IP CORE MANUAL



AXI4-Stream Merge IP

px_axis_pdti_mrg



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Manual Part Number: 807.48317 Rev: 1.0 - December 09, 2016

Manual Revision History

Date	Version		Comments
12/09/16	1.0	Initial Release	

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Table of Contents

		Page
	IP Facts	
Descri	ption	5
•	es	
Table	1-1: IP Facts Table	5
	Chapter 1: Overview	
Function	onal Description	7
Figure	1-1: AXI4-Stream Merge Core Block Diagram	7
Applic	ations	8
System	n Requirements	8
Licensi	ing and Ordering Information	8
Contac	ting Technical Support	8
Docum	nentation	8
	rds nance	
	ce Utilization	
	2-1: Resource Usage and Availability	
	tions and Unsupported Features	
	c Parameters	
Table 2	2-2: Generic Parameters	10
	Chapter 3: Port Descriptions	
AXI4-S	Stream Core Interfaces	11
3.1.1	I/O Data (PD) Interface	
	Table 3-1: I/O Data Interface Port Descriptions	
3.1.2	Timestamp (PTS) Interface	
	Table 3-2: Timestamp Interface Port Descriptions	
3.1.3	Data Information (PI) Interface	
214	Table 3-3: Data Information Interface Port Descriptions	
3.1.4	Combined Data/ Timestamp/ Information (PDTI) Interface	

Table of Contents

		Page
	Chapter 4: Designing with the Core	
4.1	General Design Guidelines	15
	Figure 4-1: AXI4-Stream Merge Core Block Diagram with I/O Signals	15
4.2	Clocking	16
4.3	Resets	16
4.4	Interrupts	16
4.5	Interface Operation	16
4.6	Programming Sequence	16
4.7	Timing Diagrams	16
	Chapter 5: Design Flow Steps	
	Figure 5-1: AXI4-Stream Merge Core in Pentek IP Catalog	17
	Figure 5-2: AXI4-Stream Merge Core IP Symbol	18
5.2	User Parameters	18
5.3	Generating Output	18
5.4	Constraining the Core	19
5.5	Simulation	19
5.6	Synthesis and Implementation	19

IP Facts

Description

Pentek's NavigatorTM AXI4-Stream Merge Core enables concatenation of raw I/O data, timestamp, and data information AXI4-Streams into a combined Data/ Timestamp/ Information AXI4-Stream output.

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

Features

- Supports AXI4-Stream user interfaces
- Software programmable width of input data streams
- Supports up to 32 bytes wide input data stream
- Delays of up to 31 clock cycles can be introduced into the input data streams
- AXI4-Stream output is the I/O raw data combined with its time-aligned timestamp and data information

Table 1-1: IP Facts Table				
Core Specifics				
Supported Design Family ^a	Kintex [®] Ultrascale			
Supported User Interfaces	AXI4-Stream			
Resources	See Table 2-1			
Provided with the Cor	'e			
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 2016.3 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-Streams of the Pentek Jade series boards follow the following formats:

- Input/Output Raw Data (PD) Streams: These are AXI4-Streams that which contain only I/O data.
- **Timestamp (PTS) Streams:** These are AXI4-Streams which contain only timestamps and a time-aligned copy of the timing events that created them.
- **Data Information (PI) Streams:** These are AXI4-Streams that indicate the data type and packing information of the I/O data streams.
- Combined Data/ Timestamp/ Information Streams: These are AXI4-Streams that combine the data with its time-aligned timestamp, and data information streams.

For more details about these AXI4-Stream formats refer to Section 3.1. The AXI4-Stream Merge Core accepts I/O Raw Data Streams, Timestamp Streams, Data Information Streams and generates a combined Data/ Timestamp/ Information AXI4-Stream output.

The width of the I/O data stream can be defined by the user using the generic parameter data_byte_width (see Section 2.5). The incoming AXI4-Streams can be delayed based on the user requirement by defining their respective generic parameters.

Figure 1-1 is a top-level block diagram of the Pentek AXI4-Stream Merge Core. The modules within the block diagram are explained in the later sections of this manual.

