Verification Continuum™

VC Verification IP
SPI
UVM User Guide

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SYNOPSYS®

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Preface

About This Guide

This guide contains installation, setup, and usage material for SystemVerilog users of SPI Universal Verification Methodology (UVM) Verification IP and for design or verification engineers who want to verify SPI operations using a UVM testbench written in SystemVerilog. Readers are assumed to be familiar with SPI, Object-Oriented Programming (OOP), SystemVerilog, and UVM techniques.

Guide Organization

The chapters of this guide are organized as follows:

Chapter 1,"Introduction", introduces VC VIP for SPI and its features.

Chapter 2, "Installation and Setup", describes system requirements and provides instructions on how to install, configure, and begin using VC VIP for SPI.

Chapter 3, "General Concepts", introduces SPI VIP within a UVM environment and describes data objects and components that comprise the VIP.

Chapter 4, "Getting Started Example", shows how to install and run a getting started example.

Chapter 5, "Catalog and Part Numbers", provides you the information on the catalogs of vendor memory parts which you can use to configure your VIP and manage your testbench.

Chapter 6, "Using Protocol Analyzer with Memory Models", helps you debug designs with SPI VIP in SPI Flash mode.

Chapter 7, "Verification Features", discusses supported verification tools in detail.

Chapter 8, "Usage Notes", provides the notes on SPI usage.

Chapter A, "Reporting Problems", outlines the process for working through and reporting VC VIP for SPI issues.

Web Resources

- Documentation through SolvNetPlus: https://solvnetplus.synopsys.com (Synopsys password required)
- Synopsys Common Licensing (SCL): http://www.synopsys.com/keys

Customer Support

For Customer Support, perform any of the following tasks:

- Go to https://solvnetplus.synopsys.com and open a case.

  Enter the information according to your environment and your issue.
- Send an e-mail message to support_center@synopsys.com
  - Include the Product name, Sub Product name, and Product version for which you want to register the problem.
- Telephone your local support center:
  - North America:

    Call 1-800-245-8005 from 7 AM to 5:30 PM Pacific time, Monday through Friday
  - All other countries:

    http://www.synopsys.com/support/support_ctr

1 Introduction

VC VIP for SPI supports the verification of SOC designs that include interfaces implementing SPI specifications. This document describes the use of the VIP in testbenches that comply with the SystemVerilog UVM. This approach leverages advanced verification technologies and tools that provide the following features:

- Protocol functionality and abstraction
- Constrained random verification
- Functional coverage
- Rapid creation of complex tests
- Proven testbench architecture that provides maximum reuse, scalability, and modularity
- Proven verification approach and methodology
- Transaction-level and self-checking tests
- Object-oriented interface that allows OOP techniques

This chapter consists of the following sections:

This document assumes that you are familiar with SPI, OOP, SystemVerilog, and UVM.

Synopsys provides a SPI UVM basic Quickstart example demonstrating many features of the UVM methodology and the tasks with instructions to use the model. The Quickstart example is available at the following location:

```
$DESIGNWARE_HOME/.../spi_svt/test/sverilog/tb_spi_svt_uvm_basic_1m_1s_sys/
```

The README file describes the steps to run the example.

1.1 Product Overview

SPI VIP is a suite of UVM-based verification components that are compatible for use with SystemVerilog-compliant testbenches. SPI VIP suite simulates SPI transactions through active agents, as defined by SPI specifications. The suite provides a SPI agent that contains a TxRx component and a monitor component along with the handles to activity ports. After instantiating the agent, you can select and combine the active and passive modes of the agent to create an environment that verifies SPI features in the DUT. SPI agent supports all the functionalities normally associated with active and passive UVM components, including the creation of transactions, checking and reporting protocol correctness, and transaction logging.

1.2 Simulator Support

SPI VIP supports the following language and simulator:

- Language: SystemVerilog
- Simulators: VCS, NCV, and MTI

1.3 Methodology Features

SPI VIP currently supports the following methodology features:

- IP organized as an agent, which includes a TxRx component.
- Analysis ports for connecting to the Scoreboard or any other component
- Callbacks

1.4 SPI Feature Support

SPI VIP supports the following protocol-related features:

- Master and Slave Mode verification
- All SPI Operating Modes
- Baud rate control for Master Agent
- Payload size control and data value control

1.4.1 Motorola SPI standard specification

This Mode is selected when the frame format in configuration object is selected as `svt_spi_types::SPI_STD` and SPI feature is selected as `svt_spi_types::SPI`.

- Register Data Width (8/16/32)
- Bit and Byte Endianness support
- Data Transfer Modes (Transmit & Receive Mode, Tx Only, Rx Only and EEPROM)
- Configurable timers (Leading, Trailing and Idle time between transfer)
- Multi-Master Mode with Mode Fault Detection is supported

- Support Slave RDY feature to handle flow control.
- Support to add additional data in current transaction via Callback `load_tx_fifo`.

1.4.2 National Semiconductor Microwire

This mode is selected when the frame format in configuration object is selected as

- `svt_spi_types::SPI_STD` and SPI feature is selected as `svt_spi_types::UWIRE`
- Configurable Control Word and Data Width
- Data Transfer Modes (transmit and receive mode)
- Sequential and Non Sequential Transfer
- Handshaking mode (Busy/Ready status)
- Slave configurable timer to drive Busy status during Handshaking mode (Uwire Busy Timer)
- Multi-Master Mode with Mode Fault Detection is supported

1.4.3 Texas Instrument SSP Mode Specification

- This mode is selected when the frame format in configuration object is selected as `svt_spi_types::SPI_STD` and SPI feature is selected as `svt_spi_types::SSP`.
  - Register Data Width (8/16/32)
  - Configurable data frame width (can be enabled through configuration parameter `enable_configurable_data_frame_width`)
  - Bit and Byte Endianness support
  - Data Transfer modes (Transmit and Receive mode, Tx only and Rx only)
  - Multi-Master Mode with Mode Fault Detection is supported

1.4.4 SPI Multilane Mode

This Mode is selected when the frame format in configuration object is selected as `svt_spi_types::SPI_MULTILANE`. It allows complete user configurability in terms of Multiple I/O ports and configurable length and lane count for Instruction, Address, Wait Cycle and Data Phase.

- Multi I/O Support (Dual/Quad and Octal)
- Configurable length for Instruction, Address and Data Phase
- Configurable lane count for Instruction, Address and Data Phase

1.4.5 SPI SAFE Mode

This mode is selected when the frame format in configuration object is selected as `svt_spi_types::SPI_SAFE` and SPI feature is selected as `svt_spi_types::SPI`.

- Frame modes supported: `IN_FRAME` and `OUT_OF_FRAME`
- Slave select `type` supported: `DEDICATED_CS` and `COMMON_CS`
- Timing checks supported

1.4.6 SPI Flash Mode

This mode is selected when the frame format in configuration object is selected as `svt_spi_types::SPI_FLASH`.

Attention

For `frame_formats` SPI_FLASH mode, the operational timers like Page Program Timer, Chip Erase Timer, and so on are scaled down by 10^3. This can be run in full scale mode by setting the configuration class `svt_spi_configuration` variable `flash_timer_scale_down_factor` to 1.

- Supports the following Flash specification:

Table 1-1 Supported Flash Specification

Vendor Name	Spec Name	Revision Number	Timing Checks Support	Passive Monitor Support
QUAD NOR FLASH				
MICRON (NOR)	N25q_1Gb_3v_65nm (1 GB)	Rev. M, 03/14	No	No
	N25q_16mb_1_8v_65nm (16 MB)	Rev. F, 01/14	No	No
	N25q_256Mb_1_8V_65nm (256 MB)	Rev. M, 03/14	No	No
	N25q_512mb_1_8v_65nm (512 MB)	Rev. L, 03/14	No	No
	MT25QU512ABB	Rev. D, 6/16	No	No
	MT25QL128ABA (128 MB)	Rev. J, 05/18	Yes	No
	MT25QU128ABA (128 MB)	Rev. J, 05/18	Yes	No
WINBOND (NOR)	W25X10BV (1 MB, 2 MB, 4 MB)	Rev B, Aug 20, 2009	No	No
	W25Q20BW (2 MB)	Rev C, Nov 22, 2013	No	No
	W25Q16DW (16 MB)	Rev J, Sept 01, 2014	No	No
	W25Q128BV (128 MB)	Rev H, Oct 03, 2013	No	No
	W25Q256JW (256 MB)	Rev A11, Feb 22, 2017	Yes	No
CYPRESS (NOR)	CY14V101Q3_001_67191_0E_V (1 MB)	Rev. *E, Nov 13, 2014	No	No
SPANSION (NOR)	S25FS128S (128 MB)	Rev. *L Nov 21, 2018	Yes	No
	S25FL512S(512 MB)	Rev 09, Jan 21, 2015	Yes	No
	S25FS512S (512 MB)	Rev. *I Apr 06, 2018	Yes	No
	S25FS256S (256 MB)	Rev. *L Nov 21, 2018	Yes	No

Table 1-1 Supported Flash Specification

Vendor Name	Spec Name	Revision Number	Timing Checks Support	Passive Monitor Support
MACRONIX (NOR)	MX25R1635F	Rev. 0.01, Feb. 06, 2015	Yes	Yes
	MX25L6445E (64 MB)	Rev. 1.8, Dec 26, 2011	Yes	No
	MX25L12865E (128 MB)	Rev. 1.4, Feb 10, 2012	Yes	No
	MX25U3235F (32 MB)	Rev. 1.6, July 12, 2017	Yes	Yes
	MX25U25635F (256 MB)	Rev. 1.5, Aug 04, 2016	Yes	Yes
ST (NOR)	M95128-W/R/DF (128 kB)	Rev 17, May 2015	No	No
ISSI (NOR)	IS25WP128 (128 MB)	Rev. A1, 02/07/2017	No	No
	IS25WP256D (256 MB)	Rev. 0B, 11/28/2016	Yes	No
MICROCHIP (NOR Flash)	23A1024 (1 Mbit)	Rev. C, Jan 2015	No	No
APMEMORY (NOR)	APS1604M-SQR (16 MB)	Rev. 2.1, Dec 07, 2018	Yes	No
	APS6404L-SQR (64 MB)	Rev. 3.2, Nov 29, 2018	Yes	No
EVERSPIN (NOR)	MR10Q010 (1 MB)	Rev. 5.6 June 01, 2018	Yes	Yes
QUAD NAND FLASH				
GIGADEVICE (NAND Flash)	GD5F1GQ4UAW (1 GB)	Rev 0.3, 10/10/2012	No	No
GIGADEVICE (NAND Flash)	GD5F1GQ4RB (1 GB)	Rev 1.3, Mar. 15, 2016	No	No
Micron (NAND Flash)	MT29F1G01AAADD (1 GB)	Rev. B, 02/11	No	No
Micron (NAND Flash)	MT29F2G01ABBGDWB (1 GB)	Rev. F, 09/16	No	No
Micron (NAND Flash)	MT29F2G01ABBGDSF (1 GB)	Rev. F, 09/16	No	No
OCTAL Flash				
Micron (Octal- XTRM Flash)	MT35XU512ABA (512 MB)	Rev. D, 08/16	Yes	No
Macronix (Octal Flash)	MX25UM51245G (512 MB Version 1.0)	Rev. 1.2, Dec 08, 2016	Yes	No
Macronix (Octal Flash)	MX25LM51245G (512 MB Version 0.01)	Rev. 1.0, Nov 24, 2016	Yes	No

Table 1-1 Supported Flash Specification

Vendor Name	Spec Name	Revision Number	Timing Checks Support	Passive Monitor Support
APMEMORY (Octal Flash)	APS6408LOAx5 (64 MB)	Rev. 1.8, Dec 7, 2017	Yes	No
	APS6408LOAx7 (64 MB)			
	APS3208LOAx5 (32 MB)			
	APS3208LOAx7 (32 MB)			
	APS12808LOAx5 (128 MB)			
	APS12808LOAx7 (128 MB)			
	APS6408LOBx5 (64 MB)	Rev. 1.7, Jan 2, 2018	Yes	No
	APS6408LOBx7 (64 MB)			
	APS3208LOBx5 (32 MB)			
	APS3208LOBx7 (32 MB)			
	APS12808LOBx5 (128 MB)			
	APS12808LOBx7 (128 MB)			
	APS25608NOBRx5 (256MB)	Rev. 0.34 Aug 29, 2019	Yes	No
	APS25608NOBRx7 (256MB)			
	APS51208NOBRx5 (512MB)	Rev. 0.35 Aug 29, 2019	Yes	No
	APS51208NOBRx7 (512MB)			
DUAL OCTAL FLASH				
APMEMORY (Dual Octal Flash)	APS256XXNOBR5 (256 MB)	Rev. 0.34 Aug 29, 2019	Yes	No
	APS256XXNOBR7 (256 MB)			
	APS512XXNOBRx5 (512MB)	Rev. 0.35 Aug 29, 2019	Yes	No
	APS512XXNOBRx7 (512MB)			
xSPI NOR FLASH				
ADESTO (NOR)	ATXP032 (32 MB)	DS-XP032-114F-12/2018	Yes	No
JEDEC (NOR)	JESD251	July 2018	Yes	No
JEDEC (NOR)	JESD251-A1	October 2018	Yes	No

- Support basic Memory functions such as initialize, save, restore, load, dump, and compare
- Timing checks

- Independent of the timescale used to compile the user environment
- No timescale limit
- Configurable values, bounds (min, max, typ)
- Dynamic reconfiguration

- Backdoor access to memory contents
- Protocol and Usage Checks
- Special Memory Mode in Protocol Analyzer

1.5 SPI Specification

SPI VIP supports the following SPI standard specification:

- Motorola S12SP1V3/D SPI Block Guide V03.06

2 Installation and Setup

This chapter leads you through the installing and setting up SPI VIP. After completing this checklist, the provided example testbench will be operational and SPI VIP will be ready to use.

