Version 1.11 - December 2021

Abstract

This application describes the calculation of the PHY delay values for the syn1588® Gbit Switch and syn1588® PCIe NIC. The syn1588® Dual NIC uses the identical PHY delay values (for both network interfaces) as the syn1588® PCIe NIC – SFP version.

The receive PHY delay will be automatically subtracted from the receive timestamp while the transmit PHY delay will be added to the transmit timestamp drawn by the respective syn1588® timestamping units.

syn1588® Gbit Switch

RX PHY Delay

The timestamp is drawn following a 3-stage synchronizer engine running at 125 MHz (i.e. 8 ns) resulting in a delay of 2,5 periods (i.e. 20 ns) on the average. This value has to be subtracted from the timestamp drawn.

Additionally the Marvell PHY adds a delay that need to be subtracted from the timestamp drawn.

GMII	**Description**	**t [ns]**
	timestamper synchronizer stage	-20
	input delay 3 clocks	-24
	PHY delay	-191
	RX PHY delay register value	**-235**
MII	**Description**	**t [ns]**
	timestamper synchronizer stage	-20
	input delay 7 clocks	-280
	PHY delay	-229
	RX PHY delay register value	**-529**

TX PHY Delay

There is one clock delay while sending the data to the PHY. This value has to be added to the timestamp drawn.

The timestamp is drawn following a 3-stage synchronizer engine running at 125 MHz (i.e. 8 ns) resulting in a delay of 2,5 periods (i.e. 20 ns) on the average. This value has to be subtracted from the timestamp drawn.

Additionally the (Marvell) PHY adds a delay that need to be added to the timestamp drawn.

GMII	**Description**	**t [ns]**
	output register 1 gmii clock at port_handling	8
	timestamper synchronizer stage	-20
	PHY delay	122
	total delay	**110**
MII	**Description**	**t [ns]**
	output register 1 mii clock at port_handling	40
	timestamper synchronizer stage	-20
	PHY delay	116
	total delay	**136**

RX PHY Delay (Build 115 and newer)

The timestamp is drawn following a 3-stage synchronizer engine running at 125 MHz (i.e. 8 ns) resulting in a delay of 2,5 periods (i.e. 20 ns) on the average. This value has to be subtracted from the timestamp drawn.

Additionally the (Marvell) PHY adds a delay that need to be subtracted from the timestamp drawn.

GMII	**Description**	**t [ns]**
	timestamper synchronizer stage	-20
	input delay 1 clocks	-8
	PHY delay	-191
	RX PHY delay register value	**-219**
MII	**Description**	**t [ns]**
	timestamper synchronizer stage	-20
	input delay 3 clocks	-120
	PHY delay	-229
	RX PHY delay register value	**-369**

TX PHY Delay (Build 115 and newer)

Starting with firmware build version 115 a modified timestamping structure is used resulting in a different delay behavior.

GMII	**Description**	**t [ns]**
	output delay	136
	timestamper synchronizer stage	-20
	PHY delay	122
	total delay	**238**
MII	**Description**	**t [ns]**
	output delay	1360
	timestamper synchronizer stage	-20
	PHY delay	116
	total delay	**1456**

syn1588® PCIe NIC - Board Revision 1.5

RX PHY Delay

There are two input registers in the receive MAC resulting in a delay of 16 ns for GMII or 80 ns for MII. This value has to be subtracted from the timestamp drawn.

The timestamp is drawn following a 3-stage synchronizer engine running at 87,5 MHz (i.e. 11.43 ns) resulting in a delay of 2,5 periods (i.e. 28,57 ns) on the average. Two stages of the synchronizer are compensated within the syn1588® Clock_M IP core resulting in a delay of 5,72 ns. This value has to be subtracted from the timestamp drawn.

Additionally the Marvell PHY 88E1111 adds a delay that need to be subtracted from the timestamp drawn.

GMII	**Description**	**t [ns]**
	input registers	-16
	timestamper synchronizer stage	-29
	average compensated timestamper synchronizer delay	-6
	PHY device delay	-191
	PHY delay register value	**-213**
MII	**Description**	**t [ns]**
	input register	-80
	timestamper synchronizer stage	-6
	PHY device delay	-229
	PHY delay register value	**-315**

TX PHY Delay

There is one output register for GMII (i.e. 8 ns) in the unit topcore and one clock delay while sending the data to the PHY resulting in a delay of 16 ns for GMII or 80 ns for MII. This value has to be added to the timestamp drawn.

The timestamp is drawn following a 3-stage synchronizer engine running at 87,5 MHz (i.e. 11.43 ns) resulting in a delay of 2,5 periods (i.e. 28,57 ns) on the average. Two stages of the synchronizer are compensated within the syn1588® Clock_M IP core resulting in a delay of 5,72 ns. This value has to be subtracted from the timestamp drawn.

