APB AVIP

mirafra
TECHNOLOGIES

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Contents

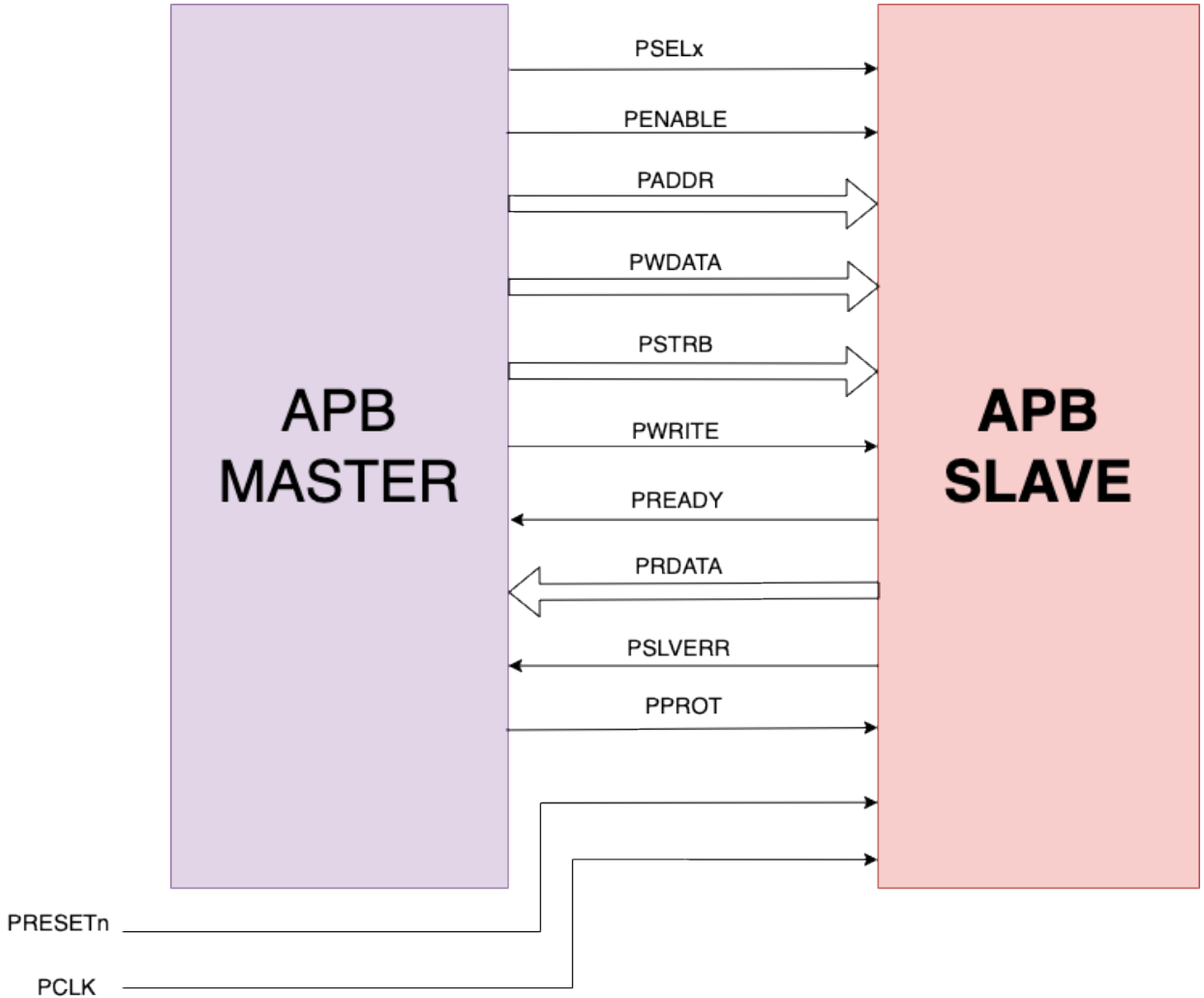
Introduction

- APB is part of the AMBA (Advanced Microcontroller Bus Architecture) protocol family.
- It defines a low-cost interface that is optimised for minimal power consumption and reduced interface complexity.
- Not pipelined, used to connect to low-bandwidth peripherals.
- APB can be interfaced with AHB, AHB-lite, AXI and AXI4.
- Used to access the programmable control registers of the peripheral devices.

