procedure in the README for github.com/riscv/docs-templates).
- Git features.
- a few procedures associated, specifically, with Git updates.

3.2.1. Indicate changes

With apologies for requiring a manual step at this time, indicators for the changed lines must be inserted:

```
[.Changed]#SELECT clause#

Text without the change bar

[.Changed]#Text with the change bar#
```

SELECT clause

Text without the change bar

Text with the change bar

For change bars associated with headings, place the change indicator after the heading indicator and before the text, like the following:

```
== [.Changed]#SELECT clause#
```

3.2.2. Check for changed lines before a `git commit`

You can double check for all changed lines just before doing a commit, using this pattern:

```
git blame <file> | grep -n '^0\{8\} ' | cut -f1 -d:
```

This lists the line numbers of chnages within the specified file like the following:

```
5
38
109
237
```

3.3. Footnotes

Asciidoc has a limitation in that footnotes appear at the end of each chapter. Asciidoctor does not support footnotes appearing at the bottom of each page.

You can add footnotes to your presentation using the footnote macro. If you plan to reference a footnote more than once, use the footnote macro with a target that you identify in the brackets.

```
Initiate the hail-and-rainbow protocol at one of three levels:

- doublefootnote:[The double hail-and-rainbow level makes my toes tingle.]
- tertiary
- apocalyptic

A bold statement!footnote:disclaimer[Opinions are my own.]

Another outrageous statement.footnote:disclaimer[]
```

Renders as:

The hail-and-rainbow protocol can be initiated at three levels:

- double [1]
- tertiary
- apocalyptic

A bold statement! [2]

Another outrageous statement.[2]

3.4. Index markers

There are two types of index terms in AsciiDoc:

A flow index term. appears in the flow of text (a visible term) and in the index. This type of index term can only be used to define a primary entry:

```
indexterm2:[<primary>] or ((<primary>))
```

A concealed index term. a group of index terms that appear only in the index. This type of index term can be used to define a primary entry as well as optional secondary and tertiary entries:

```
indexterm:[<primary>, <secondary>, <tertiary>]
```

--or--

```
(((<primary>, <secondary>, <tertiary>)))
```

```
The Lady of the Lake, her arm clad in the purest shimmering samite,
held aloft Excalibur from the bosom of the water,
signifying by divine providence that I, ((Arthur)), ①
was to carry Excalibur (((Sword, Broadsword, Excalibur))). ②
That is why I am your king. Shut up! Will you shut up?!
Burn her anyway! I'm not a witch.
Look, my liege! We found them.

indexterm2:[Lancelot] was one of the Knights of the Round Table. ③
indexterm:[knight, Knight of the Round Table, Lancelot] ④
```

① The double parenthesis form adds a primary index term and includes the term in the generated output.

② The triple parenthesis form allows for an optional second and third index term and does not include the terms in the generated output (a concealed index term).

③ The inline macro `indexterm2\:[primary]` is equivalent to the double parenthesis form.

④ The inline macro `indexterm:\[primary, secondary, tertiary]` is equivalent to the triple parenthesis form.

If you're defining a concealed index term (the indexterm macro), and one of the terms contains a comma, you must surround that segment in double quotes so the comma is treated as content. For example:

```
I, King Arthur.
indexterm:[knight, "Arthur, King"]
```

I, King Arthur.

--or--

```
I, King Arthur.
(((knight, "Arthur, King")))
```

I, King Arthur.

3.5. Bibliography and references

There are two ways of handling bibliographies:

- making manual entries to which you can create links from the text in the body of your document.
- using automated features provided by asciidoctor-bibtex[]

You can add bibliographic entries to the last appendix that you use in a book document.

3.5.1. Automated bibliography procedures with asciidoctor-bibtex

Asciidoctor-bibtex enables options that allow for establishing a single source of bibliographic entries for RISC-V specifications. As an added benefit we can make use of existing bibtex files.

For asciidoctor-bibtex to work, please install the Ruby gems as documented in the docs-templates README file.

This has now been tested and is the preferred procedure for adding a biliography.

The doc header file in the docs-templates repo now contains the following attributes for the purpose of implementing a biliograpy using asciidoctor-bibtex:

```
:bibtex-file: resources/references.bib
:bibtex-order: alphabetical
:bibtex-style: ieee
```

The repo also contains the most recent version of the `riscv-spec.bib` file for asciidocotor-bibtex to use while building the bibliogrpahy.

When you run asciidoctor-bibtex as part of the build, it searches for the bibtex file first in the folder and subfolders of the document header, and then in `\~/Documents`."

Within your text, add author-year references using the pattern:

```
 cite:[riscvtr(12)]
```

with the result, [2 p. 12]

Add age numbers (locators) using the pattern:

```
cite:[Kim-micro2005(45)]
```

with the result: [1 p. 45]

Add pretext using the pattern:

```
cite:See[Kim-micro2005(45)]
```

with the result: See [1 p. 45]

It's possible to include other files, which are also processed.

To to prevent problems with other appendices, leave keep the index as the second-to-last appendix and the bibliography as the last appendix in you list of included chapter sections within the book-header file.

Citations must be contained within a single line.

The bibliography section of the book must be set up as follows, to receive the entries during the build:

```
== Bibliography

bibliography::[]
```

When using the automated option, *do not* manually add entries to the `bibliography.adoc` file.

Following are example json-formatted bibliographic entries:

```
@book{Lane12a,
    author = {P. Lane},
    title =  {Book title},
    publisher = {Publisher},
    year =   {2000}
}

@book{Lane12b,
    author = {K. Mane and D. Smith},
    title =  {Book title},
    publisher = {Publisher},
    year =   {2000}
}

@article{Anderson04,
    author = {J. R. Anderson and D. Bothell and M. D. Byrne and S. Douglass and C.
Lebiere and Y. L. Qin},
    title = {An integrated theory of the mind},
    journal = {Psychological Review},
    volume = {111},
    number = {4},
    pages = {1036--1060},
    year = {2004}
}
```

3.5.2. Manual bibliography procedures

While the automated procedure and use of the RISC-V bibtex file is preferred, it is also possible to manually create and reference a bibliogprapy.

Text with markup that will generate links:

```
_The Pragmatic Programmer_ <<pp>> should be required reading for all developers.
To learn all about design patterns, refer to the book by the "`Gang of Four`"
<<gof>>.
```

Links from within text to bibliographic entries:

```
[bibliography]
== References

* [[[pp]]] Andy Hunt & Dave Thomas. The Pragmatic Programmer:
From Journeyman to Master. Addison-Wesley. 1999.
* [[[gof,gang]]] Erich Gamma, Richard Helm, Ralph Johnson & John Vlissides.
Design Patterns: Elements of Reusable Object-Oriented Software. Addison-Wesley.
1994.
```

Text that links to bibliography:

The Pragmatic Programmer [pp] should be required reading for all developers. To learn all about design patterns, refer to the book by the “Gang of Four” [gof].

[1] The double hail-and-rainbow level makes my toes tingle.
[2] Opinions are my own.

Index

Bibliography

[1] H. Kim, O. Mutlu, J. Stark, and Y. N. Patt, “Wish Branches: Combining Conditional Branching and Predication for Adaptive Predicated Execution,” in *Proceedings of the 38th annual IEEE/ACM International Symposium on Microarchitecture*, 2005, pp. 43–54.

[2] A. Waterman, Y. Lee, D. A. Patterson, and K. Asanović, “The RISC-V Instruction Set Manual, Volume I: Base User-Level ISA,” EECS Department, University of California, Berkeley, UCB/EECS-2011-62, May 2011.


RISC-V