

USB4 SIGTEST User Manual

Date: ~~Dec-Agu, 2024~~2025

Revision: 0.999

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>
0.96	Jul 2024	<p>Updated TX GEN4 tx_frequency_variation function</p> <p>Updated LFPS RX calibration function</p> <p>Updated Pattern Detect command line (added s4p usage)</p>
0.98	Sep 2024	<p>Updated TX GEN4 TX_FFE test</p> <p>Updated BERT IL function</p> <p>Added support for Anritsu Network Analyzer s-parameter format used in GEN4 RL</p> <p>Added option to run ui_jitter_vertical function with PRBS11 to support DCD fail flow</p>

		Added GEN4 Captive Device TX testing functions Added GEN4 Captive Device RX calibration functions Updated LFPS function to support Captive Device Updated Pattern Detect function to support Captive Device
0.99	DecJun 20254	Added de-embedding capability for Gen2/3 Updated BERT IL function: added IL delta between IL @ 6.4GHz and 12.8GHz, 3.2GHz and 6.4GHz Updated RX GEN4 channel calibration to worst case condition test Updated complementary folder

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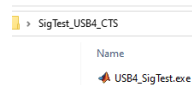
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1 Introduction

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:

1. System requirements:
 - Minimum memory: 32GB RAM
 - Recommended memory: 48GB RAM and higher.
2. Install Matlab Runtime Compiler MCR R2024ba.
3. Run the executable .exe file:
 - a) Create folder, for example "SigTest_USB4_CTS"
 - b) Place the USB4_SigTest.exe into the folder "SigTest_USB4_CTS"



- c) 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

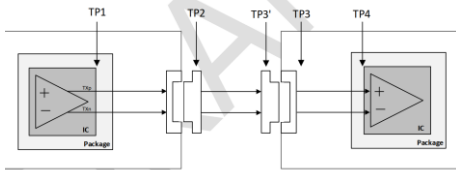
1. technology = **gen2_rounded/gen2_legacy/gen3_rounded/gen3_legacy/gen4**

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/tp3_captive**
 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.

tp3_captive – transmitter Captive Device compliance test point, requires the de-embedding of 1 m coax cable.

4. **Gen2-3** cts_test_name =
ui_ssc_eyeye/rise_fall_time/jitter/ac_common_mode/transmitter_equalization/electrical_idle_voltage/tx_frequency_variation_training/tp3

ui_ssc_eyeye – 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, Average Unit Interval (Gen2 legacy only), 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/tx_best_preset_ctle/wireless_band_conducted_diff/wireless_band_conducted_com/clk_info/LFPS/pattern_detect

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 GEN2/3/4

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 as specified in CTS otherwise set record length to $500\mu\text{s}$ 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: $(\text{CH1} + \text{CH3})/2$). 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 not include embedding or de-embedding. SigTest version includes embedding as needed in TX TP3 and de-embedding analysis. Cable assembly connecting DUT to Oscilloscope shall be measured using Network analyzer, then provided (normal mode) as parameter to SigTest tool for every test related to USB4-V2 GEN2 – GEN3 (TX TP2 and TP3 and RX TP3). 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

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

5.2 TP2

5.2.1 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 C:\Desktop\SigTest_USB4_CTS\1m_coax_cable.s4pnone
```

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```
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

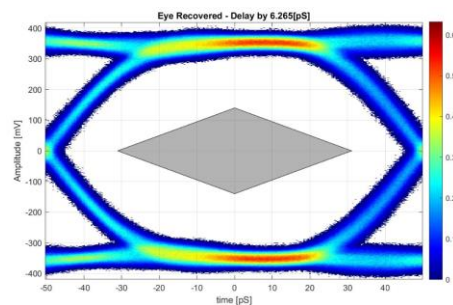
Name

- 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

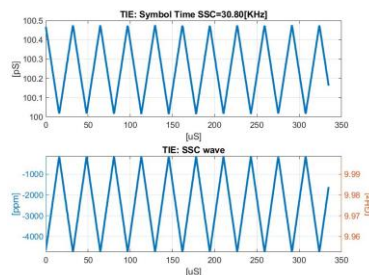
1.1. The .CSV file ui_ssc_eye_result_21-Oct-2020.csv

Electrical Compliance Test Specification for gen2_rounded					
Date:	21-Oct-20				
File: tp2_prbs31.bin					
Minimum Unit Interval Measurement [ps]:	PASS	UI Min Min	100.016081	UI Min Max	100.019604
SSC Down Spread Range Measurement[%]:	PASS	Min SSC_Down_Spread_Range	0.451389	Max SSC_Down_Spread_Range	0.458343
SSC Down Spread Rate Measurement[KHz]:	PASS	Min SSC_Down Spread Rate	30.716886	Max SSC_Down Spread Rate	30.887801
SSC Phase Deviation Measurement [ns p-p]:	PASS	SSC Phase Deviation	18.959192	CTS: Min SSC Phase Deviation	2.5
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]	89.381492
Informative: Symbol Rate [GHz]:	NONE	Symbol Rate	9.975472	Drift [PPM]	-2432.82
				CTS: UI Min Max	99.97
				CTS: Max SSC_Down_Spread_Range	0.5
				30 CTS: Max SSC_Down Spread Rate	33
				22	
				393.984185	

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



5.2.2 cts_test_name - rise_fall_time

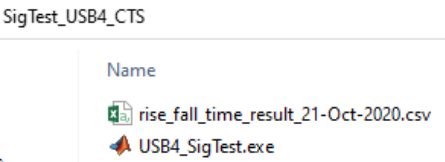
Run the following command from the PowerShell window:

```
.\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
C:\Desktop\SigTest_USB4_CTS\1m coax cable.s4pnone
```

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```
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:



1.4. 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

5.2.3 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
C:\Desktop\SigTest_USB4_CTS\1m coax cable.s4pnone
```

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```
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:

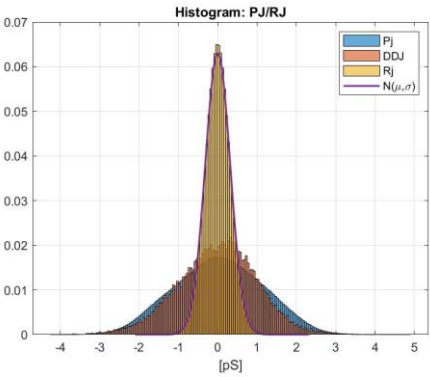
SigTest_USB4_CTS

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

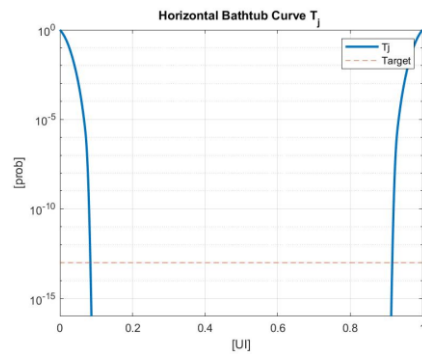
1.5. The .CSV file jitter_result_21-Oct-2020.csv

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

1.6. The .jpg file histogram_pj_rj_ddj_gen2_rounded_tp2_jitter.jpg



1.7. The .jpg file tj_bathtub_gen2_rounded_tp2_jitter.jpg



5.2.4 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 C:\Desktop\SigTest_USB4_CTS\1m coax cable.s4pnone
```

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```
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

1.8. 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

5.2.5 cts_test_name - electrical_idle_voltage

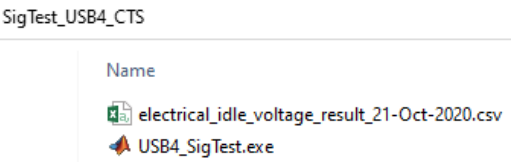
Run the following command from the PowerShell window:

```
.\USB4_SigTest.exe gen2_rounded tx tp2 electrical_idle_voltage
C:\Desktop\SigTest_USB4_CTS\Waveforms\TP2\ tp2_eidle.bin none
electrical_idle_voltage
C:\Desktop\SigTest_USB4_CTS\1m coax cable.s4pnone

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
```

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Report files location:



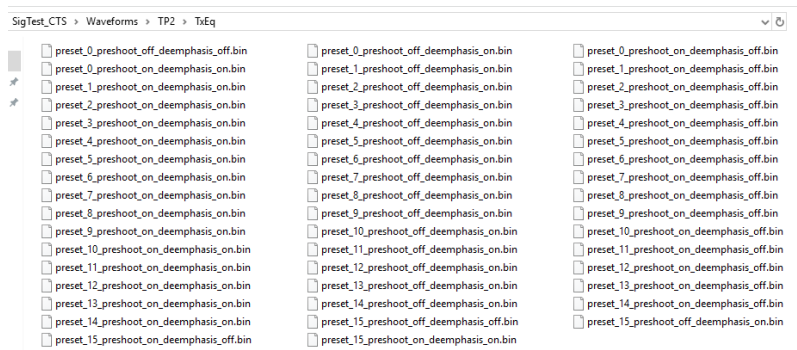
5.1. The .CSV file electrical_idle_voltage_result_21-Oct-2020.csv

Electrical Compliance Test Specification for gen2_rounded					
Date:	21-Oct-20				
DIR:C:\Desktop\SigTest_USB4_CTS\Waveforms\TP2\					
File: tp2_eidle.bin					
Electrical Idle Voltage Measurement[mV]:	PASS	V_ELEC_IDLE	1.663508	CTS: Max V_ELEC_IDLE	20

5.2.6 cts_test_name - transmitter_equalization

Notes:

- a) The saved waveforms for each preset shall be located in the same folder.
- b) The waveforms names shall be the same as in the screenshot below.
- c) 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  
C:\Desktop\SigTest_USB4_CTS\1m coax cable.s4pnone
```

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```


Running SIGTEST : Technology : GEN3_ROUNDED, TestMode : TX, TestPoint : TP2
The following tests are in progress ...
Transmitter Equalization
Loading File preset_0_preshoot_on_deemphasize_on.bin ....
Loading File preset_0_preshoot_off_deemphasize_on.bin ....
Loading File preset_0_preshoot_on_deemphasize_off.bin ....
Loading File preset_1_preshoot_on_deemphasize_on.bin ....
Loading File preset_1_preshoot_off_deemphasize_on.bin ....
Loading File preset_1_preshoot_on_deemphasize_off.bin ....
Loading File preset_2_preshoot_on_deemphasize_on.bin ....
Loading File preset_2_preshoot_off_deemphasize_on.bin ....
Loading File preset_2_preshoot_on_deemphasize_off.bin ....
Loading File preset_3_preshoot_on_deemphasize_on.bin ....
Loading File preset_3_preshoot_off_deemphasize_on.bin ....
Loading File preset_3_preshoot_on_deemphasize_off.bin ....
Loading File preset_4_preshoot_on_deemphasize_on.bin ....
Loading File preset_4_preshoot_off_deemphasize_on.bin ....
Loading File preset_4_preshoot_on_deemphasize_off.bin ....
Loading File preset_5_preshoot_on_deemphasize_on.bin ....
Loading File preset_5_preshoot_off_deemphasize_on.bin ....
Loading File preset_5_preshoot_on_deemphasize_off.bin ....
Loading File preset_6_preshoot_on_deemphasize_on.bin ....
Loading File preset_6_preshoot_off_deemphasize_on.bin ....
Loading File preset_6_preshoot_on_deemphasize_off.bin ....
Loading File preset_7_preshoot_on_deemphasize_on.bin ....
Loading File preset_7_preshoot_off_deemphasize_on.bin ....
Loading File preset_7_preshoot_on_deemphasize_off.bin ....
Loading File preset_8_preshoot_on_deemphasize_on.bin ....
Loading File preset_8_preshoot_off_deemphasize_on.bin ....
Loading File preset_8_preshoot_on_deemphasize_off.bin ....
Loading File preset_9_preshoot_on_deemphasize_on.bin ....
Loading File preset_9_preshoot_off_deemphasize_on.bin ....
Loading File preset_9_preshoot_on_deemphasize_off.bin ....
Loading File preset_10_preshoot_on_deemphasize_on.bin ....
Loading File preset_10_preshoot_off_deemphasize_on.bin ....
Loading File preset_10_preshoot_on_deemphasize_off.bin ....
Loading File preset_11_preshoot_on_deemphasize_on.bin ....
Loading File preset_11_preshoot_off_deemphasize_on.bin ....
Loading File preset_11_preshoot_on_deemphasize_off.bin ....
Loading File preset_12_preshoot_on_deemphasize_on.bin ....
Loading File preset_12_preshoot_off_deemphasize_on.bin ....
Loading File preset_12_preshoot_on_deemphasize_off.bin ....
Loading File preset_13_preshoot_on_deemphasize_on.bin ....
Loading File preset_13_preshoot_off_deemphasize_on.bin ....
Loading File preset_13_preshoot_on_deemphasize_off.bin ....
Loading File preset_14_preshoot_on_deemphasize_on.bin ....
Loading File preset_14_preshoot_off_deemphasize_on.bin ....
Loading File preset_14_preshoot_on_deemphasize_off.bin ....
Loading File preset_15_preshoot_on_deemphasize_on.bin ....
Loading File preset_15_preshoot_off_deemphasize_on.bin ....
Loading File preset_15_preshoot_on_deemphasize_off.bin ....
Loading File preset_0_preshoot_off_deemphasize_off.bin ....
Loading File preset_15_preshoot_off_deemphasize_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

5.2. 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	
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	
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	
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	
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			