This chapter consists of the following major steps:

2.1 Verifying Hardware Requirements

SPI VIP requires the following configuration for Solaris or Linux workstation:

- 400 MB available disk space for installation
- 16 GB Virtual memory (recommended)

2.2 Verifying Software Requirements

SPI VIP is qualified for use with the certain versions of platforms and simulators. This section lists the software required by SPI VIP and consists of the following sub-sections:

- Platform/OS and Simulator Software
- SCL Software
- Third-Party Software

2.2.1 Platform/OS and Simulator Software

Platform/OS and VCS: You need the versions of your platform/OS and simulator that have been qualified for use. For more details, refer SPI VIP Release Notes.

2.2.2 SCL Software

Synopsys Common Licensing (SCL) software provides the licensing function for SPI VIP. For details on acquiring SCL software, see the installation instructions in Licensing Information.

2.2.3 Third-Party Software

Following is the list of third-party software:

- **Adobe Acrobat**: SPI VIP documents are available in Acrobat PDF files. Adobe Acrobat Reader is available for free from http://www.adobe.com.
- **HTML Browser:** SPI VIP includes a class-reference documentation in HTML that supports the following browser/platform combinations:
  - Microsoft Internet Explorer 6.0 or later (Windows)
  - Firefox 1.0 or later (Windows and Linux)
  - Netscape 7.x (Windows and Linux)

2.3 Preparing for Installation

Perform the following steps to prepare for installation:

a. Set `DESIGNWARE_HOME` to the absolute path where SPI VIP is to be installed:

```
setenv DESIGNWARE_HOME absolute_path_to_designware_home
```

b. Ensure that your environment and PATH variables are set correctly, including the following:

- `DESIGNWARE_HOME/bin` – The absolute path as described in the previous step.
- `LM_LICENSE_FILE` – The absolute path to a file that contains the license keys for your third-party tools. Also, include the absolute path to the third-party executable in your PATH variable.

```
% setenv LM_LICENSE_FILE <my_license_file|port@host>
```

- `SNPSLMD_LICENSE_FILE` – The absolute path to a file that contains the license keys for Vera and SCL software or the `port@host` reference to this file.

```
% setenv SNPSLMD_LICENSE_FILE $LM_LICENSE_FILE
```

- `DW_LICENSE_FILE` - The absolute path to a file that contains the license keys for the VIP product software or the port@host reference to this file.

```
% setenv DW_LICENSE_FILE <my_VIP_license_file|port@host>
```

2.4 Downloading and Installing

You can download software from the Download center using either HTTPS or FTP, or with a command-line FTP session. If you do not know your Synopsys SolvNet password or you do not remember it, go to http://solvnet.synopsys.com.

You require the passive mode of FTP. The passive command toggles between the passive and active mode. If your FTP utility does not support the passive mode, use HTTP. For additional information, refer to the following web page:

https://www.synopsys.com/apps/protected/support/EST-FTP_Accelerator_Help_Page.html

Attention Electronic Software Transfer (EST) system only displays products that your site is entitled to download. If the product you are looking for is not available, contact est-ext@synopsys.com.

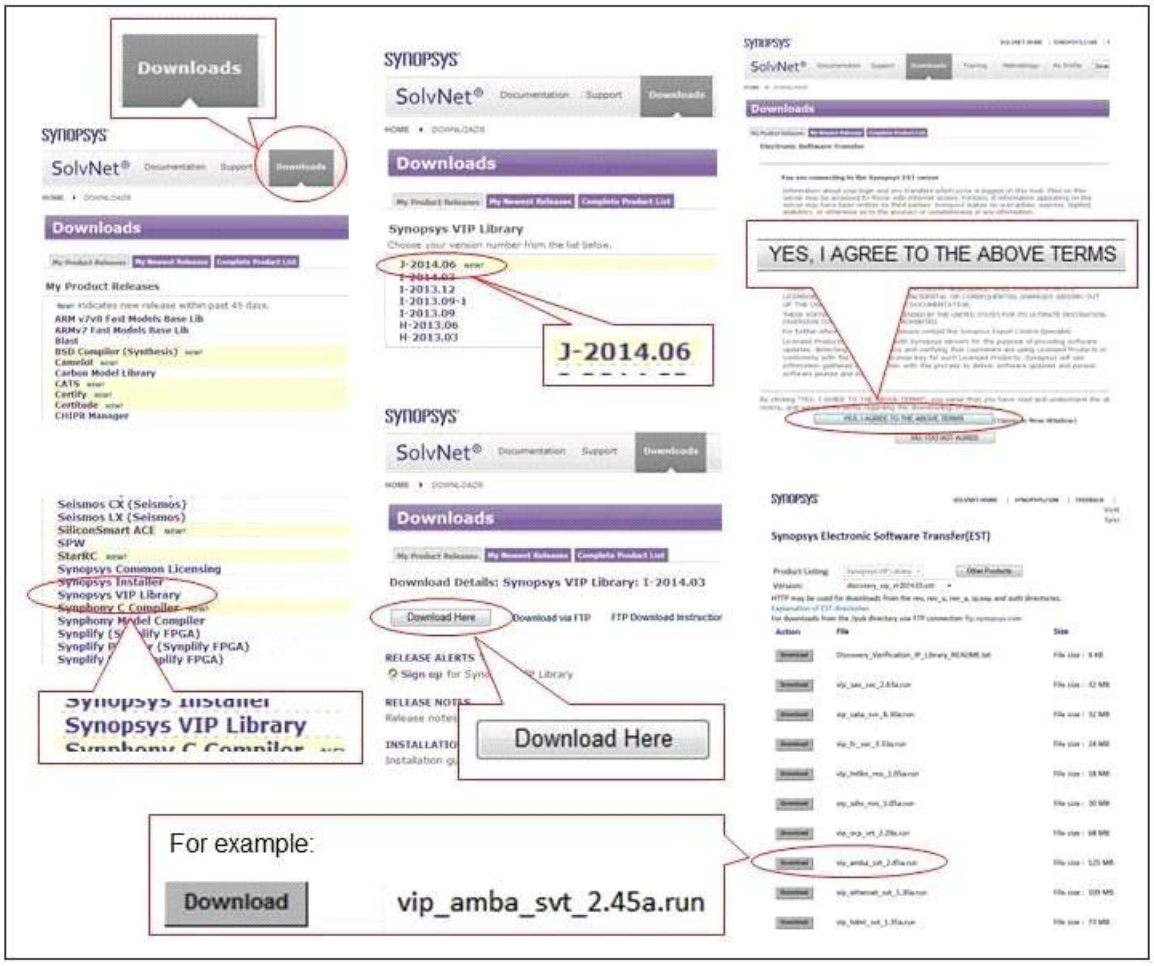
This section consists of the following subsections:

2.4.1 Downloading From EST (Download Center)

Perform the following steps to download from EST system:

a. Point your web browser to http://solvnet.synopsys.com.
b. Enter your Synopsys SolvNet Username and Password.
c. Click the `Sign In` button.
d. Make the following selections on SolvNet to download the `.run` file of the VIP (See Figure 2-1).
   i. `Downloads` tab
   ii. VC VIP Library product releases
   iii. <release_version>
   iv. `Download Here` button
   v. `Yes, I Agree to the Above Terms` button
   vi. Download `.run` file for the VIP

Figure 2-1SolvNet Selections for the VIP Download



e. Set the `DESIGNWARE_HOME` environment variable to a path where you want to install the VIP.

```
% setenv DESIGNWARE_HOME VIP_installation_path
```

f. Execute the `.run` file by invoking its filename. The VIP is unpacked and all files and directories are installed under the path specified by the `DESIGNWARE_HOME` environment variable. The `.run` file can be executed from any directory. The important step is to set the `DESIGNWARE_HOME` environment variable before executing the `.run` file.

2.4.2 Downloading Using FTP With a Web Browser

Follow Step a to Step e of Section 2.4.1 and then perform the following steps:

a. Click the **Download via FTP** link instead of the **Download Here** button.

b. Click the **Click Here To Download** button.

c. Select the file(s) that you want to download.

d. Follow browser prompts to select a destination location.

2.5 Setting Up a New VIP

Once you have installed the VIP, you must set up the VIP for use. All VIP suites contain various components such as transceivers, masters, slaves, and monitors depending on a protocol. The setup process gathers all the required component files you need to incorporate into your testbench and simulation runs.

You have the choice to set up all of them or only specific components. For example, SPI VIP contains the following components:

- `spi_agent_svt`: This is the VIP agent model, which encapsulates a sequencer, a driver, and a monitor.
- `spi_txrx_svt`: This is the VIP agent driver or receiver model.

You can set up either an individual component, or the entire set of components within one protocol suite. Use the Synopsys tool, namely `dw_vip_setup`, for these tasks. It resides in `$DESIGNWARE_HOME/bin`.

To get help on `dw_vip_setup`, use the following command:

```
% $DESIGNWARE_HOME/bin/dw_vip_setup --help
```

To set up a model component, `spi_agent_svt`, to the `design_dir` directory, use the following command:

```
% $DESIGNWARE_HOME/bin/dw_vip_setup -path design_dir -add spi_agent_svt -svlog
```

To set up an entire set of components to the `design_dir` directory, use the following command:

```
% $DESIGNWARE_HOME/bin/dw_vip_setup -path design_dir -add spi_agent_svt spi_txrx_svt -
svlog
```

or

```
%$DESIGNWARE_HOME/bin/dw_vip_setup -path design_dir -add -model_list
<input_file_containing_models_one_per_line> -svlog
For example, %$DESIGNWARE_HOME/bin/dw_vip_setup -path design_dir -add -model_list
<file_name> -svlog

%$DESIGNWARE_HOME/bin/dw_vip_setup -path design_dir  -a(dd) <model1> <model2> <model3> -
svtb

cat <file_name>:
spi_agent_svt
spi_txrx_svt
```

This command sets up all required files in `design_dir`. The `dw_vip_setup` utility creates directories in `design_dir`, which contain all necessary model files. The following three directories include files for every VIP:

- **examples**: Each VIP includes example testbenches. The `dw_vip_setup` utility adds them in this directory, along with a script for simulation. If an example testbench is specified on the command line, this directory contains all files required for model, suite, and system testbenches.
- **include**: Language-specific include files that contain critical information for Synopsys models. The `include/sverilog` directory and the `include/verilog` directory are specified in simulator commands to locate model files.
- **src**: Synopsys-specific include files. The `src/sverilog/vcs` directory and the `src/verilog/vcs` directory must be included in the simulator command to locate model files.

Some components are "top level" and they set up the entire suite. You have the choice to set up the entire suite, or just one component such as a monitor.

There must be only one `design_dir` installation per simulation, regardless of the number of VC Verification and Implementation IPs you have in your project. It is recommended not to create this directory in `$DESIGNWARE_HOME`.

2.6 Installing and Setting Up More Than One VIP Protocol Suite

All VIPs for a project must be set up in a single common directory once you execute the `*.run` file. You may have different projects. In this case, the projects can use their own VIP setup directory. However, all the VIPs used by that specific project must reside in a common directory.

