

# USB4 SIGTEST User Manual

Date: Jun , 2024

Revision: 0.9~~50~~

**Revision History:**

| Revision | Issue Date   | Comments  |
|----------|--------------|---|
| 0.5      | Feb 2022     | GEN2-3 – no change<br>Added guidance for GEN4 TX tests:<br>UI, SSC, Jitter, Vertical voltage tests, ACCM  |
| 0.7      | Mar 2022     | Added guidance for GEN4 TX tests:<br>EI, RL, IRL<br>Added guidance for GEN4 RX tests:<br>RX calibration at TP3', RL, IRL  |
| 0.72     | Apr 2022     | Added guidance for GEN4 RX tests:<br>RX calibration at TP3  |
| 0.83     | Dec 2022     | Editorial<br>Added GEN4 RX/TX frequency variation tests<br>Added Swing Attenuation analysis for presets40/41 in GEN4 TX txffe test<br>Removed GEN4 TX TX_PULSE_PEAK Measurement in ui_jitter_vertical test report   |
| 0.85     | Jan 2023     | Improved GEN4 txffe analysis accuracy<br>Fixed GEN4 TX_ISI_MARGIN analysis  |
| 0.86     | Feb-Mar 2023 | Editorial<br>Fixing EI test – Vpeak instead of ptp<br>Added missing comma in GEN4 test report – Informative: Symbol rate<br>Updated GEN4 RX stressed signal calibration section.<br>Added BERT Insertion Loss extraction procedure<br>Updated GEN4 RX channel calibration to worst case condition algorithm. Added allowed convergence conditions |
| 0.87     | Sep 2023     | Editorial<br>Updated TX GEN2/3 non-rounded SSC rate and phase deviation limits according to spec change<br>Added Aggressor's calibration procedure for GEN4 RX testing<br>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 <math>28.5 \pm 0.5\text{dB}</math>; 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 <math>0\text{dB} \pm 0.1\text{dB}</math></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> |
| <u>0.95</u> | Jun 2024 | <p>Updated RX GEN4 channel calibration to worst case condition test: fixed BERT IL extraction</p> <p>Updated TX GEN4 <u>tx frequency variation</u> function</p> <p>Updated TX_ISI_MARGIN limit according to ECR</p> <p>Updated LFPS RX calibration function</p> <p><u>Added Gen4 Pattern detect function</u></p>   |

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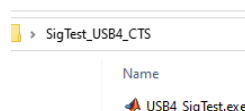
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## 1 Introduction

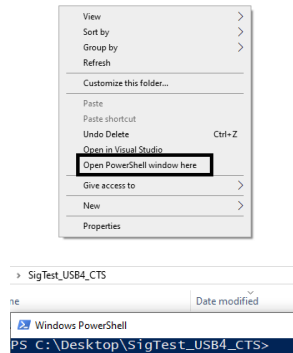
SigTest is the USB4 post-processing analysis software tool. SigTest is capable of rendering the signal quality measurements captured with the Oscilloscope. The post processed parameters are checked against the specified pass/fail criteria.

## 2 Installation and execution:

- System requirements:  
Minimum memory: 32GB RAM  
Recommended memory: 48GB RAM and higher.
- Install Matlab Runtime Compiler MCR R2021b.
- Run the executable .exe file:
  - Create folder, for example "SigTest\_USB4\_CTS"
  - Place the USB4\_SigTest.exe into the folder "SigTest\_USB4\_CTS"



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



## 3 Usage

### 3.1 Command template

USB4\_SigTest.exe technology test\_mode test\_point cts\_test\_name wdir file1 file2  
report\_name de\_embedding

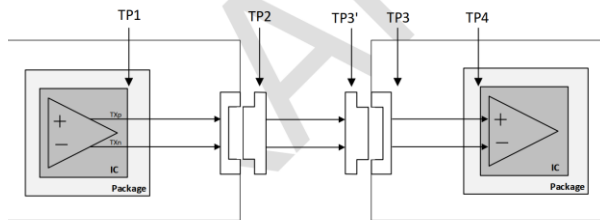
### 3.2 Input arguments list

1. technology = **gen2\_rounded/gen2\_legacy/gen3\_rounded/gen3\_legacy/gen4**

SigTest supports all USB4 bitrates:

**gen2\_rounded** = 10Gb/s  
**gen3\_rounded** = 20Gb/s  
**gen2\_legacy** = 10.3125Gb/s  
**gen3\_legacy** = 20.625Gb/s  
**gen4** = 25.6Gb/s

2. test\_mode = **tx/rx**  
**tx** - SigTest supports the transmitter Router Assembly compliance tests.  
**rx** - SigTest supports the receiver Router Assembly stressed eye calibration.
3. test\_point = **tp2/tp3\_prime/tp3**  
 SigTest supports the Router Assembly compliance tests at following test points.



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

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

**tp3\_prime** (TP3' in the screenshot above) - receiver Router Assembly stressed eye calibration test point. No de-embedding / embedding is required.

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

4.

**Gen2-3** cts\_test\_name =

**ui\_ssc\_eye/rise\_fall\_time/jitter/ac\_common\_mode/transmitter\_equalization/electrical\_idle\_voltage/tx\_frequency\_variation\_training/tp3**

**ui\_ssc\_eye** – the test done using PRBS31 pattern and includes the following transmitter compliance tests: Minimum Unit Interval, SSC\_Down\_Spread\_Range, SSC\_Down\_Spread\_Rate, SSC\_Phase\_Deviation, SSC\_Slew\_Rate, Eye Diagram Measurement ( including eye height and eye width measurements ).

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

**rise\_fall\_time** – the test done using SQ128 pattern and includes the following transmitter compliance tests: Rise Time, Fall Time.

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

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

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

**ac\_common\_mode** – the test done using PRBS31 pattern and includes the following transmitter compliance test: AC\_CM.

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

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

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

**electrical\_idle\_voltage** - the test done when the DUT is in electrical idle mode and includes the following transmitter compliance test: V\_ELEC\_IDLE.

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

**tx\_frequency\_variation\_training** - the test done using several patterns PRBS31, SQ128, SQ4 as described in the CTS section 3.3.7.4 and includes the following transmitter compliance test: INIT\_FREQ\_VARIATION, DELTA\_FREQ\_200ns, DELTA\_FREQ\_1000ns.

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

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

**Gen4** cts\_test\_name =

**txffe\_test/ui\_jitter\_vertical/ac\_common\_mode/electrical\_idle\_voltage/rl/calibration/calibration\_bert\_il\_extraction/tx\_frequency\_variation/rx\_frequency\_variation**

cts\_test\_name description embedded per command

5. wdir = waveform\_directory

**wdir** – the full path to the waveform location

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

## 4 Scope settings

### 4.1 Data acquisition setting

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



## 4.2 Cable assembly de-embedding/embedding

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

Test mode: Tx, Test point: TP2

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

Test mode: Tx, Test point: TP3

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

Test mode: Rx, Test point: TP3 Prime

- No de-embedding and no embedding shall be applied

Test mode: Rx, Test point: TP3

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

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

## 5 GEN2-3 Router Assembly Transmitter Testing

### 5.1 General notes

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

### 5.2 TP2

1. cts\_test\_name - **ui\_ssc\_eye**

Run the following command from the PowerShell window:





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

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

Report files location:

SigTest\_USB4\_CTS

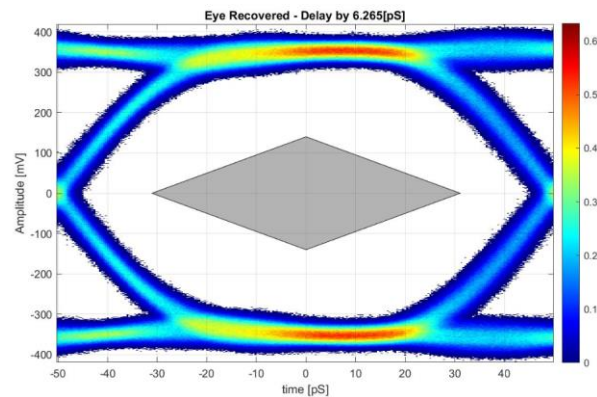
Name

 ui\_ssc\_eye\_result\_21-Oct-2020.csv  
 eye\_diagram\_gen2\_rounded\_tp2\_ui\_ssc\_eye.jpg  
 tie\_period\_frequency\_gen2\_rounded\_tp2\_ui\_ssc\_eye.jpg  
 USB4\_SigTest.exe

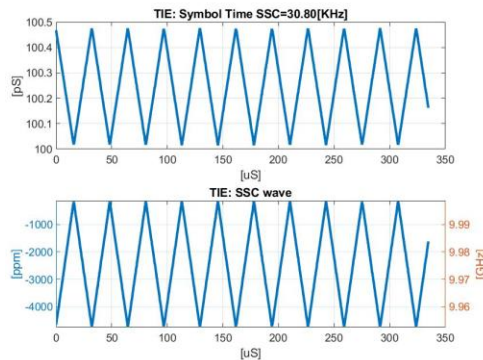
- 1.1.1. The .CSV file ui\_ssc\_eye\_result\_21-Oct-2020.csv

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

1.2. The .jpg file eye\_diagram\_gen2\_rounded\_tp2\_ui\_ssc\_eye.jpg



1.3. The .jpg file tie\_period\_frequency\_gen2\_rounded\_tp2\_ui\_ssc\_eye.jpg



## 2. cts\_test\_name - rise\_fall\_time



Run the following command from the PowerShell window:

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

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

Report files location:

## SigTest\_USB4\_CTS

| Name  |
|---|
|  rise_fall_time_result_21-Oct-2020.csv |
|  USB4_SigTest.exe                      |

2.1. The .CSV file gen2\_rounded\_rise\_fall\_time\_result\_21-Oct-2020.csv

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

## 3. cts\_test\_name – jitter





Run the following command from the PowerShell window:

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

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

Report files location:

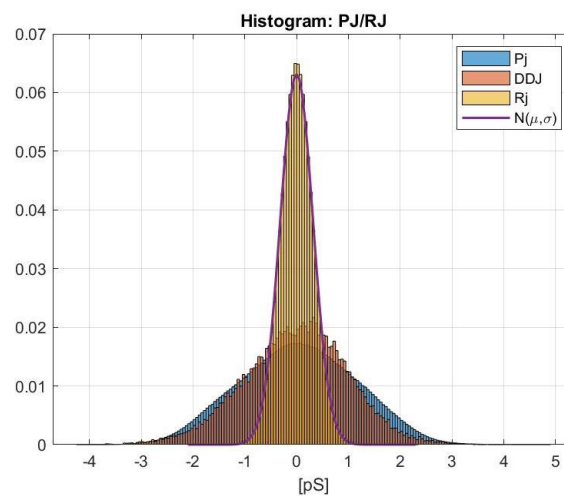
## SigTest\_USB4\_CTS

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

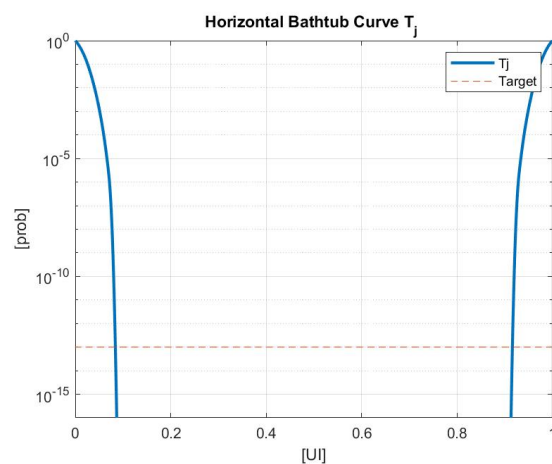
3.1. The .CSV file jitter\_result\_21-Oct-2020.csv

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

3.2. The .jpg file histogram\_pj\_rj\_ddj\_gen2\_rounded\_tp2\_jitter.jpg



3.3. The .jpg file tj\_bathtub\_gen2\_rounded\_tp2\_jitter.jpg



4. cts\_test\_name - **ac\_common\_mode**

Run the following command from the PowerShell window:


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


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

Report files location:

SigTest\_USB4\_CTS

Name

 ac\_common\_mode\_result\_21-Oct-2020.csv

 USB4\_SigTest.exe

4.1. The .CSV file ac\_common\_mode\_result\_21-Oct-2020.csv

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

5. cts\_test\_name - **electrical\_idle\_voltage**

Run the following command from the PowerShell window:



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

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

Report files location:

## SigTest\_USB4\_CTS

### Name

 electrical\_idle\_voltage\_result\_21-Oct-2020.csv  
 USB4\_SigTest.exe

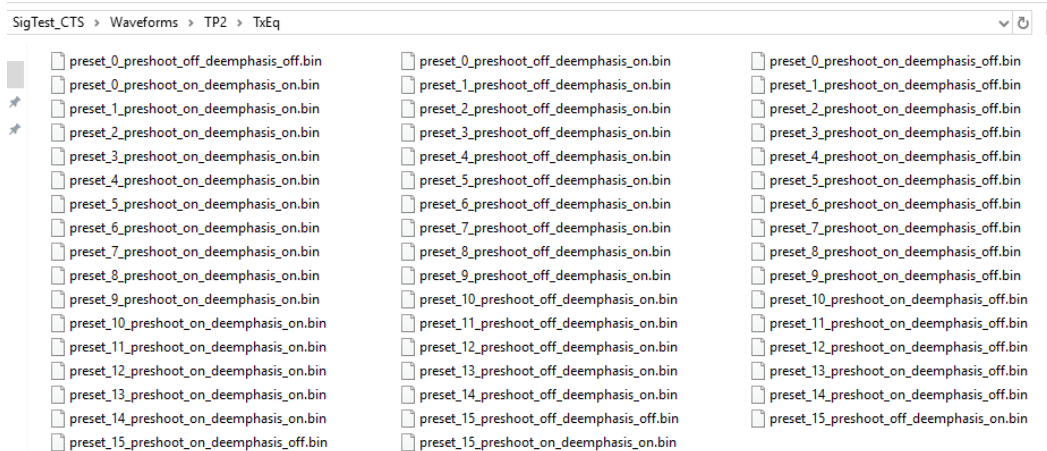
### 5.1. The .CSV file electrical\_idle\_voltage\_result\_21-Oct-2020.csv

