

USB4 SIGTEST User Manual

Date: Jun , 2024

Revision: 0.95

Revision History:

Revision	Issue Date	Comments
0.5	Feb 2022	GEN2-3 – no change Added guidance for GEN4 TX tests: UI, SSC, Jitter, Vertical voltage tests, ACCM
0.7	Mar 2022	Added guidance for GEN4 TX tests: EI, RL, IRL Added guidance for GEN4 RX tests: RX calibration at TP3', RL, IRL
0.72	Apr 2022	Added guidance for GEN4 RX tests: RX calibration at TP3
0.83	Dec 2022	Editorial Added GEN4 RX/TX frequency variation tests Added Swing Attenuation analysis for presets40/41 in GEN4 TX txffe test Removed GEN4 TX TX_PULSE_PEAK Measurement in ui_jitter_vertical test report
0.85	Jan 2023	Improved GEN4 txffe analysis accuracy Fixed GEN4 TX_ISI_MARGIN analysis
0.86	Feb-Mar 2023	Editorial Fixing EI test – Vpeak instead of ptp Added missing comma in GEN4 test report – Informative: Symbol rate Updated GEN4 RX stressed signal calibration section. Added BERT Insertion Loss extraction procedure Updated GEN4 RX channel calibration to worst case condition algorithm. Added allowed convergence conditions
0.87	Sep 2023	Editorial Updated TX GEN2/3 non-rounded SSC rate and phase deviation limits according to spec change Added Aggressor's calibration procedure for GEN4 RX testing Added de-embedding support for TX GEN4 tests

		<p>Aligned TX_ISI_MARGIN analysis between IRL and ui_jitter_vertical tests</p> <p>Updated best preset selection criteria in GEN4 TXFFE test</p>
0.9	Jan 2024	<p>Editorial</p> <p>Updated best preset selection criteria in GEN4 TXFFE test</p> <p>Updated BERT Insertion Loss extraction test, added BERT frequency response new plot</p> <p>Updated RX GEN4 channel calibration to worst case condition test: changed end-to-end ILfit tolerance range to $28.5 \pm 0.5\text{dB}$; removed VSWING adjustment; updated RX calibration report format; added two new plots; updated SigTest abort notification wording in case of extracted end-to-end channel ILfit at Nyquist is out of defined 1dB tolerance window and in case the end-to-end operating margin is far-off the target $0\text{dB} \pm 0.1\text{dB}$</p> <p>Removed EVEN/ODD jitter impact out of TX GEN4 SNDR calculation</p> <p>Changed termination to 50ohm in all GEN4 TX/RX voltage related tests (aligned to Signal Analyzer and Generator termination)</p> <p>Updated TX/RX SWING limits according to ECR</p> <p>Updated GEN4 TX/RX IRL limits according to ECR</p> <p>Added LFPS test support (still under development)</p>
0.95	Jun 2024	<p>Updated RX GEN4 channel calibration to worst case condition test: fixed BERT IL extraction</p> <p>Updated TX GEN4 tx_frequency_variation function</p> <p>Updated TX_ISI_MARGIN limit according to ECR</p> <p>Updated LFPS RX calibration function</p> <p>Added Gen4 Pattern detect function</p>

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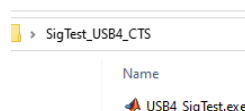
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1 Introduction

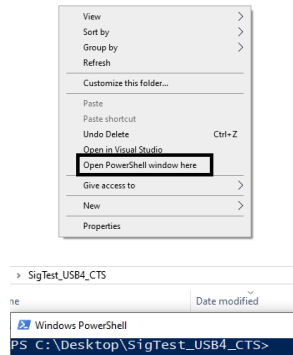
SigTest is the USB4 post-processing analysis software tool. SigTest is capable of rendering the signal quality measurements captured with the Oscilloscope. The post processed parameters are checked against the specified pass/fail criteria.

2 Installation and execution:

- System requirements:
Minimum memory: 32GB RAM
Recommended memory: 48GB RAM and higher.
- Install Matlab Runtime Compiler MCR R2021b.
- Run the executable .exe file:
 - Create folder, for example "SigTest_USB4_CTS"
 - Place the USB4_SigTest.exe into the folder "SigTest_USB4_CTS"



- Open PowerShell window from the folder created in #1 by pressing SHIFT + Right mouse button and then press on "Open PowerShell window here"



3 Usage

3.1 Command template

USB4_SigTest.exe technology test_mode test_point cts_test_name wdir file1 file2
report_name de_embedding

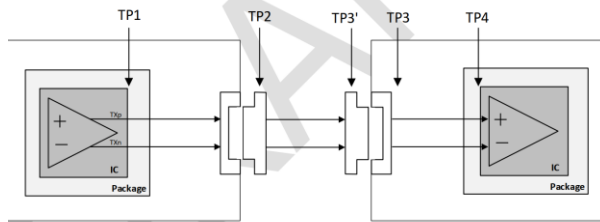
3.2 Input arguments list

1. technology = **gen2_rounded/gen2_legacy/gen3_rounded/gen3_legacy/gen4**

SigTest supports all USB4 bitrates:

gen2_rounded = 10Gb/s
gen3_rounded = 20Gb/s
gen2_legacy = 10.3125Gb/s
gen3_legacy = 20.625Gb/s
gen4 = 25.6Gb/s

2. test_mode = **tx/rx**
tx - SigTest supports the transmitter Router Assembly compliance tests.
rx - SigTest supports the receiver Router Assembly stressed eye calibration.
3. test_point = **tp2/tp3_prime/tp3**
 SigTest supports the Router Assembly compliance tests at following test points.



tp2 - transmitter Router Assembly compliance test point, which requires the de-embedding of 1 m coax cable.

tp3 - transmitter Router Assembly compliance test point, which requires the de-embedding of 1 m coax cable and embedding of 2m/0.8m passive cable for Gen2/Gen3 respectively.

tp3_prime (TP3' in the screenshot above) - receiver Router Assembly stressed eye calibration test point. No de-embedding / embedding is required.

tp3 - receiver Router Assembly stressed eye calibration test point, which requires the de-embedding of 1 m coax cable.

4.

Gen2-3 cts_test_name =

ui_ssc_eye/rise_fall_time/jitter/ac_common_mode/transmitter_equalization/electrical_idle_voltage/tx_frequency_variation_training/tp3

ui_ssc_eye – the test done using PRBS31 pattern and includes the following transmitter compliance tests: Minimum Unit Interval, SSC_Down_Spread_Range, SSC_Down_Spread_Rate, SSC_Phase_Deviation, SSC_Slew_Rate, Eye Diagram Measurement (including eye height and eye width measurements).

Test Methods in the CTS section Gen2: 3.3.2.4, 3.3.3.4, 3.3.4.4, 3.3.5.4, 3.3.6.4, 3.3.17.4 Gen3: 3.4.2.4, 3.4.3.4, 3.4.4.4, 3.4.5.4, 3.4.6.4, 3.4.17.4

rise_fall_time – the test done using SQ128 pattern and includes the following transmitter compliance tests: Rise Time, Fall Time.

Test Method in the CTS section Gen2: 3.3.8.4 Gen3: 3.4.8.4

jitter - the test done using PRBS15 pattern and includes the following transmitter compliance tests: Total Jitter, UJ, UDJ, DDJ, UDJ_LF, DCD.

Test Methods in the CTS section Gen2: 3.3.10.4, 3.3.11.4, 3.3.12.4, 3.3.13.4, 3.3.14.4, 3.3.15.4 Gen3: 3.4.10.4, 3.4.11.4, 3.4.12.4, 3.4.13.4, 3.4.14.4, 3.4.15.4

ac_common_mode – the test done using PRBS31 pattern and includes the following transmitter compliance test: AC_CM.

Test Method in the CTS section Gen2: 3.3.16.4 Gen3: 3.4.16.4

transmitter_equalization - the test done using SQ128 pattern and includes the following transmitter compliance test: Pre-shoot and De-emphasis for all USB4 v1 (GEN2-3) presets.

Test Method in the CTS section Gen2: 3.3.1.4 Gen3: 3.4.1.4

electrical_idle_voltage - the test done when the DUT is in electrical idle mode and includes the following transmitter compliance test: V_ELEC_IDLE.

Test Method in the CTS section Gen2: 3.3.9.4 Gen3: 3.4.9.4

tx_frequency_variation_training - the test done using several patterns PRBS31, SQ128, SQ4 as described in the CTS section 3.3.7.4 and includes the following transmitter compliance test: INIT_FREQ_VARIATION, DELTA_FREQ_200ns, DELTA_FREQ_1000ns.

Test Method in the CTS section Gen2: 3.3.7.4 Gen3: 3.4.7.4

tp3 - the test done using several patterns PRBS31, PRBS15 as described in the CTS section Gen2: 3.3.18.4, 3.3.19.4, 3.3.20.4, 3.3.21.4 Gen3: 3.4.18.4, 3.4.19.4, 3.4.20.4, 3.4.21.4

Gen4 cts_test_name =

txffe_test/ui_jitter_vertical/ac_common_mode/electrical_idle_voltage/rl/calibration/calibration_bert_il_extraction/tx_frequency_variation/rx_frequency_variation

cts_test_name description embedded per command

5. wdir = waveform_directory

wdir – the full path to the waveform location

- Captured waveform can be provided in differential or single ended format
6. Captured waveform in Differential Format case:
file1 = waveform_name.bin/ waveform_name.trc/ waveform_name.wfm
waveform_name – the waveform full name, including the waveform format that represent the scope vendor:
waveform_name.bin – KS Scope
waveform_name.trc – Lecroy Scope
waveform_name.wfm – TEK Scope
file2 = **none** – this input parameter shall be “none” in this SigTest revision
 7. Captured waveform in Single Ended Format case:
file1 = waveform_name_p.bin/ waveform_name_p.trc/ waveform_name_p.wfm
waveform_name_p is Single Ended P signal
file2 = waveform_name_n.bin/ waveform_name_n.trc/ waveform_name_n.wfm
waveform_name_n is Single Ended N signal
 8. report_name = **report_name**
report_name – any relevant report name chosen by operator.
 9. de_embedding:
 - **none** – this input parameter shall be “none” in this SigTest revision for GEN2-3
 - **full path to s4p file** - this input parameter shall be full path to s4p file (including) for GEN4

4 Scope settings

4.1 Data acquisition setting

1. Sampling Rate $\geq 80\text{GSa/s}$ for Gen2/Gen3/Gen4
2. The evaluated record length shall be $500\mu\text{s}$ per channel
3. No CDR, no average, no interpolation and no equalization shall be applied
4. The scope BW shall be 16GHz for Gen2, 21GHz for Gen3, 25G for Gen4
5. Adjust vertical scale to fit signal into scope screen
6. The saved waveforms for all Gen2-3 Router Assembly compliance transmitter and receiver tests shall be differential (for example: CH1 - CH3), except of the waveform for **ac_common_mode** test that shall be common (for example: (CH1 + CH3)/2). For Gen4 Router Assembly compliance transmitter and receiver tests can be in differential or single ended formats
7. The waveforms shall include the correct test pattern type per test according to the CTS and the tests pattern length, otherwise the test will interrupt and exit

4.2 Cable assembly de-embedding/embedding

- a. **USB4-V2 (GEN2-GEN3):** The waveforms shall include the De-embedding and Embedding depend on the Router Assembly compliance test point and the test mode as following:

Test mode: Tx, Test point: TP2

- De-embedding of the cable from the plug test fixture to the scope

Test mode: Tx, Test point: TP3

- De-embedding of the cable from the plug test fixture to the scope and the embedding of Type-C cable 2m for Gen2, 0.8m for Gen3 speeds

Test mode: Rx, Test point: TP3 Prime

- No de-embedding and no embedding shall be applied

Test mode: Rx, Test point: TP3

De-embedding of the cable connecting from the last receptacle to the scope

- b. **USB4-V2 (GEN4):** The waveforms shall not include the De-embedding. SigTest version includes de-embedding analysis. Cable assembly connecting DUT to Oscilloscope shall be measured using Network analyzer, then provided as parameter to SigTest tool for every test related to USB4-V2 GEN4

5 GEN2-3 Router Assembly Transmitter Testing

5.1 General notes

- a) All setups and test procedures shall be the same as described in the USB4 Electrical - Router Assembly Compliance Test Specification paragraph 3.
- b) The SigTest post processed results shall replace the scope application calculations.

5.2 TP2

1. cts_test_name - **ui_ssc_eye**

Run the following command from the PowerShell window:





```
.\USB4_SigTest.exe gen2_rounded tx tp2 ui_ssc_eye  
C:\Desktop\SigTest_USB4_CTS\Waveforms\TP2\ tp2_prbs31.bin none ui_ssc_eye none
```

```
Running SIGTEST : Technology : GEN2_ROUNDED, TestMode : TX, TestPoint : TP2  
The following tests are in progress ...  
Minimum Unit Interval Measurement  
SSC Down Spread Range Measurement  
SSC Down Spread Rate Measurement  
SSC Phase Deviation Measurement  
SSC Slew Rate Measurement  
Eye Diagram Measurement  
Loading File tp2_prbs31.bin ....  
Writing tie_period_frequency_gen2_rounded_tp2_ui_ssc_eye.jpg  
Writing eye_diagram_gen2_rounded_tp2_ui_ssc_eye.jpg  
Writing result to .\ui_ssc_eye_result_21-Oct-2020.csv  
The tests are completed
```

Report files location:

SigTest_USB4_CTS

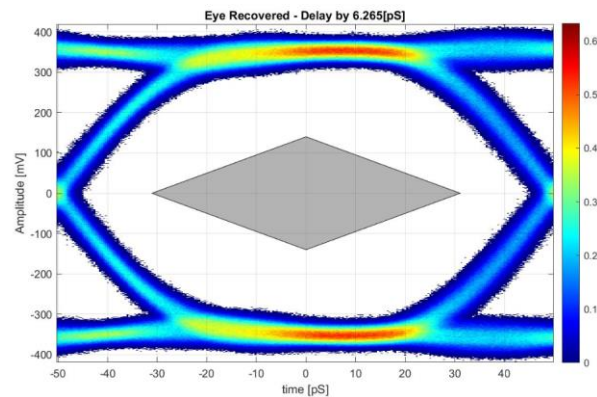
Name

 ui_ssc_eye_result_21-Oct-2020.csv
 eye_diagram_gen2_rounded_tp2_ui_ssc_eye.jpg
 tie_period_frequency_gen2_rounded_tp2_ui_ssc_eye.jpg
 USB4_SigTest.exe

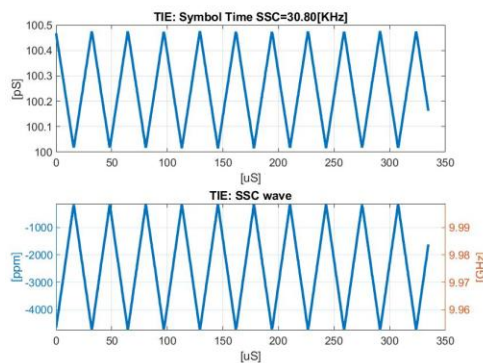
- 1.1.1. The .CSV file ui_ssc_eye_result_21-Oct-2020.csv

Electrical Compliance Test Specification for gen2_rounded									
Date:	21-Oct-20								
DIR:C:\Desktop\SigTest_USB4_CTS\Waveforms\TP2\									
File: tp2_prbs31.bin									
Minimum Unit Interval Measurement [pS]:	PASS	UI Min Min	100.016081	UI Min Max	100.019604	CTS: UI Min Min	99.97	CTS: UI Min Max	100.03
SSC Down Spread Range Measurement[%]:	PASS	Min SSC_Down_Spread_Range	0.451389	Max SSC_Down_Spread_Range	0.458343	CTS: Min SSC_Down_Spread_Range	0.4	CTS: Max SSC_Down_Spread_Range	0.5
SSC Down Spread Rate Measurement[KHz]:	PASS	Min SSC Down Spread Rate	30.716886	Max SSC Down Spread Rate	30.887801	CTS: Min SSC Down Spread Rate	30	CTS: Max SSC Down Spread Rate	33
SSC Phase Deviation Measurement [ns p-p]:	PASS	SSC Phase Deviation	18.959192	CTS: Min SSC Phase Deviation	2.5	CTS: Max SSC Phase Deviation	22		
SSC Slew Rate Measurement [ppm/us]:	PASS	SSC Slew Rate	550.560944	CTS: SSC Slew Rate	1250				
Eye Diagram Measurement:	PASS	Eye: Count of Violation	0 EyeWidth [pS]		89.281492	EyeHeight[mV]	593.984185		
Informative: Symbol Rate [GHz]:	NONE	Symbol Rate	9.975472	Drift [PPM]	-2452.82				

1.2. The .jpg file eye_diagram_gen2_rounded_tp2_ui_ssc_eye.jpg



1.3. The .jpg file tie_period_frequency_gen2_rounded_tp2_ui_ssc_eye.jpg



2. cts_test_name - rise_fall_time



Run the following command from the PowerShell window:

```
.\USB4_SigTest.exe gen2_rounded tx tp2 rise_fall_time
C:\Desktop\SigTest_USB4_CTS\Waveforms\TP2\ tp2_sq128.bin none
gen2_rounded_rise_fall_time none
```

```
Running SIGTEST : Technology : GEN2_ROUNDED, TestMode : TX, TestPoint : TP2
The following tests are in progress ...
Rise/Fall Time Measurement
Loading File tp2_sq128.bin ....
Writing result to .\rise_fall_time_result_21-Oct-2020.csv
The tests are completed
```

Report files location:

SigTest_USB4_CTS

Name
 rise_fall_time_result_21-Oct-2020.csv
 USB4_SigTest.exe

2.1. The .CSV file gen2_rounded_rise_fall_time_result_21-Oct-2020.csv

Electrical Compliance Test Specification for gen2_rounded					
Date:	21-Oct-20				
DIR:C:\Desktop\SigTest_USB4_CTS\Waveforms\TP2\					
File: tp2_sq128.bin					
Rise-Time Measurement[pS]:	PASS	Rise Time	33.009421	CTS: Min Rise Time	10
Fall-Time Measurement[pS]:	PASS	Fall Time	32.982458	CTS: Min Fall Time	10

3. cts_test_name – jitter





Run the following command from the PowerShell window:

```
.\USB4_SigTest.exe gen2_rounded tx tp2 jitter
C:\Desktop\SigTest_USB4_CTS\Waveforms\TP2\ tp2_prbs15.bin none jitter none
```

```
Running SIGTEST : Technology : GEN2_ROUNDED, TestMode : TX, TestPoint : TP2
The following tests are in progress ...
Total Jitter Measurement
UJ Measurement
UDJ Measurement
DDJ Measurement
Low Frequency UDJ Measurement
DCD Measurement
Loading File tp2_prbs15.bin ....
Writing tj_bathtub_gen2_rounded_tp2_jitter.jpg
Writing histogram_pj_rj_ddj_gen2_rounded_tp2_jitter.jpg
Writing result to .\jitter_result_21-Oct-2020.csv
The tests are completed
```

Report files location:

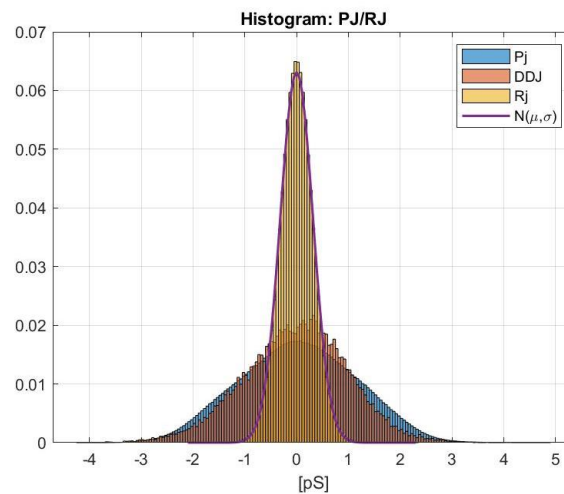
SigTest_USB4_CTS

Name
 jitter_result_21-Oct-2020.csv
 histogram_pj_rj_ddj_gen2_rounded_tp2_jitter.jpg
 tj_bathtub_gen2_rounded_tp2_jitter.jpg
 USB4_SigTest.exe

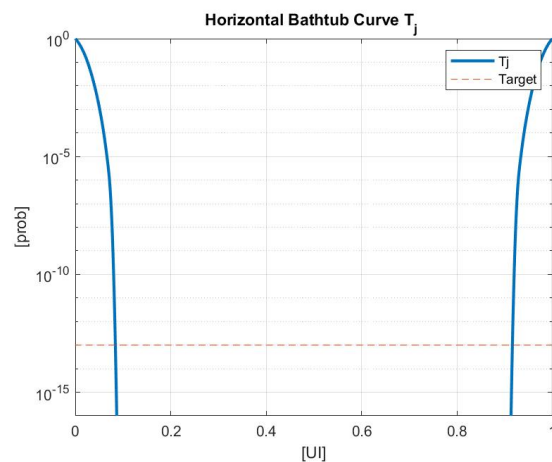
3.1. The .CSV file jitter_result_21-Oct-2020.csv

Electrical Compliance Test Specification for gen2_rounded					
Date:	21-Oct-20				
DIR:C:\Desktop\SigTest_USB4_CTS\Waveforms\TP2\					
File: tp2_prbs15.bin					
Total Jitter (BER=1e-13) Measurement Ulp-p:	PASS	Tj	0.168537	CTS: Max TJ	0.38
UJ Measurement Ulp-p:	PASS	UJ Jitter Ulp-p	0.090646	CTS: Max UJ	0.31
UDJ Measurement Ulp-p:	PASS	UDJ jitter Ulp-p	0.031796	CTS: Max UDJ	0.17
UDJ LF Measurement Ulp-p:	PASS	UDJ LF jitter Ulp-p	0.018213	CTS: Max UDJ LF	0.04
DDJ Measurement Ulp-p:	PASS	DDJ jitter Ulp-p	0.077891	CTS: Max DDJ	0.15
DCD Measurement Ulp-p:	PASS	DCD jitter Ulp-p	0.015579	CTS: Max DCD	0.03
Informative: Symbol Rate [GHz]:	NONE	Symbol Rate	9.975472	Drift [PPM]	-2452.85