The examples in this chapter call that directory as `design_dir`, but you can use any name. In this example, assume you have the AXI-suite setup in the `design_dir` directory. In addition to AXI VIP, you require SPI and USB VIP suites.

First, follow the previous instructions on downloading and installing SPI VIP and USB suites.

Once installed, you must set up and locate SPI and USB suites in the same `design_dir` location as AMBA. Use the following commands:

```
// First install AXI.
%unix> $DESIGNWARE_HOME/bin/dw_vip_setup -path design_dir
-add axi_system_env_svt-svlog
//Add SPI to the same design_dir directory as AXI.
%unix> $DESIGNWARE_HOME/bin/dw_vip_setup -path design_dir
-add spi_agent_svt spi_txrx_svt -svlog
// Add USB to the same design_dir directory as AMBA and SPI
%unix> $DESIGNWARE_HOME/bin/dw_vip_setup -path design_dir
-add usb_system_env_svt -svlog
```

To specify other model names, see the VIP documentation.

By default, all VIPs use the latest installed version of SVT. Synopsys maintains backward compatibility with the previous versions of SVT. As a result, you may mix and match models using the previous versions of SVT.

Note, if you participate in an Early Adopter (EA) program, you may get a VIP which brings along a newer SVT version than what is currently installed. In this case, note the following after you set up the EA version of the model:

- All installed VIP models use EA SVT after EA VIP is installed.
- Synopsys attempts to maintain backward compatibility of new EA SVT releases with the latest LCA VIPs.
- In the case, where EA SVT changes are not backward incompatible, you can use the `-svt` option of `dw_vip_setup` to use a specific version of SVT.
- Synopsys does not recommend you to use the `-svt` option as you must remember to remove this when all VIPs move to a compatible version of SVT. Use `-svt` as a workaround only.

Following is an example of using the `-svt` switch:

```
% $DESIGNWARE_HOME/bin/dw_vip_setup -path vip_model_design_dir -add amba_system_env_svt
svlog -svt 2.10a
```

2.7 Updating an Existing Model

To add an update an existing model, perform the following steps:

a. Install the model to the same location as your other VIPs by setting the `$DESIGNWARE_HOME` environment variable.

b. Issue the following command using `design_dir` as the location for your project directory:

```
%unix> $DESIGNWARE_HOME/bin/dw_vip_setup -path design_dir
-add spi_agent_svt spi_txrx_svt -svlog
```

You can also update your `design_dir` by specifying the version number of the model. Use the following command for the same:

```
%unix> dw_vip_setup -path design_dir -add spi_agent_svt spi_txrx_svt -v J-
2014.12-SP1
```

2.8 Including and Importing Model Files Into Your Testbench

Once you set up models, you must include and import various files into your top testbench files to use the VIP. The code snippet of the includes and imports for SPI VIP is as follows:

```
/* include uvm package before VIP includes, If not included elsewhere*/
`include "uvm_pkg.sv"

/* include AXI, AHB, and APB VIP interface */
`include "svt_ahb_if.svi"
`include "svt_axi_if.svi"
`include "svt_apb_if.svi"

/** Include SPI interface*/
`include "svt_spi_if.svi"

/** Include AMBA SVT UVM package */
`include "svt_amba.uvm.pkg"
```

```
/** Include SPI SV UVM package */
`include "svt_spi.uvm.pkg"

/** Import UVM Package */
import uvm_pkg::*;

/** Import SVT UVM Package */
import svt_uvm_pkg::*;

/** Import AMBA VIP */
import svt_amba_uvm_pkg::*;

/** Import SPI SVT UVM Package*/
import svt_spi_uvm_pkg::*;
```

You must also include various VIP directories on the simulator's command line. Add the following switches and directories to all compile scripts:

```
+incdir+<design_dir>/include/verilog
+incdir+<design_dir>/include/sverilog
+incdir+<design_dir>/src/verilog/<vendor>
+incdir+<design_dir>/src/sverilog/<vendor>
```

Supported vendors are vcs, mti, and ncv. For example:

```
+incdir+<design_dir>/src/sverilog/vcs
```

Using the previous examples, the `design_dir` directory would be `design_dir`.

2.9 Compile-Time and Runtime Options

Every Synopsys example has ASCII files containing compile-time and runtime options. The examples for SPI VIP are at the following location:

```
$DESIGNWARE_HOME/vip/svt/spi_svt/latest/examples/sverilog/<test_name>
```

For example:
`$DESIGNWARE_HOME/vip/svt/spi_svt/latest/examples/sverilog/tb_spi_svt_uvm_basic_1m_1s_sys`

The following files contain the options:

- For compile-time options:

  `sim_build_options (also, vcs_build_options)`
- For runtime options:

  `sim_run_options (also, vcs_run_options)`

These files contain both optional and required switches. For SPI SVT, the following are the contents of each file, listing optional and required switches:

```
sim_build_options
Required: +define+UVM_PACKER_MAX_BYTES=16384
Required: +define+UVM_DISABLE_AUTO_ITEM_RECORDING
Required: +define+SVT_SPI
```

```
Required: +define+SYNOPSYS_SV
Required: +define+ SVT_SPI_DATA_WIDTH=8 +define+SVT_SPI_IO_WIDTH=1
```

Note

`UVM_PACKER_MAX_BYTES` define needs to be set to maximum value as required by each VIP title in your testbench. For example, if VIP title 1 needs `UVM_PACKER_MAX_BYTES` to be set to 8192, and VIP title 2 needs `UVM_PACKER_MAX_BYTES` to be set to 500000, you need to set `UVM_PACKER_MAX_BYTES` to 500000.

```
vcs_build_options(VCS-specific) :
Required: -timescale=100ps/100ps
Required: ${DESIGNWARE_HOME}/vip/svt/common/latest/C/lib/${platform}/libmemserver.so
sim_run_options
Required: +UVM_TESTNAME=$scenario
Optional: +UVM_MAX_QUIT_COUNT=10,1
```

where, `scenario` is the UVM testname you pass to a simulator.

Note

The following build option must be included in command line for all SPI modes. ${DESIGNWARE_HOME}/vip/svt/common/latest/C/lib/${platform}/libmemserver.so For further details, refer to the example testbench directory.

2.10 Licensing Information

SPI VIP uses Synopsys Common Licensing (SCL) software to control its usage. You can find the general SCL information from the following link:

http://www.synopsys.com/keys

Perform the VIP License check order and feature names as per the following steps:

- `VIP-SPI-BUS-SVT` (SPI-STD Modes)
- `VIP-SPI-SVT` (SPI FLASH-Dual/Quad, SPI Multilane)
- `VIP-SPI-OCT-SVT` (Octal SPI FLASH Mode)
- `VIP-SPI-SAFE-SVT` (SPI SAFE Mode)
- `VIP-LIBRARY-SVT + DESIGNWARE-REGRESSION + VIP-SPI-SAFE-BETA-SVT` (SPI SAFE Mode)
- `VIP-MEMORY-SVT` (SPI FLASH-Dual/Quad, SPI Multilane)
- `VIP-SOC-LIBRARY-SVT` (SPI, SPI FLASH-Dual/Quad, SPI Multilane)

Only one license is consumed per simulation session, irrespective of how many VIP products are instantiated in the design. Each of the above features can also be enabled by VIP Library license. For more details, see VC VIP Library Release Notes.

The licensing key must reside in the files that are indicated by specific environment variables. For information about setting these licensing environment variables, see Environment Variable and Path Settings.

This section consists of the following sub-sections:

- License Polling
- Simulation License Suspension
- Simulation Modes

2.10.1 License Polling

If you request a license and none are available, License Polling allows your request to exist until a license is available instead of exiting immediately. To control License Polling, use the `DW_WAIT_LICENSE` environment variable in the following way:

- To enable License polling, set the `DW_WAIT_LICENSE` environment variable to 1.
- To disable License polling, unset the `DW_WAIT_LICENSE` environment variable. By default, license polling is disabled.

2.10.2 Simulation License Suspension

All verification IP products support License suspension. The simulators that support License suspension allows the model to check-in its license token while the simulator is suspended and then checkout the license token when the simulation is resumed.

This capability is simulator-specific; All simulators do not support license check-in during License Suspension.

2.10.3 Simulation Modes

SPI VIP supports the following two defines:

- Mandatory defines: The following defines are mandatory to make the VIP work in the UVM mode:
  - `SVT_UVM_TECHNOLOGY`: This define makes the SVT base classes to incorporate the UVM methodology base classes.
  - `SVT_SPI`: This define makes the methodology agnostic VIP to incorporate the SVT UVM base classes.
  - `SVT_SPI_DATA_WIDTH`: This define specifies the width of Data Frame in Transaction class.
  - `SVT_SPI_IO_WIDTH`: This define specifies the lane count to be utilized for SPI Interface. For Standard SPI specification, SVT_SPI_IO_WIDTH is set to 1. Please refer to the release notes for supported values.
- Optional defines: The UVM define, namely `UVM_DISABLE_AUTO_ITEM_RECORDING`, is an optional define for the VIP. By default, it is defined in the VIP defines file. Note that if you execute `start_item/finish_item (or `uvm_do* macro)` executed from `uvm_sequence#(REQ,RSP)`, it automatically triggers `begin_event` and `end_events` via calls to `begin_tr` and `end_tr`. While convenient, it is generally the responsibility of drivers to mark a transaction's progress during execution. To allow the driver to control sequence item timestamps, events, and recording, you must add `+define+UVM_DISABLE_AUTO_ITEM_RECORDING` when compiling the UVM package.

Alternatively, you may use a transaction's event pool and events to define custom events for the driver to trigger and sequences to wait on. Any in-between events such as marking the beginning of the address and data phases of the transaction execution could be implemented via events pool.

2.11 Environment Variable and Path Settings

The following environment variables and path settings are required by SPI VIP verification models:

- `DESIGNWARE_HOME`: The absolute path to where the VIP is installed.
- `DW_LICENSE_FILE`: The absolute path to file that contains the license keys for the VIP product software or the port@host reference to this file.
- `SNPSLMD_LICENSE_FILE`: The absolute path to file(s) that contains the license keys for Synopsys software (VIP and/or other Synopsys Software tools) or the port@host reference to this file.

Note
For faster license checkout of Synopsys VIP software, ensure to place the desired license files at the front of the list of arguments to SNPSLMD_LICENSE_FILE.

- `LM_LICENSE_FILE`: The absolute path to a file that contains the license keys for both Synopsys software and/or your third-party tools.

Note
You can set the Synopsys VIP License using any of the three license variables in the following order:

```
DW_LICENSE_FILE -> SNPSLMD_LICENSE_FILE -> LM_LICENSE_FILE
```

If DW_LICENSE_FILE environment variable is enabled, the VIP will ignore SNPSLMD_LICENSE_FILE and LM_LICENSE_FILE settings. Therefore, to get the most efficient Synopsys VIP license checkout performance, set the DW_LICENSE_FILE with only the License servers which contain Synopsys VIP licenses. Also, include the absolute path to the third party executable in your PATH variable.

Simulator-Specific Settings

Your simulation environment and `PATH` variables must be set as required to support your simulator.

2.12 Determining Your Model Version

The following steps describes how to check your model version:

Note Verification IP products are released and versioned by the suite and not by the individual model. The version number of a model indicates the suite version.

