

PLATO ICU RDCU

FPGA SPW Conformance Test

Doc No. PLATO-IWF-PL-TR-0100

Issue No. 1.0

Issue Date Jul 22, 2021

Prepared by J. Tonfat

Document Signature	S
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1 Introduction

1.1 Scope

This document describes all conformance tests performed on the SpaceWire IP core used in the PLATO RDCU FPGA.

1.2 Applicable and Reference Documents

1.2.1 Applicable Documents

	Document Reference	Title	Issue	Date
AD1		Space Wire Test Adapter	1.2	03/2017
AD2				
AD3				
AD4				
AD5				

1.2.2 Applicable ECSS Standards

	Document Reference	Title	Issue	Date
EC1	ECSS-E-ST-50-12C	SpaceWire – Links, nodes, routers and networks	С	07/2008
EC2				
EC3				
EC4				

1.2.3 Reference Documents

	Document Reference	Title	Issue	Date
RD1		SpaceWire Conformance Tester Mk2 User Manual	2.0	10/2018
RD2		ProASIC3/E Starter Kit User's Guide	Rev 5	10/2012
RD3				
RD4				
RD5				

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1.3 Terms, Definitions and Abbreviated Terms

1.3.1 Acronyms & Abbreviations

FPGA	Field Programmable Gate Array
ICU	Instrument Control Unit
RDCU	Router and Data Compression Unit
SpW	Space Wire
TBC	To be confirmed
TBD	To be done
TLI	Test Link Interface (the Conformance Tester link which probes the UUT)
UUT	Unit Under Test

1.3.2 Definitions

1 Nibble	4 Bits
1 Byte	8 Bits
1 Word	16 Bits
1 Double Word	32 Bits

1.3.3 Conventions

Decimal separator	A point will be used as decimal separator in the document as usual in the United States.
Thousands separator	A comma is used as thousands separator.
Hexadecimal values	Hexadecimal values start always with 0x (e.g.: 0x12AC) or with the appendix hex.
Decimal values	Decimal values do not have any prefix (e.g.: 1234).



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2 **Test Environment**

2.1 **Test Item**

Test Item:	ProASIC3/E Starter Kit Board + SPW IP Verification Board
C.I. No.:	
Serial No.:	

Test Conditions 2.2

Parameter	Nominal Value	Tolerances	Condition
Temperature	26°C	± 2°C	
Relative Humidity	55%	± 10%	
Cleanliness	100.000		

2.3 **Test Personnel**

Function / Responsibility	Qualification / Skillness	Name
Test Conductor		Tonfat



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2.4 Instrumentation and Test Equipment

2.4.1 Measurement Equipment, Jigs and Tools

No.	Quantity	ity Description	Manufacturer	Model No.	Serial No.	Calibration Date	
140.	Quantity	Description	Manadatarer	model No.	ociiai No.	Next	Last
1	1	Oscilloscope	Tektronix	MSO4104B	C010867		
2	1	Digital Multi Meter	Fluke	189	82620082		
3	1	ProASIC3/E Starter Kit Board	Microsemi	A3PE-STARTER- KIT-2			
4	1	SPW IP Verification Board	IWF				
5	1	SpW USB Brick	STAR-Dundee	Mk2	32111297		
6	1	DESWBO SpaceWire Connection Status Monitor	DYNAMIC ENGINEERING	10-2006-1004			
7	1	RDCU EGSE PC	IWF				
8	1	SpW Conformance Tester	STAR-Dundee	Mk2	1721-0375		

2.4.2 Cables

No.	Quantity	Specification / Reference	C.INo. / Serial No.	Remark
1	2	Ground Cable		
2	2	Space Wire Cable MDM 9		
3				

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2.5 Safety, Handling and General Test Requirements

Full ESD protection shall be applied. The test bench shall be covered by ESD protective surface. Test personnel handling the board or probes to measure at the board have to wear ESD protection wrist wraps.

No other specific safety procedures are to be applied.

2.6 Test Set-Up

2.6.1 Electrical Set-Up

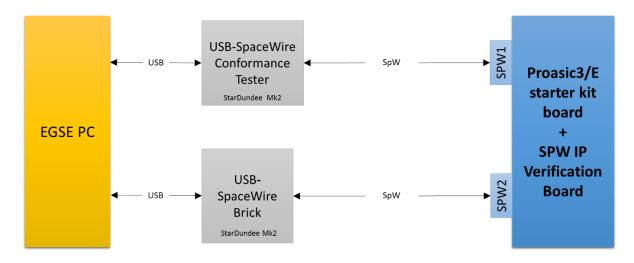


Figure 1: SpaceWire Conformance Test

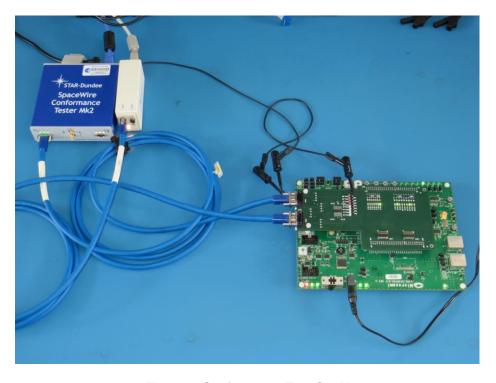


Figure 2: Conformance Test Set-Up



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Important Adjustments and Configuration to be checked 2.6.2

Adjustment / Configuration	Yes / No
Before powering the devices, review that the grounds of the equipment at both ends of each SpaceWire link are connected. It prevents a significant common mode voltage between the two units resulting in the maximum input voltage at one end or the other being exceeded. This could result in damage to either unit.	

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2.7 Test Philosophy

The SpW IP core implemented on the PLATO ICU RDCU FPGA cannot be tested directly with the SpW Conformance tester because the SpW interface is behind a SpW Router.

Therefore, the SpW IP core is implemented on a test board. The test board is composed of a commercial development board and a custom board. The commercial board contains the FPGA where the SpW IP core is implemented and the custom board contains LVDS drivers and receivers, test leds and test access pins to FPGA signals.

The test board implements two SpW IP cores that can be configured in self-loopback or connected to the other SpW IP core.

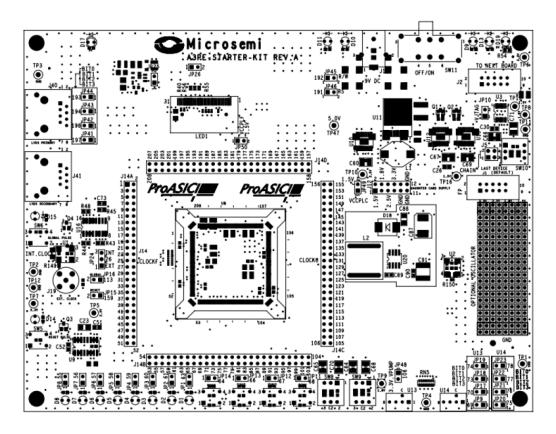


Figure 3: Commercial Development Board [RD2]

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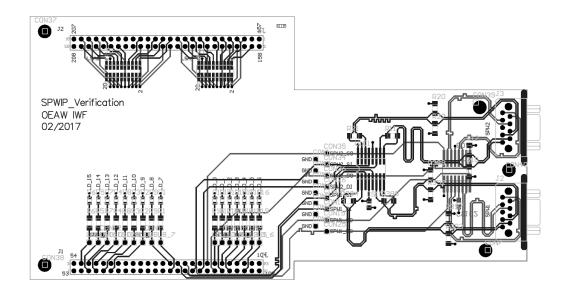


Figure 4: SpaceWire IP Verification Board

The SpW conformance test is performed by the SpW conformance tester device and the software that controls this device.

The proposed tests list is based on the list provided by the SpW conformance tester.

2.7.1 SpW IP Configurations

The following table shows the tested SpW IP configurations that reflect the possible configurations in the PLATO ICU RDCU FPGA.

Configuration	Mode	Link rate
1	link autostart	10 Mbps
2	link autostart	100 Mbps
3	link autostart	2 Mbps

Table 1: SpW IP tested configurations

2.7.2 Tests List

The tests list is organized in groups. This organization also is done by the SpW conformance tester. The list shows all the available tests and the tests that are not applicable are marked and explained. The unit under test (UUT) is the SpW IP core.

2.7.2.1 Group: Bit-level

• Test: Determine Link State

[EC1] reference: 6.3.2

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Test: Link Initialisation Test

Test: Start Up Link Speed
 [EC1] reference: 6.6.5

Test: Start Up Waveform
 [EC1] reference: 7.5; 8.5.3.2

• Test: Link Shutdown Analysis

[EC1] reference: 8.11.1

• Test: Disconnect Timeout

[EC1] reference: 8.9.2.1; 8.11.2

• Test: Simultaneous D/S Transition Check

[EC1] reference: 6.3.2

2.7.2.2 Group: Exchange

[EC1] reference: 8.5

Test: Validate ErrorWait
 [EC1] reference: 8.5.2.3

Test: Validate Ready

[EC1] reference: 8.5.2.4

As mentioned in the conformance tester user manual [RD1], if the UUT has moved from Ready to Connecting by the time the FCT is processed then the FCT test may fail because the UUT won't treat the FCT as an error.

Test: Validate Started
 [EC1] reference: 8.5.2.5

Test not applicable. The UUT is in autostart mode.

