cocotbext APB

March 24, 2025

Jay Convertino

Contents

1 Usage

1.1 Introduction

Cocotb extension to test APB3 bus master, and slave devices.

1.2 Dependencies

The following are the dependencies of the cores.

- iverilog (simulation)
- cocotb (simulation)
- cocotb-bus (simulation)

1.3 In a Simulation

Below is a simple example for reading and writing data from register zero in the cocotb extension.

```
master  = apb3Master(dut, "apb", dut.clk, dut.rstn)
slave = apb3EchoSlave(dut, "apb", dut.clk, dut.rstn)

await master.write(0, 0xAAAAAAAA)

rx_data = await master.read(0)

assert 0xAAAAAAAA == rx_data, "RECEIVED␣DATA␣DOES␣NOT␣
    ↪ MATCH"
```

2 Architecture

Please see 4 for more information.

apb3Master tests APB3 slave devices by executing read/write requests from the python test bench.

apb3EchoSlave provides a simple slave that will echo all register writes back over read when requested.

apb3Monitor tests to make sure signals are proper. Simple core at the moment, only checks for 0 at rest and if the penable is correct per pselect.

2.1 Directory Guide

Below highlights important folders from the root of the directory.

1. **docs** Contains all documentation related to this project.
    - **manual** Contains user manual and github page that are generated from the latex sources.
2. **cocotbext** Contains source files for the extension
    - **apb.three** Contains source files for the APB version three extension.
3. **tests** Contains test files for cocotb

3 Simulation

A simulation for testing the cores can be run to verify operation.

3.1 cocotb

To use the cocotb tests you must install the following python libraries.

```
$ pip install cocotb
$ pip install -e .
```

Then you must enter the tests folder and enter the mil-std-1553 folder. From there you may execute the following command which will kick off the test.

```
$ make
```

4 Code Documentation

Natural docs is used to generate documentation for this project. The next lists the following sections.

- **init** Python init code.
- **monitor** Contains bus monitor code.
- **driver** Contains bus driver code.
- **absbus** Contains bus abstraction for monitor, and driver code.
- **busbase** Contains bus base for threads and read/write methods.
- **cocotb test** Python TestFactory code.
- **cocotb verilog test wrapper** Verilog wrapper module.

__init__.py

AUTHORS

JAY CONVERTINO

DATES

2025/03/06

INFORMATION

Brief

MIL-STD-1553 define for packages license: License MIT Copyright 2025 Jay Convertino

Permission is hereby granted, free of charge, to any person obtaining a copy of this software and associated documentation files (the "Software"), to deal in the Software without restriction, including without limitation the rights to use, copy, modify, merge, publish, distribute, sublicense, and/or sell copies of the Software, and to permit persons to whom the Software is furnished to do so, subject to the following conditions:

The above copyright notice and this permission notice shall be included in all copies or substantial portions of the Software.

THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM, OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.

"""

Copyright (c) 2020 Alex Forencich

Permission is hereby granted, free of charge, to any person obtaining a copy of this software and associated documentation files (the "Software"), to deal in the Software without restriction, including without limitation the rights to use, copy, modify, merge, publish, distribute, sublicense, and/or sell copies of the Software, and to permit persons to whom the Software is furnished to do so, subject to the following conditions:

The above copyright notice and this permission notice shall be included in all copies or substantial portions of the Software.

THE SOFTWARE IS PROVIDED "AS IS", WITHOUT WARRANTY OF ANY KIND, EXPRESS OR IMPLIED, INCLUDING BUT NOT LIMITED TO THE WARRANTIES OF MERCHANTABILITY FITNESS FOR A PARTICULAR PURPOSE AND NONINFRINGEMENT. IN NO EVENT SHALL THE AUTHORS OR COPYRIGHT HOLDERS BE LIABLE FOR ANY CLAIM, DAMAGES OR OTHER LIABILITY, WHETHER IN AN ACTION OF CONTRACT, TORT OR OTHERWISE, ARISING FROM, OUT OF OR IN CONNECTION WITH THE SOFTWARE OR THE USE OR OTHER DEALINGS IN THE SOFTWARE.

"""

monitor.py

AUTHORS

JAY CONVERTINO

DATES

2025/03/11

INFORMATION

Brief

Monitor for APB3

License MIT

apb3Monitor

Check signals to make sure they are applied properly.

FUNCTIONS

__init__

```
def __init__(
self,
entity,
name,
clock,
resetn,
                                                                    *
args,
                                                                   **
kwargs
)
```

Setup defaults and call base class constructor.

_check_type

```
def _check_type(
self,
trans
)
```

Check and make sure we are only sending apb3trans, this is only here to satisify the need to have it.

_run

```
async def _run(
self
)
```

_run thread that deals with checking signals, simple check for now.

driver.py

AUTHORS

JAY CONVERTINO

DATES

2025/03/11

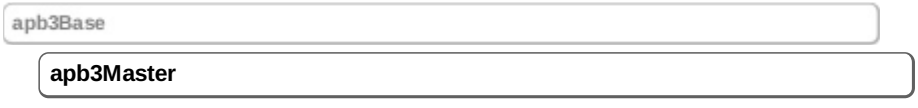
INFORMATION

Brief

Bus Driver for APB3

License MIT

apb3Master



Drive slave devices over the APB3 bus

FUNCTIONS

__init__

```
def __init__(
self,
entity,
name,
clock,
resetn,
                                                                    *
args,
                                                                   **
kwargs
)
```

Setup defaults and call base class constructor.

read

```
async def read(
self,
address
)
```

Read from a address and return data

write

```
async def write(
self,
address,
data
)
```

Write to a address some data

_check_type

```
def _check_type(
self,
trans
)
```

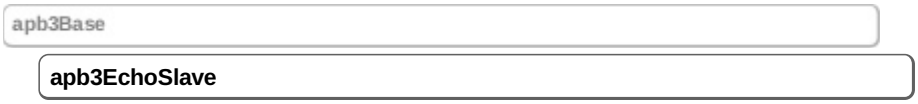
Check and make sure we are only sending 2 bytes at a time and that it is a bytes/bytearray

_run

```
async def _run(
self
)
```

_run thread that deals with read and write queues.

apb3EchoSlave



Respond to master reads and write by returning data, simple echo core.

