

PrimeCell® Synchronous Serial Port (SSP) Cycle Model

Version 9.1.0

User Guide

Non-Confidential



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User Guide

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Preface

A Cycle Model component is a library developed from ARM intellectual property (IP) that is generated through Cycle Model Studio™. The Cycle Model then can be used within a virtual platform tool, for example, SoC Designer.

About This Guide

This guide provides all the information needed to configure and use the Cycle Model in SoC Designer.

Audience

This guide is intended for experienced hardware and software developers who create components for use with SoC Designer. You should be familiar with the following products and technology:

- SoC Designer
- Hardware design verification
- Verilog or SystemVerilog programming language

Conventions

This guide uses the following conventions:

Convention	Description	Example
<code>courier</code>	Commands, functions, variables, routines, and code examples that are set apart from ordinary text.	<code>sparseMem_t SparseMemCreateNew();</code>
<i>italic</i>	New or unusual words or phrases appearing for the first time.	<i>Transactors</i> provide the entry and exit points for data ...
bold	Action that the user performs.	Click Close to close the dialog.
<text>	Values that you fill in, or that the system automatically supplies.	<platform>/ represents the name of various platforms.
[text]	Square brackets [] indicate optional text.	\$CARBON_HOME/bin/modelstudio [<filename>]
[text1 text2]	The vertical bar indicates “OR,” meaning that you can supply text1 or text 2.	\$CARBON_HOME/bin/modelstudio [<name>.symtab.db <name>.ccfg]

Also note the following references:

- References to C code implicitly apply to C++ as well.
- File names ending in .cc, .cpp, or .cxx indicate a C++ source file.

Further reading

This section lists related publications. The following publications provide information that relate directly to SoC Designer:

- *SoC Designer Installation Guide*
- *SoC Designer User Guide*
- *SoC Designer Standard Component Library Reference Manual*

The following publications provide reference information about ARM® products:

- *AMBA 3 AHB-Lite Overview*
- *AMBA Specification (Rev 2.0)*
- *AMBA AHB Transaction Level Modeling Specification*
- *Architecture Reference Manual*

See <http://infocenter.arm.com/help/index.jsp> for access to ARM documentation.

The following publications provide additional information on simulation:

- IEEE 1666™ SystemC Language Reference Manual, (IEEE Standards Association)
- SPIRIT User Guide, Revision 1.2, SPIRIT Consortium.

Glossary

AMBA	<i>Advanced Microcontroller Bus Architecture.</i> The ARM open standard on-chip bus specification that describes a strategy for the interconnection and management of functional blocks that make up a System-on-Chip (SoC).
AHB	<i>Advanced High-performance Bus.</i> A bus protocol with a fixed pipeline between address/control and data phases. It only supports a subset of the functionality provided by the AMBA AXI protocol.
APB	<i>Advanced Peripheral Bus.</i> A simpler bus protocol than AXI and AHB. It is designed for use with ancillary or general-purpose peripherals such as timers, interrupt controllers, UARTs, and I/O ports.
AXI	<i>Advanced eXtensible Interface.</i> A bus protocol that is targeted at high performance, high clock frequency system designs and includes a number of features that make it very suitable for high speed sub-micron interconnect.
Cycle Model	A software object created by the Cycle Model Studio (or <i>Cycle Model Compiler</i>) from an RTL design. The Cycle Model contains a cycle- and register-accurate model of the hardware design.
Cycle Model Studio	Graphical tool for generating, validating, and executing hardware-accurate software models. It creates a Cycle Model, and it also takes a Cycle Model as input and generates a component that can be used in SoC Designer, Platform Architect, or Accellera SystemC for simulation.
CASI	<i>ESL API Simulation Interface</i> , is based on the SystemC communication library and manages the interconnection of components and communication between components.
CADI	<i>ESL API Debug Interface</i> , enables reading and writing memory and register values and also provides the interface to external debuggers.
CAPI	<i>ESL API Profiling Interface</i> , enables collecting historical data from a component and displaying the results in various formats.
Component	Building blocks used to create simulated systems. Components are connected together with unidirectional transaction-level or signal-level connections.
ESL	<i>Electronic System Level.</i> A type of design and verification methodology that models the behavior of an entire system using a high-level language such as C or C++.
HDL	<i>Hardware Description Language.</i> A language for formal description of electronic circuits, for example, Verilog.
RTL	<i>Register Transfer Level.</i> A high-level hardware description language (HDL) for defining digital circuits.
SoC Designer	High-performance, cycle accurate simulation framework which is targeted at System-on-a-Chip hardware and software debug as well as architectural exploration.
SystemC	SystemC is a single, unified design and verification language that enables verification at the system level, independent of any detailed hardware and software implementation, as well as enabling co-verification with RTL design.
Transactor	<i>Transaction adaptors.</i> You add transactors to your component to connect your component directly to transaction level interface ports for your particular platform.