3.2. The .jpg file histogram_pj_rj_ddj_gen2_rounded_tp2_jitter.jpg



3.3. The .jpg file tj_bathtub_gen2_rounded_tp2_jitter.jpg



4. cts_test_name - **ac_common_mode**

Run the following command from the PowerShell window:



```
.\USB4_SigTest.exe gen2_rounded tx tp2 ac_common_mode  
C:\Desktop\SigTest_USB4_CTS\Waveforms\TP2\ tp2_prbs31_common.bin none  
ac_common_mode none
```

```
Running SIGTEST : Technology : GEN2_ROUNDED, TestMode : TX, TestPoint : TP2  
The following tests are in progress ...  
AC Common Mode Measurement  
Loading File tp2_prbs31_common.bin ....  
Writing result to .\ac_common_mode_result_21-Oct-2020.csv  
The tests are completed
```

Report files location:

SigTest_USB4_CTS

Name

 ac_common_mode_result_21-Oct-2020.csv
 USB4_SigTest.exe

4.1. The .CSV file ac_common_mode_result_21-Oct-2020.csv

Electrical Compliance Test Specification for gen2_rounded					
Date:	21-Oct-20				
DIR:C:\Desktop\SigTest_USB4_CTS\Waveforms\TP2\					
File: tp2_prbs31_common.bin					
AC CM Measurement:	PASS	AC CM: Vac [mVp2p]	81.2	CTS: Max AC CM [mVp2p]	100

5. cts_test_name - **electrical_idle_voltage**

Run the following command from the PowerShell window:



```
.\USB4_SigTest.exe gen2_rounded tx tp2 electrical_idle_voltage  
C:\Desktop\SigTest_USB4_CTS\Waveforms\TP2\ tp2_eidle.bin none electrical_idle_voltage  
none
```

```
Running SIGTEST : Technology : GEN2_ROUNDED, TestMode : TX, TestPoint : TP2  
The following tests are in progress ...  
Electrical Idle Voltage Measurement  
Loading File tp2_eidle.bin ....  
Writing result to .\electrical_idle_voltage_result_21-Oct-2020.csv  
The tests are completed
```

Report files location:

SigTest_USB4_CTS

Name

 electrical_idle_voltage_result_21-Oct-2020.csv
 USB4_SigTest.exe

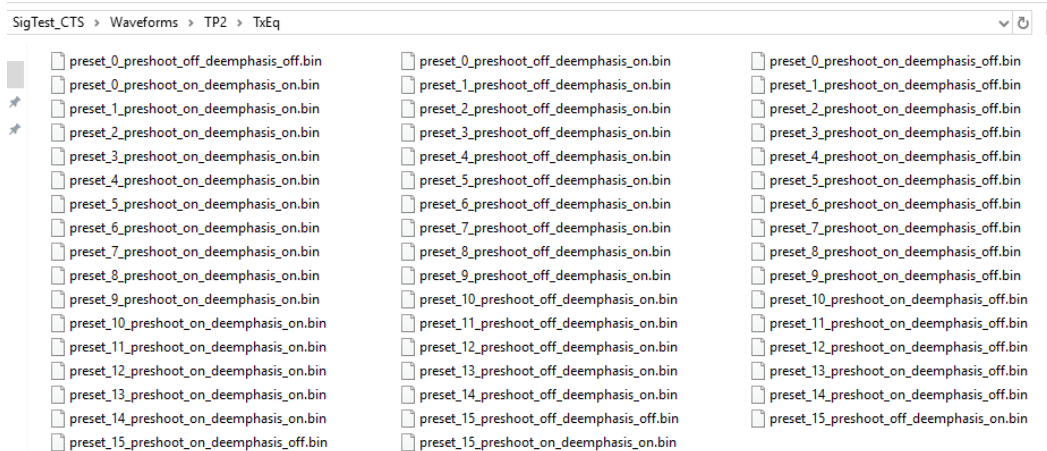
5.1. The .CSV file electrical_idle_voltage_result_21-Oct-2020.csv

Electrical Compliance Test Specification for gen2_rounded					
Date:	21-Oct-20				
DIR:C:\Desktop\SigTest_USB4_CTS\Waveforms\TP2\					
File: tp2_idle.bin					
Electrical Idle Voltage Measurement[mV]:	PASS	V_ELEC_IDLE	1.663508	CTS: Max V_ELEC_IDLE	20

6. cts_test_name - **transmitter_equalization**

Notes:

- The saved waveforms for each preset shall be located in the same folder.
- The waveforms names shall be the same as in the screenshot below.
- SIGEST is capable of analyzing partial presets set. (preset0 and preset15 must be included)



Run the following command from the PowerShell window:



```
.\USB4_SigTest.exe gen3_rounded tx tp2 transmitter_equalization  
C:\Desktop\SigTest_USB4_CTS\Waveforms\TP2\TxEq\ " " none transmitter_equalization  
none
```

```
Running SIGTEST : Technology : GEN3_ROUNDED, TestMode : TX, TestPoint : TP2  
The following tests are in progress ...  
Transmitter Equalization  
Loading File preset_0_preshoot_on_deemphasis_on.bin ....  
Loading File preset_0_preshoot_off_deemphasis_on.bin ....  
Loading File preset_0_preshoot_on_deemphasis_off.bin ....  
Loading File preset_1_preshoot_on_deemphasis_on.bin ....  
Loading File preset_1_preshoot_off_deemphasis_on.bin ....  
Loading File preset_1_preshoot_on_deemphasis_off.bin ....  
Loading File preset_2_preshoot_on_deemphasis_on.bin ....  
Loading File preset_2_preshoot_off_deemphasis_on.bin ....  
Loading File preset_2_preshoot_on_deemphasis_off.bin ....  
Loading File preset_3_preshoot_on_deemphasis_on.bin ....  
Loading File preset_3_preshoot_off_deemphasis_on.bin ....  
Loading File preset_3_preshoot_on_deemphasis_off.bin ....  
Loading File preset_4_preshoot_on_deemphasis_on.bin ....  
Loading File preset_4_preshoot_off_deemphasis_on.bin ....  
Loading File preset_4_preshoot_on_deemphasis_off.bin ....  
Loading File preset_5_preshoot_on_deemphasis_on.bin ....  
Loading File preset_5_preshoot_off_deemphasis_on.bin ....  
Loading File preset_5_preshoot_on_deemphasis_off.bin ....  
Loading File preset_6_preshoot_on_deemphasis_on.bin ....  
Loading File preset_6_preshoot_off_deemphasis_on.bin ....  
Loading File preset_6_preshoot_on_deemphasis_off.bin ....  
Loading File preset_7_preshoot_on_deemphasis_on.bin ....  
Loading File preset_7_preshoot_off_deemphasis_on.bin ....  
Loading File preset_7_preshoot_on_deemphasis_off.bin ....  
Loading File preset_8_preshoot_on_deemphasis_on.bin ....  
Loading File preset_8_preshoot_off_deemphasis_on.bin ....  
Loading File preset_8_preshoot_on_deemphasis_off.bin ....  
Loading File preset_9_preshoot_on_deemphasis_on.bin ....  
Loading File preset_9_preshoot_off_deemphasis_on.bin ....  
Loading File preset_9_preshoot_on_deemphasis_off.bin ....  
Loading File preset_10_preshoot_on_deemphasis_on.bin ....  
Loading File preset_10_preshoot_off_deemphasis_on.bin ....  
Loading File preset_10_preshoot_on_deemphasis_off.bin ....  
Loading File preset_11_preshoot_on_deemphasis_on.bin ....  
Loading File preset_11_preshoot_off_deemphasis_on.bin ....  
Loading File preset_11_preshoot_on_deemphasis_off.bin ....  
Loading File preset_12_preshoot_on_deemphasis_on.bin ....  
Loading File preset_12_preshoot_off_deemphasis_on.bin ....  
Loading File preset_12_preshoot_on_deemphasis_off.bin ....  
Loading File preset_13_preshoot_on_deemphasis_on.bin ....  
Loading File preset_13_preshoot_off_deemphasis_on.bin ....  
Loading File preset_13_preshoot_on_deemphasis_off.bin ....  
Loading File preset_14_preshoot_on_deemphasis_on.bin ....  
Loading File preset_14_preshoot_off_deemphasis_on.bin ....  
Loading File preset_14_preshoot_on_deemphasis_off.bin ....  
Loading File preset_15_preshoot_on_deemphasis_on.bin ....  
Loading File preset_15_preshoot_off_deemphasis_on.bin ....  
Loading File preset_15_preshoot_on_deemphasis_off.bin ....  
Loading File preset_0_preshoot_off_deemphasis_off.bin ....  
Loading File preset_15_preshoot_off_deemphasis_off.bin ....  
Writing result to .\transmitter_equalization_result_21-Oct-2020.csv  
The tests are completed
```

Report files location:

SigTest_USB4_CTS

Name

 transmitter_equalization_result_21-Oct-2020.csv
 USB4_SigTest.exe

6.1. The .CSV file transmitter_equalization_result_21-Oct-2020.csv

Electrical Compliance Test Specification for gen3_rounded						
Date:	21-Oct-20					
DIR:C:\Desktop\SigTest_USB4_CTS\Waveforms\TP2\TxEq\						
File:						
Transmitter Equalization Test:						
Preset#	Pre-shoot	De-emphasis	Pre-shoot[dB]	De-emphasis[dB]	CTS: Pre-shoot[dB]	CTS: De-emphasis[dB]
0	PASS	PASS	0	0	0	0
1	PASS	PASS	0	-1.4	0	-1.9
2	PASS	PASS	0	-3.3	0	-3.6
3	PASS	PASS	0	-4.4	0	-5
4	PASS	PASS	0	-7.7	0	-8.4
5	PASS	PASS	0.7	0	0.9	0
6	PASS	PASS	0.8	-1.6	1.1	-1.9
7	PASS	PASS	1.2	-3.8	1.4	-3.8
8	PASS	PASS	1.4	-5.2	1.7	-5.8
9	PASS	PASS	2.4	-7.8	2.1	-8
10	PASS	PASS	1.4	0	1.7	0
11	PASS	PASS	1.8	-1.9	2.2	-2.2
12	PASS	PASS	2.2	-3	2.5	-3.6
13	PASS	PASS	3.2	-6.3	3.4	-6.7
14	PASS	PASS	4.2	0.2	3.6	0
15	PASS	PASS	1.4	-1.4	1.7	-1.7
Swing	Swing[dB]	CTS: Min Swing[dB]	CTS: Max Swing[dB]			
PASS	3.3	2.5	4.5			

7. cts_test_name – tx_frequency_variation_training

Run the following command from the PowerShell window:




```
.\USB4_SigTest.exe gen3_rounded tx tp2 tx_frequency_variation_training
C:\Desktop\SigTest_USB4_CTS\Waveforms\ tx_frequency_variation_training.bin none
tx_frequency_variation_training none
```

```
Running SIGTEST : Technology : GEN3_ROUNDED, TestMode : TX, TestPoint : TP2
The following tests are in progress ...
TX Frequency Variation Training Measurement
Loading File tx_frequency_variation_training.bin ...
Writing clock_switch_analysis_gen3_rounded_tp2_tx_frequency_variation_training.jpg
Writing result to .\tx_frequency_variation_training_result_25-Oct-2020.csv
The tests are completed
```

Report files location:

SigTest_USB4_CTS

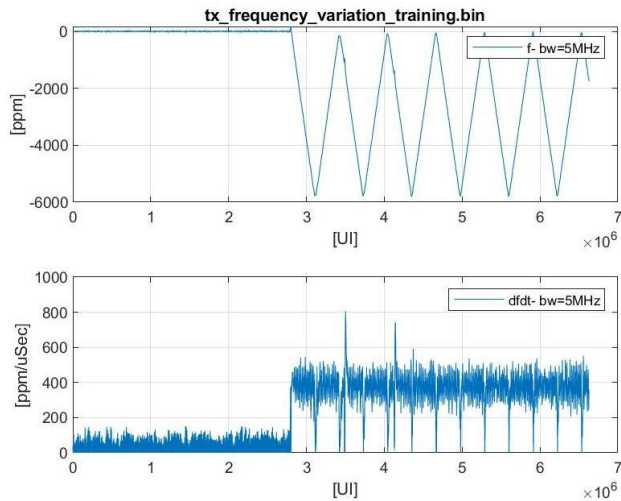
Name

-  tx_frequency_variation_training_result_22-Oct-2020.csv
-  clock_switch_analysis_gen3_rounded_tp2_tx_frequency_variation_training.jpg
-  USB4_SigTest.exe

7.1. The .csv file tx_frequency_variation_training_result_22-Oct-2020.csv

Electrical Compliance Test Specification for gen3_rounded						
Date:	22-Oct-20					
DIR:C:\Desktop\SigTest_USB4_CTS\Waveforms\						
File: tx_frequency_variation_training.bin						
TX Frequency Variation Training Measurement:						
INIT_FREQ_VARIATION:	PASS	INIT_FREQ_VARIATION result:	60.724875	CTS: Min INIT_FREQ_VARIATION	-300	CTS: Max INIT_FREQ_VARIATION 300
DELTA_FREQ_200nS:	PASS	DELTA_FREQ_200nS result:	190.715962	CTS: Max DELTA_FREQ_200nS	1400	
DELTA_FREQ_1000nS:	PASS	DELTA_FREQ_1000nS result:	673.97266	CTS: Max DELTA_FREQ_1000nS	2200	
Informative: Symbol Rate [GHz]:	NONE	Symbol Rate	19.949354	Drift [PPM]	-2532.28	

- 7.2. The .jpg file
clock_switch_analysis_gen3_rounded_tp2_tx_frequency_variation_training.jpgz



5.3 TP3







8. cts_test_name – **tp3**

Notes:

- Save 5 waveforms with PRBS31 pattern using the scope configuration above.
- Save 1 waveform with PRBS15 pattern using the scope configuration above.
- The saved waveforms for each trial shall be in the same folder.
1 trial – prbs15 and 5 trials – prbs31.
- The waveforms names shall be the same as in the screenshot below.

SigTest_USB4_CTS > Waveforms > TP3

Name






-  tp3_prbs15.bin
-  tp3_prbs31_trial_1.bin
-  tp3_prbs31_trial_2.bin
-  tp3_prbs31_trial_3.bin
-  tp3_prbs31_trial_4.bin
-  tp3_prbs31_trial_5.bin

Run the following command from the PowerShell window:

```
.\USB4_SigTest.exe gen2_rounded tx tp3 tp3  
C:\Desktop\SigTest_USB4_CTS\Waveforms\TP3\ tp3.bin none eye_jitter none
```

```
Running SIGTEST : Technology : GEN2_ROUNDED, TestMode : TX, TestPoint : TP3  
The following tests are in progress ...  
Total Jitter TP3 Measurement  
UJ TP3 Measurement  
UDJ TP3 Measurement  
Eye Diagram TP3 Measurement  
Loading File tp3_prbs31_trial_1.bin ...  
Loading File tp3_prbs31_trial_2.bin ...  
Loading File tp3_prbs31_trial_3.bin ...  
Loading File tp3_prbs31_trial_4.bin ...  
Loading File tp3_prbs31_trial_5.bin ...  
Loading File tp3_prbs31_trial_2.bin ...  
Writing eye_diagram_gen2_rounded_tp3_eye_jitter.jpg  
Loading File tp3_prbs15.bin ...  
Writing tj_bathtub_gen2_rounded_tp3_eye_jitter.jpg  
Writing histogram_pj_rj_ddj_gen2_rounded_tp3_eye_jitter.jpg  
Writing result to .\eye_jitter_result_25-Oct-2020.csv  
The tests are completed
```

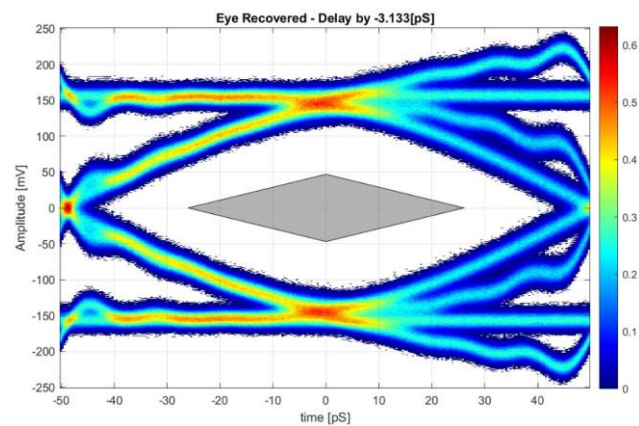
Report files location:

SigTest_USB4_CTS	
	Name
	eye_jitter_result_21-Oct-2020.csv
	histogram_pj_rj_ddj_gen2_rounded_tp3_eye_jitter.jpg
	tj_bathtub_gen2_rounded_tp3_eye_jitter.jpg
	eye_diagram_gen2_rounded_tp3_eye_jitter.jpg
	USB4_SigTest.exe

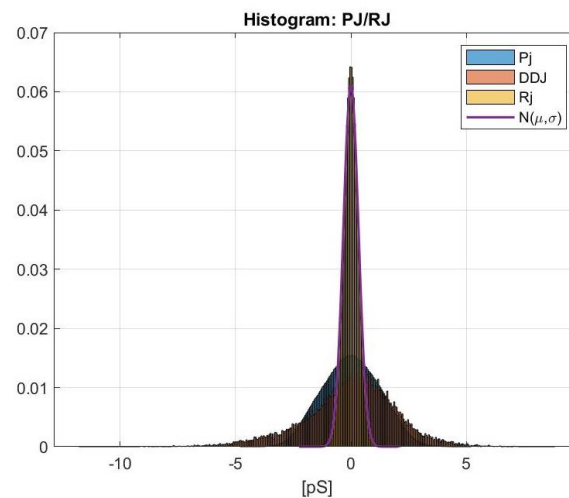
8.1.1. The .CSV file eye_jitter_result_21-Oct-2020.csv

Electrical Compliance Test Specification for gen2_rounded															
Date:	21-Oct-20														
DIR C:\Desktop\SigTest_USB4_CTS\Waveforms\TP3\															
File: tp3.bin															
Total Jitter (BER=1e-13) Measurement Up-p:	PASS	TJ	0.299601 CTS: Max TJ		0.6										
UI Measurement Up-p:	PASS	UI Jitter Up-p	0.093693 CTS: Max UI		0.31										
UI Measurement Up-p:	PASS	UI Jitter Up-p	0.094974 CTS: Max UI		0.17										
Eye Diagram Measurements:	PASS	Eye Count of Violation	0 EyeWidth[ps]		81.841387 EyeHeight[mV]		207.027864								
Informative: Symbol Rate [G/s]	NONE	Symbol Rate	9.975465 Drift [PPM]		-2453.53										
CTLE-Adc[dB]	0	DfE[mV]	Eye Height[mV]	Eye Width[ps]	Eye Height[mV]	Eye Width[ps]	Eye Height[mV]	Eye Width[ps]	Eye Height[mV]	Eye Width[ps]	Eye Height[mV]	Eye Width[ps]	Eye Height[mV]	Eye Width[ps]	Area[mV*ps]
1	0	50	1.409	0.785	0.285	1.175	0.318	1.175	1.457	0.783	0.315	0.783	0.76	0.94	0.64
0.891	1	48.2	142.647	62.262	129.546	59.129	140.216	63.437	141.373	61.479	136.547	61.479	138.07	61.557	8504.51
0.794	2	42	170.9	71.269	162.341	70.877	172.953	70.485	172.992	70.485	168.59	70.485	169.56	70.72	11990.66
0.708	3	36.7	197.61	78.317	191.643	77.925	199.418	79.883	198.652	80.275	194.414	79.1	196.35	79.1	15533.05
0.631	4	32	208.352	82.233	205.568	80.667	206.991	81.058	208.858	82.235	205.37	83.016	207.03	81.841	16943.65
0.562	5	27.8	196.69	80.275	195.141	82.235	197.331	83.016	199.43	82.625	194.596	81.45	196.64	81.92	16109.95
0.501	6	24	185.353	76.751	182.983	76.359	185.388	79.883	185.091	79.492	181.683	74.01	184.1	77.299	14233.46
0.447	7	20.7	170.463	70.877	168.146	72.443	172.005	72.443	171.527	71.269	168.334	72.052	170.09	71.817	12215.35
0.398	8	17.8	154.847	66.57	153.365	67.744	156.741	67.744	156.386	67.744	154.618	67.744	155.19	67.509	10476.95
0.355	9	15.2	138.71	62.262	139.772	61.87	142.913	63.045	140.059	63.828	140.079	63.045	140.31	62.81	8815.04
Optimal CTLE: 4															

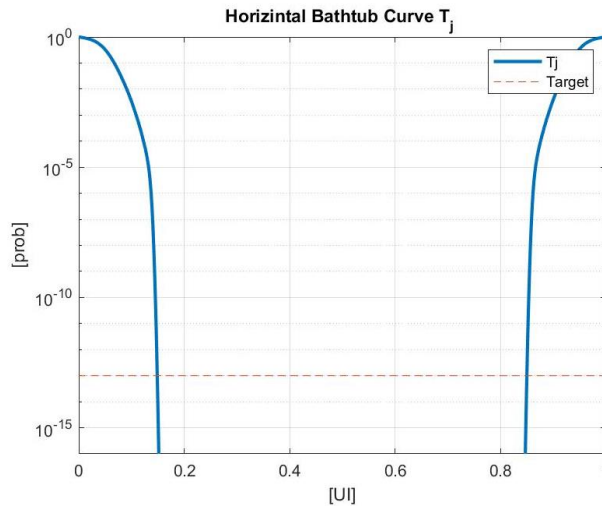
8.2. The .jpg file eye_diagram_gen2_rounded_tp3_eye_jitters.jpg



8.3. The .jpg file histogram_pj_rj_ddj_gen2_rounded_tp3_eye_jitters.jpg



8.4. The .jpg file tj_bathtub_gen2_rounded_tp3_eye_jitters.jpg



6 GEN4 Router Assembly Transmitter Testing

6.1 Oscilloscope intrinsic noise cancelation

See Appendix C of USB4 GEN4 CTS document for scope intrinsic noise measurement procedure.