Test: Validate Connecting
 [EC1] reference: 8.5.2.6

Test: Validate Run
 [EC1] reference: 8.5.2.7



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2.7.2.3 Group: EOP/EEP

Test: Empty Packet (EOP)
 [EC1] reference: 8.9.3.2

Test: Empty Packet (EEP)
 [EC1] reference: 8.9.3.2

• Test: Empty Packet Loopback (EOP)

[EC1] reference: 8.9.3.2

The UUT must be in self-loopback mode.

• Test: Empty Packet Loop-back (EEP)

[EC1] reference: 8.9.3.2

The UUT must be in self-loopback mode.

Test: Send Packet With EEP

[EC1] reference: 10.5.3

2.7.2.4 Group: Time-code

[EC1] reference: 8.12

• Test: Investigate UUT time-code support

[EC1] reference: 8.12.2.{a, i, j, k, m, o}

Test not applicable. The UUT does not support time-codes.

• Test: Time-code/NCHAR confusion

[EC1] reference: 8.12.2

Test not applicable. The UUT does not support time-codes.

Test: UUT receives valid time-codes

[EC1] reference: 8.12.2.j; 8.12.2.k

Test not applicable. The UUT does not support time-codes.

Test: UUT ignores invalid time-codes

[EC1] reference: 8.12.2.i; 8.12.2.o

Test not applicable. The UUT does not support time-codes.

Test: Measure time-code frequency



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[EC1] reference: 8.12.2.{d, e, f, m}

Test not applicable. The UUT does not support time-codes.

2.7.2.5 Group: Credit

[EC1] reference: 8.3

Test: FCT Overflow Check
 [EC1] reference: 8.3.{i, j}

Test: NCHAR (EOP) Overflow Check
 [EC1] reference: 8.3.{d, e, f, g}; 8.5.3.8

This test requires that the TLI link rate is faster than the UUT link rate.

Test: NCHAR (EEP) Overflow Check

[EC1] reference: 8.3.{d, e, f, g}; 8.5.3.8

This test requires that the TLI link rate is faster than the UUT link rate.

Test: Empty Packet Credit Check

[EC1] reference: 8.2.1; 8.3.{d, e, f, g}; 8.5.3.8

The UUT must consume all packets sent to it otherwise this test will fail incorrectly.

• Test: UUT Credit Error Check

[EC1] reference: 8.3.{d, e, f, g, i, j}

2.7.2.6 <u>Group: Packet (1)</u>

[EC1] reference: 9; 10

Test: UUT is data loop-back

[EC1] reference: 9; 10

The UUT should be configured as loop-back and send back the received packets.

Test: UUT is data sink

[EC1] reference: 9; 10

The user must check that the UUT received and processed the transmitted packet correctly. The UUT should not send back the received packets.

Test: UUT is data source

[EC1] reference: 9; 10

The UUT should be configured as a packet source which continuously transmits data packets.



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The test setup should use the UUT SpW link 2 connected to USB-SpW brick and from the EGSE software sends packets. The SpW link 2 should forward the packets to SpW link 1.

2.7.2.7 Group: Packet (2)

[EC1] reference: 9; 10

Test: UUT is command receiver

[EC1] reference: 9; 10

The test is not applicable. The UUT only implements the SpW IP core and it cannot process a command and generate a reply.

• Test: UUT is command sender

[EC1] reference: 9; 10

The test is not applicable. The UUT only implements the SpW IP core and it cannot generate a command and process a reply.

2.7.2.8 Group: Other

Test: Started 12.8 microsecond timeout

[EC1] reference: 8.5.2.5.h

Test not applicable. The UUT is in autostart mode.

• Test: Connecting 12.8 microsecond timeout

[EC1] reference: 8.5.2.6.f

• Test: Maximum Bit Period

[EC1] reference: 6.6.1

Test: NULL Arrival Times

[EC1] reference: 8.5

• Test: Error Recovery Time

[EC1] reference: 8.5

• Test: Continuous NULLs



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2.8 Test Summary

The test results performed for all three configurations shows that the SpW IP core used for the PLATO RDCU FPGA implementation is in line with the SpW standard definition.

Some tests results of the SpW conformance test program indicate a failure. Detailed analysis of the results shows that the behavior is explainable and all failures are caused only by the specific test conditions.

For details about the test results see the chapters below.

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3 Tests Results

The test results are extracted from the report generated by the software tool of the SpW Conformance Tester.

3.1 Group: Bit-level

3.1.1 Test: Determine Link State

Configuration	Result
1	Status: Success
	Result: UUT link is auto-start enabled
2	Status: Success
	Result: UUT link is auto-start enabled
3	Status: Success
	Result: UUT link is auto-start enabled

Table 2: Results for test: Determine Link State

3.1.2 Test: Link Initialisation Test

Configuration	Result	
1	Status: Success	
	Result: Link initialisation was correct	
2	Status: Success	
	Result: Link initialisation was correct	
3	Status: Success	
	Result: Link initialisation was correct	

Table 3: Results for test: Link Initialisation Test

3.1.3 Test: Start Up Link Speed

Configuration	Result
1	Status: Success
	Result: Startup rate within (10 Mbits/second +/- 1 Mbit/second)
	Measurement Accuracy Minimum Maximum
	Bit-to-bit: 10.00 +/- 0.00 0.13 10.00 +/- 0.13 10.00 +/- 0.13
	Rise-to-rise: 10.00 +/- 0.00 0.06 10.00 +/- 0.06 10.00 +/- 0.06
	Fall-to-fall: 10.00 +/- 0.00 0.06 10.00 +/- 0.06 10.00 +/- 0.06
2	Status: Success
	Result: Startup rate within (10 Mbits/second +/- 1 Mbit/second)



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		Measurement	Accuracy	Minimum	Maximum
	Bit-to-bit:	10.00 +/- 0.00	0.13	10.00 +/- 0.13	10.00 +/- 0.13
	Rise-to-rise:	10.00 +/- 0.00	0.06	10.00 +/- 0.06	10.00 +/- 0.06
	Fall-to-fall:	10.00 +/- 0.00	0.06	10.00 +/- 0.06	10.00 +/- 0.06
3	Status: Success				
	Result: Startup r	ate within (10 M	bits/seco	nd +/- 1 Mbit/se	econd)
		Measurement	Accuracy	Minimum	Maximum
	Bit-to-bit:	10.00 +/- 0.00	0.13	10.00 +/- 0.13	10.00 +/- 0.13
	Rise-to-rise:	10.00 +/- 0.00	0.06	10.00 +/- 0.06	10.00 +/- 0.06
	Fall-to-fall:	10.00 +/- 0.00	0.06	10.00 +/- 0.06	10.00 +/- 0.06

Table 4: Results for test: Start Up Link Speed

3.1.4 Test: Start Up Waveform

Configuration	Result	
1	Status: Success	
	Result: Valid start-up waveform 011101000	
	D: 0111010001000100010001	
	s: 1101111011101110111011	
2	Status: Success	
	Result: Valid start-up waveform 011101000	
	D: 0111010001000100010001	
	s: 1101111011101110111011	
3	Status: Success	
	Result: Valid start-up waveform 011101000	
	D: 0111010001000100010001	
	s: 1101111011101110111011	

Table 5: Results for test: Start Up Waveform

3.1.5 Test: Link Shutdown Analysis

Configuration	Result
1	Status: Success
	Result: Valid shutdown time (100.00 +/- 1.25 ns < 555 ns)
2	Status: Success
	Result: Valid shutdown time (10.00 +/- 1.25 ns < 555 ns)



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3	Status: Success			
	Result: Valid shutdown time (500.00 +/- 1.25 ns < 555 ns)			

Table 6: Results for test: Link Shutdown Analysis

3.1.6 **Test: Disconnect Timeout**

Configuration	Result
1	Status: Success
	Result: Timeout within valid range of 727 to 1000 ns inclusive
2	Status: Success
	Result: Timeout within valid range of 727 to 1000 ns inclusive
3	Status: Success
	Result: Timeout within valid range of 727 to 1000 ns inclusive

Table 7: Results for test: Disconnect Timeout

The diagrams generate by for test are shown in appendix 4.4.

Test: Simultaneous D/S Transition Check 3.1.7

Configuration	Result
1	Status: Success
	Result: No simultaneous D/S transitions detected.
2	Status: Success
	Result: No simultaneous D/S transitions detected.
3	Status: Failed
	Result: UUT didn't send enough bits

Table 8: Results for test: Simultaneous D/S Transition Check

The configuration 3 fails because during the sampling window, there are not enough bit transitions.

