# Analysis of C2M updated Channels for 200Gbps - up to $34 d B$ channels 

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## C2M Channel Analysis -Goals

- Find a minimal reference Serdes without MLSE feature that meets the needs of updated channels based on 2 RU, 64 port, 512 Radix, 1.6T/port system design
- Cover both Cabled_host and PCB_host channels with "Max feasible" skew version
- No Skew and Excessive skew for comparison only


## C2M Channel Analysis - Setup

- Simulation setup Includes
>Both types of packages ( Type A and Type B)
$>$ Mixing of Package types for
>Package variations
- Host Silicon package trace lengths - 8 mm to 45 mm
- Module Silicon package trace lengths - $4 \mathrm{~mm}-12 \mathrm{~mm}$
>Cover all Cabled_host and PCB_host channels
- All skew version(s)
$>$ Refer included COM table for other details of Reference Serdes.


## C2M Channel Analysis - PKG B



## C2M Channel Analysis - All conditions



## Includes:

Packages A and B
Host side: $8 \mathrm{~mm}-45 \mathrm{~mm}$
Module side: $4 \mathrm{~mm}-12 \mathrm{~mm}$
all Skew versions of channels
No skew, Max_tolerable and excessive,

## Ref Serdes:

TX:
A_v: 0.45 V with $\mathrm{Rd}=50 \mathrm{Ohm}$
4 pre-tap
CTLE:
gDC $=-10 \mathrm{~dB} ; \mathrm{gDC}$ _HP $=-4 \mathrm{~dB}$
RX:
1 Tap DFE
40 post tap FFE: 8 fixed +8 banks of 4 floating up to 80 Ul 4 pre-tap

Observation: CTLE is adopting to lower range of capability. gDC: upto -7 dB

## C2M Channel Analysis - all conditions for channels >30 dB



C 2 M channels with Pkg A and Pkg B variations - Bump2 Bump Loss >30 dB


This type of ref. Serdes is covering up to 32 dB of cabled host channels and up to 34 dB of PCB host channels

## C2M Channel Analysis - PKG B with MLSE



## Includes:

Packages B
Host side: 45 mm
Module side: 8 mm
all Skew versions of channels :
No skew, Max_tolerable and excessive,

## Ref Serdes (with MLSE):

TX:
A_v: 0.413 V with $\mathrm{Rd}=50 \mathrm{Ohm}$
4 pre-tap
CTLE:
gDC $=-10 \mathrm{~dB} ; \mathrm{gDC}_{-} \mathrm{HP}=-4 \mathrm{~dB}$ RX:
1 Tap DFE
40 post tap FFE: 8 fixed +8 banks of 4 floating up to 60UI
4 pre-tap

## C2M Channel Analysis with MLSE - All conditions



Includes:
Packages A and B
Host side: $8 \mathrm{~mm}-45 \mathrm{~mm}$
Module side: $4 \mathrm{~mm}-12 \mathrm{~mm}$
all Skew versions of channels :
No skew, Max_tolerable and excessive

Ref Serdes (with MLSE, max benefit capped at 0.75 dB ): TX:
A_v: 0.413 V with $\mathrm{Rd}=50 \mathrm{Ohm}$ 4 pre-tap
CTLE:
gDC $=-10 \mathrm{~dB} ;$ gDC_HP $=-4 \mathrm{~dB}$
RX:
1 Tap DFE
40 post tap FFE: 8 fixed +8 banks of 4 floating up to 60UI 4 pre-tap

Observation: CTLE is adopting to lower range of capability. gDC : upto -7 dB

## C2M Channel Analysis w MLSE - all conditions for channels >30 dB

C2M channneels with Pkg A and Pkg B variations


This type of ref. Serdes is covering up to 32 dB of cabled host channels and up to 34 dB of PCB host channels

## Conclusions

- For varying package conditions and max feasible system intrapair skew conditions, the same reference Serdes can support:
- Cabled_host channels up to 32 dB
- PCB_host channels up to 34 dB
- Recommend C2M Electrical Interfaces target max Loss up to 34dB.
- There is room for further simplification of Ref. Rx or additional noise margins based on future work - like the implementation of MMSE algorithms etc..

```
Ref Serdes without MLSE:
TX:
A v: 0.45V with Rd=50 Ohm
4 pre-tap
CTLE:
gDC =-10 dB; gDC_HP = -4 dB
RX:
1 Tap DFE
40 post tap FFE: 8 fixed+ 8 banks of 4 floating up to 80UI
4 pre-tap
```

```
Ref Serdes (with MLSE, max benefit capped at 0.75dB):
TX:
A_v: 0.413V with Rd =50 Ohm
4 pre-tap
CTLE:
gDC =-10 dB; gDC_HP =-4 dB
RX:
1 Tap DFE
40 post tap FFE: 8 fixed+ 8 banks of 4 floating up to 60UI
4 pre-tap
```


