PLATO ICU RDCU

FPGA SPW Conformance Test

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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	C	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				

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).

2 Test Environment

2.1 Test Item

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

2.2 Test Conditions

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

2.4 Instrumentation and Test Equipment

2.4.1 Measurement Equipment, Jigs and Tools

No.	Quantity	Description	Manufacturer	Model No.	Serial No.	Calibration Date	
						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.I.-No. / Serial No.	Remark
1	2	Ground Cable		
2	2	Space Wire Cable MDM 9		
3				

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

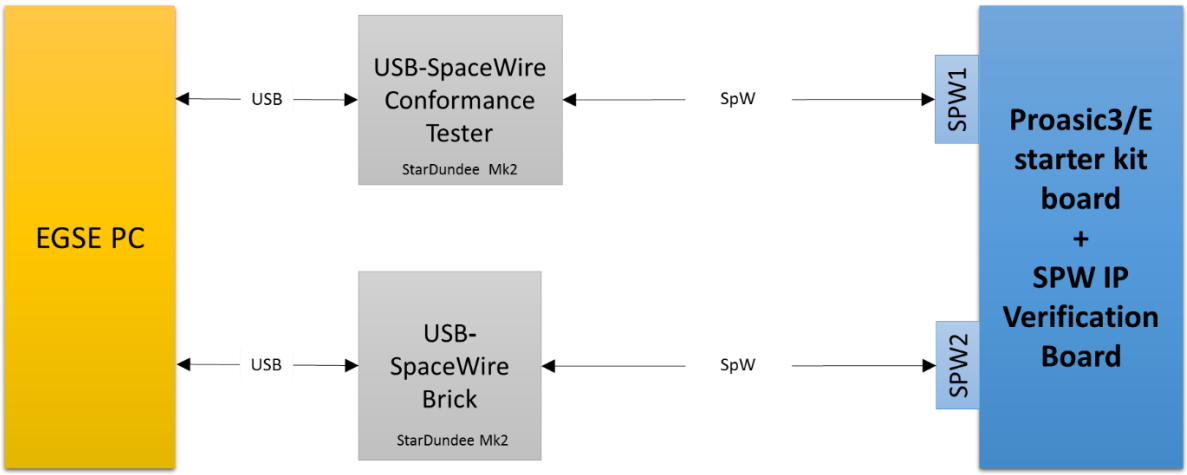

Figure 1: SpaceWire Conformance Test

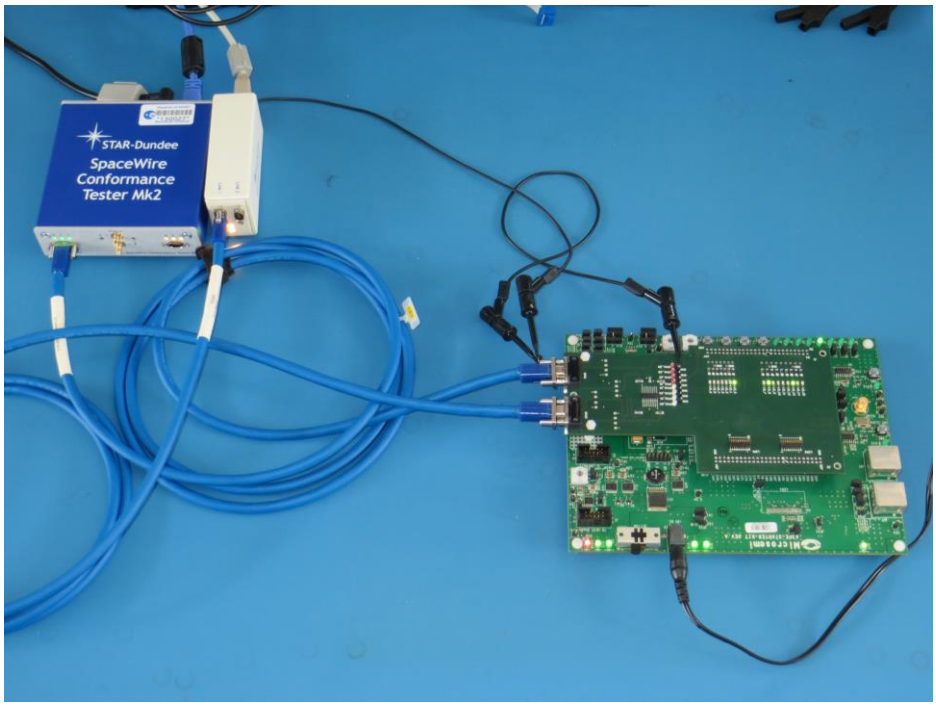

Figure 2: Conformance Test Set-Up

2.6.2 Important Adjustments and Configuration to be checked

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.	Yes

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.

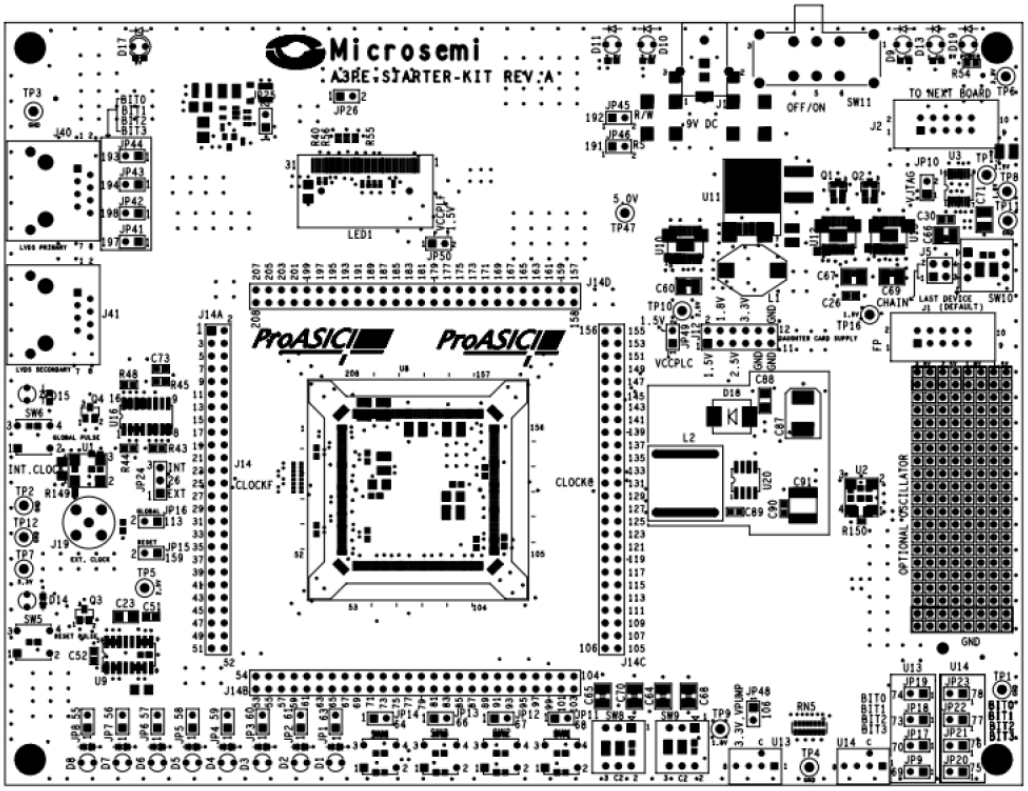

Figure 3: Commercial Development Board [RD2]

