

C2M Simulation and Methodology

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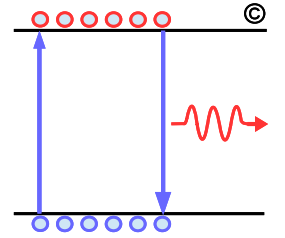
IEEE 802.3ck Task Force

Long Beach

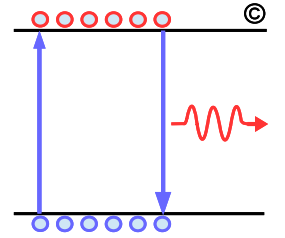
Jan 15, 2019

Contributors

- Mike Dudek – Marvel
- Rich Mellitz - Samtec

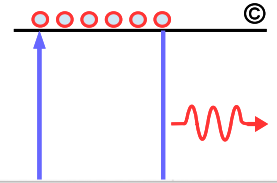


Overview



- ❑ **The TP1a/TP5 is a weak generic equalizer to observe and sampler the signal**
 - The actual equalizer may need additional capability to recover the signal at slicer
- ❑ **COM 2.5.7 produces nearly identical results to COM 2.5.1 if one uses BJ package**
 - $\eta_0 = 8.2 \times 10^{-9}$ added and reduces COM by ~ 0.2 dB
 - To have consistency with results from Sept/Nov $fr = 1.0$ but based on feedback received and low cost better to reduce fr to 0.75
 - If we choose to reduce $fr = 0.75$ on a channel with COM of ~ 3 dB on channel with low ICN ~ 0.2 dB COM penalty but ~ 0.1 dB gain on channel with high ICN
- ❑ **The new CK proposed packaged has significant penalty for C2M applications**
 - Using CK package over BJ package has ~ 1.5 dB COM penalty on high ILD channels
 - For detail of BJ package used here with C_p/C_{dcaps} and impedance has improved see COM 2.5.1 spreadsheet
 - For detail of CK packaged used here see COM 2.5.7 spreadsheet
- ❑ **Short channels combined with CK proposed packaged may require much more capable equalizer such 12T FFE or 5T FFE+1T DFE**
 - Complexity/power such class of equalizer could be an issue for 800G modules.

COM Code 2.51



❑ Filter coefficient selected to have the improved CL120E response scaled for 53.1 GBd

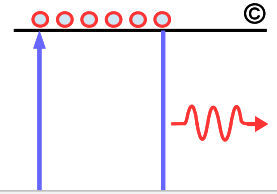
– http://www.ieee802.org/3/ck/public/tools/tools/mellitz_3ck_adhoc_01_100318_COM2p51.zip

| Table 93A-1 parameters | | | | I/O control | | | Table 93A-3 parameters | | |
|------------------------|---------------|---------|---------------------|---------------------|-----------------------------|---------|-------------------------|-----------------------|-------|
| Parameter | Setting | Units | Information | | | | Parameter | Setting | Units |
| f_b | 53.1 | GBd | | DIAGNOSTICS | 1 | logical | package_tl_gamma0_a1_a2 | [0 1.734e-3 1.455e-4] | |
| f_min | 0.05 | GHz | | DISPLAY_WINDOW | 1 | logical | package_tl_tau | 6.141E-03 | ns/mm |
| Delta_f | 0.01 | GHz | | CSV_REPORT | 1 | logical | package_Z_c | [90 90] | Ohm |
| C_d | [0.9e-4 0] | nF | [TX RX] | RESULT_DIR | .\results\100GEL_WG_{date}\ | | | | |
| z_p select | [1 2 3] | | [test cases to run] | SAVE_FIGURES | 0 | logical | | | |
| z_p (TX) | [14 15 30] | mm | [test cases] | Port Order | [1 3 2 4] | | | | |
| z_p (NEXT) | [14 15 30] | mm | [test cases] | RUNTAG | C2M_1218 | | | | |
| z_p (FEXT) | [14 15 30] | mm | [test cases] | COM_CONTRIBUTION | 0 | logical | | | |
| z_p (RX) | [0 0 0] | mm | [test cases] | | | | | | |
| C_p | [0.9e-4 0] | nF | [TX RX] | Operational | | | | | |
| R_0 | 50 | Ohm | | COM Pass threshold | 3 | dB | | | |
| R_d | [45 45] | Ohm | [TX RX] | ERL Pass threshold | 10.5 | dB | | | |
| A_v | 0.45 | V | | DER_0 | 1.00E-05 | | | | |
| A_fe | 0.45 | V | | T_r | 6.16E-03 | ns | | | |
| A_ne | 0.63 | V | | FORCE_TR | 1 | logical | | | |
| L | 4 | | | | | | | | |
| M | 32 | | | TDR and ERL options | | | | | |
| filter and Eq | | | | TDR | 1 | logical | | | |
| f_r | 0.75 | *fb | | ERL | 1 | logical | | | |
| c(0) | 0.65 | | min | ERL_ONLY | 0 | logical | | | |
| c(-1) | [-0.2:0.02:0] | | [min:step:max] | TR_TDR | 0.01 | ns | | | |
| c(-2) | [0:0.02:0.1] | | [min:step:max] | N | 300 | | | | |
| c(1) | [-0.1:0.02:0] | | [min:step:max] | TDR_Butterworth | 1 | logical | | | |
| N_b | 0 | UI | | beta_x | 1.70E+09 | | | | |
| b_max(1) | 0.5 | | | rho_x | 0.18 | | | | |
| b_max(2..N_b) | 0.2 | | | fixture delay time | 0 | | | | |
| g_DC | [-14:0.5:-4] | dB | [min:step:max] | Receiver testing | | | | | |
| f_z | 18.55345912 | GHz | | RX_CALIBRATION | 0 | logical | | | |
| f_p1 | 53.1 | GHz | | Sigma BBN step | 5.00E-03 | V | | | |
| f_p2 | 28.2 | GHz | | | | | | | |
| g_DC_HP | [-3:0.5:-1] | | [min:step:max] | Noise, jitter | | | | | |
| f_HP_PZ | 1.2 | GHz | | sigma_RJ | 0.01 | UI | | | |
| ffe_pre_tap_len | 0 | UI | | A_DD | 0.02 | UI | | | |
| ffe_post_tap_len | 4 | UI | | eta_0 | 8.20E-09 | V^2/GHz | | | |
| Include PCB | 0 | logical | | SNR_TX | 33 | dB | | | |
| ffe_tap_step_size | 0 | | | R_LM | 0.95 | | | | |
| ffe_main_cursor_min | 0.7 | | | | | | | | |
| ffe_pre_tap1_max | 0.3 | | | | | | | | |
| ffe_post_tap1_max | 0.3 | | | | | | | | |
| ffe_tapn_max | 0.125 | | | | | | | | |
| ffe_backoff | 3 | | | | | | | | |

COM Code 2.5.7

❑ Filter coefficient selected to have the improved CL120E response scaled for 53.1 GBd

– http://www.ieee802.org/3/ck/public/tools/tools/mellitz_3ck_adhoc_01_121918_COM2p57.zip

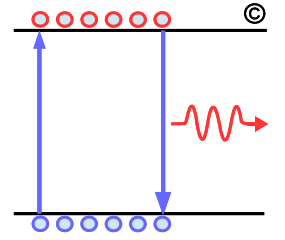


| Table 93A-1 parameters | | | |
|------------------------|-------------------------|---------|---------------------|
| Parameter | Setting | Units | Information |
| f_b | 53.1 | GBd | |
| f_min | 0.05 | GHz | |
| Delta_f | 0.01 | GHz | |
| C_d | [0.9e-4 0] | nF | [TX RX] |
| z_p select | [1 2 3] | | [test cases to run] |
| z_p (TX) | [14 15 30; 1.8 1.8 1.8] | mm | [test cases] |
| z_p (NEXT) | [14 15 30; 1.8 1.8 1.8] | mm | [test cases] |
| z_p (FEXT) | [14 15 30; 1.8 1.8 1.8] | mm | [test cases] |
| z_p (RX) | [0 0 0; 0 0 0] | mm | [test cases] |
| C_p | [0.9e-4 0] | nF | [TX RX] |
| R_0 | 50 | Ohm | |
| R_d | [45 45] | Ohm | [TX RX] |
| A_v | 0.45 | V | |
| A_fe | 0.45 | V | |
| A_ne | 0.63 | V | |
| L | 4 | | |
| M | 32 | | |
| filter and Eq | | | |
| f_r | 1 | *fb | |
| c(0) | 0.65 | | min |
| c(-1) | [-0.2;0.02;0] | | [min:step:max] |
| c(-2) | [0;:0.2;0.1] | | [min:step:max] |
| c(1) | [-0.1;0.02;0] | | [min:step:max] |
| N_b | 0 | UI | |
| b_max(1) | 0.5 | | |
| b_max(2..N_b) | 0.2 | | |
| g_DC | [-14;0.5;-4] | dB | [min:step:max] |
| f_z | 18.55345912 | GHz | |
| f_p1 | 53.1 | GHz | |
| f_p2 | 28.2 | GHz | |
| g_DC_HP | [-3;0.5;-1] | | [min:step:max] |
| f_HP_PZ | 1.2 | GHz | |
| ffe_pre_tap_len | 0 | UI | |
| ffe_post_tap_len | 6 | UI | |
| Include PCB | 0 | logical | |
| ffe_tap_step_size | 0 | | |
| ffe_main_cursor_min | 0.7 | | |
| ffe_pre_tap1_max | 0.3 | | |
| ffe_post_tap1_max | 0.3 | | |
| ffe_tapn_max | 0.125 | | |
| ffe_backoff | 3 | | |