- To determine the versions of VIP models installed in your `$DESIGNWARE_HOME` tree, use the following setup utility:

```
% $DESIGNWARE_HOME/bin/dw_vip_setup -i home
```

- To determine the versions of VIP models in your design directory, use the following setup utility:

```
% $DESIGNWARE_HOME/bin/dw_vip_setup -p design_dir_path -i design
```

2.13 Integrating SPI Verification IP Into Your Testbench

After installing the VIP, use the following procedures to set up the VIP for use in testbenches:

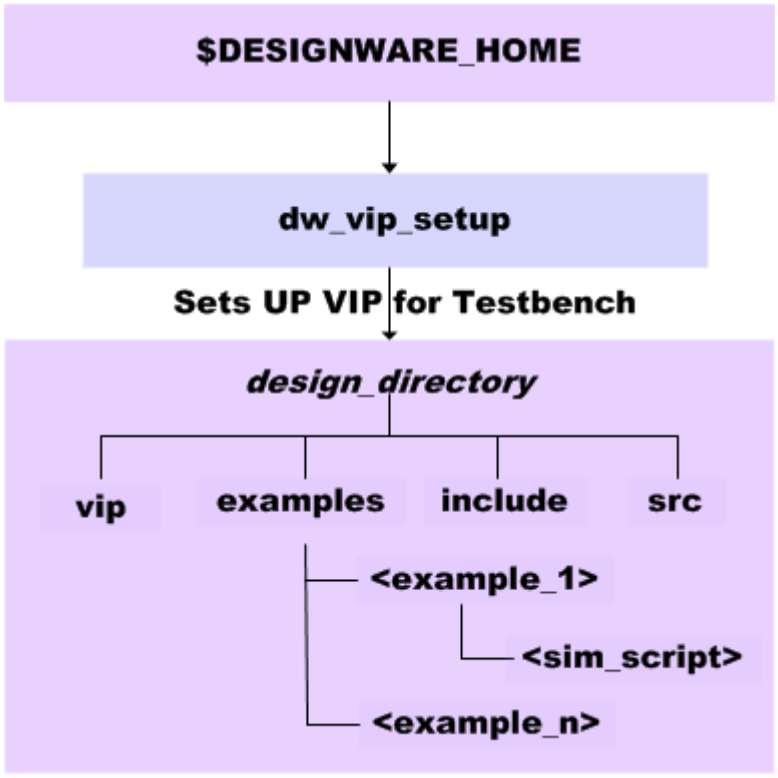
- Creating a Testbench Design Directory
- The dw_vip_setup Utility

2.13.1 Creating a Testbench Design Directory

A design directory contains a version of the VIP that is set up and ready to use in a testbench. The `dw_vip_setup` utility is used to create the design directories. For more information on `dw_vip_setup`, see The dw_vip_setup Utility.

A design directory gives you the control over the version of VIP in your testbench as it is isolated from the `DESIGNWARE_HOME` installation. You can use `dw_vip_setup` to update the VIP in your design directory. Figure 2-2 shows this process and the contents of a design directory.

Figure 2-2Design Directory Created by dw_vip_setup



A design directory contains the following sub-directories:

examples Each VIP includes example testbenches. The `dw_vip_setup` utility adds them in this directory, along with a script for simulation. If an example testbench is specified on the command line, this directory contains all the files required for model, suite, and system testbenches.

include Language-specific include files that contain the critical information for VIP models. This directory is specified in simulator command lines.

src VIP-specific include files (not used by all VIP). This directory may be specified in simulator command lines.

vip A database of all the VIP models used in the testbench. The `dw_vip_setup` utility reads this file to rebuild or recreate a design setup.

Do not modify this file because `dw_vip_setup` depends on the original content.

2.13.2 The dw_vip_setup Utility

The `dw_vip_setup` utility provides the following features:

- Adds, removes, or updates VIP models in a design directory
- Adds example testbenches to a design directory, the VIP models they use (if necessary), and creates a script for simulating the testbench using any of the supported simulators
- Restores (cleans) example testbench files to their original state
- Reports information about your installation or design directory, including version information

This section consists of the following subsections:

- "Setting Environment Variables" on page 29
- "The dw_vip_setup Command" on page 29

2.13.2.1 Setting Environment Variables

Before running `dw_vip_setup`, the `DESIGNWARE_HOME` environment must point to the location where the VIP is installed.

2.13.2.2 The dw_vip_setup Command

From the command prompt, invoke the `dw_vip_setup` command. The `dw_vip_setup` command checks command-line argument syntax and makes sure that the requested input files exist. The general form of the command is as follows:

```
% dw_vip_setup [-p[ath] directory] switch (model [-v[ersion] latest | version_no] )
```

or

```
% dw_vip_setup [-p[ath] directory] switch -m[odel_list] filename
```

where,

[**-p**[ath] *directory*] The optional `-path` argument specifies the path to your design directory. When omitted, `dw_vip_setup` uses the current working directory.

switch The `switch` argument defines the `dw_vip_setup` operation.

Tables 2-1 lists the switches and their applicable sub-switches.

Table 2-1 Setup Program Switch Descriptions

Switch	Description
-a[dd] (*model* [**-v**[ersion] *version*]) …	Adds the specified model or models to the specified design directory or the current working directory. If you do not specify a version, the latest version is assumed. The model names are as follows: • `spi_agent_svt` • `spi_txrx_svt` The `-add` switch makes `dw_vip_setup` to build suite libraries from the same suite as the specified models, and to copy the other necessary files from `$DESIGNWARE_HOME`.
-r[emove] *model*	Removes all versions of the specified model or models from the design. The `dw_vip_setup` command does not attempt to remove any include files used solely by the specified model or models. The model names are as follows: • `spi_agent_svt` • `spi_txrx_svt`
-u[pdate] (*model* [**-v**[ersion] *version*]) …	Updates to the specified model version for the specified model or models. The `dw_vip_setup` script updates to the latest models when you do not specify a version. The model names are as follows: • `spi_agent_svt` • `spi_txrx_svt` The -update switch makes `dw_vip_setup` to build suite libraries from the same suite as the specified models, and to copy other necessary files from `$DESIGNWARE_HOME`.
-e[xample] {*scenario* | *model*/*scenario*} [**-v**[ersion] *version*]	The `dw_vip_setup` script configures a testbench example for a single model or a system testbench for a group of models. The command creates a simulator-run program for all supported simulators. If you specify a scenario (or system) example testbench, the models needed for the testbench are included automatically and do not need to be specified in the command. **Note:** Use the `-info` switch to list all available system examples.
-ntb	Not supported.

Switch	Description
-svtb	Use this switch to set up models and example testbenches for SystemVerilog. The resulting design directory is streamlined and you can use it in SystemVerilog simulations.
-c[lean] {*scenario* | *model*/*scenario*}	Cleans the specified scenario or testbench in either the design directory (as specified by the `-path` switch) or the current working directory. This switch deletes all files in the specified directory, then restores all Synopsys-created files to their original contents.
-i/nfo design | home[:<product>[:<version>[:<methodology>]]]	Generate an informational report on a design directory or VIP installation. `design`: If the '`-info design`' switch is specified, the tool displays product and version content within the specified design directory to standard output. This output can be captured and used as a modellist file for input to this tool to create another design directory with the same content. `home`: If the '`-info home`' switch is specified, the tool displays product, version, and example content within the VIP installation to standard output. Optional filter fields can also be specified such as <product>, <version>, and <methodology> delimited by colons (:). An error will be reported if a nonexistent or invalid filter field is specified. Valid methodology names include: OVM, RVM, UVM, VMM and VLOG.
-h[elp]	Returns a list of valid `dw_vip_setup` switches and their correct syntax.
model	The SPI VIP models are as follows: • `spi_agent_svt` • `spi_txrx_svt` The `model` argument defines the model or models that `dw_vip_setup` acts upon. This argument is not needed with the `-info` or `-help` switches. All switches that require the `model` argument may also use a model list. You may specify a version for each listed model, using the `-version` option. If omitted, `dw_vip_setup` uses the latest version. The `-update` switch ignores the model-version information.
-m[odel_list] *filename*	Specifies a file name which contains a list of model names to be added, updated or removed in the design directory. This switch is only valid when following an operation switch such as -add, -update or -remove. Only one model name per line and each model may include a version selector. The default version is 'latest'. This switch is optional, but if given the filename argument is required. Lines in the file starting with the pound symbol (#) will be ignored.
-s[uite_list] *filename*	Specifies a file name which contains a list of suite names to be added, updated or removed in the design directory. This switch is only valid when following an operation switch such as -add, -update or -remove. Only one suite name per line and each suite may include a version selector. The default version is 'latest'. This switch is optional, but if given the filename argument is required. Lines in the file starting with the pound symbol (#) will be ignored.
-b/ridge	Updates the specified design directory to reference the current `DESIGNWARE_HOME` installation. All product versions contained in the design directory must also exist in the current `DESIGNWARE_HOME` installation.

Switch	Description
-pa	Enables the run scripts and Makefiles generated by dw_vip_setup to support PA. If this switch is enabled, and the testbench example produces XML files, PA will be launched and the XML files will be read at the end of the example execution. For run scripts, specify `-pa`. For Makefiles, specify `-pa = 1`.
-waves	Enables the run scripts and Makefiles generated by dw_vip_setup to support the `fsdb` waves option . To support this capability, the testbench example must generate an FSDB file when compiled with the WAVES Verilog macro set to `fsdb,` that is, `+define+WAVES=\"fsdb\"`. If a .fsdb file is generated by the example, the Verdi nWave viewer will be launched. For run scripts, specify `-waves fsdb`. For Makefiles, specify `WAVES=fsdb`.
-doc	Creates a doc directory in the specified design directory which is populated with symbolic links to the `DESIGNWARE_HOME` installation for documents related to the given model or example being added or updated.
-methodology <name>	When specified with -doc, only documents associated with the specified methodology name are added to the design directory. Valid methodology names include: OVM, RVM, UVM, VMM, and VLOG.
-copy	When specified with -doc, documents are copied into the design directory, not linked.
`-simulator <vendor>`	When used with the `-example` switch, only simulator flows associated with the specified vendor are supported with the generated run script and Makefile. **Note**: Currently the vendors VCS, MTI, and NCV are supported.

Note The `dw_vip_setup` command treats all lines beginning with "#" as comments.

3 General Concepts

UVM is an object-oriented approach. It provides a blueprint for building testbenches using the constrained random verification. In addition, the resulting structure supports Directed testing. This chapter describes the data objects that support higher structures which comprise SPI VIP.

This chapter assumes that you are familiar with SystemVerilog and UVM. For more information, see the following:

- For the IEEE SystemVerilog standard, refer the following:
  - IEEE Standard for SystemVerilog - Unified Hardware Design, Specification, and Verification Language
- For an essential reference guide describing UVM as it is represented in SystemVerilog, along with a class reference, see http://www.accellera.org.

This chapter consists of the following sections:

3.1 SPI VIP in a UVM Environment

SPI agent encapsulates the following components:

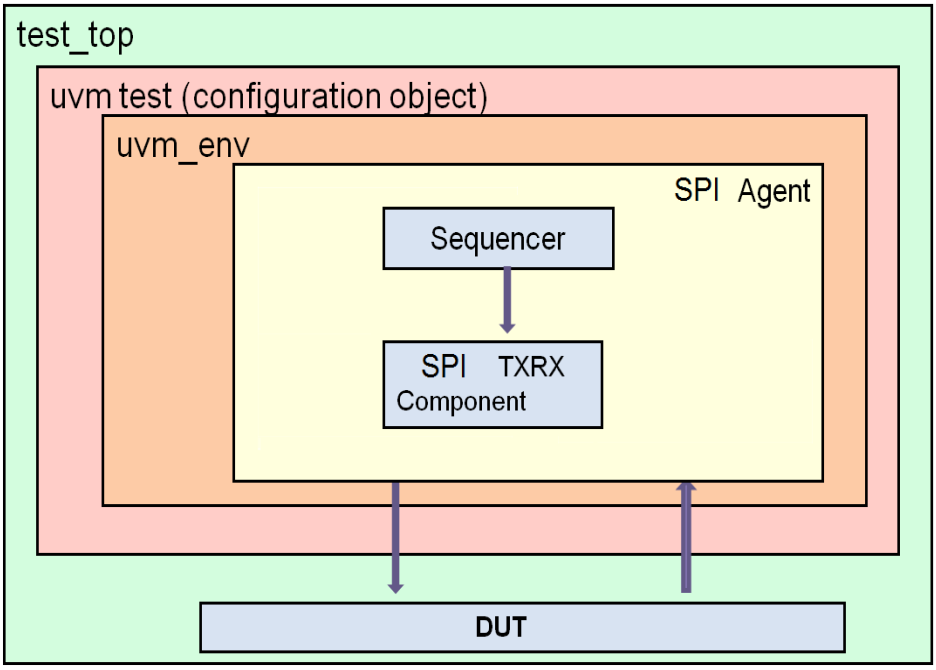
- Sequencer - Data SPI sequencer
- Driver - Instance of a transceiver model

You can configure the above components in the agent using the agent configuration. You should provide the agent configuration to SPI Agent in the build phase of a test case.

You can provide SPI transaction through sequences to Sequencer. Within the agent, Driver gets sequences from Sequencer. Driver then drives the SPI transactions on the SPI Interface. After the SPI transaction on the bus is complete, the completed sequence item is provided to the analysis port for use by analysis components, such as Scoreboard.