Chapter 1

Using the Model Kit Component in SoC Designer

This chapter describes the functionality of the Model component, and how to use it in SoC Designer. It contains the following sections:

- [SSP PL022 Model Functionality](#)
- [Adding and Configuring the SoC Designer Component](#)
- [Available Component ESL Ports](#)
- [Setting Component Parameters](#)
- [Debug Features](#)
- [Available Profiling Data](#)

1.1 SSP PL022 Model Functionality

The PrimeCell SSP is an AMBA compliant System-on-Chip peripheral. SSP is an AMBA slave module, and connects to the APB. This model supports receive and transmit direction transaction port for data transfer.

This section provides a summary of the functionality of the model compared to that of the hardware. For details of the functionality of the hardware that the model simulates, refer to the *ARM PrimeCell® Synchronous Serial Port (PL022) Technical Reference Manual*.

- [Fully Functional and Accurate Features](#)
- [Fully Functional and Approximate Features](#)
- [Features Additional to the Hardware](#)

1.1.1 Fully Functional and Accurate Features

The following features of the SSP PL022 hardware implementation are fully implemented in the SSP PL022 model.

- Compliance to the AMBA (Rev 2.0) Specification
- Programmable clock bit rate and prescale.
- Separate transmit and receive first-in, first-out memory buffers, 16 bits wide, 8 locations deep.
- Identification registers that uniquely identify the PrimeCell SSP. These can be used by an operating system to automatically configure itself.
- Independent masking of transmit FIFO, receive FIFO, and receive overrun interrupts.
- Internal loop back test mode.

1.1.2 Fully Functional and Approximate Features

- The APB interface is modeled as an APB transaction interface. For more information on this, refer to *RVModelLib_MxAPB.pdf* provided with AMBA2 package for SoC Designer Model Library.
 - In particular, this APB interface does not contain a *reset* port and *clock* port. Instead, the *reset* port and *clock* port are provided separately.
- Programmable data frame size from 4 to 16 bits.
 - This value can be programmed in SSPCR0 register bits [3:0], however this does not have any affect on data transfer size. You need to put data that is of correct size, as programmed in SSPCR0.
- SSPRXINTR, SSPTXINTR, SSPRORINTR, and SSPRTINTR are supported along with SSPINTR combined interrupt via *Intp* signal master port.
 - In one cycle first based on the SSPMIS register content any of the four interrupts are raised (SSPRXINTR, SSPTXINTR, SSPRORINTR, SSPRTINTR). Then in the same cycle, the combined interrupt SSPINTR is raised.

1.1.3 Features Additional to the Hardware

The following features that are implemented in the SSP PL022 model do not exist in the SSP PL022 hardware. These features have been added to the model for enhanced usability.

- Apart from data being transmitted or received from SSP_OUT/SSP_IN, files present in the HOST machine can also be used for input and output. The filenames along with their path for input and output should be specified in the component parameters “OPFileName” and “IPFileName”.

1.2 Adding and Configuring the SoC Designer Component

The following topics briefly describe how to use the component. See the *SoC Designer User Guide* for more information.

- [SoC Designer Component Files](#)
- [Adding the Cycle Model to the Component Library](#)
- [Adding the Component to the SoC Designer Canvas](#)

1.2.1 SoC Designer Component Files

The component files are the final output from the Cycle Model Studio compile and are the input to SoC Designer. There are two versions of the component; an optimized *release* version for normal operation, and a *debug* version.

On Linux the *debug* version of the component is compiled without optimizations and includes debug symbols for use with gdb. The *release* version is compiled without debug information and is optimized for performance.

On Windows the *debug* version of the component is compiled referencing the debug runtime libraries, so it can be linked with the debug version of SoC Designer. The *release* version is compiled referencing the release runtime library. Both release and debug versions generate debug symbols for use with the Visual C++ debugger on Windows.

The provided component files are listed below:

Table 1-1 SoC Designer Component Files

Platform	File	Description
Linux	maxlib.lib<model_name>.conf	SoC Designer configuration file
	lib<component_name>.mx.so	SoC Designer component runtime file
	lib<component_name>.mx_DBG.so	SoC Designer component debug file
Windows	maxlib.lib<model_name>.windows.conf	SoC Designer configuration file
	lib<component_name>.mx.dll	SoC Designer component runtime file
	lib<component_name>.mx_DBG.dll	SoC Designer component debug file

Additionally, this User Guide PDF file is provided with the component.