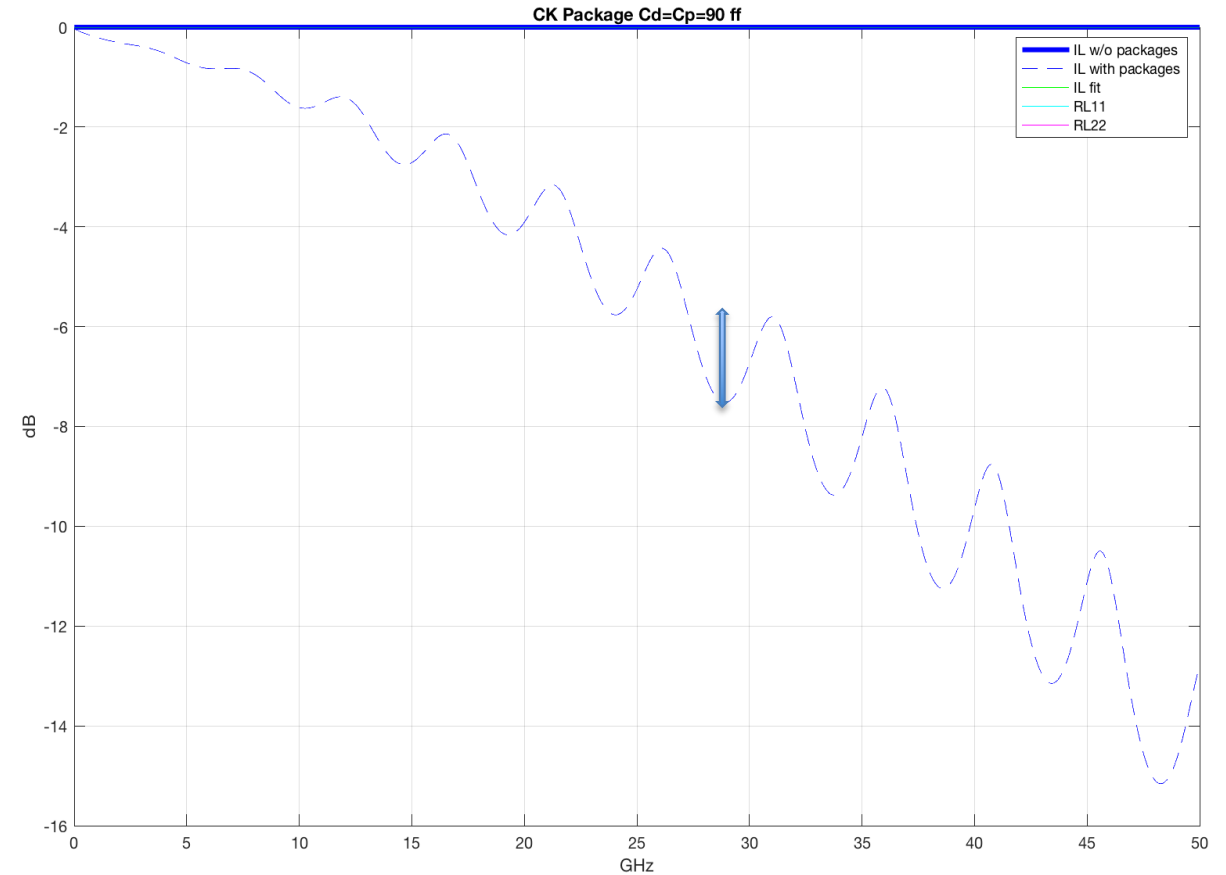
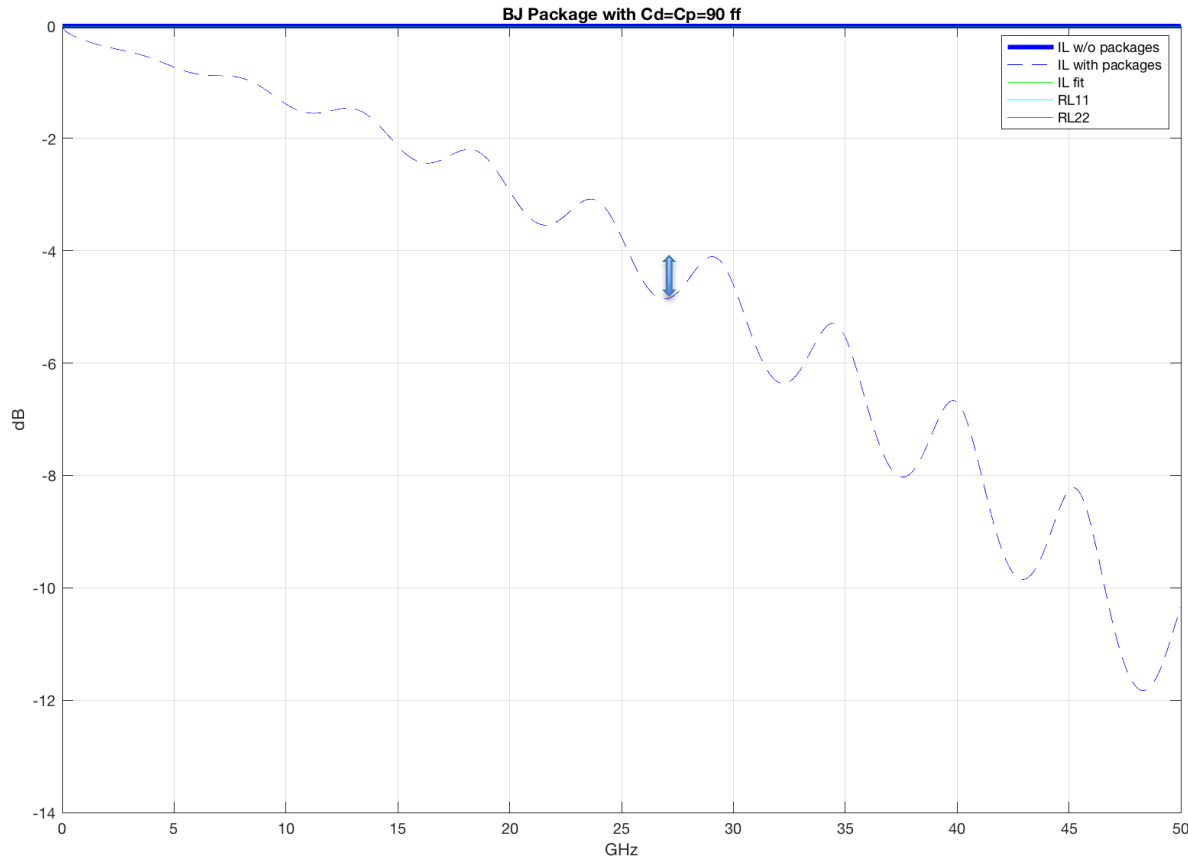
| I/O control | | |
|---------------------|-----------------------------|---------|
| DIAGNOSTICS | 1 | logical |
| DISPLAY_WINDOW | 1 | logical |
| CSV_REPORT | 1 | logical |
| RESULT_DIR | .\results\100GEL_WG_{date}\ | |
| SAVE_FIGURES | 0 | logical |
| Port Order | [1 3 2 4] | |
| RUNTAG | C2M_1218 | |
| COM_CONTRIBUTION | 0 | logical |
| Operational | | |
| COM Pass threshold | 3 | dB |
| ERL Pass threshold | 10.5 | dB |
| DER_0 | 1.00E-05 | |
| T_r | 6.16E-03 | ns |
| FORCE_TR | 1 | logical |
| TDR and ERL options | | |
| TDR | 1 | logical |
| ERL | 1 | logical |
| ERL_ONLY | 0 | logical |
| TR_TDR | 0.01 | ns |
| N | 300 | |
| TDR_Butterworth | 1 | logical |
| beta_x | 1.70E+09 | |
| rho_x | 0.18 | |
| fixture delay time | 0 | |
| Receiver testing | | |
| RX_CALIBRATION | 0 | logical |
| Sigma BBN step | 5.00E-03 | V |
| Noise, jitter | | |
| sigma_RJ | 0.01 | UI |
| A_DD | 0.02 | UI |
| eta_0 | 8.20E-09 | V^2/GHz |
| SNR_TX | 33 | dB |
| R_LM | 0.95 | |

| Table 93A-3 parameters | | |
|-------------------------|---------------------------|-------|
| Parameter | Setting | Units |
| package_tl_gamma0_a1_a2 | [0 0.0009909 0.0002772] | |
| package_tl_tau | 6.1400E-03 | ns/mm |
| package_Z_c | [87.5 87.5 ; 92.5 92.5] | Ohm |
| Table 92-12 parameters | | |
| Parameter | Setting | Units |
| board_tl_gamma0_a1_a2 | [0 3.8206e-04 9.5909e-05] | |
| board_tl_tau | 5.790E-03 | ns/mm |
| board_Z_c | 90 | Ohm |
| z_bp (TX) | 50 | mm |
| z_bp (NEXT) | 50 | mm |
| z_bp (FEXT) | 50 | mm |
| z_bp (RX) | 0 | mm |

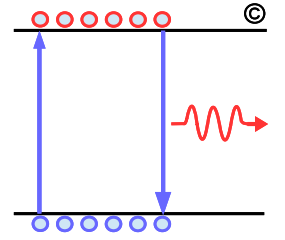
15 mm BJ vs CK Package for $C_d=C_p=90$ ff



□ CK package has ~2x higher ILD at Nyquist compare to BJ package!