## Backup

| ble 93A-1 parameters |  |  |  |
| :---: | :---: | :---: | :---: |
| Parameter | Setting | Units | Information |
| f.b | 106.25 | GBd |  |
| $f$ min | 0.05 | GHz |  |
| Delta ff | 0.01 | $\mathrm{GHz}^{\text {G }}$ |  |
| c_d | ${ }^{[0.4 e-4} 0.9 e-41.1$ e-4 $-0.4 e-40.9 e-4$ | nF | [TXRx] |
| Ls | [0.130.15 0.14; 0.13 0.15 0.14] | nH | [TXRX] |
| c.b | [0.33-4 $0.3 \mathrm{e}-4]$ | nF | [TXRX] |
| 2_p select | [12345678910111213141516 |  | [testcasesto run) |
| 2_p (TX) |  | mm | [testcases] |
| 2_p ( NEXT ) | [444444888888121212121212; $0000000000000000 ; 000$ [0000000000] | mm | [testcases] |
| 2_p (fExT) |  | mm | [testcases] |
| 2_p (RX) | $\left[\begin{array}{l}{[44444488888121212121212 ;} \\ 0000000000000000 ; 0000 \\ 00000000000000 ; 00000000\end{array}\right.$ $00000000000000 ; 00000000$ 0000000000 ] | mm | [testcases] |
| PKG Tx FFE Preset | - |  |  |
| C.p | [0.5e-4 0.5-4] | nF | [ $7 \times \mathrm{KX}$ ] |
| ${ }_{\text {R }}$, | ${ }^{50}$ | Ohm |  |
| $\frac{\mathrm{R}}{\mathrm{R}} \mathrm{d}$ | ${ }_{\text {[50 50] }}^{0.45}$ | Ohm | [ $\mathrm{T} \times \mathrm{RXX}$ ] |
| $\begin{aligned} & \text { Av } \\ & \text { Af fe } \end{aligned}$ | 0.45 | v | vp/ff= |
| A_ne | 0.45 | v |  |
| $\llcorner$ | 4 |  |  |
| M | 32 |  |  |
| filterand Eq |  |  |  |
| ${ }_{\text {f }}^{\text {c }}$ ( 0 | 0.75 | *fb | min |
| c-1) | [-0.4:0.0.02:0.0.3] | [-0.4:4:002:0] | [min:step:max] |
| cl-2) | [0:00.02:0.0.04] | [0:00.02:0.0.2] | [min:step:max] |
| c(-3) | [-0.04:0:022:0] | -0.004:0.02:0] | [min:step:max] |
| c-4) | [-0.02:0:02: 0 :04] | $0_{0}^{[0.02: 022: 0.0 .}$ | [ministep:max] |
| c(1) | [-0.04:0:02:0:04] | $\begin{gathered} 1- \\ \text { 0.12:02:0.0 } \\ 4] \end{gathered}$ | [min:step:max] |
| N b | 1 | $u$ |  |
| $\mathrm{b}_{\text {max }}(1)$ | 1 |  | As/dffel |
| $\frac{\mathrm{b} \max (2 . . . N-\mathrm{N})}{\mathrm{b} \min (1)}$ | [0.30.2**ones $(1,22]]$ |  | $\text { As/dffe2... } \mathrm{N} \text { b }$ |
| $\mathrm{b}^{\min (2 \ldots \mathrm{~N} \cdot \mathrm{~b})}$ | $\left[-0.2-0.2^{*}\right.$ ones $\left.[1,22]\right]$ |  | As/dffe2... ${ }^{\text {b }}$ |
| g_Dc | [-10:1:0] | dB | [min:step:max] |
| f_ | 42.5 | GHz |  |
| $\mathrm{f}_{\mathrm{p} 1}$ | 42.5 | GHz |  |
| $\mathrm{f}_{\mathrm{p}} \mathrm{p}$ | 106.25 | GHz |  |
|  |  |  | [min:step:max] |
| ${ }_{\text {f. HP } . \text { PZ }}$ | 1.328125 | GHz |  |
| Butterworth | 1 | logical | include infr |
| Raised Cosine | 0 | logical | include in fr F |
| RC Start | $6.70 E+10$ | Hz | start freafor RCO |
| RC.end | 7.97E +10 | Hz | end fregfor RCos |
| ffe_pre_tap_len | 4 | UI |  |
| ffe post tap len | 8 | UI |  |
| ffe_tap_step_size | 0 |  |  |
| ${ }^{\text {ffe main cursor min }}$ | 0.7 |  |  |
| Afe post tap1 1 max | 0.7 |  |  |
| ffe tapn max | 0.7 |  |  |
| ffe backoff | 0 |  |  |
| Sample adiustment | [00] | phase |  |


