

IP CORE MANUAL



AXI4-Lite Address Substitution IP

`px_axil_addr_sub`

PENTEK

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IP Facts

Description

Pentek's Navigator™ AXI4-Lite Address Substitution Core is designed to substitute a specified number of upper bits of the AXI4-Lite address with a user-defined value.

This core complies with the ARM® AMBA® AXI4 Specification. This user manual defines the hardware interface, software interface, and parameterization options for the AXI4-Lite Address Substitution Core.

Features

- Supports upto 32-bit AXI4-Lite user interface
- User-programmable number of upper bits of the AXI4-Lite address to be substituted
- User programmable value of the substituted address bits

Table 1-1: IP Facts Table	
Core Specifics	
Supported Design Family ^a	Kintex® Ultrascale
Supported User Interfaces	AXI4-Lite
Resources	See Table 2-1
Provided with the Core	
Design Files	VHDL
Example Design	Not Provided
Test Bench	Not Provided
Constraints File	Not Provided ^b
Simulation Model	N/A
Supported S/W Driver	N/A
Tested Design Flows	
Design Entry	Vivado® Design Suite 2016.4 or later
Simulation	Vivado VSim
Synthesis	Vivado Synthesis
Support	
Provided by Pentek fpgasupport@pentek.com	

a.For a complete list of supported devices, see the [Vivado Design Suite Release Notes](#).

b.Clock constraints can be applied at the top level module of the user design.

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Chapter 1: Overview

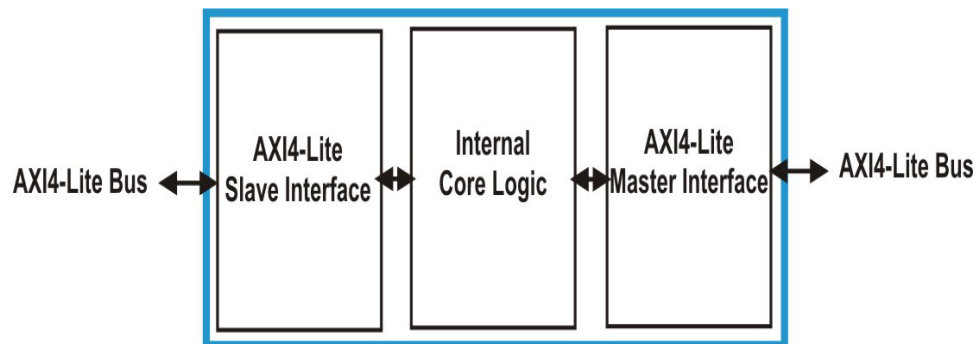
1.1 Functional Description

The AXI4-Lite Address Substitution Core is used to replace the upper bits of the AXI4-Lite address with the user defined value of the **sub_address** generic parameter as defined in [Section 2.5](#). The number of address bits to be replaced can also be defined by the user through the generic parameters.

[Figure 1-1](#) is a top-level block diagram of the Pentek AXI4-Lite Address Substitution Core. The modules within the block diagram are explained in the later sections of this manual.

- ❑ **AXI4-Lite Interface:** This module implements a AXI4-Lite Slave and Masters Interfaces for data reception and transmission. For additional details about the AXI4-Lite Interface, refer to [Section 3.1 AXI4-Lite Core Interfaces](#).

Figure 1-1: AXI4-Lite Address Substitution Core Block Diagram



1.2 Applications

The AXI4-Lite Address Substitution Core can be incorporated into any user design the upper bits the AXI4-Lite address are to be substituted with a user-defined value.

1.3 System Requirements

For a list of system requirements, see the [Vivado Design Suite Release Notes](#).

1.4 Licensing and Ordering Information

This core is included with all Pentek Navigator FPGA Design Kits for Pentek Jade series board products. Contact Pentek for Licensing and Ordering Information (www.pentek.com).

1.5 Contacting Technical Support

Technical Support for Pentek's Navigator FPGA Design Kits is available via e-mail (fpgasupport@pentek.com) or by phone (201-818-5900 ext. 238, 9 am to 5 pm EST).