Figure 3-1 shows where the VIP fits into the UVM methodology. In the layered approach that is typical for UVM, the VIP fits into the lower levels, which allow you to focus on the higher level of abstraction.

Figure 3-1The SPI VIP in a UVM Environment



3.2 SPI VIP Programming Interface

This section gives an overview of the following programming interface in the SPI UVM VIP:

- Configuration Objects
- Sequence Items
- Analysis Port
- Callbacks
- Tiered Messaging
- Coverage

3.2.1 Configuration Objects

Configuration objects convey the agent-level and protocol-level testbench configuration. These data objects contain built-in constraints, which come into effect when these objects are randomized. The configuration is of the following two types:

- **Static Configuration**: Static configuration parameters specify a configuration value which cannot be changed when the system is running. For example, "enable_txrx_cov" to enable the MAC coverage.
- **Dynamic Configuration**: Dynamic configuration parameters specify a configuration value which can be changed at any time, regardless of whether the system is running. An example of a dynamic configuration parameter is a timeout value. The configuration data objects contain built-in constraints, which come into effect when the configuration objects are randomized.

SPI VIP describes the following configuration:

- **Agent Configuration**: The configuration has the `svt_spi_agent_configuration` base class for configuring agents, including Monitor, Transceiver, and Sequencer.

  For more information on this class, refer the class reference HTML documentation using the following path:

  ```
  $DESIGNWARE_HOME/vip/svt/spi_svt/latest/doc/spi_svt_uvm_class_reference/html/class_svt_spi_agent_configuration.html
  ```

  It is mandated by the SVT architecture that an instance of `svt_spi_agent_configuration` or extended configuration be passed to the agent via `set` in `build_phase`. See the following code for the same:

  ```
  uvm_config_db#(svt_spi_agent_configuration)::set(this, "*","cfg",cfg);
  ```

3.2.2 Sequence Items

The transaction objects, which extend from the `uvm_sequence_item` base class, define a unit of SPI protocol information that is passed across the bus. The attributes of transaction objects are public and are accessed directly to set and get values. Most of the transaction attributes can be randomized. The transaction objects represent the desired activity to be simulated on the bus, or the actual bus activity that is monitored. The transaction objects store data content and protocol execution information for SPI transactions in terms of the timing details of the transactions.

These data objects extend from the `uvm_sequence_item` base class and implement all the methods specified by UVM for that class. The transaction objects are used to perform the following:

- Generate random stimulus
- Report observed transactions
- Collect functional-coverage statistics
- Support error injection

The class properties are public and accessed directly to set and read values. The transaction data objects support randomization and provide built-in constraints.

The SPI VIP also provides the following two constraints:

- **The valid_ranges constraint:** It limits the generated values to those acceptable to Driver. These constraints ensure basic VIP operations and should never be disabled. These correspond in most cases to limits set by the protocol.

- **The reasonable_* constraint:** It can be disabled individually or as a block. It limits the simulation by setting simulation boundaries. Disabling these constraints may slow the simulation and introduce system memory issues.

The VIP supports extending transaction data classes for customizing randomization constraints. This allows you to disable some `reasonable_*` constraints and replace them with constraints appropriate to your system. The individual `reasonable_*` constraint maps to independent fields, each of which can be disabled. The class provides the `reasonable_constraint_mode()` method to enable or disable blocks of the `reasonable_*` constraints. For more information, see "More on Constraints" on page 40.

SPI VIP defines the following transaction class:

- **Transaction Class (`svt_spi_transaction`):** It implements a base class for SPI transactions. A SPI transaction generates a stimulus from the Tx side of the VIP. On the Rx side, the transaction gives the details on the data transmitted and received across the VIP. For the detailed description of class members and methods, refer the class reference HTML documentation.

3.2.3 Analysis Port

At the end of a transaction, Monitor writes the transaction to an analysis port. You can use this analysis port to connect to Scoreboard, or any other purpose, where a transaction object for the completed transaction is required.

SPI VIP provides the following analysis ports:

- **Transmit Activity Analysis Port (`tx_xact_observed_port`):** It provides a mechanism for retrieving transaction results occurring from the SPI bus interface, which is transmitted by the VIP. These transactions are used by subscriber components such as Scoreboard for further checking on the Tx direction.
- **Rx Activity Analysis Port (`rx_xact_observed_port`):** It provides a mechanism for retrieving transaction results occurring from the SPI bus interface, which is received by the VIP. These transactions are used by the subscriber components such as scoreboard for further checking on the Rx direction.

3.2.4 Callbacks

Callbacks are an access mechanism that enables the insertion of user-defined code and allows access to objects, such as transaction objects and functional coverage status objects, and also can be used to deviate the normal transaction flow (e.g. insert delay etc.).

Both Driver and Monitor are associated with a callback class that contains a set of callback methods. These methods are called as part of the normal flow of the procedural code. There are the following differences between callback methods and other methods that set them apart.

- Callback methods are virtual methods with no code and they do not provide any functionality unless they are extended. The exception to this rule is that some of the callback methods for Functional coverage already contain the default implementation of a coverage model.

- The callback class is accessible to users. You can extend the class including the testbench-specific extensions of the default callback methods, specific variables and/or methods that are used to control the behavior of the testbench using the callbacks support.
- Callbacks are called within the sequential flow at places where external access would be useful. In addition, the arguments to the methods include references to the relevant data objects. For example, just before Agent puts a transaction object into an analysis port, which is an appropriate location to sample the functional coverage since the object reflects the activity that took place on SPI interface pins. A callback at this point with an argument referencing the transaction object allows this exact scenario.

SPI VIP uses callbacks in the following main applications:

- Access for functional coverage
- Change transaction fields
- Insertion of user-defined code

3.2.5 Tiered Messaging

The VIP includes Tiered Messaging architecture to display debug messages, which help you to find the status of the current simulation.

This section consists of the following two sub-sections:

- Verbosity Level
- Message Structure

3.2.5.1 Verbosity Level

Tiered messages are distributed over the following three levels of verbosity:

- `UVM_LOW`: This level includes the following important status messages about the VIP:
  - Transaction start and finish event message
  - Baud rate selection message
  - Slave and Master Id selected for a particular SPI transaction
- `UVM_HIGH`: This level includes the transitions of a State machine in the VIP BFM Rx side.

3.2.5.2 Message Structure

A tiered message has the following structure:

```
<message location>: [<message id>]: <message>
```

where,

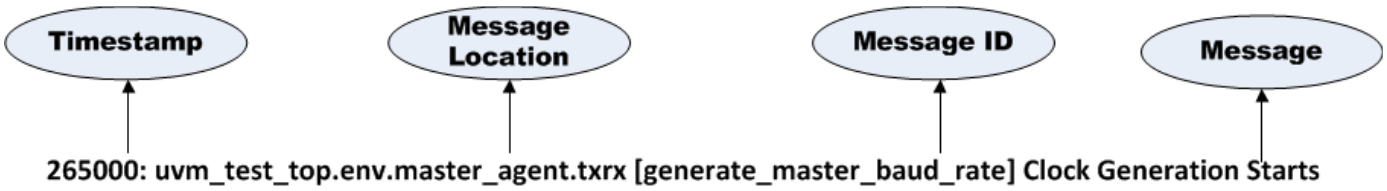
`<message location>`: This field indicates the agent instance from where messages are triggered. This field also states whether a message is from `*.driver` or `*.monitor`.

`<message id>`: Every message comes with a message id, which specifies the clause tag of the message. For example, generate_master_baud_rate means this message comes from the generate_master_baud_rate module.

<message>: The actual message to be printed.

Figures 3-2 shows the structure of a tiered message.

Figure 3-2 Message Structure



3.2.6 Coverage

Functional coverage measures the progress of a verification effort. In general, with the UVM technology, you can accomplish coverage through one or more callback class instances registered with transactor. By default, transactor does not have the registered instance of the coverage callback class, and so no coverage is reported. To enable coverage, you must enable one of the Coverage Enable properties listed in Agent Configuration classes. Based on the Coverage Enable property asserted by you, the respective callback associated with the coverage type would be registered.

Functional coverage in the UVM environment supports the following:

- Transaction coverage at the Packet level
- Configuration coverage which is based on selection of various modes. Example: SPI Std/SPI Multilane, Operation Mode 0/1/2/3 etc

Coverage Model

The predefined coverage model consists of numerous covergroups. Each covergroup defines bins in terms of coverpoints (signals, variables, and so on), and sample events, all of which are defined outside the covergroup.

You can use the pre-defined coverage model without alteration or you can extend it. You can also create your own coverage model, either as an addition or as a replacement. Coverage data is provided through callbacks that are applied to the data flowing through Monitor transactor.

Attention As with all callbacks, the coverage callbacks must be registered with Transactor before they can be used. This applies for the default coverage callback (it is not registered by default) as well as any user-defined coverage callback.

The VIP coverage model supports the following coverages:

- **Transaction Coverage**: SPI VIP agent gives a handle of transaction objects for generating coverage for Transaction properties.

The following list summarizes the steps to create a functional coverage model:

1. Define the following on the extended callback class:
   a. Events to sample-on in the callback object
   b. Data fields to map to the bins on the callback object
   c. Covergroups to sample events and tie the data to the bins on the callback object
2. Create the callback to do the following:
   a. Move the transaction or significant event data into the callback object data fields
   b. Trigger the sample event

3.2.6.1 Coverage Report Generation

During Coverage report generation, you must use the `instcov_for_score` switch to compute the coverage score.

Issue the following command using the `instcov_for_score` switch:

```
urg -group instcov_for_score -dir *.vdb
```

3.3 Interfaces and Modports

SystemVerilog models signal connections using interfaces and modports. Interfaces define the set of signals, which make a port connection. Modports define the collection of signals for a port, the direction of the signals, and the clock with respect to which these signals are driven and sampled.

The top-level interface is `svt_spi_if`.

Each agent gets an individual instance of interface. The connection between master and slave interface is done in top file.

We instantiate and create an agent in UVM environment file:

```
svt_spi_agent master_agent;
svt_spi_agent slave_agent;
```

An agent gets an interface handle using any one of following methods:

- The agent is tied to interface in the top via set that happens in top.sv file.

```
uvm_config_db#(virtual
svt_spi_if)::set(uvm_root::get(),"uvm_test_top.env.master_agent","master_vif",
spi_master_if);
```

- The interface can be passed on to an agent instance through the `svt_spi_agent_configuration` object.

```
master_cfg.spi_if = master_vif;
/** Apply the configuration to the agents */
uvm_config_db#(svt_spi_agent_configuration)::set(this, "master_agent", "cfg",
master_cfg);
```

3.4 More on Constraints

VIP uses objects with constraints for transactions, configurations, and exceptions. The constraints define the range of randomized values that are used to create each object during the simulation. The tests in a UVM flow are primarily defined by constraints.

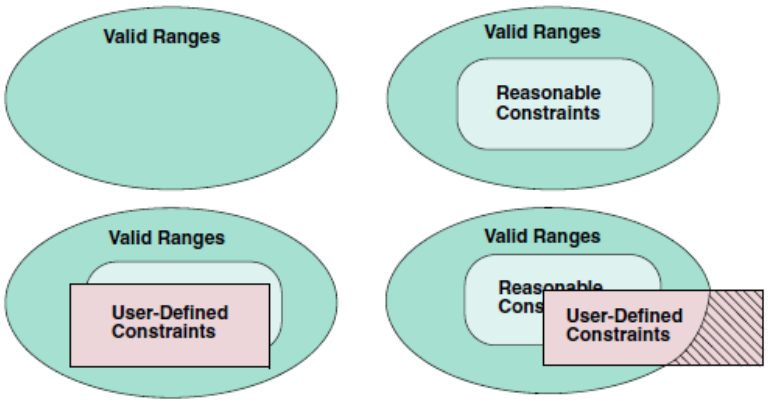
The classes that provide random attributes allow you to define the contents of the resulting object. When you call the `randomize()` method, all random attributes are randomized using all constraints that are enabled.

Constraint randomization is sometimes viewed as a process whereby the simulation engine takes the control of class members away from a user. In fact, the opposite is true. Randomization is an additional way for a user to assign class members and there are several ways to control the process. The following techniques apply when working with randomization:

- Randomization only occurs when the `randomize()` method of an object is called, and it is completely up to the test code when, or even if, this occurs.
- Constraints form a rule set to follow when randomization is performed. By controlling constraints, the testbench has influence over the outcome. A direct control can be exerted by constraining a member to a single value. The constraints can also be enabled or disabled.
- Each random member has a random mode that can be turned ON or OFF, giving you the control of what is randomized.
- A user can assign a value to a member at any time. Randomization does not affect the other methods of assigning class members.