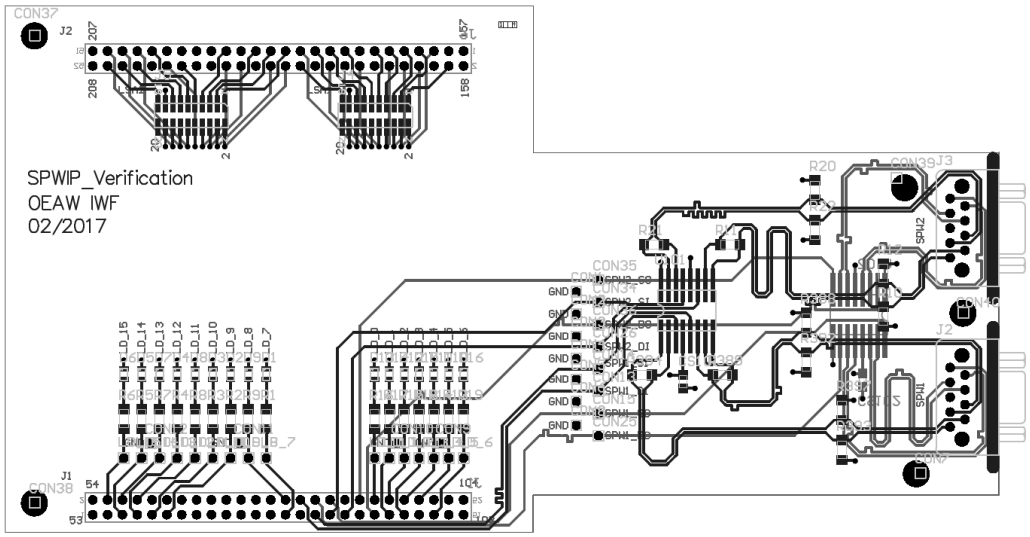

Figure 4: SpaceWire IP Verification Board

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

- 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

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

[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 Group: Packet (1)

[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.

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

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.

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)

	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 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

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: 01110100010001000100010001 S: 11011110111011101110111011
2	Status: Success Result: Valid start-up waveform 011101000 D: 01110100010001000100010001 S: 11011110111011101110111011
3	Status: Success Result: Valid start-up waveform 011101000 D: 01110100010001000100010001 S: 11011110111011101110111011

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)

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.

3.1.7 Test: Simultaneous D/S Transition Check

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

	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
2	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: moved to ErrorReset Response to NCHAR: correct: moved to ErrorReset Response to TCODE: correct: moved 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 FCT: correct: moved to ErrorReset Response to NCHAR: correct: moved to ErrorReset Response to TCODE: correct: moved to 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

	Response to NCHAR: correct: moved to ErrorReset Response to TCODE: correct: moved to ErrorReset
2	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
3	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

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

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

2	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
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 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

	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)

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)

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.

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.

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

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.

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 micro-seconds)
2	Status: Success Result: Valid timeout duration (11.640 < 12.900 < 14.330 micro-seconds)
3	Status: Success Result: Valid timeout duration (11.640 < 12.700 < 14.330 micro-seconds)

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.

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

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 17:39:52
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: 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  10.00 +/- 0.06
Note:   Measurement duration 12.80 microseconds (128 bits)
Note:   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

Test:   Link Shutdown Analysis
Status: Success
Result: Valid shutdown time (100.00 +/- 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: 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 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
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


[ErrorWait]
```

```
[Ready]


[Started]


[Connecting]


[Run]


[EOP/EEP]
Test:   Empty Packet (EOP)
Status: Success
Result: Did not disconnect (correct)
   Empty EOP packets sent:       8

Test:   Empty Packet (EEP)
Status: Success
Result: Did not disconnect (correct)
   Empty EEP packets sent:       8

Test:   Empty Packet Loopback (EOP)
Status: Success
Result: Did not disconnect (correct)
   Empty EOP packets sent:       8
   Empty EOP packets received:   0
   Empty EEP packets received:   0