5.2.7 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
C:\Desktop\SigTest_USB4_CTS\1m_coax_cable.s4pnone
```

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```
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:

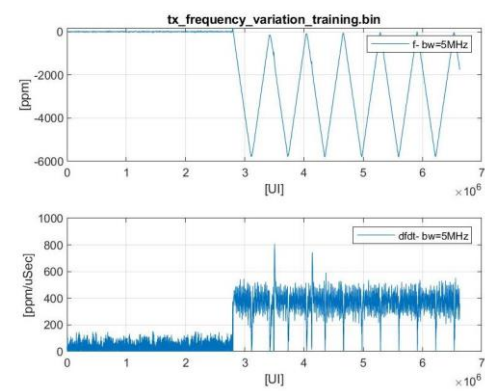
SigTest_USB4_CTS

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

5.3. 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:	673.97286 CTS: Max DELTA_FREQ_1000nS	2200	
Informative: Symbol Rate [GHz]:	NONE	Symbol Rate	19.949354 Drift [PPM]	-2532.28	

5.4. The .jpg file
clock_switch_analysis_gen3_rounded_tp2_tx_frequency_variation_training.jpgz



5.3 TP3

5.3.1 cts_test_name – tp3

Notes:

- a) Save 5 waveforms with PRBS31 pattern using the scope configuration above.
- b) Save 1 waveform with PRBS15 pattern using the scope configuration above.
- c) The saved waveforms for each trial shall be in the same folder.
1 trial – prbs15 and 5 trials – prbs31.
- d) 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:

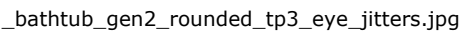
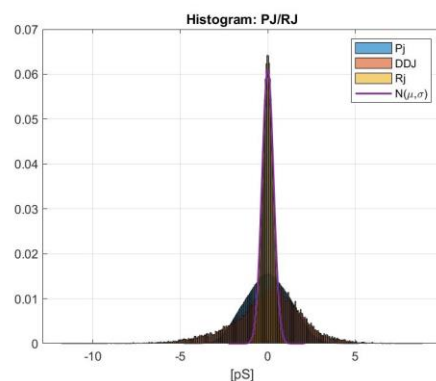
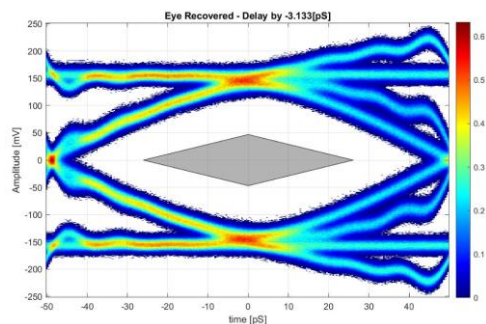
```
.\USB4_SigTest.exe gen2_rounded tx tp3 tp3
C:\Desktop\SigTest_USB4_CTS\Waveforms\TP3\ tp3.bin none eye_jitter
C:\Desktop\SigTest_USB4_CTS\1m coax cable.s4prnone
```

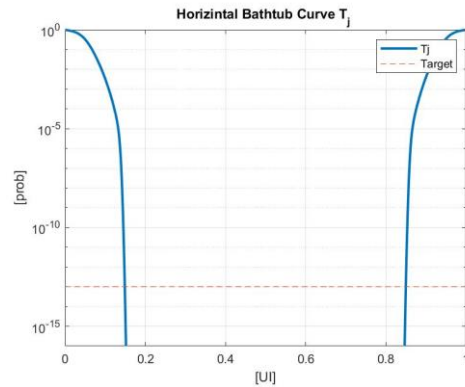
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```
Running SIGTEST : Technology : GEN2_ROUNDED, TestMode : TX, TestPoint : TP3
The following tests are in progress ...
Total Jitter TP3 Measurement
UJ TP3 Measurement
UDJ TP3 Measurement
Eye Diagram TP3 Measurement
Loading File tp3_prbs31_trial_1.bin ...
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

[illegible]



6 GEN4 Router Assembly Transmitter Testing

6.1 Oscilloscope intrinsic noise cancellation

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:

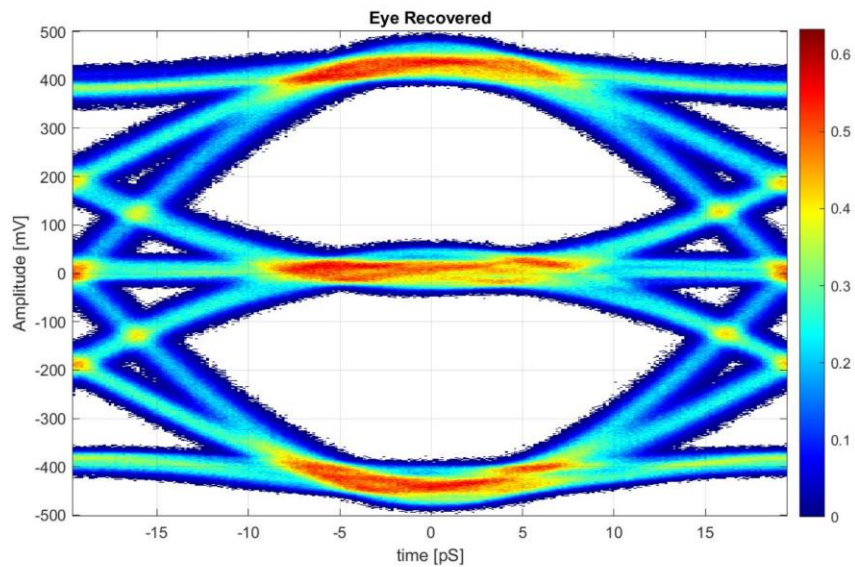
Waveforms	17/12/2022 10:21	File folder	
tmp_sndr.txt	16/12/2022 17:25	Text Document	1 KB
txffe_test_report_result_eye_diagram_gen4_tp2.jpg	16/12/2022 18:33	JPG File	182 KB
txffe_test_report_result_result.csv	16/12/2022 18:33	Microsoft Excel Co...	5 KB
USB4_SigTest.exe	16/12/2022 15:14	Application	5,532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

5.9. 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_Fall[TXFFE(-2)	TXFFE(-1)	TXFFE(0)	TXFFE(1)	c(-2)	c(-1)	c(0)	c(1)	MaxErr	DDI[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	0.01131	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]	S CTS: Max Swing Attenuation [dB]		7											
Preset 41	PASS	VSWING_RATIO	6.29 CTS: Min Swing Attenuation [dB]	S CTS: Max Swing Attenuation [dB]		7											
Informative:																	
Best TXFFE	6 Min. DDI		0.5625 [Ulp2p]														
Informative: Symbol Rate [Ghz]:	NONE	Symbol Rate	25.56218 Drift [PPM]														
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

5.10. 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_CIS> .\USB4_SigTest.exe gen4 tx tp2 ui_jitter_vertical C:\Sigtest_USB4_CIS\Waveforms\txrfv\pan3_ptps_preset_19.bin none ui_ssc_jitter_vertical_report_result.s
parameter_for_deembedding.s4p
***** SIGTEST Version: 0.91 *****
Running SIGTEST : Technology : GDM, TestNode : TX, TestPoint : TP2
The following tests are in progress ...
USB4 Gen4: UI,SSC,Jitters and Vertical
Loading File: C:\Sigtest_USB4_CIS\Waveforms\txrfv\pan3_ptps7_preset_19.bin ....
TP2: De-Embedded s_parameter_for_deembedding.s4p File
>> SSC Estimated:
>> SSC Frequency 31.009544[Khz]
>> SSC Amplitude Harmonics(p5):0.040223, 0.000244, 0.004257,
Writing ui_ssc_jitter_vertical_report_result_tie_period_frequency_gen4_tp2.jpg
>> UI min = -2450.064468[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_dsj_gen4_tp2.jpg
>>> PRBS LOADED !!!
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]
InformativeIntrinsic Scope Noise = 0.000[mV-rms]
TX LEVELS MISMATCH = 0.998
TX LEVEL = +208.5[mV]
TX LEVEL = -0.4[mV]
TX LEVEL = -208.4[mV]
V_Steady-State = +208.7[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=0.208611[V]
Attenuation=-4.187[dB],F=12.000000[Ghz]
PAN-3:Eye(1):EyeHeight=84.8[mV], EyeWidth=0.371[UI]-14.5[p5]
PAN-3:Eye(2):EyeHeight=79.6[mV], EyeWidth=0.348[UI]-13.6[p5]
PAN-3:EyeHeight=79.6[mV], EyeWidth=0.348[UI]-13.6[p5]
Writing ui_ssc_jitter_vertical_report_result_eye_diagram_gen4_tp2.jpg
Writing result to .ui_ssc_jitter_vertical_report_result_result.csv
The tests are completed

```

Report files location:

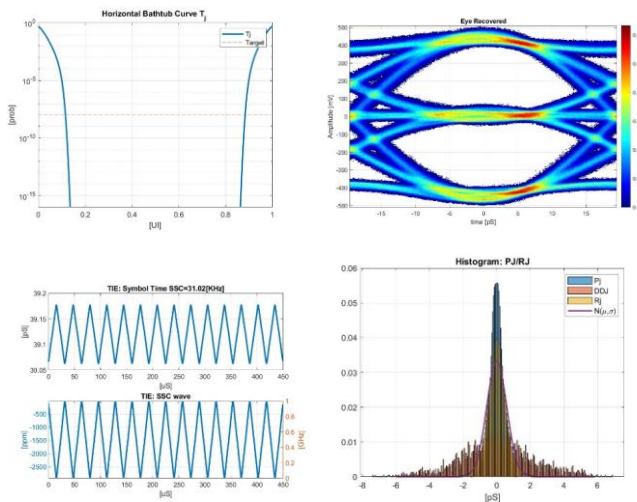
	Waveforms	18/04/2024 15:01	File folder	
	s_parameter_for_deembedding.S4P	25/04/2023 13:05	S4P File	738 KB
	USB4_SigTest.exe	31/03/2024 13:44	Application	24,165 KB
	ui_ssc_jitter_vertical_report_result_tie_peri...	18/04/2024 15:40	JPG File	250 KB
	ui_ssc_jitter_vertical_report_result_tj_bath...	18/04/2024 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_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

5.11. 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:\JV_WORK\USB4\Gmain\run_pam3								
File:	pam3_prts7_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	39.0742
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	0.3
SSC_Down_Spread_Rate Measurement[Hz]:	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	33
SSC_Phase_Deviation Measurement [m-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 Up-p:	PASS	UI Jitter Up-p	0.145603	CTS: Max UI	0.17				
UDI Measurement Up-p:	PASS	UDI jitter Up-p	0.027259	CTS: Max UDI	0.075				
UDI LP Measurement Up-p:	PASS	UDI LP jitter Up-p	0.007856	CTS: Max UDI LP	0.03				
DCD Measurement Up-p:	PASS	DCD jitter Up-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	503.590463	CTS: Min V_SWING	390	CTS: Max V_SWING	500		
TX_ISI_MARGIN Measurement[db](TXPFE=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]					

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



In the case of a fail in EVEN_ODD parameter only, ui_jitter_vertical test should be run with PRBS11 pattern to check the EVEN_ODD value.(refer to CTS test method section 3.3.2.4):

Best preset file name shall include “_prbs11_” wording

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\ Pam2_prbs11_Preset_19.bin none
ui_ssc_jitter_vertical_report_result s_parameter_for_deembedding.s4p
```

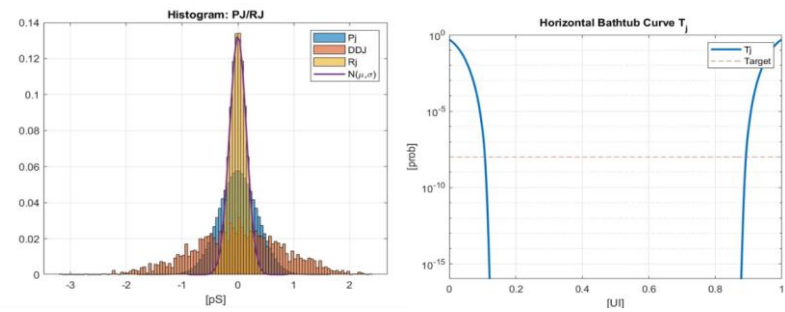
Report files location:

- Name
- ui_ssc_vertical_prbs11_report_result.csv
- ui_ssc_vertical_prbs11_report_histogram_pj_rj_ddj_gen4_tp2.jpg
- ui_ssc_vertical_prbs11_report_tj_bathtub_gen4_tp2.jpg
- USB4_SigTest.exe
- s_parameter_for_deembedding.s4p
- Waveforms

The .csv file ui_ssc_jitter_vertical_prbs11_result.csv as a results example

Electrical Compliance Test Specification for GEN4					
Date:	30-Aug-24				
DIR:	C:\SigTest\Waveforms\				
File:	Pam2_prbs11_Preset_19.bin				
DCD Measurement Ulp-p:	PASS	DCD jitter Ulp-p	0.001974	CTS: Max DCD	0.02
Informative:	Symbol Rate [GH	25.568817	Drift [PPM]	-1218.1	
Informative:	Intrinsic Scope Noise File Not Found!!!				

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! 0.021 ****
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 ....
[P2]: De-Embedded_s_parameter_for_deembedding.s4p File
Detected 50128 Wave before Clock Switch event
INIT_FREQ_VARIATION[ppm]: Mean=250.009359, Max=250.009660,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[psps]: 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
```

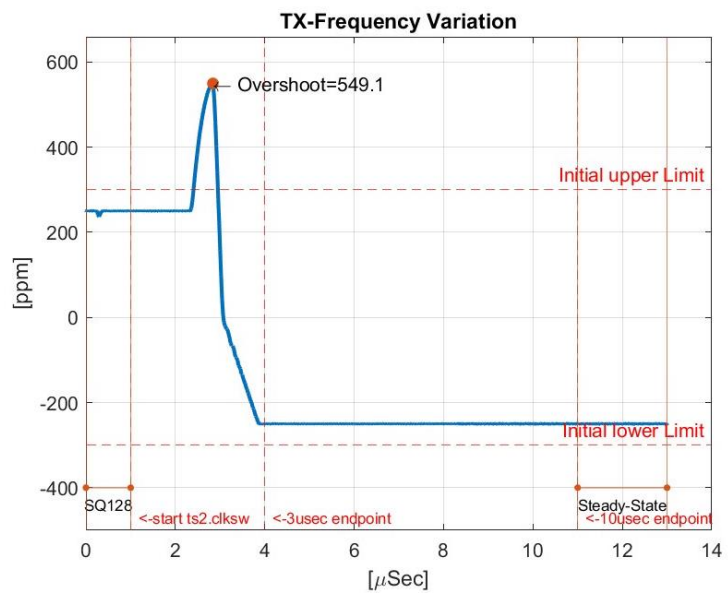
Report files location:

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

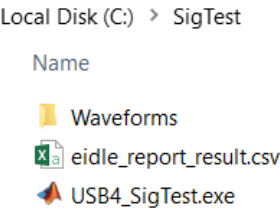
This function calculates Electrical Idle voltage while the DUT is in electrical idle mode and includes the following transmitter compliance test: V_ELEC_IDLE

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:

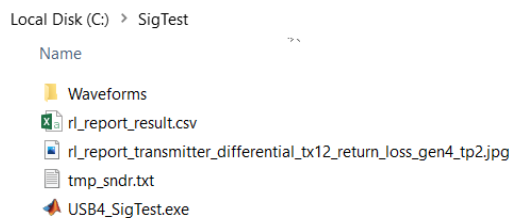
```
.\USB4_SigTest.exe gen4 tx tp2 rl C:\SigTest_USB4_CTS\Waveforms\rl\pam3_prts7_preset_19.bin none rl_report none pam3_prts7_preset_19_s2p.s2p
```

Command example w/o signal waveform file:

```
.\USB4_SigTest.exe gen4 tx tp2 rl C:\SigTest_USB4_CTS\Waveforms\rl\none none 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 = +136.2[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=-4.60[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 result to .\rl_report_result.csv
The tests are completed
```

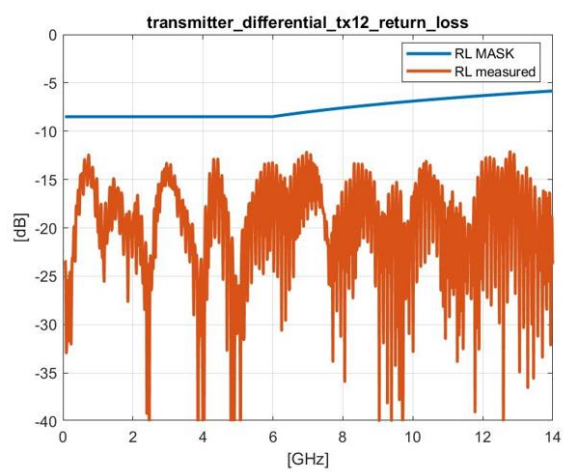
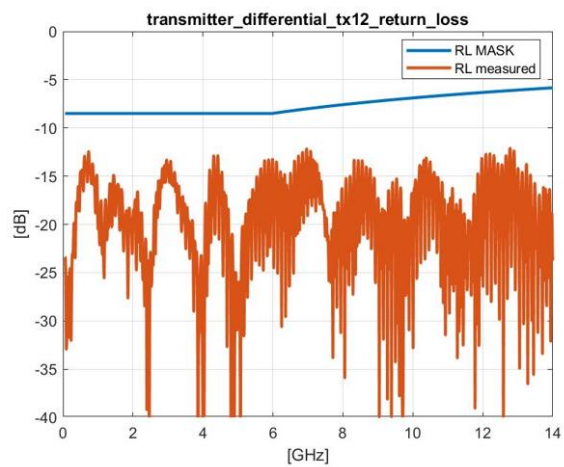
2. report file location:



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

7.2.1 cts_test_name – jitter

The test below shall be used for the following calibrations:

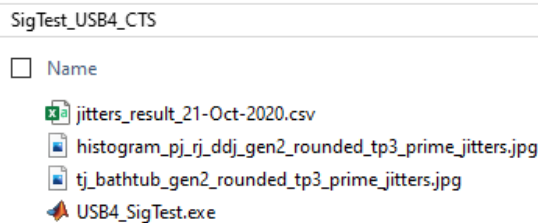
- a) 4.2.1.1 Data Dependent Jitter - DDJ calibration
- b) 4.2.1.3 Random Jitter - RJ calibration
- c) 4.2.1.4 Periodic Jitter - PJ calibration
- d) 4.2.1.5 Total Jitter - TJ calibration