Figure 3-3 shows the scope of the constraints that are part of all VIP.

Figure 3-3Constraints: Valid Ranges, Reasonable, and User-Defined



The following list describes the constraints in detail:

- **Valid Range Constraints**

- Provided with VIP
- Keep values within a range that Driver can handle
- Not tied to protocol limits
- Turned on by default, and should not be turned off or modified

- **Reasonable Constraints**
  - Provided with VIP
  - Keep values within protocol limits (typically) to generate worthwhile traffic
  - In some cases, keep simulations to a reasonable length and size
  - Defined to be "reasonable" by Synopsys (you can override)
  - May result in conditions that are a subset of the protocol
  - Turned on by default and can be turned off or modified (you should review these constraints)
- **User-Defined Constraints**
  - Provide a way to define specific tests
  - Constraints that lie outside the valid ranges will result in the constraint failure.

All constraints that are enabled are included in the simulation.

4 Getting Started Example

This release provides a getting started example. The example shows the following information:

- Instantiating classes and UVM components
- Using and setting up SPI UVM agents
- Connecting a Verilog HDL interconnect to the SystemVerilog interface
- Building a UVM test environment by extending from the `uvm_env` base class
- Applying transmit or receive and system constraints for Random testing
- Using sequences
- Generating random transactions
- Registering factories
- Creating a test directory structure

This chapter consists of the following sections:

4.1 Installing the Basic Example

This step occurs after you invoke the `*.run` file to install the entire SPI VIP test suite.

To install the example, you need to use the `dw_vip_setup` script. For more information, see The dw_vip_setup Utility. Use the following command to invoke `dw_vip_setup`:

```
$DESIGNWARE_HOME/bin/dw_vip_setup -path <design_dir> -e
spi_svt/tb_spi_svt_uvm_basic_1m_1s_sys -svtb
```

where,

- Name of the example: `tb_spi_svt_uvm_basic_1m_1s_sys`
- Install location of the example: `-path <design_dir>`

4.2 Running the Basic Example

You can use the `dw_vip_setup` generated script to run the example.

You must install UVM and also set the `UVM_HOME` variable. For example: setenv UVM_HOME $VCS_HOME/etc/uvm

The following code snippet shows how to run the basic example from a script

```
cd <design_dir>/examples/sverilog/spi_svt/tb_spi_svt_uvm_basic_1m_1s_sys/

// To run the example using the generated run script with a sample command line
// in VCS

./run_spi_svt_uvm_basic_1m_1s_sys base_test vcsvlog-svlog

// To run the example using the generated run script with a sample command line
//in VCS with waveform dumping enabled

./run_spi_svt_uvm_basic_1m_1s_sys -w fsdb base_test vcsvlog-svlog

// To see all options with the run_spi_svt_uvm_basic_1m_1s_sys example type

./run_spi_svt_uvm_basic_1m_1s_sys -h
```

4.2.1 Running the Example with +incdir+

In the current setup, you install the VIP under *DESIGNWARE_HOME* followed by creation of a design directory which contains the versioned VIP files. With every newer version of the already installed VIP requires the design directory to be updated. This results in:

- Consumption of additional disk space
- Increased complexity to apply patches

The new alternative approach of directly pulling in all the files from *DESIGNWARE_HOME* eliminates the need for design directory creation. VIP version control is now in the command line invocation.

The following code snippet shows how to run the basic example from a script:

```
cd <testbench_dir>/examples/sverilog/ spi_svt/tb_spi_svt_uvm_basic_1m_1s_sys/

// To run the example using the generated run script with +incdir+

./ run_spi_svt_uvm_basic_1m_1s_sys -verbose -incdir base_test vcsvlog
```

For example, the following compile log snippet shows the paths and defines set by the new flow to use VIP files right out of *DESIGNWARE_HOME* instead of *design_dir*.

```
vcs -l ./logs/compile.log -q -Mdir=./output/csrc \
+define+DESIGNWARE_INCDIR=<DESIGNWARE_HOME> \
+define+SVT_LOADER_UTIL_ENABLE_DWHOME_INCDIRS
+incdir+<DESIGNWARE_HOME>/vip/svt/spi_svt/<vip_version>/sverilog/include \
-CFLAGS -DVCS +incdir+/remote/vip/apps/UVM/latest/src
/remote/vip/apps/UVM/latest/src/dpi/uvm_dpi.cc \
-full64 -sverilog +define+SVT_SPI +define+UVM_PACKER_MAX_BYTES=1500000
+define+SVT_SPI_DATA_WIDTH=8 \
+define+SVT_SPI_IO_WIDTH=1 +define+SVT_MEM_ENABLE_DEPTH_INDEPENDENT_VALUES
+define+SVT_UVM_TECHNOLOGY \
+define+SYNOPSYS_SV
+incdir+<testbench_dir>/examples/sverilog/spi_svt/tb_spi_svt_uvm_basic_1m_1s_sys/. \
```

```
+incdir+<testbench_dir>/examples/sverilog/spi_svt/tb_spi_svt_uvm_basic_1m_1s_sys/../../e
nv \
+incdir+<testbench_dir>/examples/sverilog/spi_svt/tb_spi_svt_uvm_basic_1m_1s_sys/../env
\
+incdir+<testbench_dir>/examples/sverilog/spi_svt/tb_spi_svt_uvm_basic_1m_1s_sys/env \
+incdir+<testbench_dir>/examples/sverilog/spi_svt/tb_spi_svt_uvm_basic_1m_1s_sys/dut \
+incdir+<testbench_dir>/examples/sverilog/spi_svt/tb_spi_svt_uvm_basic_1m_1s_sys/hdl_int
erconnect \
+incdir+<testbench_dir>/examples/sverilog/spi_svt/tb_spi_svt_uvm_basic_1m_1s_sys/lib \
+incdir+<testbench_dir>/examples/sverilog/spi_svt/tb_spi_svt_uvm_basic_1m_1s_sys/tests \
-o ./output/simvcssvlog -f top_files -f hdl_files
```

Note For VIPs with dependency, include the `+incdir+` for each dependent VIP.

4.2.2 Supported Methodologies with Simulators

Table 4-1 lists the methodologies supported with simulators.

Table 4-1 Supported Methodologies with Simulators

Methodology	VCS	MTI	IUS
UVM	Supported	Supported	Not Supported
OVM	Supported	Supported	Not supported
VMM	Supported	Supported	Not supported
HDL	Not Supported	Not Supported	Not Supported

4.2.3 Getting Help on Example Run/Make Scripts

You can get help on the generated make/run scripts in the following ways:

1. Invoke the run script with no switches, as in:

```
run_spi_svt_uvm_basic_1m_1s_sys
  usage: run_spi_svt_uvm_basic_1m_1s_sys [-32] [-incdir] [-verbose] [-debug] [-waves]
[-clean] [-nobuild] [-norun] [-pa] <scenario> <simulator>
  where   <scenario> is one of:   all base_test eeprom_test reset_test
master_rx_slave_tx_test master_tx_slave_rx_test
master_txrx_slave_txrx_with_reconfigurable_data_frame_width_test
<simulator> is one of:  vcsvlog vcsmxvlog mtivlog vcsmxpcvlog vcsmxpipvlog ncvlog
vcspcvlog vcsscvlog vcsvhdl ncmvlog
      -32       forces 32-bit mode on 64-bit machines
      -incdir      use DESIGNWARE_HOME include files instead of design directory
      -verbose  enable verbose mode during compilation
      -debug    enable debug mode for SVT simulations
      -waves    [fsdb|verdi|dve|dump] enables waves dump and optionally opens viewer
      (VCS only)
      -clean    clean simulator generated files
      -nobuild  skip simulator compilation
      -norun    exit after simulator compilation
      -pa       invoke PA after execution
```

2. Invoke the make file with help switch as in:

```
gmake help
Usage: gmake USE_SIMULATOR=<simulator> [VERBOSE=1] [DEBUG=1] [FORCE_32BIT=1]
[WAVES=fsdb|verdi|dve|dump] [NOBUILD=1] [PA=1] [<scenario> ...]
       Valid simulators are: vcsvlog vcsmxvlog mtivlog vcsmxpcvlog vcsmxpipvlog ncvlog
vcspcvlog vcsscvlog vcsvhdl ncmvlog
       Valid scenarios are:  all base_test eeprom_test reset_test
master_rx_slave_tx_test master_tx_slave_rx_test
master_txrx_slave_txrx_with_reconfigurable_data_frame_width_test
```

Note You must have PA installed if you use the -pa or PA=1 switches.

4.2.4 Multi-Master Mode with Mode Fault Detection in all SPI STD Modes

The `ss_in_n` Master interface signal connection update in `spi_svt_interconnect_sv_wrapper`.

Reference Testbench:
tb_spi_svt_uvm_basic_multi_agent_sys/hdl_interconnect/spi_svt_interconnect_sv_wrapper.sv

Connection code snippet:

```
wire master_collective_slave_select [`SVT_SPI_MAX_NUM_MASTERS];
wire [(`SVT_SPI_MAX_NUM_MASTERS-1):0] slave_select_input_bit_vector;

for (i=0; i < `SVT_SPI_MAX_NUM_MASTERS; i=i+1) begin :MASTER_CONNECT
assign master_collective_slave_select[i]  = cs_polarity ? (|spi_master_if_arr[i].ss_n) :
(&spi_master_if_arr[i].ss_n);
assign spi_master_if_arr[i].ss_in_n = cs_polarity ? (|slave_select_input_bit_vector) :
(&slave_select_input_bit_vector);
             end
for (ss_in_n_connect=0; ss_in_n_connect < `SVT_SPI_MAX_NUM_MASTERS;
ss_in_n_connect=ss_in_n_connect+1) begin : MASTER_SS_IN_N_CONNECT
assign slave_select_input_bit_vector[ss_in_n_connect] =
(master_collective_slave_select[ss_in_n_connect] === 1'bx ||
master_collective_slave_select[ss_in_n_connect] === 1'bz) ? (cs_polarity ? 1'b0 : 1'b1)
: master_collective_slave_select[ss_in_n_connect];
            end
```

5 Catalog and Part Numbers

5.1 Overview

The Synopsys SPI VIP provides you the catalogs of vendor memory parts which you can use to configure your VIP and manage your testbench. The following sections describe the catalog and part numbers and how to use them.

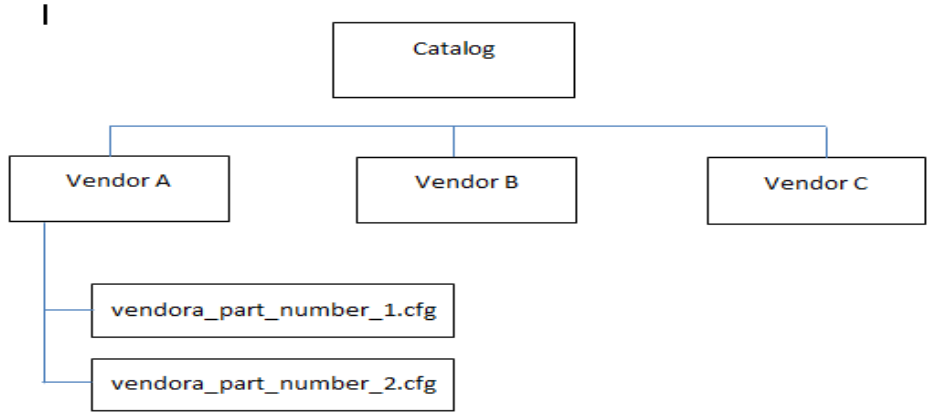
5.2 Location of Vendor Catalogs After Installation

After installation, vendor catalogs are located in the following directory:

```
$DESIGNWARE_HOME/vip/svt/spi_svt/latest/catalog
```

The catalog directory has a typical structure shown in the Figures 5-1.

Figure 5-1 Catalog Directory Structure



5.3 Contents of a Part Number *.cfg File

The part *.cfg files are ASCII files which sets values for the behavior of any given model.