| 1/0 control |  |  | Table $93 \mathrm{~A}-3$ parameters |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: |
| diagnostics | 1 | logical | Parameter | Setting | Units |
| DIIPPAY_WINDOW | 1 | logical | package_ti gamma0 al a2 | [ 00.00084550 .000340225 ] |  |
| CSV REPORT | 1 | logical | package til tau | 0.00648805 | $\mathrm{ns} / \mathrm{mm}$ |
| RESULT DIR | .\|results\C2M B \{date] $^{\text {a }}$ |  | package_Z. | [9292; 70 70; 80 80; 100100$]$ | Ohm |
| SAVE_FIGURES | 0 | logical |  |  |  |
| Portorder | [1324] |  | Parameter | Setting |  |
| RUNTAG | C2M_B |  | board_t1 gamma0 al a a | [06.44084e-4 3.6036e-05] | $1.5 \mathrm{db} / \mathrm{in}$ @ 566 |
| COM_CONTRIBUTION | 0 | ${ }^{\text {logical }}$ | board_tı_tau | 5.790E-03 | ns/mm |
| Operational |  |  | board_z_c | 100 | ohm |
| ERL Pass treshold | 9.7 | dB | z_bp (TX) | 125 | mm |
| com Pass threshold | 3 | db | z_bp (next) | 0 | mm |
| VEC Pass threshold | 10.69073041 | db | 2_bp (FEXT) | 125 | mm |
| DER 0 | 2.67E-05 |  | $2 \mathrm{bp}(\mathrm{RX})$ | 0 | mm |
| $\mathrm{T}_{\text {r }}$ | 4.00-03 | ns | c.0 | [0.2e-40] | nF |
| FORCE TR | 1 | logical | C 1 | [0.2e-40] | nF |
| PMD_type | c2acom |  | Include PCB | 0 | logical |
| ${ }_{\text {EW }}$ | 1 |  |  |  |  |
| TDR and ERL options |  | logical |  |  |  |
| TDR | 1 | logical | Seletions (rectangle, gaussian,dual_rayleigh,trian gle |  |  |
| ERL | 1 | logical | Histogram_Window_Weight | gaussian | selection |
| ERL ONLY | 0 | ns | ar | 0.02 | UI |
| TR_Tor | 0.01 |  |  |  |  |
| N | 2000 | logical |  |  |  |
| TDR_ Butterworth | 1 |  | ICN parameters |  |  |
| beta $x$ | 0 |  | ${ }_{\text {f }} \mathrm{f}$ | 0.594 | ${ }_{\text {Fb }}$ |
|  | 0.618 | UI | ${ }_{f}^{f} \mathrm{f}$ | 0.594 | ${ }_{\text {Fb }}$ |
| N bx | 0 |  | $\ddagger$ | 79.688 | GHz |
| fixture delaytime | [00] |  | A_ft | 0.450 | v |
| Tukey Window | 1 |  | A nt | 0.450 | $v$ |
| Noise, jitter |  | $\cup 1$ |  |  |  |
| ${ }_{\text {Sigma }}^{\text {A }}$ D | ${ }_{0}^{0.01}$ | $\xrightarrow[\mathrm{N} \times 2 / \mathrm{GH2}]{\mathrm{Ul}}$ | Floating Tap Control $\mathbf{N ~ b g}$ | 8 | 012 or 3 groups |
| eta 0 | 6.00E-09 | dB | N bf | 4 | taps pergroup |
| SNR_TX | 33 |  | N_f | 80 | tans |
| R_LM | 0.95 |  | bmaxg | 0.2 | floating taps |
| $\underbrace{\text { 11-2022 }}_{\text {highlighted are undere-consideration }}$ |  |  | B float RSS MAX | 0.1 | rss tail tap limit |
|  |  |  | N_tail_start | 61 | (U) start of tail t |
| MLSE | 1 | $\square$ | Receivertesting |  |  |
|  | 。 |  | ${ }^{\text {RX CALIBRATION }}$ Sigma BBNstep | $\frac{0}{5.00 E-03}$ | $\stackrel{\text { logical }}{\mathrm{V}}$ |