1.6 Documentation

This user manual is the main document for this IP core. The following documents provide supplemental material:

- 1) *Vivado Design Suite User Guide: Designing with IP*
- 2) *Vivado Design Suite User Guide: Programming and Debugging*
- 3) *ARM AMBA AXI4 Protocol Version 2.0 Specification*
<http://www.arm.com/products/system-ip/amba-specifications.php>

Chapter 2: General Product Specifications

2.1 Standards

The AXI4-Lite Address Substitution Core has bus a interface that complies with the [ARM AMBA AXI4-Lite Protocol Specification](#).

2.2 Performance

The performance of the AXI4-Lite Address Substitution Core is limited only by the FPGA logic speed. The values presented in this section should be used as an estimation guideline. Actual performance can vary.

2.2.1 Maximum Frequencies

The AXI4-Lite Address Substitution Core is designed to meet a target frequency of 250 MHz on a Kintex Ultrascale -2 speed grade FPGA. 250 MHz is typically the PCI Express (PCIe®) AXI bus clock frequency.

2.3 Resource Utilization

The resource utilization of the AXI4-Lite Address Substitution Core is shown in [Table 2-1](#). Resources have been estimated for the Kintex Ultrascale XCKU060 -2 speed grade device. These values were generated using the Vivado Design Suite.

Table 2-1: Resource Usage and Availability	
Resource	# Used
LUTs	73
Flip-Flops	269

NOTE: Actual utilization may vary based on the user design in which the AXI4-Lite Address Substitution Core is incorporated.

2.4 Limitations and Unsupported Features

This section is not applicable to this IP core.

2.5 Generic Parameters

The generic parameters of the AXI4-Lite Address Substitution Core are described in [Table 2-2](#). These parameters can be set as required by the user application while customizing the core.

Table 2-2: Generic Parameters		
Port/Signal Name	Type	Description
num_bits	Integers	Number of Address Bits: This parameter defines the number of upper bits of the AXI4-Lite address to be substituted.
sub_address	std_logic_vector	Substitute Address: This parameter defines the value of the address to be substituted in the upper bits of the AXI4-Lite address

Chapter 3: Port Descriptions

This chapter provides details about the port descriptions for the following interface types:

- [AXI4-Lite Core Interfaces](#)

3.1 AXI4-Lite Core Interfaces

The AXI4-Lite Address Substitution Core uses an AXI4-Lite Slave and Master Interfaces across the input and output ports respectively. [Table 3-1](#) defines the ports in the AXI4-Lite Slave and Master Interfaces. See the [AMBA AXI4-Lite Specification](#) for more details on operation of the AXI4-Lite interfaces.

Table 3-1: AXI4-Lite Interface Port Descriptions			
Port	Direction	Width	Description
axi_aclk	Input	1	Clock
axi_aresetn	Input	1	Reset: Active low.
AXI4-Lite Slave Interface			
s_axi_awaddr	Input	32	Write Address: Address used for write operations. It must be valid when s_axi_awvalid is asserted and must be held until s_axi_awready is asserted by the AXI4-Lite Address Substitution Core.
s_axi_awprot	Input	3	Protection: The AXI4-Lite Address Substitution Core ignores these bits.
s_axi_awvalid	Input	1	Write Address Valid: This input must be asserted to indicate that a valid write address is available on s_axi_awaddr . The AXI4-Lite Address Substitution Core asserts s_axi_awready when it is ready to accept the address. The s_axi_awvalid must remain asserted until the rising clock edge after the assertion of s_axi_awready .
s_axi_awready	Output	1	Write Address Ready: This output is asserted by the AXI4-Lite Address Substitution Core when it is ready to accept the write address. The address is latched when s_axi_awvalid and s_axi_awready are high on the same cycle.