Attention
In this release, *.cfg files are not encrypted. There will be a mix of unencrypted and encrypted files in the upcoming releases.

```
//Description:1Gb, 3V
//Density    :256Mbx4
//Speed      :108MHz
catalog_part_number=N25Q_1Gb_3V_65nm
catalog_vendor=MICRON
catalog_package=NOR
catalog_class=SPI_FLASH
data_width=8
addr_width=27
attr_width=1
die_addr_width=2
segment_addr_width=1
sector_addr_width=8
subsector_addr_width=4
page_addr_width=4
row_addr_width=8
hold_lane_id=3
vpp_lane_id=2
write_protect_lane_id=2
micron_status_register_val@mode_register_cfg=80
micron_nonvolatile_configuration_register_val@mode_register_cfg=FF_CF
manufacturer_id@mode_register_cfg=20
device_id_memory_type@mode_register_cfg=BA
device_id_memory_capacity@mode_register_cfg=21
unique_id[0]@mode_register_cfg=10
…
unique_id[16]@mode_register_cfg=ff
micron_parameter_data_structure[0]@mode_register_cfg=53
…
micron_parameter_data_structure[15]@mode_register_cfg=ff
micron_parameter_id[0]@mode_register_cfg=E5
…
micron_parameter_id[35]@mode_register_cfg=00
tW_min_ms@timing_cfg=1.3
tW_max_ms@timing_cfg=8
tW_timeout_ms@timing_cfg=9
tPP_min_ms@timing_cfg=0.4
tPP_max_ms@timing_cfg=5
tPP_timeout_ms@timing_cfg=6
tpp_vpph_ms@timing_cfg=0.4
tPOTP_min_ms@timing_cfg=0.2
tPOTP_max_ms@timing_cfg=5
tPOTP_timeout_ms@timing_cfg=6
tSSE_min_s@timing_cfg=0.25
tSSE_max_s@timing_cfg=0.8
tSSE_timeout_s@timing_cfg=1.0
tSE_min_s@timing_cfg=0.7
tSE_max_s@timing_cfg=3
tSE_timeout_s@timing_cfg=4
tBE_min_s@timing_cfg=240
```

```
tBE_max_s@timing_cfg=480
tBE_timeout_s@timing_cfg=490
tWNVCR_min_s@timing_cfg=0.2
tWNVCR_max_s@timing_cfg=3
tWNVCR_timeout_s@timing_cfg=3.5
suspend_latency_for_program_us@timing_cfg=7
suspend_latency_for_erase_us@timing_cfg=15
suspend_latency_for_subsector_4kb_erase_us@timing_cfg=15
last_sample_to_vpph_assert_min_delay_ns@timing_cfg=10
last_sample_to_vpph_assert_max_delay_ns@timing_cfg=200
```

5.4 Hierarchical Structure of Vendor Memory Parts

The parts catalog is structured in the following hierarchy pattern as shown in the Tables 5-1.

Table 5-1 Structure of Vendor Catalogs

Name	Description
Catalog	One particular collection of part numbers for a specific memory class.
Part	A specific memory part. This is matched with a.cfg file that supplies the VIP configuration needed to configure the VIP for that particular part.

5.5 Catalog Classes and Features

The SPI Memory classes used to manage catalogs and part numbers are as follows:

- `svt_mem_vendor_part`: Default part catalog entry. If additional or different part selection criteria are required for a specific suite, they should be added in a derived class. It must be specialized with a policy class that contains a static "#get()" method returning the full path to the installation directory of the suite.
- `svt_mem_part_mgr`: You can use this class to choose vendor parts within all available catalogs.

5.5.1 Configuring An Agent Using Catalog Configuration Files

To configure your Agent to behave as a Vendor part, perform the following:

- Create a Policy Class. A policy class defines the search criteria you want to follow or limit in searching for a suitable part.
- Use the `svt_mem_part_mgr` class to select a specific part using any or all of the following characteristics:
  - Vendor name (Micron, Macronix, and so on) user get_vendor_name()
  - Part name (N25Q_1Gb_3V_65nm, N25Q_512Mb_3V_65nm and so on) using `get_part_number()`
- Once a part is selected, then use `get_cfgfile()` to get the path to the *.cfg file which can be loaded into the configuration object.

You can find online documentation about the `svt_mem_part_mgr` class using the SPI UVM Online Help located at:

```
$DESIGNWARE_HOME/vip/svt/spi_svt/doc/spi_svt_uvm_class_reference/html/index.html
```

6 Using Protocol Analyzer with Memory Models

6.1 Overview

Synopsys provides Protocol Analyzer (PA) to help you debug designs with SPI VIP in SPI Flash mode. This chapter describes the steps to enable the generation of PA data, and an overview of PA features which support debugging testbenche with SPI VIP in Flash mode.

6.2 Enabling the SPI VIP to Generate Data for Protocol Analyzer

To use Protocol Analyzer to debug memory transactions, you must enable the SPI VIP to generate data for the Protocol Analyzer. In your UVM environment class, set the following to generate data for the Protocol Analyzer:

```
// Members to generate data defined in svt_spi_configuration class.
   svt_spi_configuration cfg;
//Enable XML generation for SPI transaction activity
   slave_cfg.enable_txrx_xml_gen = 1'b1;
//Enable XML generation for memory transaction activity
   slave_cfg.spi_mem_cfg.enable_xact_xml_gen = 1'b1;
//Enable .mempa file generation from memcore.
   slave_cfg.spi_mem_cfg.enable_memcore_xml_gen = 1'b1;
```

6.3 Protocol Analyzer Memory Map View

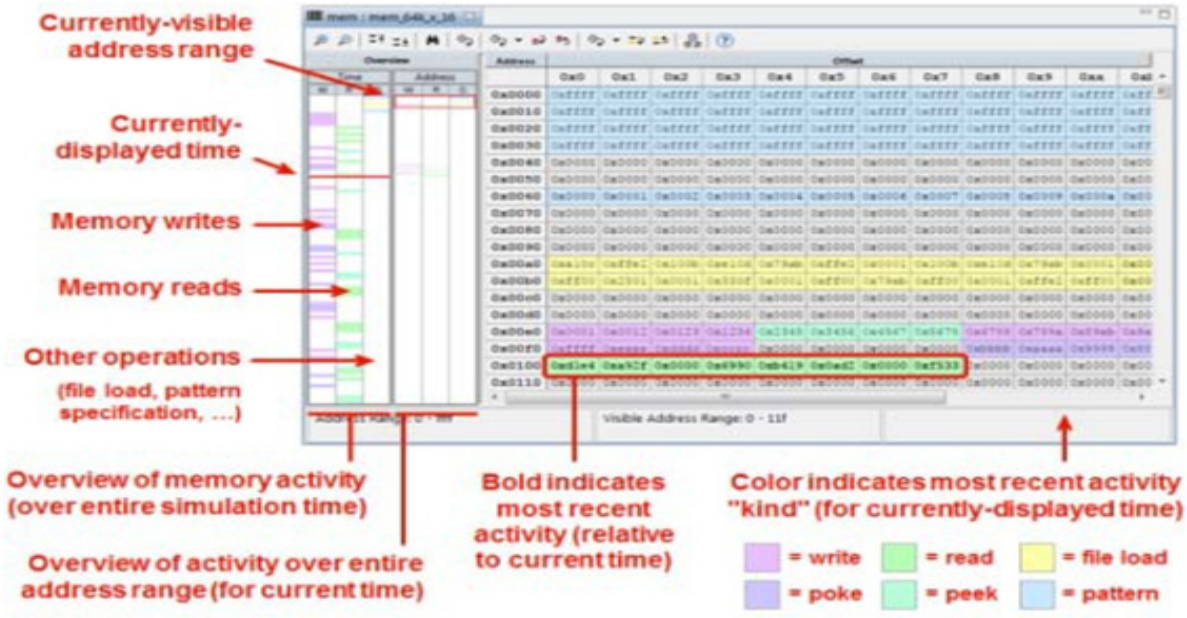
By setting the `cfg.enable_memcore_xml_gen` to 1, the model creates a **.mempa* file which captures memory values and all transactions to the memory space during a simulation run. This view is unique to memory models within PA. This section provides a general overview of the Memory Map View.

For detailed instructions on using PA, refer to the built-in Help as shown in the Figure 6-1. Help buttons appear on the upper right corner of the toolbar.

Figure 6-1 Protocol Analyzer Help

After invoking a Memory View referencing the data created by the memory model, Protocol Analyzer displays the view as shown in the Figure 6-2

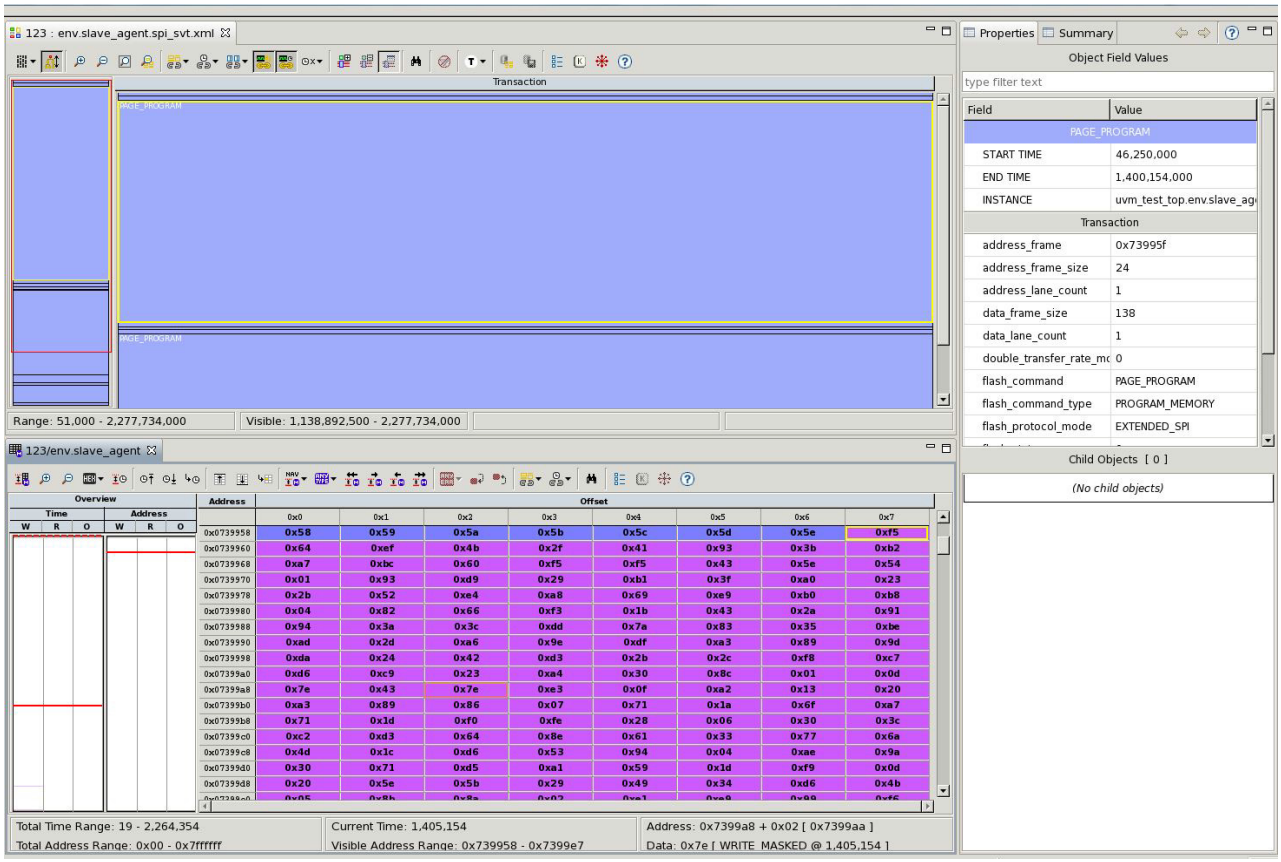
Figure 6-2 Protocol Analyzer Memory Map Window



In the above figure, the left panel displays entire simulation run in terms of transaction types, address, and simulation time including the It includes the details about every read, write and other transactions (backdoor memory peeks and pokes). The right panel updates with the value of the memory location. Within the left panel, you can choose to read the contents of memory referencing any parameter such as address, transaction type, or simulation time. The right panel shows the value of memory using those parameters.

You can simultaneously watch the Memory View and the Protocol Views. If you synchronize them, each window tracks the other. For example, in the Figure 6-3, the Memory View shows the contents of memory for the selected transaction in the lower window.