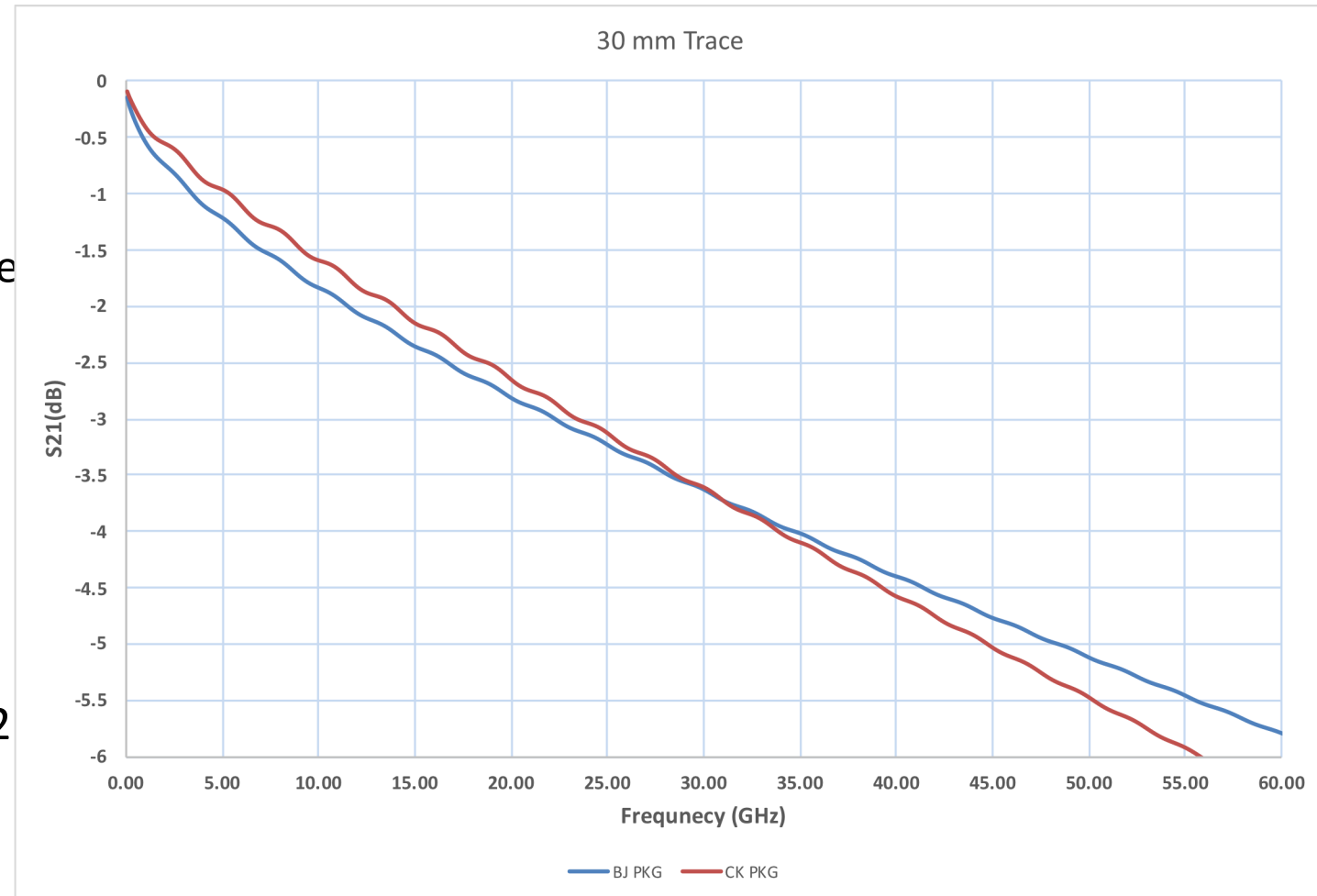


BJ vs CK Trace Losses



□ Comparisons of BJ vs CK 30 mm trace excluding CK 0.18 mm via

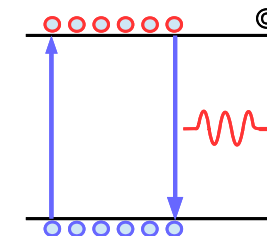
- The BJ package generally performs ~0.5 dB worse than well designed packages but new CK package even perform worse than BJ package
- Both BJ and CK 30 mm traces have similar losses at Nyquist
- Higher ILD associated with CK package likely as result of 0.18 mm via section
- The CK package double reflections on short traces are cancelled in case of CR/KR having equalizer with length ≥ 32 UI but C2M link must live with double reflections!



COM Analysis of Tracy Channels

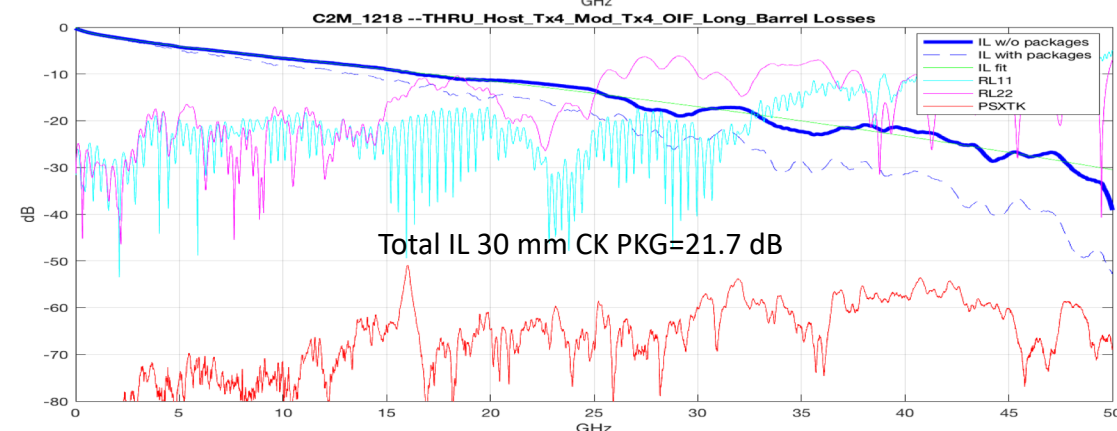
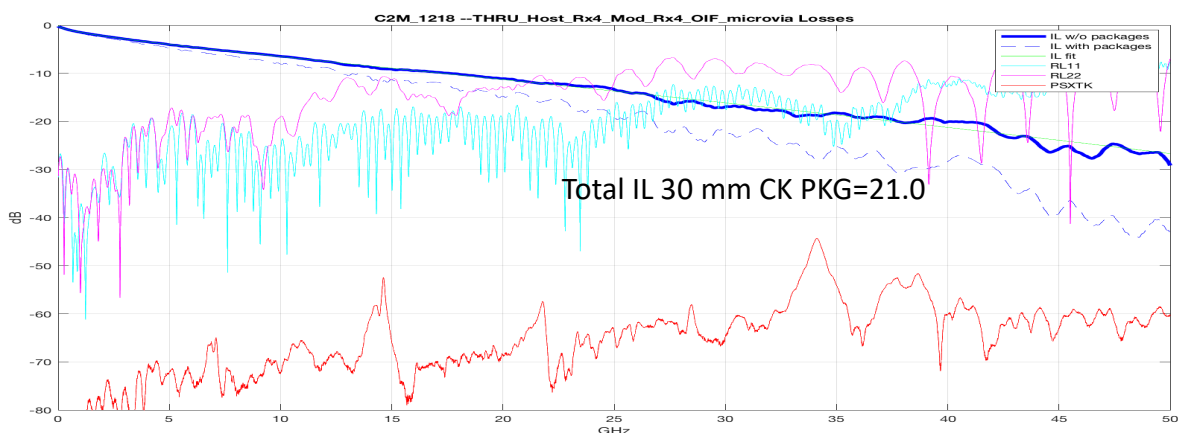
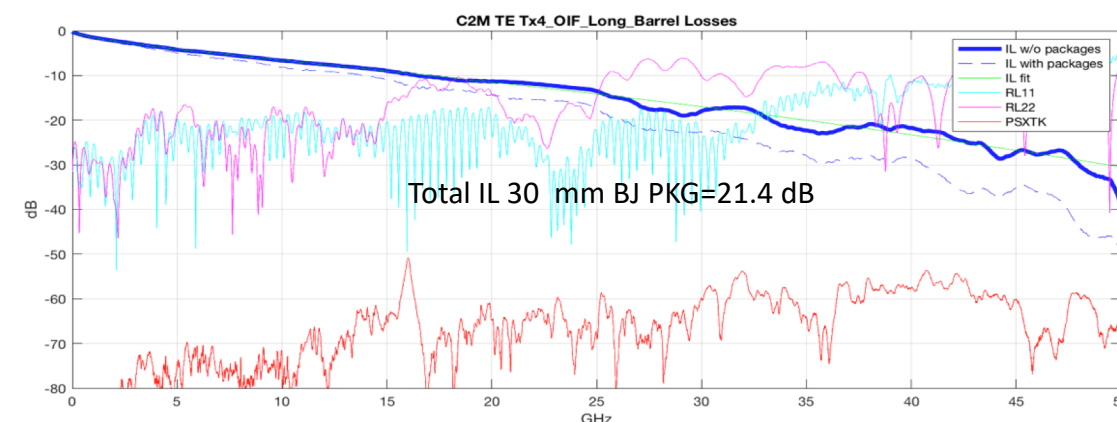
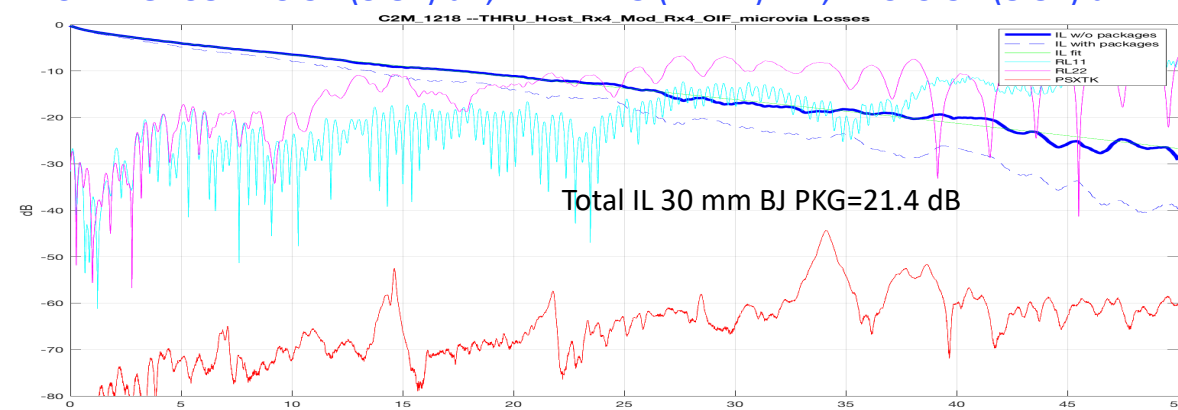
8.5" OSFP (16 dB) channels, CK package reduces loss but increases ILD at significant COM penalty!