| Trable 93A-1 parameters |  |  |  |
| :---: | :---: | :---: | :---: |
| Parameter | Setting | Units | Information |
| $f$ b | 106.25 | GBd |  |
| $f_{\text {f min }}$ | 0.05 | GHz |  |
| Delta $f$ | 0.01 | GHz |  |
| c_d | $\begin{aligned} & {[0.4 e-40.9 e-4 \text { 1.1.e-4-4.04e-4 0.9e-4 }} \\ & 1.1 e-4] \end{aligned}$ | nF | [TX XX] |
| Ls | [0.130.15 0.14; 0.13 0.15 0.14] | nH | [TXRX] |
| c b | [0.3e-4 0.3e-4] | nF | [TXRX] |
| 2_p select | [1234567891011121314151617 18 [ |  | [test casestor run] |
| 2_p (TX) | [8152430404581524304045815 243040 45;1.8 1.81 .81 .81 .81 .81 .81 .8 <br> $1.81 .81 .81 .81 .81 .81 .81 .81 .81 .8]$ | mm | [testcases] |
| 2_p ( NEXT ) | [444444888888121212121212; | mm | [testcases] |
| 2_p (FEXT) | [8152430404581524304045815 $24304045 ; 1.81 .81 .81 .81 .81 .81 .81 .8$ $1.81 .81 .81 .81 .81 .81 .81 .81 .81 .8]$ $[484$ | mm | [testcases] |
| $2 \mathrm{zp}(\mathrm{RX})$ | $[444444888888121212121212 ;$ $00000000000000000]$ | mm | [testcases] |
| PKG_Tx_FFE_preset | - |  |  |
| C ${ }^{\text {p }}$ | [0.5e-4 0.5-4] | nF | [TXRX] |
| R_0 | 50 | Ohm |  |
| R_d | [5050] | Ohm | [TXRX] |
| Av | 0.45 | v | vp/vf= |
| A fe | 0.45 | v | $\mathrm{vp} / \mathrm{lf}=$ |
| A_ne | 0.45 | $v$ |  |
| L | 4 |  |  |
| M | 32 |  |  |
| filterand Eq |  |  |  |
| $\mathrm{f}_{\mathrm{s}} \mathrm{r}$ | 0.75 | *fb |  |
| c(0) | 0.54 |  | min |
| c-1) | [-0.4:0.0.02:0.0.3] | [-0.4:0.0.02:0] | [min:step:max] |
| cl-2) | [0:00:02:00.04] | [0:000:02:0.2] | [min:step:max] |
| cl-3) | [-0.04:0.02:0] | [-0.04:00.02:0] | [min:step:max] |
| c(-4) | [-0.02:00:02:0.04] | $\begin{array}{\|c\|c\|c\|c\|c\|c::c\|c\|:\|c\|} \hline 02] \end{array}$ | [min:step:max] |
| c(1) | [-0.04:0:02:0.04] | $\begin{array}{c\|c\|} \hline \text { I- } \\ \hline .12: 00: 0.00 \\ 4] \end{array}$ | [min:step:max] |
| N_b | 1 | UI |  |
| $\mathrm{b}_{\max (1)}$ | 1 |  | As/dffel |
| $\mathrm{b}_{\text {max }}(2 . \ldots \mathrm{N}-\mathrm{b})$ | [0.30.2 ${ }^{\text {* }}$ ones $\left.(1,22)\right]$ |  | As/dffe2... $\mathrm{N}^{\text {b }}$ |
| b min(1) | 0 |  | As/diffe1 |
| $\mathrm{b}^{\min }$ (2...N-b) | $\left[-0.2-0.02^{*}\right.$ ones $\left.(1,22]\right]$ |  | As/dffe2...N $\mathrm{b}^{\text {b }}$ |
| g_dc | [-20:1:0] | dB | [min:step:max] |
| $\mathrm{f}_{\text {- }}$ | 42.5 | GHz |  |
| $\mathrm{f}_{\mathrm{f}} \mathrm{p}$ | 42.5 | GHz |  |
| $\mathrm{f}_{\mathrm{p}} \mathrm{p}$ | 106.25 | GHz |  |
| g_DC. HP | [-6:1:0] |  | [min:step:max] |
| $f$ HP PZ | 1.328125 | GHz |  |
| Butterworth | 1 | logical | include infr |
| Raised_Cosine | 0 | logical | include infr |
| RC. Start | $6.70 ¢+10$ | Hz | start freqfor RCos |
| RC _ end | 7.97E +10 | Hz | end freqfor RCos |
| ffe_pre_taplen | 4 | UI |  |
| ffe post_ tap_len | 8 | U |  |
| ffe tap step size | 0 |  |  |
| ffe_main_cursor_min | 0 |  |  |
| ffe_pre_tap1_max | 0.7 |  |  |
| ffe_ post_ tap1_max | 0.7 |  |  |
| ffe tapn_max | 0.7 |  |  |
| ffe_backoff | 0 |  |  |
| Sample adjustment | [00] | phase |  |