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

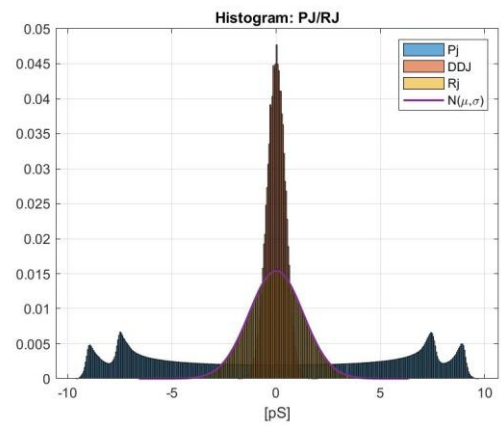
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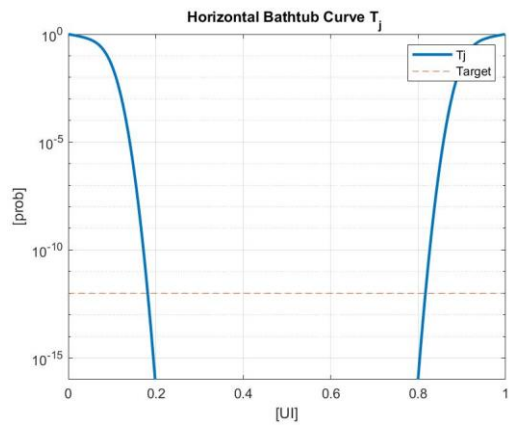
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Electrical Compliance Test Specification for gen2_rounded					
Date:	21-Oct-20				
DIR:C:\Desktop\SigTest_USB4_CTS\Waveforms\TP3_Prime\					
File: TP3_Prime_Gen2_Rounded.bin					
Total Jitter (BER=1e-12) Measurement Ulp-p:	Tj	0.363443			
PJ Jitter 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



7.2.2 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:

SigTest_USB4_CTS

☐ Name

 ac_common_mode_result_21-Oct-2020.csv

 USB4_SigTest.exe

2.1-1.4. 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

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3.2.1.5. 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:

SigTest_USB4_CTS

☐ Name

 eye_result_21-Oct-2020.csv

 eye_diagram_gen2_rounded_tp3_prime_eye.jpg

 USB4_SigTest.exe

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

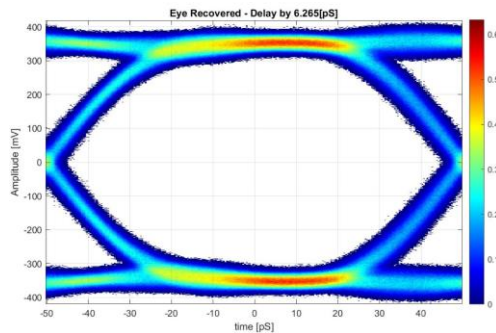
Electrical Compliance Test Specification for gen2_rounded					
Date:	21-Oct-20				
DIR:	C:\Desktop\SigTest_USB4_CTS\Waveforms\TP3_Prime\				
File:	TP3_Prime_Gen2_Rounded_prbs31.bin				
Eye Diagram Measurement:	EyeWidth [pS]	89.281492	EyeHeight[mV]	593.984184	
Informative: Symbol Rate [GHz]:	NONE	Symbol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

3.2.1.6. The .jpg file eye_diagram_gen2_rounded_tp3_prime_eye.jpg

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4.7.2.4 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
```

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```
***** 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:

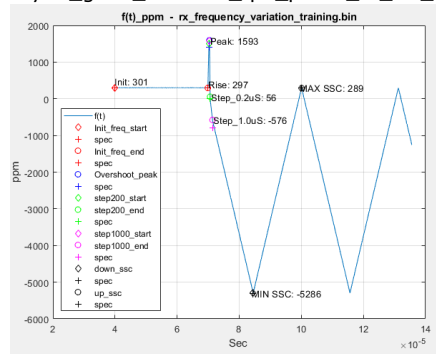
Name	Date modified	Type	Size
rx_clk_switch_cal_result_21-Jul-2021.csv	7/21/2021 3:40 PM	Microsoft Excel C...	2 KB
rx_clock_switch_analysis_gen2_rounded_tp3_prime_rx_clk_switch_cal.jpg	7/21/2021 3:40 PM	JPG File	75 KB
rx_frequency_variation_training.bin	7/21/2021 3:40 PM	Binary File	48 KB

4.1.3.1. 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

4.2.3.2. 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

4.7.3.1 cts_test_name – tp3

The test below shall be used for the following calibration:

- a) 4.2.2.1 Input Eye Diagram

Notes:

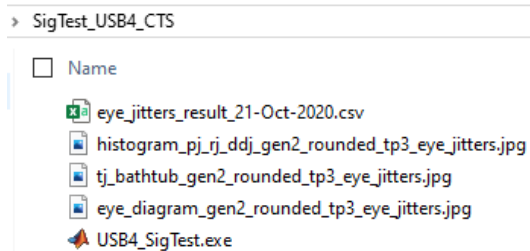
- e) Save 5 waveforms with PRBS31 pattern using the scope configuration above.
- f) Save 1 waveform with PRBS15 pattern using the scope configuration above.
- g) The saved waveforms for each trial shall be in the same folder.
1 trial – prbs15 and 5 trials – prbs31.
- h) The waveforms names shall be the 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  
C:\Desktop\SigTest_USB4_CTS\1m coax cable.s4prnone
```

```
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:



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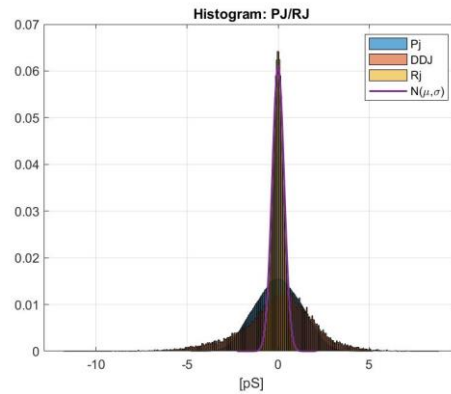
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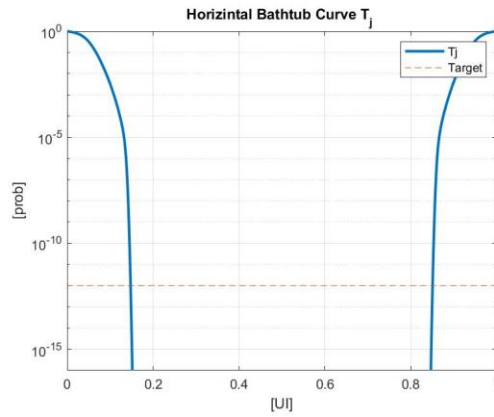
4.1-1.7. The .csv file eye_jitters_result_21-Oct-2020.csv

Electrical Compliance Test Specification for gen2_rounded															
Date: 25-Oct-20															
Dir:C:\Desktop\SigTest_USB4_CTS\Waveform\TP3\Run															
File: tp3.bin															
Eye Diagram Measurement:		EyeWidth [µs]		81.841387		EyeHeight[mV]		207.027864							
Informative: Symbol Rate [Unit]		Symbol Rate		9.373465		Dir:R [ps/s]		-2453.53							
CTLE-Adc[dB]		CTLE-OC Gain[dB]		0FE[mV]		Eye Height[mV]		Eye Width[µs]		Eye Height[mV]		Eye Width[µs]		Area[mV*µs]	
		1		0		50		1.409		0.783		0.285		1.175	
		0.881		1		48.2		142.847		62.282		129.946		59.129	
		0.708		3		36.7		187.61		78.317		191.643		77.925	
		0.631		4		32		208.352		82.233		205.568		80.667	
		0.562		5		27.8		196.89		80.275		195.141		82.233	
		0.501		6		24		185.353		76.751		182.983		76.359	
		0.447		7		20.7		170.463		70.877		168.146		72.443	
		0.398		8		17.8		154.847		66.57		153.365		67.744	
		0.355		9		15.2		138.71		62.262		139.772		61.87	
Optimal CTLE:		4													

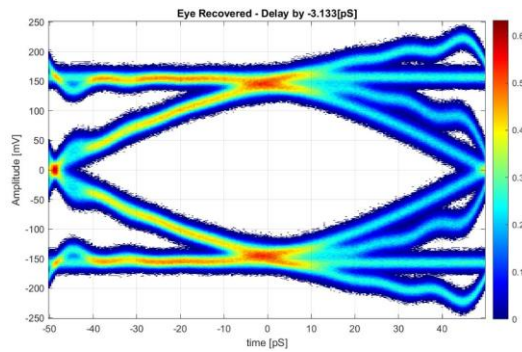
4.2-1.8. The .jpg file histogram_pj_rj_ddj_gen2_rounded_tp3_eye_jitters.jpg



4.3-1.9. The .jpg file tj_bathtub_gen2_rounded_tp3_eye_jitters.jpg



4.4.1.10. The .jpg file eye_diagram_gen2_rounded_tp3_eye_jitters.jpg



7.3.2 cts test name – mbe analysis

The command below shall be used for the following test:

4.4.1 Multi Error-Burst Gen3 - Informative

In order to run this test you shall prepare 2 files *.csv as detailed in CTS:
EH BER file.csv and dfe file.csv

Run the following command from the PowerShell window:

.\USB4 SigTest.exe gen3 rounded rx tp3 mbe analysis
C:\Desktop\SigTest USB4 CTS\Waveforms\TP3\ example EH BER file.csv
none rx burst test none exmaple dfe file.csv

```
*** Actual ***
Window size N = 16
Base BER = 1.09e-19
d: 684.85 and 734.48
sigma: 76.50 and 80.68
3 DFE taps
-200.2          92.4          61.6
Burst Restart Probability is 1.45e-11
Writing result to .\rx_burst_results_result.csv
The tests are completed
```

Report files:

- rx_burst_test_result.csv
- rx_burst_test_gaussian_fit_extrapolation_gen3_rounded_tp3_prime.jpg
- rx_burst_test_gaussian_fit_gen3_rounded_tp3_prime.jpg

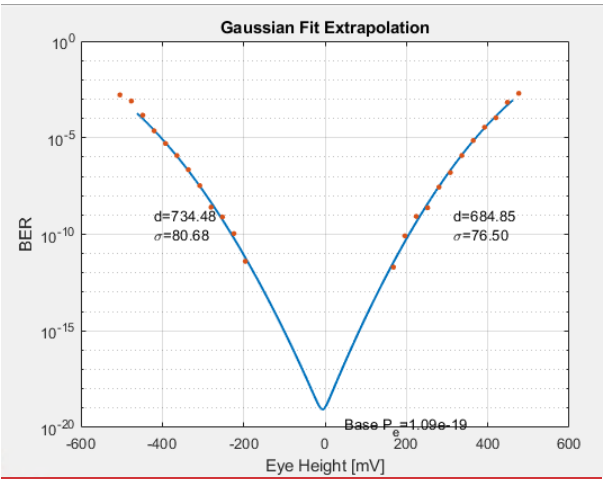
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1.11. The csv. rx burst test result File

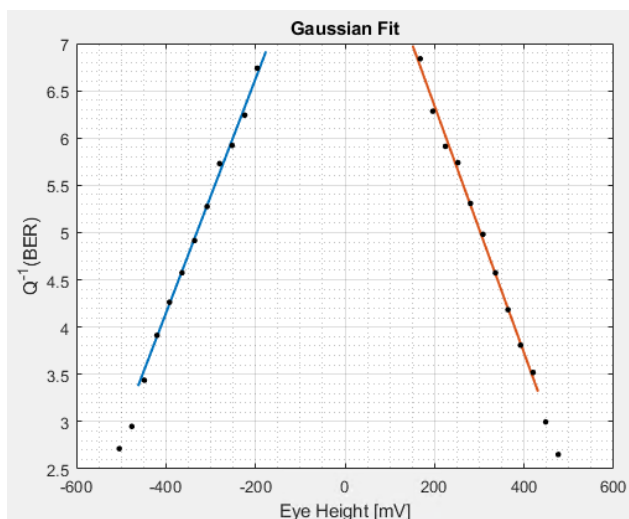
File:	example_EH_BER_file.csv				
Informative: Burst Restart Error & CODED BER Measurement:	PASS	P_CODED_BER	2.30E-31	CTS: P_CODED_BER(max)	1.00E-19
Informative:	P_UNCODED_BER:	1.09E-19			
Informative:	P_BR:	1.45E-11			

1.12. The .jpg file

rx burst results gaussian fit extrapolation gen3 rounded tp3 prime.jpg



1.13. The .jpg file rx_burst_results_gaussian_fit_gen3_rounded_tp3_prime.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  
t_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:

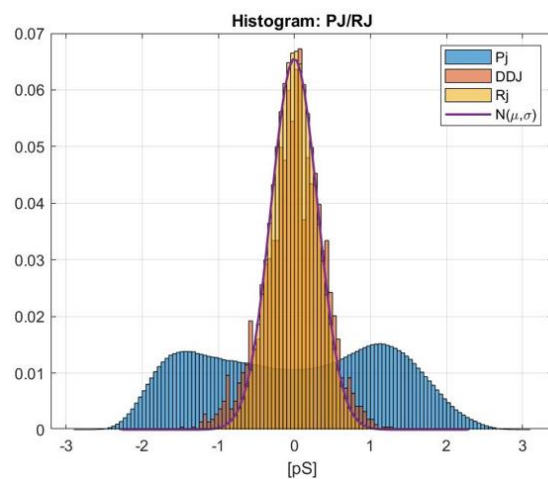
Local Disk (C:) > SigTest

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

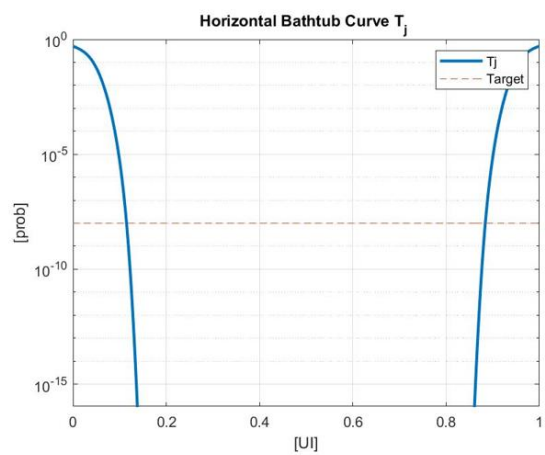
3. calibration_report_result.csv report file as an example

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
- IL delta [dB] – BERT Insertion Loss difference at 6.4GHz - 12.8GHz
- IL delta [dB] – BERT Insertion Loss difference at 3.2GHz – 6.4GHz

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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  
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: 0.99 *****  
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 ....  
Warning: At TP3, there is no De-Embeddd File!!!  
BERT IL Extraction: -2.844971[dB] at f=12.800000[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:

Local Disk (C:) > SigTest

Name

Waveforms

bert_il_extraction_bert_il_extraction_gen4_tp3.jpg

bert_il_extraction_result.csv

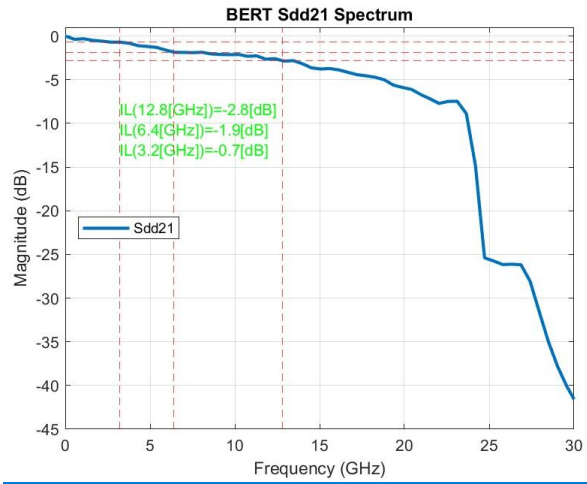
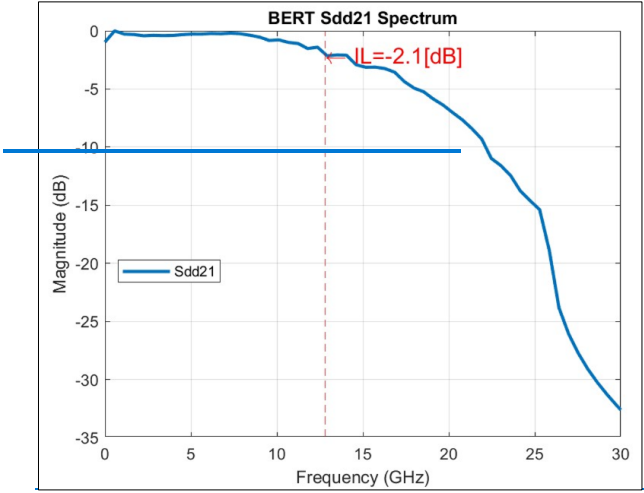
USB4_SigTest.exe

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

Electrical Compliance Test Specification for GEN4					
Date:	12-Jun-25				
DIR:	C:\SigTest\Waveforms\				
File:	BERT_SDD21.bin				
Calibration Bert_IL extraction Measurement:	PASS	BERT_IL 12.8GHz[dB]:	-2.844971	CTS: Max BERT_IL	-3
BERT_IL3.2GHz - BERT_IL6.4GHz	PASS	1.156022	CTS Min:	0	
BERT_IL6.4GHz - BERT_IL12.8GHz	PASS	0.992081	CTS Min:	0.7	
Informative [dB]:	BERT_IL 12.8GHz	-2.844971	BERT_IL3.2GHz	-0.696867	BERT_IL6.4GHz -1.85289
Informative:	Symbol Rate [GHz]	25.59993	Drift[PPM]	-2.74	

4. BERT Frequency Response plot

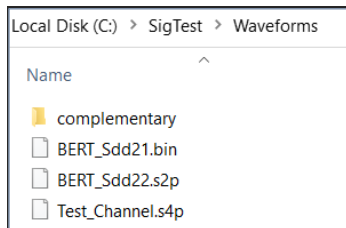


8.3.3 Channel calibration to worst case condition

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
```