- http://www.ieee802.org/3/100GEL/public/tools/c2m/tracy_100GEL_02_0118.zip (long barrel)
- http://www.ieee802.org/3/100GEL/public/tools/c2m/tracy_100GEL_06_0118.zip (Micro Via).



Tracy T4 MicroVia, FOM_ILD=0.23, ICN=0.67 mV, ICR=48, ERL11=14.0, ERL22=7.8
 BJ PKG: COM=3.90 (5.96) dB, EH=13.75 (16.6) mV, VEC=8.83 (6.09) dB
 CK PKG: COM=3.54 (3.87) dB, EH=12.75 (11.74) mV, VEC=9.52 (8.87) dB

Tracy T4 LongBarrel, FOM_ILD=0.42, ICN=0.54 mV, ICR=46, ERL11=13.4, ERL22=8.6
 BJ PKG: COM=3.02 (3.24) dB, EH=9.63 (8.9) mV, VEC=10.64 (10.14) dB
 CK PKG: COM=1.58 (2.34) dB, EH=5.30 (6.64) mV, VEC=15.58 (12.52) dB

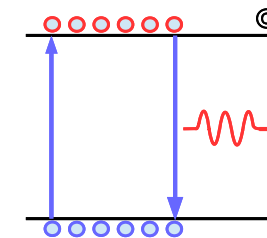


Result in (x) are for 30 mm PKG.

COM Analysis of Tracy Channels

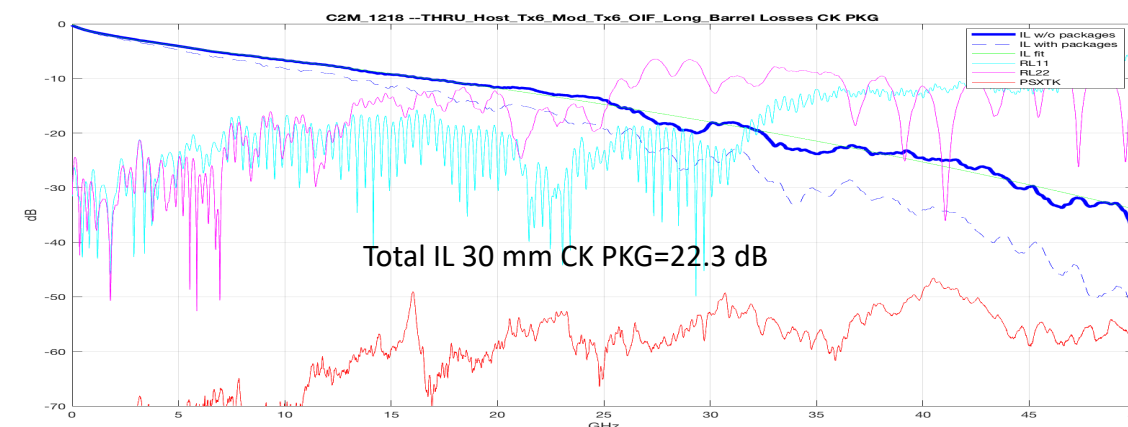
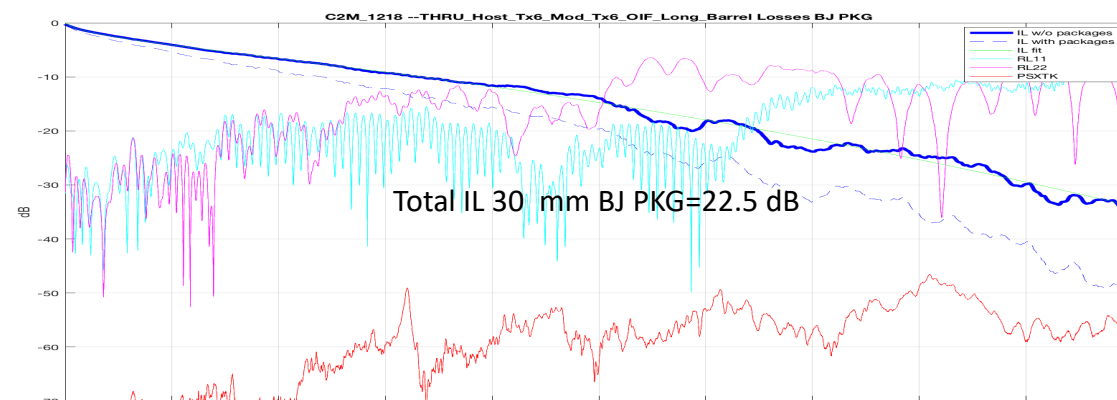
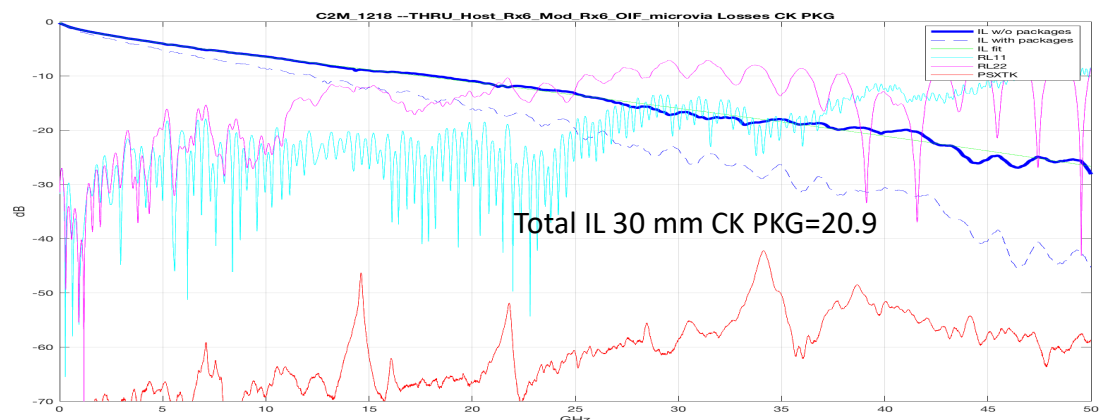
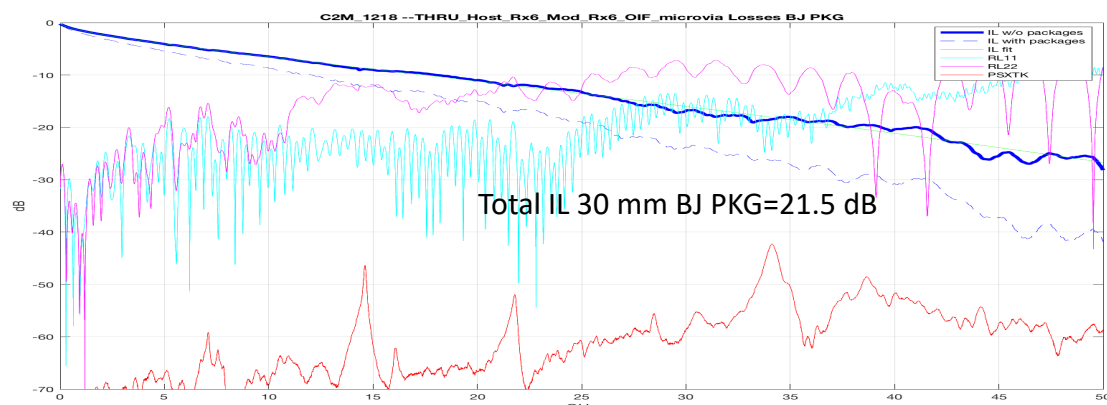
8.5" OSFP (16 dB) channels, CK package reduces loss but increases ILD at significant COM penalty!