KEY FEATURES

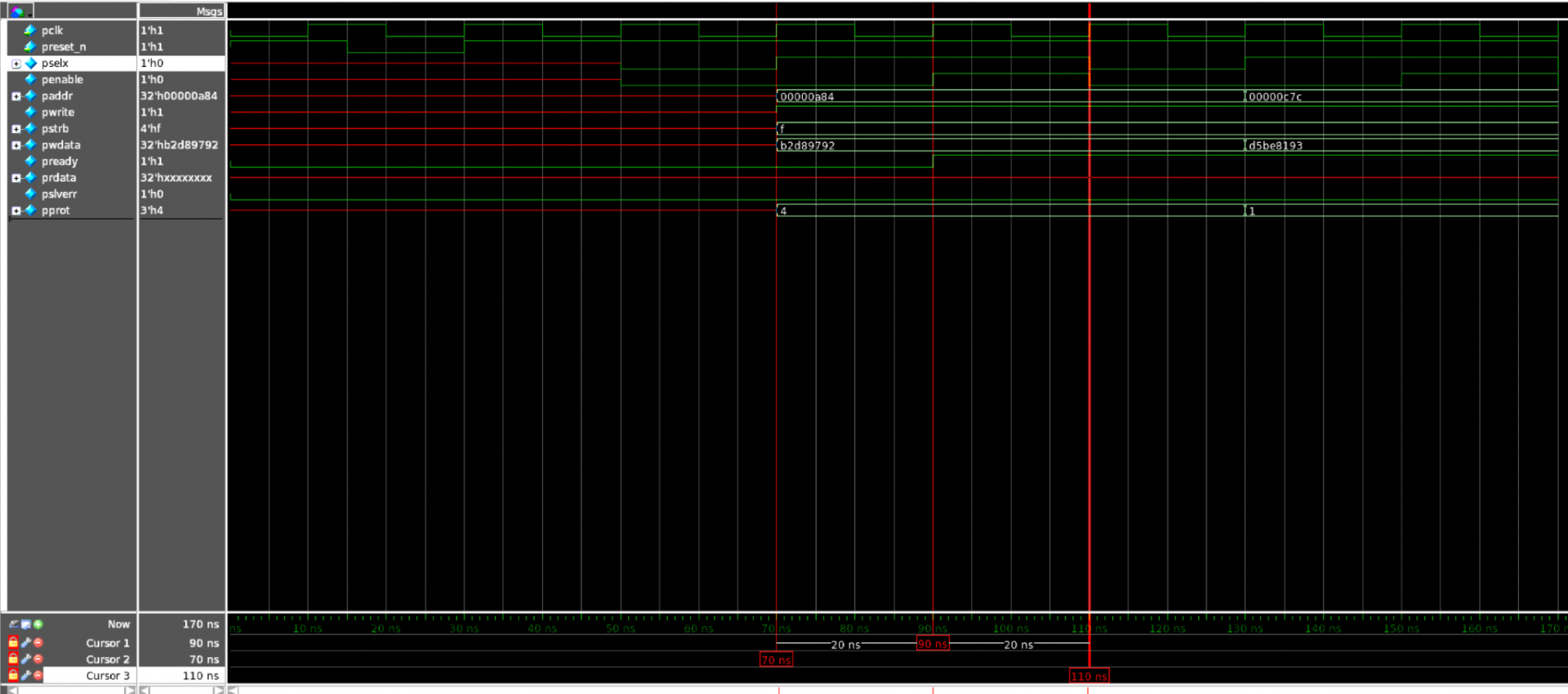
- It supports addresses up to 32 bit wide.
- APB4 support for write strobe signal to enable data transfer on the write data bus.
- Single Master - Single Slave.
- Programmable wait state insertion.
- Random PSLVERR insertion.
- User preferred read-data configuration.
- In APB, every transfer takes at least two cycles (Setup Phase and Access Phase).
- Supports Memory Mapping