scope_intrinsic_noise file shall be located in wdir (waveforms location)

6.2 TP2

The following section describes the usage of USB4 SigTest commands for TX GEN4 according to cts_test_name

6.2.1 txffe_test

This function reads all TXFFE preset files and estimates the transmitter TXFFE coefficients for all USB4 v2 GEN4 presets. The SIGTEST also reports for the best TXFFE preset in terms of best preset criteria. SIGEST is capable of analyzing partial presets set (preset0 must be included)

Run the following command from the PowerShell window:

Command example for differential signal:

```
.\USB4_SigTest.exe gen4 tx tp2 txffe_test
C:\SigTest_USB4_CTS\Waveforms\txffe\ pam3_prts7_preset_.trc none
txffe_test_report_result c:\s_parameter_for_deembedding.s4p
```

```

PS C:\SigTest_USB4_CTS> .\USB4_SigTest.exe gen4 tx tp2 txffe_test C:\SigTest_USB4_CTS\Waveforms\txffe\ pam3_prts7_preset_.trc none
txffe_test_report_result s_parameter_for_deembedding.S4P
***** SIGTEST Version: 0.91 *****
Running SIGTEST : Technology : GEN4, TestMode : TX, TestPoint : TP2
The following tests are in progress ...
TX-FFE Test
Loading Files: pam3_prts7_preset_0.trc ...
TP2: De-Embedded s_parameter_for_deembedding.S4P File

```

Command example for single-ended signals:

```

.\USB4_SigTest.exe gen4 tx tp2 txffe_test
C:\SigTest_USB4_CTS\Waveforms\txffe\ pam3_prts7_preset_.trc
pam3_prts7_preset_.trc txffe_test_report_result
s_parameter_for_deembedding.s4p

```

Files name suffix shall be in following form *_{{preset_num}}_p* and *_{{preset_num}}_n*
For example,

```

pam3_prts7_preset_0_p.trc
pam3_prts7_preset_0_n.trc
pam3_prts7_preset_1_p.trc
pam3_prts7_preset_1_n.trc
...and so on

```

Report files location:

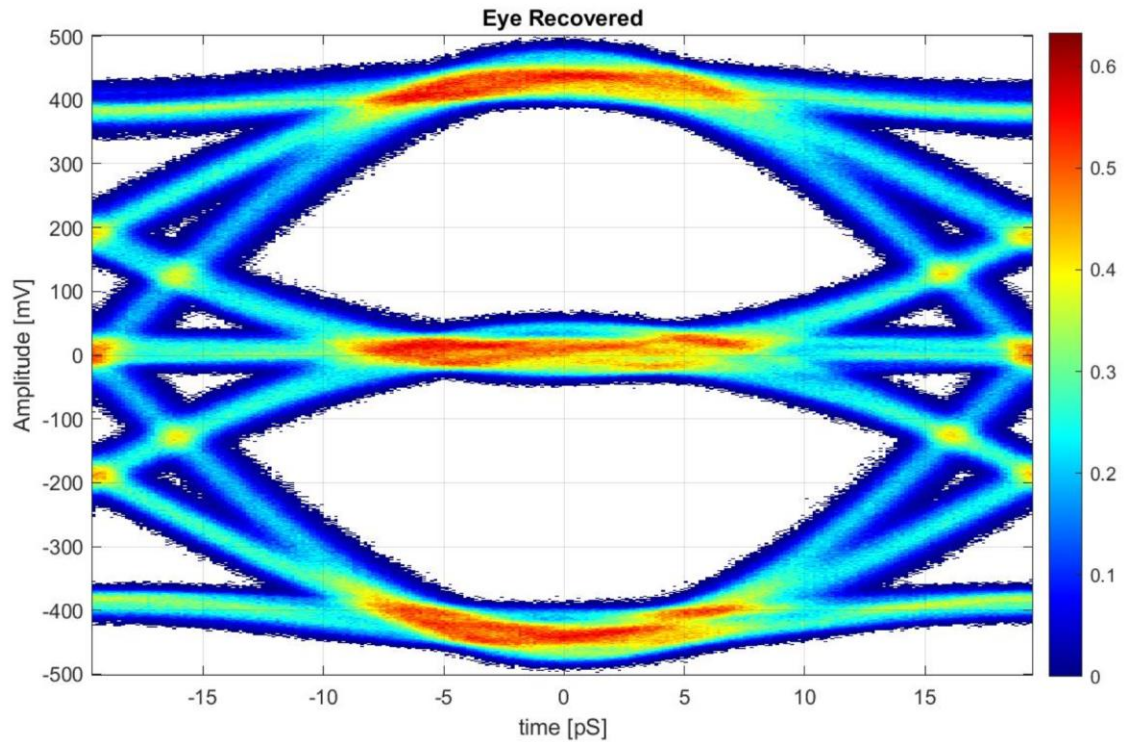
 Waveforms	17/12/2022 10:21	File folder	
 tmp_sndr.txt	16/12/2022 17:25	Text Document	1 KB
 txffe_test_report_result_eye_diagram_gen4_tp2.jpg	16/12/2022 18:33	JPG File	182 KB
 txffe_test_report_result_result.csv	16/12/2022 18:33	Microsoft Excel Co...	5 KB
 USB4_SigTest.exe	16/12/2022 15:14	Application	5,532 KB

8.5. The .csv file txffe_test_report_result_result.csv as a results example

Electrical Compliance Test Specification for GEN4												
Date:	16-Dec-22											
DIR:	C:\SigTest_USB4_CTS\Waveforms\txffe\											
File:	pam3_prts7_preset_trc											
Transmitter Equalization Test:												
preset_number	TXFFE_Fail	TXFFE(-2)	TXFFE(-1)	TXFFE(0)	TXFFE(1)	c(-2)	c(-1)	c(0)	c(1)	MaxErr	DDJ[Ulp2p]	
0	PASS	0	0		1	0	0	0	1	0	0.628906	
1	PASS	0	0		0.95	-0.05	-0.002218	0.009598	0.929405	-0.05878	0.020595	0.578125
2	PASS	0	0		0.9	-0.1	-0.001167	0.005334	0.89132	-0.10218	0.00868	0.570312
3	PASS	0	0		0.85	-0.15	-0.002083	0.009318	0.833265	-0.15533	0.016735	0.582031
4	PASS	0	-0.05		0.95	0	-0.000093	-0.05299	0.944854	0.002059	0.005146	0.628906
5	PASS	0	-0.05		0.9	-0.05	-0.002123	-0.04632	0.895819	-0.05573	0.005734	0.578125
6	PASS	0	-0.05		0.85	-0.1	-0.001143	-0.04975	0.849076	-0.10003	0.001143	0.5625
7	PASS	0	-0.05		0.8	-0.15	-0.001857	-0.04837	0.796583	-0.15319	0.003417	0.601562
8	PASS	0	-0.1		0.9	0	-0.002853	-0.09417	0.899546	-0.00343	0.005828	0.652344
9	PASS	0	-0.1		0.85	-0.05	-0.003585	-0.09233	0.847961	-0.05613	0.007673	0.605469
10	PASS	0	-0.1		0.8	-0.1	-0.002801	-0.09552	0.80035	-0.10133	0.004478	0.578125
11	PASS	0	-0.1		0.75	-0.15	0.000008	-0.10487	0.749504	-0.14562	0.004873	0.605469
12	PASS	0	-0.15		0.85	0	-0.003267	-0.1476	0.84777	-0.00137	0.003267	0.675781
13	PASS	0	-0.15		0.8	-0.05	-0.004181	-0.146	0.795063	-0.05475	0.004937	0.625
14	PASS	0	-0.15		0.75	-0.1	-0.004523	-0.14598	0.747156	-0.10234	0.004523	0.589844
15	PASS	0	-0.15		0.7	-0.15	0.000008	-0.15794	0.696896	-0.14516	0.007935	0.859375
16	PASS	0.025	-0.15		0.825	0	0.026806	-0.15594	0.806122	0.011131	0.018878	0.671875
17	PASS	0.025	-0.15		0.775	-0.05	0.021451	-0.14556	0.7767	-0.05629	0.00629	0.613281
18	PASS	0.025	-0.15		0.725	-0.1	0.023933	-0.15207	0.726231	-0.09777	0.002231	0.605469
19	PASS	0.025	-0.15		0.675	-0.15	0.026376	-0.15768	0.671286	-0.14466	0.007682	0.875
20	PASS	0	-0.2		0.8	0	-0.002073	-0.19561	0.800331	0.001989	0.004392	0.722656
21	PASS	0	-0.2		0.75	-0.05	-0.004567	-0.19103	0.749677	-0.05473	0.008972	0.671875
22	PASS	0	-0.2		0.7	-0.1	-0.00269	-0.1959	0.702454	-0.09896	0.004105	0.8125
23	PASS	0	-0.2		0.65	-0.15	-0.002958	-0.19589	0.648898	-0.15226	0.004114	1
24	PASS	0.025	-0.2		0.775	0	0.02174	-0.19191	0.783321	-0.00303	0.008321	0.722656
25	PASS	0.025	-0.2		0.725	-0.05	0.022516	-0.19404	0.729402	-0.05404	0.005958	0.65625
26	PASS	0.025	-0.2		0.675	-0.1	0.027751	-0.20444	0.676412	-0.0914	0.008601	0.828125
27	PASS	0.025	-0.2		0.625	-0.15	0.024719	-0.19878	0.62532	-0.15118	0.001217	1
28	PASS	0.05	-0.2		0.75	0	0.051806	-0.19858	0.742619	0.006993	0.007381	0.730469
29	PASS	0.05	-0.2		0.7	-0.05	0.047801	-0.19238	0.703519	-0.0563	0.00762	0.671875
30	PASS	0.05	-0.2		0.65	-0.1	0.049822	-0.19676	0.653078	-0.10035	0.003244	0.878906
31	PASS	0.05	-0.2		0.6	-0.15	0.050925	-0.19825	0.598836	-0.15199	0.001985	1
32	PASS	0	-0.25		0.75	0	-0.005947	-0.24134	0.748659	-0.00406	0.008663	0.796875
33	PASS	0	-0.25		0.7	-0.05	-0.004514	-0.24538	0.696702	-0.0534	0.004619	0.8125
34	PASS	0.025	-0.25		0.725	0	0.020255	-0.2441	0.731802	-0.00384	0.006802	0.777344
35	PASS	0.025	-0.25		0.675	-0.05	0.023357	-0.24982	0.675696	-0.05113	0.001643	0.800781
36	PASS	0.05	-0.25		0.7	0	0.04903	-0.24833	0.702038	0.000602	0.002038	0.800781
37	PASS	0.05	-0.25		0.65	-0.05	0.049934	-0.25058	0.648788	-0.0507	0.001212	0.84375
38	PASS	0.075	-0.25		0.675	0	0.074867	-0.2474	0.677385	-0.00035	0.002603	0.851562
39	PASS	0.075	-0.25		0.625	-0.05	0.076085	-0.24949	0.622467	-0.05196	0.002533	0.878906
40	PASS	0	-0.1		0.4	0	0.000499	-0.10552	0.384281	0.009701	0.015719	0.84375
41	PASS	0	0		0.5	0	-0.002195	0.004046	0.49065	0.003109	0.00935	0.722656
Preset Swing Attenuation [dB]:												
Preset 40	PASS	VSWING_RATIO	6.55	CTS: Min Swing Attenuation [dB]	5	CTS: Max Swing Attenuation [dB]	7					
Preset 41	PASS	VSWING_RATIO	6.29	CTS: Min Swing Attenuation [dB]	5	CTS: Max Swing Attenuation [dB]	7					
Informative:	Best TXFFE		6	Min. DDJ	0.5625	[Ulp2p]						
Informative: Symbol Rate [GHz]:	NONE	Symbol Rate	25.56218	Drift [PPM]	-1477.24							
Informative:	EyeHeight		197.87	[mV]								
Informative:	EyeWidth		17.115127	[pS]								

In this example the best TX FFE preset is 6. The corresponding waveform shall be used for ui_jitter_vertical test

8.6. The .jpg file txffe_test_report_result_eye_diagram_gen4_tp2.jpg



6.2.2 ui_jitter_vertical

This function calculates USB4 v2 GEN4 Transmitter Specification parameters (at TP2) such as UI, SSC, Jitter and Vertical performance using the best TXFFE preset signal waveform (reported in txffe_test)

Run the following command from the PowerShell window:

Command example:

```
.\USB4_SigTest.exe gen4 tx tp2 ui_jitter_vertical
C:\SigTest_USB4_CTS\Waveforms\txffe\ pam3_prts7_preset_19.trc none
ui_ssc_jitter_vertical_report_result s_parameter_for_deembedding.s4p
```












```

PS C:\SigTest_USB4_CTS> .\USB4_SigTest.exe gen4 tx tp2 ui_jitter_vertical C:\SigTest_USB4_CTS\Waveforms\txffe\ pam3_prts7_preset_19.bin none ui_ssc_jitter_vertical_report_result s_
parameter_for_deembedding.s4p
***** SIGTEST Version: 0.91 *****
Running SIGTEST : Technology : GEN4, TestMode : TX, TestPoint : TP2
The following tests are in progress ...
USB4 Gen4: UI, SSC, Jitters and Vertical
Loading File: C:\SigTest_USB4_CTS\Waveforms\txffe\pam3_prts7_preset_19.bin ....
TP2: De-Embedded s_parameter_for_deembedding.s4p File
>> SSC Estimated:
>> SSC Frequency 31.009544[Khz]
>> SSC Amplitude Harmonics[pS]:0.040223, 0.000244, 0.004257,
Writing ui_ssc_jitter_vertical_report_result_tie_period_frequency_gen4_tp2.jpg
>> UI_min = -2458.664460[ppm],max=-21.924875[ppm]
Writing ui_ssc_jitter_vertical_report_result_tj_bathtub_gen4_tp2.jpg
Writing ui_ssc_jitter_vertical_report_result_histogram_pj_rj_ddj_gen4_tp2.jpg
>>> PRTS LOCKED !!!
Number of symbol: #11497292,BER: = 0
Distortion Noise: Without removal O/E jitter =2.89[mVrms], with removal O/E=2.70[mVrms], O/E =1.03[mVrms]
Informative:Intrinsic Scope Noise = 0.000[mV-rms]
TX LEVELS MISMATCH = 0.998
TX LEVEL = +200.5[mV]
TX LEVEL = -0.4[mV]
TX LEVEL = -200.4[mV]
V_Steady-State = +200.7[mV]
TX_SNR = 34.1[dB]
TX_ISI_MARGIN = 9.2[dB]
TX Budget: Dist=2.7[mV], Noise=3.1[mV] total= 4.1[mV]
PulsePeak=0.200411[V]
Attenuation=-4.1071[dB],F=12.800000[Ghz]
PAM-3, Eye(1):EyeHeight=84.8[mV], EyeWidth=0.371[UI]=14.5[pS]
PAM-3, Eye(2):EyeHeight=79.6[mV], EyeWidth=0.348[UI]=13.6[pS]
PAM-3:EyeHeight=79.6[mV], EyeWidth=0.348[UI]=13.6[pS]
Writing ui_ssc_jitter_vertical_report_result_eye_diagram_gen4_tp2.jpg
Writing result to .ui_ssc_jitter_vertical_report_result.csv
The tests are completed

```

Report files location:

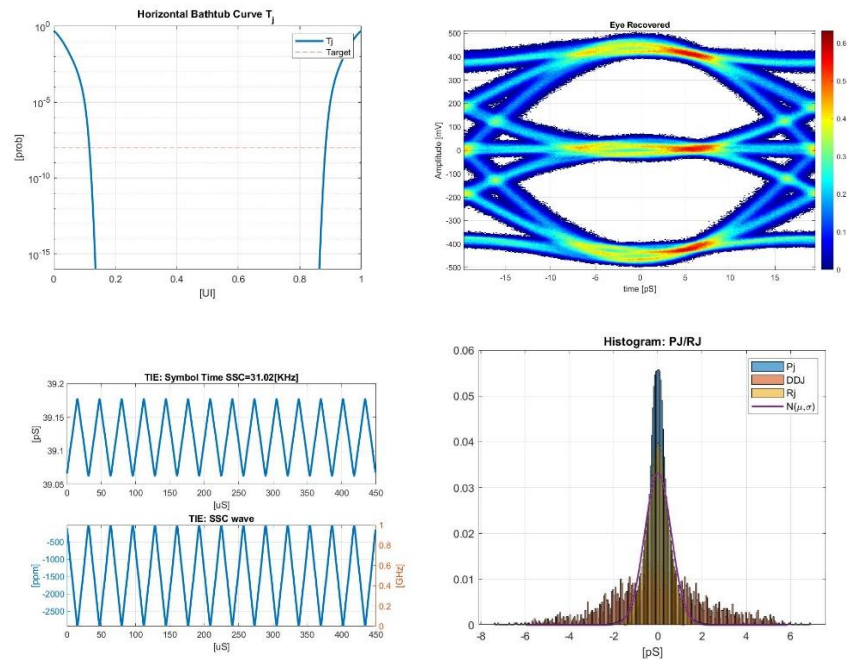
	Waveforms	18/04/2024 15:01	File folder	
	s_parameter_for_deembedding.S4P	25/04/2023 13:05	S4P File	738 KB
	USB4_SigTest.exe	31/03/2024 13:44	Application	24,165 KB
	ui_ssc_jitter_vertical_report_result_tie_peri...	18/04/2024 15:40	JPG File	250 KB
	ui_ssc_jitter_vertical_report_result_tj_bath...	18/04/2024 15:40	JPG File	66 KB
	ui_ssc_jitter_vertical_report_result_histogr...	18/04/2024 15:40	JPG File	60 KB
	tmp_sndr.txt	18/04/2024 15:40	Text Document	1 KB
	ui_ssc_jitter_vertical_report_result_eye_di...	18/04/2024 15:41	JPG File	341 KB
	ui_ssc_jitter_vertical_report_result.c...	18/04/2024 15:41	Microsoft Excel C...	4 KB

Note: scope_intrinsic_noise.bin/trc/wfm shall be placed at the same location as best preset waveform

8.7. The .csv file ui_ssc_jitter_vertical_report_result.csv as a results example

Electrical Compliance Test Specification for GEN4							
Date:	06-Feb-22						
Dir:	C:\EV_WORK\USB4SI\G\main\run_pam3						
File:	pam3_prtst7_preset_19.trc						
Minimum Unit Interval Measurement [pS]:	PASS	UI Min Min	39.061388	UI Min Max	39.062231	CTS: UI Min Min	39.0508 CTS: UI Min Max
SSC_Down_Spread_Range Measurement[%]:	FAIL	Min SSC_Down_Spread_Range	0.296948	Max SSC_Down_Spread_Range	0.300794	CTS: Min SSC_Down_Spread_Range	0.2 CTS: Max SSC_Down_Spread_Range
SSC_Down_Spread_Rate Measurement[KHz]:	PASS	Min SSC_Down_Spread_Rate	30.932407	Max SSC_Down_Spread_Rate	31.101453	CTS: Min SSC_Down_Spread_Rate	30 CTS: Max SSC_Down_Spread_Rate
SSC_Phase_Deviation Measurement [ns p-p]:	PASS	SSC_Phase_Deviation	12.973242	CTS: Min SSC_Phase_Deviation	2.5	CTS: Max SSC_Phase_Deviation	15.5
SSC_Slew_Rate Measurement [ppm/us]:	PASS	SSC_Slew_Rate	223.598872	CTS:MAX SSC_Slew_Rate	500		
UI Measurement Ulp-p:	PASS	UI Jitter Ulp-p	0.145603	CTS: Max UI	0.17		
UDI Measurement Ulp-p:	PASS	UDI jitter Ulp-p	0.027259	CTS: Max UDI	0.075		
UDI LF Measurement Ulp-p:	PASS	UDI LF jitter Ulp-p	0.007856	CTS: Max UDI LF	0.03		
DCD Measurement Ulp-p:	PASS	DCD jitter Ulp-p	0.000513	CTS: Max DCD	0.02		
Informative: Symbol Rate [GHz]:	NONE	Symbol Rate	25.562139	Drift [PPM]	-1478.94		
Vertical Analysis Test:							
TX_SNR Measurement [dB]:	PASS	TX_SNR [dB]	32.541019	CTS: Min TX_SNR	32.5		
TX_LEVELS_MISMATCH Measurement:	PASS	TX_LEVELS_MISMATCH	0.999616	CTS: Min TX_LEVELS_MISMATCH	0.975		
V_SWING Measurement [mV]:	FAIL	V_SWING	503.590461	CTS: Min V_SWING	390	CTS: Max V_SWING	500
TX_ISI_MARGIN Measurement[dB](TXFE=19):	PASS	TX_ISI_MARGIN	12.428694	CTS: Min TX_ISI_MARGIN	11.5		
TX Noise Budget:	Distortion AWGN Total						
Measured(mVrms):	2.7	5.4	6.05				
Informative:	EyeHeight	29.23	[mV]				
Informative:	EyeWidth	4.125975	[pS]				

8.8. The SIGTEST saves the following plots (.jpg format)



6.2.3 tx_frequency_variation

This function calculates USB4 v2 GEN4 Tx Frequency Variation parameters





Run the following command from the PowerShell window:

Command example:

```
.\USB4_SigTest.exe gen4 tx tp2 frequency_variation_training
C:\SigTest_USB4_CTS\Waveforms tx_frequency_variation.bin none
tx_frequency_variation_report s_parameter_for_deembedding.s4p
```

```
PS C:\SigTest> .\USB4_SigTest.exe gen4 tx tp2 frequency_variation_training C:\SigTest\Waveforms frequency_variation_training.bin none frequency_variation_training s_parameter_for_deembedding.s4p
**** SIGTEST Version: 0.92E ****
Running SIGTEST : Technology : GEN4, TestMode : TX, TestPoint : TP2
The following tests are in progress ...
Frequency Variation Training Measurement
Loading File: C:\SigTest\Waveforms\Frequency_variation_training.bin ....
TP2: De-Embedded s_parameter_for_deembedding.s4p File
Detected SQ1B8 Wave before Clock Switch event
INIT_FREQ_VARIATION[ppm]: Mean=250.009359, Max250.009660,Min=250.009014
DELTA_FREQ_200nS[ppm]: 514.133666
DELTA_FREQ_1000nS[ppm]: 792.295973
Steady_State_FREQ_VARIATION[ppm]: Mean=-250.000091, Max=-246.756559,Min=-253.027788
Steady_State_SLEW_RATE[ppm/uSec]: 2.773285
TX Frequency Overshoot[ppm]: 549.091447
Writing frequency_variation_training_tx_clock_switch_analysis_gen4_tp2.jpg
Writing result to .\frequency_variation_training_result.csv
The tests are completed
```