Test:   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:   0

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:          correct: did not move to ErrorReset
   Response to  2 FCTs:         correct: did not move to ErrorReset
   Response to  3 FCTs:         correct: did not move to ErrorReset
   Response to  4 FCTs:         correct: did not move to ErrorReset
   Response to  5 FCTs:         correct: did not move to ErrorReset
   Response to  6 FCTs:         correct: did not move to ErrorReset
   Response to  7 FCTs:         correct: did not move to ErrorReset
   Response to  8 FCTs:         correct: moved to ErrorReset
   Response to  9 FCTs:         correct: moved to ErrorReset
   Response to 10 FCTs:         correct: moved to ErrorReset
   Response to 11 FCTs:         correct: moved to ErrorReset
   Response to 12 FCTs:         correct: moved to ErrorReset
```

```
   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
Note:   See Waveform panel for updated waveform trace
Note:   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
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
Note:   See Waveform panel for updated waveform trace
Note:   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
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>

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 0f 0d <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:   Connecting 12.8 microsecond timeout
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)

Test:   NULL Arrival Times
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
Note:   Edge 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:   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 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)
Note:   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)
```

```
Note:   Average link rate 10.00 Mbits/second
Note:   Skew estimate 1.25 +/- 1.25 ns (assuming constant link rate)
```

4.2 SpW IP Configuration 2 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 17:48:19
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
   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
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: 011101000100010001000100010001
   S: 110111101110111011101110111011
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
```

```
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 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
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
```

```
[ErrorWait]


[Ready]


[Started]


[Connecting]


[Run]


[EOP/EEP]
Test:   Empty Packet (EOP)
Status: Success
Result: Did not disconnect (correct)
   Empty EOP packets sent:       8

Test:   Empty Packet (EEP)
Status: Success
Result: Did not disconnect (correct)
   Empty EEP packets sent:       8

Test:   Empty Packet Loopback (EOP)
Status: Success
Result: Did not disconnect (correct)
   Empty EOP packets sent:       8
   Empty EOP packets received:   0
   Empty EEP packets received:   0

Test:   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:   0

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
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
```

```
Test:   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
Note:   First time-code after link reset was 3 not 1


[Credit]
Test:   FCT Overflow Check
Status: Success
Result: All tests passed
   Response to  1 FCT:          correct: did not move to ErrorReset
   Response to  2 FCTs:         correct: did not move to ErrorReset
   Response to  3 FCTs:         correct: did not move to ErrorReset
   Response to  4 FCTs:         correct: did not move to ErrorReset
   Response to  5 FCTs:         correct: did not move to ErrorReset
   Response to  6 FCTs:         correct: did not move to ErrorReset
   Response to  7 FCTs:         correct: did not move to ErrorReset
   Response to  8 FCTs:         correct: moved to ErrorReset
   Response to  9 FCTs:         correct: moved to ErrorReset
   Response to 10 FCTs:         correct: moved to ErrorReset
   Response to 11 FCTs:         correct: moved to ErrorReset
   Response to 12 FCTs:         correct: moved to ErrorReset
   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
Note:   See Waveform panel for updated waveform trace
Note:   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 100.00 Mbits/second
        UUT link rate too high relative to TLI link rate
Note:   Used UUT receive time of 2 seconds
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
Note:   See Waveform panel for updated waveform trace
Note:   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 100.00 Mbits/second
        UUT link rate too high relative to TLI link rate
Note:   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>