1.2.2 Adding the Cycle Model to the Component Library

The compiled Cycle Model component is provided as a configuration file (*.conf*). To make the component available in the Component Window in SoC Designer Canvas, perform the following steps:

1. Launch SoC Designer Canvas.
2. From the *File* menu, select **Preferences**.
3. Click on **Component Library** in the list on the left.
4. Under the *Additional Component Configuration Files* window, click **Add**.
5. Browse to the location where the SoC Designer model is located and select the component configuration file:
 - maxlib.lib<model_name>.conf (for Linux)
 - maxlib.lib<model_name>.windows.conf (for Windows)
6. Click **OK**.
7. To save the preferences permanently, click the **OK & Save** button.

The component is now available from the SoC Designer *Component Window*.

1.2.3 Adding the Component to the SoC Designer Canvas

Locate the component in the *Component Window* and drag it out to the Canvas.

1.3 Available Component ESL Ports

Table 1-2 describes the ESL ports that are exposed in SoC Designer. See the *ARM PrimeCell® SSP (PL022) Technical Reference Manual* for more information.

Table 1-2 ESL Component Ports

ESL Port	Description	Direction	Type
SSPCLKIN	PrimeCell SSP clock input.	Input	Signal slave
SSPFSSIN	PrimeCell SSP frame input.	Input	Signal slave
SSPRXDMACLR	DMA request clear, asserted by the DMA controller to clear the receive request signals.	Input	Signal slave
SSPTXDMACLR	DMA request clear, asserted by the DMA controller to clear the transmit request signals.	Input	Signal slave
SSP_IN	32 bit port used for receiving data from signal master port. The data received via this port is displayed in SSPDR register.	Input	Signal slave
apb	APB port for memory mapped register accesses and data. This interface is expected to be connected to an AXI compliant interface via some AXI2APB bridge. Refer to the SSP PL220 TRM for details of the memory mapped registers.	Input	Transaction slave
reset	Input reset. Reset port for receiving hardware reset signal.	Input	Signal slave
clk-in	Input clock. SSP component is clocked at the frequency of the clock connected to this port. If <i>clk-in</i> is not connected, the clock frequency is taken from SoC Designer System Properties.	Input	Clock slave
SSPCLKOUT	PrimeCell SSP clock output.	Output	Signal master
SSPFSSOUT	PrimeCell SSP frame, or slave select output.	Output	Signal master
SSPRXDMABREQ	PrimeCell SSP receive DMA burst request (active HIGH).	Output	Signal master
SSPRXDMASREQ	PrimeCell SSP receive DMA single request (active HIGH).	Output	Signal master
SSPTXDMABREQ	PrimeCell SSP transmit DMA burst request (active HIGH).	Output	Signal master
SSPTXDMASREQ	PrimeCell SSP transmit DMA single request (active HIGH).	Output	Signal master
SSP_OUT	32 bit port used to transmit data to connected signal slave port. The data transmitted via this port is taken from the SSPDR register.	Output	Signal master

Table 1-2 ESL Component Ports (continued)

ESL Port	Description	Direction	Type
intp	This port is used to provide interrupts to the interrupt controller. The value contains the interrupt number and the extended value contains the interrupt low or high value. Unique interrupt numbers can be specified for each interrupt supported via object parameters – see Table 1-3 on page 1-7 for more details.	Output	Signal master
nSSPCTLOE	Output enable signal (active LOW) for <i>SSP-CLKOUT</i> output from the PrimeCell SSP.	Output	Signal master
nSSPOE	Output enable signal (active LOW) to indicate when <i>SSPTXD</i> is valid.	Output	Signal master

All pins that are not listed in this table have been either tied or disconnected for performance reasons.

1.4 Setting Component Parameters

You can change the settings of all the component parameters in SoC Designer Canvas, and of some of the parameters in SoC Designer Simulator. To modify the component's parameters:

1. In the Canvas, right-click on the component and select **Edit Parameters...**. You can also double-click the component. The *Edit Parameters* dialog box appears.
2. In the *Parameters* window, double-click the **Value** field of the parameter that you want to modify.
3. If it is a text field, type a new value in the *Value* field. If a menu choice is offered, select the desired option. The parameters are described in Table 1-3.

Table 1-3 Component Parameters

Name	Description	Allowed Values	Default Value	Runtime ¹
Align Waveforms	When set to <i>true</i> , waveforms dumped from the component are aligned with the SoC Designer simulation time. The reset sequence, however, is not included in the dumped data. When set to <i>false</i> , the reset sequence is dumped to the waveform data, however, the component time is not aligned with the SoC Designer time.	true, false	true	No
apb Base Address	Base address for APB region accessed via the <i>apb</i> slave port.	0x0 - 0xffffffff	0x0	No
apb Enable Debug Messages	Whether debug messages are logged for the <i>apb</i> port.	true, false	false	Yes
apb Size	APB region size.	0x0-0xFFFFFFFF	0x100000000	No
Carbon DB Path	Sets the directory path to the database file.	Not Used	empty	No
Dump Waveforms	Whether SoC Designer dumps waveforms for this component.	true, false	false	Yes
Enable Debug Messages	Enable or disable the capture of debug messages.	true, false	false	Yes
intp int_1 id (SSPINTR)	The combined interrupt number of SSPRXINTR, SSPTXINTR, SSPRTINTR, and SSPRORINTR. Always comes on “intp” signal master port after the individual interrupt has come. Both come in the same simulation cycle.	0-31	7	Yes
intp int_2 id (SSPRXINTR)	Interrupt number for Receive FIFO, having 4 or more values.	0-31	2	Yes
intp int_3 id (SSPTXINTR)	Interrupt number for Transmit FIFO, having 4 or less values.	0-31	8	Yes