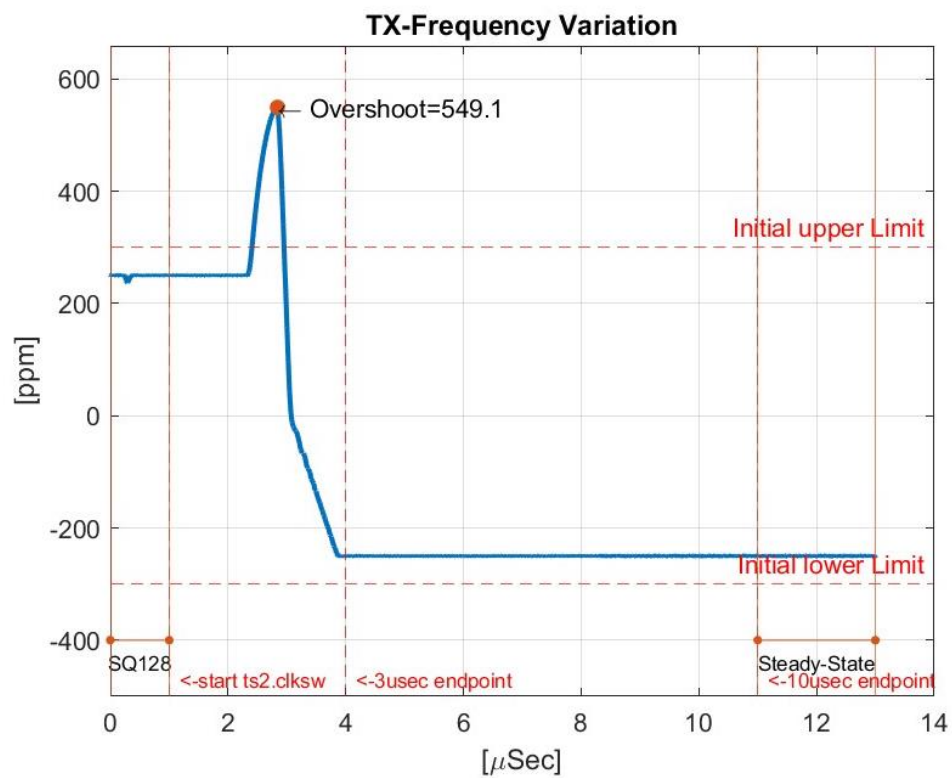
Report files location:

 tx_frequency_variation_report_result.csv	05/12/2022 16:05	Microsoft Excel C...	1 KB
 tx_frequency_variation_report_tx_clock_switch_analysis_gen4_tp2.jpg	05/12/2022 16:05	JPG File	52 KB
 USB4_SigTest.exe	04/12/2022 14:44	Application	5,522 KB
 Waveforms	05/12/2022 16:03	File folder	

The .csv file tx_frequency_variation_report_result.csv as a results example

Electrical Compliance Test Specification for GEN4					
Date:	28-May-24				
DIR:	C:\SigTest\Waveforms\				
File:	frequency_variation_training.bin				
TX Frequency Variation Training Measurement:					
INIT_FREQ_VARIATION:	PASS	INIT_FREQ_VARIATION result:	250.009359 CTS: Min INIT_FREQ_VARIATION	-300 CTS: Max INIT_FREQ_VARIATION	300
DELTA_FREQ_200nS:	PASS	DELTA_FREQ_200nS result:	514.133666 CTS: Max DELTA_FREQ_200nS	600	
DELTA_FREQ_1000nS:	PASS	DELTA_FREQ_1000nS result:	792.295973 CTS: Max DELTA_FREQ_1000nS	900	
FREQ_OVERSHOOT:	PASS	FREQ_OVERSHOOT result:	549.091447 CTS: Max FREQ_OVERSHOOT	600	
STEADY_STATE_FREQ_VARIATION:	PASS	STEADY_STATE_FREQ_VARIATION result:	-250.000091 CTS: Min STEADY_STATE_FREQ_VARIATION	-300 CTS: Max STEADY_STATE_FREQ_VARIATION	300
STEADY_STATE_SLEW_RATE:	PASS	STEADY_STATE_SLEW_RATE result:	2.773285 CTS: Max STEADY_STATE_SLEW_RATE	500	
Informative:	Symbol Rate [GHz]	25.596677	Drift [PPM]	-129.81	

The SIGTEST saves the following plot (.jpg format)



6.2.4 electrical_idle_voltage

This function calculates Electrical Idle voltage while the DUT is in electrical idle mode and includes the following transmitter compliance test: V_ELEC_IDLE

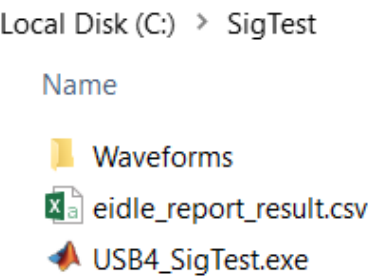
Run the following command from the PowerShell window:

Command example:

```
.\USB4_SigTest.exe gen4 tx tp2 electrical_idle_voltage
C:\SigTest\Waveforms\ tx_gen4_eidle.bin none eidle_report s_parameter_for_deembedding.s4p
```

```
PS C:\SigTest_USB4_CTS> .\USB4_SigTest.exe gen4 tx tp2 electrical_idle_voltage C:\SigTest\Waveforms\ tx_gen4_eidle.bin none eidle_report s_parameter_for_deembedding.s4p
***** SIGTEST Version: 0.91 *****
Running SIGTEST : Technology : GEN4, TestMode : TX, TestPoint : TP2
The following tests are in progress ...
Electrical Idle Voltage Measurement
Loading File: C:\SigTest\Waveforms\tx_gen4_eidle.bin ....
TP2: De-Embedded s_parameter_for_deembedding.s4p File
Writing result to .\eidle_report_result.csv
The tests are completed
```

Report file location:



eidle_report_result.csv as a result example

Electrical Compliance Test Specification for GEN4					
Date:	07-Mar-22				
DIR:	C:\SigTest\Waveforms\				
File:	tx_gen4_eidle.bin				
Electrical Idle Voltage Measurement[mV]:	PASS	V_ELEC_IDLE	11.29415	CTS: Max V_ELEC_IDLE	20

6.2.5 ac_common_mode

This function calculates AC_CM using PRTS7 pattern and includes the following transmitter compliance test: AC_CM

Run the following command from the PowerShell window:

Command example:

```
.\USB4_SigTest.exe gen4 tx tp2 ac_common_mode  
C:\SigTest_USB4_CTS\Waveforms\accm\ pam3_prts7_preset_acommon.bin none  
ac_common_mode_results s_parameter_for_deembedding.s4p
```

```
PS C:\SigTest_USB4_CTS> .\USB4_SigTest.exe gen4 tx tp2 ac_common_mode C:\SigTest_USB4_CTS\Waveforms\accm\ pam3_prts7_preset_acommon.bin none ac_common_mode_results s_parameter_for_deembedding.s4p  
***** SIGTEST Version: 0.91 *****  
Running SIGTEST : Technology : GEN4, TestMode : TX, TestPoint : TP2  
The following tests are in progress ...  
AC Common Mode Measurement  
Loading File: C:\SigTest_USB4_CTS\Waveforms\accm\pam3_prts7_preset_acommon.bin ....  
TP2: De-Embedded s_parameter_for_deembedding.s4p File  
Writing result to \ac-common_mode_results_result.csv  
The tests are completed
```

5.1. The .csv file ac_common_mode_report_result.csv as a results example

Electrical Compliance Test Specification for GEN4					
Date:	18-Apr-24				
DIR:	C:\SigTest_USB4_CTS\Waveforms\accm\				
File:	pam3_prts7_preset_acommon.bin				
AC CM Measurement:	PASS	AC CM: Vac [mVp2p]	80.2	CTS: Max AC CM [mVp2p]	100

6.2.6 rl

This function calculates Return Loss (rl) and Integrated Return Loss (irl) for TX lanes. Expected inputs for For TX RL and IRL analysis are s2p file and signal waveform of the best TXFFE preset in terms of minimum DDJ peak to peak (same signal waveform which is used for **ui_jitter_vertical**). In case no signal waveform file provided the function will still calculate RL and IRL, although IRL spec limit and pass/fail criteria should be ignored as no ISI_Margin result presents

1. Run the following command from the PowerShell window:

Command example:

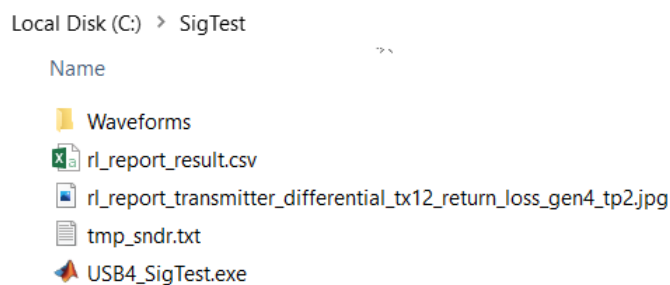
```
.\USB4_SigTest.exe gen4 tx tp2 rl C:\SigTest_USB4_CTS\Waveforms\rl\pam3_prts7_preset_19.bin none rl_report none pam3_prts7_preset_19_s2p.s2p
```

Command example w/o signal waveform file:

```
.\USB4_SigTest.exe gen4 tx tp2 rl C:\SigTest_USB4_CTS\Waveforms\rl\rl_report none pam3_prts7_preset_19_s2p.s2p
```

```
PS C:\SigTest_USB4_CTS> .\USB4_SigTest.exe gen4 tx tp2 rl C:\SigTest_USB4_CTS\Waveforms\rl\pam3_prts7_preset_19.bin none rl_report none pam3_prts7_preset_19_s2p.s2p
***** SIGTEST Version: 0.91 *****
Running SIGTEST : Technology : GEN4, TestMode : TX, TestPoint : TP2
The following tests are in progress ...
Transmitter Return Loss & Integrated Return Loss
Loading File: C:\SigTest_USB4_CTS\Waveforms\rl\pam3_prts7_preset_19.bin ....
Distortion Noise: without removal O/E jitter =2.15[mVrms], with removal O/E=1.56[mVrms], O/E =1.47[mVrms]
Informative:Intrinsic Scope Noise = 0.000[mV-rms]
TX LEVELS MISMATCH = 0.999
TX LEVEL = +136.3[mV]
TX LEVEL = -0.2[mV]
TX LEVEL = -136.3[mV]
V_Steady-State = +144.1[mV]
TX_SNR = 37.0[dB]
TX_ISI_MARGIN = 7.8[dB]
TX Budget: Dist=1.6[mV], Noise=1.1[mV] total= 1.9[mV]
PulsePeak=0.136303[V]
Attenuation=-4.601[dB], F=12.800000[GHz]
Reading S parameters File: C:\SigTest_USB4_CTS\Waveforms\rl\pam3_prts7_preset_19_s2p.s2p ..
The C:\SigTest_USB4_CTS\Waveforms\rl\pam3_prts7_preset_19_s2p.s2p Sparameters is normalized to 42.500000[Ohm]
IRL=-12.5[dB]
Writing rl_report_transmitter_differential_return_loss_gen4_tp2.jpg
Writing result to .\rl_report_result.csv
The tests are completed
```

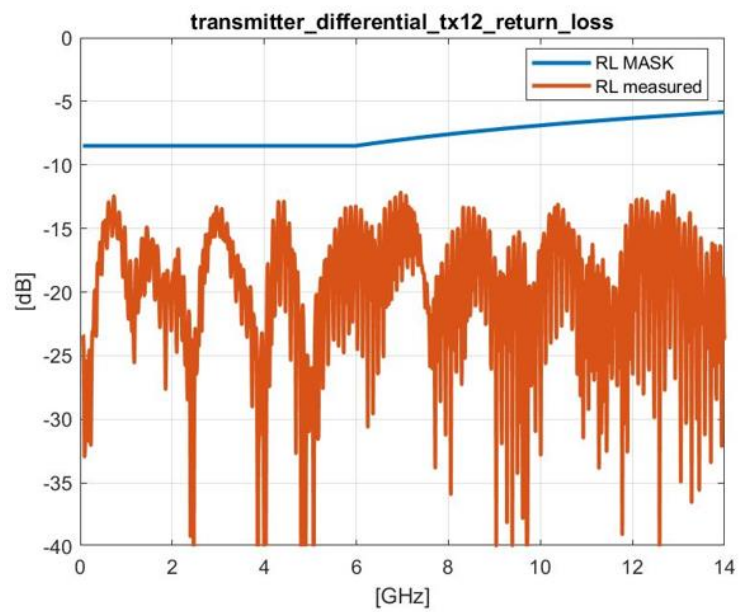
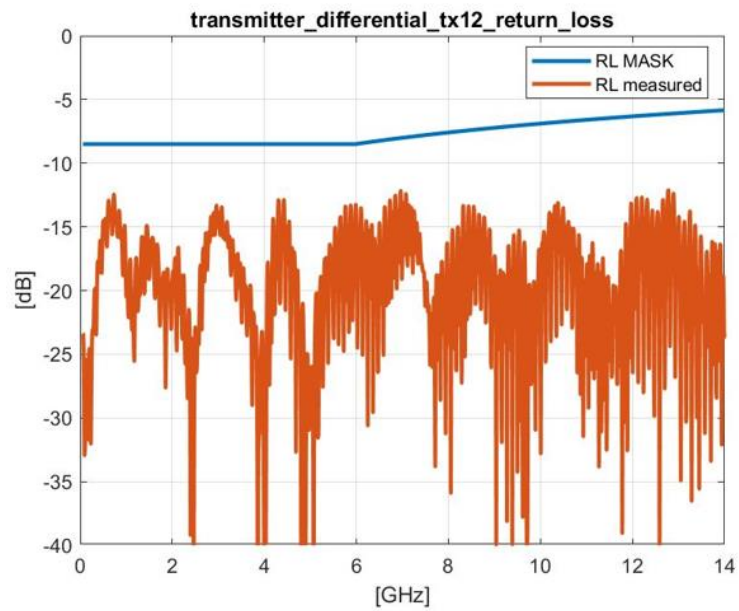
2. report file location:



3. rl_report_result.csv as a result example

Electrical Compliance Test Specification for GEN4						
Date:	08-Mar-22					
DIR:	C:\SigTest\Waveforms\					
File:	pam3_prts7_preset_19.bin					
Transmitter Return Loss & Integrated Return Loss						
IRL:	PASS	IRL[dB]:	-35.962857	CTS: Max IRL	-14.714878	
Informative:	TX_ISI_Margin[dB]	12				
Informative:	Sdd22 MASK:	PASS				
Informative:	Sdd22 max[dB]	-12.5	Margin[dB]	4	Fmax[GHz]	0.730062
Informative: Symbol Rate [GHz]:	NONE	Symbol Rate	25.563502	Drift [PPM]	-1425.7	

- Sdd22 max[dB] indicates closest to spec mask absolute RL result
 - Sdd22 MASK indicates RL pass/fail criteria
 - Margin[dB] indicates the delta between absolute RL result to spec mask
 - Fmax[GHz] indicates the frequency of the closest to spec mask absolute RL result
 - IRL[dB] indicates calculated IRL
 - IRL indicates IRL pass/fail criteria
 - CTS: Max IRL indicates the IRL spec limit calculated using corresponding TX_ISI_Margin[dB]
4. rl_report_transmitter_differential_tx12_return_loss_gen4_tp2.jpg
Return Loss plot with spec mask



7 GEN2-3 Router Assembly Receiver stressed eye calibration

7.1 General notes

- a) The receiver stressed eye calibration procedure shall be the same as described in the USB4 Electrical - Router Assembly Compliance Test Specification paragraph 4.
- b) The SigTest post processed results shall replace the scope application calculations.

7.2 TP3' – Case1

- 1. cts_test_name – **jitter**

The test below shall be used for the following calibrations:

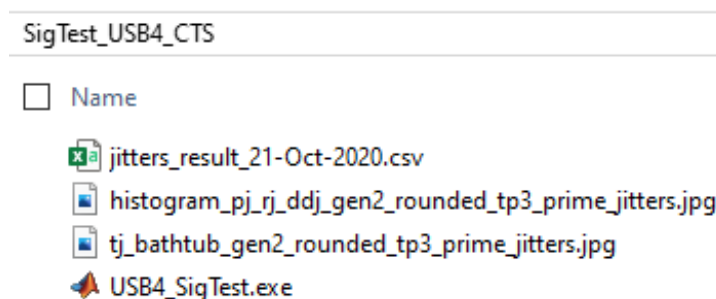
- a) 4.2.1.1 Data Dependent Jitter - DDJ calibration
- b) 4.2.1.3 Random Jitter - RJ calibration
- c) 4.2.1.4 Periodic Jitter - PJ calibration
- d) 4.2.1.5 Total Jitter - TJ calibration

Run the following command from the PowerShell window:

```
.\USB4_SigTest.exe gen2_rounded rx tp3_prime jitter  
C:\Desktop\SigTest_USB4_CTS\Waveforms\TP3_Prime\  
TP3_Prime_Gen2_Rounded_prbs15.bin none jitters none
```

```
Running SIGTEST : Technology : GEN2_ROUNDED, TestMode : RX, TestPoint : TP3_PRIME  
The following tests are in progress ...  
Data Dependent Jitter - DDJ Calibration  
Random Jitter - RJ Calibration  
Periodic Jitter - PJ Calibration  
Total Jitter - TJ Calibration  
Loading File TP3_Prime_Gen2_Rounded_prbs15.bin ....  
Writing tj_bathtub_gen2_rounded_tp3_prime_jitters.jpg  
Writing histogram_pj_rj_ddj_gen2_rounded_tp3_prime_jitters.jpg  
Writing result to .\jitters_result_21-Oct-2020.csv  
The tests are completed
```

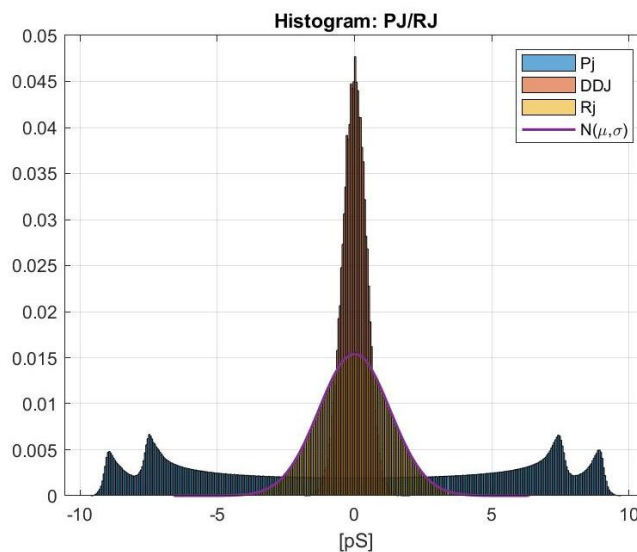
Report files location:



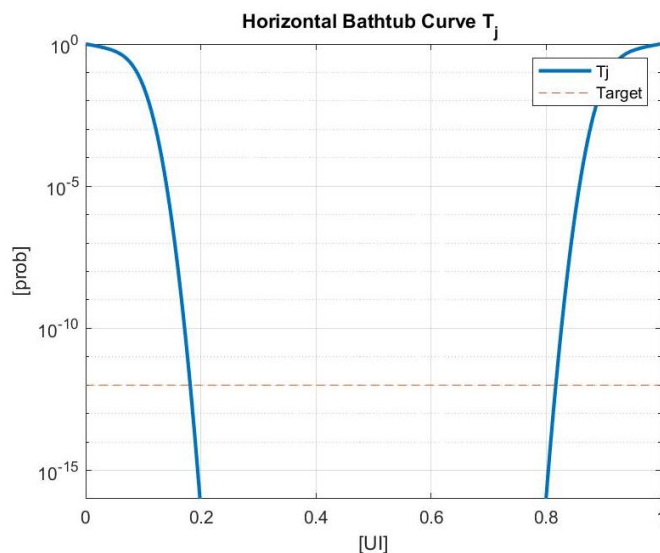
- 1.1.1. The csv. File jitters_result_21-Oct-2020.csv

Electrical Compliance Test Specification for gen2_rounded					
Date:	21-Oct-20				
DIR:C:\Desktop\SigTest_USB4_CTS\Waveforms\TP3_Prime\					
File: TP3_Prime_Gen2_Rounded.bin					
Total Jitter (BER=1e-12) Measurement Ulp-p:	Tj	0.363443			
PJ Jitter Measurement mUI:	PJ-rms	58.981258			
RJ Jitter Measurement mUI:	RJ-rms	12.812331			
DDJ Measurement Ulp-p:	DDJ jitter Ulp-p	0.038398			
Informative: Symbol Rate [GHz]:	NONE	Symbol Rate	9.974974	Drift [PPM]	-2502.56

1.2. The .jpg file histogram_pj_rj_ddj_gen2_rounded_tp3_prime_jitters.jpg



1.3. The .jpg file tj_bathtub_gen2_rounded_tp3_prime_jitters.jpg



2. cts_test_name – **ac_common_mode**

The test below shall be used for the following calibration:

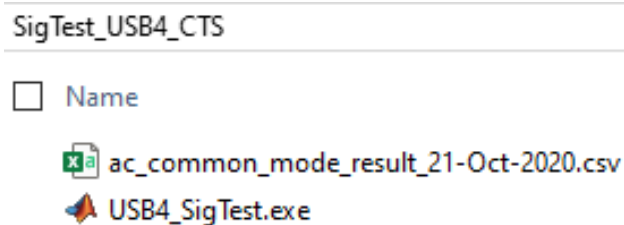
a) 4.2.1.2 AC Common Mode Measurements

Run the following command from the PowerShell window:

```
.\USB4_SigTest.exe gen2_rounded rx tp3_prime ac_common_mode  
C:\Desktop\SigTest_USB4_CTS\Waveforms\TP3_Prime\  
TP3_Prime_Gen2_Rounded_prbs31_common.bin none ac_common_mode none
```

```
Running SIGTEST : Technology : GEN2_ROUNDED, TestMode : RX, TestPoint : TP3_PRIME  
The following tests are in progress ...  
AC Common Mode - Calibration  
Loading File TP3_Prime_Gen2_Rounded_prbs31_common.bin ....  
Writing result to .\ac_common_mode_result_21-Oct-2020.csv  
The tests are completed
```

Report files location:



2.1. The .csv file ac_common_mode_result_21-Oct-2020.csv

Electrical Compliance Test Specification for gen2_rounded		
Date:	21-Oct-20	
DIR:C:\Desktop\SigTest_USB4_CTS\Waveforms\TP3_Prime\		
File: TP3_Prime_Gen2_Rounded_prbs31_common.bin		
AC CM Measurement:	AC CM: Vac [mVp2p]	81.2

3. cts_test_name – **ui_ssc_eye**

The test above shall be used for the following calibration:

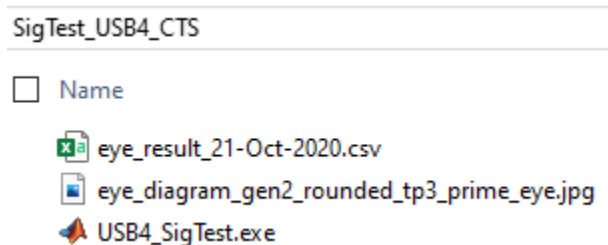
a) 4.2.1.6 Input Eye Diagram

Run the following command from the PowerShell window:

```
.\USB4_SigTest.exe gen2_rounded rx tp3_prime ui_ssc_eye  
C:\Desktop\SigTest_USB4_CTS\Waveforms\TP3_Prime\  
TP3_Prime_Gen2_Rounded_prbs31.bin none eye none
```

```
Running SIGTEST : Technology : GEN2_ROUNDED, TestMode : RX, TestPoint : TP3_PRIME  
The following tests are in progress ...  
Input Eye Diagram - Calibration  
Loading File TP3_Prime_Gen2_Rounded_prbs31.bin ....  
Writing eye_diagram_gen2_rounded_tp3_prime_eye.jpg  
Writing result to .\eye_result_21-Oct-2020.csv  
The tests are completed
```

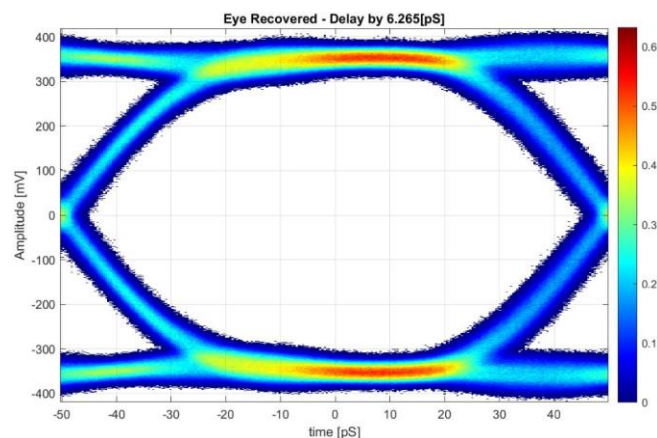
Report files location:



3.1. The .csv file eye_result_21-Oct-2020.csv

Electrical Compliance Test Specification for gen2_rounded					
Date:	21-Oct-20				
DIR:C:\Desktop\SigTest_USB4_CTS\Waveforms\TP3_Prime\ File: TP3_Prime_Gen2_Rounded_prbs31.bin					
Eye Diagram Measurement:	EyeWidth [pS]	89.281492	EyeHeight[mV]	593.984184	
Informative: Symbol Rate [GHz]:	NONE	Symbol Rate	9.975472	Drift [PPM]	-2452.82

3.2. The .jpg file eye_diagram_gen2_rounded_tp3_prime_eye.jpg



4. cts_test_name – **frequency_variation_training**

there is a need to calibrate the RX SSC profile to meet CTS requirement.

Run the following command from the PowerShell window:

```
.\USB4_SigTest.exe gen2_rounded rx tp3_prime frequency_variation_training
C:\Desktop\SigTest_USB4_CTS\Waveforms\TP3_prime\
rx_frequency_variation_training.bin none rx_clk_switch_cal none
```

```
***** SIGTEST Version: 0.6 *****
Running SIGTEST : Technology : GEN2_ROUNDED, TestMode : RX, TestPoint : TP3_PRIME
The following tests are in progress ...
TX Frequency Variation Training Measurement
Loading File rx_frequency_variation_training.bin ...
Writing rx_clock_switch_analysis_gen2_rounded_tp3_prime_rx_clk_switch_cal.jpg
Writing result to .\rx_clk_switch_cal_result_21-Jul-2021.csv
The tests are completed
```

Report files location:

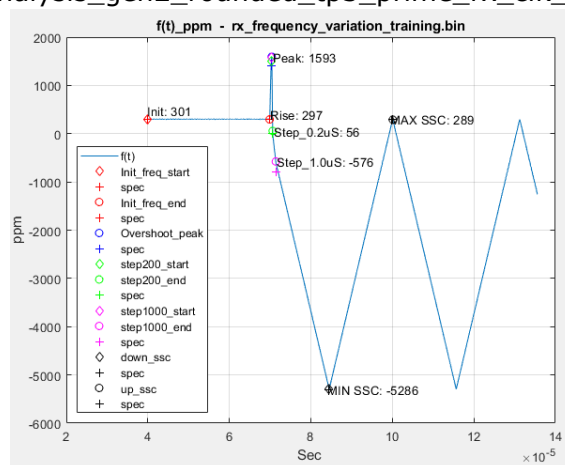
Name	Date modified	Type	Size
rx_clk_switch_cal_result_21-Jul-2021.csv	7/21/2021 3:40 PM	Microsoft Excel C...	2 KB
rx_clock_switch_analysis_gen2_rounded_tp3_prime_rx_clk_switch_cal.jpg	7/21/2021 3:40 PM	JPG File	75 KB
rx_frequency_variation_training.bin	7/21/2021 3:33 PM	IPC File	48 KB

4.1. The .csv file rx_clk_switch_cal_result_21-Jul-2021.csv

Electrical Compliance Test Specification for gen2_rounded			
Date:21-Jul-2021			
DIR:C:\Desktop\SigTest_USB4_CTS\Waveforms\TP3_prime\			
File: rx_frequency_variation_training.bin			
RX Frequency Variation Training Measurement:			
INIT_FREQ_VARIATION:	PASS	RX_INIT_FREQ_VARIATION result:	298.659135 CTS: Min RX_INIT_FREQ_VARIATION -300 CTS: Target INIT_FREQ_VARIATION 300
DELTA_FREQ_200ns:	PASS	RX_DELTA_FREQ_200nS result:	-1389.83096 CTS: Abs target RX_DELTA_FREQ_200 1400
DELTA_FREQ_1000ns:	PASS	RX_DELTA_FREQ_1000nS result:	-2189.70318 CTS: Abs target RX_DELTA_FREQ_1000 2200
FREQ_OVERSHOOT:	PASS	RX_FREQ_OVERSHOOT result:	1593.431124 CTS: Target RX_FREQ_OVERSHOOT 1600
Informative: Symbol Rate [GHz]:	NONE	Symbol Rate	9.981822 Drift [PPM] -1817.76

4.2. The .jpg file

rx_clock_switch_analysis_gen2_rounded_tp3_prime_rx_clk_switch_cal.jpg



Note – there is a need to calibrate RX SSC profile for RX frequency variation training test over TP3, the usage is the same except the test point

.\USB4_SigTest.exe gen3_legacy rx **tp3** frequency_variation_training
C:\Desktop\SigTest_USB4_CTS\Waveforms\TP3\ rx_frequency_variation_training.bin
none rx_clk_switch_cal_tp3 none

All same but over results the overshoot limit is 1400ppm

	A	B	C	D	E	F	G	H
1	Electrical Compliance Test Specification for gen3_legacy							
2	Date:21-Jul-2021							
3	DIR:C:\Desktop\SigTest_USB4_CTS\Waveforms\TP3\							
4	File: rx_frequency_variation_training.bin							
5	RX Frequency Variation Training Measurement:							
6	INIT_FREQ_VARIATION:	PASS	RX_INIT_FREQ_VARIATION result:	299.818	CTS: Min RX_INIT_FREQ_VARIATION	-300	CTS: Target INIT_FREQ_VARIATION	300
7	DELTA_FREQ_200nS:	PASS	RX_DELTA_FREQ_200nS result:	-1386.11	CTS: Abs target RX_DELTA_FREQ_200nS	1400		
8	DELTA_FREQ_1000nS:	PASS	RX_DELTA_FREQ_1000nS result:	-2184.71	CTS: Abs target RX_DELTA_FREQ_1000nS	2200		
9	FREQ_OVERSHOOT:	PASS	RX_FREQ_OVERSHOOT result:	1389.743	CTS: Target RX_FREQ_OVERSHOOT	1400		
10	Informative: Symbol Rate [GHz]:	NONE	Symbol Rate	20.58823	Drift [PPM]	-1782.83		
11								
12								

7.3 TP3 – Case2

4. cts_test_name – **tp3**

The test below shall be used for the following calibration:

a) 4.2.2.1 Input Eye Diagram

Notes:

- e) Save 5 waveforms with PRBS31 pattern using the scope configuration above.
- f) Save 1 waveform with PRBS15 pattern using the scope configuration above.
- g) The saved waveforms for each trial shall be in the same folder.
 - 1 trial – prbs15 and 5 trials – prbs31.
- h) The waveforms names shall be the same as in the screenshot below.

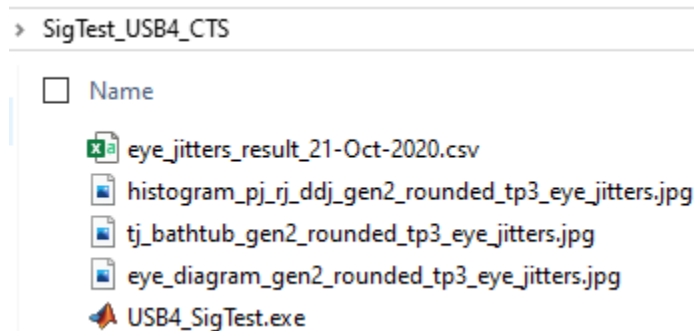
Run the following command from the PowerShell window:

```
.\USB4_SigTest.exe gen2_rounded rx tp3 tp3
```

```
C:\Desktop\SigTest_USB4_CTS\Waveforms\TP3\Rx\ tp3.bin none eye_jitters none
```

```
Running SIGTEST : Technology : GEN2_ROUNDED, TestMode : RX, TestPoint : TP3
The following tests are in progress ...
Receiver TP3 Input Eye Diagram Calibration
Loading File tp3_prbs31_trial_1.bin ...
Loading File tp3_prbs31_trial_2.bin ...
Loading File tp3_prbs31_trial_3.bin ...
Loading File tp3_prbs31_trial_4.bin ...
Loading File tp3_prbs31_trial_5.bin ...
Loading File tp3_prbs31_trial_2.bin ...
Writing eye_diagram_gen2_rounded_tp3_eye_jitters.jpg
Loading File tp3_prbs15.bin ...
Writing tj_bathtub_gen2_rounded_tp3_eye_jitters.jpg
Writing histogram_pj_rj_ddj_gen2_rounded_tp3_eye_jitters.jpg
Writing result to .\eye_jitters_result_25-Oct-2020.csv
The tests are completed
```

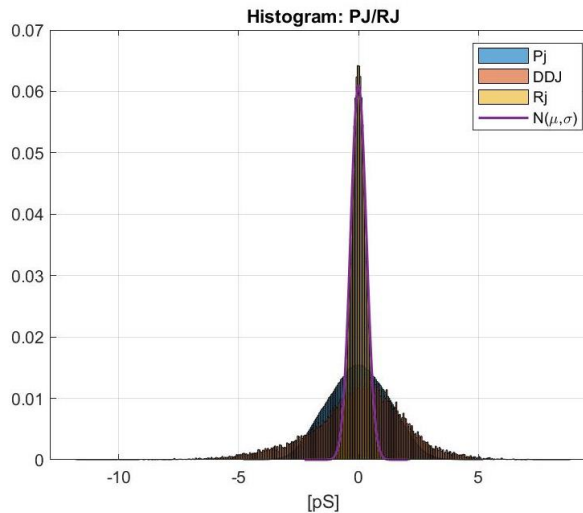
Report files location:



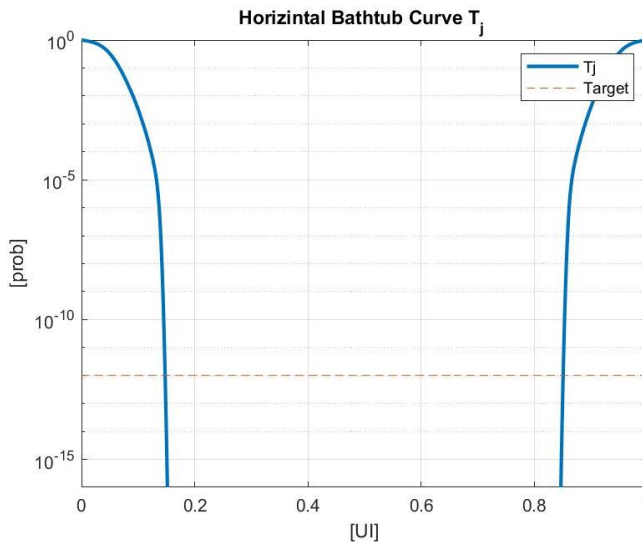
4.1. The .csv file eye_jitters_result_21-Oct-2020.csv

Electrical Compliance Test Specification for gen2_rounded																
Date: 25-Oct-20																
DIR:\Desktop\SigTest_US84_CTS\Waveforms\TP3\R\X																
File: tp3 bin																
Eye Diagram Measurement																
Informative Symbol Rate [Gbit/s]																
CTLE-Adc[dB]																
EyeWidth [ps]																
8.1841387																
EyeHeight[mV]																
207.027864																
NONE																
Symbol rate																
9.975465 Drift [ppm]																
-2453.53																
CTLE-DC Gain[dB]																
Drift[mV]																
Eye Height[mV]																
Eye Width[ps]																
Eye Height[mV]																
Eye Width[ps]																
Eye Height[mV]																
Eye Width[ps]																
Eye Height[mV]																
Eye Width[ps]																
Eye Height[mV]																
Eye Width[ps]																
Avg. Height[mV]																
Avg. Width[ps]																
Area[mVps]																
1																
0																
50																
1.409																
0.783																
0.285																
1.175																
0.318																
1.175																
1.457																
0.783																
0.313																
0.783																
0.76																
0.94																
0.64																
0.891																
1																
48.2																
142.647																
62.262																
129.546																
59.129																
140.216																
63.437																
141.373																
61.479																
136.547																
61.479																
138.07																
61.557																
8504.51																
0.794																
2																
42																
170.9																
71.269																
162.341																
70.877																
172.953																
70.485																
172.992																
70.485																
168.59																
70.485																
169.56																
70.72																
11593.66																
0.798																
3																
36.7																
197.61																
78.317																
191.643																
77.925																
199.418																
79.883																
198.65																
80.275																
194.414																
79.81																
196.35																
79.1																
15533.05																
0.631																
4																
32																
208.352																
82.233																
205.588																
80.667																
206.991																
81.058																
208.588																
82.233																
205.37																
83.016																
207.03																
81.841																
16943.65																
0.562																
5																
27.8																
196.275																
80.275																
182.233																
197.331																
189.416																
198.65																
194.569																
81.45																
196.54																
81.92																
16108.95																
0.501																
6																
24																
185.353																
76.751																
182.983																
76.359																
185.388																
79.883																
185.091																
79.492																
181.683																
74.01																
184.1																
77.29																
14233.46																
0.447																
7																
20.7																
170.463																
70.877																
168.146																
72.443																
172.005																
72.443																
171.527																
71.269																
168.334																
72.052																
170.09																
71.817																
12213.35																
0.398																
8																
17.8																
154.847																
66.57																
153.365																
67.744																
156.741																
67.744																
156.386																
67.744																
154.618																
67.744																
155.19																
67.509																
10476.95																
0.355																
9																
15.2																
138.71																
62.262																
139.772																
61.87																
142.913																
63.045																
140.059																
63.828																
140.079																
63.045																
140.31																
62.81																
8813.04																
Optimal CTLE: 4																

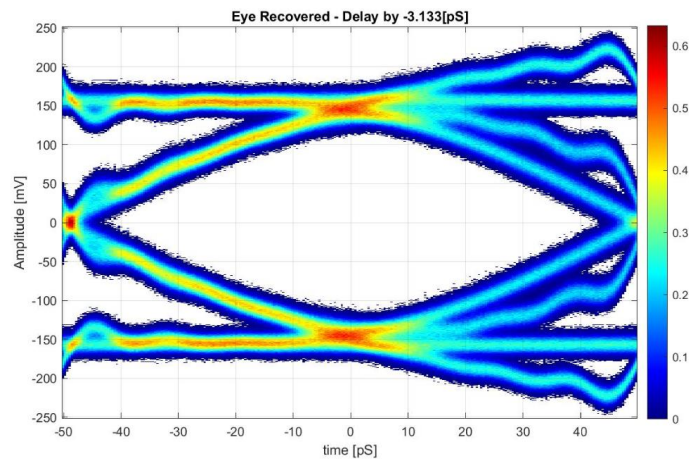
4.2. The .jpg file histogram_pj_rj_ddj_gen2_rounded_tp3_eye_jitters.jpg



4.3. The .jpg file tj_bathtub_gen2_rounded_tp3_eye_jitters.jpg



4.4. The .jpg file eye_diagram_gen2_rounded_tp3_eye_jitters.jpg



8 GEN4 Router Assembly Receiver Testing

8.1 General notes

This section describes commands list for Receiver testing

8.2 Oscilloscope intrinsic noise cancelation

See Appendix D of USB4 GEN4 CTS document for scope intrinsic noise measurement procedure.

scope_intrinsic_noise_p and scope_intrinsic_noise_n files shall be located in wdir (waveforms location)

8.3 GEN4 Router Assembly Receiver stressed signal calibration

This section describes commands list to be used for TP3' calibration for case1, BERT output calibration for case2, channel calibration to worst case condition for TP3

8.3.1 TP3' for Case1 and BERT output calibration for Case2

This procedure shall be used for RX calibration purpose for both TP3' and BERT output calibration.

Input signal for analysis are two single ended signal waveforms (p and n). Output report for analysis includes all calibration components as defined in spec. Waveform file names shall include prefixes: "p_..." and "n_..."