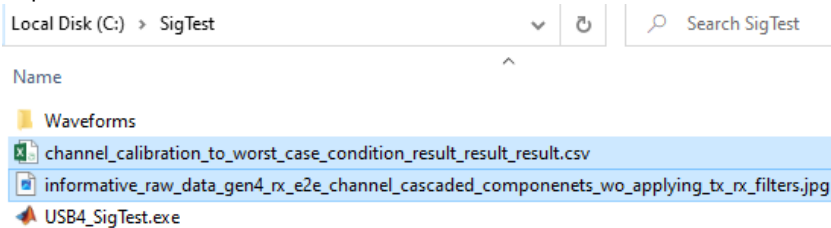


```

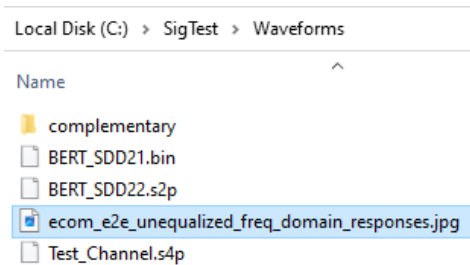
PS C:\Sigrest> .\USB4_Sigrest.exe gen4 rx tp3 calibration C:\SigTest\waveforms\BERT_Sdd21.bin none channel_calibration_to_worst_case_co
ndition_result_result.csv none none
***** SIGTEST Version: 0.9a *****
Running SIGTEST : Technology : GEN4, TestMode : RX, TestPoint : TP3
The following tests are in progress...
USB4 gen4channel 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 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_S3 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:



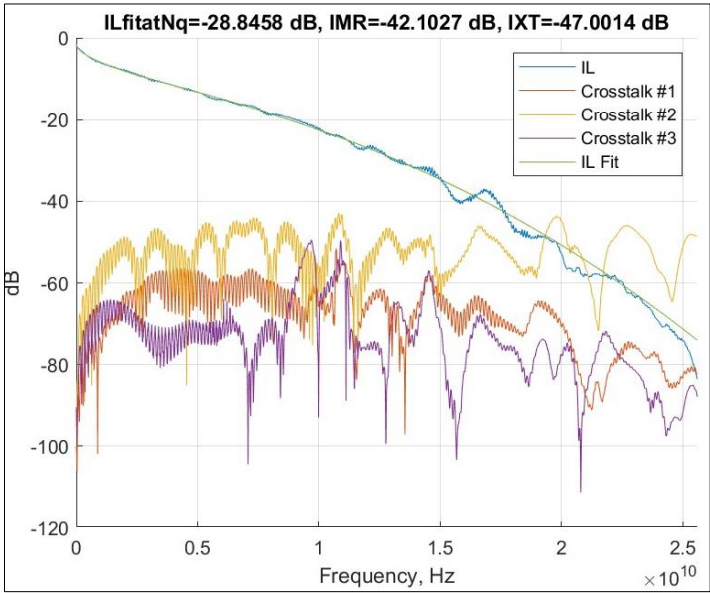
And



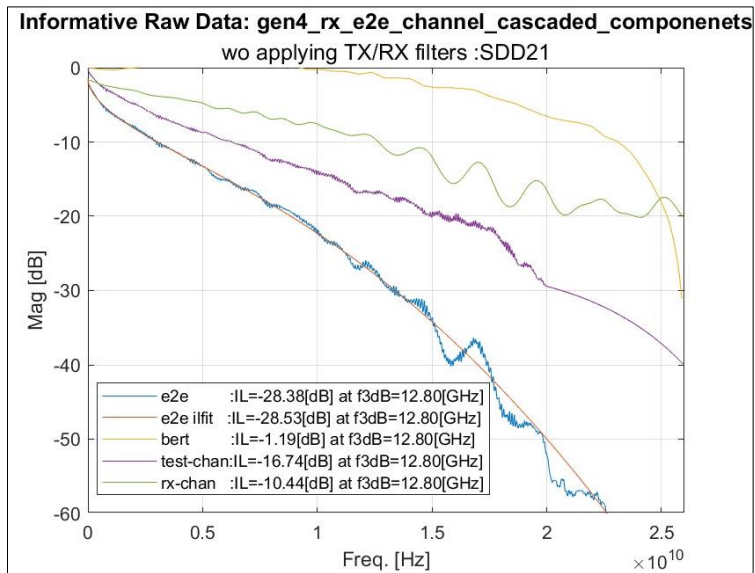
3. channel_calibration_to_worst_case_condition_result_result.csv

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
```

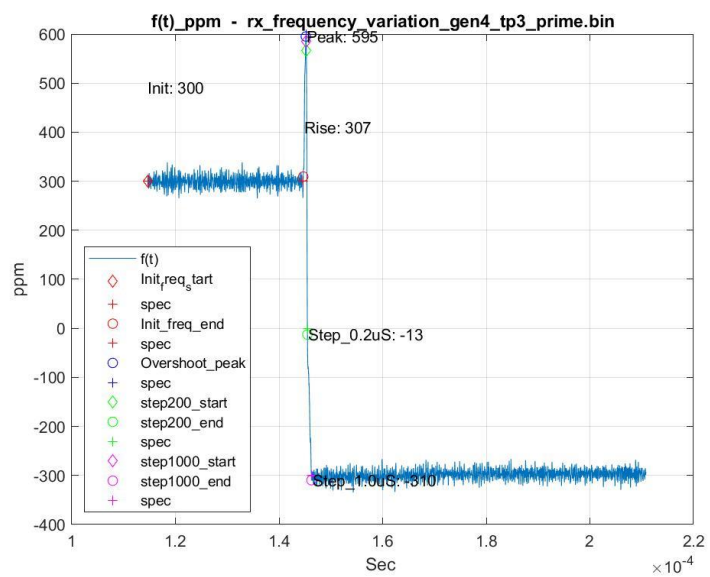
Report files location:

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

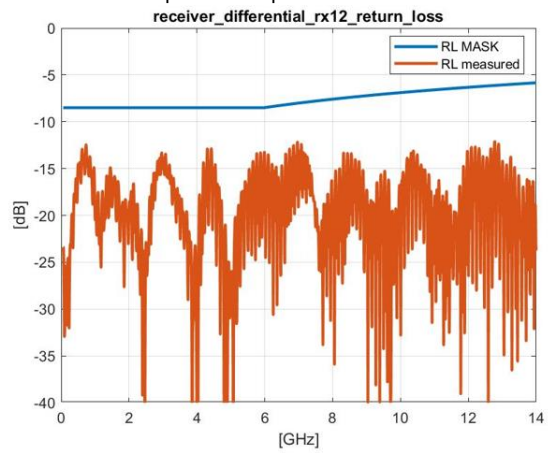
Name
Waveforms
rl_report_receiver_differential_rx12_return_loss_gen4_tp2.jpg
rl_report_result.csv
USB4_SigTest.exe

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
```

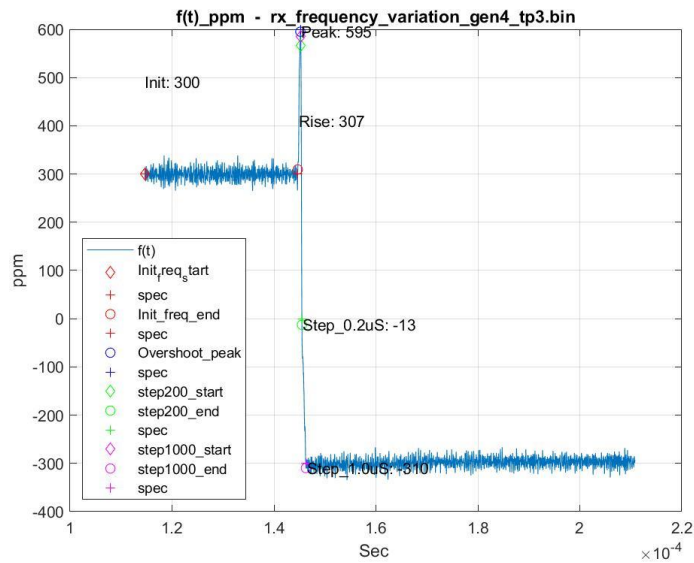
Report files location:

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)



9 GEN2-3 Captive device Transmitter Testing

TBD

10 GEN4 Captive device Transmitter Testing

10.1 txffe_test

This function reads all TXFFE preset files and estimates the transmitter TXFFE coefficients for all USB4 v2 GEN4 presets. SIGEST can analyze partial presets set (preset0 must be included). This function does not estimates best preset

Run the following command from the PowerShell window:

Command example for differential signal:

```
.\USB4_SigTest.exe gen4 tx tp3_captive txffe_test
C:\SigTest_USB4_CTS\Waveforms\captive pam3_prts7_preset_.bin none
txffe_test_report_result s_parameter_for_deembedding.s4p
```

Files name suffix shall be in following form `_ {preset_num}`





```
PS C:\SigTest_USB4_CTS> .\USB4_SigTest.exe gen4 txp3_captive txffe_test C:\SigTest_USB4_CTS\Waveforms\captive\pam3_prts7_preset_0_bin none txffe_captive_report_results_s_parameter_for_deembedding.s4p
*** SIGTEST Version: 4.90 ***
Running SIGTEST : Technology : GEN4, TestMode : TX, TestPoint : TP3_CAPTIVE
The following tests are in progress ...
TX-PFE test
Loading File: C:\SigTest_USB4_CTS\Waveforms\captive\pam3_prts7_preset_0_bin ....
TP3-TX: De-Embedded s_parameter_for_deembedding.s4p & Embedded none Files
>>> Preset #0:Failed=0,Tags [0.000,0.000,1.000,0.000] vs. Estimated=[0.000,0.000,0.000,0.000],MaxERR=0.000
>>> TXFFE set -0.003-Criterion= 1.000000
eyeClosed=1.000000[Upp],003-PRBS=0.196266[Upp],TX_15t_Margin=9.139916[dB]
Loading File: C:\SigTest_USB4_CTS\Waveforms\captive\pam3_prts7_preset_1_bin ....
TP3-TX: De-Embedded s_parameter_for_deembedding.s4p & Embedded none Files
>>> Preset #1:Failed=0,Tags [0.000,0.000,0.950,-0.050] vs. Estimated=[0.001,-0.004,0.937,-0.050],MaxERR=0.013
>>> TXFFE set -1.003-Criterion= 1.000000
eyeClosed=1.000000[Upp],003-PRBS=0.226888[Upp],TX_15t_Margin=9.232946[dB]
Loading File: C:\SigTest_USB4_CTS\Waveforms\captive\pam3_prts7_preset_2_bin ....
TP3-TX: De-Embedded s_parameter_for_deembedding.s4p & Embedded none Files
>>> Preset #2:Failed=0,Tags [0.000,0.000,0.900,-0.100] vs. Estimated=[-0.000,-0.003,0.890,-0.110],MaxERR=0.010
>>> TXFFE set -2.003-Criterion= 0.942336
eyeClosed=0.941316[Upp],003-PRBS=0.258102[Upp],TX_15t_Margin=9.816781[dB]
Loading File: C:\SigTest_USB4_CTS\Waveforms\captive\pam3_prts7_preset_3_bin ....
TP3-TX: De-Embedded s_parameter_for_deembedding.s4p & Embedded none Files
>>> Preset #3:Failed=0,Tags [0.000,0.000,0.850,-0.150] vs. Estimated=[-0.003,0.001,0.842,-0.156],MaxERR=0.008
>>> TXFFE set -3.003-Criterion= 0.933514
eyeClosed=0.933514[Upp],003-PRBS=0.288778[Upp],TX_15t_Margin=10.049352[dB]
Loading File: C:\SigTest_USB4_CTS\Waveforms\captive\pam3_prts7_preset_4_bin ....
TP3-TX: De-Embedded s_parameter_for_deembedding.s4p & Embedded none Files
>>> Preset #4:Failed=0,Tags [0.000,-0.050,0.950,0.000] vs. Estimated=[0.000,-0.053,0.939,-0.008],MaxERR=0.011
>>> TXFFE set -4.003-Criterion= 1.000000
eyeClosed=1.000000[Upp],003-PRBS=0.213833[Upp],TX_15t_Margin=10.283851[dB]
Loading File: C:\SigTest_USB4_CTS\Waveforms\captive\pam3_prts7_preset_5_bin ....
TP3-TX: De-Embedded s_parameter_for_deembedding.s4p & Embedded none Files
>>> Preset #5:Failed=0,Tags [0.000,-0.050,0.900,-0.050] vs. Estimated=[-0.000,-0.052,0.888,-0.061],MaxERR=0.012
>>> TXFFE set -5.003-Criterion= 0.924009
eyeClosed=0.924009[Upp],003-PRBS=0.232981[Upp],TX_15t_Margin=10.555650[dB]
Loading File: C:\SigTest_USB4_CTS\Waveforms\captive\pam3_prts7_preset_6_bin ....
TP3-TX: De-Embedded s_parameter_for_deembedding.s4p & Embedded none Files
>>> Preset #6:Failed=0,Tags [0.000,-0.050,0.850,-0.100] vs. Estimated=[-0.000,-0.052,0.845,-0.103],MaxERR=0.005
>>> TXFFE set -6.003-Criterion= 0.827919
eyeClosed=0.827919[Upp],003-PRBS=0.261781[Upp],TX_15t_Margin=10.565846[dB]
Loading File: C:\SigTest_USB4_CTS\Waveforms\captive\pam3_prts7_preset_7_bin ....
TP3-TX: De-Embedded s_parameter_for_deembedding.s4p & Embedded none Files
>>> Preset #7:Failed=0,Tags [0.000,-0.050,0.800,-0.150] vs. Estimated=[0.001,-0.055,0.791,-0.151],MaxERR=0.009
>>> TXFFE set -7.003-Criterion= 0.803028
eyeClosed=0.803028[Upp],003-PRBS=0.298196[Upp],TX_15t_Margin=11.287625[dB]
Loading File: C:\SigTest_USB4_CTS\Waveforms\captive\pam3_prts7_preset_8_bin ....
TP3-TX: De-Embedded s_parameter_for_deembedding.s4p & Embedded none Files
>>> Preset #8:Failed=0,Tags [0.000,-0.100,0.900,0.000] vs. Estimated=[-0.000,-0.102,0.891,-0.006],MaxERR=0.009
>>> TXFFE set -8.003-Criterion= 0.761832
eyeClosed=0.761832[Upp],003-PRBS=0.229082[Upp],TX_15t_Margin=10.163827[dB]
Loading File: C:\SigTest_USB4_CTS\Waveforms\captive\pam3_prts7_preset_9_bin ....
TP3-TX: De-Embedded s_parameter_for_deembedding.s4p & Embedded none Files
>>> Preset #9:Failed=0,Tags [0.000,-0.100,0.850,-0.050] vs. Estimated=[-0.001,-0.101,0.845,-0.052],MaxERR=0.005
>>> TXFFE set -9.003-Criterion= 0.753616
eyeClosed=0.753616[Upp],003-PRBS=0.247907[Upp],TX_15t_Margin=10.861701[dB]
Loading File: C:\SigTest_USB4_CTS\Waveforms\captive\pam3_prts7_preset_10_bin ....
TP3-TX: De-Embedded s_parameter_for_deembedding.s4p & Embedded none Files
>>> Preset #10:Failed=0,Tags [0.000,-0.100,0.800,-0.100] vs. Estimated=[-0.000,-0.103,0.796,-0.100],MaxERR=0.004
>>> TXFFE set -10.003-Criterion= 0.769254
eyeClosed=0.769254[Upp],003-PRBS=0.260079[Upp],TX_15t_Margin=10.810946[dB]
Loading File: C:\SigTest_USB4_CTS\Waveforms\captive\pam3_prts7_preset_11_bin ....
TP3-TX: De-Embedded s_parameter_for_deembedding.s4p & Embedded none Files
>>> Preset #11:Failed=0,Tags [0.000,-0.100,0.750,-0.150] vs. Estimated=[-0.000,-0.103,0.745,-0.152],MaxERR=0.005
>>> TXFFE set -11.003-Criterion= 0.808364
eyeClosed=0.808364[Upp],003-PRBS=0.186511[Upp],TX_15t_Margin=11.077870[dB]
Loading File: C:\SigTest_USB4_CTS\Waveforms\captive\pam3_prts7_preset_12_bin ....
TP3-TX: De-Embedded s_parameter_for_deembedding.s4p & Embedded none Files
>>> Preset #12:Failed=0,Tags [0.000,-0.150,0.850,0.000] vs. Estimated=[-0.002,-0.152,0.841,-0.006],MaxERR=0.009
>>> TXFFE set -12.003-Criterion= 0.737068
```

Command example for single-ended signals:

```
.\USB4_SigTest.exe gen4 tp3_captive txffe_test
C:\SigTest_USB4_CTS\Waveforms\captive\ pam3_prts7_preset_0_bin
pam3_prts7_preset_0_bin txffe_test_captive_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.bin
pam3_prts7_preset_0_n.bin
pam3_prts7_preset_1_p.bin
pam3_prts7_preset_1_n.bin
...and so on

Report

Name	Date modified	Type	Size
 Waveforms	25/06/2024 11:29	File folder	
 s_parameter_for_deembedding.s4p	12/06/2023 7:14	S4P File	564 KB
 txffe_captive_report_results_result	25/06/2024 12:45	Microsoft Excel C...	5 KB
 USB4_SigTest.exe	25/06/2024 11:02	Application	24,192 KB

files location:

The .csv file txffe_test_report_result_result.csv as a results example

Electrical Compliance Test Specification for GEN4										
Date:	25-Jun-24									
DIR:	C:\SigTest_USB4_CTS\Waveforms\captive\									
File:	pam3_prts7_preset_bin									
Transmitter Equalization Test:										
presets_number	TXFFE_Failed	TXFFE(-2)	TXFFE(-1)	TXFFE(0)	TXFFE(1)	c(-2)	c(-1)	c(0)	c(1)	MaxErr
0 PASS		0	0		1	0	0	0	1	0
1 PASS		0	0		0.95	-0.05	0.000967	-0.003788	0.936553	-0.058682
2 PASS		0	0		0.9	-0.1	-0.000131	-0.000638	0.889559	-0.109672
3 PASS		0	0		0.85	-0.15	-0.000602	0.000649	0.842465	-0.156285
4 PASS		0	-0.05		0.95	0	0.000332	-0.053038	0.93874	-0.007789
5 PASS		0	-0.05		0.9	-0.05	-0.000094	-0.051613	0.887505	-0.060788
6 PASS		0	-0.05		0.85	-0.1	-0.000129	-0.051913	0.845006	-0.102952
7 PASS		0	-0.05		0.8	-0.15	0.001131	-0.055091	0.791091	-0.152687
8 PASS		0	-0.1		0.9	0	-0.00038	-0.102232	0.8912	-0.006188
9 PASS		0	-0.1		0.85	-0.05	-0.001093	-0.101335	0.845154	-0.052418
10 PASS		0	-0.1		0.8	-0.1	-0.000222	-0.103026	0.796487	-0.100266
11 PASS		0	-0.1		0.75	-0.15	-0.000073	-0.103357	0.744878	-0.151691
12 PASS		0	-0.15		0.85	0	-0.000789	-0.152317	0.840599	-0.006296
13 PASS		0	-0.15		0.8	-0.05	-0.001804	-0.150924	0.793398	-0.053875
14 PASS		0	-0.15		0.75	-0.1	-0.001411	-0.151674	0.744966	-0.10192
15 PASS		0	-0.15		0.7	-0.15	0.000589	-0.155357	0.692626	-0.151427
16 PASS	0.025	-0.15			0.825	0	0.025306	-0.152802	0.82143	0.000461
17 PASS	0.025	-0.15			0.775	-0.05	0.0242	-0.150473	0.770556	-0.054771
18 PASS	0.025	-0.15			0.725	-0.1	0.024013	-0.149971	0.722007	-0.104009
19 PASS	0.025	-0.15			0.675	-0.15	0.026122	-0.153588	0.667356	-0.152934
20 PASS	0	-0.2			0.8	0	-0.001274	-0.19678	0.800088	0.001859
21 PASS	0	-0.2			0.75	-0.05	0.00041	-0.200712	0.750819	-0.048059
22 PASS	0	-0.2			0.7	-0.1	-0.00132	-0.196701	0.701657	-0.100312
23 PASS	0	-0.2			0.65	-0.15	0.001769	-0.201401	0.648405	-0.148425
24 PASS	0.025	-0.2			0.775	0	0.025732	-0.19801	0.772965	0.003293
25 PASS	0.025	-0.2			0.725	-0.05	0.027094	-0.200704	0.724557	-0.047646
26 PASS	0.025	-0.2			0.675	-0.1	0.025425	-0.197479	0.677013	-0.100083
27 PASS	0.025	-0.2			0.625	-0.15	0.026601	-0.197619	0.621084	-0.154696
28 PASS	0.05	-0.2			0.75	0	0.051727	-0.197646	0.74696	0.003667
29 PASS	0.05	-0.2			0.7	-0.05	0.052203	-0.199006	0.699705	-0.049086
30 PASS	0.05	-0.2			0.65	-0.1	0.053109	-0.199704	0.65005	-0.097137
31 PASS	0.05	-0.2			0.6	-0.15	0.053707	-0.199493	0.594665	-0.152134
32 PASS	0	-0.25			0.75	0	-0.002325	-0.246607	0.750893	-0.000175
33 PASS	0	-0.25			0.7	-0.05	-0.000337	-0.249639	0.699219	-0.050505
34 PASS	0.025	-0.25			0.725	0	0.025936	-0.249011	0.72206	0.002993
35 PASS	0.025	-0.25			0.675	-0.05	0.02465	-0.247867	0.674748	-0.052734
36 PASS	0.05	-0.25			0.7	0	0.051173	-0.248007	0.699186	0.001634
37 PASS	0.05	-0.25			0.65	-0.05	0.050794	-0.24748	0.649004	-0.052722
38 PASS	0.075	-0.25			0.675	0	0.076039	-0.245831	0.676538	-0.001592
39 PASS	0.075	-0.25			0.625	-0.05	0.078926	-0.249576	0.621508	-0.04999
40 PASS	0	-0.1			0.4	0	-0.000102	-0.10232	0.395585	-0.001993
41 PASS	0	0			0.5	0	-0.000233	-0.001261	0.4961	-0.000405
Preset Swing Attenuation [dB]:										
Preset 40	PASS	VSWING_RATIO	5.7 CTS: Min Swing Attenuation [dB]			5 CTS: Max Swing Attenuation [dB]			7	
Preset 41	PASS	VSWING_RATIO	5.9 CTS: Min Swing Attenuation [dB]			5 CTS: Max Swing Attenuation [dB]			7	
Informative:										
	Symbol Rate [GH	25.6	Drift [PPM	0						

10.2 tx_best_preset_ctle

This function reads all TXFFE preset files and returns the best preset and CTLE_DC.

Run the following command from the PowerShell window:

Command example:

```
.\USB4_SigTest.exe gen4 tx tp3_captive tx_best_preset  
C:\SigTest_USB4_CTS\Waveforms\captive\ pam3_prts7_preset_bin none  
tx_best_preset_ctle_report_result s_parameter_for_deembedding.s4p
```

```
PS C:\SigTest_USB4_CTS> .\USB4_SigTest.exe gen4 tx tp3_captive tx_best_preset_ctle C:\SigTest_USB4_CTS\Waveforms\captive\pam3_prts7_preset_bin none tx_best_preset_ctle_report_results s_parameter_for_deembedding.s4p
***** SIGTEST Version: 0.95 *****
Running SIGTEST : Technology : GEN4, TestMode : TX, TestPoint : TP3_CAPTIVE
The following tests are in progress ...
Transmitter Preset Calibration
Loading file: C:\SigTest_USB4_CTS\Waveforms\captive\pam3_prts7_preset_0.bin ....
TP3-Tx: An embedded s_parameter_for_deembedding.s4p & Embedded wave files
```

Report files location:

Name	Date modified	Type	Size
Waveforms	25/06/2024 11:29	File folder	
s_parameter_for_deembedding.s4p	12/06/2023 7:14	S4P File	564 KB
tx_best_preset_ctle_report_results_result	25/06/2024 13:46	Microsoft Excel C...	2 KB
USB4_SigTest.exe	25/06/2024 11:02	Application	24,192 KB

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

The .csv file tx_best_preset_ctle_report_result.csv as a results example

Electrical Compliance Test Specification for GEN4			
Date:	27-Jun-24		
DIR:	C:\SigTest_USB4_CTS\Waveforms\captive\		
File:	pam3_prts7_preset_bin		
Informative:	Symbol Rate [GHz]	0 Drift [PPM]	-1000000
Informative:Best CTLE index	5		
Informative:Best TXFFE preset	9		
Informative:	EyeHeight	43.12 [mV]	
Informative:	EyeWidth	5.800286 [pS]	

10.3 ui_jitter_vertical

This function calculates USB4 v2 GEN4 Captive device Transmitter Specification parameters (at TP3_captive) such as UI, SSC, Jitter and Vertical performance using the best TXFFE preset signal waveform and best CTLE (reported in tx_best_preset_ctle)

Best preset file name suffix shall be as follows CTLE_{best ctle number}.{waveform format}

Run the following command from the PowerShell window:

Command example: `.\USB4_SigTest.exe gen4 tx tp3_captive ui_jitter_vertical C:\SigTest_USB4_CTS\Waveforms\captive\pam3_prts7_preset_5_CTLE_9.bin none`

ui_jitter_vertical_captive_report_result
s_parameter_for_deembedding.s4p

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

```
PS C:\SigTest_USB4_CTS> .\USB4_SigTest.exe gen4 tx tp3_captive_ui_jitter_vertical C:\SigTest_USB4_CTS\Waveforms\Captive\pam3_prts7_preset_9_CU1E_5.bin new ui_ssc_jitter_vertical_captive_report_result_s_parameter_for_deembedding.s4p
USB4_SigTest Version: 0.24 - 2024-06-06
Running SIGTEST : Technology : 6nm, TestMode : TX, TestPoint : TP3_CAPTIVE
The following tests are in progress...
Jitter Noise: UI SSC Jitter and Vertical
Loading File: C:\SigTest_USB4_CTS\Waveforms\Captive\pam3_prts7_preset_9_CU1E_5.bin ....
TP3 TX: De-embedded_s_parameter_for_deembedding.s4p & Embedded noise files
Loading File: C:\SigTest_USB4_CTS\Waveforms\Captive\scope_intrinsic_noise.bin ....
Measured Noise Input: Noise1_111110[mrms]
UI SSC Estimated:
  UI SSC Frequency: 31.000400[ghz]
  UI SSC Amplitude Harmonics[p5]: 0.000251, 0.000439, 0.000714,
  Writing ui_ssc_jitter_vertical_captive_report_result_ttr_per_ind_frequency_gen4_tx3_captive.jpg
  UI Min = -2414.150037[ps], Max=9.000251[ps]
  Writing ui_ssc_jitter_vertical_captive_report_result_tj_bathtub_gen4_tx3_captive.jpg
  Writing ui_ssc_jitter_vertical_captive_report_result_histogram_p5_1_601_gen4_tx3_captive.jpg
  UI LOCKED on Pattern: pam3_prts7 !!!
Number of Symbols: 81483559, RMS = 0
Distortion Noise: without removal O/E [jitter <2.46[mrms], with removal O/E<2.15[mrms], O/E <1.15[mrms]
Informative Intrinsic Scope Noise = 1.31[mV-rms]
TX LEVELS MISMATCH = 0.999
TX LEVEL = 43.92[dBm]
TX LEVEL = 40.8[mW]
TX LEVEL = 43.92[dBm]
V_Steady-State = 101.1[mV]
R_NORM = 24.7[dB]
TX_25I_MARGIN = 10.1[dB]
TX Budget: Dist=2.1[mV], Noise=1.4[mV] total= 2.5[mV]
  FullPower=1.5000[ps]
  attenuation=-11.244[dB], r=12.000000[db]
  gen4_tx3_tx1_txymagn=29.11[mV], txymatch= 389[UI]<12.11[ps]
  gen4_tx3_tx1_txymagn=28.11[mV], txymatch= 389[UI]<11.9[ps]
  gen4_txymagn=29.11[mV], txymatch= 389[UI]<12.11[ps]
  Writing ui_ssc_jitter_vertical_captive_report_result_eye_diagram_gen4_tx3_captive.jpg
  Writing result_csv_ui_ssc_jitter_vertical_captive_report_result_result.csv
  gen4_tx3_tx1_txymagn=29.11[mV]
```

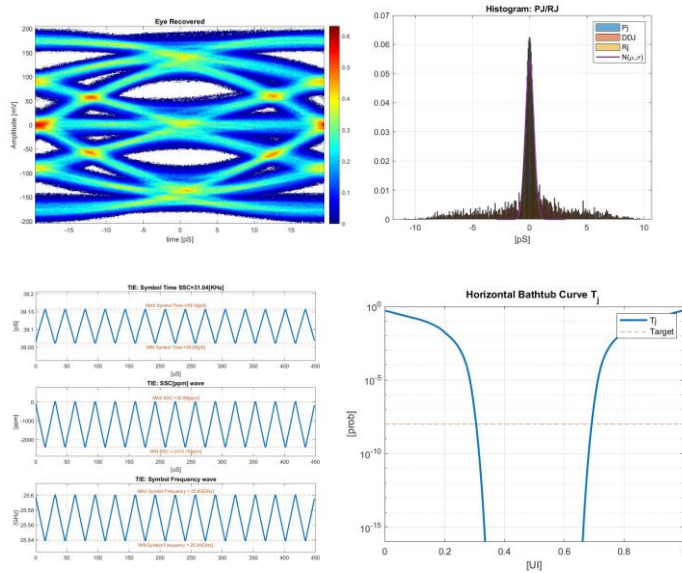
Report files location:

Name	Date modified	Type	Size
Waveforms	25/06/2024 11:29	File folder	
s_parameter_for_deembedding.s4p	12/06/2023 7:14	S4P File	564 KB
ui_ssc_jitter_vertical_captive_report_result...	25/06/2024 14:23	JPG File	323 KB
ui_ssc_jitter_vertical_captive_report_result...	25/06/2024 14:23	JPG File	55 KB
ui_ssc_jitter_vertical_captive_report_result...	25/06/2024 14:23	Microsoft Excel C...	2 KB
ui_ssc_jitter_vertical_captive_report_result...	25/06/2024 14:22	JPG File	247 KB
ui_ssc_jitter_vertical_captive_report_result...	25/06/2024 14:22	JPG File	66 KB
USB4_SigTest.exe	25/06/2024 11:02	Application	24,192 KB

The .csv file ui_ssc_jitter_vertical_captive_report_result.csv as a results example