APB4 INTERFACE


APB
MASTER
APB
SLAVE
PSELx
PENABLE
PADDR
PWDATA
PSTRB
PWRITE
PREADY
PRDATA
PSLVERR
PPROT
PRESETn
PCLK

Signal	Source	Description
PCLK	Clock source	Clock. The rising edge of **PCLK** times all transfers on the APB.
PRESETn	System bus equivalent	Reset. The APB reset signal is active LOW. This signal is normally connected directly to the system bus reset signal.
PADDR	APB bridge	Address. This is the APB address bus. It can be up to 32 bits wide and is driven by the peripheral bus bridge unit.
PPROT	APB bridge	Protection type. This signal indicates the normal, privileged, or secure protection level of the transaction and whether the transaction is a data access or an instruction access.
PSELx	APB bridge	Select. The APB bridge unit generates this signal to each peripheral bus slave. It indicates that the slave device is selected and that a data transfer is required. There is a **PSELx** signal for each slave.
PENABLE	APB bridge	Enable. This signal indicates the second and subsequent cycles of an APB transfer.
PWRITE	APB bridge	Direction. This signal indicates an APB write access when HIGH and an APB read access when LOW.
PWDATA	APB bridge	Write data. This bus is driven by the peripheral bus bridge unit during write cycles when **PWRITE** is HIGH. This bus can be up to 32 bits wide.
PSTRB	APB bridge	Write strobes. This signal indicates which byte lanes to update during a write transfer. There is one write strobe for each eight bits of the write data bus. Therefore, **PSTRB[n]** corresponds to **PWDATA[(8n + 7):(8n)]**. Write strobes must not be active during a read transfer.
PREADY	Slave interface	Ready. The slave uses this signal to extend an APB transfer.
PRDATA	Slave interface	Read Data. The selected slave drives this bus during read cycles when **PWRITE** is LOW. This bus can be up to 32-bits wide.
PSLVERR	Slave interface	This signal indicates a transfer failure. APB peripherals are not required to support the **PSLVERR** pin. This is true for both existing and new APB peripheral designs. Where a peripheral does not include this pin then the appropriate input to the APB bridge is tied LOW.