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 0f 0d <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:   Connecting 12.8 microsecond timeout
Status: Success
Result: Valid timeout duration (11.640 < 12.900 < 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)

Test:   NULL Arrival Times
Status: Success
Result: Success
Note:   Unable to identify first ErrorReset segment
Note:   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)
```

```
Note:   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
                  Measured rate      Accuracy  Minimum Rate       Maximum Rate
   Bit-to-bit:    101.59 +/-  12.70     19.05   88.89 +/-  11.11  114.29 +/-  19.05
   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
Note:   Measurement duration 40.95 microseconds (4095 bits)
Note:   Average link rate 100.00 Mbits/second
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
Date/time:        20-Jul-2021 16:54:51
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

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  10.00 +/- 0.06
Note:   Measurement duration 12.60 microseconds (126 bits)
Note:   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

Test:   Link Shutdown Analysis
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 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
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
```

```
   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


[ErrorWait]


[Ready]


[Started]


[Connecting]


[Run]


[EOP/EEP]
Test:   Empty Packet (EOP)
Status: Success
Result: Did not disconnect (correct)
   Empty EOP packets sent:       8

Test:   Empty Packet (EEP)
Status: Success
Result: Did not disconnect (correct)
   Empty EEP packets sent:       8

Test:   Empty Packet Loopback (EOP)
Status: Success
Result: Did not disconnect (correct)
   Empty EOP packets sent:       8
   Empty EOP packets received:   0
   Empty EEP packets received:   0

Test:   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:   0

Test:   Send Packet With EEP
Status: Success
Result: Successfully transmitted the packet
   Packet transmitted (hexadecimal):
```

```
      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

Test:   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 Hz
   Maximum tick frequency  = 1.00 Hz
Note:   First time-code after link reset was 32 not 1


[Credit]
Test:   FCT Overflow Check
Status: Success
Result: All tests passed
   Response to  1 FCT:          correct: did not move to ErrorReset
   Response to  2 FCTs:         correct: did not move to ErrorReset
   Response to  3 FCTs:         correct: did not move to ErrorReset
   Response to  4 FCTs:         correct: did not move to ErrorReset
   Response to  5 FCTs:         correct: did not move to ErrorReset
   Response to  6 FCTs:         correct: did not move to ErrorReset
   Response to  7 FCTs:         correct: did not move to ErrorReset
   Response to  8 FCTs:         correct: moved to ErrorReset
   Response to  9 FCTs:         correct: moved to ErrorReset
   Response to 10 FCTs:         correct: moved to ErrorReset
   Response to 11 FCTs:         correct: moved to ErrorReset
   Response to 12 FCTs:         correct: moved to ErrorReset
   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
Result: UUT disconnected
Note:   See Waveform panel for updated waveform trace
Note:   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
Note:   Used UUT receive time of 2 seconds
Note:   Result might be due to empty packet handling not NCHAR credit error
```

```
Test:   NCHAR (EEP) Overflow Check
Status: Success
Result: UUT disconnected
Note:   See Waveform panel for updated waveform trace
Note:   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
Note:   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>

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 0f 0d <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
```

```
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)

Test:   NULL Arrival Times
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
Note:   Edge 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:   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)
Note:   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
                  Measured rate      Accuracy  Minimum Rate       Maximum Rate
   Bit-to-bit:      2.00 +/-   0.01      0.01    2.00 +/-   0.00    2.01 +/-   0.01
   Rise-to-rise:    0.00 +/-   0.00      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 +/-   0.00
Note:   All rate measurements are in Mbits/second
Note:   Measurement duration 40.50 microseconds (81 bits)
Note:   Average link rate 2.00 Mbits/second
Note:   Skew estimate 1.25 +/- 1.25 ns (assuming constant link rate)
```