Figure 6-3 Synchronized View



7 Verification Features

This chapter consists of the following sections:

7.1 Verification Planner

Verification Planner is a verification planning tool, which is incorporated into several Synopsys products. Verification Planner is a technology that allows you to think about the verification process at a high-level overview while working with the real objective of the low-level verification data. Verification Planner allows you to convert the low-level data into useful information to plan and track the progress of verification projects.

An Hierarchical Verification Plan (HVP) is a comprehensive model that allows you to hierarchically describe a verification plan.

The section consists of the following subsection:

7.1.1 Back Annotation With Verdi

A set of `.hvp` files are present in the following directory to work with Verdi:

```
$DESIGNWARE_HOME/vip/svt/spi_svt/doc/VerificationPlans
```

You can load these .hvp files in Verdi and perform back annotation using Verdi with the simulation coverage output.

The steps to load the .hvp file and coverage in Verdi are as follows:

a. Launch Verdi using the following steps:
```
% verdi -cov &
```
b. Open the `.hvp` file: `Plan -> Open Plan`. Choose one of the top `.hvp` files.
c. Open coverage database (`.vdb`): `File -> Open/Add Database`.
d. Use a predefined layout: `Window -> Plan Mode` or `Window -> Coverage + Plan Mode`.

e. Back Annotate: In the `Hvp` window, click the `recalculate` button.

Now, you should see the back-annotated plan in the `Hvp` window. Expand its levels for details, if needed.

8 Usage Notes

8.1 NOR Flash

8.1.1 Spansion S25FL512S Device SFDP

Spansion S25FL512S Device SFDP address space is based on the following modes:

- HPLC Mode
- EHPLC Mode

8.1.1.1 HPLC Mode

- Address space CFI alternate vendor-specific extended query parameters 90h-HPLC and 9Ah-HPLC are present.
- Parameter 90h-EHPLC and 9Ah-EHPLC modes are not be included in the address space.
- Vacant space 16'h1118 to 16'h111D are filled with 'hFF.
- As per the specification, CFI parameter ID=A5 starts from 16'h111E.

8.1.1.2 EHPLC Mode

- Address Space CFI alternate vendor-specific extended query parameters 90h-EHPLC and 9Ah-EHPLC are present.
- Parameter 90h-HPLC and 9Ah-HPLC modes are not be included in address space.
- Vacant space 16'h1118 to 16'h111D are filled with 'hFF.
- As per the specification, CFI parameter ID=A5 starts from 16'h111E.

8.2 NAND Flash

8.2.1 GigaDevice GD5F1GQ4UAW

- Bad Block Inhibit
  - This bit when asserted prohibits erase operation on Bad Block and sets the Erase Failure in Status Register.
  - VIP supports Erase operation on Block (Good/Bad) when this bit is disabled.

- NAND Flash device supports multiple operation flow (Program, Internal Data move, Reading from Page). Each operation flow consists of multiple commands sequence.

  For example, Internal Data move operation consists of following commands sequence:

  - 13H (PAGE READ to cache)
  - Optional 84H/C4H/ 34H(PROGRAM LOAD RANDOM DATA)
  - 06H (WRITE ENABLE)
  - 10H (PROGRAM EXECUTE)
  - 0FH (GET FEATURE command to read the status)

  VIP assumes that if a RESET or abrupt termination takes in between Operation flow/Command in progress, then Flash Controller (Master) must restart the operation flow.

A
Reporting Problems

A.1 Introduction

This chapter outlines the process for working through and reporting VIP transactor issues encountered in the field. It describes the data you must submit when a problem is initially reported to Synopsys. After a review of the initial information, Synopsys may decide to request adjustments to the information being requested, which is the focus of the next section. This section outlines the process for working through and reporting problems. It shows how to use Debug Automation to enable all the debug capabilities of any VIP. In addition, the VIP provides a case submittal tool to help you pack and send all pertinent debug information to Synopsys Support.

A.2 Debug Automation

Every Synopsys model contains a feature called "debug automation". It is enabled through *svt_debug_opts* plusarg. The Debug Automation feature allows you to enable all relevant debug information. The following are critical features of debug automation:

- Enabled by the use of a command line run-time plusarg.
- Can be enabled on individual VIP instances or multiple instances using regular expressions.
- Enables debug or verbose message verbosity:
  - The timing window for message verbosity modification can be controlled by supplying `start_time` and `end_time`.
- Enables at one time any, or all, standard debug features of the VIP:
  - Transaction Trace File generation
  - Transaction Reporting enabled in the transcript
  - PA database generation enabled
  - Debug Port enabled
  - Optionally, generates a file name *svt_model_out.fsdb* when Verdi libraries are available

When the Debug feature is enabled, then all VIP instances that are enabled for debug will have their messages routed to a file named *svt_debug.transcript*.

A.3 Enabling and Specifying Debug Automation Features

Debug Automation is enabled through the use of a run-time plusarg named +*svt_debug_opts. T*his plusarg accepts an optional string-based specification to control various aspects Debug Automation. If this

command control specification is not supplied, then the feature will default to being enabled on all VIP instances with the default options listed as follows:

Note the following about the plusarg:

- The command control string is a comma separated string that is split into the multiple fields.
- All fields are optional and can be supplied in any order.

The command control string uses the following format (white space is disallowed):

```
inst:<inst>,type:<string>,feature:<string>,start_time:<longint>,end_time:<longint>,verbosity:<string>
```

The following table explains each control string:

Table A-1 Control Strings for Debug Automation plusarg

Field	Description
inst	Identifies the VIP instance to apply the debug automation features. Regular expressions can be used to identify multiple VIP instances. If this value is not supplied, and if a type value is not supplied, then the debug automation feature will be enabled on all VIP instances.
type	Identifies a class type to apply the debug automation features. When this value is supplied then debug automation will be enabled for all instances of this class type.
feature	Identifies a sub-feature that can be defined by VIP designers to identify smaller grouping of functionality that is specific to that title. The definition and implementation of this field is left to VIP designers, and by default it has no effect on the debug automation feature. (Specific to VIP titles)
start_time	Identifies when the debug verbosity settings will be applied. The time must be supplied in terms of the timescale that the VIP is compiled. If this value is not supplied, then the verbosity settings will be applied at time zero.
end_time	Identifies when the debug verbosity settings will be removed. The time must be supplied in terms of the timescale that the VIP is compiled. If this value is not supplied, then the debug verbosity remains in effect until the end of the simulation.
verbosity	Message verbosity setting that is applied at the `start_time`. Two values are accepted in all methodologies: DEBUG and VERBOSE. UVM and OVM users can also supply the verbosity that is native to their respective methodologies (UVM_HIGH/UVM_FULL and OVM_HIGH/OVM_FULL). If this value is not supplied then the verbosity defaults to DEBUG/UVM_HIGH/OVM_HIGH. When this feature is enabled, then all VIP instances that are enabled for debug will have their messages routed to a file named `svt_debug.transcript`.

Examples:

Enable on all VIP instances with default options:

```
+svt_debug_opts
```

Enable on all instances:

- containing the string "endpoint" with a verbosity of UVM_HIGH
- starting at time zero (default) until the end of the simulation (default):

```
+svt_debug_opts=inst:/.*endpoint.*/,verbosity:UVM_HIGH
```

Enable on all instances:

- starting at time 1000 until time 1500:

```
+svt_debug_opts=start_time:1000,end_time:1500,verbosity:VERBOSE
```

Enable debug feature on all instances using default options:

- By setting the macro SVT_DEBUG_OPTS to 1 in the command line, the debug feature is enabled on all instances using default options. The macro will enable the XMLs and Trace files.

```
gmake <testname> SVT_DEBUG_OPTS=1 PA=FSDB
```

Note

The SVT_DEBUG_OPTS option is available through the installed VIP examples, but if required, in customer environments, then a similar feature should be added to their environment.
The PA=FSDB option is available in public examples and is required to enable Verdi libraries, and that when this option is used, then the Debug Opts file will record VIP activity to a file named `svt_model_log.fsdb`.
In addition, the SVT Automated Debug feature will enable waveform generation to an FSDB file, if the Verdi libraries are available. When enabled this feature, it should cause the simulator to dump waveform information only for the VIP interfaces.

When this feature is enabled then all VIP instances that have been enabled for debug will have their messages routed to a file named `svt_debug.transcript`.

A.4 Debug Automation Outputs

The Automated Debug feature generates a *svt_debug.out* file. It records important information about the debug feature itself, and data about the environment that the VIPs are operating in. This file records the following information:

- The compiled timeunit for the SVT package
- The compiled timeunit for each SVT VIP package
- Version information for the SVT library
- Version information for each SVT VIP
- Every SVT VIP instance, and whether the VIP instance has been enabled for debug
- For every SVT VIP enabled for debug, a list of configuration properties that have been modified to enable debug will be listed
- A list of all methodology phases will be recorded, along with the start time for each phase

The following are the output files generated:

- *svt_debug.out*: It records important information about the debug feature itself, and data about the environment that the VIPs are operating. One file is optionally created when this feature is enabled, depending on if the Verdi libraries are available.
- *svt_debug.transcript*: Log files generated by the simulation run.
- *transaction_trace*: Log files that records all the different transaction activities generated by VIPs.
- *svt_model_log.fsdb*: Contains PA FSDB information (if the VIP supports this), and which contains other recorded activity. The additional information records signal activity associated with the VIP interface, TLM input (through SIPP ports), other TLM output activity, configurations applied to the VIP, and all callback activity (recorded by before and after callback execution).

A.5 FSDB File Generation

To enable FSDB writing capabilities, the simulator compile-time options and environment must be updated to enable this. The steps to enable this are specific to the simulator being used (the {LINUX/LINUX64} label needs to be replaced based on the platform being used). The ability to write to an FSDB file requires that the user supplies the Verdi dumper libraries when they compile their testbench. If these are not supplied then the VIP will not be enabled to generate the *svt_model_log.fsdb* file.

A.5.1 VCS

The following must be added to the compile-time command:

```
-debug_access
```

For more information on how to set the FSDB dumping libraries, see "Appendix B" section in *Linking Novas Files with Simulators and Enabling FSDB Dumping* guide available at *$VERDI_HOME/doc/linking_dumping.pdf*.

A.5.2 Questa

The following must be added to the compile-time command:

```
+define+SVT_FSDB_ENABLE -pli novas_fli.so
```

A.5.3 Incisive

The following must be added to the compile-time command:

```
+define+SVT_FSDB_ENABLE -access +r
```

A.6 Initial Customer Information

Follow these steps when you call the Synopsys Support Center:

1. Before you contact technical support, be prepared to provide the following:
   - A description of the issue under investigation.
   - A description of your verification environment.

Enable the Debug Opts feature. For more information, see the Debug Automation.

A.7 Sending Debug Information to Synopsys

To help you debug testing issues, follow the given instructions to pack all pertinent debug information into one file which you can send to Synopsys (or to other users in your company):

1. Create a description of the issue under investigation. Include the simulation time and bus cycle of the failure, as well as any error or warning messages that are part of the failure.
2. Create a description of your verification environment. Assemble information about your simulation environment, making sure to include:
   - OS type and version
   - Testbench language (SystemVerilog or Verilog)
   - Simulator and version
   - DUT languages (Verilog)
3. Use the VIP case submittal tool to pack a file with the appropriate debug information. It has the following usage syntax:

```
$DESIGNWARE_HOME/bin/snps_vip_debug [-directory <path>]
```

The tool will generate a “<username>.<uniqid>.svd” file in the current directory. The following files are packed into a single file:

- FSDB
- HISTL
- MISC
- SLID
- SVTO
- SVTX
- TRACE
- VCD
- VPD
- XML

If any one of the above files are present, then the files will be saved in the "<username>.<uniqid>.svd" in the current directory. The simulation transcript file will not be part of this and it will be saved separately.

The -directory switch can be specified to select an alternate source directory.

4. You will be prompted by the case submittal tool with the option to include additional files (compile and simulation logs) within the SVD file. The simulation transcript files cannot be automatically identified and it must be provided during this step.
5. The case submittal tool will display options on how to send the file to Synopsys.

A.8 Limitations

Enabling DEBUG or VERBOSE verbosity is an expensive operation, both in terms of runtime and disk space utilization. The following steps can be used to minimize this cost:

- Only enable the VIP instance necessary for debug. By default, the `+svt_debug_opts` command enables Debug Opts on all instances, but the `'inst'` argument can be used to select a specific instance.
- Use the `start_time` and `end_time` arguments to limit the verbosity changes to the specific time window that needs to be debugged.