Additionally the Marvell PHY 88E1111 adds a delay that need to be added to the timestamp drawn.

GMII	**Description**	**t [ns]**
	output register & TX delay	16
	timestamper synchronizer stage	-29
	average compensated timestamper synchronizer delay	-6
	PHY device delay	122
	PHY delay register value	**132**
MII	**Description**	**t [ns]**
	output register & TX delay	80
	timestamper synchronizer stage	-29
	average compensated timestamper synchronizer delay	-6
	PHY device delay	116
	PHY delay register value	**190**

syn1588® PCIe NIC - Board Revision 2.x

RX PHY Delay

There are three input registers in the receive MAC resulting in a delay of 24 ns for GMII or 120 ns for MII. This value has to be subtracted from the timestamp drawn.

The timestamp is drawn following a 3-stage synchronizer engine running at 125 MHz (i.e. 8 ns) resulting in a delay of 2,5 periods (i.e. 20 ns) on the average. Two stages of the synchronizer are compensated within the syn1588® Clock_M IP core resulting in a delay of 4 ns. This value has to be subtracted from the timestamp drawn.

Additionally the PHY (Micrel KSZ9031) adds a delay that need to be subtracted from the timestamp drawn. The PHY delay register value is the same at TSE_MAC and syn1588®Clock_M RX time-stampers.

GMII	**Description**	**t [ns]**
	input registers	-24
	timestamper synchronizer stage	-20
	average compensated timestamper synchronizer delay	-4
	PHY device delay	-359
	PHY delay register value	**-387**
MII	**Description**	**t [ns]**
	input register	-120
	timestamper synchronizer stage	-20
	average compensated timestamper synchronizer delay	-4
	PHY device delay	-445
	PHY delay register value	**-569**

TX PHY Delay

There is one output register for GMII (i.e. 8 ns) and one clock delay while sending the data to the PHY resulting in a delay of 16 ns for GMII or 80 ns for MII. This value has to be added to the timestamp drawn. In addition, there is one output register while sending the transmit data from the MAC to the syn1588®Clock_M. This means an additional period of GMII/MII (8 ns/40 ns) clock period has to the added to the PHY delay register of the MAC time-stamper but it is not to be added for that of the syn1588®Clock_M transmit time-stamper.

The timestamp is drawn following a 3-stage synchronizer engine running at 125 MHz (i.e. 8 ns) resulting in a delay of 2,5 periods (i.e. 20 ns) on the average. Two stages of the synchronizer are compensated within the syn1588® Clock_M IP core resulting in a delay of 4 ns. This value has to be subtracted from the timestamp drawn.

Additionally the PHY (Micrel KSZ9031) adds a delay that need to be added to the timestamp drawn.

GMII	**Description**	**t [ns]**
	output register & TX delay	16
	additional output register from TX_MAC to CLOCK_M	8
	timestamper synchronizer stage	-20
	average compensated timestamper synchronizer delay	-4
	PHY device delay	135
	PHY delay register value CLOCK_M	**147**
	PHY delay register value TX_MAC	**155**
MII	**Description**	**t [ns]**
	output register & TX delay	80
	additional output register from TX_MAC to CLOCK_M	40
	timestamper synchronizer stage	-20
	average compensated timestamper synchronizer delay	-4
	PHY device delay	166
	PHY delay register value CLOCK_M	**242**
	PHY delay register value TX_MAC	**282**

syn1588® PCIe NIC – SFP Version (Rev 2.1)

RX PHY Delay: Fiber Transceiver Module

There are three input registers in the receive MAC resulting in a delay of 24 ns for GMII. This value has to be subtracted from the timestamp drawn.

The timestamp is drawn following a 3-stage synchronizer engine running at 125 MHz (i.e. 8 ns) resulting in a delay of 2,5 periods (i.e. 20 ns) on the average. Two stages of the synchronizer are compensated within the syn1588® Clock_M IP core resulting in a delay of 4 ns. This value has to be subtracted from the timestamp drawn.

Additionally, the PCS/PMA unit as well as the clock crossing FIFO (5.5 clocks on the average) after the MAC adds a delay that need to be subtracted from the timestamp drawn. The PHY delay register value is the same at TSE_MAC and syn1588®Clock_M RX time-stampers.