4.4 Disconnect timeout test diagrams

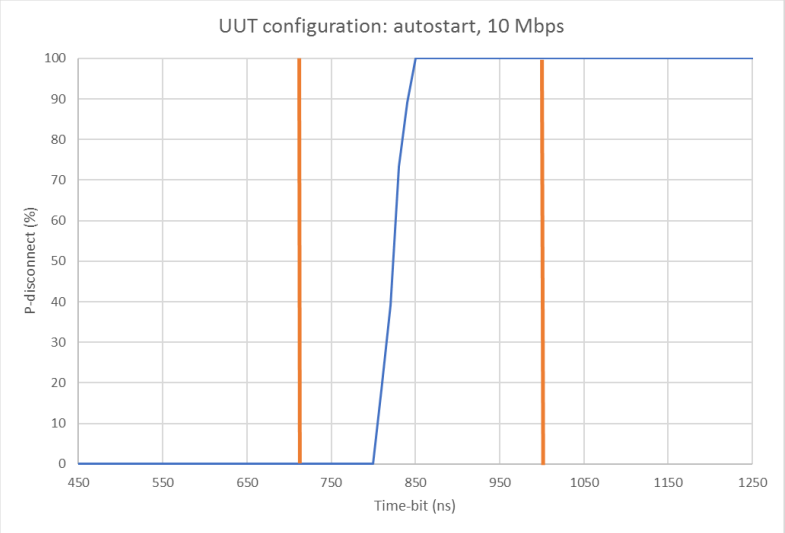

Diagram 1: Disconnection timeout for configuration 1

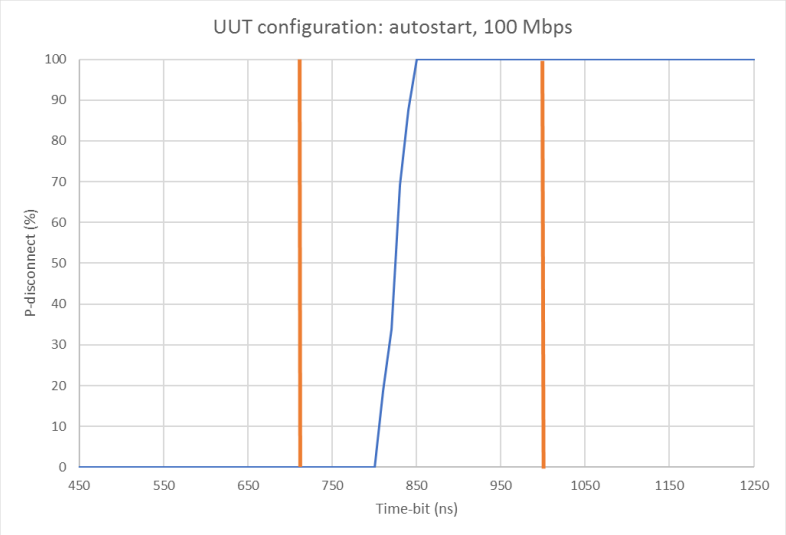

Diagram 2: Disconnection timeout for configuration 2

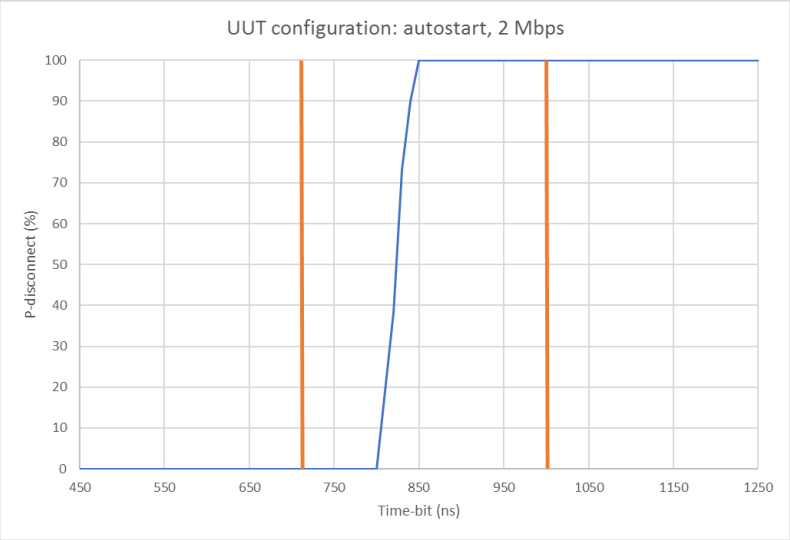

Diagram 3: Disconnection timeout for configuration 3