- http://www.ieee802.org/3/100GEL/public/tools/c2m/tracy_100GEL_02_0118.zip (long barrel)
- http://www.ieee802.org/3/100GEL/public/tools/c2m/tracy_100GEL_06_0118.zip (Micro Via).



Tracy T6 MicroVia, FOM_ILD=0.23, ICN=0.98 mV, ICR=46, ERL11=15.4, ERL22=8.3
 BJ PKG: COM=3.90 (5.4) dB, EH=14 (14) mV, VEC=8.8 (6.7) dB
 CK PKG: COM=3.8 (4.6) dB, EH=13.2 (14.2) mV, VEC=9.0 (7.7) dB

Tracy T6 LongBarrel, FOM_ILD=0.39, ICN=1.0 mV, ICR=40.2, ERL11=11.1, ERL22=9.1
 BJ PKG: COM=4.9 (4.3) dB, EH=14.6 (12.6) mV, VEC=7.3 (8.2) dB
 CK PKG: COM=1.8 (2.6) dB, EH=6.4 (7.5) mV, VEC=14.7 (11.7) dB

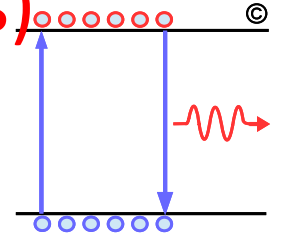


Result in (x) are for 30 mm PKG.

COM Analysis on Lim Nov-18 Channels (Legacy Contacts)

- Lim Nov-2018 channel ICR still pretty low ~30 dB and with high ICN, but the crosstalk peak at 15 GHz eliminated, with this improvement passes with good margin on 30 mm package

— http://www.ieee802.org/3/ck/public/tools/c2m/lim_3ck_01_0918_QDD_legacy_pairs.zip



Lim 14 dB FOM_ILD=0.129, ICN=2.79 mV, ICR=31.5, ERL11=9.1, ERL22=12.2

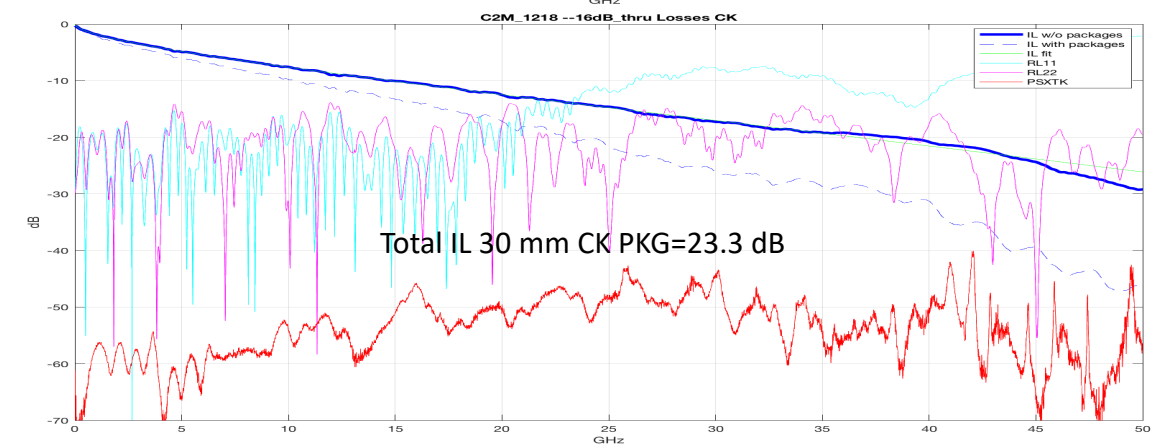
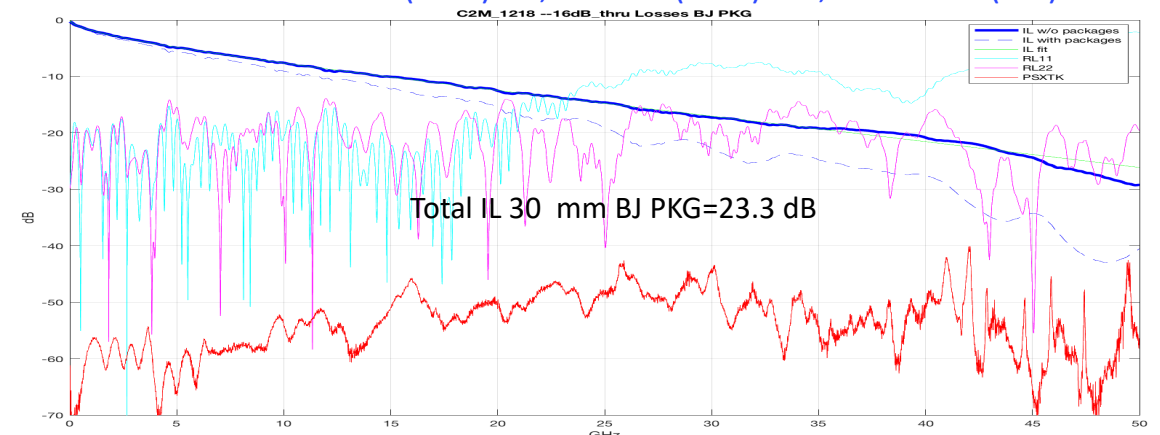
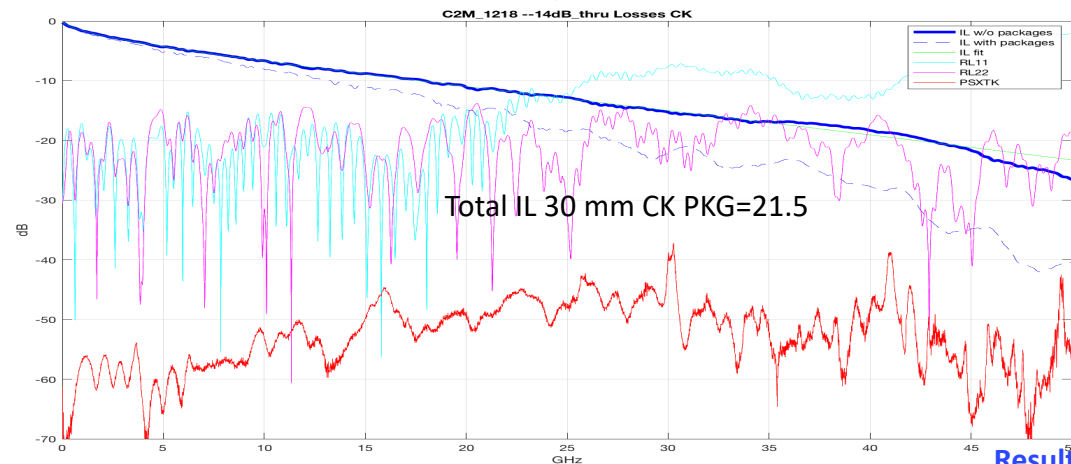
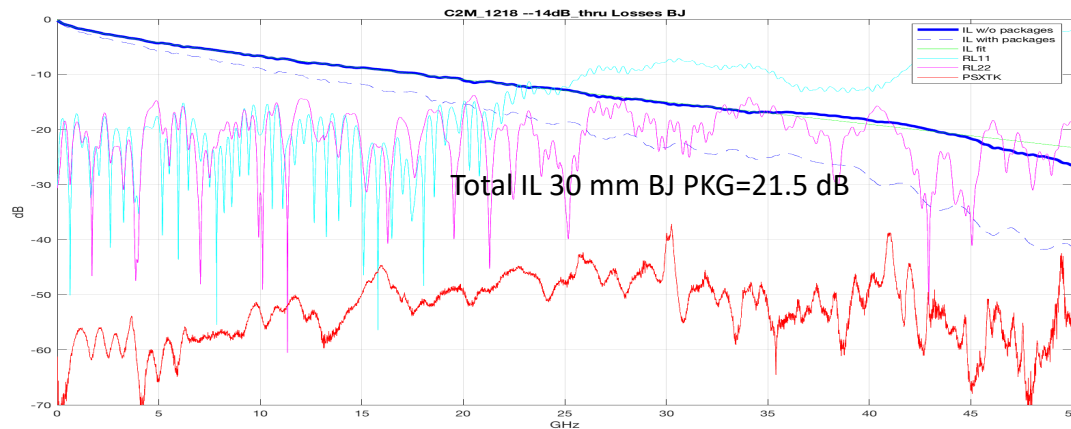
BJ PKG: COM=2.58 (4.44) dB, EH=15.3 (15.9) mV, VEC=11.8 (8.0) dB

CK PKG: COM=2.74 (3.86) dB, EH=14.7 (15.4) mV, VEC=11.4 (8.9) dB

Lim 16 dB, FOM_ILD=0.127, ICN=2.37 mV, ICR=30.8 dB, ERL11=8.8, ERL22=11.6

BJ PKG: COM=2.63 (4.16) dB, EH=12.1 (12.1) mV, VEC=11.6 (8.4) dB

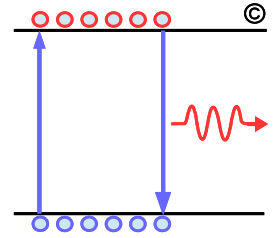
CK PKG: COM=2.60 (4.31) dB, EH=9.9 (12.6) mV, VEC=11.7 (8.2) dB



Result in (x) are for 30 mm PKG.