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

## 6. cts\_test\_name - **transmitter\_equalization**

### Notes:

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



Run the following command from the PowerShell window:



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

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

Report files location:

SigTest\_USB4\_CTS

Name

 transmitter\_equalization\_result\_21-Oct-2020.csv  
 USB4\_SigTest.exe



### 6.1. The .CSV file transmitter\_equalization\_result\_21-Oct-2020.csv

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

### 7. cts\_test\_name – tx\_frequency\_variation\_training

Run the following command from the PowerShell window:




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

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

Report files location:

SigTest\_USB4\_CTS

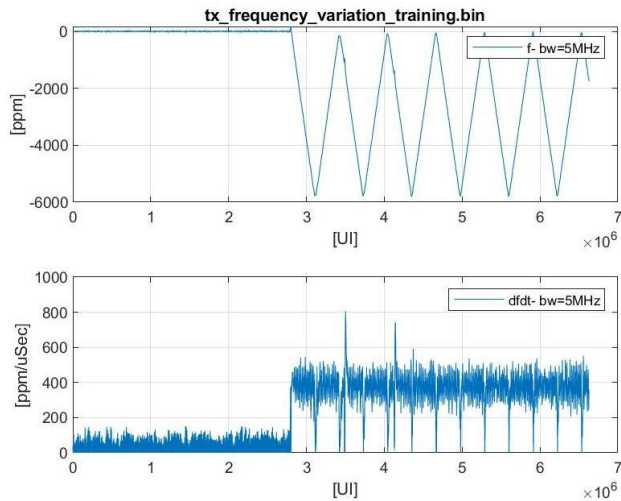
Name

 tx\_frequency\_variation\_training\_result\_22-Oct-2020.csv  
 clock\_switch\_analysis\_gen3\_rounded\_tp2\_tx\_frequency\_variation\_training.jpg  
 USB4\_SigTest.exe

### 7.1. The .csv file tx\_frequency\_variation\_training\_result\_22-Oct-2020.csv

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

- 7.2. The .jpg file  
clock\_switch\_analysis\_gen3\_rounded\_tp2\_tx\_frequency\_variation\_training.jpgz



## 5.3 TP3







### 8. cts\_test\_name – **tp3**

Notes:

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

SigTest\_USB4\_CTS > Waveforms > TP3

Name






-  tp3\_prbs15.bin
-  tp3\_prbs31\_trial\_1.bin
-  tp3\_prbs31\_trial\_2.bin
-  tp3\_prbs31\_trial\_3.bin
-  tp3\_prbs31\_trial\_4.bin
-  tp3\_prbs31\_trial\_5.bin

Run the following command from the PowerShell window:

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

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

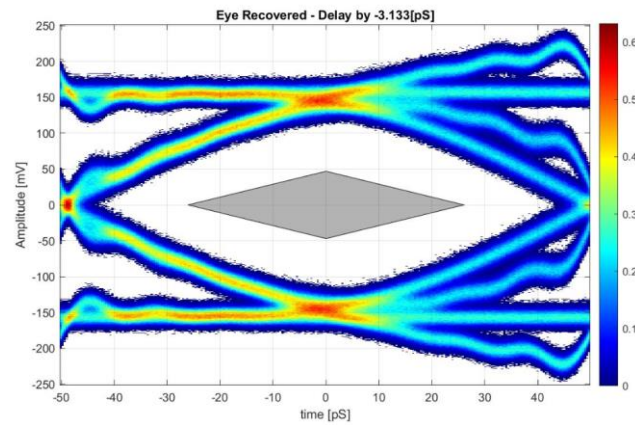
Report files location:

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

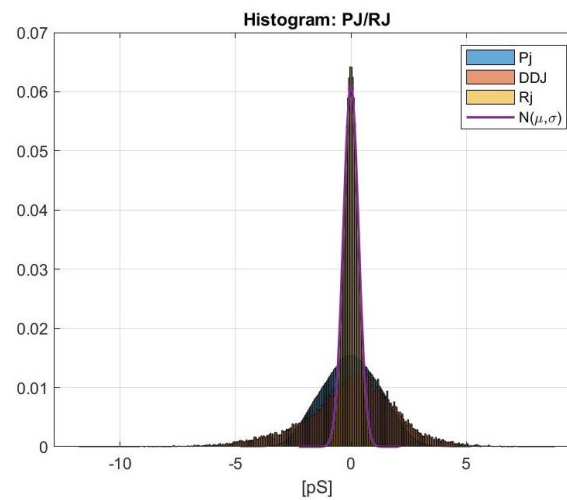
8.1. The .CSV file eye\_jitter\_result\_21-Oct-2020.csv

|   |           |                        |                      |               |                         |               |                |               |                |               |                |               |                 |                |             |
|---|-----------|------------------------|----------------------|---------------|-------------------------|---------------|----------------|---------------|----------------|---------------|----------------|---------------|-----------------|----------------|-------------|
| Electrical Compliance Test Specification for gen2_rounded |           |                        |                      |               |                         |               |                |               |                |               |                |               |                 |                |             |
| Date:   | 21-Oct-20 |                        |                      |               |                         |               |                |               |                |               |                |               |                 |                |             |
| Dir: C:\Desktop\SigTest_USB4_CTS\Waveforms\TP3\           |           |                        |                      |               |                         |               |                |               |                |               |                |               |                 |                |             |
| File: tp3.bin   |           |                        |                      |               |                         |               |                |               |                |               |                |               |                 |                |             |
| Total Jitter (BER=1e-13) Measurement Up-p:                | PASS      | TJ                     | 0.299601 CTS: Max TJ |               | 0.6                     |               |                |               |                |               |                |               |                 |                |             |
| UI Measurement Up-p:                                      | PASS      | UI Jitter Up-p         | 0.093693 CTS: Max UI |               | 0.31                    |               |                |               |                |               |                |               |                 |                |             |
| UI Measurement Up-p:                                      | PASS      | UI Jitter Up-p         | 0.094974 CTS: Max UI |               | 0.17                    |               |                |               |                |               |                |               |                 |                |             |
| Eye Diagram Measurements:                                 | PASS      | Eye Count of Violation | 0 EyeWidth [ps]      |               | 81.841387 EyeHeight[mV] |               | 207.027864     |               |                |               |                |               |                 |                |             |
| Informative: Symbol Rate [Ghz]                            | NONE      | Symbol Rate            | 9.975465 Drift [PPM] |               | -2453.53                |               |                |               |                |               |                |               |                 |                |             |
| CTLE-Adc[dB]  | 0         | DfE[mV]                | Eye Height[mV]       | Eye Width[ps] | Eye Height[mV]          | Eye Width[ps] | Eye Height[mV] | Eye Width[ps] | Eye Height[mV] | Eye Width[ps] | Eye Height[mV] | Eye Width[ps] | Avg. Height[mV] | Avg. Width[ps] | Area[mV*ps] |
| 1   | 0         | 50                     | 1.409                | 0.785         | 0.285                   | 1.175         | 0.318          | 1.175         | 1.457          | 0.783         | 0.315          | 0.783         | 0.76            | 0.94           | 0.64        |
| 0.891   | 1         | 48.2                   | 142.647              | 62.262        | 129.546                 | 59.129        | 140.216        | 63.437        | 141.373        | 61.479        | 136.547        | 61.479        | 138.07          | 61.557         | 8504.51     |
| 0.794   | 2         | 42                     | 170.9                | 71.269        | 162.341                 | 70.877        | 172.953        | 70.485        | 172.992        | 70.485        | 168.59         | 70.485        | 169.56          | 70.72          | 11990.66    |
| 0.708   | 3         | 36.7                   | 197.61               | 78.317        | 191.643                 | 77.925        | 199.418        | 79.883        | 198.652        | 80.275        | 194.414        | 79.1          | 196.35          | 79.1           | 15533.05    |
| 0.631   | 4         | 32                     | 208.352              | 82.233        | 205.568                 | 80.667        | 206.991        | 81.058        | 208.858        | 82.233        | 205.37         | 83.016        | 207.65          | 81.841         | 16949.65    |
| 0.562   | 5         | 27.8                   | 196.69               | 80.275        | 195.141                 | 82.233        | 197.331        | 83.016        | 199.43         | 82.625        | 194.596        | 81.45         | 196.64          | 81.92          | 16109.95    |
| 0.501   | 6         | 24                     | 185.353              | 76.751        | 182.983                 | 76.359        | 185.388        | 79.883        | 185.091        | 79.492        | 181.683        | 74.01         | 184.1           | 77.299         | 14235.46    |
| 0.447   | 7         | 20.7                   | 170.463              | 70.877        | 168.146                 | 72.443        | 172.005        | 72.443        | 171.527        | 71.269        | 168.334        | 72.052        | 170.09          | 71.817         | 12215.35    |
| 0.398   | 8         | 17.8                   | 154.847              | 66.57         | 153.365                 | 67.744        | 156.741        | 67.744        | 156.386        | 67.744        | 154.618        | 67.744        | 155.19          | 67.509         | 10476.95    |
| 0.355   | 9         | 15.2                   | 138.71               | 62.262        | 139.772                 | 61.87         | 142.913        | 63.045        | 140.059        | 63.828        | 140.079        | 63.045        | 140.31          | 62.81          | 8815.04     |
| Optimal CTLE: 4   |           |                        |                      |               |                         |               |                |               |                |               |                |               |                 |                |             |

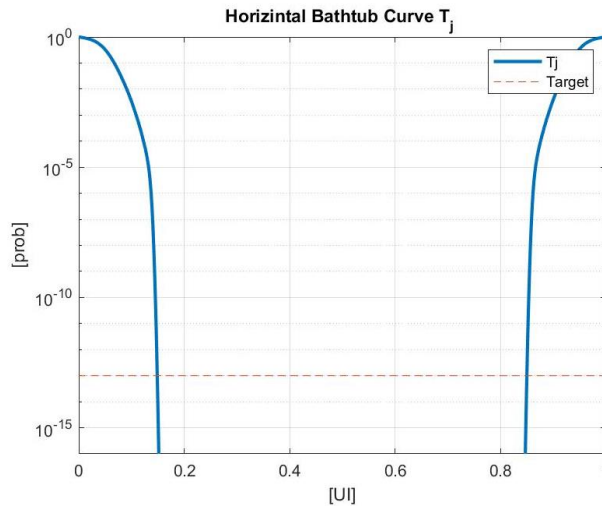
8.2. The .jpg file eye\_diagram\_gen2\_rounded\_tp3\_eye\_jitters.jpg



8.3. The .jpg file histogram\_pj\_rj\_ddj\_gen2\_rounded\_tp3\_eye\_jitters.jpg



8.4. The .jpg file tj\_bathtub\_gen2\_rounded\_tp3\_eye\_jitters.jpg



## 6 GEN4 Router Assembly Transmitter Testing

### 6.1 Oscilloscope intrinsic noise cancelation

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

scope\_intrinsic\_noise file shall be located in wdir (waveforms location)

### 6.2 TP2

The following section describes the usage of USB4 SigTest commands for TX GEN4 according to cts\_test\_name

#### 6.2.1 txffe\_test

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

Run the following command from the PowerShell window:

**Command example for differential signal:**

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

```

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

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 none
***** SIGTEST Version: 0.83 *****
Running SIGTEST : Technology : GEN4, TestMode : TX, TestPoint : TP2
The following tests are in progress ...
TX-FFE Test
Loading Files: pam3_prts7_preset_0.trc ...