Basic APB timing diagram



PLANNING PHASE

Verification Plan ->

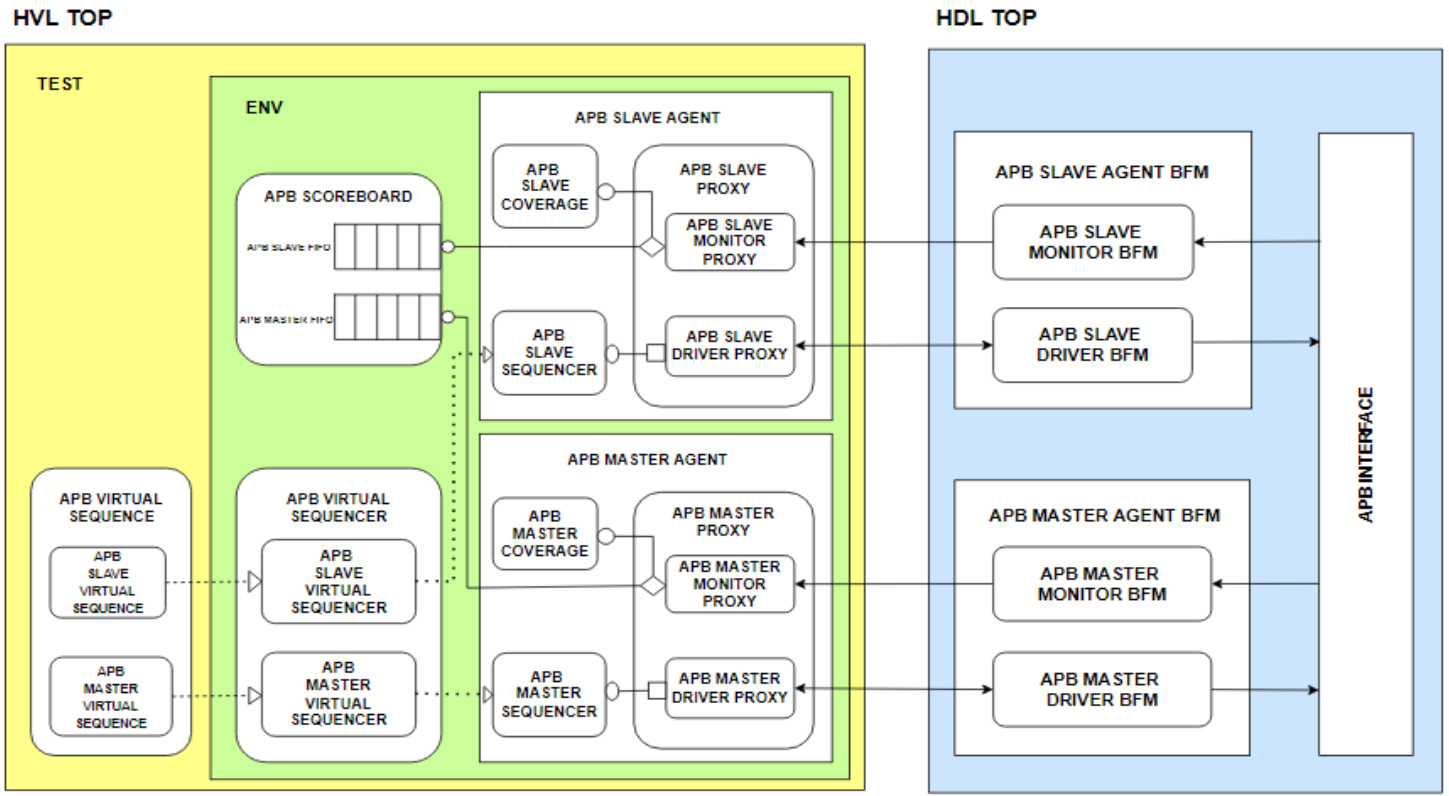
apb_avip_verification_plan

Coverage Plan ->

apb_avip_coverage_plan

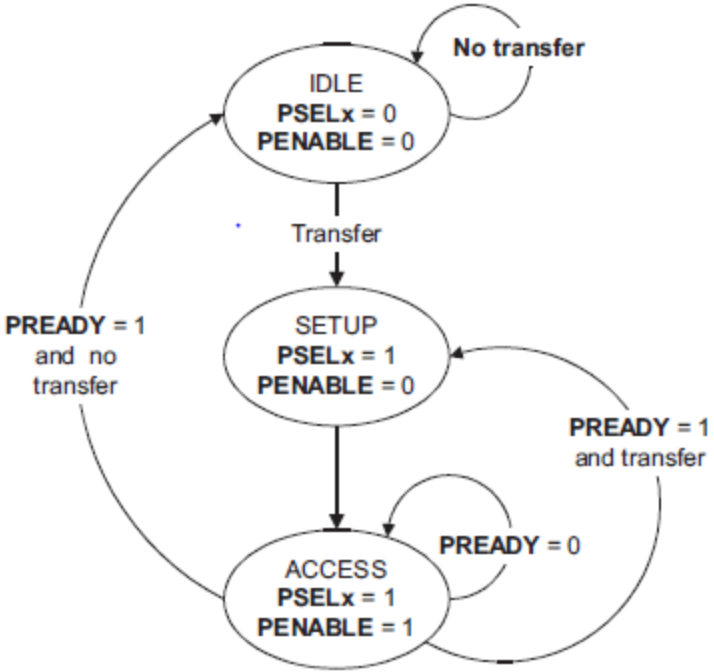
Assertion Plan ->

apb_avip_assertion_plan


HVL TOP
HDL TOP
TEST
ENV
APB SLAVE AGENT
APB SCOREBOARD
APB SLAVE FIFO
APB MASTER FIFO
APB SLAVE COVERAGE
APB SLAVE PROXY
APB SLAVE MONITOR PROXY
APB SLAVE SEQUENCER
APB SLAVE DRIVER PROXY
APB MASTER AGENT
APB MASTER COVERAGE
APB MASTER PROXY
APB MASTER MONITOR PROXY
APB MASTER SEQUENCER
APB MASTER DRIVER PROXY
APB VIRTUAL SEQUENCE
APB SLAVE VIRTUAL SEQUENCE
APB MASTER VIRTUAL SEQUENCE
APB VIRTUAL SEQUENCER
APB SLAVE VIRTUAL SEQUENCER
APB MASTER VIRTUAL SEQUENCER
APB SLAVE AGENT BFM
APB SLAVE MONITOR BFM
APB SLAVE DRIVER BFM
APB MASTER AGENT BFM
APB MASTER MONITOR BFM
APB MASTER DRIVER BFM
APB INTERFACE

Implementation

APB Flowchart



Flowcharts

Master Driver ->

apb_avip_master_driver_flowchart

Slave Driver ->

apb_avip_slave_driver_flowchart

Master Monitor ->

apb_avip_master_monitor_flowchart

Slave Monitor ->

apb_avip_slave_monitor_flowchart

Scoreboard Run Phase ->

apb_avip_run_phase_flowchart

APB Environment Configuration

```
APB_ENV_CONFIG
-----------------------------------------------
Name                    Type             Size  Value
-----------------------------------------------
apb_env_cfg_h           apb_env_config   -     @496
  has_scoreboard        integral         1     1
  has_virtual_seqr      integral         1     1
  no_of_slaves          integral         32    'd1
-----------------------------------------------
```