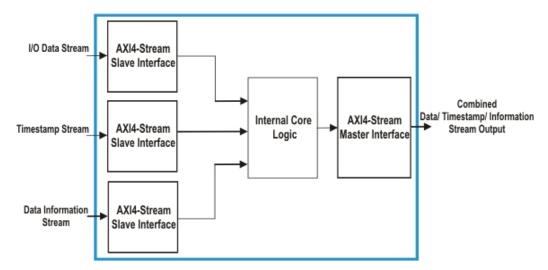


Figure 1-1: AXI4-Stream Merge Core Block Diagram

1.1 Functional Description (continued)

■ AXI4-Stream Interface: The AXI4-Stream Merge Core has four AXI4-Stream Interfaces. At the input, AXI4-Stream Slave Interfaces are used to receive AXI4-Streams and at the output AXI4-Stream Master Interfaces are used to transfer data streams through the output ports. For more details about the AXI4-Stream Interfaces refer to Section 3.1 AXI4-Stream Core Interfaces.

1.2 Applications

The AXI4-Stream Merge core can be incorporated into any Kintex Ultrascale FPGA, where concatenation of Data, Timestamp and Information Streams into a combined output AXI4-Stream is required.

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-Stream Merge Core has a bus interface that complies with the *ARM AMBA AXI4-Stream Protocol Specification*.

2.2 Performance

The performance of the AXI4-Stream Merge Core is limited only by the clock frequency of the AXI4-Streams in the user design.

2.3 Resource Utilization

The resource utilization of the AXI4-Stream Merge 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	17			
Flip-Flops	66			
Memory LUTs	17			

NOTE: Actual utilization may vary based on the user design in which the AXI4-Stream Merge 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-Stream Merge Core are described in Table 2-2. These parameters can be set as required by the user application while customizing the core. The input delay generic parameters are used to align the incoming AXI4-Streams to generate the output AXI4-Stream.

Table 2-2: Generic Parameters				
Port/Signal Name	Туре	Description		
data_byte_width	Integer	Data Byte Width: This parameter indicates the width of the input data stream across the AXI4-Stream Slave Interface in bytes. It can range from 1 to 32 bytes.		
data_stream_delay		I/O Data Stream Delay: This parameter defines the delay to be introduced to the I/O Data Stream input. It can range from 0 to 31.		
time_stream_delay		Timestamp Stream Delay: This parameter defines the delay to be introduced to the Timestamp Stream input. It can range from 0 to 31.		
info_stream_delay		Data Information Stream Delay: This parameter defines the delay to be introduced to the Data Information Stream input. It can range from 0 to 31.		

Chapter 3: Port Descriptions

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

• AXI4-Stream Core Interfaces

3.1 AXI4-Stream Core Interfaces

The AXI4-Stream Merge Core has the following AXI4-Stream Interfaces, used to receive and transfer data streams.

- I/O Data (PD) Interface: This core has an I/O Data AXI4-Stream Slave Interface at the input of the core to receive I/O data streams.
- Timestamp (PTS) Interface: The AXI4-Stream Merge Core has a Timestamp Interface to receive timestamp data streams.
- Data Information (PI) Stream Interface: This core has a Data Information Interface to receive the data type and packing information of the AXI data streams.
- Combined Data/ Timestamp/ Information (PDTI) Interface: This core implements a Combined Data/ Timestamp/ Information AXI4-Stream across the output to transfer the concatenated streams.

3.1.1 I/O Data (PD) Interface

The AXI4-Stream Merge core implements an I/O Data Interface across the input to receive I/O data streams. This is an AXI4-Stream Slave interface.

Table 3-1 defines the ports in the AXI4-Stream Slave I/O Data Interface. See the *AMBA AXI4-Stream Specification* for more details on the operation of the AXI4-Stream Interface.

Table 3-1: I/O Data Interface Port Descriptions				
Port	Port Direction Width Description			
s_axis_aclk	Input	1	AXI4-Stream Clock	
s_axis_aresetn			Reset: Active Low.	

Table 3-1: I/O Data Interface Port Descriptions (Continued)					
Port	Direction	Width	Description		
s_axis_pd_tdata	Input	depends on the generic parameter data_byte_width	Input Data: This is the input data stream to the core.		
s_axis_pd_tvalid	Input	1	Input Data Valid: Asserted when data is valid on s_axis_pd_tdata. This signal is mapped to the output m_axis_pdti_tvalid.		

3.1.2 Timestamp (PTS) Interface

The Timestamp Interface is used to accept timestamp streams which contains only timestamp and a time-aligned copy of the timing events that created the timestamp. This is an AXI4-Stream Slave Interface.