```

### Command example for single-ended signals:

```

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

```

Files name suffix shall be in following form *\_{{preset\_num}}\_p* and *\_{{preset\_num}}\_n*

For example,

```

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

```

### Report files location:

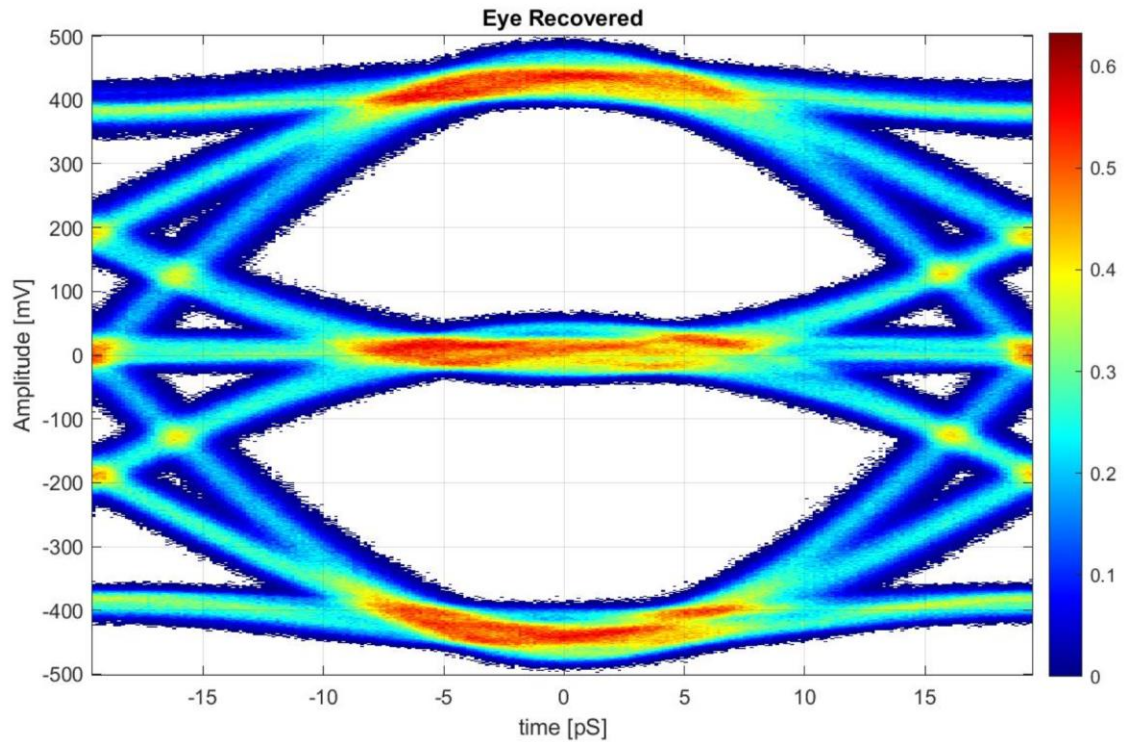
|   |                  |                       |          |
|---|------------------|-----------------------|----------|
|  Waveforms   | 17/12/2022 10:21 | File folder           |          |
|  tmp_sndr.txt                                      | 16/12/2022 17:25 | Text Document         | 1 KB     |
|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

### 8.5. The .csv file txffe\_test\_report\_result\_result.csv as a results example

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

In this example the best TX FFE preset is 6. The corresponding waveform shall be used for ui\_jitter\_vertical test

8.6. The .jpg file txffe\_test\_report\_result\_eye\_diagram\_gen4\_tp2.jpg



### 6.2.2 ui\_jitter\_vertical

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

Run the following command from the PowerShell window:

**Command example:**

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












```

PS C:\SigTest_USB4_CTS> .\USB4_SigTest.exe gen4 tx tp2 ui_jitter_vertical C:\SigTest_USB4_CTS\Waveforms\txffe\ pam3_prts7_preset_19.bin none ui_ssc_jitter_vertical_report_result s.
parameter_for_deembedding.s4p
***** SIGTEST Version: 0.91 *****
Running SIGTEST : Technology : GEN4, TestMode : TX, TestPoint : TP2
The following tests are in progress ...
USB4 Gen4: UI,SSC,Jitters and Vertical
Loading File: C:\SigTest_USB4_CTS\Waveforms\txffe\pam3_prts7_preset_19.bin ....
TP2: De-Embedded s_parameter_for_deembedding.s4p File
>> SSC Estimated:
>> SSC Frequency 31.009544[Khz]
>> SSC Amplitude Harmonics[pS]:0.040223, 0.000244, 0.004257,
Writing ui_ssc_jitter_vertical_report_result_tie_period_frequency_gen4_tp2.jpg
>> UI_min = -2458.664460[ppm],max=-21.924875[ppm]
Writing ui_ssc_jitter_vertical_report_result_tj_bathub_gen4_tp2.jpg
Writing ui_ssc_jitter_vertical_report_result_histogram_pj_rj_ddj_gen4_tp2.jpg
>>> PRTS LOCKED !!!
Number of symbol: #11497292,BER: = 0
Distortion Noise: Without removal O/E jitter =2.89[mVrms], with removal O/E=2.70[mVrms], O/E =1.03[mVrms]
Informative:Intrinsic Scope Noise = 0.000[mV-rms]
TX LEVELS MISMATCH = 0.998
TX LEVEL = +200.5[mV]
TX LEVEL = -0.4[mV]
TX LEVEL = -200.4[mV]
V_Steady-State = +200.7[mV]
TX_SNR = 34.1[dB]
TX_ISI_MARGIN = 9.2[dB]
TX Budget: Dist=2.7[mV], Noise=3.1[mV] total= 4.1[mV]
PulsePeak=0.200411[V]
Attenuation=-4.1071[dB],F=12.800000[GHz]
PAM-3, Eye(1):EyeHeight=84.8[mV], EyeWidth=0.371[UI]=14.5[pS]
PAM-3, Eye(2):EyeHeight=79.6[mV], EyeWidth=0.348[UI]=13.6[pS]
PAM-3:EyeHeight=79.6[mV], EyeWidth=0.348[UI]=13.6[pS]
Writing ui_ssc_jitter_vertical_report_result_eye_diagram_gen4_tp2.jpg
Writing result to .ui_ssc_jitter_vertical_report_result.csv
The tests are completed

```

## Report files location:

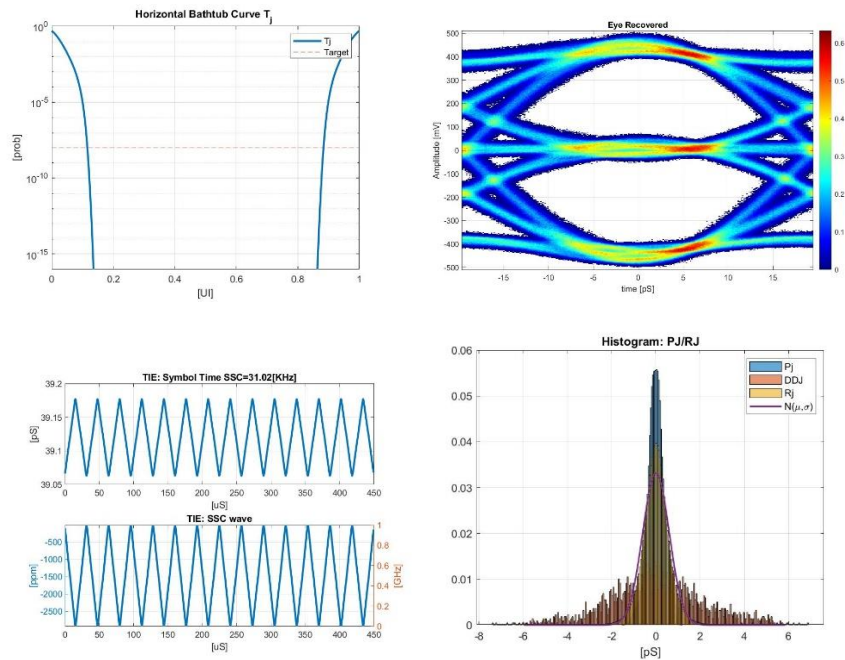
|   |  |                  |                      |           |
|---|--|------------------|----------------------|-----------|
|    | Waveforms  | 18/04/2024 15:01 | File folder          |           |
|    | s_parameter_for_deembedding.S4P                  | 25/04/2023 13:05 | S4P File             | 738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

Note: scope\_intrinsic\_noise.bin/trc/wfm shall be placed at the same location as best preset waveform

8.7. The .csv file ui\_ssc\_jitter\_vertical\_report\_result.csv as a results example

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

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



## 6.2.3 tx\_frequency\_variation

This function calculates USB4 v2 GEN4 Tx Frequency Variation parameters





Run the following command from the PowerShell window:

### Command example:

```
.\USB4_SigTest.exe gen4 tx tp2 frequency_variation_training  
C:\SigTest USB4 CTS\Waveforms tx_frequency_variation.bin none  
tx_frequency_variation_report s_parameter_for_deembedding.s4p
```

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

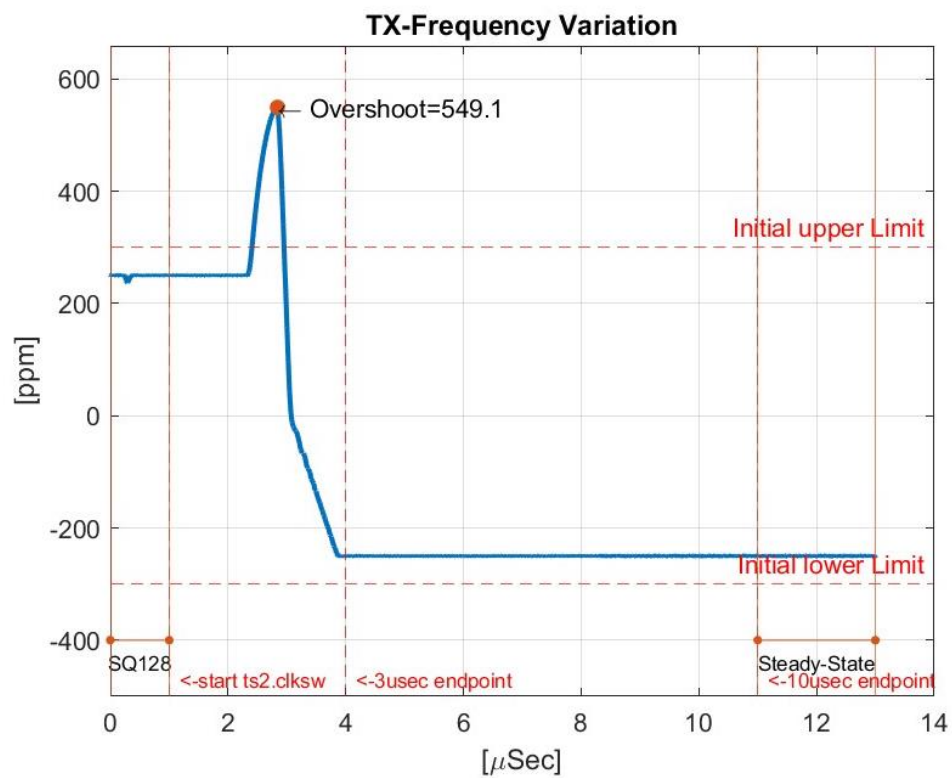
### Report files location:

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

The .csv file tx\_frequency\_variation\_report\_result.csv as a results example

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

The SIGTEST saves the following plot (.jpg format)



## 6.2.4 electrical\_idle\_voltage

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

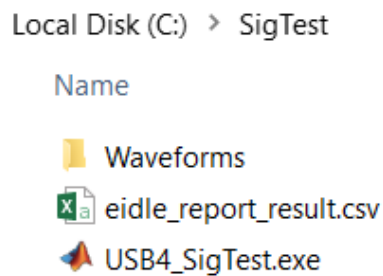
Run the following command from the PowerShell window:

### Command example:

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

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

Report file location:



eidle\_report\_result.csv as a result example

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

## 6.2.5 ac\_common\_mode

This function calculates AC\_CM using PRTS7 pattern and includes the following transmitter compliance test: AC\_CM

Run the following command from the PowerShell window:

### Command example:

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

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

### 5.1.1 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 |

|   |                                   |                    |      |                        |     |
|---|-----------------------------------|--------------------|------|------------------------|-----|
| Electrical Compliance Test Specification for GEN4 |                                   |                    |      |                        |     |
| Date:   | 6-Feb-22                          |                    |      |                        |     |
| DIR:  | C:\EV_WORK\USB4SIG\main\run_pam3\ |                    |      |                        |     |
| File:   | pam3_prts7_preset_4common.bin     |                    |      |                        |     |
| AC CM Measurement:                                | PASS                              | AC CM: Vac [mVp2p] | 82.1 | 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\
C:\SigTest\Waveforms\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\
C:\SigTest\Waveforms\ none none rl_report none
pam3_prts7_preset_19_s2p.s2p
```

```
PS C:\SigTest> .\USB4_SigTest.exe gen4 tx tp2 rl C:\SigTest\Waveforms\ pam3_prts7_preset_19.bin
none rl_report none pam3_prts7_preset_19_s2p.s2p
***** SIGTEST Version: 0.72 *****
Running SIGTEST : Technology : GEN4, TestMode : TX, TestPoint : TP2
The following tests are in progress ...
Transmitter Return Loss & Integrated Return Loss
Loading File: C:\SigTest\Waveforms\pam3_prts7_preset_19.bin ....
Loading File: C:\SigTest\Waveforms\scope_intrinsic_noise.bin ...
Informative: Intrinsic Scope Noise = 1.473[mV-rms]
TX LEVELS MISMATCH = 0.999
TX LEVEL = +165.6[mV]
TX LEVEL = -0.2[mV]
TX LEVEL = -165.6[mV]
V_Steady-State = +187.7[mV]
TX_PULSE_PEAK = +165.6[mV]
TX_SNR = 34.7[dB]
TX_ISI_MARGIN = 12.0[dB]
TX Budget: Dist=2.7[mV], Noise=1.4[mV] total= 3.0[mV]
Error After ISI reduction Statistic information:
Reading S parameters File: C:\SigTest\Waveforms\pam3_prts7_preset_19_s2p.s2p ..
IRL=-36.0[dB]
Writing rl_report_transmitter_differential_tx12_return_loss_gen4_tp2.jpg
Writing result to .\rl_report_result.csv
The tests are completed
```