APB Master Agent Configuration

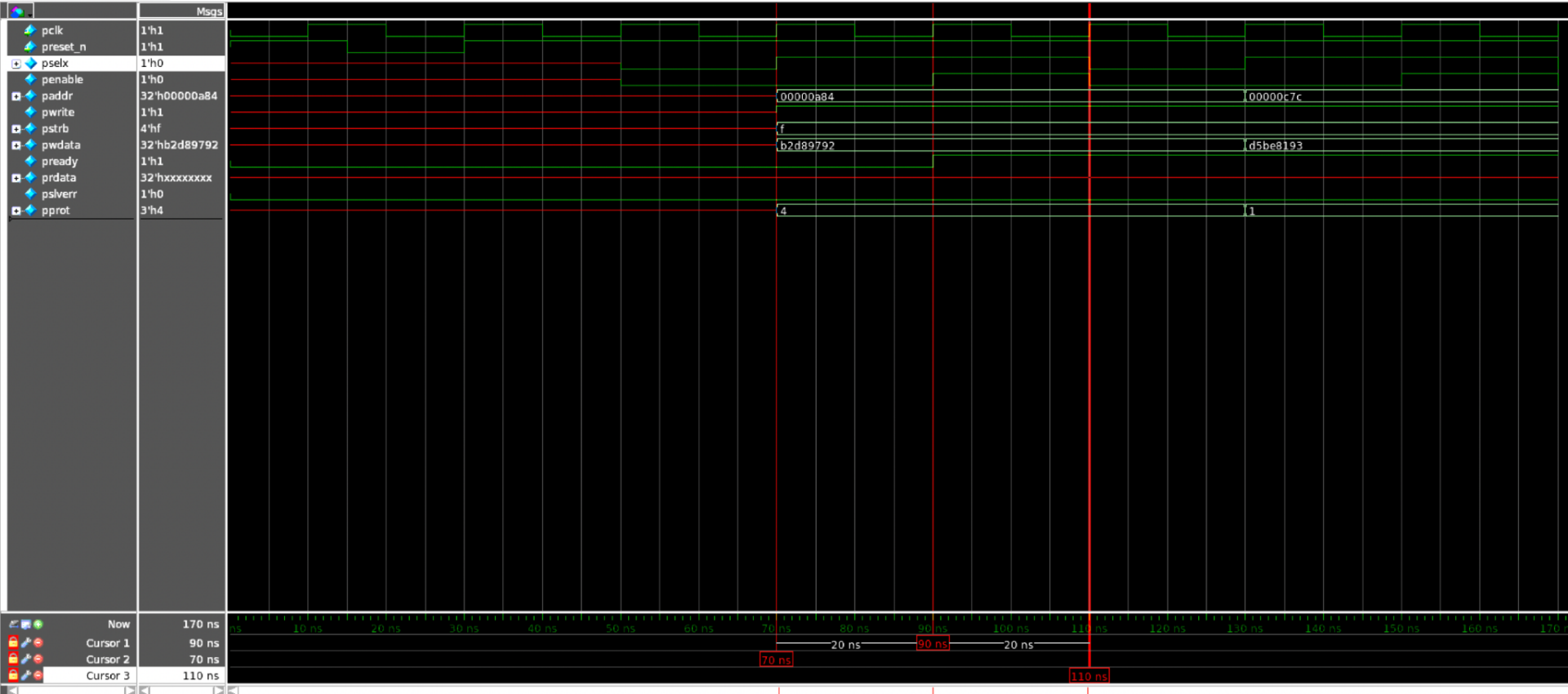
```
APB_MASTER_AGENT_CONFIG
------------------------------------------------------------------------
Name                                Type                          Size  Value
------------------------------------------------------------------------
apb_master_agent_config             apb_master_agent_config       -     @497
  is_active                         integral                      1     1
  has_coverage                      integral                      1     1
  no_of_slaves                      integral                      32    'd1
  master_min_addr_range_array[0]    integral                      32    'h0
  master_max_addr_range_array[0]    integral                      32    'hfff
------------------------------------------------------------------------
```

APB Slave Agent Configuration

```
APB_SLAVE_CONFIG[0]
----------------------------------------------------------------------
Name                          Type                        Size  Value
----------------------------------------------------------------------
apb_slave_agent_config[0]     apb_slave_agent_config      -     @502
  is_active                   string                      10    UVM_ACTIVE
  slave_id                    integral                    32    'd0
  has_coverage                integral                    1     1
  max_address                 integral                    32    'hfff
  min_address                 integral                    32    'h0
----------------------------------------------------------------------
```

OUTPUT

OUTPUT WAVEFORM



Coverage

Coverage Summary by Type:

Total Coverage:					36.23%	**35.80%**
Coverage Type	**Bins**	**Hits**	**Misses**	**Weight**	**% Hit**	**Coverage**
Covergroups	417	37	380	1	8.87%	**31.67%**
Statements	1269	549	720	1	43.26%	**43.26%**
Branches	959	243	716	1	25.33%	**25.33%**
FEC Conditions	13	4	9	1	30.76%	**30.76%**
Toggles	1109	532	577	1	47.97%	**47.97%**

DEMO

References

1. APB TB ARCHITECTURE DIAGRAM
2. APB TB DOCUMENT
3. APB_AVIP_USER_GUIDE
4. APB GITHUB LINK

Q & A

Thank You