Table 3-2 defines the ports in the Timestamp Interface. See the *AMBA AXI4-Stream Specification* for more details on the operation of the AXI4-Stream Interface.

Table 3-2: Timestamp Interface Port Descriptions				
Port	Direction	Width	Description	
s_axis_aclk	Input	1	AXI4-Stream Clock	
s_axis_aresetn			Reset: Active Low.	
s_axis_pts_tdata	Input	64	Timestamp Data: This is the timestamp of the data on the I/O Data Bus across the I/O Data Interface.	
s_axis_pts_tvalid		1	Data Valid: Asserted when data is valid on s_axis_pts_tdata.	
s_axis_pts_tuser		24	Sideband Data: These bits indicate the gate/sync/ PPS positions of the timing events that created the timestamps. tuser[7:0] - Gate positions tuser[15:8] - Sync positions tuser[23:16] - PPS positions	

3.1.3 Data Information (PI) Interface

The AXI4-Stream Merge Core has a Data Information Interface across the input to receive data streams which allow the identification of the data type and packing of incoming data on the I/O Data bus. This is an AXI4-Stream Slave interface.

Table 3-3 defines the ports in the Data Information Interface. See the *AMBA AXI4-Stream Specification* for more details on the operation of the AXI4-Stream Interface.

Table 3-3: Data Information Interface Port Descriptions				
Port	Direction	Width	Description	
s_axis_aclk	Input	1	AXI4-Stream Clock	
s_axis_aresetn	1		Reset: Active Low.	
s_axis_pi_tdata	Input	16	Data Information Bus: The data from the Data Information bus provides the following information: tdata[3:0] - Samples/ Cycle tdata[4] - I/Q data of the sample=> 0 = I; 1 = Q tdata[6:5] - Data Format => 0 = 8-bit samples; 1 = 16-bit; 2 = 24-bit; 3 = 32-bit tdata[7] - Data Type => 0 = Real; 1 = I/Q tdata[15:8] - channel [7:0] Note: The bits [15:8] define the channel number in the user design from where the data is being received.	
s_axis_pi_tvalid		1	Data Valid: Asserted when data is valid on s_axis_pi_tdata.	

3.1.4 Combined Data/ Timestamp/ Information (PDTI) Interface

The Combined Data/ Timestamp/ Information Interface is used to transfer output AXI4-Streams generated by combining the input AXI4-Streams. This is an AXI4-Stream Master Interface.

Table 3-4 defines the ports in the Combined Data/ Timestamp/ Data Information Interface. See the *AMBA AXI4-Stream Specification* for more details on the operation of the AXI4-Stream Interface.

Port	Direction	Width	Description
m_axis_pdti_tdata	Output	depends on the generic parameter data_byte_width	Output Data: This is the output data of the AXI4- Stream Merge Core obtained from the I/O Data Interface.
m_axis_pdti_tvalid		1	Output Data Valid: Asserted when data is valid on m_axis_pdti_tdata.
m_axis_pdti_tuser		128	Output Sideband Information: This is the sideband information transmitted alongside the data stream. tuser [63:0] - Timestamp[63:0] tuser [71:64] - Gate Positions tuser [79:72] - Sync Positions tuser [87:80] - PPS Positions tuser [91:88] - Samples per clock cycle tuser[92] - I/Q data of the sample => 0 = I; 1 = Q tuser [94:93] - Data Format => 0 = 8-bit; 2 = 24-bit; 3 = 32-bit tuser [95] - Data Type => 0 = Real; 1 = I/Q tuser [103:96] - channel [7:0] tuser [127:104] - Reserved Note: The bits [103:96] define the channel number in the user design from where the data is being received.

Chapter 4: Designing with the Core

This chapter includes guidelines and additional information to facilitate designing with the AXI4-Stream Merge Core.

4.1 General Design Guidelines

The AXI4-Stream Merge Core provides the required logic to generate an AXI4-Stream output by concatenating the incoming AXI4-Streams. This IP core has AXI4-Stream user interfaces. The user can customize the core by setting the generic parameters based on the application requirement as described in Section 2.5.

Figure 4-1 is the block diagram of the AXI4-Stream Merge Core with the input and output signals shown. This diagram illustrates the output signals generated by the AXI4-Stream Merge core, by concatenating the input signals. For more details about the input and output signals, refer to Section 3.1.