1. cts_test_name – **calibration**
2. test_point = **tp3_prime**

1. Run the following command from the PowerShell window:

Command example:

.\USB4_SigTest.exe gen4 rx tp3_prime calibration C:\SigTest\Waveforms\
p_prts7_preset_0.bin n_prts7_preset_0.bin calibration_report none

```
PS C:\SigTest> .\USB4_SigTest.exe gen4 rx tp3_prime calibration C:\SigTest\Waveforms\ p_prts7_preset_0.bin n_prts7_preset_0.bin calibration_report none
***** SIGTEST Version: 0.72 *****
Running SIGTEST : Technology : GEN4, TestMode : RX, TestPoint : TP3_PRIME
The following tests are in progress ...
USB4 gen4:Calibration ACCM, Jitters and Vertical
Loading File P: C:\SigTest\Waveforms\p_prts7_preset_0.bin & File N:C:\SigTest\Waveforms\n_prts7_preset_0.bin ....
Loading File: C:\SigTest\Waveforms\scope_intrinsic_noise.bin ....
Writing calibration_report_tj_bathtub_gen4_tp3_prime.jpg
Writing calibration_report_histogram_pj_rj_ddj_gen4_tp3_prime.jpg
Informative:Intrinsic Scope Noise = 3.431[mV-rms]
TX LEVELS MISMATCH = 0.975
TX LEVEL = +526.1[mV]
TX LEVEL = -8.8[mV]
TX LEVEL = -518.0[mV]
V_Steady-State = +514.4[mV]
TX_PULSE_PEAK = +526.1[mV]
TX_SNR = 32.4[dB]
TX_ISI_MARGIN = 19.4[dB]
TX_Budget: Dist=3.2[mV] Noise=12.3[mV] total= 12.7[mV]
Writing result to : \Calibration_report_result.csv
The tests are completed
PS C:\SigTest>
```

2. Report files location:

Local Disk (C:) > SigTest

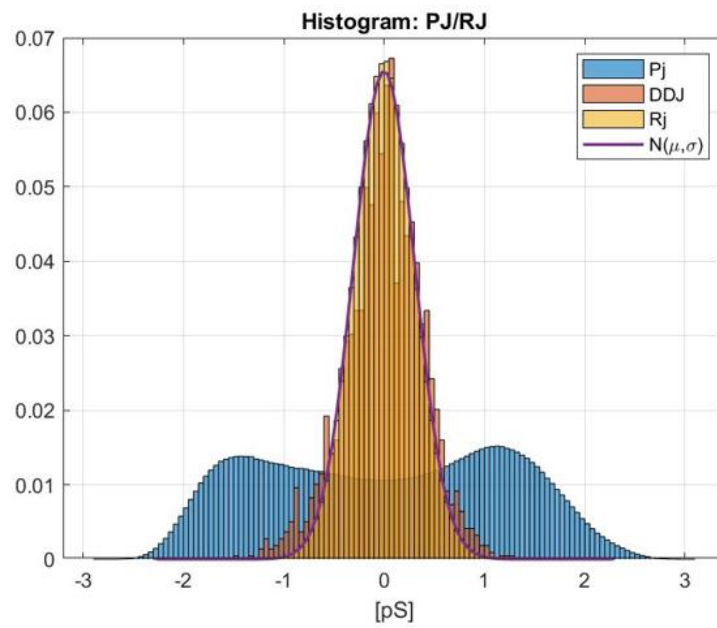
Name

- Waveforms
- calibration_report_histogram_pj_rj_ddj_gen4_tp3_prime.jpg
- calibration_report_result.csv
- calibration_report_tj_bathtub_gen4_tp3_prime.jpg
- tmp_sndr.txt
- USB4_SigTest.exe

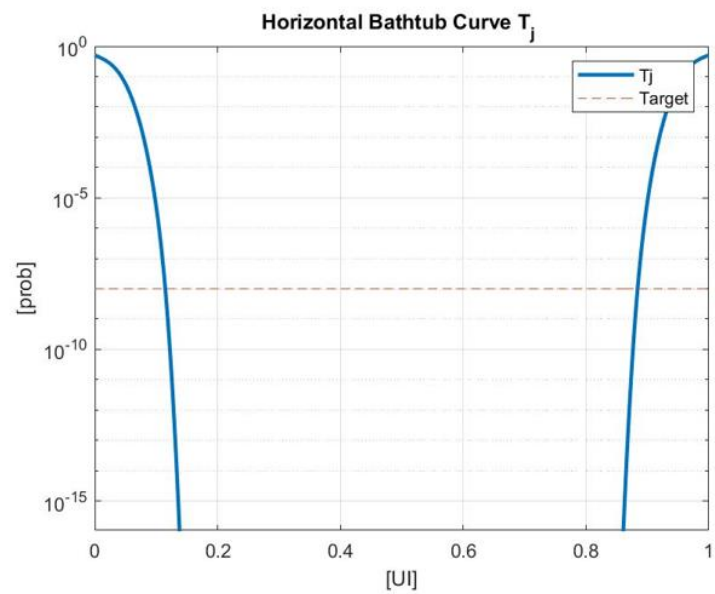
3. calibration_report_result.csv report file as an example

Electrical Compliance Test Specification for GEN4						
Date:	07-Mar-22					
DIR:	C:\SigTest\Waveforms\					
Files:	p_prts7_preset_0.bin	n_prts7_preset_0.bin				
AC CM Measurement:	AC CM: Vac [mVp2p]	85.1				
PJ Jitter Measurement mUIp-p:	PJ-p-p	86.968214				
RJ Jitter Measurement mUIrms:	RJ-rms	6.044195				
Informative: Symbol Rate [GHz]:	NONE	Symbol Rate	25.561618	Drift [PPM]	-1499.28	
Vertical Analysis Test:						
TX_SNR Measurement [dB]:	TX_SNR [dB]	32.367073				
TX_LEVELS_MISMATCH Measurement:	TX_LEVELS_MISMATCH	0.97538				
V_SWING Measurement [mVp-p]:	V_SWING-p-p	1028.8				

4. calibration_report_histogram_pj_rj_ddj_gen4_tp3_prime.jpg



5. calibration_report_tj_bathtub_gen4_tp3_prime.jpg



8.3.2 BERT Insertion Loss extraction

This procedure shall be used for BERT Insertion Loss extraction purpose and shall be used in Test_Channel Insertion Loss target estimation

Input file for analysis is:

- BERT_Sdd21.[scope format]

The file name shall be as listed above. The location of the file shall be specified in command line (see command line example below).

Output excel report includes:

- IL[dB] – BERT Insertion Loss at 12.8GHz

1. cts_test_name – **calibration_bert_il_extraction**
2. test_point = **tp3**

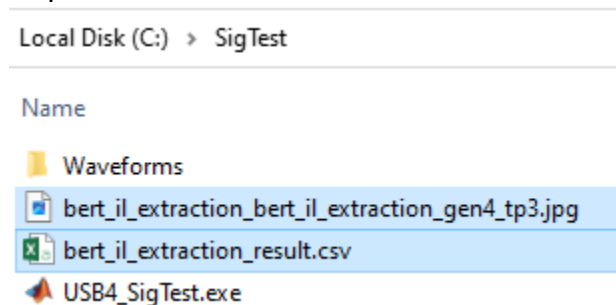
1. Run the following command from the PowerShell window:

Command example:

```
.\USB4_SigTest.exe gen4 rx tp3 calibration_bert_il_extraction  
C:\SigTest\Waveforms\ BERT_Sdd21.bin none bert_il_extraction.csv none  
none
```

```
PS C:\SigTest> .\USB4_SigTest.exe gen4 rx tp3 calibration_bert_il_extraction C:\SigTest\Waveforms\ BERT_Sdd21.bin none bert_il_extraction.csv none none  
***** SIGTEST Version: 0.9a *****  
Running SIGTEST : Technology : GEN4, TestMode : RX, TestPoint : TP3  
The following tests are in progress ...  
USB4 gen4: Channel calibration to worst case condition  
Loading File: C:\SigTest\Waveforms\BERT_Sdd21.bin ....  
BERT IL Extraction: -2.05[dB] at f=12.8[GHz]  
Writing bert_il_extraction_bert_il_extraction_gen4_tp3.jpg  
Writing result to .\bert_il_extraction_result.csv  
The tests are completed
```

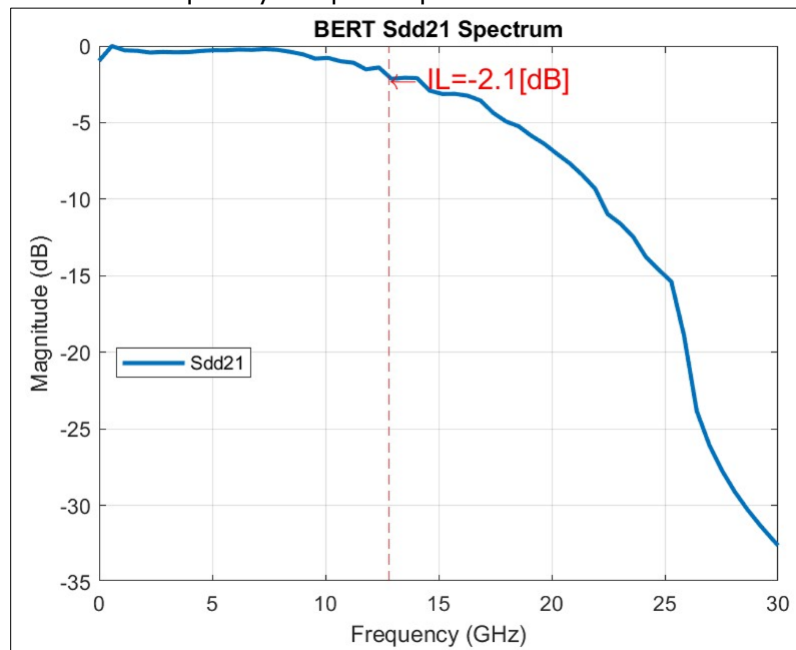
2. Report files location:



3. Bert_il_extraction.csv

Electrical Compliance Test Specification for GEN4					
Date:	28-Feb-23				
DIR:	C:\SigTest\Waveforms\				
File:	BERT_Sdd21.bin				
Calibration BERT IL Extraction Test:					
Informative:	IL[dB]	-1.8			
Informative: Symbol Rate [GHz]:	NONE	Symbol Rate	25.600011	Drift [PPM]	0.41

4. BERT Frequency Response plot

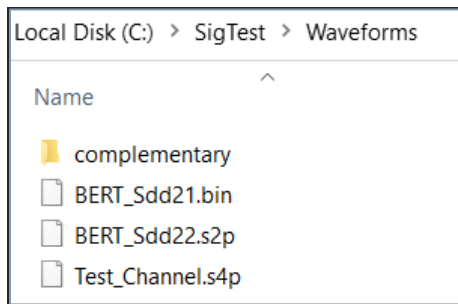


8.3.3 Channel calibration to worst case condition

This procedure shall be used for RX calibration purpose for channel calibration to worst case condition.

Input files for analysis are:

- Test_Channel.s4p
- BERT_Sdd22.s2p
- BERT_Sdd21.[scope format]
- complementary (folder)



The file names shall be as listed above. The location of the files shall be specified in command line (see command line example below). The complementary folder provided as zip file along with SigTest code and includes all required files for ECOM analyzer

Output excel report includes four calibration components as defined in CTS:

- End-2-End channel insertion loss at Nyquist
- TX_SJ_increase [SJ magnitude increase]
- ECOM convergence initial value
- ECOM convergence final value

1. cts_test_name – **calibration**
2. test_point = **tp3**

1. Run the following command from the PowerShell window:

Command example:

```
.\USB4_SigTest.exe gen4 rx tp3 calibration C:\SigTest\Waveforms\  
BERT_Sdd21.bin none  
channel_calibration_to_worst_case_condition_result_result.csv none  
none
```

```

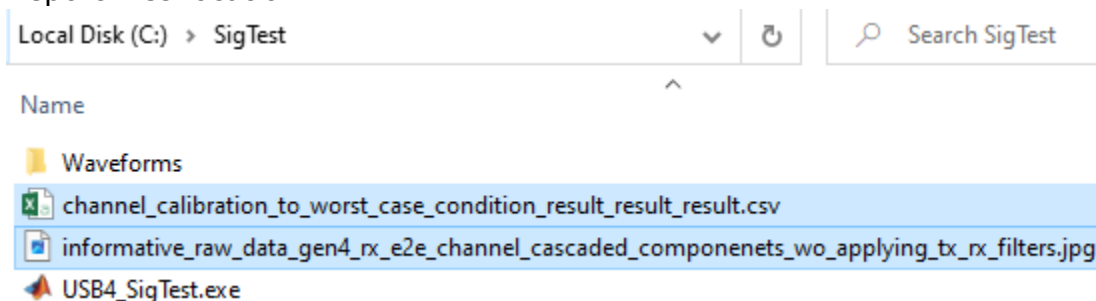
PS C:\SigTest> .\USB4_SigTest.exe gen4 rx tp3 calibration C:\SigTest\waveforms\BERT_Sdd21.bin none channel_calibration_to_worst_case_co
ndition_result_result.csv none none
***** SIGTEST Version: 0.9a *****
Running SIGTEST : Technology : GEN4, TestMode : RX, TestPoint : TP3
The following tests are in progress ...
USB4 gen4:channel calibration to worst case condition
Loading File: C:\SigTest\waveforms\BERT_Sdd21.bin ....
run_ecom_from_s4p 1.0
call for ecom for channel 0
Load config data from spreadsheet...
Load channel s4p files:      1      2      3      4
Skip Cascading Tx die-loading with channel...
Skip Cascading Rx die-loading with channel...
Skip Cascading Tx die-loading with channel...
Skip Cascading Rx die-loading with channel...
Skip Cascading Tx die-loading with channel...
Skip Cascading Rx die-loading with channel...
Skip Cascading Tx die-loading with channel...
Skip Cascading Rx die-loading with channel...
Apply Tx and Rx termination...
Apply Tx filter...
Apply Rx filter...
Calculate IL_fit_at_Nq, IMR, and IXT...
Writing the figure: Channel Frequency Transfer Functions to C:\SigTest\waveforms directory ...
Get channel impulse responses...
Get TX FFE presets...
Get RX CTLE impulse responses. This may take some time...
Apply TX FFE Get to CTLE impulse responses. This may take some time...
Start to find the optimal EQ. This may take some time ...
Process CTLE Index:
    1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
    21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
    41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60
    61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80
    81 82 83 84 85 86 87 88 89 90 91

Process the tie-breakers ...
Try TX FFE = 0.05,-0.2,0 and CTLE DC Gain = -8,-3: ecom_h=-0.176 dB and ecom_w = -0.010 dB
Try TX FFE = 0.05,-0.2,-0.05 and CTLE DC Gain = -6,-3: ecom_h=-0.197 dB and ecom_w = -0.019 dB
Try TX FFE = 0.05,-0.2,0 and CTLE DC Gain = -8,-4: ecom_h=-0.381 dB and ecom_w = -0.098 dB
Try TX FFE = 0.025,-0.2,0 and CTLE DC Gain = -8,-3: ecom_h=-0.149 dB and ecom_w = -0.059 dB
Try TX FFE = 0.05,-0.2,-0.05 and CTLE DC Gain = -6,-4: ecom_h=-0.434 dB and ecom_w = -0.152 dB
FAIL ... COM_h = -0.149 dB
Finish statistical analysis!
Finish
run_ecom_from_s4p 1.0
call for ecom for channel 0
Load config data from spreadsheet...
Load channel s4p files:      1      2      3      4
Skip Cascading Tx die-loading with channel...
Skip Cascading Rx die-loading with channel...
Skip Cascading Tx die-loading with channel...
Skip Cascading Rx die-loading with channel...
Skip Cascading Tx die-loading with channel...
Skip Cascading Rx die-loading with channel...
Skip Cascading Tx die-loading with channel...
Skip Cascading Rx die-loading with channel...
Apply Tx and Rx termination...
Apply Tx filter...
Apply Rx filter...
Calculate IL_fit_at_Nq, IMR, and IXT...
Writing the figure: Channel Frequency Transfer Functions to C:\SigTest\waveforms directory ...
Get channel impulse responses...
Get TX FFE presets...
Get RX CTLE impulse responses. This may take some time...
Apply TX FFE Get to CTLE impulse responses. This may take some time...
Start to find the optimal EQ. This may take some time ...
Process CTLE Index:
    1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17 18 19 20
    21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
    41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60
    61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80
    81 82 83 84 85 86 87 88 89 90 91

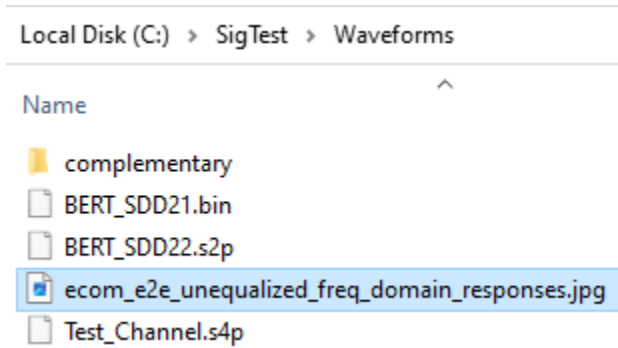
Process the tie-breakers ...
Try TX FFE = 0.05,-0.2,0 and CTLE DC Gain = -8,-3: ecom_h=-0.028 dB and ecom_w = -0.075 dB
Try TX FFE = 0.05,-0.2,0 and CTLE DC Gain = -8,-4: ecom_h=-0.234 dB and ecom_w = -0.040 dB
Try TX FFE = 0.05,-0.2,-0.05 and CTLE DC Gain = -6,-3: ecom_h=-0.046 dB and ecom_w = -0.035 dB
Try TX FFE = 0.025,-0.2,0 and CTLE DC Gain = -8,-3: ecom_h=-0.021 dB and ecom_w = 0.000 dB
Try TX FFE = 0.05,-0.2,0 and CTLE DC Gain = -9,-3: ecom_h=-0.057 dB and ecom_w = -0.030 dB
FAIL ... COM_h = -0.021 dB
Finish statistical analysis!
Finish
====>>> ECOM=-0.02dB (Initial ECOM=-0.15dB)
====>>> TX_S1 Increase=-0.005 [UI]
Writing result to .\channel_calibration_to_worst_case_condition_result_result_result.csv
The tests are completed

```

2. Report files location:



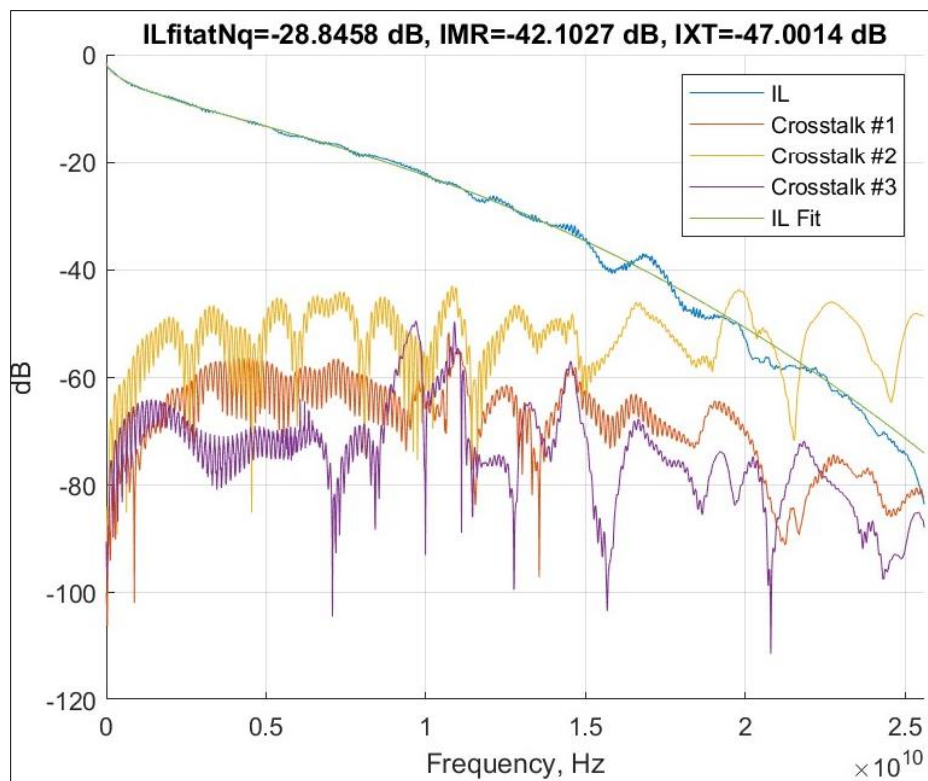
And



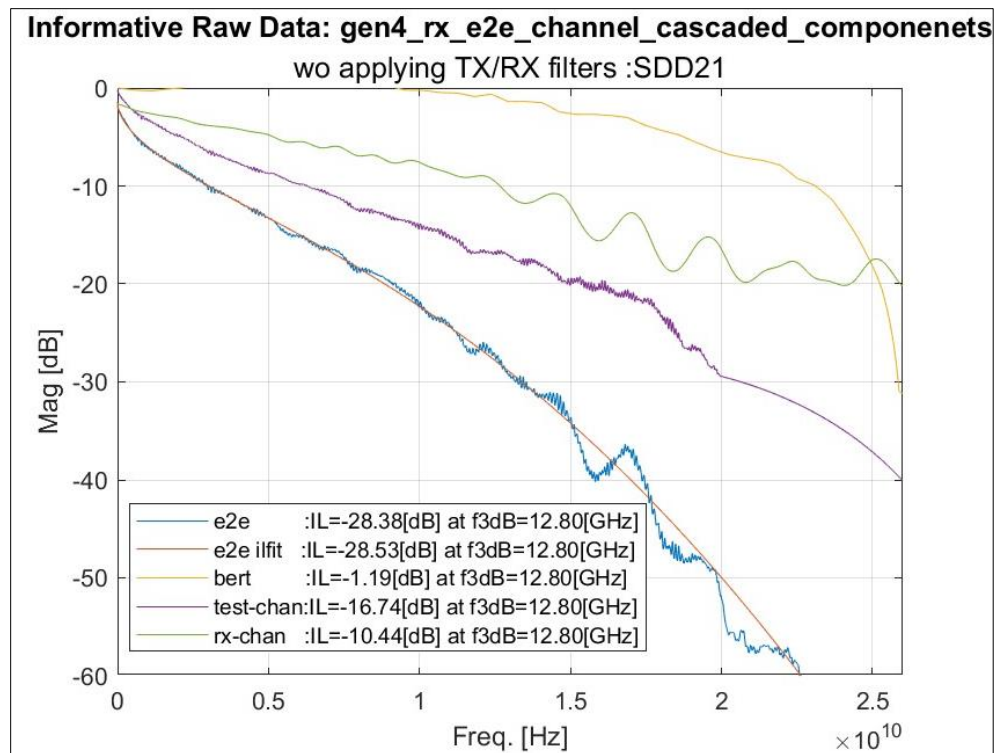
3. channel_calibration_to_worst_case_condition_result_result.csv

Electrical Compliance Test Specification for GEN4						
Date:	26-Dec-23					
DIR:	C:\SigTest\Waveforms\					
File:	BERT_Sdd21.bin					
Calibration:	End-to-End Channel ILfit at Nyquist	-28.9 [dB]	CTS: Min	-29	CTS: Max	-28
Calibrate to:	TX_SJ_increase [mUIp-p]	-5	CTS: Min	-10	CTS: Max	10
Calibration:	ECOM Convergence init value	-0.1488				
Calibration:	ECOM Convergence final value	-0.02088	CTS: Min	-0.1	CTS: Max	0.1
Informative:	Symbol Rate [GHz]	25.60001	Drift [PPM]	0.38		

4. ECOM End-to-End channel ILfit plot



5. SigTest End-to-End Channel and components plot (informative info)



6. Failure flow

End-to-End Channel ILfit is out of defined tolerance, Sigtest aborts with following message:

The overall end-to-end channel ILfit at 12.8GHz is -34.2[dB] which is out of the required range=[-29.0,-28.0] [dB] --> The Test Channel shall be adjusted!!!