Table 1-3 Component Parameters (continued)

Name	Description	Allowed Values	Default Value	Runtime ¹
intp_int_4_id (SSPRTINTR)	The Receive Timeout Interrupt Number.	0-31	4	Yes
intp_int_5_id (SSPRORINTR)	Interrupt number for Receive Over run of Receive FIFO.	0-31	3	Yes
IPFileName	Serial input file name with path which will be used for receiving data. This file name comes into effect only when it has a valid value.	<i>string</i>	empty	No
OPFileName	Serial output file name with path which will be used to transmit data to. This file name comes into effect only when it has a valid value.	<i>string</i>	empty	No
Waveform File ²	Name of the waveform file.	<i>string</i>	arm_cm_Ssp_pl022.vcd	No
Waveform Timescale	Sets the timescale to be used in the waveform.	Many values in drop-down	1 ns	No

1. *Yes* means the parameter can be dynamically changed during simulation, *No* means it can be changed only when building the system, *Reset* means it can be changed during simulation, but its new value will be taken into account only at the next reset.
2. When enabled, SoC Designer writes accumulated waveforms to the waveform file in the following situations: when the waveform buffer fills, when validation is paused and when validation finishes, and at the end of each validation run.

1.5 Debug Features

The SSP PL022 model has a debug interface (CADI) that allows the user to view, manipulate and control the registers in the SoC Designer Simulator.

1.5.1 Registers Information

This section lists the register views available for the SSP PL022 model in the SoC Designer Simulator. The SSP PL022 model has four sets of registers that are accessible via the debug interface. Registers are grouped into sets according to functional area.

- [General Registers](#)
- [Test Registers](#)
- [Peripheral ID Registers](#)
- [PrimeCell ID Registers](#)

See the *ARM PrimeCell® SSP (PL022) Technical Reference Manual* for detailed descriptions of these registers.

1.5.1.1 General Registers

Table 1-4 shows the General registers.

Table 1-4 General Registers Summary

Register	Description	Type
SSPCR0	Control register 0	read-write
SSPCR1	Control register 1	read-write
SSPDR	Receive FIFO (read) data register	read-only
SSPSR	Status register	read-only
SSPCPSR	Clock prescale register	read-write
SSPIMSC	Interrupt mask set and clear register	read-write
SSPRIS	Raw interrupt status register	read-only
SSPMIS	Masked interrupt status register	read-only
SSPICR	Interrupt clear register	read-only
SSPDMACR	DMA control register	read-write

1.5.1.2 Test Registers

Table 1-5 shows the Test registers.

Table 1-5 Test Registers Summary

Register	Description	Type
SSPTCR	Test control register	read-write
SSPITIP	Integration test input register	bits [4:3] read-write bits [2:0] read-only
SSPITOP	Integration test output register	read-write
SSPTDR	Test data register	read-write

1.5.1.3 Peripheral ID Registers

Table 1-6 shows the Peripheral Identification registers.

Table 1-6 Peripheral ID Registers Summary

Register	Description	Type
SSPPeriphID0	Peripheral Identification register bits 7:0. Identifies the part number of the peripheral.	read-only
SSPPeriphID1	Peripheral Identification register bits 15:8. Identifies the part number and designer of the peripheral.	read-only
SSPPeriphID2	Peripheral Identification register bits 23:16. Identifies the revision and designer of the peripheral.	read-only
SSPPeriphID3	Peripheral Identification register bits 31:24. Identifies the configuration of the peripheral.	read-only

1.5.1.4 PrimeCell ID Registers

Table 1-7 shows the PrimeCell Identification registers.

Table 1-7 PrimeCell ID Registers Summary

Register	Description	Type
SSPPCellID0	PrimeCell Identification register bits 7:0. Determines the reset value.	read-only
SSPPCellID1	PrimeCell Identification register bits 15:8. Determines the reset value.	read-only
SSPPCellID2	PrimeCell Identification register bits 23:16. Determines the reset value.	read-only
SSPPCellID3	PrimeCell Identification register bits 31:24. Determines the reset value.	read-only

1.6 Available Profiling Data

The SSP PL022 model component has no profiling capabilities.