4.5 NULL arrival time test diagrams

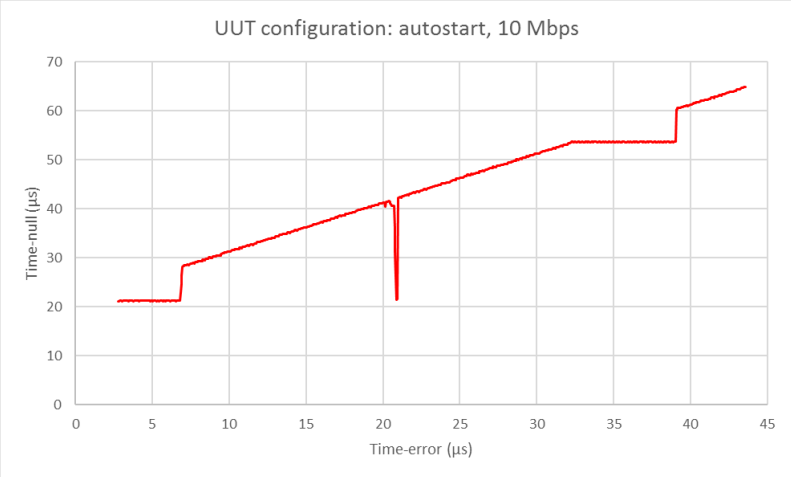

Diagram 4: NULL arrival time for configuration 1

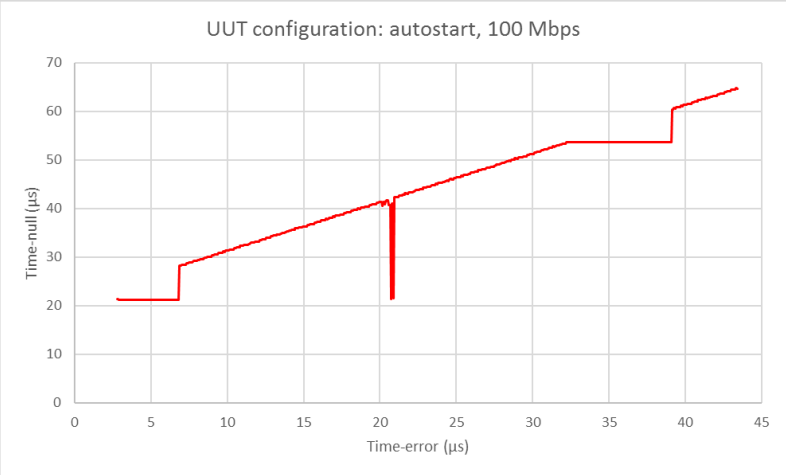

Diagram 5: NULL arrival time for configuration 2

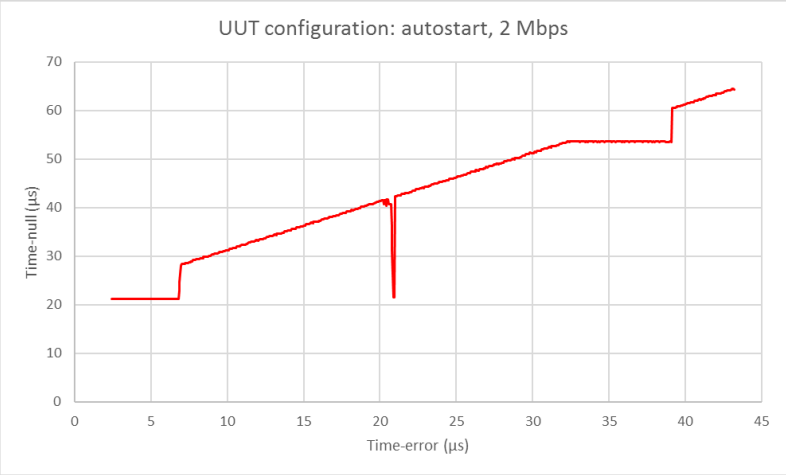

Diagram 6: NULL arrival time for configuration 3