3.2 **Group: Exchange**

3.2.1 Test: Validate ErrorWait

Configuration	Result
1	Status: Success
	Result: All tests passed
	Response to parity error: correct: moved to ErrorReset

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	Response to	ESC-EOP:	correct:	moved t	o ErrorReset
	Response to	ESC-EEP:	correct:	moved t	to ErrorReset
	Response to	ESC-ESC:	correct:	moved t	to ErrorReset
	Response to	FCT:	correct:	moved t	o ErrorReset
	Response to	NCHAR:	correct:	moved t	to ErrorReset
	Response to	TCODE:	correct:	moved t	to ErrorReset
2	Status: Succes	SS			
	Result: All te	ests passed			
	Response to	parity error:	correct:	moved t	to ErrorReset
	Response to	ESC-EOP:	correct:	moved t	o ErrorReset
	Response to	ESC-EEP:	correct:	moved t	o ErrorReset
	Response to	ESC-ESC:	correct:	moved t	o ErrorReset
	Response to	FCT:	correct:	moved t	o ErrorReset
	Response to	NCHAR:	correct:	moved t	o ErrorReset
	Response to	TCODE:	correct:	moved t	co ErrorReset
3	Status: Succes	SS			
	Result: All te	ests passed			
	Response to	parity error:	correct:	moved t	to ErrorReset
	Response to	ESC-EOP:	correct:	moved t	to ErrorReset
	Response to	ESC-EEP:	correct:	moved t	o ErrorReset
	Response to	ESC-ESC:	correct:	moved t	o ErrorReset
	Response to	FCT:	correct:	moved t	to ErrorReset
	Response to	NCHAR:	correct:	moved t	to ErrorReset
	Response to	TCODE:	correct:	moved t	o ErrorReset

Table 9: Results for test: Validate ErrorWait

3.2.2 Test: Validate Ready

Configuration	Result
1	Status: Failed
	Result: One or more tests failed
	Response to parity error: correct: moved to ErrorReset
	Response to ESC-EOP: correct: moved to ErrorReset
	Response to ESC-EEP: correct: moved to ErrorReset
	Response to ESC-ESC: correct: moved to ErrorReset
	Response to FCT: failed: did not move to ErrorReset

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	Response	to	NCHAR:	correct:	moved	to	ErrorReset
	Response	to	TCODE:	correct:	moved	to	ErrorReset
2	Status: Fail	ed					
	Result: One	or	more tests fa:	iled			
	Response	to	parity error:	correct:	moved	to	ErrorReset
	Response	to	ESC-EOP:	correct:	moved	to	ErrorReset
	Response	to	ESC-EEP:	correct:	moved	to	ErrorReset
	Response	to	ESC-ESC:	correct:	moved	to	ErrorReset
	Response	to	FCT:	failed: 0	did not	mo	ve to ErrorReset
	Response	to	NCHAR:	correct:	moved	to	ErrorReset
	Response	to	TCODE:	correct:	moved	to	ErrorReset
3	Status: Fail	.ed					
	Result: One	or	more tests fa	iled			
	Response	to	parity error:	correct:	moved	to	ErrorReset
	Response	to	ESC-EOP:	correct:	moved	to	ErrorReset
	Response	to	ESC-EEP:	correct:	moved	to	ErrorReset
	Response	to	ESC-ESC:	correct:	moved	to	ErrorReset
	Response	to	FCT:	failed: o	did not	mo	ve to ErrorReset
	Response	to	NCHAR:	correct:	moved	to	ErrorReset
	Response	to	TCODE:	correct:	moved	to	ErrorReset

Table 10: Results for test: Validate Ready

This test failed for the three configurations. The failed case is the response to FCT. As mentioned in the conformance tester user manual [RD1], if the UUT has moved from Ready to Connecting by the time the FCT is processed then the FCT test may fail because the UUT won't treat the FCT as an error.

3.2.3 Test: Validate Connecting

	5
Configuration	Result
1	Status: Success
	Result: All tests passed
	Response to parity error: correct: moved to ErrorReset
	Response to ESC-EOP: correct: moved to ErrorReset
	Response to ESC-EEP: correct: moved to ErrorReset
	Response to ESC-ESC: correct: moved to ErrorReset
	Response to FCT: correct: did not move to ErrorReset
	Response to NCHAR: correct: moved to ErrorReset
	Response to TCODE: correct: moved to ErrorReset

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Status: Success
Result: All tests passed
Response to parity error: correct: moved to ErrorReset
Response to ESC-EOP: correct: moved to ErrorReset
Response to ESC-EEP: correct: moved to ErrorReset
Response to ESC-ESC: correct: moved to ErrorReset
Response to FCT: correct: did not move to ErrorReset
Response to NCHAR: correct: moved to ErrorReset
Response to TCODE: correct: moved to ErrorReset
Status: Success
Result: All tests passed
Response to parity error: correct: moved to ErrorReset
Response to ESC-EOP: correct: moved to ErrorReset
Response to ESC-EEP: correct: moved to ErrorReset
Response to ESC-ESC: correct: moved to ErrorReset
Response to FCT: correct: did not move to ErrorReset
Response to NCHAR: correct: moved to ErrorReset
Response to TCODE: correct: moved to ErrorReset

Table 11: Results for test: Validate Connecting

3.2.4 Test: Validate Run

Configuration	Result
1	Status: Success
	Result: All tests passed
	Response to parity error: correct: moved to ErrorReset
	Response to ESC-EOP: correct: moved to ErrorReset
	Response to ESC-EEP: correct: moved to ErrorReset
	Response to ESC-ESC: correct: moved to ErrorReset
	Response to one FCT: correct: did not move to ErrorReset
	Response to NCHAR: correct: did not move to ErrorReset
	Response to TCODE: correct: did not move to ErrorReset
2	Status: Success
	Result: All tests passed
	Response to parity error: correct: moved to ErrorReset
	Response to ESC-EOP: correct: moved to ErrorReset



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	Response to ESC-EEP: correct: moved to ErrorReset
	Response to ESC-ESC: correct: moved to ErrorReset
	Response to one FCT: correct: did not move to ErrorReset
	Response to NCHAR: correct: did not move to ErrorReset
	Response to TCODE: correct: did not move to ErrorReset
3	Status: Success
	Result: All tests passed
	Response to parity error: correct: moved to ErrorReset
	Response to ESC-EOP: correct: moved to ErrorReset
	Response to ESC-EEP: correct: moved to ErrorReset
	Response to ESC-ESC: correct: moved to ErrorReset
	Response to one FCT: correct: did not move to ErrorReset
	Response to NCHAR: correct: did not move to ErrorReset
	Response to TCODE: correct: did not move to ErrorReset

Table 12: Results for test: Validate Run

3.3 Group: EOP/EEP

3.3.1 Test: Empty Packet (EOP)

Configuration	Result
1	Status: Success
	Result: Did not disconnect (correct)
	Empty EOP packets sent: 8
2	Status: Success
	Result: Did not disconnect (correct)
	Empty EOP packets sent: 8
3	Status: Success
	Result: Did not disconnect (correct)
	Empty EOP packets sent: 8

Table 13: Results for test: Empty Packet (EOP)

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3.3.2 Test: Empty Packet (EEP)

Configuration	Result
1	Status: Success
	Result: Did not disconnect (correct)
	Empty EEP packets sent: 8
2	Status: Success
	Result: Did not disconnect (correct)
	Empty EEP packets sent: 8
3	Status: Success
	Result: Did not disconnect (correct)
	Empty EEP packets sent: 8

Table 14: Results for test: Empty Packet (EEP)

3.3.3 Test: Empty Packet Loopback (EOP)

Configuration	Result
1	Status: Success
	Result: Did not disconnect (correct)
	Empty EOP packets sent: 8
	Empty EOP packets received: 0
	Empty EEP packets received: 0
2	Status: Success
	Result: Did not disconnect (correct)
	Empty EOP packets sent: 8
	Empty EOP packets received: 0
	Empty EEP packets received: 0
3	Status: Success
	Result: Did not disconnect (correct)
	Empty EOP packets sent: 8
	Empty EOP packets received: 0
	Empty EEP packets received: 0

Table 15: Results for test: Empty Packet Loopback (EOP)

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3.3.4 Test: Empty Packet Loop-back (EEP)

Configuration	Result
1	Status: Success
	Result: Did not disconnect (correct)
	Empty EEP packets sent: 8
	Empty EEP packets received: 0
	Empty EOP packets received: 0
2	Status: Success
	Result: Did not disconnect (correct)
	Empty EEP packets sent: 8
	Empty EEP packets received: 0
	Empty EOP packets received: 0
3	Status: Success
	Result: Did not disconnect (correct)
	Empty EEP packets sent: 8
	Empty EEP packets received: 0
	Empty EOP packets received: 0

Table 16: Results for test: Empty Packet Loop-back (EEP)

3.3.5 Test: Send Packet With EEP

Configuration	Result
1	Status: Success
	Result: Successfully transmitted the packet
2	Status: Success
	Result: Successfully transmitted the packet
3	Status: Success
	Result: Successfully transmitted the packet

Table 17: Results for test: Send Packet With EEP

3.4 Group: Time-code

The tests in this group are not applicable because the UUT does not support time-codes.

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3.5 Group: Credit

3.5.1 Test: FCT Overflow Check

Configuration	Result
1	Status: Success
	Result: All tests passed
2	Status: Success
	Result: All tests passed
3	Status: Success
	Result: All tests passed

Table 18: Results for test: FCT Overflow Check

3.5.2 Test: NCHAR (EOP) Overflow Check

Configuration	Result
1	Status: Failed
	Result: UUT didn't disconnect
2	Status: Failed
	Result: UUT didn't disconnect
3	Status: Success
	Result: UUT disconnected

Table 19: Results for test: NCHAR (EOP) Overflow Check

The test for configurations 1 and 2 failed because the UUT is able to send FCTs fast enough to prevent the credit error.