COM Analysis on Lim Nov-18 Channels (new contacts)

- Lim Nov-2018 channel ICR still pretty low ~30 dB and with high ICN, but the crosstalk peak at 15 GHz eliminated, with this improvement passes with good margin on 30 mm package

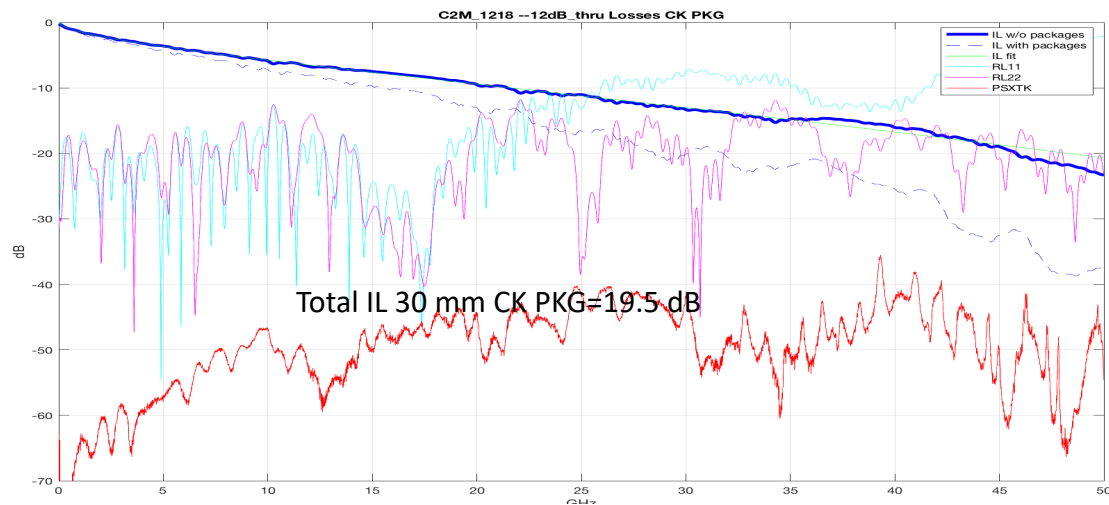
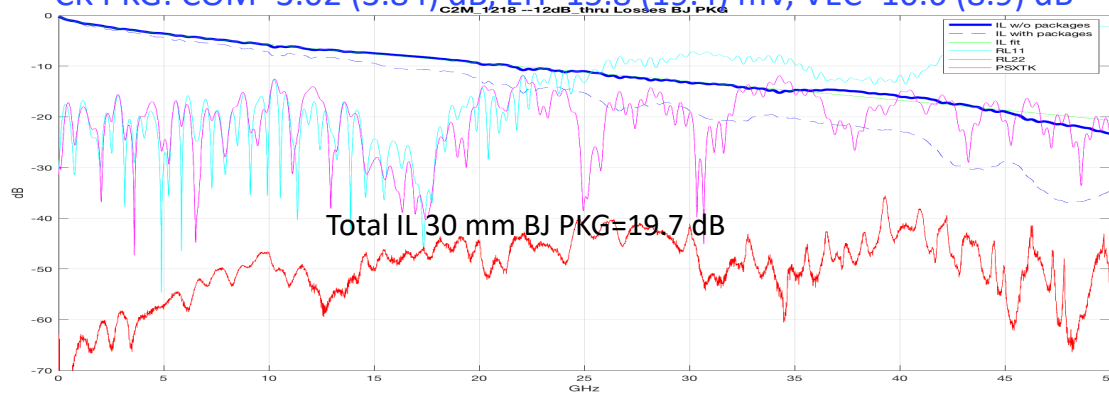


— http://www.ieee802.org/3/ck/public/tools/c2m/lim_3ck_01_0918_QDD_new_pairs.zip

Lim 12 dB, FOM_ILD=0.145, ICN=3.76 mV, ICR=30.2 dB, , ERL11=8.3, ERL22=11.5

BJ PKG: COM=2.6 (4.3) dB, EH=15.9 (19.2) mV, VEC=11.7 (8.1) dB

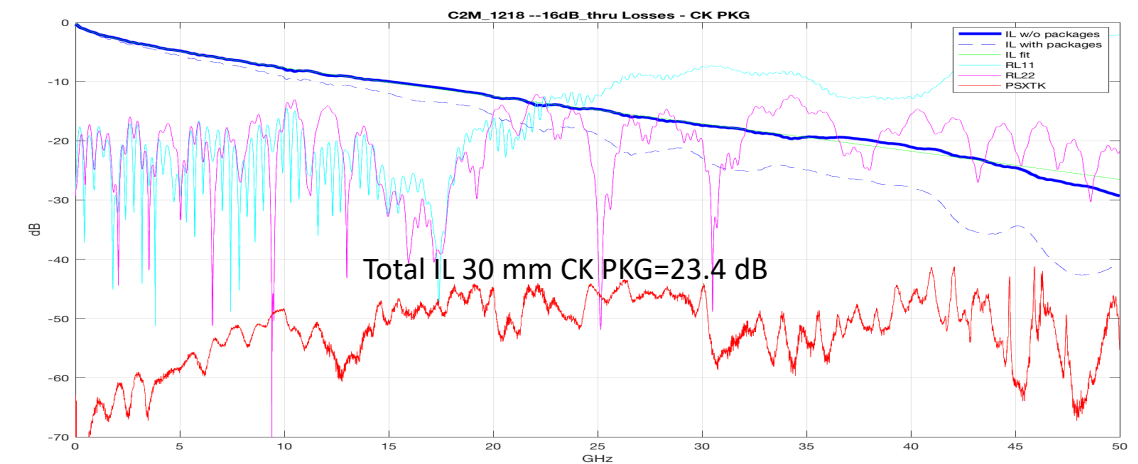
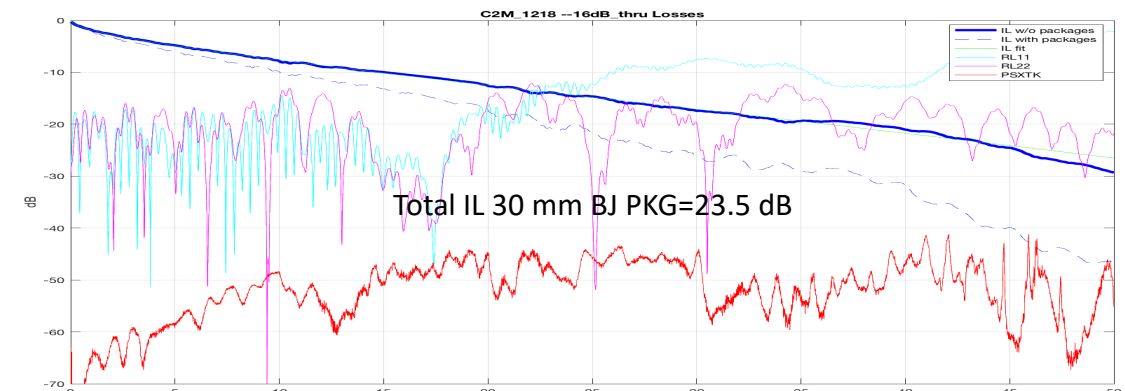
CK PKG: COM=3.02 (3.84) dB, EH=15.8 (19.4) mV, VEC=10.6 (8.9) dB



Lim 16 dB, FOM_ILD=0.142, ICN=2.92 mV, ICR=30.8 dB, , ERL11=8.8, ERL22=11.6

BJ PKG: COM=2.47 (3.9) dB, EH=11.6 (13.3) mV, VEC=12.1 (8.8) dB

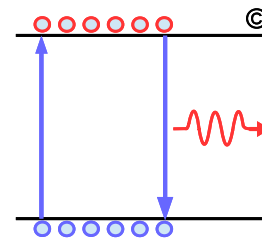
CK PKG: COM=2.57 (3.6) dB, EH=9.9 (10.8) mV, VEC=11.8 (9.4) dB



Result in (x) are for 30 mm PKG.