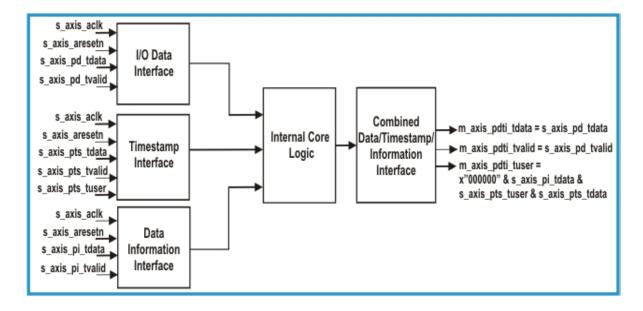


Figure 4-1: AXI4-Stream Merge Core Block Diagram with I/O Signals

4.2 Clocking

AXI4-Stream Clock: s_axis_aclk

This clock is used to clock all the ports in the AXI4-Stream Merge Core.

4.3 Resets

Main reset: s_axis_aresetn

This is an active low reset synchronous with s_axis_aclk.

4.4 Interrupts

This section is not applicable to this IP core.

4.5 Interface Operation

I/O Data (PD) Interface: This is an AXI4-Stream Slave Interface used to receive data streams and is associated with s axis aclk. For more details about this interface, refer to Section 3.1.1.

Timestamp (PTS) Interface: This is an AXI4-Stream Slave Interface used to receive timestamp and timing event data and is associated with **s_axis_aclk**. For more details about this interface, refer to Section 3.1.2.

Data Information (PI) Interface: This is an AXI4-Stream Slave Interface used to receive information about the incoming data across the I/O data interface and is associated with **s axis aclk**. For more details about this interface, refer to Section 3.1.3.

Combined Sample Data/ Timestamp/ Information (PDTI) Interface: AXI4-Stream Merge Core implements this AXI4-Stream Master interface across the output to transfer data streams and is associated with s axis aclk. For more details about this interface, refer to Section 3.1.4.

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.

Chapter 5: Design Flow Steps

5.1 Pentek IP Catalog

This chapter describes customization and generation of the Pentek AXI4-Stream Merge 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_axis_pdti_mrg_v1_0** as shown in Figure 5-1.

IP Catalog ? _ D 2 X Q-Search: Interfaces Cores **→** ^1 AXI4 Name Status License px_axis_pdti48_split_v1_0 AXI4-Stream Production Included Included px_axis_pdti_adv_v1_0 AXI4, AXI4-Stream Production Included px_axis_pdti_iqx4pack_v1_0 AXI4-Stream Production Z px_axis_pdti_mrg_v1_0 AXI4-Stream Production Induded px_axis_pdti_mux_v1_0 AXI4, AXI4-Stream Production Included px_axis_pdti_split_v1_0 AXI4-Stream Production Included X px_axis_pwr_meter_v1_0 Production Included AXI4, AXI4-Stream px_axis_round_v1_0 AXI4-Stream Production Included > Details Name: px_axis_pdti_mrg_v1_0 1.0 (Rev. 13) Version: Interfaces: AXI4-Stream Description: Combines AXI4-Stream Data, Time Data, and Data Info streams into a Pentek AXIS_PDTI Production Status: Included License: Change Log: View Change Log Vendor: Pentek, Inc.

Figure 5-1: AXI4-Stream Merge Core in Pentek IP Catalog

Cancel

5.1 Pentek IP Catalog (continued)

When you select the **px_axis_pdti_mrg_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.

Customize IP px_axis_pdti_mrg_v1_0 (1.0) 🜃 Documentation 🛅 IP Location 🎧 Switch to Defaults Component Name px_axis_pdti_mrg_0 Show disabled ports (3) [1 - 32] Data Byte Width Data Stream Delay 7 [0 - 31] [0 - 31] Info Stream Delay 7 ⊕s_axis_pd Time Stream Delay 0 (3 [0 - 31] ⊕s_axis_pi ♣s_axis_pts m_axis_pdti 🕁 🚟 axis_aclk axis aresetn

Figure 5-2: AXI4-Stream Merge Core IP Symbol

5.2 User Parameters

The user parameters of this IP 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-Stream Merge Core in Vivado Design Suite.

Required Constraints

The XDC constraints are not provided with the AXI4-Stream Merge 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 AXI4-Stream clock (s_axis_aclk) is based on the clock frequency of the input data streams from the user logic.

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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