Table 3-1: AXI4-Lite Interface Port Descriptions (Continued)

Port	Direction	Width	Description
s_axi_wdata	Input	32	Write Data: This data will be written to the address specified by s_axi_awaddr when s_axi_wvalid and s_axi_wready are both asserted. The value must be valid when s_axi_wvalid is asserted and held until s_axi_wready is also asserted.
s_axi_wstrb	Input	4	Write Strobes: This signal, when asserted, indicates the number of bytes of valid data on the s_axi_wdata signal. Each of these bits, when asserted, indicate that the corresponding byte of s_axi_wdata contains valid data. Bit 0 corresponds to the least significant byte, and bit 3 to the most significant.
s_axi_wvalid	Input	1	Write Valid: This signal must be asserted to indicate that the write data is valid for a write operation. The value on s_axi_wdata is written into the register at address s_axi_awaddr when s_axi_wready and s_axi_wvalid are high on the same cycle.
s_axi_wready	Output	1	Write Ready: This signal is asserted by the AXI4-Lite Address Substitution Core when it is ready to accept data. The value on s_axi_wdata is written into the register at address s_axi_awaddr when s_axi_wready and s_axi_wvalid are high on the same cycle, assuming that the address has already or simultaneously been submitted.
s_axi_bresp	Output	2	Write Response: The AXI4-Lite Address Substitution Core indicates success or failure of a write transaction through this signal, which is valid when s_axi_bvalid is asserted; 00 = Success of normal access 01 = Success of exclusive access 10 = Slave Error 11 = Decode Error Note: For more details about this signal refer to the AMBA AXI Specification .
s_axi_bready	Input	1	Write Response Ready: This signal must be asserted by the user logic when it is ready to accept the Write Response.
s_axi_bvalid	Output	1	Write Response Valid: This signal is asserted by the AXI4-Lite Address Substitution Core when the write operation is complete and the Write Response is valid. It is held until s_axi_bready is asserted by the user logic.

Table 3-1: AXI4-Lite Interface Port Descriptions (Continued)			
Port	Direction	Width	Description
s_axi_araddr	Input	32	Read Address: Address used for read operations. It must be valid when s_axi_arvalid is asserted and must be held until s_axi_arready is asserted by the AXI4-Lite Address Substitution Core.
s_axi_arprot	Input	3	Protection: These bits are ignored by the AXI4-Lite Address Substitution Core
s_axi_arvalid	Input	1	Read Address Valid: This input must be asserted to indicate that a valid read address is available on the s_axi_araddr . The AXI4-Lite Address Substitution Core asserts s_axi_arready when it ready to accept the Read Address. This input must remain asserted until the rising clock edge after the assertion of s_axi_arready .
s_axi_arready	Output	1	Read Address Ready: This output is asserted by the AXI4-Lite Address Substitution Core when it is ready to accept the read address. The address is latched when s_axi_arvalid and s_axi_arready are high on the same cycle.
s_axi_rdata	Output	32	Read Data: This value is the data read from the address specified by the s_axi_araddr when s_axi_arvalid and s_axi_arready are high on the same cycle.
s_axi_rresp	Output	2	Read Response: The AXI4-Lite Address Substitution Core indicates success or failure of a read transaction through this signal, which is valid when s_axi_rvalid is asserted; 00 = Success of normal access 01 = Success of exclusive access 10 = Slave Error 11 = Decode Error Note: For more details about this signal refer to the AMBA AXI Specification .
s_axi_rvalid	Output	1	Read Data Valid: This signal is asserted by the AXI4-Lite Address Substitution Core when the read is complete and the read data is available on s_axi_rdata . It is held until s_axi_rready is asserted by the user logic.
s_axi_rready	Input	1	Read Data Ready: This signal is asserted by the user logic when it is ready to accept the Read Data.