```
PS C:\SigTest\USB4_CTS> .\USB4_SigTest.exe gen4 tx tp2 rl C:\SigTest\USB4_CTS\Waveforms\rl\ pam3_prts7_preset_19.bin none rl_report none pam3_prts7_preset_19_s2p.s2p
***** SIGTEST Version: 0.91 *****
Running SIGTEST : Technology : GEN4, TestMode : TX, TestPoint : TP2
The following tests are in progress ...
Transmitter Return Loss & Integrated Return Loss
Loading File: C:\SigTest\USB4_CTS\Waveforms\rl\pam3_prts7_preset_19.bin ....
Distortion Noise: without removal O/E jitter =2.15[mVrms], with removal O/E=1.56[mVrms], O/E =1.47[mVrms]
Informative: Intrinsic Scope Noise = 0.000[mV-rms]
TX LEVELS MISMATCH = 0.999
TX LEVEL = +136.3[mV]
TX LEVEL = -0.2[mV]
TX LEVEL = -136.3[mV]
V_Steady-State = +144.1[mV]
TX_SNR = 37.0[dB]
TX_ISI_MARGIN = 7.8[dB]
TX Budget: Dist=1.6[mV], Noise=1.1[mV] total= 1.9[mV]
PulsePeak=0.136303[v]
Attenuation=-4.601[dB],F=12.800000[GHz]
Reading S parameters File: C:\SigTest\USB4_CTS\Waveforms\rl\pam3_prts7_preset_19_s2p.s2p ..
The C:\SigTest\USB4_CTS\Waveforms\rl\pam3_prts7_preset_19_s2p.s2p Sparameters is normalized to 42.500000[Ohm]
IRL=-12.5[dB]
Writing rl_report_transmitter_differential_return_loss_gen4_tp2.jpg
Writing result to .\rl_report_result.csv
The tests are completed
```

2. report file location:

Local Disk (C:) > SigTest

Name

- Waveforms
- rl\_report\_result.csv
- rl\_report\_transmitter\_differential\_tx12\_return\_loss\_gen4\_tp2.jpg
- tmp\_sndr.txt
- USB4\_SigTest.exe

### 3. rl\_report\_result.csv as a result example

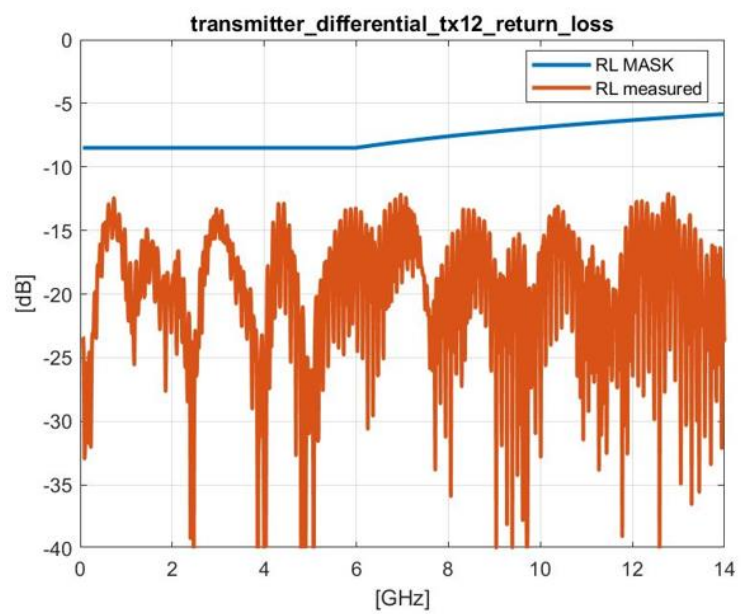
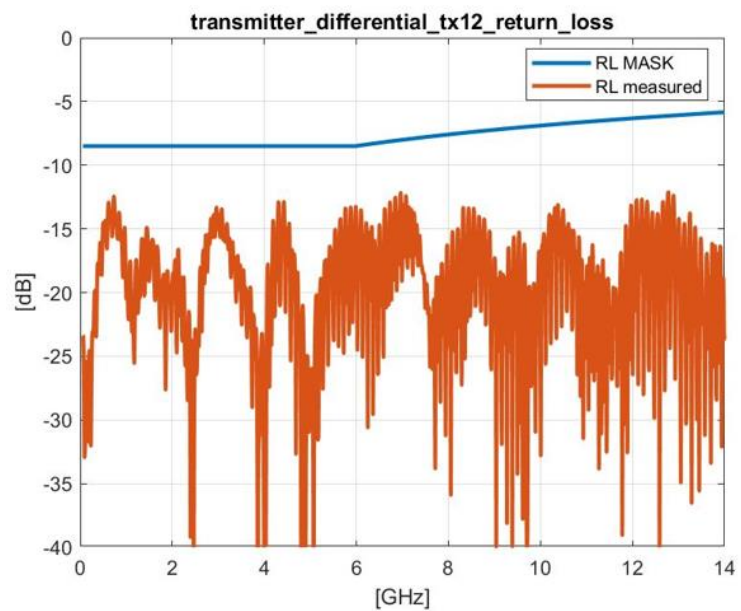
|   |                          |             |            |              |            |          |
|---|--------------------------|-------------|------------|--------------|------------|----------|
| Electrical Compliance Test Specification for GEN4 |                          |             |        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

- Sdd22 max[dB] indicates closest to spec mask absolute RL result
- Sdd22 MASK indicates RL pass/fail criteria
- Margin[dB] indicates the delta between absolute RL result to spec mask
- Fmax[GHz] indicates the frequency of the closest to spec mask absolute RL result
- IRL[dB] indicates calculated IRL
- IRL indicates IRL pass/fail criteria
- CTS: Max IRL indicates the IRL spec limit calculated using corresponding TX\_ISI\_Margin[dB]

### 4. rl\_report\_transmitter\_differential\_tx12\_return\_loss\_gen4\_tp2.jpg

Return Loss plot with spec mask





## 7 GEN2-3 Router Assembly Receiver stressed eye calibration

### 7.1 General notes

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

### 7.2 TP3' – Case1

- 1. cts\_test\_name – **jitter**

The test below shall be used for the following calibrations:

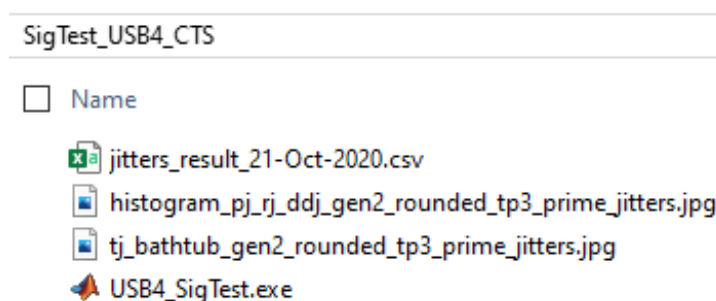
- a) 4.2.1.1 Data Dependent Jitter - DDJ calibration
- b) 4.2.1.3 Random Jitter - RJ calibration
- c) 4.2.1.4 Periodic Jitter - PJ calibration
- d) 4.2.1.5 Total Jitter - TJ calibration

Run the following command from the PowerShell window:

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

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

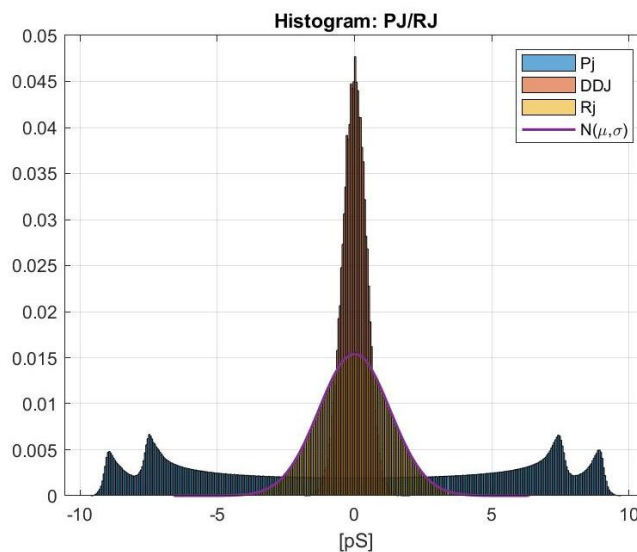
Report files location:



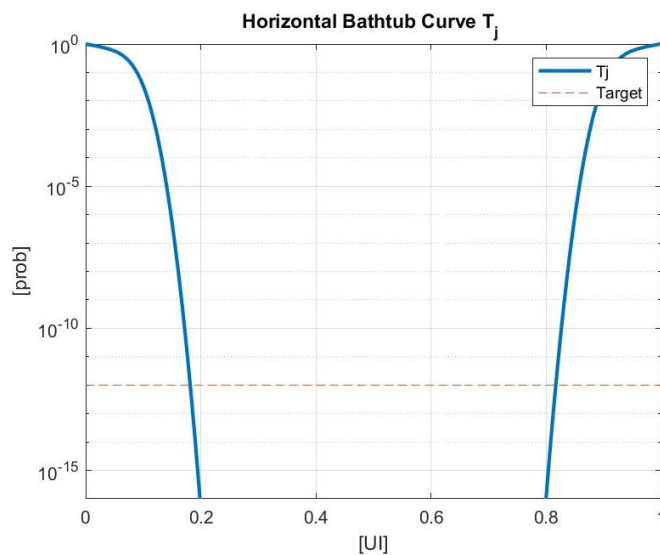
- 1.1.1. The csv. File jitters\_result\_21-Oct-2020.csv

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

1.2. The .jpg file histogram\_pj\_rj\_ddj\_gen2\_rounded\_tp3\_prime\_jitters.jpg



1.3. The .jpg file tj\_bathtub\_gen2\_rounded\_tp3\_prime\_jitters.jpg



2. cts\_test\_name – **ac\_common\_mode**

The test below shall be used for the following calibration:

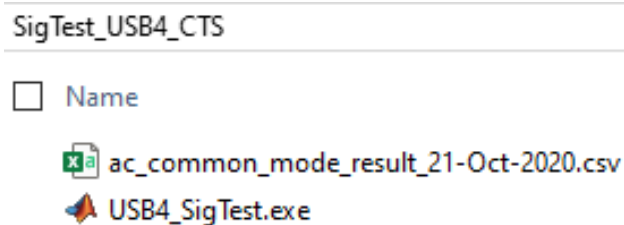
a) 4.2.1.2 AC Common Mode Measurements

Run the following command from the PowerShell window:

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

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

Report files location:



2.1. The .csv file ac\_common\_mode\_result\_21-Oct-2020.csv

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

3. cts\_test\_name – **ui\_ssc\_eye**

The test above shall be used for the following calibration:

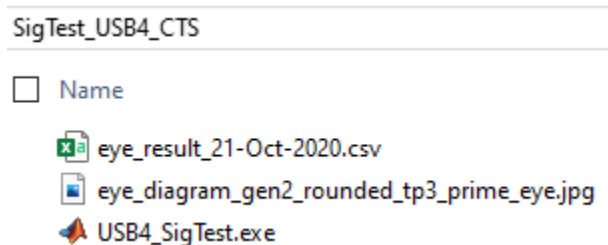
a) 4.2.1.6 Input Eye Diagram

Run the following command from the PowerShell window:

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

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

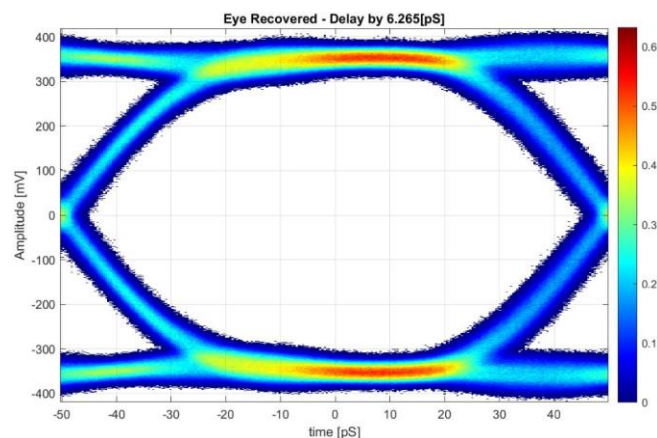
Report files location:



3.1. The .csv file eye\_result\_21-Oct-2020.csv

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

3.2. The .jpg file eye\_diagram\_gen2\_rounded\_tp3\_prime\_eye.jpg



4. cts\_test\_name – **frequency\_variation\_training**

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

Run the following command from the PowerShell window:

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

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

Report files location:

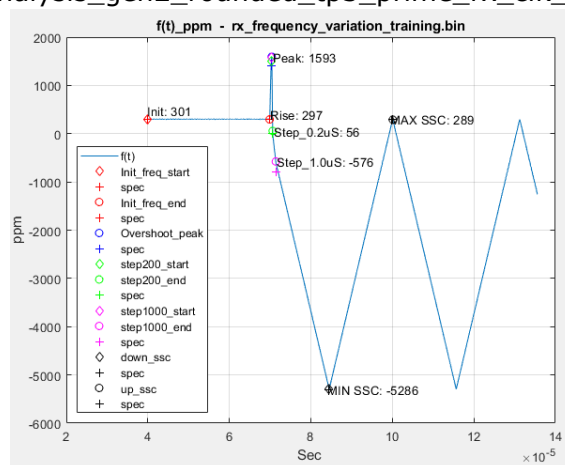
| Name  | Date modified     | Type                 | Size  |
|---|-------------------|----------------------|-------|
| rx_clk_switch_cal_result_21-Jul-2021.csv                              | 7/21/2021 3:40 PM | Microsoft Excel C... | 2 KB  |
| rx_clock_switch_analysis_gen2_rounded_tp3_prime_rx_clk_switch_cal.jpg | 7/21/2021 3:40 PM | JPG File             | 75 KB |
| rx_frequency_variation_training.bin                                   | 7/21/2021 3:33 PM | IPC File             | 46 KB |

#### 4.1. The .csv file rx\_clk\_switch\_cal\_result\_21-Jul-2021.csv

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

#### 4.2. The .jpg file

rx\_clock\_switch\_analysis\_gen2\_rounded\_tp3\_prime\_rx\_clk\_switch\_cal.jpg



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

.\USB4\_SigTest.exe gen3\_legacy rx **tp3** frequency\_variation\_training  
C:\Desktop\SigTest\_USB4\_CTS\Waveforms\TP3\ rx\_frequency\_variation\_training.bin  
none rx\_clk\_switch\_cal\_tp3 none

All same but over results the overshoot limit is 1400ppm

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

## 7.3 TP3 – Case2

### 4. cts\_test\_name – **tp3**

The test below shall be used for the following calibration:

#### a) 4.2.2.1 Input Eye Diagram

Notes:

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

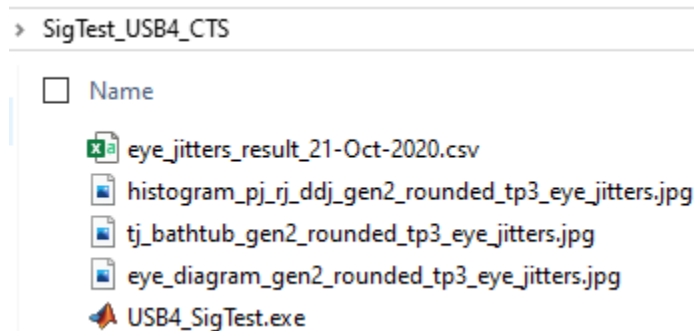
Run the following command from the PowerShell window:

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

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

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

Report files location:

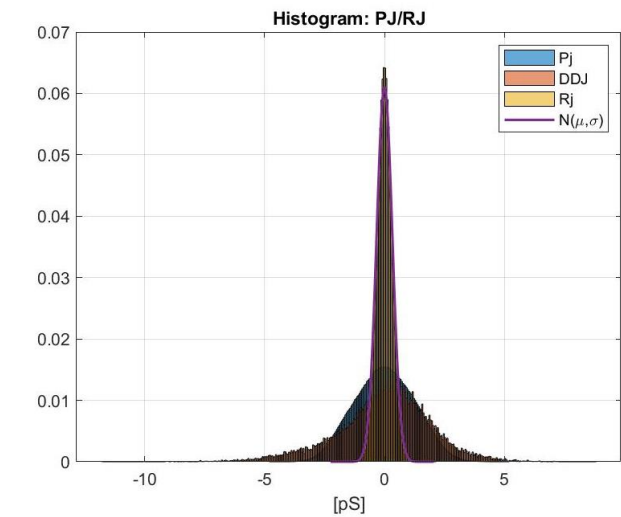




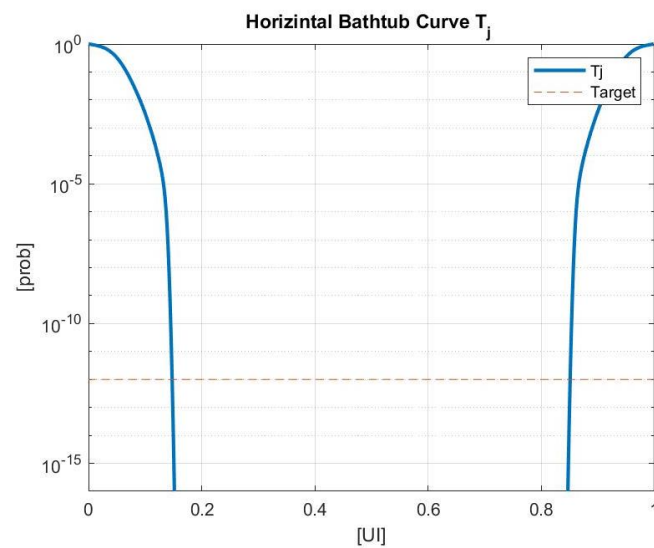
4.1. The .csv file eye\_jitters\_result\_21-Oct-2020.csv

|   |                  |           |                |               |                |               |                |               |                |               |                |               |                 |                |             |
|---|------------------|-----------|----------------|---------------|----------------|---------------|----------------|---------------|----------------|---------------|----------------|---------------|-----------------|----------------|-------------|
| Electrical Compliance Test Specification for gen2_rounded |                  |           |                |               |                |               |                |               |                |               |                |               |                 |                |             |
| Date: 25-Oct-20   |                  |           |                |               |                |               |                |               |                |               |                |               |                 |                |             |
| DIR:C:\Desktop\SigTest_USB4_CTS\Waveforms\TP3\Rx\         |                  |           |                |               |                |               |                |               |                |               |                |               |                 |                |             |