GMII	Description	t [ns]
	input registers	-24
	timestamper synchronizer stage	-20
	average compensated timestamper synchronizer delay	-4
	clock crossing FIFO	-44
	PCS/PMA delay	-48
	PHY delay register value	**-140**

TX PHY Delay: Fiber Transceiver Module

There is one output register for GMII (i.e. 8 ns) and one clock delay while sending the data to the PHY resulting in a delay of 16 ns for GMII. This value has to be added to the timestamp drawn. In addition, there is one output register while sending the transmit data from the MAC to the syn1588®Clock_M. This means an additional period of GMII (8 ns) clock period has to the added to the PHY delay register of the MAC time-stamper but it is not to be added for that of the syn1588®Clock_M transmit time-stamper.

The timestamp is drawn following a 3-stage synchronizer engine running at 125 MHz (i.e. 8 ns) resulting in a delay of 2,5 periods (i.e. 20 ns) on the average. Two stages of the synchronizer are compensated within the syn1588® Clock_M IP core resulting in a delay of 4 ns. This value has to be subtracted from the timestamp drawn.

Additionally, the PCS/PMA unit as well as the clock crossing FIFO (5.5 clocks on the average) in front of the MAC adds a delay that need to be added to the timestamp drawn.

GMII	**Description**	**t [ns]**
	output register & TX delay	16
	additional output register from TX_MAC to CLOCK_M	8
	timestamper synchronizer stage	-20
	average compensated timestamper synchronizer delay	-4
	clock crossing FIFO	44
	PCS/PMA delay	8
	PHY delay register value CLOCK_M	**44**
	PHY delay register value TX_MAC	**52**

RX PHY Delay: Copper Transceiver Module

There are three input registers in the receive MAC resulting in a delay of 24 ns for GMII or 120 ns for MII. This value has to be subtracted from the timestamp drawn.

The timestamp is drawn following a 3-stage synchronizer engine running at 125 MHz (i.e. 8 ns) resulting in a delay of 2,5 periods (i.e. 20 ns) on the average. Two stages of the synchronizer are compensated within the syn1588® Clock_M IP core resulting in a delay of 4 ns. This value has to be subtracted from the timestamp drawn.

Additionally the PCS/PMA unit as well as the clock crossing FIFO (5.5 clocks on the average) after the MAC and the PHY in the SFP transceiver module adds a delay that need to be subtracted from the timestamp drawn. The PHY delay register value is the same at TSE_MAC and syn1588®Clock_M RX time-stampers.

GMII	**Description**	**t [ns]**
	input registers	-24
	timestamper synchronizer stage	-20
	average compensated timestamper synchronizer delay	-4
	clock crossing FIFO	-44
	PCS/PMA delay	-143
	PHY device delay	-272
	PHY delay register value	**-507**
MII	**Description**	**t [ns]**
	input register	-120
	timestamper synchronizer stage	-20
	average compensated timestamper synchronizer delay	-4
	clock crossing FIFO	-220
	PCS/PMA delay	-215
	PHY device delay	-272
	PHY delay register value	**-851**

TX PHY Delay: Copper Transceiver Module

There is one output register for GMII (i.e. 8 ns) and one clock delay while sending the data to the PHY resulting in a delay of 16 ns for GMII or 80 ns for MII. This value has to be added to the timestamp drawn. In addition, there is one output register while sending the transmit data from the MAC to the syn1588®Clock_M. This means an additional period of GMII/MII (8 ns/40 ns) clock period has to the added to the PHY delay register of the MAC time-stamper but it is not to be added for that of the syn1588®Clock_M transmit time-stamper.

The timestamp is drawn following a 3-stage synchronizer engine running at 125 MHz (i.e. 8 ns) resulting in a delay of 2,5 periods (i.e. 20 ns) on the average. Two stages of the synchronizer are compensated within the syn1588® Clock_M IP core resulting in a delay of 4 ns. This value has to be subtracted from the timestamp drawn.

Additionally the PCS/PMA as well as the clock crossing FIFO (5.5 clocks on the average) in front of the MAC and the PHY in the SFP transceiver module unit adds a delay that need to be added to the timestamp drawn.

GMII	Description	t [ns]
	output register & TX delay	16
	additional output register from TX_MAC to CLOCK_M	8
	timestamper synchronizer stage	-20
	average compensated timestamper synchronizer delay	-4
	clock crossing FIFO	44
	PCS/PMA delay	104
	PHY device delay	280
	PHY delay register value CLOCK_M	**420**
	PHY delay register value TX MAC	**428**
MII	**Description**	**t [ns]**
	output register & TX delay	80
	additional output register from TX_MAC to CLOCK_M	40
	timestamper synchronizer stage	-20
	average compensated timestamper synchronizer delay	-4
	clock crossing FIFO	220
	PCS/PMA delay	376
	PHY device delay	280
	PHY delay register value CLOCK_M	**932**
	PHY delay register value TX MAC	**972**

Summary

This application note described the calculation of the PHY delay correction values.

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