3.5.3 Test: NCHAR (EEP) Overflow Check

Configuration	Result
1	Status: Failed
	Result: UUT didn't disconnect
2	Status: Failed
	Result: UUT didn't disconnect
3	Status: Success
	Result: UUT disconnected

Table 20: Results for test: NCHAR (EEP) Overflow Check

The test for configurations 1 and 2 failed because the UUT is able to send FCTs fast enough to prevent the credit error.



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3.5.4 Test: Empty Packet Credit Check

Configuration	Result
1	Status: Success
	Result: UUT correctly credit counts empty packets
2	Status: Success
	Result: UUT correctly credit counts empty packets
3	Status: Success
	Result: UUT correctly credit counts empty packets

Table 21: Results for test: Empty Packet Credit Check

3.5.5 Test: UUT Credit Error Check

Configuration	Result
1	Status: Success
	Result: No credit errors detected
2	Status: Success
	Result: No credit errors detected
3	Status: Success
	Result: No credit errors detected

Table 22: Results for test: UUT Credit Error Check

3.6 Group: Packet (1)

3.6.1 Test: UUT is data loop-back

Configuration	Result
1	Status: Success
	Result: Received loop-back packet was correct
2	Status: Success
	Result: Received loop-back packet was correct
3	Status: Success
	Result: Received loop-back packet was correct

Table 23: Results for test: UUT is data loop-back

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3.6.2 Test: UUT is data sink

Configuration	Result
1	Status: Success
	Result: Packet sent: please check arrival at UUT
2	Status: Success
	Result: Packet sent: please check arrival at UUT
3	Status: Success
	Result: Packet sent: please check arrival at UUT

Table 24: Results for test: UUT is data sink

The received packet is forwarded to UUT SpW link 2 and then to the EGSE software where the received packet is visually inspected.

3.6.3 Test: UUT is data source

Configuration	Result
1	Status: Success
	Result: Received 10 packets
2	Status: Success
	Result: Received 10 packets
3	Status: Success
	Result: Received 10 packets

Table 25: Results for test: UUT is data source

The EGSE software generates the packets that are sent to the UUT SpW link 2. Then, the packets are forwarded to the UUT SpW link 1. Finally, the packet is sent to the SpW conformance tester.

3.7 Group: Packet (2)

The tests in this group are not applicable because the UUT only implements the SpW IP core and it cannot process/generate a command or reply.

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3.8 Group: Other

3.8.1 Test: Connecting 12.8 microsecond timeout

Configuration	Result
1	Status: Success
	Result: Valid timeout duration (11.640 < 12.700 < 14.330 microseconds)
2	Status: Success Result: Valid timeout duration (11.640 < 12.900 < 14.330 microseconds)
3	Status: Success Result: Valid timeout duration (11.640 < 12.700 < 14.330 microseconds)

Table 26: Results for test: Connecting 12.8 microsecond timeout

3.8.2 Test: Maximum Bit Period

Configuration	Result
1	Status: Success
	Result: Maximum bit period within valid range of 727 to 1000 ns
2	Status: Success
	Result: Maximum bit period within valid range of 727 to 1000 ns
3	Status: Success
	Result: Maximum bit period within valid range of 727 to 1000 ns

Table 27: Results for test: Maximum Bit Period

3.8.3 Test: NULL Arrival Times

Configuration	Result
1	Status: Success
	Result: Success
2	Status: Success
	Result: Success
3	Status: Success
	Result: Success

Table 28: Results for test: NULL Arrival Times

The diagrams generate by for test are shown in appendix 4.5.

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3.8.4 Test: Error Recovery Time

Configuration	Result
1	Status: Success
	Result: Link recovery time within expected range of 18.46 to 22.55 microseconds
2	Status: Success Result: Link recovery time within expected range of 18.46 to 22.55 microseconds
3	Status: Success Result: Link recovery time within expected range of 18.46 to 22.55 microseconds

Table 29: Results for test: Error Recovery Time

The diagrams generate by for test are shown in appendix 4.6.

3.8.5 Test: Continuous NULLs

Configuration	Result
1	Status: Success
	Result: Success
2	Status: Success
	Result: Success
3	Status: Success
	Result: Success

Table 30: Results for test: Continuous NULLs

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4 Appendix - SpW Conformance Tester complete test reports

4.1 SpW IP Configuration 1 test report

```
[Cover]
Test title: SPW IP development board conformance test Device name: SPW IP implemented on development board
Device version: 1.0
Test operator: J. Tonfat
Institution: OEAW/IWF
Date/time: 20-Jul-2021
API version: 4.05(10242)
                    20-Jul-2021 17:39:52
Driver version: 4.05(10242)
Firmware version: 1.05
Software version: 2.0(569)
Hardware version: 2.00(1)
Notes/comments: FPGA: PROASIC3E
UUT link rate: 10 Mbps
UUT mode: autostart
[Settings]
[Bit-level]
Test: Determine Link State
Status: Success
Result: UUT link is auto-start enabled
Note: See Waveform panel for updated waveform trace
Test: Link Initialisation Test
Status: Success
Result: Link initialisation was correct
Note: Used UUT error response delay (UUT delta) of 2 microseconds
Test: Start Up Link Speed
Status: Success
Result: Startup rate within (10 Mbits/second +/- 1 Mbit/second)
   Measurement Accuracy Minimum Maximum

Bit-to-bit: 10.00 +/- 0.00 0.13 10.00 +/- 0.13 10.00 +/- 0.13

Rise-to-rise: 10.00 +/- 0.00 0.06 10.00 +/- 0.06 10.00 +/- 0.06

Fall-to-fall: 10.00 +/- 0.00 0.06 10.00 +/- 0.06
Note: Measurement duration 12.80 microseconds (128 bits)
         Average link rate 10.00 Mbits/second
Note: All rate measurements are in Mbits/second
Note: See Waveform panel for updated waveform trace
Test: Start Up Waveform
Status: Success
Result: Valid start-up waveform 011101000
   D: 01110100010001000100010001
   S: 11011110111011101110111011
Note: See Waveform panel for updated waveform trace
        Link Shutdown Analysis
Status: Success
Result: Valid shutdown time (100.00 +/- 1.25 \text{ ns} < 555 \text{ ns})
Note: See Waveform panel for updated waveform trace
         Disconnect Timeout
Status: Success
Result: Timeout within valid range of 727 to 1000 ns inclusive
Note: Checked transmit bit periods from 450 to 1280 ns
```



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Used UUT link recovery time 64 microseconds (UUT recovery) Disconnect timeout is between 810 and 840 ns (+/-10 ns)

Used 2000 iterations per time step

Test: Simultaneous D/S Transition Check

Status: Success

Result: No simultaneous D/S transitions detected.

Note: Test duration 10.00 seconds

Note: See Waveform panel for updated waveform trace

[Exchange]

Test: Validate ErrorWait

Status: Success

Result: All tests passed

Response to parity error: correct: moved to ErrorReset Response to parity effor. Coffect: moved to Efforkeset
Response to ESC-EOP: correct: moved to ErrorReset
Response to ESC-ESC: correct: moved to ErrorReset
Response to FCT: correct: moved to ErrorReset
Response to NCHAR: correct: moved to ErrorReset
Response to TCODE: correct: moved to ErrorReset
Test parameters: UUT_delta = 2 us, NCHAR = EOP+EOP, time-code = 42

Test: Validate Ready

Status: Failed

Result: One or more tests failed

Response to parity error: correct: moved to ErrorReset Response to ESC-EOP: correct: moved to ErrorReset
Response to ESC-EEP: correct: moved to ErrorReset
Response to ESC-ESC: correct: moved to ErrorReset
Response to ESC-ESC: correct: moved to ErrorReset
Response to FCT: failed: did not move to ErrorReset
Response to NCHAR: correct: moved to ErrorReset
Response to TCODE: correct: moved to ErrorReset
Test parameters: UUT_delta = 2 us, NCHAR = EOP+EOP, time-code = 42

Note: UUT might be in Started or Connecting not Ready when test was run so

Note: the results might be unreliable

Test: Validate Connecting

Status: Success

Result: All tests passed

Response to parity error: correct: moved to ErrorReset Response to ESC-EOP: correct: moved to ErrorReset
Response to ESC-EEP: correct: moved to ErrorReset
Response to ESC-ESC: correct: moved to ErrorReset
Response to FCT: correct: did not move to ErrorReset
Response to NCHAR: correct: moved to ErrorReset
Response to TCODE: correct: moved to ErrorReset
Test parameters: UUT_delta = 2 us, NCHAR = EOP+EOP, time-code = 42

Test: Validate Run

Status: Success

Result: All tests passed

Response to parity error: correct: moved to ErrorReset Response to ESC-EOP: correct: moved to ErrorReset
Response to ESC-EEP: correct: moved to ErrorReset
Response to ESC-ESC: correct: moved to ErrorReset
Response to one FCT: correct: did not move to ErrorReset
Response to NCHAR: correct: did not move to ErrorReset
Response to TCODE: correct: did not move to ErrorReset
Test parameters: UUT_delta = 2 us, NCHAR = EOP+EOP, time-code = 42