| File: tp3.bin   |                  |           |                |               |                |               |                |               |                |               |                |               |                 |                |             |
| Eye Diagram Measurement:                                  |                  |           |                |               |                |               |                |               |                |               |                |               |                 |                |             |
| Informative: Symbol Rate [Gbps]:                          |                  |           |                |               |                |               |                |               |                |               |                |               |                 |                |             |
| CTLE-Adc[dB]  |                  |           |                |               |                |               |                |               |                |               |                |               |                 |                |             |
|   | EyeWidth [ps]    | 81.841387 | EyeHeight[mV]  | 207.027864    | -2453.53       |               |                |               |                |               |                |               |                 |                |             |
|   | Symbol Rate      | 9.975465  | Drift [PPM]    |               |                |               |                |               |                |               |                |               |                 |                |             |
|   | CTLE-DC Gain[dB] | DPE[mV]   | Eye Height[mV] | Eye Width[ps] | Eye Height[mV] | Eye Width[ps] | Eye Height[mV] | Eye Width[ps] | Eye Height[mV] | Eye Width[ps] | Eye Height[mV] | Eye Width[ps] | Avg. Height[mV] | Avg. Width[ps] | Area[mV*ps] |
| 1   | 0                | 50        | 1.409          | 0.783         | 0.285          | 1.175         | 0.318          | 1.175         | 1.457          | 0.783         | 0.313          | 0.783         | 0.76            | 0.94           | 0.64        |
| 0.891   | 1                | 48.2      | 142.647        | 62.262        | 129.546        | 59.129        | 140.216        | 63.437        | 141.573        | 61.479        | 136.547        | 61.479        | 138.07          | 61.557         | 8504.51     |
| 0.794   | 2                | 42        | 170.9          | 71.269        | 162.341        | 70.877        | 172.953        | 70.485        | 172.992        | 70.485        | 168.59         | 70.485        | 169.56          | 70.72          | 11990.66    |
| 0.708   | 3                | 36.7      | 197.61         | 78.317        | 191.643        | 77.925        | 199.418        | 79.883        | 198.652        | 80.275        | 194.414        | 79.1          | 196.35          | 79.1           | 15533.05    |
| 0.631   | 4                | 32        | 208.352        | 82.233        | 205.568        | 80.667        | 206.991        | 81.058        | 208.858        | 82.233        | 205.37         | 83.016        | 207.03          | 81.841         | 16943.65    |
| 0.562   | 5                | 27.8      | 196.69         | 80.275        | 195.141        | 82.233        | 197.331        | 83.016        | 199.43         | 82.625        | 194.586        | 81.45         | 196.64          | 81.92          | 16108.95    |
| 0.501   | 6                | 24        | 185.353        | 76.751        | 182.983        | 76.359        | 185.388        | 79.883        | 185.091        | 79.492        | 181.683        | 74.01         | 184.1           | 77.299         | 14233.46    |
| 0.447   | 7                | 20.7      | 170.463        | 70.877        | 168.146        | 72.443        | 172.005        | 72.443        | 171.527        | 71.269        | 168.334        | 72.052        | 170.09          | 71.817         | 12215.35    |
| 0.398   | 8                | 17.8      | 154.847        | 66.57         | 153.365        | 67.744        | 156.741        | 67.744        | 156.386        | 67.744        | 154.618        | 67.744        | 155.19          | 67.509         | 10476.95    |
| 0.355   | 9                | 15.2      | 138.71         | 62.262        | 139.772        | 61.87         | 142.913        | 63.045        | 140.059        | 63.828        | 140.079        | 63.045        | 140.31          | 62.81          | 8813.04     |
| Optimal CTLE: 4   |                  |           |                |               |                |               |                |               |                |               |                |               |                 |                |             |

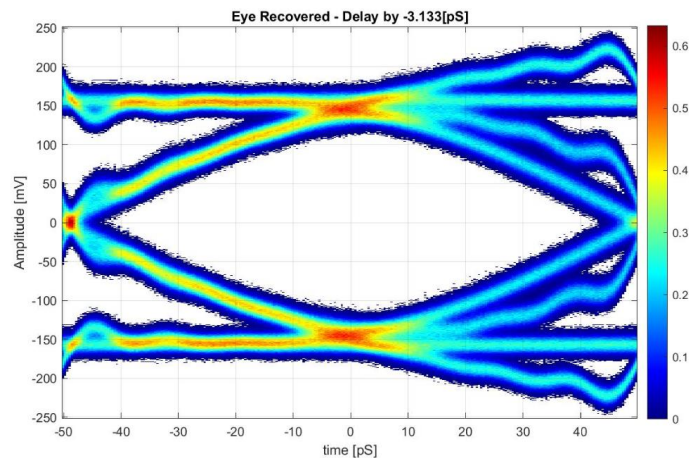
4.2. The .jpg file histogram\_pj\_rj\_ddj\_gen2\_rounded\_tp3\_eye\_jitters.jpg



4.3. The .jpg file tj\_bathtub\_gen2\_rounded\_tp3\_eye\_jitters.jpg



4.4. The .jpg file eye\_diagram\_gen2\_rounded\_tp3\_eye\_jitters.jpg



## 8 GEN4 Router Assembly Receiver Testing

### 8.1 General notes

This section describes commands list for Receiver testing

### 8.2 Oscilloscope intrinsic noise cancelation

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

scope\_intrinsic\_noise\_p and scope\_intrinsic\_noise\_n files shall be located in wdir (waveforms location)

### 8.3 GEN4 Router Assembly Receiver stressed signal calibration

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

#### 8.3.1 TP3' for Case1 and BERT output calibration for Case2

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

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

1. cts\_test\_name – **calibration**
2. test\_point = **tp3\_prime**

1. Run the following command from the PowerShell window:

## Command example:

.\USB4\_SigTest.exe gen4 rx tp3\_prime calibration C:\SigTest\Waveforms\  
p\_prts7\_preset\_0.bin n\_prts7\_preset\_0.bin calibration\_report none

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

## 2. Report files location:

Local Disk (C:) > SigTest

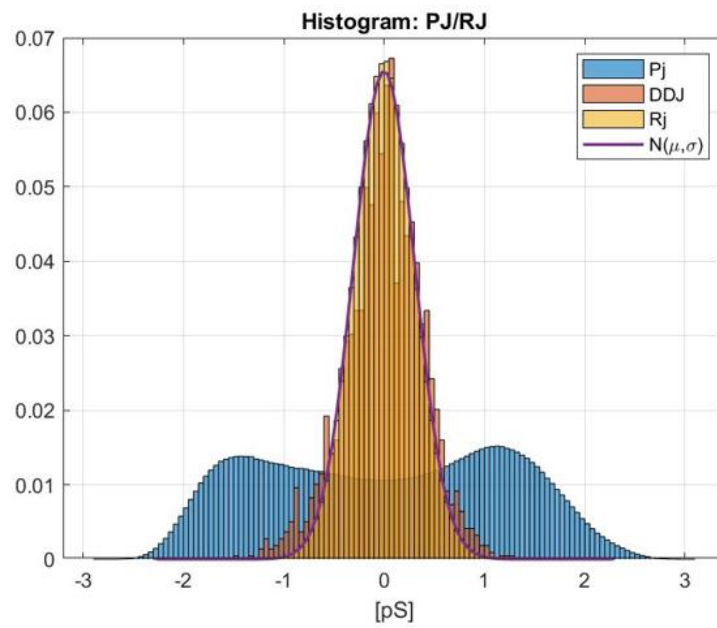
Name

- Waveforms
- calibration\_report\_histogram\_pj\_rj\_ddj\_gen4\_tp3\_prime.jpg
- calibration\_report\_result.csv
- calibration\_report\_tj\_bathtub\_gen4\_tp3\_prime.jpg
- tmp\_sndr.txt
- USB4\_SigTest.exe

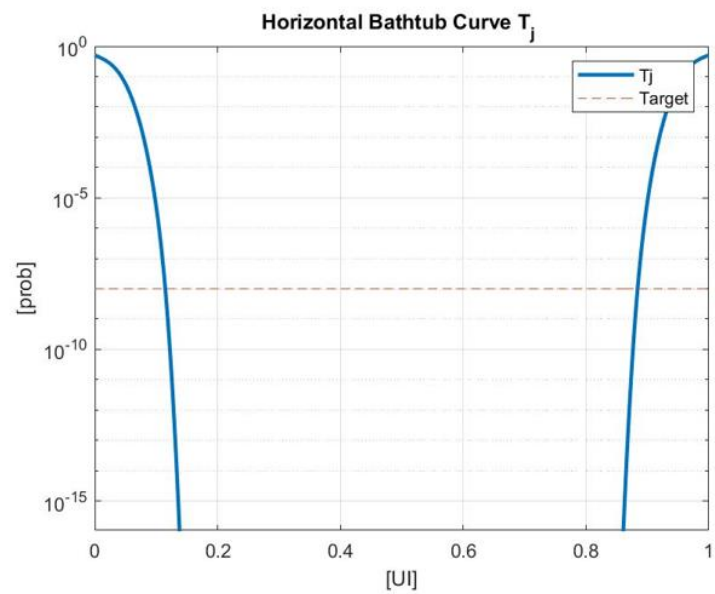
## 3. calibration\_report\_result.csv report file as an example

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

## 4. calibration\_report\_histogram\_pj\_rj\_ddj\_gen4\_tp3\_prime.jpg



5. calibration\_report\_tj\_bathtub\_gen4\_tp3\_prime.jpg



### 8.3.2 BERT Insertion Loss extraction

This procedure shall be used for BERT Insertion Loss extraction purpose and shall be used in Test\_Channel Insertion Loss target estimation

Input file for analysis is:

- BERT\_Sdd21.[scope format]

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

Output excel report includes:

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

1. cts\_test\_name – **calibration\_bert\_il\_extraction**
2. test\_point = **tp3**

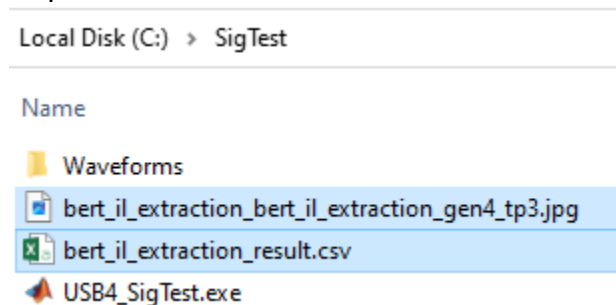
1. Run the following command from the PowerShell window:

**Command example:**

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

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

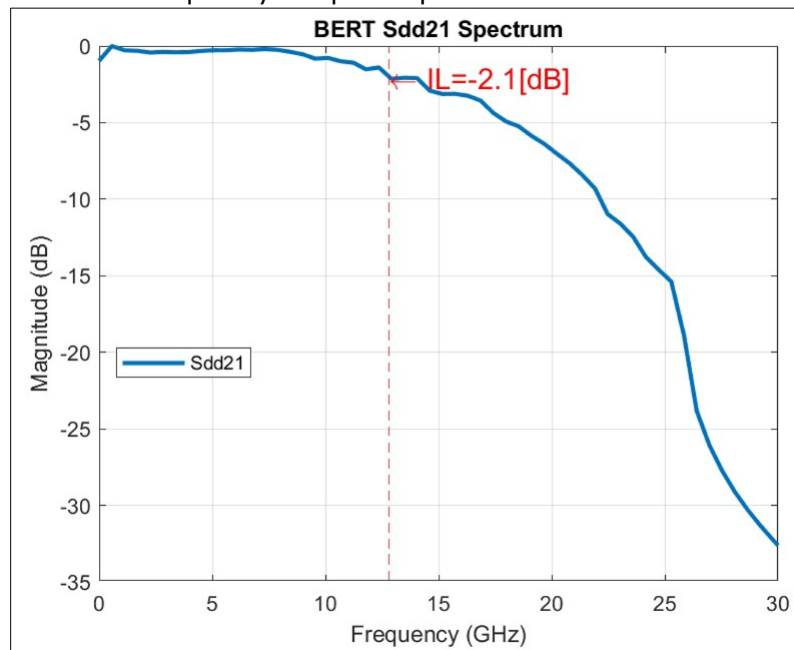
2. Report files location:



3. Bert\_il\_extraction.csv

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

#### 4. BERT Frequency Response plot

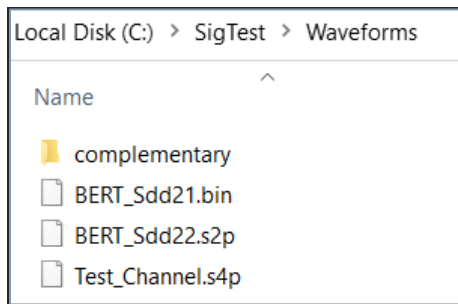


### 8.3.3 Channel calibration to worst case condition

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

Input files for analysis are:

- Test\_Channel.s4p
- BERT\_Sdd22.s2p
- BERT\_Sdd21.[scope format]
- complementary (folder)



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

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

- End-2-End channel insertion loss at Nyquist
- TX\_SJ\_increase [SJ magnitude increase ]
- ECOM convergence initial value
- ECOM convergence final value

1. cts\_test\_name – **calibration**
2. test\_point = **tp3**

1. Run the following command from the PowerShell window:

**Command example:**

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