FUNCTIONS

__init__

```
def __init__(
self,
entity,
name,
clock,
resetn,
numreg
=
256,
*
args,
**
kwargs
)
```

Setup defaults and call base class constructor.

_check_type

```
def _check_type(
self,
trans
)
```

Check and make sure we are only sending a type of apb3trans.

_run

```
async def _run(
self
)
```

_run thread that deals with read and write request over bus.

absbus.py

AUTHORS

JAY CONVERTINO

DATES

2025/03/11

INFORMATION

Brief

abstraction of the apb3 bus

License MIT

apb3trans

transaction

apb3trans

create an object that associates a data member and address for operation.

apbState

enum.**IntEnum**

An enum class that provides the current state and will change states per spec.

apb3Base

abstract base class that defines apb3 signals

VARIABLES

_signals

```
_signals
```

List of signals that are required

_optional_signals

```
_optional_signals
```

List of optional signals, these will never be required but will be used if found.

FUNCTIONS

__init__

```
def __init__(
self,
entity,
name,
clock,
resetn,
                                                                *
args,
                                                               **
kwargs
)
```

Setup defaults and call base class constructor.

busbase.py

AUTHORS

JAY CONVERTINO

DATES

2025/03/11

INFORMATION

Brief

classic bus define for packages

License MIT

busbase

busbase

apb3Base

A busbase to transmit test routine.

FUNCTIONS

__init__

```
def __init__(
self,
entity
:
SimHandleBase,
name
:
Optional[str],
clock
:
SimHandleBase,
                                                                *
args
:
Any,
                                                               **
kwargs
:
Any
)
```

Initialize the object

VARIABLES

wqueue

```
self.wqueue
```

Queue to store write requests

qqueue

```
self.qqueue
```

Queue to store read requests

rqueue

```
self.rqueue
```

Queue to store result of read requests

self._idle

```
self._idle
```

Event trigger for cocotb

self._run_cr

```
self._run_cr
```

Thread instance of _run method

FUNCTIONS

_restart

```
def _restart(
self
)
```

kill and restart _run thread.

write_count

```
def write_count(
self
)
```

How many items in the write queue

read_count

```
def read_count(
self
)
```

How many items in the read queue

write_empty

```
def write_empty(
self
)
```

Is the quene empty?

read_empty

```
def read_empty(
self
)
```

Is the quene empty?self.bus.penable.value

write_clear

```
def write_clear(
self
)
```

Remove all write items from queue

read_clear

```
def read_clear(
self
)
```

Remove all read items from queue

wait

```
async def wait(
self
)
```

Wait for the run thread to become idle.

idle

```
def idle(
self
)
```

Are all the queues empty and the _run is not active processing data.

write_trans

```
async def write_trans(
self,
trans
:
transaction
)
```

Write transaction to send to write queue

read_trans

```
async def read_trans(
self,
trans
:
transaction
)
```

Read bus and output and tranaction.

_write

```
async def _write(
self,
trans
:
transaction
)
```

Write data one element at a time

_read

```
async def _read(
self,
trans
:
transaction
)
```

Read dat one element at a time

_check_type

```
def _check_type(
self,
trans
)
```

Check and make sure we are only sending the correct transaction type

_run

```
async def _run(
self
)
```

Virtual method for _run thread that deals with read and write queues.

TB

TB

Create the device under test which is the master/slave.

FUNCTIONS

run_test

```
async def run_test(
dut,
payload_data
 =
None
)
```

Tests the source/sink for valid transmission of data.

incrementing_payload

```
def incrementing_payload()
```

Generate a list of ints that increment from 0 to 2^8

test

```
def test(
request
)
```

Main cocotb function that specifies how to put the test together.

test.v

AUTHORS

JAY CONVERTINO

DATES

2025/03/17

INFORMATION

Brief

Test bench for apb using cocotb

License MIT

test

```
module test #(
parameter
ADDRESS_WIDTH
  =
32,
parameter
BUS_WIDTH
  =
4
) ( input clk, input rstn, inout [ADDRESS_WIDTH-1:0] apb_paddr, inout apb_ps
```

Test bench loop for apb

Parameters

ADDRESS_WIDTH parameter	Width of the APB3 address port in bits.
BUS_WIDTH parameter	Width of the APB3 bus data port in bytes.

Ports

clk	Clock
rstn	Negative reset
apb_paddr	APB3 address bus, up to 32 bits wide.
apb_psel	APB3 select per slave (1 for this core).
apb_penable	APB3 enable device for multiple transfers after first.
apb_pready	APB3 ready is a output from the slave to indicate its able to process the request.
apb_pwrite	APB3 Direction signal, active high is a write access. Active low is a read access.
apb_pwdata	APB3 write data port.
apb_prdata	APB3 read data port.
apb_pslverror	APB3 error indicates transfer failure, not implimented.