ECOM convergence final value is out of defined tolerance, Sigtest aborts with following message:

8.4 TP3'

8.4.1 rx_frequency_variation

This function shall be used for USB4 v2 GEN4 Rx Frequency Variation profile calibration

Run the following command from the PowerShell window:

Command example:

```
.\USB4_SigTest.exe gen4 rx tp3_prime frequency_variation_training  
C:\SigTest_USB4_CTS\Waveforms\  
rx_frequency_variation_gen4_tp3_prime.bin none  
rx_frequency_variation_calibration_tp3_prime none
```

```
PS C:\SigTest_USB4_CTS> .\USB4_SigTest.exe gen4 rx tp3_prime frequency_variation_training C:\SigTest_USB4_CTS\Waveforms\  
rx_frequency_variation_gen4_tp3_prime.bin none rx_frequency_variation_calibration_tp3_prime none  
***** SIGTEST Version: 0.83 *****  
Running SIGTEST : Technology : GEN4, TestMode : RX, TestPoint : TP3_PRIME  
The following tests are in progress ...  
Frequency Variation Training Measurement  
Loading File: C:\SigTest_USB4_CTS\Waveforms\rx_frequency_variation_gen4_tp3_prime.bin ....  
Writing rx_frequency_variation_calibration_tp3_prime_rx_clock_switch_analysis_gen4_tp3_prime.jpg  
Writing result to .\rx_frequency_variation_calibration_tp3_prime_result.csv  
The tests are completed
```

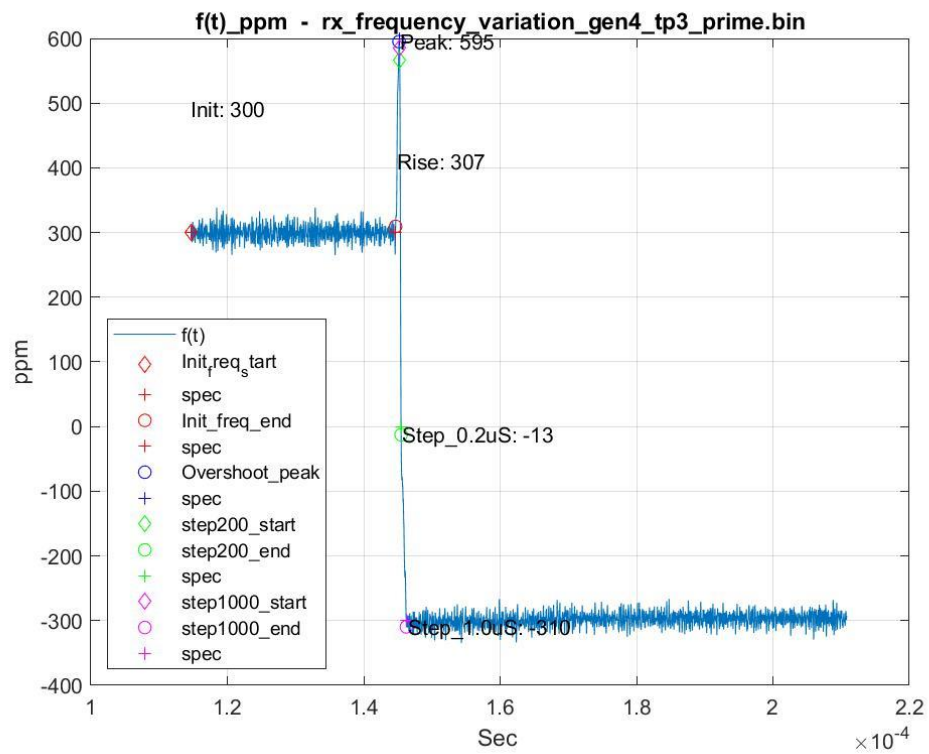
Report files location:

Waveforms	16/12/2022 16:51	File folder	
rx_frequency_variation_calibration_tp3_prime_result.csv	16/12/2022 16:56	Microsoft Excel Co...	2 KB
rx_frequency_variation_calibration_tp3_prime_rx_clock_switch_analysis_gen4_tp3_prime.jpg	16/12/2022 16:56	JPG File	73 KB
USB4_SigTest.exe	16/12/2022 15:14	Application	5,532 KB

The .csv file rx_frequency_variation_calibration_tp3_prime_result.csv as a results example

Electrical Compliance Test Specification for GEN4					
Date:	16-Dec-22				
DIR:	C:\SigTest_USB4_CTS\Waveforms\				
File:	rx_frequency_variation_gen4_tp3_prime.bin				
RX Frequency Variation Training Measurement:					
INIT_FREQ_VARIATION:	PASS	RX_INIT_FREQ_VARIATION result:	299.534768 CTS: Min RX_INIT_FREQ_VARIATION	275 CTS: Max RX_INIT_FREQ_VARIATION	325
DELTA_FREQ_200nS:	PASS	RX_DELTA_FREQ_200nS result:	578.571019 CTS: Min RX_DELTA_FREQ_200nS	575 CTS: Max RX_DELTA_FREQ_200nS	625
DELTA_FREQ_1000nS:	PASS	RX_DELTA_FREQ_1000nS result:	895.301998 CTS: Min RX_DELTA_FREQ_1000nS	875 CTS: Max RX_DELTA_FREQ_1000nS	925
FREQ_OVERSHOOT:	PASS	RX_FREQ_OVERSHOOT result:	595.098731 CTS: Min RX_FREQ_OVERSHOOT	575 CTS: Max RX_FREQ_OVERSHOOT	625
STEADY_STATE_FREQ_VARIATION:	PASS	STEADY_STATE_FREQ_VARIATION result:	-302.754177 CTS: Min STEADY_STATE_FREQ_VARIATION	-325 CTS: Max STEADY_STATE_FREQ_VARIATION	-275
Informative: Symbol Rate [GHz]:	NONE	Symbol Rate	25.598735 Drift [PPM]	-49.41	

The SIGTEST saves the following plot (.jpg format)



8.4.2 rl

This function calculates Return Loss (rl) and Integrated Return Loss (irl) for RX lanes
Expected input for RX RL and IRL analysis is s2p file only, no signal waveform is required

1. Run the following command from the PowerShell window:

Command example:

```
.\USB4_SigTest.exe gen4 rx tp2 rl C:\SigTest\Waveforms\ none none  
rl_report none pam3_prts7_preset_19_s2p.s2p
```

```
PS C:\SigTest> .\USB4_SigTest.exe gen4 rx tp2 rl C:\SigTest\Waveforms\ none none rl_report none  
pam3_prts7_preset_19_s2p.s2p  
***** SIGTEST Version: 0.72 *****  
Running SIGTEST : Technology : GEN4, TestMode : RX, TestPoint : TP2  
The following tests are in progress ...  
Receiver Return Loss & Integrated Return Loss  
Reading S parameters File: C:\SigTest\Waveforms\pam3_prts7_preset_19_s2p.s2p ..  
IRL=-36.0[dB]  
Writing rl_report_receiver_differential_rx12_return_loss_gen4_tp2.jpg  
Writing result to .\rl_report_result.csv  
The tests are completed
```

2. report file location:

Local Disk (C:) > SigTest

Name

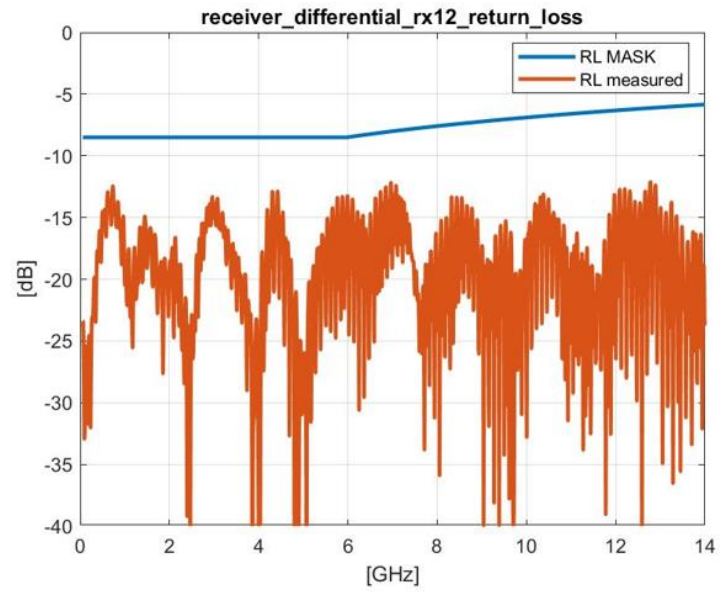
- Waveforms
- rl_report_receiver_differential_rx12_return_loss_gen4_tp2.jpg
- rl_report_result.csv
- USB4_SigTest.exe

3. rl_report_result.csv as a result example

Electrical Compliance Test Specification for GEN4						
Date:	08-Mar-22					
DIR:	C:\SigTest\Waveforms\					
File:	none					
Receiver Return Loss & Integrated Return Loss						
IRL:	PASS	IRL[dB]:	-35.962857	CTS: Max IRL	-14.5	
Informative:	Sdd11 MASK:	PASS				
Informative:	Sdd11 max[dB]	-12.5	Margin[dB]	4	Fmax[GHz]	0.730062

- **Sdd11 max[dB]** indicates closest to spec mask absolute RL result
- **Sdd11 MASK** indicates RL pass/fail criteria
- **Margin[dB]** indicates the delta between absolute RL result to spec mask
- **Fmax[GHz]** indicates the frequency of the closest to spec mask absolute RL result
- **IRL[dB]** indicates calculated IRL
- **IRL** indicates IRL pass/fail criteria
- **CTS: Max IRL** indicates the IRL spec limit

4. rl_report_receiver_differential_rx12_return_loss_gen4_tp2.jpg
Return Loss plot with spec mask



8.5 TP3

8.5.1 rx_frequency_variation

This function shall be used for USB4 v2 GEN4 Rx Frequency Variation profile calibration





Run the following command from the PowerShell window:

Command example:

```
.\USB4_SigTest.exe gen4 rx tp3 frequency_variation_training  
C:\SigTest_USB4_CTS\Waveforms\ rx_frequency_variation_gen4_tp3.bin  
none rx_frequency_variation_calibration_tp3 none
```

```
PS C:\SigTest_USB4_CTS> .\USB4_SigTest.exe gen4 rx tp3 frequency_variation_training C:\SigTest_USB4_CTS\Waveforms\ rx_fr  
equency_variation_gen4_tp3.bin none rx_frequency_variation_calibration_tp3 none  
***** SIGTEST Version: 0.83 *****  
Running SIGTEST : Technology : GEN4, TestMode : RX, TestPoint : TP3  
The following tests are in progress ...  
Frequency Variation Training Measurement  
Loading File: C:\SigTest_USB4_CTS\Waveforms\rx_frequency_variation_gen4_tp3.bin ....  
Writing rx_frequency_variation_calibration_tp3_rx_clock_switch_analysis_gen4_tp3.jpg  
Writing result to .\rx_frequency_variation_calibration_tp3_result.csv  
The tests are completed
```

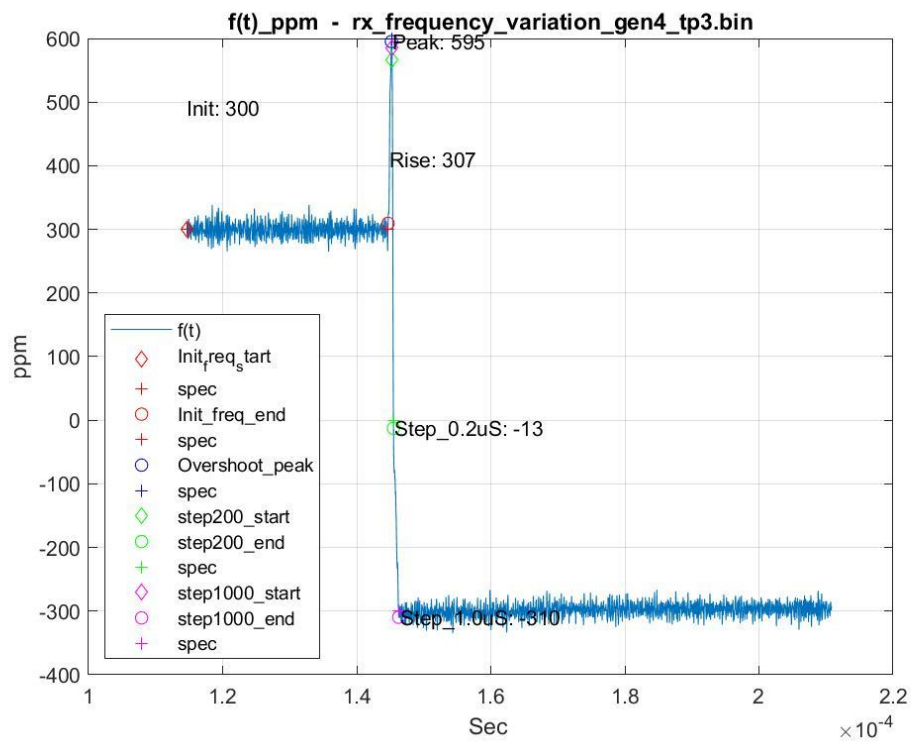
Report files location:

 Waveforms	16/12/2022 17:02	File folder	
 rx_frequency_variation_calibration_tp3_result.csv	16/12/2022 17:01	Microsoft Excel Co...	2 KB
 rx_frequency_variation_calibration_tp3_rx_clock_switch_analysis_gen4_tp3.jpg	16/12/2022 17:01	JPG File	72 KB
 USB4_SigTest.exe	16/12/2022 15:14	Application	5,532 KB

The .csv file rx_frequency_variation_report_result.csv as a results example

Electrical Compliance Test Specification for GEN4							
Date:	16-Dec-22						
DIR:	C:\SigTest_USB4_CTS\Waveforms\						
File:	rx_frequency_variation_gen4_tp3.bin						
RX Frequency Variation Training Measurement:							
INIT_FREQ_VARIATION:	PASS	RX_INIT_FREQ_VARIATION result:	299.534768	CTS: Min RX_INIT_FREQ_VARIATION	275	CTS: Max RX_INIT_FREQ_VARIATION	325
DELTA_FREQ_200ns:	PASS	RX_DELTA_FREQ_200ns result:	578.571019	CTS: Min RX_DELTA_FREQ_200ns	575	CTS: Max RX_DELTA_FREQ_200ns	625
DELTA_FREQ_1000ns:	PASS	RX_DELTA_FREQ_1000ns result:	895.301998	CTS: Min RX_DELTA_FREQ_1000ns	875	CTS: Max RX_DELTA_FREQ_1000ns	925
FREQ_OVERSHOOT:	PASS	RX_FREQ_OVERSHOOT result:	595.098731	CTS: Min RX_FREQ_OVERSHOOT	575	CTS: Max RX_FREQ_OVERSHOOT	625
STEADY_STATE_FREQ_VARIATION:	PASS	STEADY_STATE_FREQ_VARIATION result:	-302.754177	CTS: Min STEADY_STATE_FREQ_VARIATION	-325	CTS: Max STEADY_STATE_FREQ_VARIATION	-275
Informative: Symbol Rate [GHz]:	NONE	Symbol Rate	25.598735	Drift [PPM]	-49.41		

The SIGTEST saves the following plot (.jpg format)



8.6 Aggressors' calibration

This function shall be used for USB4 v2 GEN4 Rx Aggressors Amplitude calibration

Run the following command from the PowerShell window:

Command example:

```
USB4_SigTest.exe gen4 tx tp2 clk_info C:\SigTest\Waveforms\  
GEN4_RX_Aggressors_6p4GHz_clock.bin none  
GEN4_RX_Aggressors_6p4GHz_clock none
```

```
C:\SigTest>USB4_SigTest.exe gen4 tx tp2 clk_info C:\SigTest\Waveforms\ GEN4_RX_Aggressors_6p4GHz_clock.bin none GEN4_RX_Aggressors_6p4GHz_clock none  
***** SIGTEST Version: 0.87 *****  
Running SIGTEST : Technology : GEN4, TestMode : TX, TestPoint : TP2  
The following tests are in progress ...  
Clock Info Measurement  
Loading File: C:\SigTest\Waveforms\GEN4_RX_Aggressors_6p4GHz_clock.bin ....  
>>> Clock Rate=6.399986e+09[Hz]  
Writing result to .\GEN4_RX_Aggressors_6p4GHz_clock_result.csv  
The tests are completed
```

Report files location:

This PC > Local Disk (C:) > SigTest > Waveforms			
Name	Date modified	Type	Size
GEN4_RX_Aggressors_6p4GHz_clock.bin	17/04/2023 17:42	BIN File	250,001 KB

The .csv file GEN4_RX_Aggressors_6p4GHz_clock.csv as a results example

Electrical Compliance Test Specification for GEN4				
Date:	05-Jun-23			
DIR:	C:\SigTest\Waveforms\			
File:	GEN4_RX_Aggressors_6p4GHz_clock.bin			
Informative:	Symbol Rate [GHz]	12.799972	Drift [PPM]	-500001.08
Aggressor CLK Frequency [GHz]:	6.399986			
Aggressor Swing [mVp-p]:	571.3			

9 LFPS

9.1 LFPS TX

This function shall be used for USB4 v2 GEN2/3/4 LFPS Transmitter testing. Input waveforms can be either in differential or single ended mode (no ACCM result plotted while using differential signal waveform). The input signal shall be LFPS → Electrical Idle → HighSpeed (LFPS_TEST port operation mode 1)

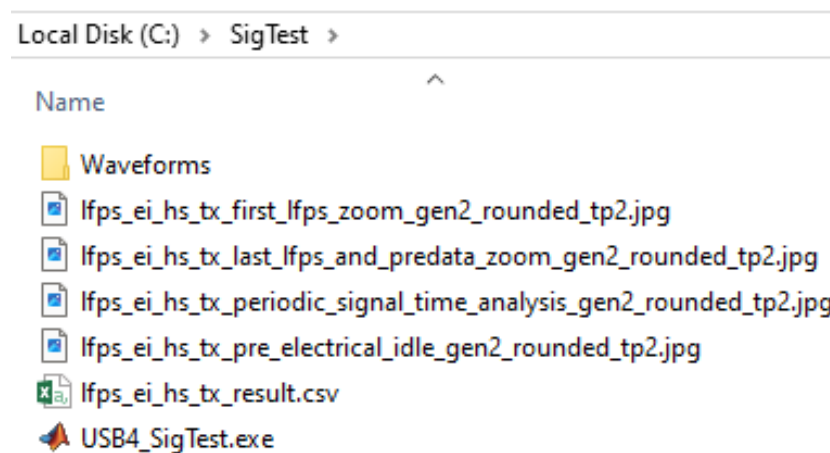
Run the following command from the PowerShell window:

Command example:

.\USB4_SigTest.exe gen2_rounded tx tp2 lfps C:\SigTest\Waveforms\lfps_ei_hs_tx_p.bin lfps_ei_hs_tx_n.bin lfps_ei_hs_tx_s_parameter_for_deembedding.s4p

```
PS C:\SigTest> .\USB4_SigTest.exe gen2_rounded tx tp2 lfps C:\SigTest\Waveforms\ lfps_ei_hs_tx_p.bin lfps_ei_hs_tx_n.bin lfps_ei_hs_tx none
***** SIGTEST Version: 0.9 *****
Running SIGTEST : Technology : GEN2_ROUNDED, TestMode : TX, TestPoint : TP2
The following tests are in progress ...
USB4 gen2_rounded:Low Frequency Periodic Signaling (LFPS)
Loading File P: C:\SigTest\Waveforms\lfps_ei_hs_tx_p.bin & File N:C:\SigTest\Waveforms\lfps_ei_hs_tx_n.bin ....
LFPS:Rate=32.65[MHz], T=30.62[nS],T1=15.312934[nS],T2=15.311700[nS],DC=50.002015[%]
Writing lfps_ei_hs_tx_periodic_signal_time_analysis_gen2_rounded_tp2.jpg
Writing lfps_ei_hs_tx_pre_electrical_idle_gen2_rounded_tp2.jpg
Writing lfps_ei_hs_tx_first_lfps_zoom_gen2_rounded_tp2.jpg
Writing lfps_ei_hs_tx_last_lfps_and_predata_zoom_gen2_rounded_tp2.jpg
Writing result to .lfps_ei_hs_tx_result.csv
The tests are completed
```

Report files location:

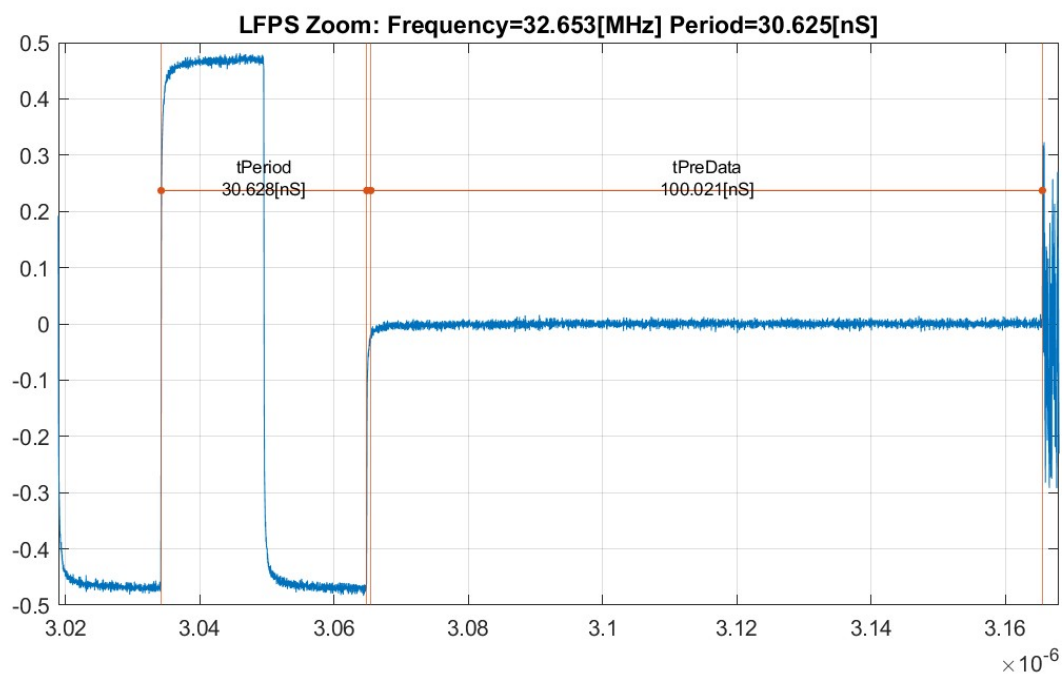
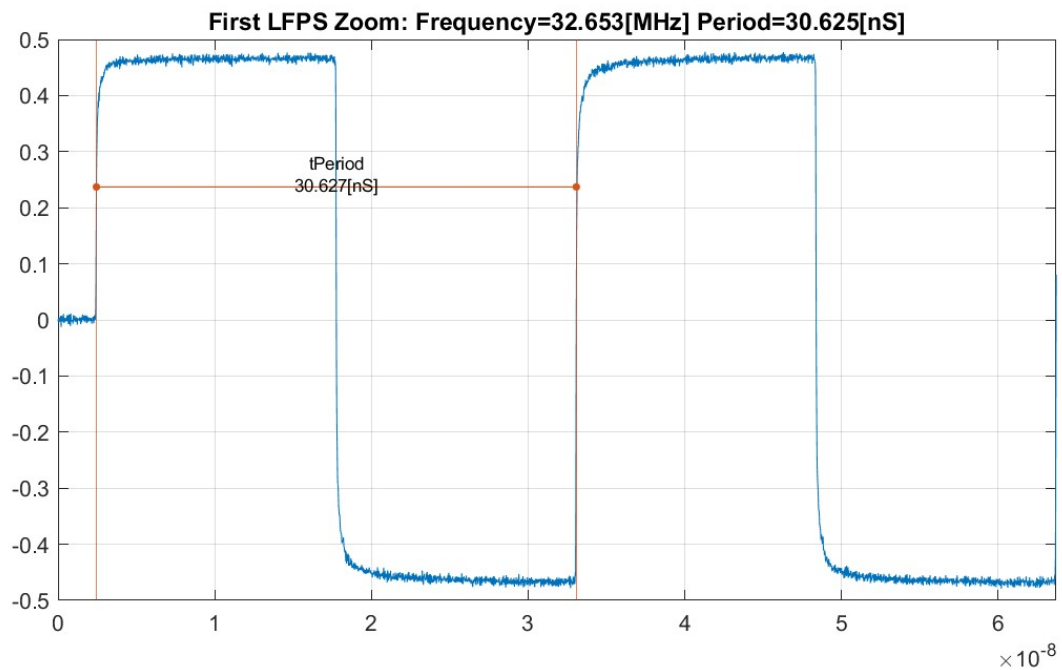