Table 3-1: AXI4-Lite Interface Port Descriptions (Continued)			
Port	Direction	Width	Description
AXI4-Lite Master Interface			
m_axi_awaddr	Output	32	Write Address: This is the substituted address. This address used for write operations. It must be valid when m_axi_awvalid is asserted and must be held until m_axi_awready is asserted by the user design.
m_axi_awprot		3	Protection: The AXI4-Lite Decompose Core ignores these bits.
m_axi_awvalid		1	Write Address Valid: This input must be asserted to indicate that a valid write address is available on m_axi_awaddr . The user design asserts m_axi_awready when it is ready to accept the address. The m_axi_awvalid must remain asserted until the rising clock edge after the assertion of m_axi_awready .
m_axi_awready	Input	1	Write Address Ready: This input is asserted by the user design when it is ready to accept the write address. The address is latched when m_axi_awvalid and m_axi_awready are high on the same cycle.
m_axi_wdata	Output	32	Write Data: This data will be written to the address specified by m_axi_awaddr when m_axi_wvalid and m_axi_wready are both asserted. The value must be valid when m_axi_wvalid is asserted and held until m_axi_wready is also asserted.
m_axi_wstrb		4	Write Strobes: This signal, when asserted, indicates the number of bytes of valid data on the m_axi_wdata signal. Each of these bits, when asserted, indicate that the corresponding byte of m_axi_wdata contains valid data. Bit 0 corresponds to the least significant byte, and bit 3 to the most significant.
m_axi_wvalid		1	Write Valid: This signal must be asserted to indicate that the write data is valid for a write operation. The value on m_axi_wdata is written into the register at address m_axi_awaddr when m_axi_wready and m_axi_wvalid are high on the same cycle.

Table 3-1: AXI4-Lite Interface Port Descriptions (Continued)			
Port	Direction	Width	Description
m_axi_wready	Input	1	Write Ready: This signal is asserted by the user design when it is ready to accept data.
m_axi_bresp		2	Write Response: The user design indicates success or failure of a write transaction through this signal, which is valid when m_axi_bvalid is asserted; 00 = Success of normal access 01 = Success of exclusive access 10 = Slave Error 11 = Decode Error Note: For more details about this signal refer to the AMBA AXI Specification .
m_axi_bready	Output	1	Write Response Ready: This signal is asserted by the AXI4-lite Decompose Core when it is ready to accept the Write Response.
m_axi_bvalid	Input	1	Write Response Valid: This signal is asserted by the user design when the write operation is complete and the Write Response is valid. It is held until m_axi_bready is asserted by the user logic.
m_axi_araddr	Output	32	Read Address: This is the substituted address. This address used for read operations. It must be valid when m_axi_arvalid is asserted and must be held until m_axi_arready is asserted by the user design.
m_axi_arprot		3	Protection: These bits are ignored by the AXI4-Lite Decompose Core
m_axi_arvalid		1	Read Address Valid: This output must be asserted to indicate that a valid read address is available on the m_axi_araddr . The user design must assert m_axi_arready when it ready to accept the Read Address. This output remains asserted until the rising clock edge after the assertion of m_axi_arready .
m_axi_arready	Input	1	Read Address Ready: This input is asserted by the user design when it is ready to accept the read address. The address is latched when m_axi_arvalid and m_axi_arready are high on the same cycle.
m_axi_rdata		32	Read Data: This value is the data read from the address specified by the m_axi_araddr when m_axi_arvalid and m_axi_arready are high on the same cycle.

Table 3-1: AXI4-Lite Interface Port Descriptions (Continued)

Port	Direction	Width	Description
m_axi_rresp	Input	2	Read Response: The user design indicates success or failure of a read transaction through this signal, which is valid when m_axi_rvalid is asserted; 00 = Success of normal access 01 = Success of exclusive access 10 = Slave Error 11 = Decode Error Note: For more details about this signal refer to the AMBA AXI Specification .
m_axi_rvalid		1	Read Data Valid: This signal is asserted by the user design when the read is complete and the read data is available on m_axi_rdata . It is held until m_axi_rready is asserted by the AXI4-Lite Decompose Core.
m_axi_rready	Output	1	Read Data Ready: This signal is asserted by the AXI4-Lite Decompose Core when it is ready to accept the Read Data.

Chapter 4: Designing with the Core

This chapter includes guidelines and additional information to facilitate designing with the AXI4-Lite Address Substitution Core.