```

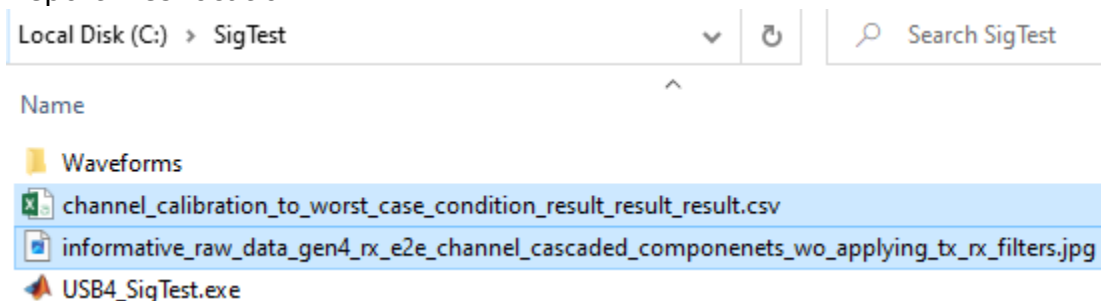
PS C:\SigTest> .\USB4_SigTest.exe gen4 rx tp3 calibration C:\SigTest\waveforms\BERT_Sdd21.bin none channel_calibration_to_worst_case_co
ndition_result_result.csv none none
***** SIGTEST Version: 0.9a *****
Running SIGTEST : Technology : GEN4, TestMode : RX, TestPoint : TP3
The following tests are in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