4.6 Error recovery time test diagrams

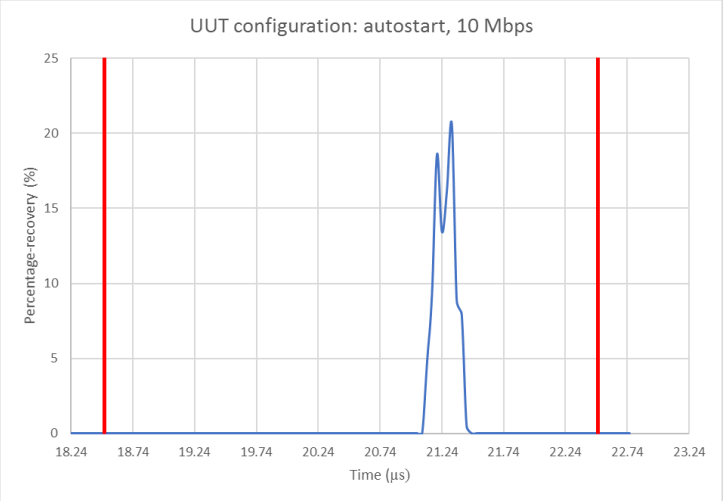

Diagram 7: Error recovery time for configuration 1

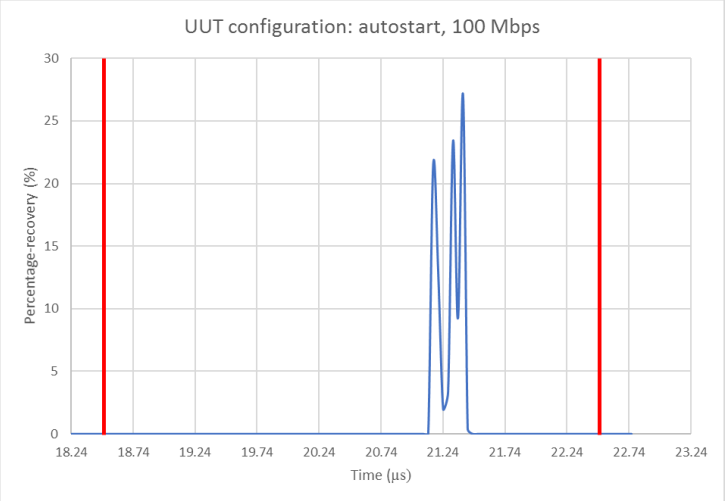

Diagram 8: Error recovery time for configuration 2

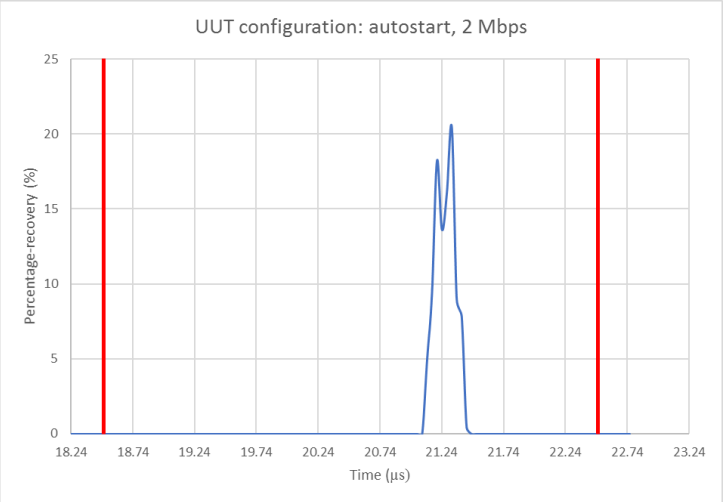

Diagram 9: Error recovery time for configuration 3