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```
[Ready]
[Started]
[Connecting]
[Run]
[EOP/EEP]
Test: Empty Packet (EOP)
Status: Success
Result: Did not disconnect (correct)
   Empty EOP packets sent:
Test:
         Empty Packet (EEP)
Status: Success
Result: Did not disconnect (correct)
   Empty EEP packets sent:
Test: Empty Packet Loopback (EOP)
Status: Success
Result: Did not disconnect (correct)
   Empty EOP packets sent:
   Empty EOP packets received:
   Empty EEP packets received:
Test: Empty Packet Loop-back (EEP)
Status: Success
Result: Did not disconnect (correct)
   Empty EEP packets sent: 8
   Empty EEP packets received:
   Empty EOP packets received:
Test: Send Packet With EEP
Status: Success
Result: Successfully transmitted the packet
   Packet transmitted (hexadecimal):
       40 01 02 03 04 <EEP>
   No packets received in reply
[Time-code]
[Credit]
Test: FCT Overflow Check
Status: Success
Result: All tests passed
   Response to 1 FCT:
Response to 2 FCTs:
Response to 3 FCTs:
                                     correct: did not move to ErrorReset
                                     correct: did not move to ErrorReset
                                       correct: did not move to ErrorReset
                                     correct: did not move to ErrorReset
   Response to 4 FCTs:
   Response to 5 FCTs:
                                     correct: did not move to ErrorReset
                                correct: did not move to ErrorReset correct: did not move to ErrorReset correct: did not move to ErrorReset correct: moved to ErrorReset
   Response to 6 FCTs:
   Response to 7 FCTs:
Response to 8 FCTs:
Response to 9 FCTs:
   Response to 10 FCTs:
   Response to 11 FCTs:
   Response to 12 FCTs:
                                       correct: moved to ErrorReset
```

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```
Response to 13 FCTs:
                               correct: moved to ErrorReset
   Response to 14 FCTs:
                               correct: moved to ErrorReset
  Response to 15 FCTs:
                               correct: moved to ErrorReset
Note: Require silent UUT or TLI at least half the UUT rate
Test: NCHAR (EOP) Overflow Check
Status: Failed
Result: UUT didn't disconnect
       See Waveform panel for updated waveform trace
       Require TLI link rate to be at least 8 times the UUT link rate
        Average TLI link rate 100.00 Mbits/second
        Average UUT link rate 10.00 Mbits/second
       Used UUT receive time of 2 seconds
Note:
Note: Result might be due to empty packet handling not NCHAR credit error
Test: NCHAR (EEP) Overflow Check
Status: Failed
Result: UUT didn't disconnect
       See Waveform panel for updated waveform trace
       Require TLI link rate to be at least 8 times the UUT link rate
        Average TLI link rate 100.00 Mbits/second
        Average UUT link rate 10.00 Mbits/second
Note:
        Used UUT receive time of 2 seconds
      Result might be due to empty packet handling not NCHAR credit error
Note:
Test: Empty Packet Credit Check
Status: Success
Result: UUT correctly credit counts empty packets
       UUT must consume all packets sent to it
Note: Used UUT link recovery time 64 microseconds (UUT_recovery)
Test: UUT Credit Error Check
Status: Success
Result: No credit errors detected
[Packet (1)]
Test: UUT is data loop-back
Status: Success
Result: Received loop-back packet was correct
   Header transmitted (hexadecimal):
      (empty)
   Packet transmitted (hexadecimal):
     40 01 02 03 <EOP>
   Packet received (hexadecimal):
     40 01 02 03 <EOP>
Test: UUT is data sink
Status: Success
Result: Packet sent: please check arrival at UUT
   Header transmitted (hexadecimal):
     (empt.v)
   Packet transmitted (hexadecimal):
     58 41 20 Of Od <EOP>
      UUT is data source
Test:
Status: Success
Result: Received 10 packets
   3a bb 68 c4 26 19 02 c7 86 2c <EOP> [length 10]
   3a bb 68 c4 26 19 02 c7 86 2c <EOP> [length 10]
   3a bb 68 c4 26 19 02 c7 86 2c <EOP> [length 10]
   3a bb 68 c4 26 19 02 c7 86 2c <EOP> [length 10]
```

3a bb 68 c4 26 19 02 c7 86 2c <EOP> [length 10] 3a bb 68 c4 26 19 02 c7 86 2c <EOP> [length 10] 3a bb 68 c4 26 19 02 c7 86 2c <EOP> [length 10]