4.1 General Design Guidelines

The AXI4-Lite Address Substitution Core provides the required logic to substitute upper bits of AXI4-Lite address with user-defined value.

4.2 Clocking

Main Clock: **axi_aclk**

This clock is used to clock all ports of the core.

4.3 Resets

Main reset: **s_axi_aresetn**

This is an active low synchronous reset associated with **axi_aclk**.

4.4 Interrupts

This section is not applicable to this IP core.

4.5 Interface Operation

AXI4-Lite Interface: This core includes an AXI4-Lite Slave and Master interfaces which are described in [Section 3.1](#).

4.6 Programming Sequence

This section is not applicable to this IP core.

4.7 Timing Diagrams

This section is not applicable to this IP core.

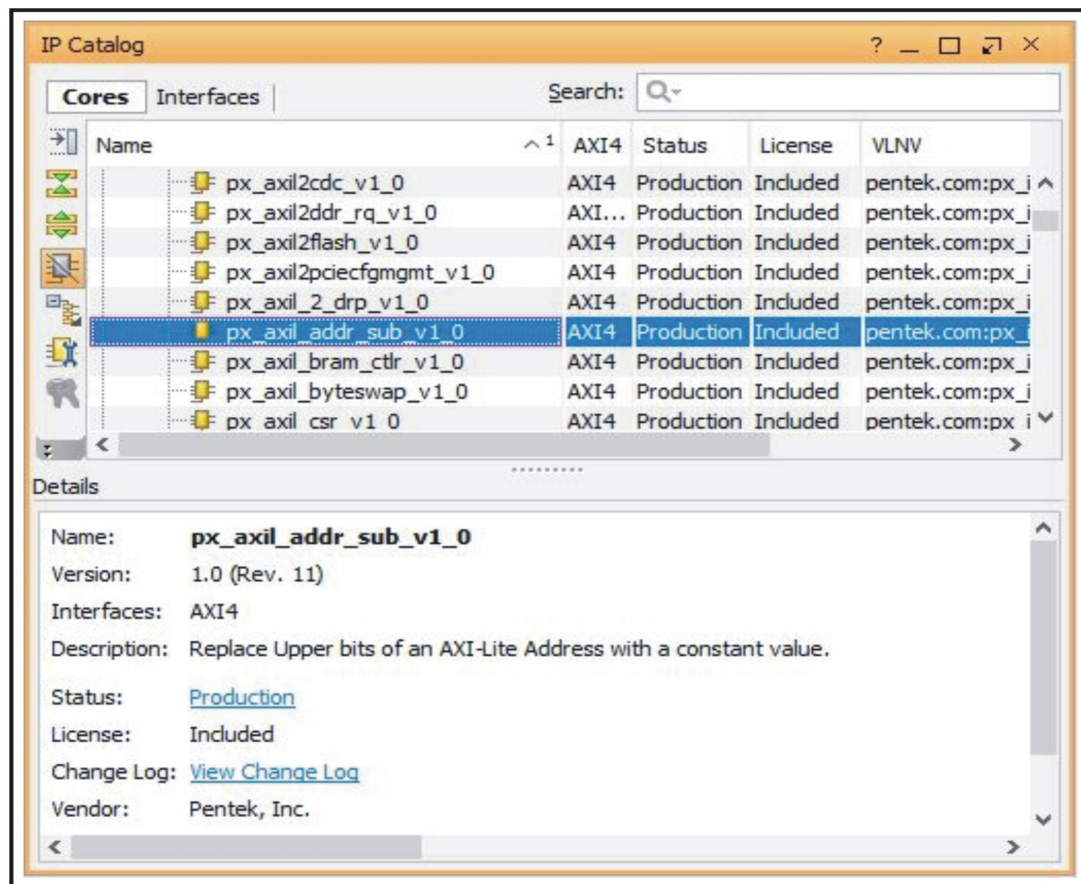
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Chapter 5: Design Flow Steps

5.1 Pentek IP Catalog

This chapter describes customization and generation of the Pentek AXI4-Lite Address Substitution Core. It also includes simulation, synthesis, and implementation steps that are specific to this IP core. This core can be generated from the Vivado IP Catalog when the Pentek IP Repository has been installed. It will appear in the IP Catalog list as **px_axil_addr_sub_v1_0** as shown in [Figure 5-1](#).