IEEE 802.3ck Task Force

Yamaichi Improved QSFP-dd on Host Channel with 2x7 mils Via stubs



These board have dramatically improved ICN (Include 7 FEXT+ 8 NEXT) but ILDs are high

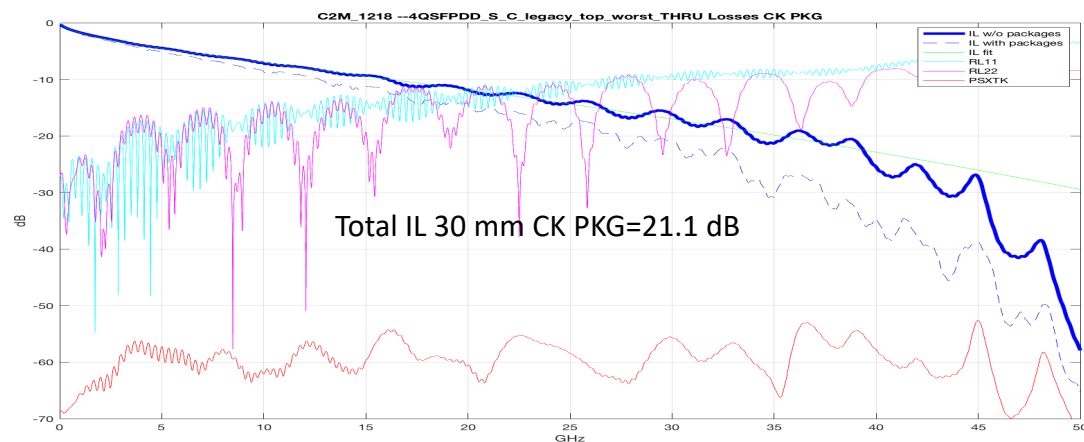
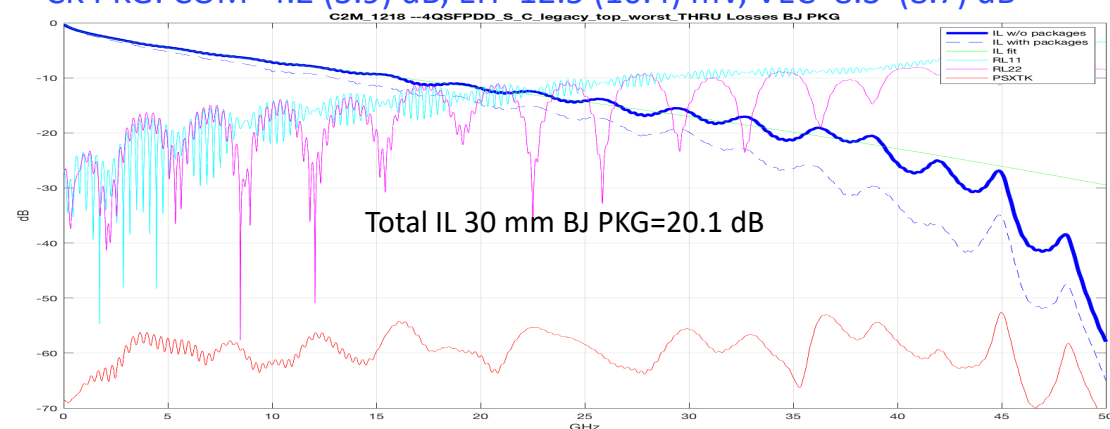
- Top-contact legacy channel loss 15.17 dB and top contact-dd channel loss is 15.21 dB.

Top-Legacy Contact (worst mating)

FOM_ILD=0.557, ICN=1.07 mV, ICR=43 dB, , ERL11=9.8, ERL22=9.6

BJ PKG: COM=4.6 (5.0) dB, EH=15.9 (14.6) mV, VEC=7.6 (7.2) dB

CK PKG: COM=4.2 (3.9) dB, EH=12.5 (10.4) mV, VEC=8.3 (8.7) dB

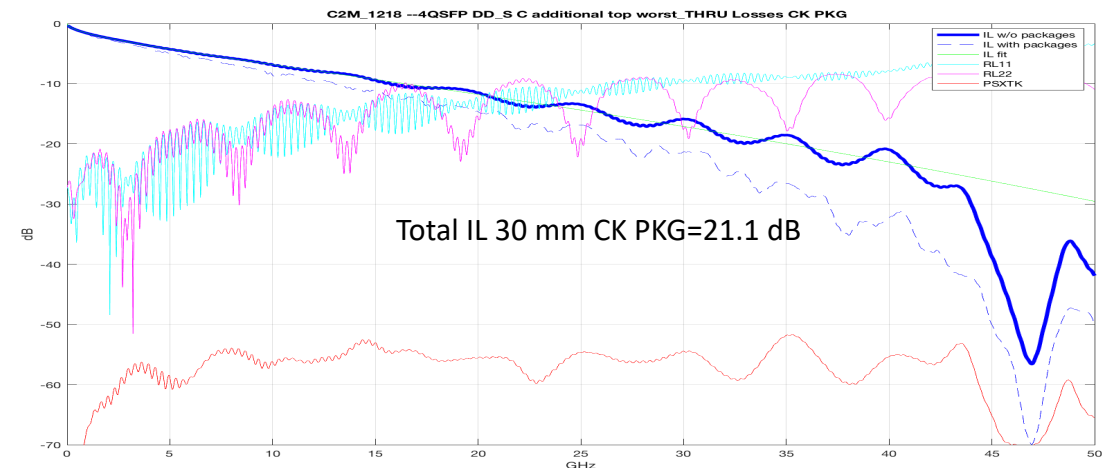
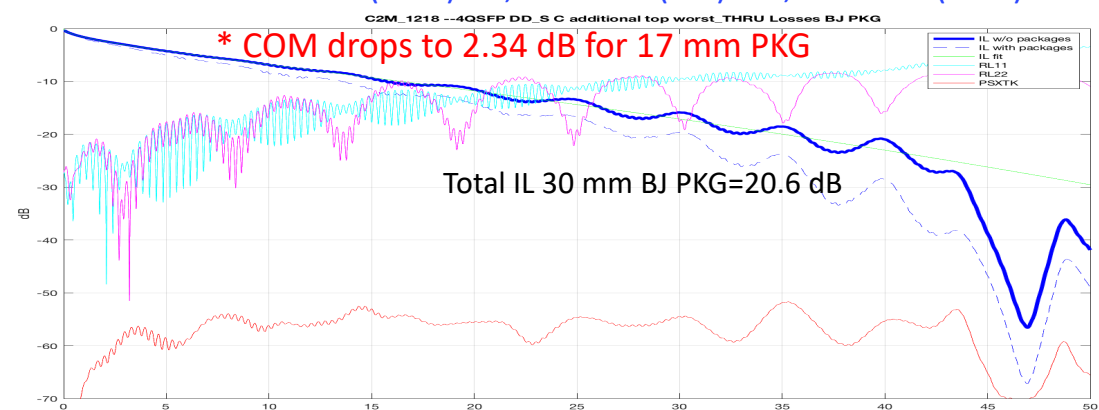


Top-dd Contact (worst mating)

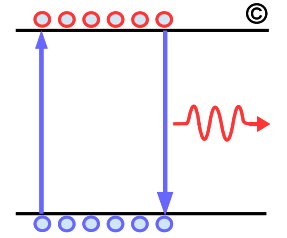
FOM_ILD=0.739, ICN=1.46 mV, ICR=40 dB, , ERL11=9.8, ERL22=9.4