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```
3a bb 68 c4 26 19 02 c7 86 2c <EOP> [length 10]
3a bb 68 c4 26 19 02 c7 86 2c <EOP> [length 10]
3a bb 68 c4 26 19 02 c7 86 2c <EOP> [length 10]
```

[Packet (2)]

[Other]

Connecting 12.8 microsecond timeout Test:

Status: Success

Result: Valid timeout duration (11.640 < 12.700 < 14.330 microseconds)

Note: Result ignores transmitter start-up but includes transmitter shutdown

time so it might not be an accurate measure of the UUT timeout.

Test: Maximum Bit Period

Status: Success

Result: Maximum bit period within valid range of 727 to 1000 ns Note: Maximum bit period between 800 and 810 ns (+/-10 ns)

NULL Arrival Times Test:

Status: Success Result: Success

Note: Edge at time 6.92 microseconds from 21.28 to 23.00 microseconds Note: Edge at time 6.96 microseconds from 23.00 to 24.72 microseconds Note: Edge at time 7.00 microseconds from 24.72 to 26.44 microseconds Note: Edge at time 7.04 microseconds from 26.44 to 28.16 microsecondsEdge at time 20.84 microseconds from 40.68 to 35.88 microseconds Note: Edge at time 20.88 microseconds from 35.88 to 31.08 microseconds Note: Note: Edge at time 20.92 microseconds from 31.08 to 26.28 microseconds Note: Edge at time 20.96 microseconds from 26.28 to 21.48 microseconds Note: Edge at time 21.08 microseconds from 21.56 to 42.28 microseconds Note: Edge at time 39.16 microseconds from 53.68 to 60.24 microseconds

Note: Unable to identify second ErrorReset segment

Note: ErrorReset+ErrorWait time is 1.25 microseconds higher than expected.

Note: First ErrorReset (dy) = 1.75 microseconds

Note: Average ErrorReset = 1.75 microseconds

Note: First ErrorReset slope = 0.00, intercept 21.25 microseconds

Note: ErrorWait slope = nan, intercept in Note: ErrorWait+Tx(null) = 0.00 microseconds nan, intercept inf microseconds

Note: Early null dip is not deep enough

Note: Early null dip width = 0.00 microseconds

Note: Used UUT link recovery time 64 microseconds (UUT_recovery)

Error Recovery Time

Status: Success

Result: Link recovery time within expected range of 18.46 to 22.55 microseconds

Note: Used UUT link recovery time 64 microseconds (UUT_recovery)

Link recovery time is between 21.08 and 21.44 microseconds (+/- 0.1)

Note: Number of test iterations: 10000

Test: Continuous NULLs

Status: Success Result: Success

[Waveform]

Test: Get UUT Waveform

Status: Success

Measured rate Accuracy Minimum Rate Maximum Rate
Bit-to-bit: 10.00 +/- 0.13 0.13 9.88 +/- 0.12 10.13 +/- 0.13
Rise-to-rise: 10.00 +/- 0.06 0.06 9.94 +/- 0.06 10.06 +/- 0.06 Fall-to-fall: 10.00 +/- 0.06 0.06 9.94 +/- 0.06 10.06 +/- 0.06

Note: All rate measurements are in Mbits/second

Note: Measurement duration 40.90 microseconds (409 bits)

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Issue:

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Average link rate 10.00 Mbits/second

Skew estimate 1.25 \pm 1.25 ns (assuming constant link rate) Note:

4.2 **SpW IP Configuration 2 test report**

[Cover]

SPW IP development board conformance test Test title: Device name: SPW IP development board conformance co.

Device version: 1.0

Test operator: J. Tonfat Institution: OEAW/IWF Institution:

20-Jul-2021 17:48:19 Date/time:

API version: 4.05(10242) Driver version: 4.05(10242) Firmware version: 1.05 Software version: 2.0(569) Hardware version: 2.00(1)

Notes/comments: FPGA: PROASIC3E

UUT link rate: 100 Mbps UUT mode: autostart

[Settings]

[Bit-level]

Test: Determine Link State

Status: Success

Result: UUT link is auto-start enabled

Note: See Waveform panel for updated waveform trace

Test: Link Initialisation Test Status: Success

Result: Link initialisation was correct

Note: Used UUT error response delay (UUT delta) of 2 microseconds

Test: Start Up Link Speed

Status: Success

Result: Startup rate within (10 Mbits/second +/- 1 Mbit/second) Measurement Accuracy Minimum Maximum

10.00 +/- 0.00 0.13 10.00 +/- 0.13 10.00 +/- 0.13 Bit-to-bit:

Note: Measurement duration 12.60 microseconds (126 bits)

Average link rate 10.00 Mbits/second Note: Note: All rate measurements are in Mbits/second Note: See Waveform panel for updated waveform trace

Test: Start Up Waveform

Status: Success

Result: Valid start-up waveform 011101000

D: 0111010001000100010001 S: 11011110111011101110111011

Note: See Waveform panel for updated waveform trace

Test: Link Shutdown Analysis

Status: Success

Result: Valid shutdown time (10.00 + /- 1.25 ns < 555 ns)Note: See Waveform panel for updated waveform trace

Test: Disconnect Timeout

Status: Success



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Issue:

1.0

Result: Timeout within valid range of 727 to 1000 ns inclusive Note: Checked transmit bit periods from 450 to 1280 ns Note: Used UUT link recovery time 64 microseconds (UUT recovery) Note: Disconnect timeout is between 810 and 840 ns (+/-10 ns)Note: Used 2000 iterations per time step Test: Simultaneous D/S Transition Check Status: Success Result: No simultaneous D/S transitions detected. Note: Test duration 10.00 seconds Note: See Waveform panel for updated waveform trace [Exchange] Test: Validate ErrorWait Status: Success Result: All tests passed Response to parity error: correct: moved to ErrorReset Response to parity error: correct: moved to ErrorReset
Response to ESC-EOP: correct: moved to ErrorReset
Response to ESC-EEP: correct: moved to ErrorReset
Response to ESC-ESC: correct: moved to ErrorReset
Response to FCT: correct: moved to ErrorReset
Response to NCHAR: correct: moved to ErrorReset
Response to TCODE: correct: moved to ErrorReset
Test parameters: UUT_delta = 2 us, NCHAR = EOP+EOP, time-code = 42 Test: Validate Ready Status: Failed Result: One or more tests failed Response to parity error: correct: moved to ErrorReset Response to ESC-EOP: correct: moved to ErrorReset
Response to ESC-EEP: correct: moved to ErrorReset
Response to ESC-ESC: correct: moved to ErrorReset
Response to FCT: failed: did not move to ErrorReset
Response to NCHAR: correct: moved to ErrorReset
Response to TCODE: correct: moved to ErrorReset
Test parameters: UUT_delta = 2 us, NCHAR = EOP+EOP, time-code = 42 Note: UUT might be in Started or Connecting not Ready when test was run so the results might be unreliable Test: Validate Connecting Status: Success Result: All tests passed Response to parity error: correct: moved to ErrorReset Response to ESC-EOP: correct: moved to ErrorReset
Response to ESC-EEP: correct: moved to ErrorReset
Response to ESC-ESC: correct: moved to ErrorReset
Response to FCT: correct: did not move to ErrorReset
Response to NCHAR: correct: moved to ErrorReset
Response to TCODE: correct: moved to ErrorReset
Test parameters: UUT_delta = 2 us, NCHAR = EOP+EOP, time-code = 42 Test: Validate Run Status: Success Result: All tests passed Response to parity error: correct: moved to ErrorReset Response to parity error: correct: moved to ErrorReset
Response to ESC-EOP: correct: moved to ErrorReset
Response to ESC-EEP: correct: moved to ErrorReset
Response to ESC-ESC: correct: moved to ErrorReset
Response to one FCT: correct: did not move to ErrorReset
Response to NCHAR: correct: did not move to ErrorReset
Response to TCODE: correct: did not move to ErrorReset
Test parameters: UUT_delta = 2 us, NCHAR = EOP+EOP, time-code = 42 Doc. Ref:

Doc. Title: ICU RDCU FPGA SPW Conformance Test

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Issue:

1.0

[ErrorWait] [Ready] [Started] [Connecting] [Run] [EOP/EEP] Test: Empty Packet (EOP) Status: Success Result: Did not disconnect (correct) Empty EOP packets sent: Test: Empty Packet (EEP) Status: Success Result: Did not disconnect (correct) Empty EEP packets sent: Test: Empty Packet Loopback (EOP) Status: Success Result: Did not disconnect (correct) Empty EOP packets sent: 8 Empty EOP packets received: Empty EEP packets received: Empty Packet Loop-back (EEP) Status: Success Result: Did not disconnect (correct) Empty EEP packets sent: 8 Empty EEP packets received: 0 Empty EOP packets received: Test: Send Packet With EEP Status: Success Result: Successfully transmitted the packet Packet transmitted (hexadecimal): 40 01 02 03 04 <EEP> No packets received in reply [Time-code] Test: Investigate UUT time-code support Status: Success Result: UUT supports time-codes UUT did not return any time-codes Time-code/NCHAR confusion Test: Status: Success Result: Packet and time-code sent: please check arrival at UUT Note: UUT ought to have received a single-byte packet 255 and time-code 42. Note: If UUT received a two-byte packet <255 42> it is treating time-codes as NCHARs which is wrong. Test: UUT receives valid time-codes Status: Success Result: Time-code 42 sent: please check arrival at UUT

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Issue:

1.0

UUT ignores invalid time-codes

Status: Success

Result: Timecode 21 sent: please check ignored by UUT

Test: Measure time-code frequency

Status: Success

Result: Time-codes received and UUT did not disconnect

7 ticks received (6 valid, 1 invalid) Measured tick frequency = 1.00 Hz Minimum tick frequency = 1.00 Hz Maximum tick frequency = 1.00 Hz

First time-code after link reset was 3 not 1

[Credit]

Test: FCT Overflow Check

Status: Success

Result: All tests passed

correct: did not move to ErrorReset correct: moved to ErrorReset Response to 1 FCT: Response to 2 FCTs: Response to 3 FCTs: 4 FCTs: Response to Response to 5 FCTs: Response to 6 FCTs: Response to 7 FCTs:

Response to 8 FCTs: Response to 9 FCTs: Response to 10 FCTs: Response to 11 FCTs: Response to 12 FCTs: Response to 13 FCTs: correct: moved to ErrorReset correct: moved to ErrorReset Response to 14 FCTs: Response to 15 FCTs: correct: moved to ErrorReset

Require silent UUT or TLI at least half the UUT rate Note:

Test: NCHAR (EOP) Overflow Check

Status: Failed

Result: UUT didn't disconnect

See Waveform panel for updated waveform trace

Require TLI link rate to be at least 8 times the UUT link rate Note:

Average TLI link rate 100.00 Mbits/second Average UUT link rate 100.00 Mbits/second UUT link rate too high relative to TLI link rate

Note: Used UUT receive time of 2 seconds

Result might be due to empty packet handling not NCHAR credit error Note:

Test: NCHAR (EEP) Overflow Check

Status: Failed

Result: UUT didn't disconnect

See Waveform panel for updated waveform trace

Require TLI link rate to be at least 8 times the UUT link rate Note:

Average TLI link rate 100.00 Mbits/second Average UUT link rate 100.00 Mbits/second UUT link rate too high relative to TLI link rate

Used UUT receive time of 2 seconds Note:

Note: Result might be due to empty packet handling not NCHAR credit error

Test: Empty Packet Credit Check

Status: Success

Result: UUT correctly credit counts empty packets UUT must consume all packets sent to it

Used UUT link recovery time 64 microseconds (UUT_recovery) Note:

Test: UUT Credit Error Check

Status: Success

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Issue:

1.0

Result: No credit errors detected

[Packet (1)] Test: UUT is data loop-back Status: Success Result: Received loop-back packet was correct Header transmitted (hexadecimal): Packet transmitted (hexadecimal): 40 01 02 03 <EOP> Packet received (hexadecimal): 40 01 02 03 <EOP> Test: UUT is data sink Status: Success Result: Packet sent: please check arrival at UUT Header transmitted (hexadecimal): (empty) Packet transmitted (hexadecimal): 58 41 20 Of Od <EOP> UUT is data source Test: Status: Success Result: Received 10 packets 3a bb 68 c4 26 19 02 c7 86 2c <EOP> [length 10] 3a bb 68 c4 26 19 02 c7 86 2c <EOP> [length 10] 3a bb 68 c4 26 19 02 c7 86 2c <EOP> [length 10] 3a bb 68 c4 26 19 02 c7 86 2c <EOP> [length 10] 3a bb 68 c4 26 19 02 c7 86 2c <EOP> [length 10] 3a bb 68 c4 26 19 02 c7 86 2c <EOP> [length 10] 3a bb 68 c4 26 19 02 c7 86 2c <EOP> [length 10] 3a bb 68 c4 26 19 02 c7 86 2c <EOP> [length 10] 3a bb 68 c4 26 19 02 c7 86 2c <EOP> [length 10] 3a bb 68 c4 26 19 02 c7 86 2c <EOP> [length 10] [Packet (2)] [Other] Test: Connecting 12.8 microsecond timeout Status: Success Result: Valid timeout duration (11.640 < 12.900 < 14.330 microseconds) Result ignores transmitter start-up but includes transmitter shutdown time so it might not be an accurate measure of the UUT timeout. Test: Maximum Bit Period Status: Success Result: Maximum bit period within valid range of 727 to 1000 ns Maximum bit period between 800 and 810 ns (+/- 10 ns) Note: Test: NULL Arrival Times Status: Success Result: Success Unable to identify first ErrorReset segment Unable to identify second ErrorReset segment Note: Unable to identify ErrorWait segment Note: Unable to identify early-null segment Note: Used UUT link recovery time 64 microseconds (UUT_recovery) Test: Error Recovery Time Status: Success Result: Link recovery time within expected range of 18.46 to 22.55 microseconds Note: Used UUT link recovery time 64 microseconds (UUT_recovery)

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Issue:

1.0

Link recovery time is between 21.12 and 21.44 microseconds (+/-0.1)

Number of test iterations: 10000 Note:

Test: Continuous NULLs

Status: Success Result: Success

[Waveform]

Test: Get UUT Waveform

Status: Success

 Measured rate
 Accuracy
 Minimum Rate
 Maximum Rate

 101.59 +/ 12.70
 19.05
 88.89 +/ 11.11
 114.29 +/ 19.05
 Bit-to-bit: Rise-to-rise: 100.39 +/- 6.27 7.62 94.12 +/- 5.88 106.67 +/- 7.62 Fall-to-fall: 100.39 +/- 6.27 7.62 94.12 +/- 5.88 106.67 +/- 7.62

Note: All rate measurements are in Mbits/second

Measurement duration 40.95 microseconds (4095 bits) Average link rate 100.00 Mbits/second Note:

Note:

Note: Skew estimate 1.25 ± -1.25 ns (assuming constant link rate)

4.3 **SpW IP Configuration 3 test report**

[Cover]

Test title: SPW IP development board conformance test Device name: SPW IP implemented on development board

Device version: 1.0

Test operator: J. Tonfat Institution: OEAW/IWF Institution:

20-Jul-2021 16:54:51 Date/time:

API version: 4.05(10242) Driver version: 4.05(10242)

Firmware version: 1.05 Software version: 2.0(569) Hardware version: 2.00(1)

Notes/comments: FPGA: PROASIC3E

UUT link rate: 2 Mbps UUT mode: autostart

[Settings]

[Bit-level]

Test: Determine Link State

Status: Success

Result: UUT link is auto-start enabled

Note: See Waveform panel for updated waveform trace

Link Initialisation Test Test:

Status: Success

Result: Link initialisation was correct

Note: Used UUT error response delay (UUT delta) of 2 microseconds

Test: Start Up Link Speed

Status: Success

Result: Startup rate within (10 Mbits/second +/- 1 Mbit/second)

Measurement Accuracy Minimum

Bit-to-bit: 10.00 +/- 0.00 0.13 10.00 +/- 0.13 10.00 +/- 0.13 Rise-to-rise: 10.00 +/- 0.00 0.06 10.00 +/- 0.06 10.00 +/- 0.06 Fall-to-fall: 10.00 +/- 0.00 0.06 10.00 +/- 0.06 10.00 +/- 0.06

Note: Measurement duration 12.60 microseconds (126 bits)

Note: Average link rate 10.00 Mbits/second

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Issue:

1.0

All rate measurements are in Mbits/second See Waveform panel for updated waveform trace Note:

Test: Start Up Waveform

Status: Success

Result: Valid start-up waveform 011101000

D: 0111010001000100010001 s: 11011110111011101110111011

Note: See Waveform panel for updated waveform trace

Link Shutdown Analysis Test:

Status: Success

Result: Valid shutdown time (500.00 +/- 1.25 ns < 555 ns)Note: See Waveform panel for updated waveform trace

Test: Disconnect Timeout

Status: Success

Result: Timeout within valid range of 727 to 1000 ns inclusive

Note: Checked transmit bit periods from 450 to 1280 ns

Note: Used UUT link recovery time 64 microseconds (UUT recovery) Note: Disconnect timeout is between 810 and 840 ns (+/- 10 ns)

Note: Used 2000 iterations per time step

Test: Simultaneous D/S Transition Check

Status: Failed

Result: UUT didn't send enough bits

Note: Test duration 2.00 seconds
Note: See Waveform panel for updated waveform trace

[Exchange]

Test: Validate ErrorWait

Status: Success

Result: All tests passed

Response to parity error: correct: moved to ErrorReset Response to parity error: Correct: moved to ErrorReset
Response to ESC-EOP: correct: moved to ErrorReset
Response to ESC-EEP: correct: moved to ErrorReset
Response to ESC-ESC: correct: moved to ErrorReset
Response to FCT: correct: moved to ErrorReset
Response to NCHAR: correct: moved to ErrorReset
Response to TCODE: correct: moved to ErrorReset
Test parameters: UUT_delta = 2 us, NCHAR = EOP+EOP, time-code = 42

Test: Validate Ready

Status: Failed

Result: One or more tests failed

Response to parity error: correct: moved to ErrorReset Response to ESC-EOP: correct: moved to ErrorReset
Response to ESC-EEP: correct: moved to ErrorReset
Response to ESC-ESC: correct: moved to ErrorReset
Response to FCT: failed: did not move to ErrorReset

Response to FCT:
Response to NCHAR:
Response to TCODE:
Correct: moved to ErrorReset
Correct: moved to ErrorReset
Test parameters:

UUT_delta = 2 us, NCHAR = EOP+EOP, time-code = 42 Note: UUT might be in Started or Connecting not Ready when test was run so

Note: the results might be unreliable

Test: Validate Started

Status: Failed

Result: UUT is not link-enabled

Test: Validate Connecting

Status: Success

Result: All tests passed

Response to parity error: correct: moved to ErrorReset

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Issue:

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```
Response to ESC-EOP:
                                           correct: moved to ErrorReset
    Response to ESC-EOP: correct: moved to ErrorReset Response to ESC-EEP: correct: moved to ErrorReset Correct: moved to ErrorReset Response to ESC-ESC: correct: moved to ErrorReset
                                       correct: did not move to ErrorReset
correct: moved to ErrorReset
correct: moved to ErrorReset
UUT delta = 2 us, NCHAR = EOP+EOP,
    Response to FCT:
    Response to NCHAR:
    Response to TCODE:
                                           UUT delta = 2 us, NCHAR = EOP+EOP, time-code = 42
    Test parameters:
Test: Validate Run
Status: Success
Result: All tests passed
    Response to parity error: correct: moved to ErrorReset
   Response to parity error: correct: moved to ErrorReset
Response to ESC-EOP: correct: moved to ErrorReset
Response to ESC-EEP: correct: moved to ErrorReset
Response to ESC-ESC: correct: moved to ErrorReset
Response to one FCT: correct: did not move to ErrorReset
Response to NCHAR: correct: did not move to ErrorReset
Response to TCODE: correct: did not move to ErrorReset
Test parameters: UUT_delta = 2 us, NCHAR = EOP+EOP, time-code = 42
[ErrorWait]
[Ready]
[Started]
[Connecting]
[Run]
[EOP/EEP]
Test: Empty Packet (EOP)
Status: Success
Result: Did not disconnect (correct)
    Empty EOP packets sent:
Test: Empty Packet (EEP)
Status: Success
Result: Did not disconnect (correct)
    Empty EEP packets sent:
Test: Empty Packet Loopback (EOP)
Status: Success
Result: Did not disconnect (correct)
    Empty EOP packets sent:
    Empty EOP packets received:
    Empty EEP packets received:
           Empty Packet Loop-back (EEP)
Test:
Status: Success
Result: Did not disconnect (correct)
    Empty EEP packets sent: 8
    Empty EEP packets received:
                                                 Ω
    Empty EOP packets received:
Test: Send Packet With EEP
Status: Success
```