Electrical Compliance Test Specification for GEN4									
Date:	25-Jun-24								
DIR:	C:\SigTest_USB4_CTS\Waveforms\Captive\								
File:	pam3_prts7_preset_9_CU1E_5.bin								
Minimum Unit Interval Measurement [ps]:	PASS	UI Min	39.058327	UI Min Max	39.060538	CTS: UI Min	39.0598	CTS: UI Min Max	39.0742
SSC Down Spread Range Measurement [%]:	PASS	Min SSC Down Spread_Range	0.251026	Max SSC Down Spread_Range	0.2617	CTS: Min SSC Down Spread_Range	0.2	CTS: Max SSC Down Spread_Range	0.3
SSC Down Spread Rate Measurement [GHz]:	PASS	Min SSC Down Spread_Rate	30.660000	Max SSC Down Spread_Rate	31.205345	CTS: Min SSC Down Spread_Rate	30	CTS: Max SSC Down Spread_Rate	33
SSC Phase Deviation Measurement [ps-p]:	PASS	SSC Phase_Deviation	10.831633	CTS: Min SSC Phase_Deviation	2.5	CTS: Max SSC Phase_Deviation	15.5		
SSC Slew Rate Measurement [ps/ns]:	PASS	SSC Slew_Rate	195.388154	CTS: Max SSC Slew_Rate	500				
UI Measurement Up-p:	PASS	UI jitter Up-p	0.091023	CTS: Max UI	0.17				
UDI Measurement Up-p:	PASS	UDI jitter Up-p	0.028458	CTS: Max UDI	0.075				
UI LF Measurement Up-p:	PASS	UI LF jitter Up-p	0.002602	CTS: Max UI LF	0.03				
DCD Measurement Up-p:	PASS	DCD jitter Up-p	0.005199	CTS: Max DCD	0.02				
Informative:		Symbol Rate [GHz]	25.589207	Drift [PPM]	-1202.86				
Vertical Analysis Test:									
TX SNDR Measurement [dB]:	PASS	TX SNDR [dB]	34.656067	CTS: Min TX SNDR	22.5				
TX LEVELS MISMATCH Measurement:	PASS	TX_LEVELS_MISMATCH	0.998971	CTS: Min TX_LEVELS_MISMATCH	0.975				
V_SWING Measurement [mV]:	PASS	V_SWING	486.009099	CTS: Min V_SWING	350	CTS: Max V_SWING	500		
PULSE PEAK_NORM Measurement [dB] (TWFF=0):	PASS	PULSE_PEAK_NORM	-12.296116	CTS: Min TPULSE_PEAK_NORM	-19				
TX Noise Budget:		Distortion		Total					
Measured [mVrms]:		2.1	1.4	2.54					
Informative:		EyeHeight		28.19	[mV]				
Informative:		EyeWidth		11.816389	[ps]				
Informative:		Intrinsic Scope Noise = 1.31[mV-rms]							

JPG that the function plots:



In the case of a fail in EVEN_ODD parameter only, ui_jitter_vertical test should be run with PRBS11 pattern to check the EVEN_ODD value.(refer to CTS test method section 5.3.2.4):

Best preset file name suffix shall be as follows CTLE_{best ctile number}.{waveform format}

Best preset file name shall include “_prbs11_” wording

Run the following command from the PowerShell window:

Command example:

```
.\USB4_SigTest.exe gen4 tx tp3_captive ui_jitter_vertical
C:\SigTest_USB4_CTS\Waveforms\txffe\ Pam2_prbs11_Preset_19_CTLE_5.bin
none ui_ssc_jitter_vertical_report_result
s_parameter_for_deembedding.s4p
```

Report files location:

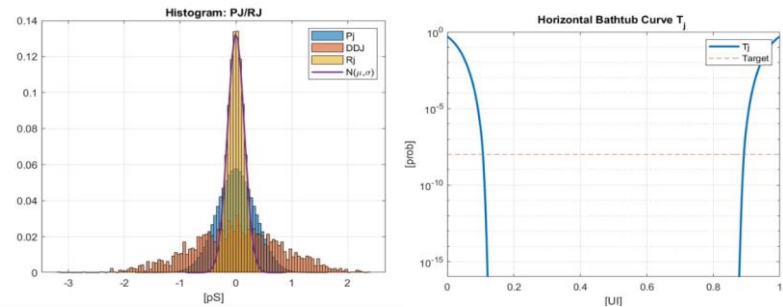
Name

- ui_ssc_vertical_prbs11_report_result.csv
- ui_ssc_vertical_prbs11_report_histogram_pj_rj_ddj_gen4_tp3_captive.jpg
- ui_ssc_vertical_prbs11_report_tj_bathtub_gen4_tp3_captive.jpg
- USB4_SigTest.exe
- s_parameter_for_deembedding.s4p
- Waveforms

The .csv file ui_ssc_jitter_vertical_prbs11_result.csv as a results example

Electrical Compliance Test Specification for GEN4					
Date:	01-Sep-24				
DIR:	C:\SigTest\Waveforms\				
File:	Pam2_prbs11_Preset_19_CTLE_5.bin				
DCD Measurement Ulp-p:	PASS	DCD jitter Ulp-p	0.001635	CTS: Max DCD	0.02
Informative:	Symbol Rate [GHz]	25.568814	Drift [PPM]	-1218.22	
Informative:	Intrinsic Scope Noise File Not Found!!!				

The SIGTEST saves the following plots (.jpg format)



10.4 tx_frequency_variation

This function calculates USB4 v2 GEN4 Captive Device Tx Frequency Variation parameters

Run the following command from the PowerShell window:

Command example:

```
.\USB4_SigTest.exe gen4 tx tp3_captive 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 tp3_captive frequency_variation_training C:\SigTest\Waveforms\ frequency_variation_training_captive.bin none frequency_variation_training_captive_report none  
**** SIGTEST Version 4.36 ****  
Running SIGTEST : Technology : GEN4, TestNode : TX, TestPoint : TP3_CAPTIVE  
The following tests are in progress ...  
Frequency Variation Training Measurement  
Loading file: C:\SigTest\Waveforms\Frequency_variation_training_captive.bin ....  
Detected S0228 have before Close switch errors  
INIT_FREQ_VARIATION(ppm): Mean=5.140925, Max=5.216384, Min=5.044794  
DELTA_FREQ_200ns(ppm): 278.933693  
DELTA_FREQ_1000ns(ppm): 289.911019  
Steady_State_FREQ_VARIATION(ppm): Mean=2.924878, Max=44.020439, Min=-36.401839  
Steady_State_STATE_SLEW(ppm/s): 64.818114  
TX Frequency Overshoot(ppm): 280.233828  
Writing frequency_variation_training_captive_report_tx_clock_switch_analysis_gen4_tp3_captive.jpg  
Writing result to: .\frequency_variation_training_captive_report_result.csv  
All tests are completed
```

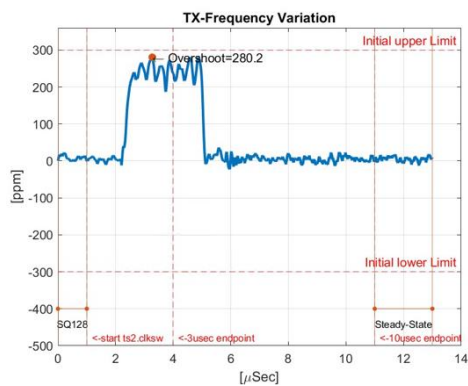
Report files location:

- Name
- USB4_SigTest_old.exe
 - USB4_SigTest.exe
 - frequency_variation_training_captive_report_tx_clock_switch_analysis_gen4_tp3_captive.jpg
 - frequency_variation_training_captive_report_result.csv
 - Waveforms

The .csv file tx_frequency_variation_report_result.csv as a results example

Electrical Compliance Test Specification for GEN4					
Date:	13-Aug-24				
Dir:	C:\SigTest\Waveforms\				
File:	frequency_variation_training_captive.bin				
TX Frequency Variation Training Measurement:					
INIT_FREQ_VARIATION:	PASS	INIT_FREQ_VARIATION result:	5.140925 CTS: Min INIT_FREQ_VARIATION	-300 CTS: Max INIT_FREQ_VARIATION	300
DELTA_FREQ_200ns:	PASS	DELTA_FREQ_200ns result:	278.933693 CTS: Max DELTA_FREQ_200ns	600	
DELTA_FREQ_1000ns:	PASS	DELTA_FREQ_1000ns result:	289.911019 CTS: Max DELTA_FREQ_1000ns	900	
FREQ_OVERSHOOT:	PASS	FREQ_OVERSHOOT result:	280.23382 CTS: Max FREQ_OVERSHOOT	600	
STEADY_STATE_FREQ_VARIATION:	PASS	STEADY_STATE_FREQ_VARIATION result:	2.924878 CTS: Min STEADY_STATE_FREQ_VARIATION	-300 CTS: Max STEADY_STATE_FREQ_VARIATION	300
STEADY_STATE_SLEW_RATE:	PASS	STEADY_STATE_SLEW_RATE result:	64.818114 CTS: Max STEADY_STATE_SLEW_RATE	500	
Informative:	Symbol Rate [GHz]	26.60013 GHz [PP4M]	5.08		

The SIGTEST saves the following plot (.jpg format)



10.5 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 tp3_captive electrical_idle_voltage
C:\SigTest\Waveforms\ tx_gen4_eidle.bin none eidle_report
s_parameter_for_deembedding.s4p
```

```
PS C:\SigTest> .\USB4_SigTest.exe gen4 tx tp3_captive electrical_idle_voltage C:\SigTest\Waveforms\ tx_gen4_eidle.bin none eidle_report s_parameter_for_deembedding.s4p
***** SIGTEST Version: 0.96 *****
Running SIGTEST : Technology : GEN4, TestMode : TX, TestPoint : TP3_CAPTIVE
The following tests are in progress ...
Electrical Idle Voltage Measurement
Loading File: C:\SigTest\Waveforms\tx_gen4_eidle.bin ....
Warning: Provided s-parameters file [1,2,3,4] port order for de-embedding is incorrect ==> it is auto reordered to [1,3,2,4] port order!!!
TP3-TX: De-Embedded s_parameter_for_deembedding.s4p & Embedded none Files
Writing result to .\eidle_report_result.csv
The tests are completed
```

Report file location:

Name
Waveforms
eidle_report_result.csv
s_parameter_for_deembedding.s4p
USB4_SigTest.exe

eidle_report_result.csv as a result example

Electrical Compliance Test Specification for GEN4					
Date:	13-Aug-24				
DIR:	C:\SigTest\Waveforms\				
File:	tx_gen4_eidle.bin				
Electrical Idle Voltage Measurement[mV]:	PASS	V_ELEC_IDLE	1.343733	CTS: Max V_ELEC_IDLE	20

10.6 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 tp3_captive ac_common_mode
C:\SigTest_USB4_CTS\Waveforms\accm\ accm.bin none
ac_common_mode_results s_parameter_for_deembedding.s4p

```
PS C:\SigTest_USB4_CTS> .\USB4_SigTest.exe gen4 tx tp3_captive ac_common_mode C:\SigTest_USB4_CTS\Waveforms\accm\ accm.bin none accm_captive_report s_parameter_for_deembedding.s4p
**** SIGTEST Version: 0.96 ****
Running SIGTEST : Technology : GEN4, TestMode : TX, TestPoint : TP3_CAPTIVE
The following tests are in progress ...
AC Common Mode Measurement
Loading file: C:\SigTest_USB4_CTS\Waveforms\accm\accm.bin ....
TP3-TX: De-Embedded s_parameter_for_deembedding.s4p & Embedded none Files
Writing result to .\accm_captive_report_result.csv
The tests are completed
```

Report file location:

Name

-  accm_captive_report_result.csv
-  USB4_SigTest.exe
-  Waveforms

The .csv file ac_common_mode_report_result.csv as a results example

Electrical Compliance Test Specification for GEN4					
Date:	26-Jun-24				
DIR:	C:\SigTest_USB4_CTS\Waveforms\accm\				
File:	accm.bin				
ACCM Measurement:	PASS	ACCM: Vac [mVp2p]	37.3	CTS: Max ACCM [mVp2p]	100

10.7 wireless_band_conducted_diff

This function calculates the Power in differential mode for each of the wi-fi bands defined in the spec

Run the following command from the PowerShell window:

Command example:

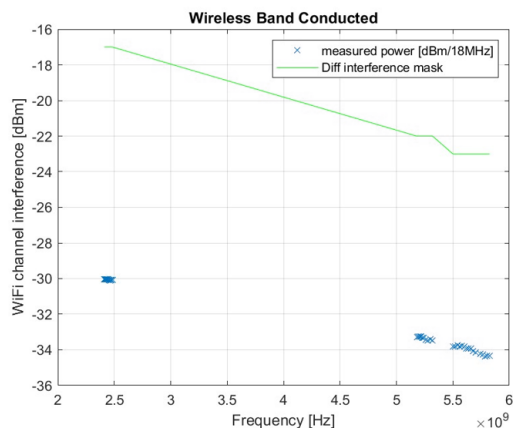
```
.\USB4_SigTest.exe gen4 tx tp2 wireless_band_conducted_diff  
C:\SigTest\Waveforms\ prts7_captive.bin none  
wireless_band_conducted_diff_results s_parameter_for_deembedding.s4p
```

```
PS C:\SigTest> .\USB4_SigTest.exe gen4 tx tp2 wireless_band_conducted_diff C:\SigTest\Waveforms\ prts7_captive.bin none wireless_band_conducted_diff_results s_parameter_for_deembedding.s4p  
**** SIGTEST Version: 0.97 ****  
Running SIGTEST : Technology : GEM4, TestMode : TX, TestPoint : TP2  
The following tests are in progress ...  
Wireless Band Conducted: Differential Mode  
Loading file: C:\SigTest\Waveforms\prts7_captive.bin ....  
Warning: Provided sparameters file {1,2,3,4} port order for de-embedding is incorrect ==> it is auto reordered to {1,3,2,4} port order!!!  
TP2: De-embedded s_parameter_for_deembedding.s4p file  
Writing wireless_band_conducted_diff_results_wireless_band_conducted_gen4_tp2.jpg  
Writing result to wireless_band_conducted_diff_results_result.csv  
The tests are completed
```

wireless_band_conducted_diff_results_result.csv as a result example

Electrical Compliance Test Specification for GEN4			
Date:	20-Aug-24		
DIR:	C:\SigTest\Waveforms\		
File:	prts7_captive.bin		
Wireless Band Conducted: Differential-Mode			
Freq[MHz]	Status	Measured Max[dBm]	
2412	PASS	-30.04	-17
2417	PASS	-30.05	-17
2422	PASS	-30.05	-17
2427	PASS	-30.05	-17
2432	PASS	-30.03	-17
2437	PASS	-30.03	-17
2442	PASS	-30.02	-17
2447	PASS	-30.04	-17
2452	PASS	-30.07	-17
2457	PASS	-30.09	-17
2462	PASS	-30.09	-17
2467	PASS	-30.08	-17
2472	PASS	-30.07	-17
2484	PASS	-30.07	-17
5180	PASS	-33.27	-22
5190	PASS	-33.25	-22
5200	PASS	-33.27	-22
5210	PASS	-33.25	-22
5220	PASS	-33.26	-22
5230	PASS	-33.32	-22
5240	PASS	-33.31	-22
5260	PASS	-33.42	-22
5280	PASS	-33.47	-22
5300	PASS	-33.42	-22
5320	PASS	-33.49	-22
5500	PASS	-33.81	-23
5520	PASS	-33.82	-23
5540	PASS	-33.74	-23
5560	PASS	-33.8	-23
5580	PASS	-33.79	-23
5600	PASS	-33.83	-23
5620	PASS	-33.94	-23
5640	PASS	-33.92	-23
5660	PASS	-33.92	-23
5680	PASS	-34.08	-23
5700	PASS	-34.16	-23
5745	PASS	-34.22	-23
5765	PASS	-34.24	-23
5785	PASS	-34.38	-23
5805	PASS	-34.34	-23
5825	PASS	-34.33	-23

The SIGTEST saves the following plot (.jpg format)



10.8 wireless_band_conducted_comm

This function calculates the Power in common mode for each of the wi-fi bands mentioned in the spec

Run the following command from the PowerShell window:

Command example:

```
.\USB4_SigTest.exe gen4 tx tp2 wireless_band_conducted_comm
C:\SigTest\Waveforms\ prts7_comm_captive.bin none
wireless_band_conducted_comm_results s_parameter_for_deembedding.s4p
```