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

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

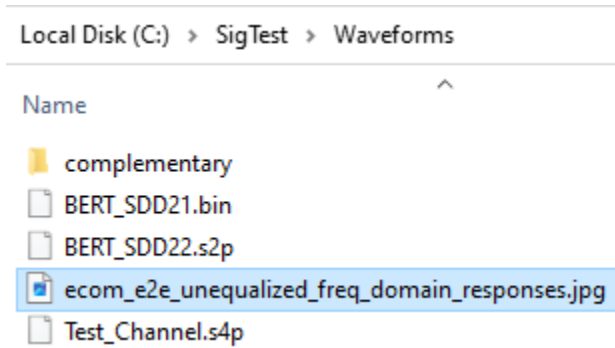
```

## 2. Report files location:



And

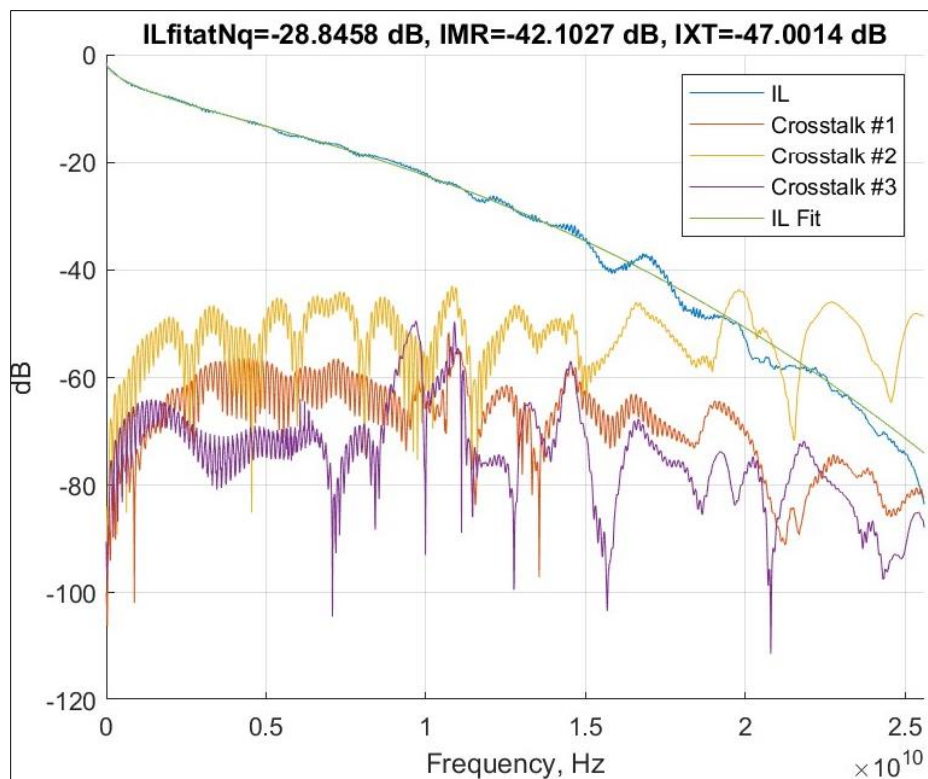




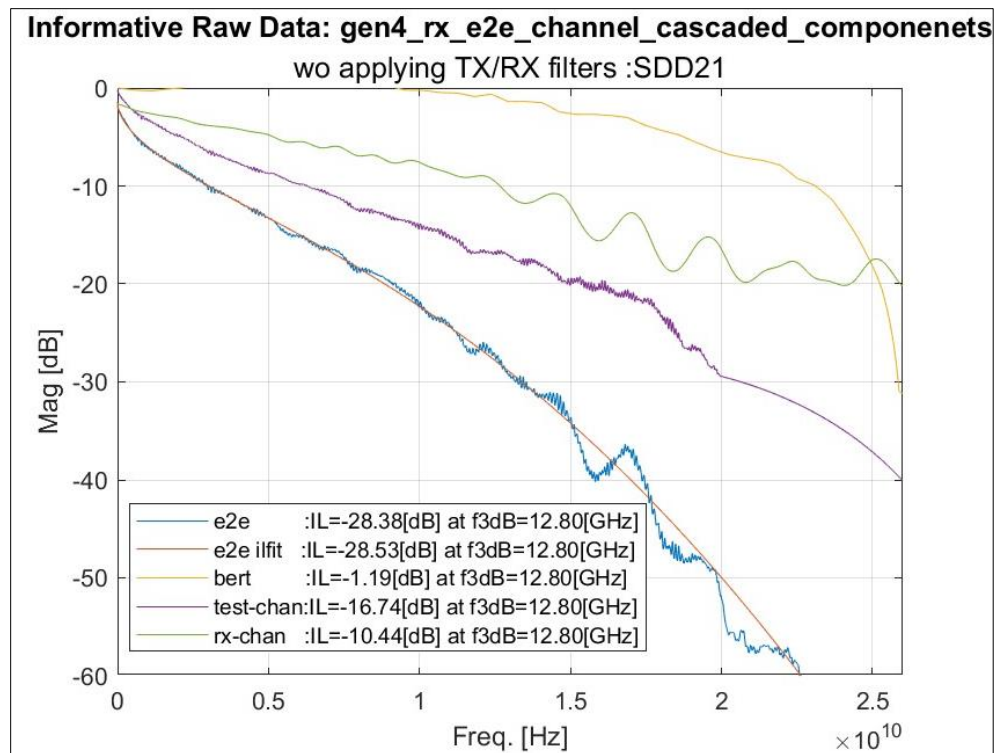
### 3. channel\_calibration\_to\_worst\_case\_condition\_result\_result.csv

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

### 4. ECOM End-to-End channel ILfit plot



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



## 6. Failure flow

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

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

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

## 8.4 TP3'

### 8.4.1 rx\_frequency\_variation

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

Run the following command from the PowerShell window:

#### Command example:

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

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

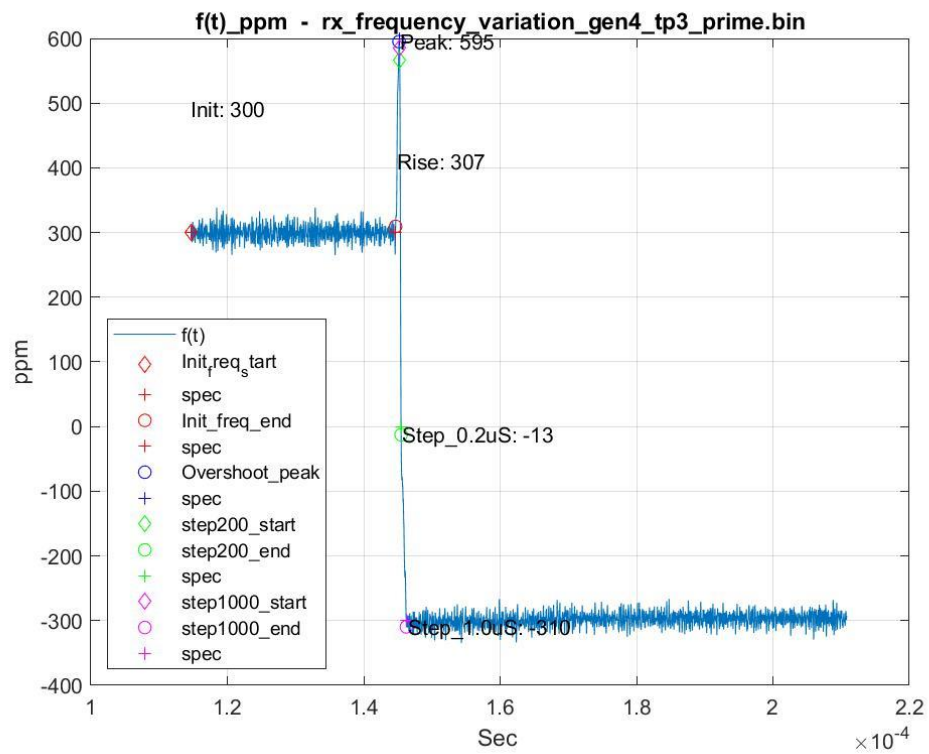
#### Report files location:

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

The .csv file rx\_frequency\_variation\_calibration\_tp3\_prime\_result.csv as a results example

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

The SIGTEST saves the following plot (.jpg format)



## 8.4.2 rl

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

1. Run the following command from the PowerShell window:

### Command example:

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

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

2. report file location:

Local Disk (C:) > SigTest

Name

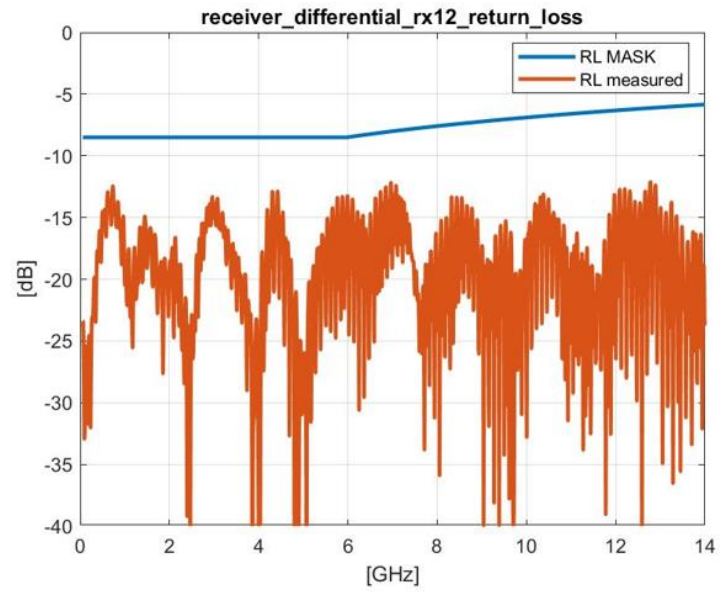
- Waveforms
- rl\_report\_receiver\_differential\_rx12\_return\_loss\_gen4\_tp2.jpg
- rl\_report\_result.csv
- USB4\_SigTest.exe

3. rl\_report\_result.csv as a result example

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

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

4. rl\_report\_receiver\_differential\_rx12\_return\_loss\_gen4\_tp2.jpg  
Return Loss plot with spec mask



## 8.5 TP3

### 8.5.1 rx\_frequency\_variation

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

Run the following command from the PowerShell window:

**Command example:**

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

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

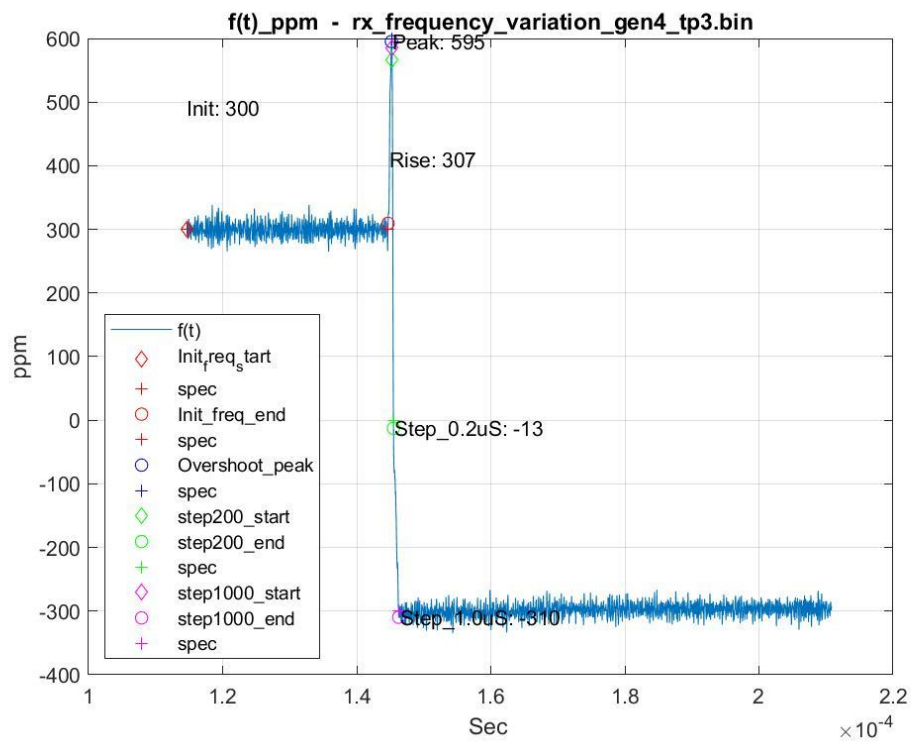
**Report files location:**

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

The .csv file rx\_frequency\_variation\_report\_result.csv as a results example

|   |                                     |                                     |  |   |      |
|---|-------------------------------------|-------------------------------------|--|---|------|
| Electrical Compliance Test Specification for GEN4 |                                     |                                     |  |   |      |
| Date:   | 16-Dec-22                           |                                     |  |   |      |
| DIR:  | C:\SigTest_USB4_CTS\Waveforms\      |                                     |  |   |      |
| File:   | rx_frequency_variation_gen4_tp3.bin |                                     |  |   |      |
| RX Frequency Variation Training Measurement:      |                                     |                                     |  |   |      |
| INIT_FREQ_VARIATION:                              | PASS                                | RX_INIT_FREQ_VARIATION result:      | 299.534768 CTS: Min RX_INIT_FREQ_VARIATION       | 275 CTS: Max RX_INIT_FREQ_VARIATION       | 325  |
| DELTA_FREQ_200nS:                                 | PASS                                | RX_DELTA_FREQ_200nS result:         | 578.571019 CTS: Min RX_DELTA_FREQ_200nS          | 575 CTS: Max RX_DELTA_FREQ_200nS          | 625  |
| DELTA_FREQ_1000nS:                                | PASS                                | RX_DELTA_FREQ_1000nS result:        | 895.301998 CTS: Min RX_DELTA_FREQ_1000nS         | 875 CTS: Max RX_DELTA_FREQ_1000nS         | 925  |
| FREQ_OVERSHOOT:                                   | PASS                                | RX_FREQ_OVERSHOOT result:           | 595.098731 CTS: Min RX_FREQ_OVERSHOOT            | 575 CTS: Max RX_FREQ_OVERSHOOT            | 625  |
| STEADY_STATE_FREQ_VARIATION:                      | PASS                                | STEADY_STATE_FREQ_VARIATION result: | -302.754177 CTS: Min STEADY_STATE_FREQ_VARIATION | -325 CTS: Max STEADY_STATE_FREQ_VARIATION | -275 |
| Informative: Symbol Rate [GHz]:                   | NONE                                | Symbol Rate                         | 25.598735 Drift [PPM]                            | -49.41                                    |      |

The SIGTEST saves the following plot (.jpg format)





## 8.6 Aggressors' calibration

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

Run the following command from the PowerShell window:

### Command example:

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

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

Report files location:

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

The .csv file GEN4\_RX\_Aggressors\_6p4GHz\_clock.csv as a results example

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

## 9 LFPS

### 9.1 LFPS TX

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

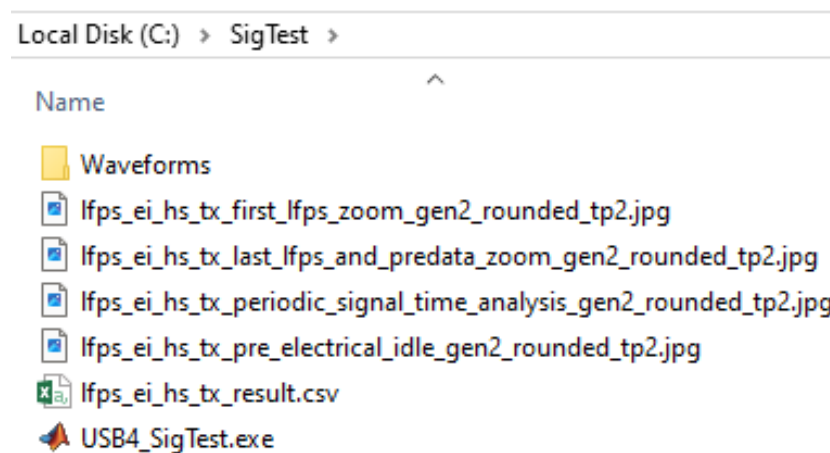
Run the following command from the PowerShell window:

### Command example:

.\USB4\_SigTest.exe gen2\_rounded tx tp2 lfps C:\SigTest\Waveforms\lfps\_ei\_hs\_tx\_p.bin lfps\_ei\_hs\_tx\_n.bin lfps\_ei\_hs\_tx none  
ε:\s parameter for deembedding.s4pnone

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

Report files location:

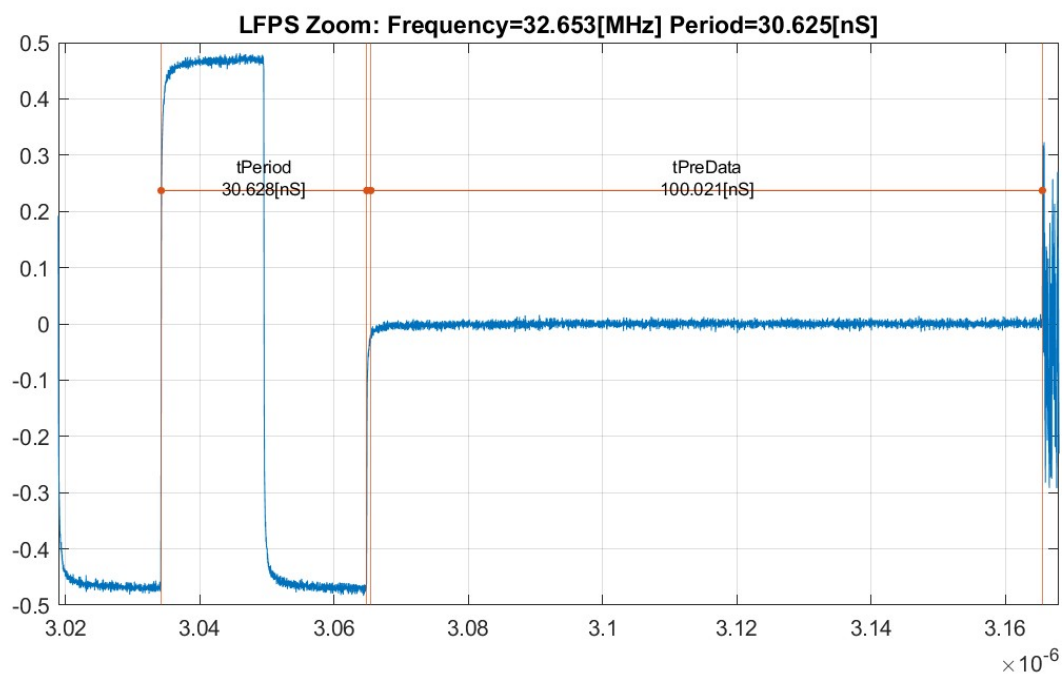
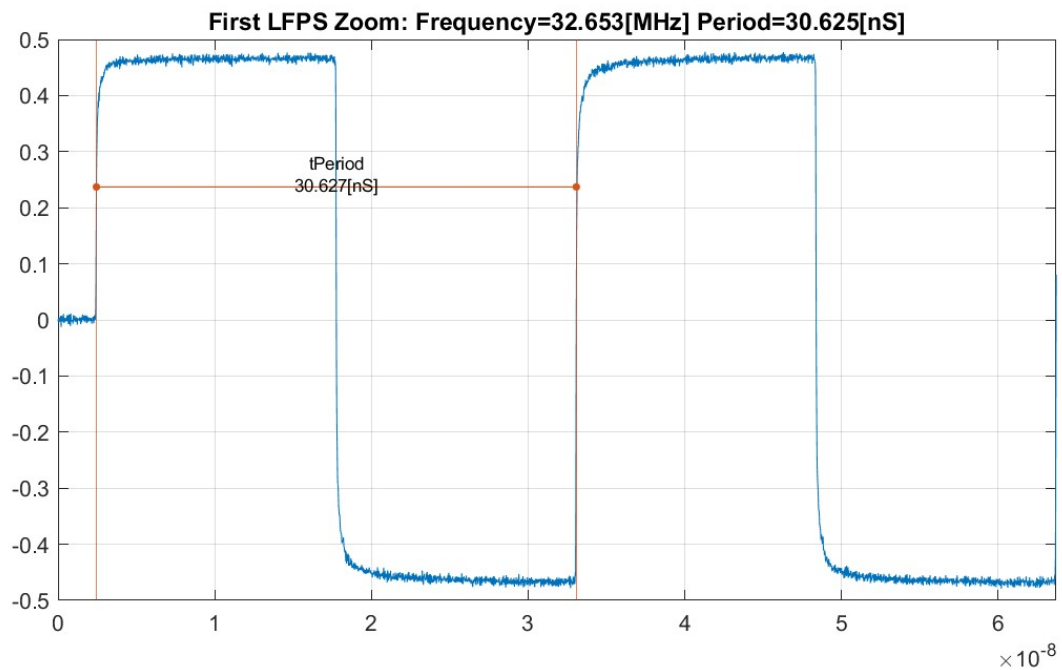


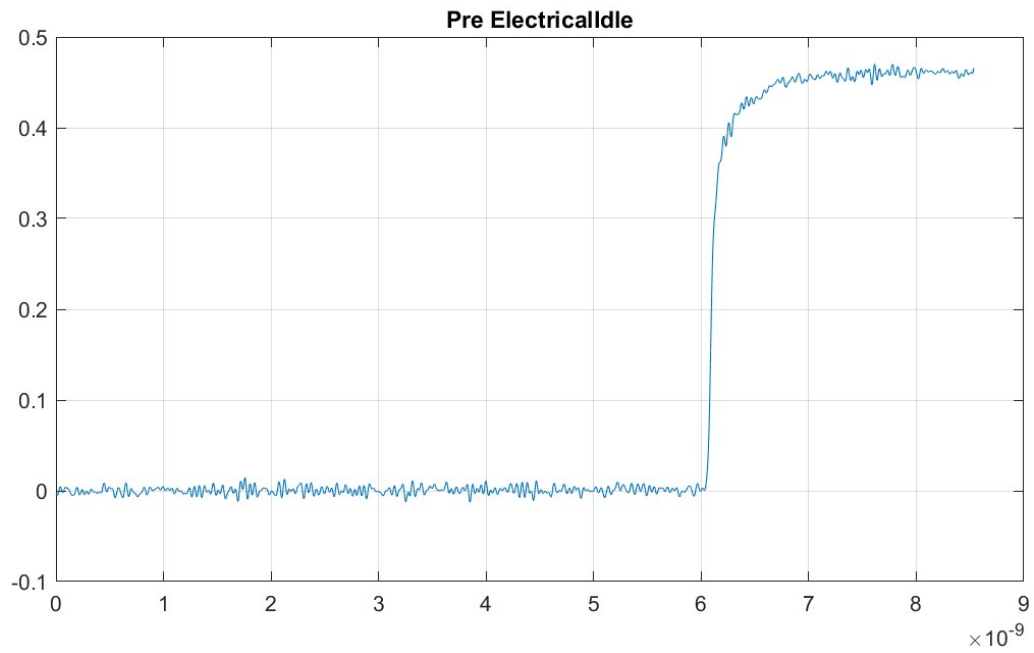
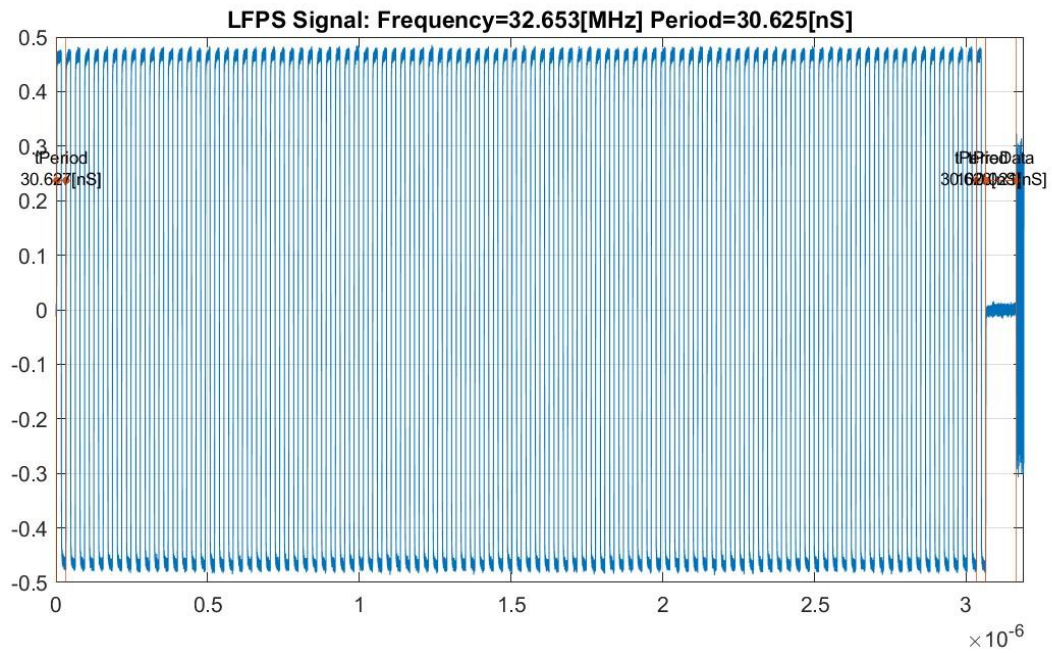
The .csv file lfps\_ei\_hs\_tx\_result.csv as a results example

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

SigTest saves the following plots:

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





## 9.2 LFPS RX calibration

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

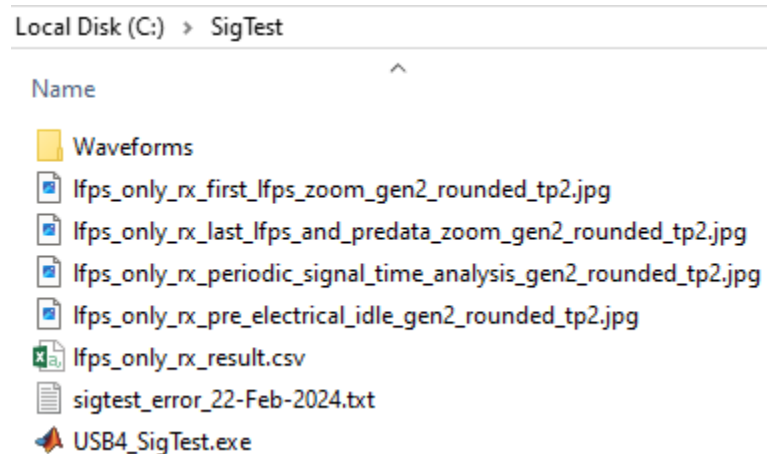
Run the following command from the PowerShell window:

### Command example:

```
.\USB4_SigTest.exe gen42_rounded rx tp2 lfps C:\SigTest\Waveforms\lfps_only_p.bin lfps_only_tx_n.bin lfps_only_rx none
```

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

### Report files location:

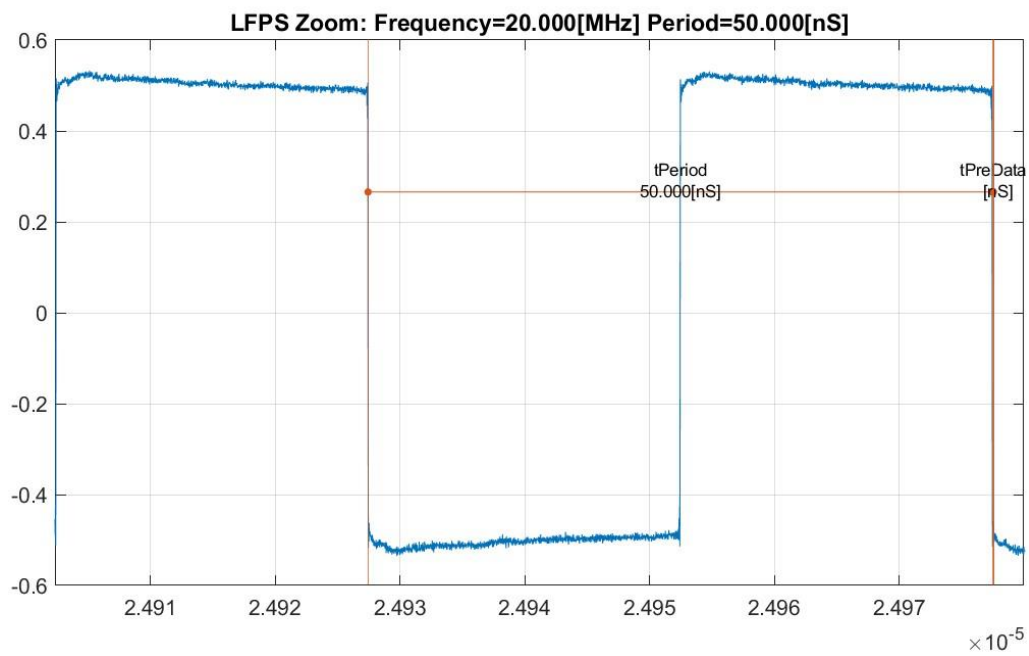
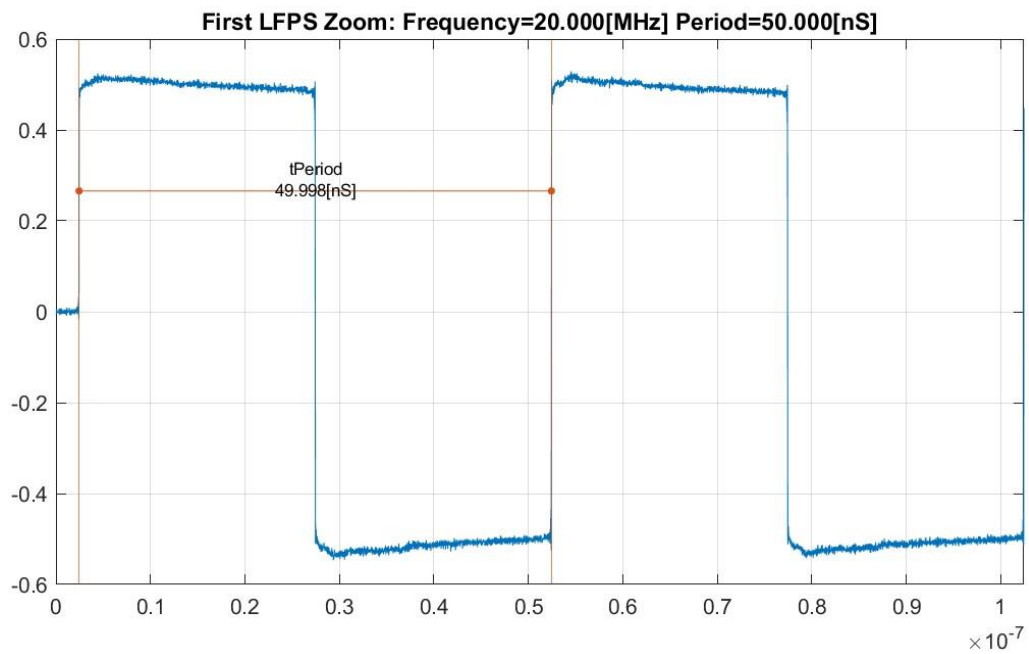


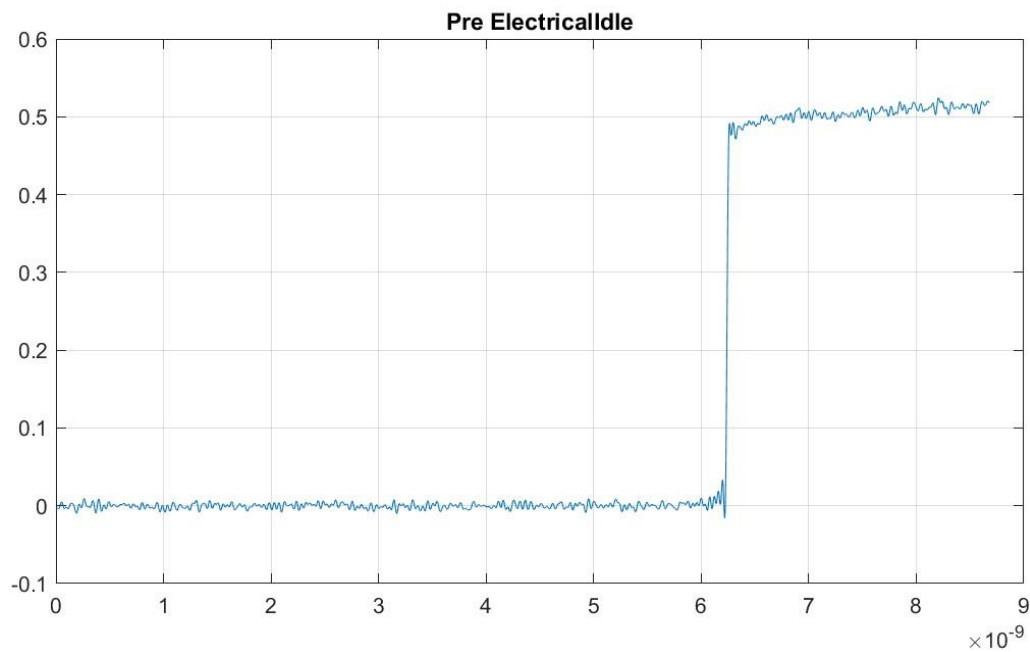
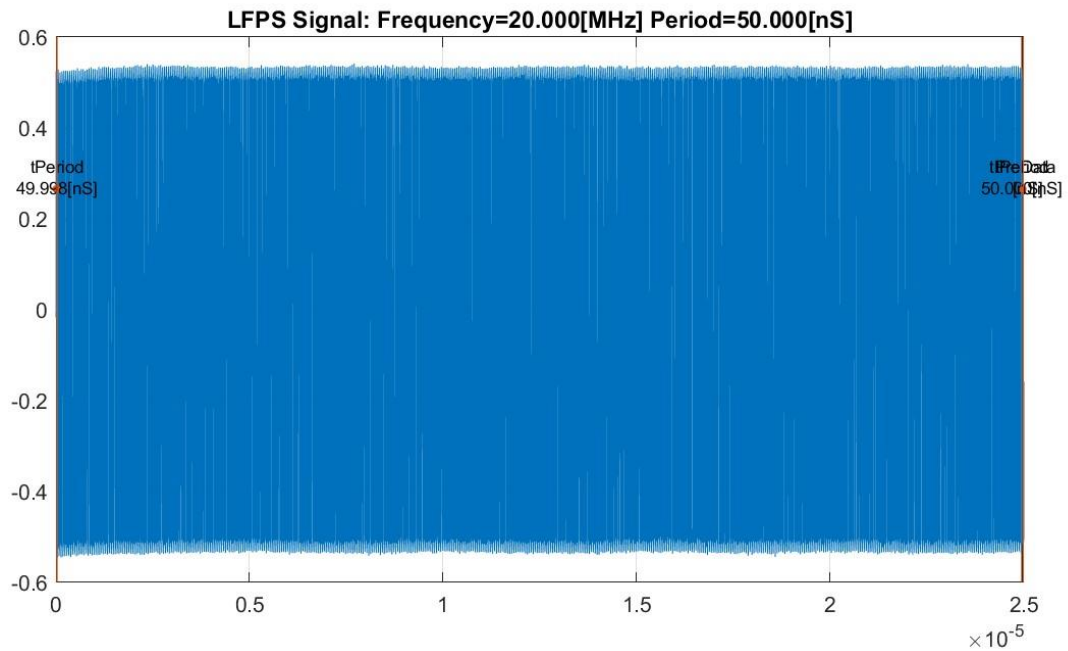
The .csv file lfps\_only\_rx\_result.csv as a results example

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





## 10 Pattern Detect

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

[illegible]