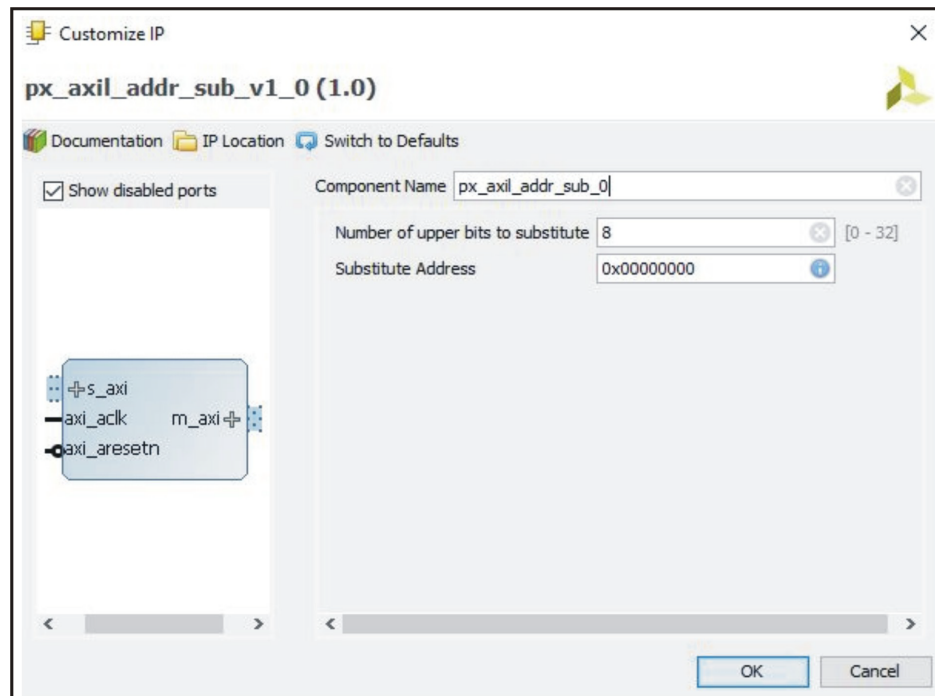
Figure 5-1: AXI4-Lite Address Substitution Core in Pentek IP Catalog



5.1 Pentek IP Catalog (continued)

When you select the **px_axil_addr_sub_v1_0** core, a screen appears that shows the core's symbol and the core's parameters (see [Figure 5-2](#)). The core's symbol is the box on the left side.

Figure 5-2: AXI4-Lite Address Substitution Core IP Symbol



5.2 User Parameters

The user parameters of this core are described in [Section 2.5](#) of this user manual.

5.3 Generating Output

For more details about generating and using IP in the Vivado Design Suite, refer to the [Vivado Design Suite User Guide - Designing with IP](#).

5.4 Constraining the Core

This section contains information about constraining the AXI4-Lite Address Substitution Core in Vivado Design Suite.

Required Constraints

The XDC constraints are not provided with the AXI4-Lite Address Substitution Core. Clock constraints can be applied in the top-level module of the user design.

Device, Package, and Speed Grade Selections

This IP works for the Kintex Ultrascale FPGAs.

Clock Frequencies

The main clock frequency (**axi_aclk**) for this IP core is 250 MHz.

Clock Management

This section is not applicable for this IP core.

Clock Placement

This section is not applicable for this IP core.

Banking and Placement

This section is not applicable for this IP core.

Transceiver Placement

This section is not applicable for this IP core.

I/O Standard and Placement

This section is not applicable for this IP core.

5.5 Simulation

This section is not applicable to this IP core.

5.6 Synthesis and Implementation

For details about synthesis and implementation see the [Vivado Design Suite User Guide - Designing with IP](#).

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