Result: Successfully transmitted the packet Packet transmitted (hexadecimal):

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Issue:

1.0

40 01 02 03 04 <EEP> Packet received (hexadecimal): 40 01 02 03 04 <EEP>

[Time-code]

Test: Investigate UUT time-code support

Status: Success

Result: UUT supports time-codes

Note: UUT did not return any time-codes

Test: Time-code/NCHAR confusion

Status: Success

Result: Packet and time-code sent: please check arrival at UUT

Note: UUT ought to have received a single-byte packet 255 and time-code 42. Note: If UUT received a two-byte packet <255 42> it is treating time-codes

as NCHARs which is wrong.

Test: UUT receives valid time-codes

Status: Success

Result: Time-code 42 sent: please check arrival at UUT

UUT ignores invalid time-codes

Status: Success

Result: Timecode 21 sent: please check ignored by UUT

Test: Measure time-code frequency

Status: Success

Result: Time-codes received and UUT did not disconnect

20 ticks received (9 valid, 11 invalid) Measured tick frequency = 1.00 Hz Minimum tick frequency = 1.00 HzMaximum tick frequency = 1.00 Hz

Note: First time-code after link reset was 32 not 1

Test: FCT Overflow Check

Status: Success

Result: All tests passed correct: did not move to ErrorReset correct: moved to ErrorReset Response to 1 FCT: Response to 2 FCTs: Response to 3 FCTs: Response to 4 FCTs: 5 FCTs: Response to Response to 6 FCTs: Response to 7 FCTs:

Response to 8 FCTs: Response to 9 FCTs: Response to 10 FCTs: Response to 11 FCTs: Response to 12 FCTs: Response to 13 FCTs: correct: moved to ErrorReset Response to 14 FCTs: correct: moved to ErrorReset Response to 15 FCTs: correct: moved to ErrorReset

Note: Require silent UUT or TLI at least half the UUT rate

Test: NCHAR (EOP) Overflow Check

Status: Success

Note:

Result: UUT disconnected

See Waveform panel for updated waveform trace

Require TLI link rate to be at least 8 times the UUT link rate

Average TLI link rate 100.00 Mbits/second Average UUT link rate 2.17 Mbits/second

Used UUT receive time of 2 seconds Note: Result might be due to empty packet handling not NCHAR credit error

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Issue:

1.0

```
NCHAR (EEP) Overflow Check
Status: Success
Result: UUT disconnected
Note:
       See Waveform panel for updated waveform trace
       Require TLI link rate to be at least 8 times the UUT link rate
       Average TLI link rate 100.00 Mbits/second
       Average UUT link rate 2.00 Mbits/second
       Used UUT receive time of 2 seconds
Note: Result might be due to empty packet handling not NCHAR credit error
Test:
       Empty Packet Credit Check
Status: Success
Result: UUT correctly credit counts empty packets
Note: UUT must consume all packets sent to it
Note: Used UUT link recovery time 64 microseconds (UUT_recovery)
Test: UUT Credit Error Check
Status: Success
Result: No credit errors detected
[Packet (1)]
Test: UUT is data loop-back
Status: Success
Result: Received loop-back packet was correct
   Header transmitted (hexadecimal):
      (empty)
   Packet transmitted (hexadecimal):
     40 01 02 03 <EOP>
   Packet received (hexadecimal):
      40 01 02 03 <EOP>
       UUT is data sink
Test:
Status: Success
Result: Packet sent: please check arrival at UUT
   Header transmitted (hexadecimal):
      (empty)
   Packet transmitted (hexadecimal):
      58 41 20 Of Od <EOP>
Test: UUT is data source
Status: Success
Result: Received 10 packets
   3a bb 68 c4 26 19 02 c7 86 2c <EOP> [length 10]
   3a bb 68 c4 26 19 02 c7 86 2c <EOP> [length 10]
   3a bb 68 c4 26 19 02 c7 86 2c <EOP> [length 10]
   3a bb 68 c4 26 19 02 c7 86 2c <EOP> [length 10]
   3a bb 68 c4 26 19 02 c7 86 2c <EOP> [length 10]
   3a bb 68 c4 26 19 02 c7 86 2c <EOP> [length 10]
   3a bb 68 c4 26 19 02 c7 86 2c <EOP> [length 10]
   3a bb 68 c4 26 19 02 c7 86 2c <EOP> [length 10]
   3a bb 68 c4 26 19 02 c7 86 2c <EOP> [length 10]
   3a bb 68 c4 26 19 02 c7 86 2c <EOP> [length 10]
[Packet (2)]
[Other]
Test:
       Started 12.8 microsecond timeout
Status: Failed
Result: UUT link is not enabled
Test: Connecting 12.8 microsecond timeout
```

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Issue:

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Status: Success

Result: Valid timeout duration (11.640 < 12.700 < 14.330 microseconds)

Note: Result ignores transmitter start-up but includes transmitter shutdown

time so it might not be an accurate measure of the UUT timeout.

Test: Maximum Bit Period

Status: Success

Result: Maximum bit period within valid range of 727 to 1000 ns

Note: Maximum bit period is 800 ns (+/- 10 ns)

NULL Arrival Times Test:

Status: Success Result: Success

Note: Edge at time 6.92 microseconds from 21.28 to 23.00 microseconds Note: Edge at time 6.96 microseconds from 23.00 to 24.72 microseconds Note: Edge at time 7.00 microseconds from 24.72 to 26.44 microseconds Note: Edge at time 7.04 microseconds from 26.44 to 28.16 microseconds Edge at time 20.84 microseconds from 40.68 to 35.88 microseconds Note: Note: Edge at time 20.88 microseconds from 35.88 to 31.08 microseconds Edge at time 20.92 microseconds from 31.08 to 26.28 microseconds Note: Edge at time 20.96 microseconds from 26.28 to 21.48 microseconds Note: Edge at time 21.08 microseconds from 21.56 to 42.32 microseconds Note: Edge at time 39.24 microseconds from 53.56 to 60.56 microseconds

Note: Unable to identify second ErrorReset segment

Note: ErrorReset+ErrorWait time is 1.25 microseconds higher than expected.

Note: First ErrorReset (dy) = 1.75 microseconds
Note: Average ErrorReset = 1.75 microseconds
Note: First ErrorReset slope = 0.00, intercept 21.24 microseconds
Note: ErrorWait slope = nan, intercept inf microseconds
Note: ErrorWait+Tx(null) = 0.00 microseconds

Note: Early null dip is not deep enough

Note: Early null dip width = 0.00 microseconds

Note: Used UUT link recovery time 64 microseconds (UUT recovery)

Test: Error Recovery Time

Status: Success

Result: Link recovery time within expected range of 18.46 to 22.55 microseconds

Note: Used UUT link recovery time 64 microseconds (UUT_recovery)

Link recovery time is between 21.12 and 21.44 microseconds (+/-0.1)

Note: Number of test iterations: 10000

Test: Continuous NULLs

Status: Success Result: Success

[Waveform]

Test: Get UUT Waveform

Status: Success

Maximum Rate 2.00 +/- 0.00 2.01 +/- 0.01 0.00 +/- 0.00 0.00 +/- 0.00 0.00 Fall-to-fall: 0.00 +/- 0.00 0.00 +/- 0.00 0.00 +/- 0.00

Note: All rate measurements are in Mbits/second

Measurement duration 40.50 microseconds (81 bits)

Average link rate 2.00 Mbits/second

Note: Skew estimate 1.25 + /- 1.25 ns (assuming constant link rate)

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Issue:

4.4 Disconnect timeout test diagrams

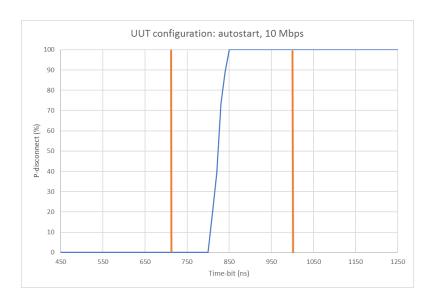


Diagram 1: Disconnection timeout for configuration 1

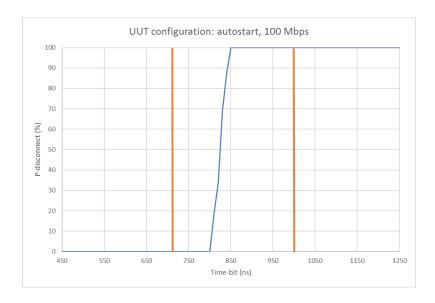


Diagram 2: Disconnection timeout for configuration 2

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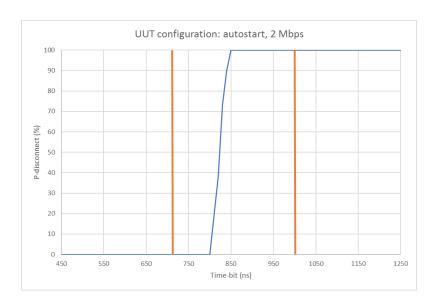


Diagram 3: Disconnection timeout for configuration 3

4.5 NULL arrival time test diagrams

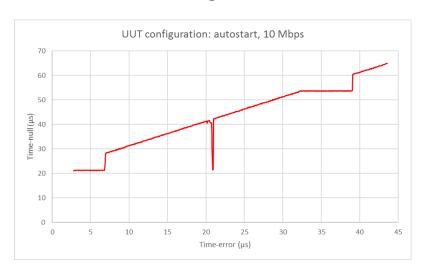


Diagram 4: NULL arrival time for configuration 1

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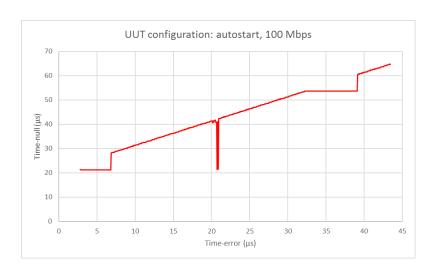


Diagram 5: NULL arrival time for configuration 2

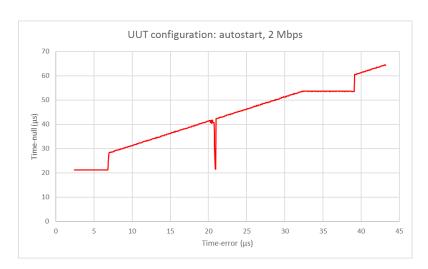


Diagram 6: NULL arrival time for configuration 3

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4.6 Error recovery time test diagrams

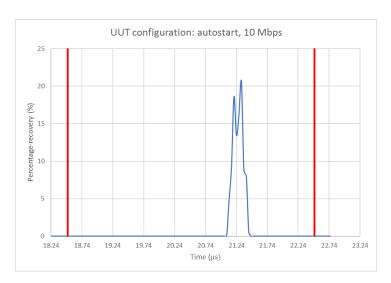


Diagram 7: Error recovery time for configuration 1

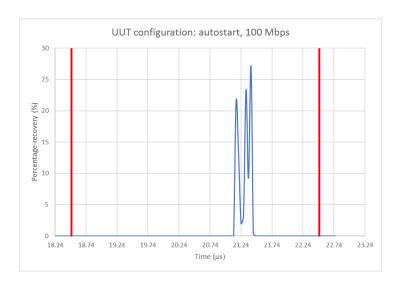


Diagram 8: Error recovery time for configuration 2



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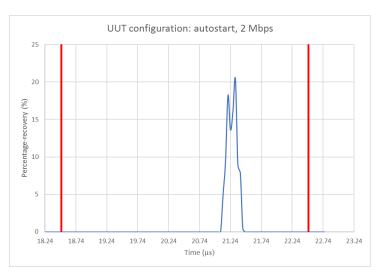


Diagram 9: Error recovery time for configuration 3