| 1/0 control |  |  |
| :---: | :---: | :---: |
| DIAGNOStics | 1 | logical |
| DIIPPLAY WINDOW | 1 | logical |
| CSV_REPORT | 1 | logical |
| RESULT_ DIR |  |  |
| SAVE_FIGURES | 0 | logical |
| Port Order | [1324] |  |
| RUNTAG | C2M A |  |
| COM CONTRIBUTION | 0 | logical |
| Operational |  |  |
| ERLPass threshold | 9.7 | dB |
| com Pass threshold | 3 | db |
| VEC Passthreshold | 10.69073041 | db |
| DER_0 | 2.677-05 |  |
| Tr | 4.00E-03 | ns |
| FORCE_TR | 1 | logical |
| PMD_type | C2Mcom |  |
| EW | 1 |  |
| TDR and ERL options |  | logical |
|  |  | logical |
| ERL | 1 | logical |
| ERL_ONLY | 0 | ns |
| TR TOR | 0.01 |  |
| N | 2000 | logical |
| TDR_Butterworth | 1 |  |
| beta_ X | , |  |
| rho $\times$ | 0.618 |  |
| TDR_W_TXPKG | 0 | UI |
| N_bx | 0 |  |
| fixturedelaytime | [00] |  |
| Tukey Window | 1 |  |
| Noise,jitter |  | $u 1$ |
| sigma_ RJ | 0.01 | $u$ |
| A.DD | 0.02 | N2/GH2 |
| eta_ 0 | 6.00--09 | dB |
| SNR_TX | 33 |  |
| R_LM | 0.95 |  |
| 11-2022 BenAftsi pk g | 022.065.02 |  |
| highlighted are underre-consideration |  |  |
| MLSE | 1 |  |

AC_CM_RMS


| Parameter | Setting |  |
| :---: | :---: | :---: |
| board tl gamma0 a1 a2 | $[06.440844-43.6036 e-05]$ | $1.5 \mathrm{db} /$ in @ 966 |


| $5.790 E-03$ | ns $/ \mathrm{mm}$ |  |
| :---: | :---: | :---: |
| board_z_c | 100 | ohm |


| board_Z_c | 100 | ohm |
| :---: | :---: | :---: | mm | $\frac{\mathrm{mm}}{\mathrm{nF}}$ |
| :--- |
| nF | $\frac{\mathrm{nF}}{\text { logical }}$



| ICN parameters |  |  |
| :---: | :---: | :---: |
| fv | 0.594 | Fb |
| ff | 0.594 | Fb |
| fn | 0.594 | Fb |
| f-2 | 79.688 | GHz |
| A_ft | 0.450 | v |
| A nt | 0.450 | $v$ |


| Floating Tap Control |  |  |
| :---: | :---: | :---: |
| N bg | 8 | 012 or 3 groups |
| N bf | 4 | taps per group |
| N_f | 80 | UI span for floatin |
| bmaxg | 0.2 | max DFE value for |
| B float RSS_MAX | 0.1 | rss tail tap limit |
| N_tail_start | 61 | (UI) start of tail ta |
| Receivertesting |  |  |
|  |  |  |
| RX_CALIBRATION | 0 | logical |
| Sigma BBNstep | 5.00-03 | v |