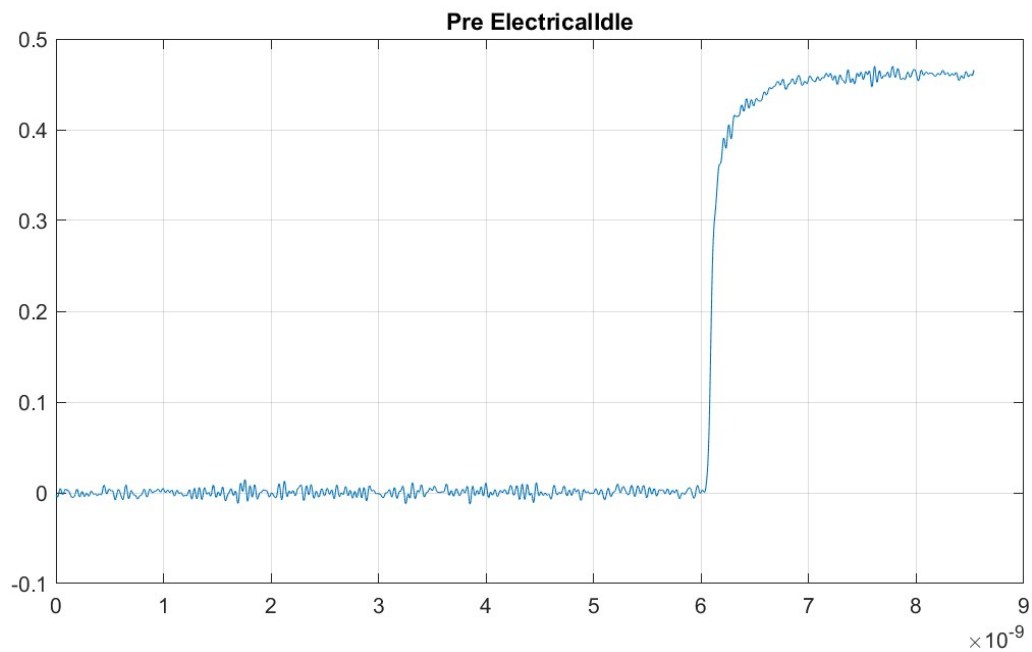
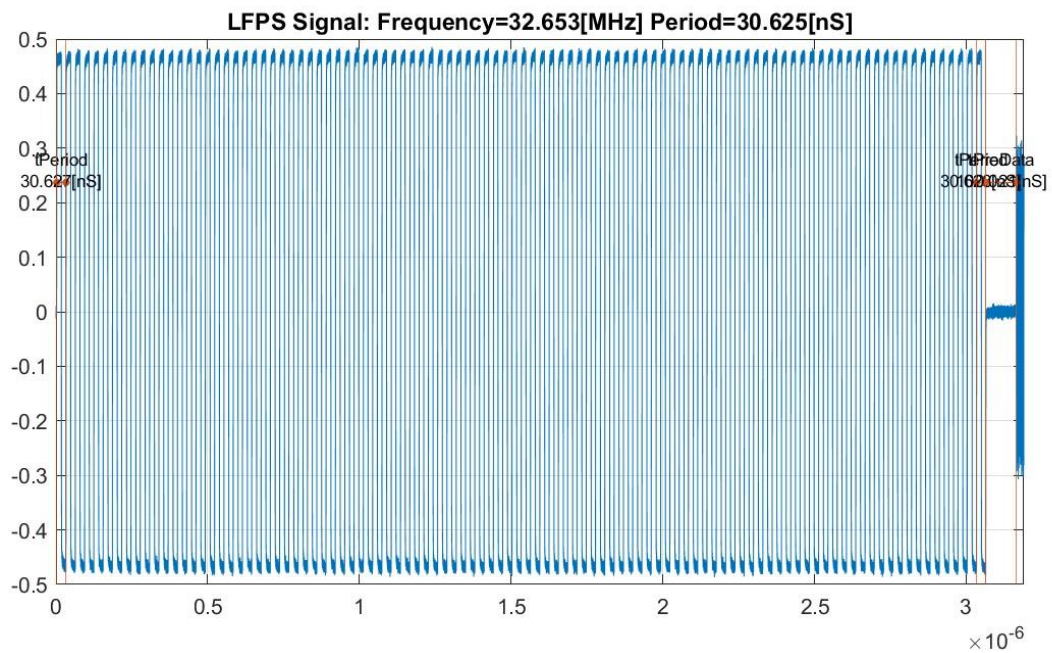
The .csv file lfps_ei_hs_tx_result.csv as a results example

Electrical Compliance Test Specification for GEN2_ROUNDED									
Date:	22-Feb-24								
DIR:	C:\SigTest\Waveforms\								
Files:	lfps_ei_hs_tx_p.bin	lfps_ei_hs_tx_n.bin							
Low Frequency Periodic Signaling (LFPS) Test:									
LFPS Detected:	TRUE								
tPreData Measurement:	PASS	tPreData[nS]	100.095	CTS: Min tPreData	80	CTS: Max tPreData	120		
tPeriod Measurement:	PASS	Min tPeriod[nS]	30.625	CTS: Min tPeriod	20	Max tPeriod	30.625	CTS: Max tPeriod	80
tRise Measurement:	PASS	Max tRise[nS]	0.117	CTS: Max trise [nS]	4				
tFall Measurement:	PASS	Max tFall[nS]	0.118	CTS: Max tfall [nS]	4				
LFPS_DUTY_CYCLE Measurement:	PASS	Min LFPS_DUTY_CYCLE[%]	50	CTS: Min DUTY CYCLE	45	CTS: Max DUTY CYCLE	55		
V_TX_DIFF_PP_LFPS Measurement:	PASS	Min V_TX_DIFF_PP_LFPS[mVp2p]	949.48	CTS: Min V_TX_DIFF_PP_LFPS[mVp2p]	800	CTS: Max V_TX_DIFF_PP_LFPS[mVp2p]	1200		
AC CM Measurement:	PASS	AC CM: V_CM_AC_LFPS[mVp2p]	38.3	CTS: Max AC CM [mVp2p]	100				
Electrical Idle Voltage Measurement[mV]:	PASS	V_ELEC_IDLE	4.49559	CTS: Max V_ELEC_IDLE	20				

SigTest saves the following plots:

1. First LFPS cycles
2. Electrical idle period
3. LFPS → Electrical Idle → High-Speed sequence
4. Electrical Idle prior LFPS





9.2 LFPS RX calibration

This function shall be used for USB4 v2 GEN2/3/4 LFPS Receiver detection testing. Input waveforms can be either in differential or single ended mode (no ACCM result plotted while using differential signal waveform). The input signal shall be LFPS only (LFPS_TEST port operation mode 0) starting with Electrical Idle

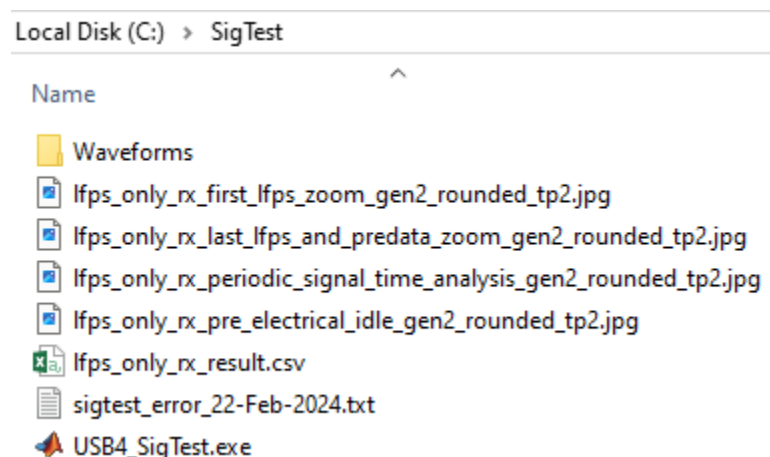
Run the following command from the PowerShell window:

Command example:

```
.\USB4_SigTest.exe gen4 rx tp2 lfps C:\SigTest\Waveforms\lfps_only_p.bin lfps_only_tx_n.bin lfps_only_rx none
```

```
PS C:\SigTest> .\USB4_SigTest.exe gen2_rounded rx tp2 lfps C:\SigTest\Waveforms\ lfps_only_rx_p.bin lfps_only_rx_n.bin lfps_only_rx none
***** SIGTEST Version: 0.9 *****
Running SIGTEST : Technology : GEN2_ROUNDED, TestMode : RX, TestPoint : TP2
The following tests are in progress ...
USB4 gen2_rounded:Low Frequency Periodic Signaling (LFPS)
Loading File P: C:\SigTest\Waveforms\lfps_only_rx_p.bin & File N:C:\SigTest\Waveforms\lfps_only_rx_n.bin ....
LFPS:Rate=33.33[MHz], T=30.00[nS],T1=15.000532[nS],T2=14.999453[nS],DC=50.001799[%]
Writing lfps_only_rx_periodic_signal_time_analysis_gen2_rounded_tp2.jpg
Writing lfps_only_rx_pre_electrical_idle_gen2_rounded_tp2.jpg
Writing lfps_only_rx_first_lfps_zoom_gen2_rounded_tp2.jpg
Writing lfps_only_rx_last_lfps_and_predata_zoom_gen2_rounded_tp2.jpg
Writing result to .\lfps_only_rx_result.csv
The tests are completed
```

Report files location:

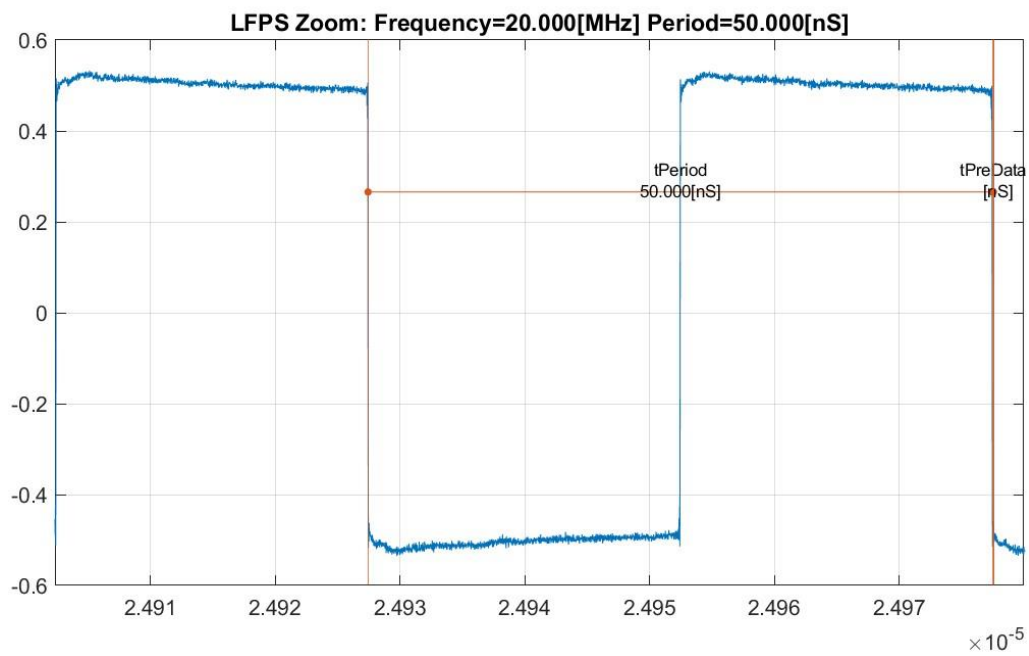
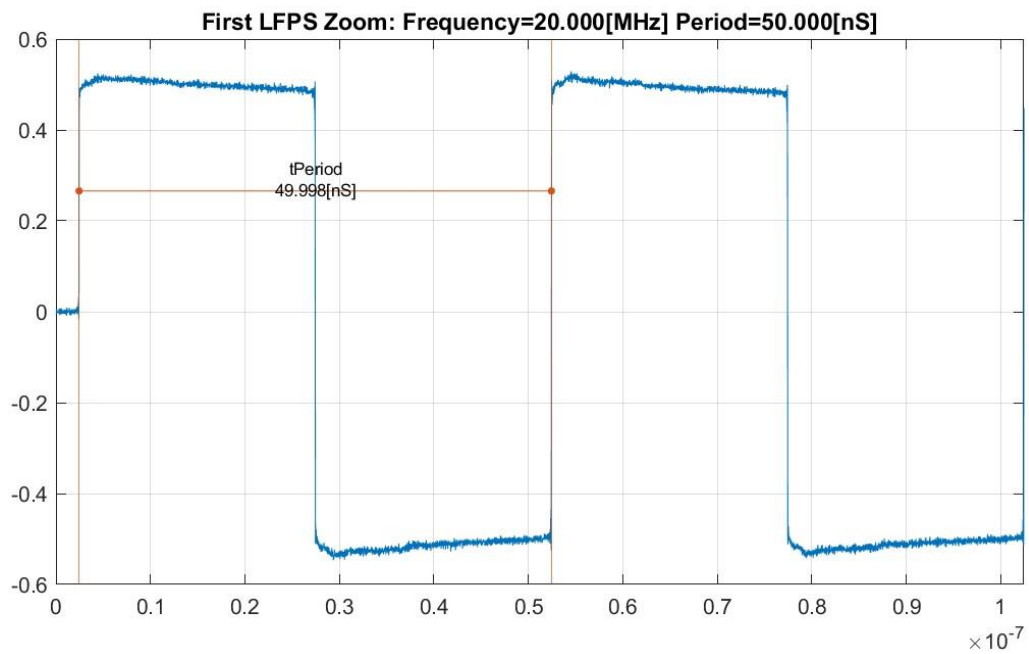


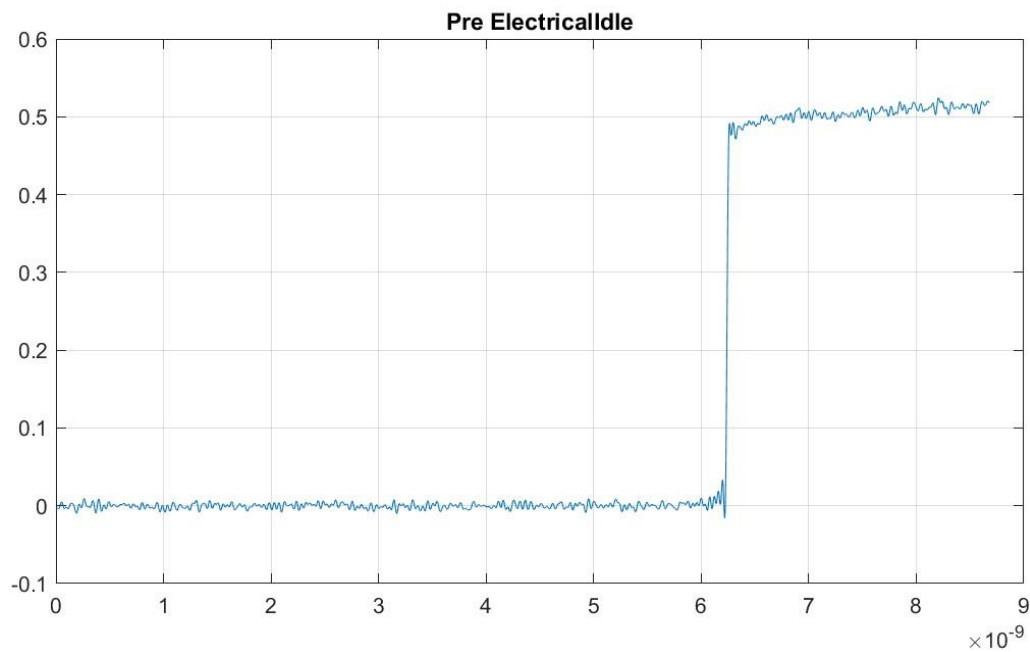
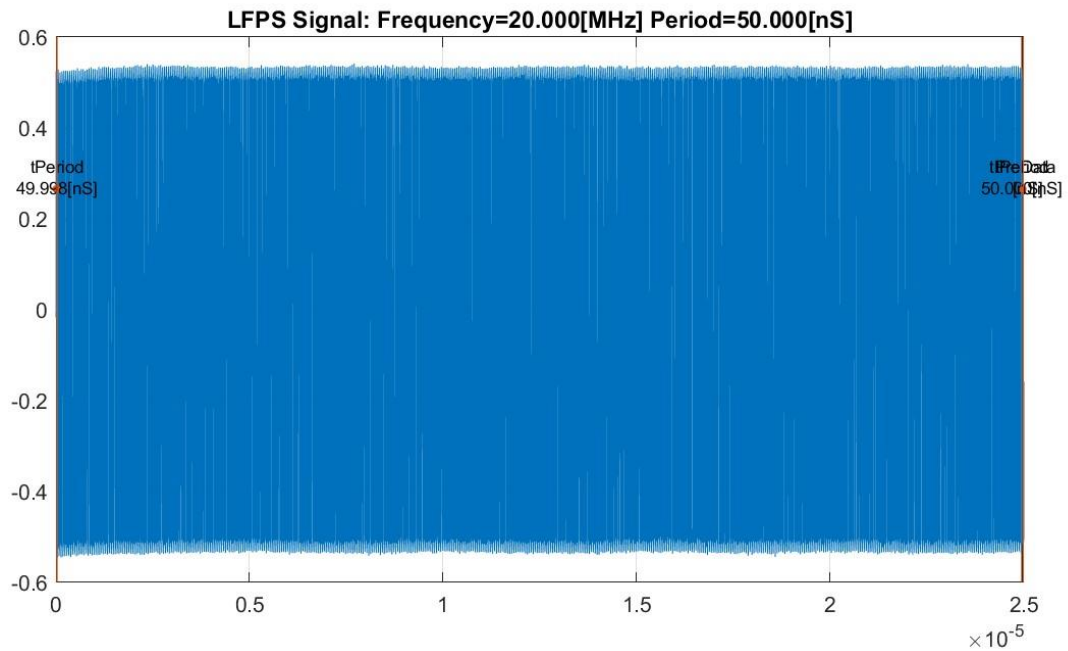
The .csv file lfps_only_rx_result.csv as a results example

Electrical Compliance Test Specification for GEN2_ROUNDED							
Date:	22-Feb-24						
DIR:	C:\SigTest\Waveforms\						
Files:	lfps_only_rx_p.bin	lfps_only_rx_n.bin					
Low Frequency Periodic Signaling (LFPS) Test:							
Only LFPS Detected:	TRUE	Cycles	833				
tPreData Measurement:	FAIL	tPreData[nS]	0	CTS: Min tPreData	80	CTS: Max tPreData	120
tPeriod Measurement:	PASS	Min tPeriod[nS]	30	CTS: Min tPeriod	20	Max tPeriod	30
tRise Measurement:	PASS	Max tRise[nS]	0.467	CTS: Max trise [nS]	4		
tFall Measurement:	PASS	Max tFall[nS]	0.438	CTS: Max tfall [nS]	4		
LFPS_DUTY_CYCLE Measurement:	PASS	Min LFPS_DUTY_CYCLE[%]	50	CTS: Min DUTY CYCLE	45	CTS: Max DUTY CYCLE	55
V_TX_DIFF_PP_LFPS Measurement:	FAIL	Min V_TX_DIFF_PP_LFPS[mVp2p]	644.77	CTS: Min V_TX_DIFF_PP_LFPS[mVp2p]	800	CTS: Max V_TX_DIFF_PP_LFPS[mVp2p]	1200
AC CM Measurement:	PASS	AC CM: V_CM_AC_LFPS[mVp2p]	19.8	CTS: Max AC CM [mVp2p]	100		
Electrical Idle Voltage Measurement[mV]:	PASS	V_ELEC_IDLE	4.780223	CTS: Max V_ELEC_IDLE	20		

SigTest saves the following plots:

1. First LFPS cycles
2. Last LFPS cycles
3. LFPS sequence
4. Electrical Idle prior LFPS





10 Pattern Detect

This function shall be used for USB4 v2 GEN4 pattern detection. This function aims to detect the pattern correctness and swing value of the TX aggressor lanes. PRTS19/PRTS7 patterns can be detected measured at TP2.

[illegible]