```
PS C:\SigTest> .\USB4_SigTest.exe gen4 tx tp2 wireless_band_conducted_comm C:\SigTest\Waveforms\ prts7_comm_captive.bin none wireless_band_conducted_comm_results s_parameter_for_deembedding.s4p
***** SIGTEST Version: 0.97 *****
Running SIGTEST - Technology : dsm, TestMode : TX, TestPoint : TP2
The following tests are in progress ...
Wireless Band Conducted Common Mode
Loading file: C:\SigTest\Waveforms\prts7_comm_captive.bin ....
Warning: Provided s-parameters file [1,1,3,4] port order for de-embedding is incorrect ==> it is auto reordered to [1,3,2,4] port order!!!
TP2: De-embedded s-parameter_for_deembedding.s4p file
Writing wireless_band_conducted_comm_results_wireless_band_conducted_gen4_tp2.jpg
Writing result to : wireless_band_conducted_comm_results_result.csv
The tests are completed
```

wireless_band_conducted_comm_results_result.csv as a result example

Electrical Compliance Test Specification for C

Date: 20-Aug-24

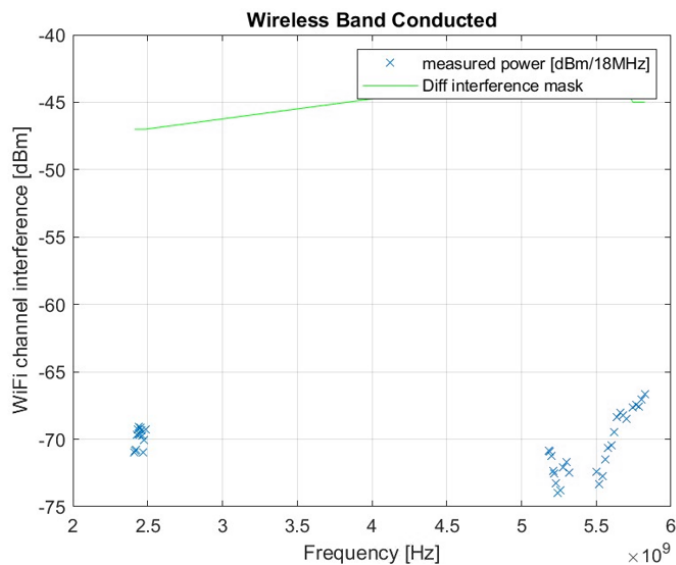
DIR: C:\SigTest\Waveforms\

File: prts7_accm_captive.bin

Wireless Band Conducted:Common-Mode

Freq[MHz]	Status	Measured	Max[dBm]
2412	PASS	-70.96	-47
2417	PASS	-70.88	-47
2422	PASS	-70.79	-47
2427	PASS	-69.69	-47
2432	PASS	-69.28	-47
2437	PASS	-69.06	-47
2442	PASS	-69.6	-47
2447	PASS	-69.65	-47
2452	PASS	-69.14	-47
2457	PASS	-69.32	-47
2462	PASS	-69.74	-47
2467	PASS	-70.95	-47
2472	PASS	-70.07	-47
2484	PASS	-69.3	-47
5180	PASS	-70.84	-43
5190	PASS	-70.88	-43
5200	PASS	-71.27	-43
5210	PASS	-72.37	-43
5220	PASS	-72.57	-43
5230	PASS	-73.24	-43
5240	PASS	-73.98	-43
5260	PASS	-73.79	-43
5280	PASS	-72.07	-43
5300	PASS	-71.68	-43
5320	PASS	-72.48	-43
5500	PASS	-72.41	-44
5520	PASS	-73.36	-44
5540	PASS	-72.74	-44
5560	PASS	-71.52	-44
5580	PASS	-70.65	-44
5600	PASS	-70.43	-44
5620	PASS	-69.49	-44
5640	PASS	-68.37	-44
5660	PASS	-68.04	-44
5680	PASS	-68.25	-44
5700	PASS	-68.51	-44
5745	PASS	-67.65	-45
5765	PASS	-67.46	-45
5785	PASS	-67.59	-45
5805	PASS	-67.06	-45
5825	PASS	-66.65	-45

The SIGTEST saves the following plot (.jpg format)



11 GEN2-3 Captive Device Receiver Testing

TBD

12 GEN4 Captive Device Receiver Testing

12.1 BERT output calibration

This procedure shall be used for RX BERT output calibration. Input signals 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_..."

3. cts_test_name = **calibration**
4. test_point = **tp3_prime**

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_prese
t_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_SNRD = 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>

```

6. Report files location:

Local Disk (C:) > SigTest

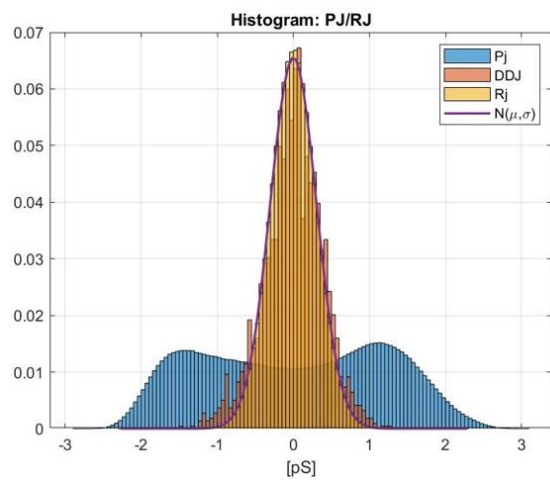
Name

-  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

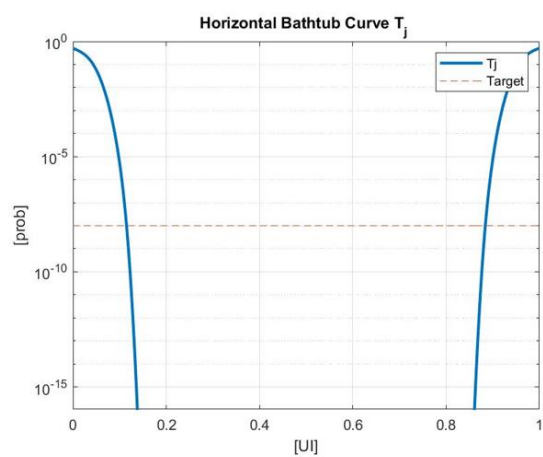
7. calibration_report_result.csv report file as an example

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_SNRD Measurement [dB]:	TX_SNRD [dB]	32.367073			
TX_LEVELS_MISMATCH Measurement:	TX_LEVELS_MISMATCH	0.97538			
V_SWING Measurement [mVp-p]:	V_SWING-p-p	1028.8			

8. calibration_report_histogram_pj_rj_ddj_gen4_tp3_prime.jpg



9. calibration_report_tj_bathtub_gen4_tp3_prime.jpg



12.2 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
- IL_delta [dB] – BERT Insertion Loss difference at 6.4GHz - 12.8GHz
- IL_delta [dB] – BERT Insertion Loss difference at 3.2GHz - 6.4GHz

Formatted: Font: (Default) Verdana, 10 pt, Font color: Text 1, Complex Script Font: Courier New, 10 pt

1. cts_test_name – **calibration_bert_il_extraction**
2. test_point = **tp3_captive**

1. Run the following command from the PowerShell window:

Command example:

```
.\USB4_SigTest.exe gen4 rx tp3_captive 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_captive calibration_bert_il_extraction C:\SigTest\Waveforms\ BERT_Sdd21.bin none bert_il_extraction.csv none none  
***** SIGTEST Version: 0.97a *****  
Running SIGTEST : Technology : GEN4, TestMode : RX, TestPoint : TP3_CAPTIVE  
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: -1.87[dB] at f=12.8[GHz]  
Writing bert_il_extraction_bert_il_extraction_gen4_tp3_captive.jpg  
Writing result to .\bert_il_extraction_result.csv  
The tests are completed  
PS C:\SigTest> .\USB4_SigTest.exe gen4 rx tp3_captive calibration_bert_il_extraction C:\SigTest\Waveforms\ BERT_SDD21.bin none bert_il_extraction.csv none none  
***** SIGTEST Version: 0.99 *****  
Running SIGTEST : Technology : GEN4, TestMode : RX, TestPoint : TP3_CAPTIVE  
The following tests are in progress ...  
USB4 gen4: Channel calibration to worst case condition  
Loading File: C:\SigTest\Waveforms\BERT_SDD21.bin ....  
Warning: At TP3, there is no De-Embeddd File!!!  
BERT IL Extraction: -2.844971[dB] at f=12.800000[GHz]  
Writing bert_il_extraction_bert_il_extraction_gen4_tp3_captive.jpg  
Writing result to .\bert_il_extraction_result.csv  
The tests are completed
```

2. Report files location:

Local Disk (C:) > SigTest

Name

Waveforms

bert_il_extraction_bert_il_extraction_gen4_tp3.jpg

bert_il_extraction_result.csv

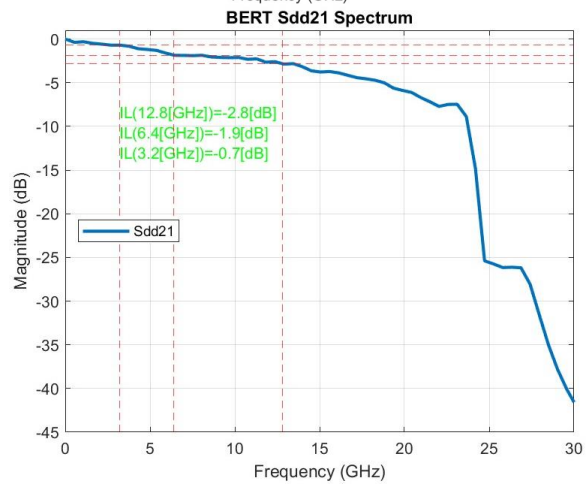
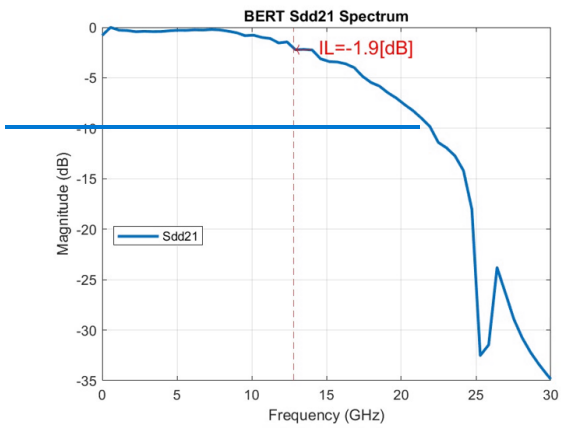
USB4_SigTest.exe

3. Bert_il_extraction.csv

Electrical Compliance Test Specification for GEN4			
Date:	03-Sep-24		
DIR:	C:\SigTest\Waveforms\		
File:	BERT_Sdd21.bin		
Calibration BERT IL Extraction Test:			
Informative:	IL[dB]	-1.9	
Informative:	Symbol Rate [GHz]	25.60001	Drift [PPM] 0.38

Electrical Compliance Test Specification for GEN4					
Date:	12-Jun-25				
DIR:	C:\SigTest\Waveforms\				
File:	BERT_SDD21.bin				
Calibration Bert_IL extraction Measurement:	PASS	BERT_IL 12.8GHz[dB]:	-2.844971	CTS: Max BERT_IL	-3
BERT_IL3.2GHz - BERT_IL6.4GHz	PASS	1.156022	CTS Min:	0	
BERT_IL6.4GHz - BERT_IL12.8GHz	PASS	0.992081	CTS Min:	0.7	
Informative [dB]:	BERT_IL 12.8GHz	-2.844971	BERT_IL3.2GHz	-0.696867	BERT_IL6.4GHz -1.85289
Informative:	Symbol Rate [GHz]	25.59993	Drift [PPM]	-2.74	

4. BERT Frequency Response plot



13 Aggressors' calibration

13.1 Aggressor's calibration Router Assembly

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

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			

13.2 Aggressor's calibration Captive Device

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

Run the following command from the PowerShell window:

Command example:

```
USB4_SigTest.exe gen4 tx tp3_captive clk_info C:\SigTest\Waveforms\
GEN4_RX_Aggressors_6p4GHz_clock.bin none
GEN4_RX_Aggressors_6p4GHz_clock none
```

14 LFPS

14.1 LFPS Router Assembly

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)

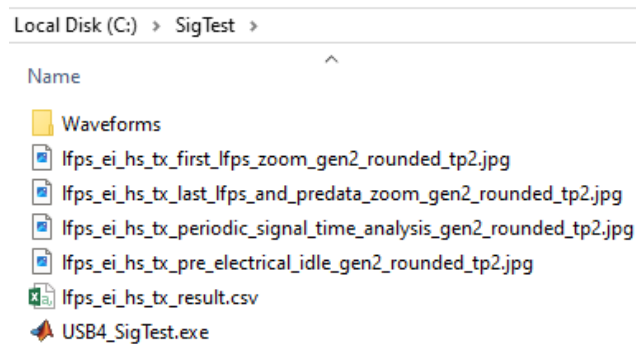
Run the following command from the PowerShell window:

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:

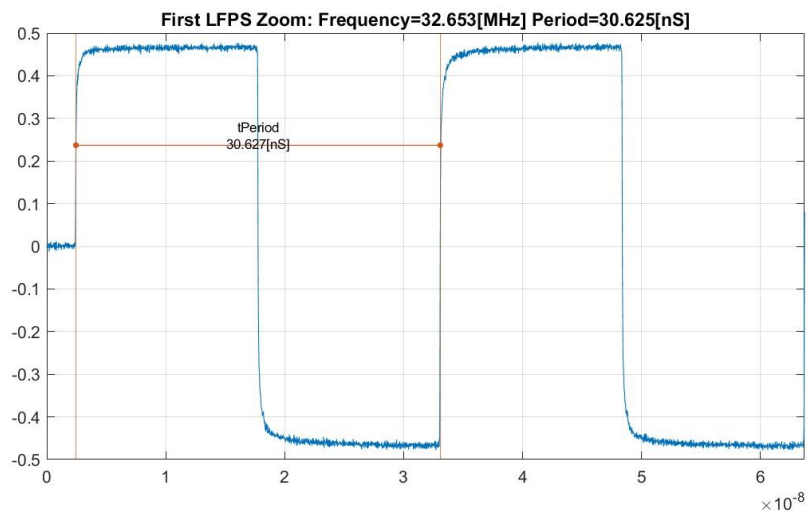


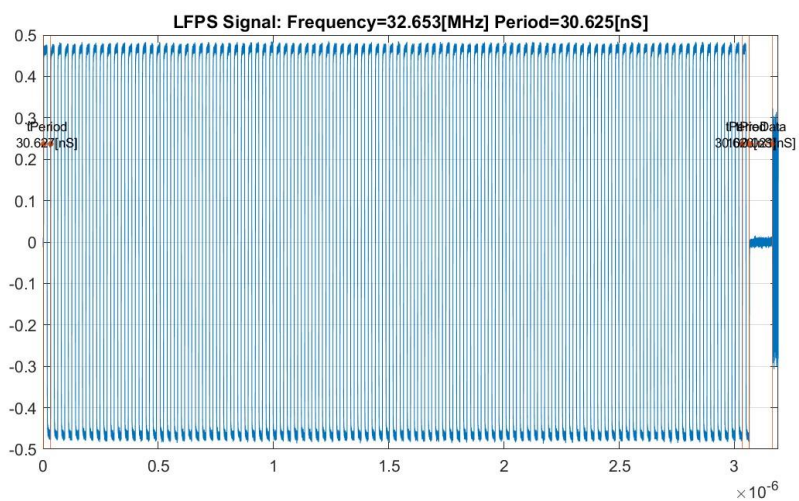
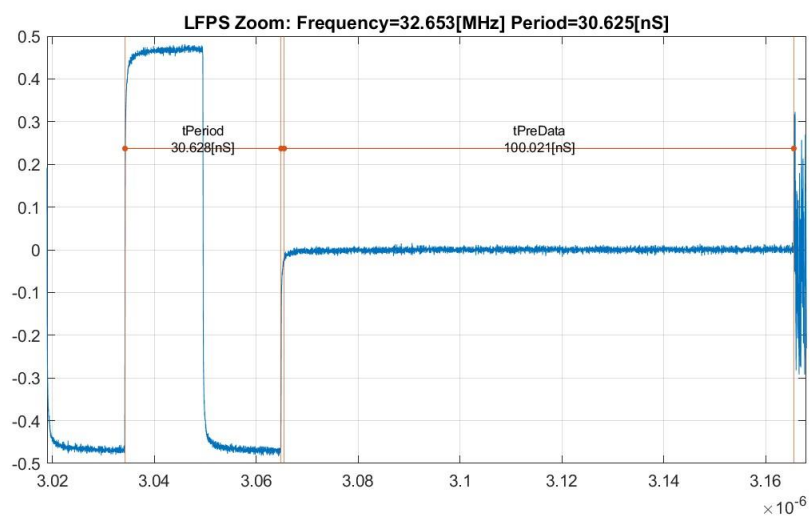
The .csv file lfps_ei_hs_tx_result.csv as a results example

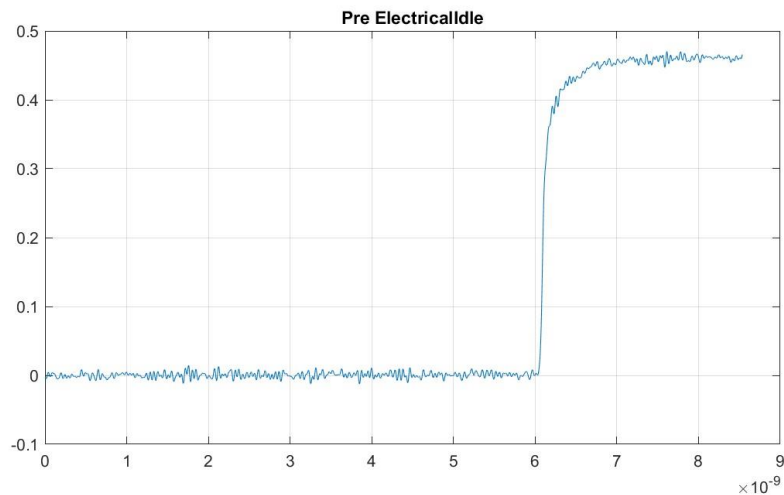
Electrical Compliance Test Specification for GEN2_ROUNDED					
Date:	22-Feb-24				
DIR:	C:\SigTest\Waveforms\				
Files:	lfps_ei_hs_tx_p.bin	lfps_ei_hs_tx_n.bin			
Low Frequency Periodic Signaling (LFPS) Test:					
LFPS Detected:	TRUE				
tPreData Measurement:	PASS	tPreData[nS]	100.095 CTS: Min tPreData	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







14.2 LFPS Captive Device

This function shall be used for USB4 v2 GEN4(Gen2/3 TBD) 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 gen4 tx tp3_captive lfps C:\SigTest\Waveforms
lfps_ei_hs_tx_n.bin lfps_ei_hs_tx_p.bin lfps_captive_report
s_parameter_for_deembedding.s4p
```

```
PS C:\SigTest> .\USB4_SigTest.exe gen4 tx tp3_captive lfps C:\SigTest\Waveforms lfps_ei_hs_tx_n.bin lfps_ei_hs_tx_p.bin lfps_captive_report s_parameter_for_deembedding.s4p
***** SIGTEST Version: 0.96 *****
Running SIGTEST : Technology : GEN4, TestMode : TX, TestPoint : TP3_CAPTIVE
The following tests are in progress ...
USB4 gen4:Low Frequency Periodic Signaling (LFPS)
Loading File P: C:\SigTest\Waveforms\lfps_ei_hs_tx_n.bin & File N:C:\SigTest\Waveforms\lfps_ei_hs_tx_p.bin ....
Warning: Provided s-parameters file [1,2,3,4] port order for de-embedding is incorrect ==> It is auto reordered to [1,3,2,4] port order!!!
TP3-TX: De-Embedded s_parameter_for_deembedding.s4p & Embedded none Files
Intra-Skew between P and N Channels 12.96[ps]
LFPS:Rate=32.65[MHz], T=36.62[ns], T1=15.312514[ns], T2=15.311609[ns], DC=50.001478[N]
Writing lfps_captive_report_periodic_signal_time_analysis_gen4_tp3_captive.jpg
Writing lfps_captive_report_pre_electrical_idle_gen4_tp3_captive.jpg
Writing lfps_captive_report_first_lfps_room_gen4_tp3_captive.jpg
Writing lfps_captive_report_last_lfps_and_predata_room_gen4_tp3_captive.jpg
Writing result to .\lfps_captive_report_result.csv
The tests are completed
```

Report files location:

Name

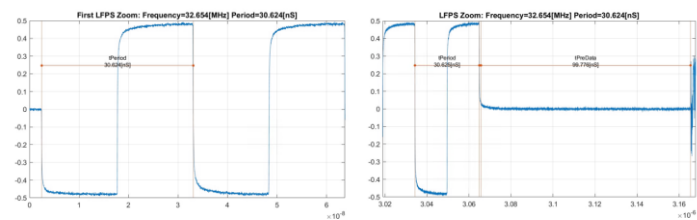
- USB4_SigTest.exe
- s_parameter_for_deembedding.s4p
- lfps_captive_report_result.csv
- lfps_captive_report_pre_electrical_idle_gen4_tp3_captive.jpg
- lfps_captive_report_periodic_signal_time_analysis_gen4_tp3_captive.jpg
- lfps_captive_report_last_lfps_and_predata_zoom_gen4_tp3_captive.jpg
- lfps_captive_report_first_lfps_zoom_gen4_tp3_captive.jpg
- eidle_report_result.csv
- Waveforms

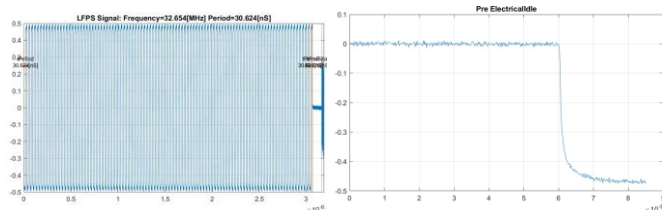
The .csv file lfps_ei_hs_tx_result.csv as a results example

Electrical Compliance Test Specification for GEN4						
Date:	13-Aug-24					
Dir:	C:\SigTest\Waveforms\					
Files:	lfps_ei_hs_n.bin	lfps_ei_hs_b.p.bin				
Low Frequency Periodic Signaling (LFPS) Test:						
LFPS Detected:	TRUE					
tPreData Measurement:	PASS	tPreData[nS]	99.769 CTS: Min tPreData	80 CTS: Max tPreData	120	
tPeriod Measurement:	PASS	Min tPeriod[nS]	30.624 CTS: Min tPeriod	20 Max tPeriod	30.624 CTS: Max tPeriod	80
tRise Measurement:	PASS	Max tRise[nS]	0.187 CTS: Max trise [nS]	4		
tFall Measurement:	PASS	Max tFall[nS]	0.193 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]	987.76 CTS: Min V_TX_DIFF_PP_LFPS[mVp2p]	800 CTS: Max V_TX_DIFF_PP_LFPS[mVp2p]	1200	
ACOM Measurement:	PASS	ACOM: V_CM_AC_LFPS[mVp2p]	38.3 CTS: Max ACOM [mVp2p]	100		
Electrical Idle Voltage Measurement[mV]:	PASS	V_ELEC_IDLE	5.950142 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





14.3 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

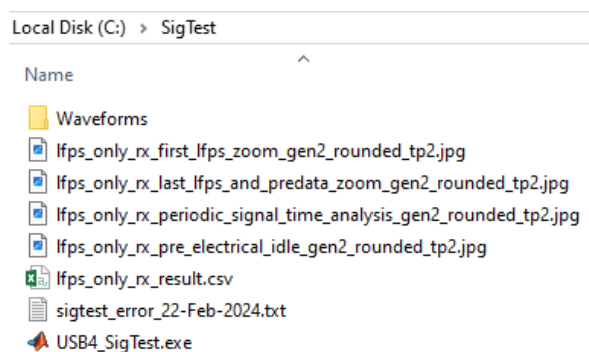
Run the following command from the PowerShell window:

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:

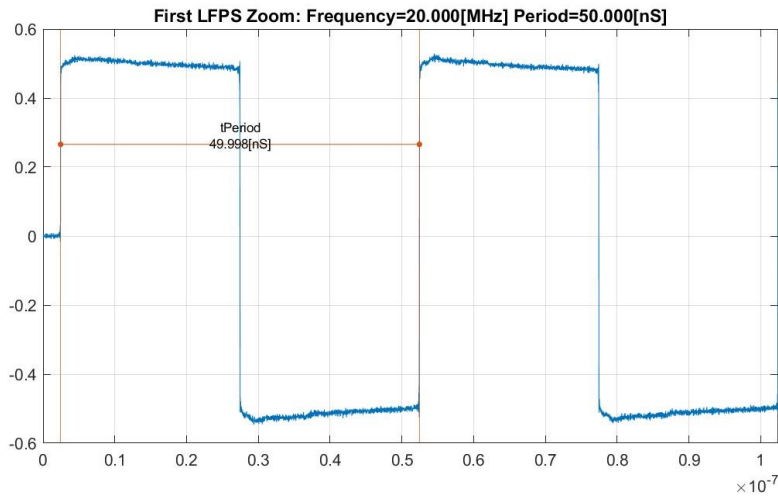


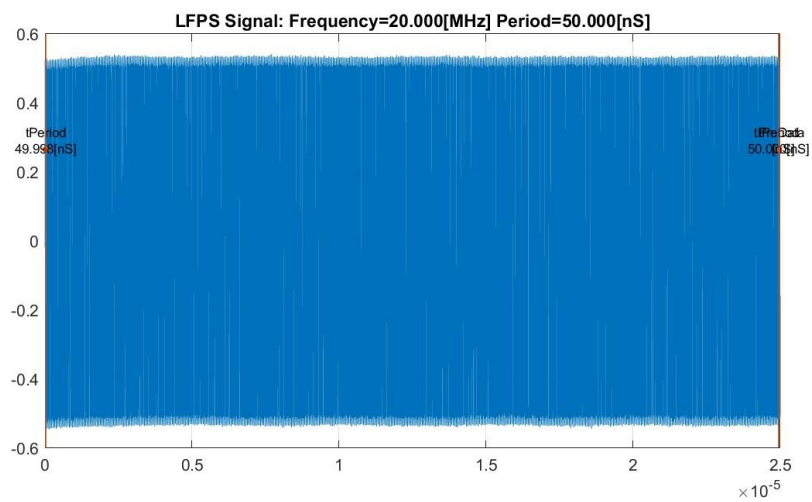
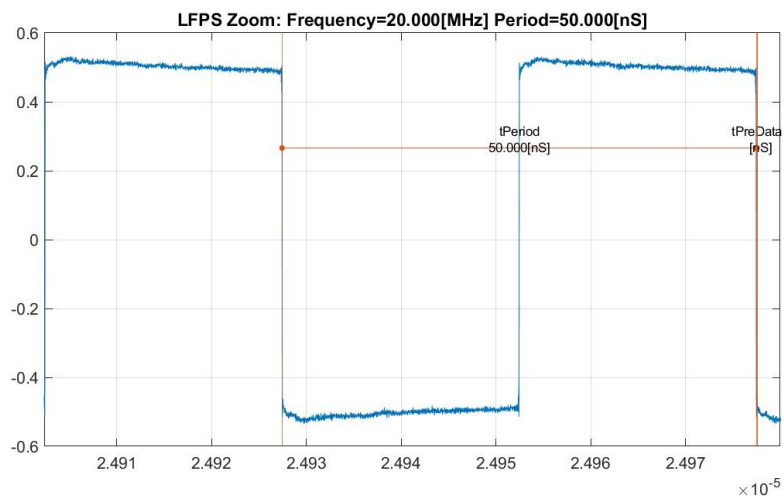
The .csv file lfps_only_rx_result.csv as a results example

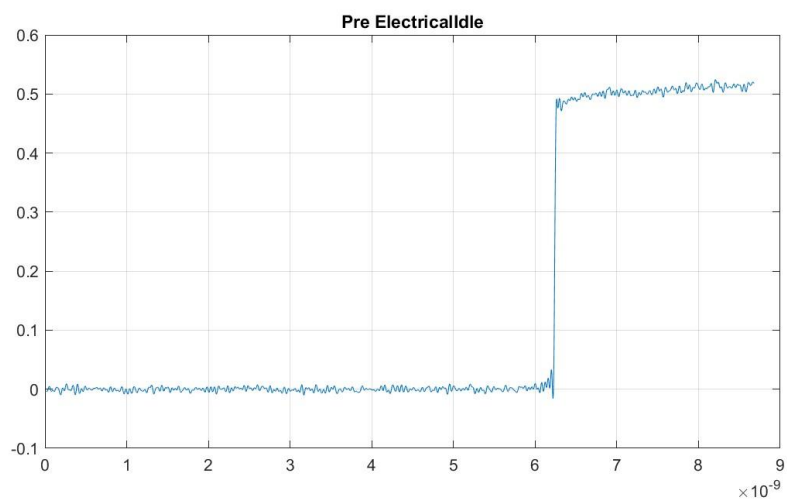
Electrical Compliance Test Specification for GEN2_ROUNDED		22-Feb-24					
Date:	C:\SigTest\Waveforms\						
DIR:	lfps_only_rx_n.bin						
Files:							
Low Frequency Periodic Signaling (LFPS) Test:							
Only LFPS Detected:	TRUE	Cycles	833				
tPreData Measurement:	FAIL	tPreData[nS]	0 CTS: Min tPreData	80 CTS: Max tPreData		120	
tPeriod Measurement:	PASS	Min tPeriod[nS]	30 CTS: Min tPeriod	20 Max tPeriod		30 CTS: Max tPeriod	80
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







15 Pattern Detect

15.1 Pattern detect Router Assembly

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 as part of TX, RX, LFPS testing. PRTS19/PRTS7 patterns can be detected measured at TP2.

Run the following command from the PowerShell window:

Command example:

```
.\USB4_SigTest.exe gen4 tx tp2 pattern_detect C:\SigTest\Waveforms\
agressor.bin none pattern_detect_result none
```

```
PS C:\SigTest> .\USB4_SigTest.exe gen4 tx tp2 pattern_detect C:\SigTest\Waveforms\agressor.bin none pattern_detect
**** SIGTEST Version: 0.92E ****
Running SIGTEST : Technology : GEN4, TestMode : TX, TestPoint : TP2
The following tests are in progress ...
Pattern Detect
Loading File: C:\SigTest\Waveforms\agressor.bin ....
Setting an Optimal CTLE index=0
ADP Equalized Enabled ...
Writing result to .\pattern_detect_result.csv
The tests are completed
```

Reports file location:

Local Disk (C:) > SigTest >				▼	🔄	Search SigTest
Name	Date modified	Type	Size			
Waveforms	28/05/2024 15:02	File folder				
pattern_detect_result	28/05/2024 14:16	Microsoft Excel C...	1 KB			
USB4_SigTest.exe	28/05/2024 8:53	Application	24,252 KB			

The .csv file pattern_detect_result.csv as a results example

Electrical Compliance Test Specification for GEN4																				
Date:	01-Jun-24																			
DIR:	C:\SigTest\Waveforms\																			
File:	agressor.bin																			
Informative:	Symbol Rate [GHz]	25.558775 Drift [PPM] -1610.35																		
Pattern-PRTS19	Detected(100.000000%): GF(3)																			
Polynomial Power:[	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19]
G(x) Generator Polynomial Coefficient:[	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2]
]																				
Logic	Level																			
	0	-1																		
	1	0																		
	2	1																		
V_SWING Measurement [mV]:	365.9																			

15.2 Pattern detect Captive Device

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 as part of TX, RX, LFPS testing. PRTS19/PRTS7 patterns can be detected measured at TP2.

Run the following command from the PowerShell window:

```

Command Example:
.\USB4_SigTest.exe gen4 tx tp3_captive pattern_detect
C:\SigTest\Waveforms\ aggressor_captive.bin none
pattern_detect_captive_result none

```

```
C:\SigTest>.\USBSigTest.exe gen4 tx tp3_captive_pattern_detect C:\SigTest\Waveforms\aggressor_captive.bin none pattern_detect_captive_result none
***** SIGTEST Version: 0.97 *****
Running SIGTEST : Technology : GEM5, TestMode : TX, TestPoint : TP3_CAPTIVE
The following tests are in progress ...
Pattern Detect
Loading File: C:\SigTest\Waveforms\aggressor_captive.bin ....
Setting an Optimal CILE Index=9
OP Equilized Enabled ...
Writing result to .\pattern_detect_captive_result_result.csv
The tests are completed
```

Reports file location:

Name	Date modified	Type	Size
Waveforms	28/05/2024 15:02	File folder	
pattern_detect_result	28/05/2024 14:16	Microsoft Excel C...	1 KB
USB4_SigTest.exe	28/05/2024 8:53	Application	24,252 KB

The .csv file pattern_detect_result.csv as a results example

Electrical Compliance Test Specification for GEN4					
Date:	20-Aug-24				
DIR:	C:\SigTest\Waveforms\				
File:	aggressor_captive.bin				
Informative:					
Pattern-PRTS19					
Polynomial Power:{	Symbol Rate [GHz] Drift [PPM] -1209.23				
G(x) Generator Polynomial Coefficient{	Detected(100.000000%); GF(3)				
}					
Logic	Level				
	0	-1			
	1	0			
	2	1			
V_SWING Measurement [mV]:	496.8				