BJ PKG: COM=3.08 (3.80) dB, EH=10.4 (10.6) mV, VEC=10.5 (9.0) dB

CK PKG: COM=3.91* (2.46) dB, EH=11.3 (7.4) mV, VEC=8.8 (12.1) dB

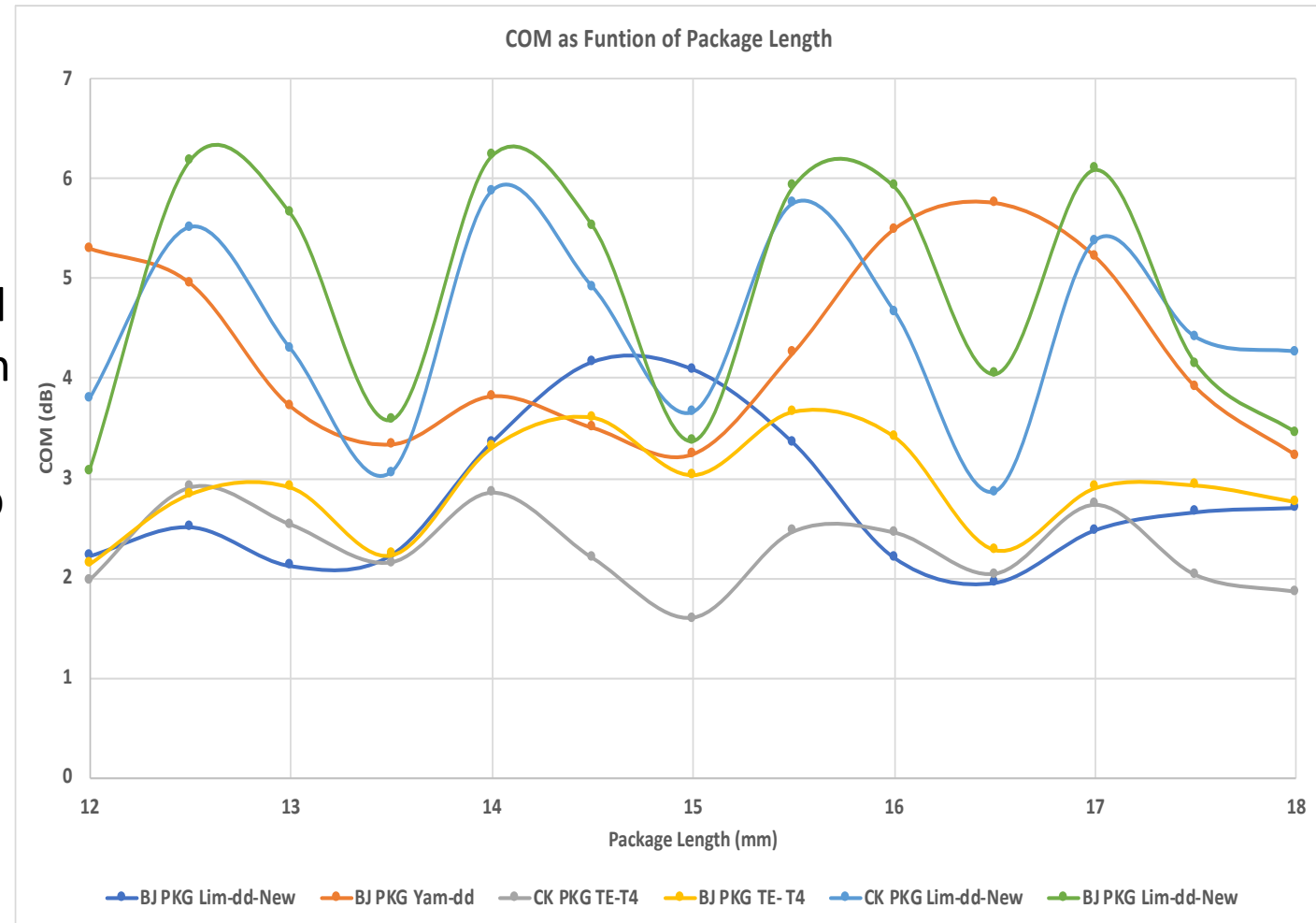


COM As Function of Package Trace Length

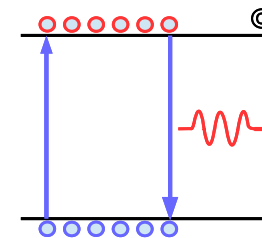


□ COM reported for short package trace lengths may not account for worst interferences

- COM results are without crosstalk
- Result indicate both package and channel dependency with > 2 dB of COM variation
- ASIC Double reflection period is ~3.5 mm
 - Yamaichi channel possibly due to high ILD may have 2nd order interference
- One method to improve short package ASIC COM is by optimizing traces length to avoid double reflection landing in middle of the eye.



Study of Lim QSFP-dd Channels as Function of Equalizer and Package

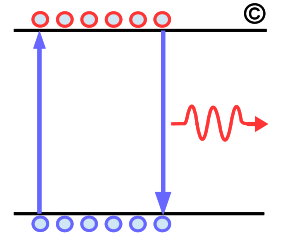


□ QSFP-dd new contacts

- Unless short ASIC packages could be tuned either 12 tap FFE or 5 tap FFE+1DFE would be necessary!

| Channel | EQ | 14 mm Package | | | 15 mm Package | | | 30 mm Package | | |
|----------------------------------------------------------------------------|-------------|---------------|---------|----------|---------------|---------|----------|---------------|---------|----------|
| | | COM (dB) | EH (mV) | VEC (dB) | COM (dB) | EH (mV) | VEC (dB) | COM (dB) | EH (mV) | VEC (dB) |
| Lim 16 dB dd CK Package ILD=0.14, ICN=2.9 ERL11=8.8 ERL22=11.6 | 5T FFE | 4.4 | 15.9 | 8.0 | 2.6 | 9.9 | 11.8 | 3.6 | 10.8 | 9.4 |
| | 7T FFE | 4.39 | 17.2 | 8.0 | 2.54 | 10.1 | 11.9 | 3.6 | 11.0 | 9.4 |
| | 9T FFE | 4.4 | 17.2 | 8.0 | 2.6 | 10.2 | 11.8 | 3.6 | 11.0 | 9.4 |
| | 12T FFE | 3.7 | 12.0 | 9.2 | 3.7 | 12.0 | 9.1 | 3.6 | 11.0 | 9.4 |
| | 5T FFE+1DFE | 4.2 | 20.6 | 8.2 | 5.3 | 23.2 | 6.8 | 4.8 | 18.4 | 7.5 |
| Lim 16 dB dd BJ Package ILD=0.14, ICN=2.9 ERL11=8.8 ERL22=11.6 | 5T FFE | 4.7 | 19.5 | 7.5 | 2.5 | 11.6 | 12.1 | 3.9 | 13.3 | 8.8 |
| | 7T FFE | 4.7 | 19.4 | 7.6 | 2.5 | 11.6 | 12.1 | 4.0 | 13.5 | 8.7 |
| | 9T FFE | 4.8 | 16.0 | 7.5 | 2.5 | 11.6 | 12.1 | 4.0 | 13.5 | 8.7 |
| | 12T FFE | 5.3 | 20.8 | 6.8 | 4.6 | 14.7 | 7.7 | 4.0 | 13.5 | 8.7 |
| | 5T FFE+1DFE | 5.5 | 23.4 | 6.6 | 4.1 | 20.5 | 8.5 | 5.0 | 19.4 | 7.2 |

Tracy Channels with Long Barrel Via

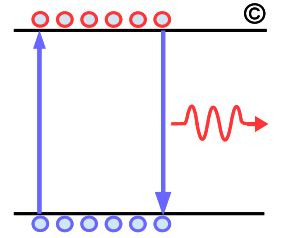


Tracy T4 and T6 both have high ILD

- With BJ package both T4 and T6 works fine with 5T FFE but incase of CK package 7-9 taps FFE would be needed!

| Channel | EQ | 14 mm Package | | | 15 mm Package | | | 30 mm Package | | |
|----------------------------------------------------------------------------|--------|---------------|---------|----------|---------------|---------|----------|---------------|---------|----------|
| | | COM (dB) | EH (mV) | VEC (dB) | COM (dB) | EH (mV) | VEC (dB) | COM (dB) | EH (mV) | VEC (dB) |
| TE T6 Channel CK Package ILD=0.39, ICN=1.0 ERL11=11.1 ERL22=9.1 | 5T FFE | 3.0 | 9.2 | 10.7 | 1.8 | 6.4 | 14.7 | 2.6 | 7.5 | 11.7 |
| | 7T FFE | 4.0 | 12.5 | 8.7 | 2.7 | 9.3 | 11.4 | 3.5 | 9.5 | 9.6 |
| | 9T FFE | 4.7 | 14.3 | 7.5 | 3.6 | 12.9 | 9.4 | 4.2 | 11.2 | 8.4 |
| TE T6 Channel BJ Package ILD=0.39, ICN=1.0 ERL11=11.1 ERL22=9.1 | 5T FFE | 5.4 | 17.6 | 6.7 | 4.9 | 14.6 | 7.3 | 4.3 | 12.6 | 8.2 |
| | 7T FFE | 4.7 | 19.4 | 7.6 | 2.5 | 11.6 | 12.1 | 4.0 | 13.5 | 8.7 |
| | 9T FFE | 5.4 | 16.4 | 6.7 | 3.9 | 11.9 | 8.7 | 4.8 | 11.9 | 7.5 |
| TE T4 Channel CK Package ILD=0.15, ICN=0.54 ERL11=8.8, ERL22=11.6 | 5T FFE | 2.8 | 9.3 | 11.1 | 1.58 | 5.3 | 15.6 | 2.5 | 6.6 | 12.5 |
| | 7T FFE | 4.5 | 13.4 | 7.9 | 3.2 | 10.5 | 10.3 | 3.8 | 10.1 | 9.0 |
| | 9T FFE | 5.5 | 17.6 | 6.6 | 4.3 | 14.1 | 8.2 | 4.7 | 13.7 | 7.6 |
| TE T4 Channel BJ Package ILD=0.15, ICN=0.54 ERL11=8.8, ERL22=11.6 | 5T FFE | 3.3 | 12.1 | 10.0 | 3.0 | 9.6 | 10.6 | 3.2 | 8.9 | 10.1 |
| | 7T FFE | 5.1 | 15.3 | 7.1 | 4.6 | 13.5 | 7.8 | 4.9 | 12.4 | 7.3 |
| | 9T FFE | 6.2 | 19.2 | 5.8 | 5.0 | 15.8 | 7.2 | 3.2 | 8.9 | 10.1 |

50G C2M Specifications



❑ 50G CL135E C2M specifications is based on C2M CL83E

- Does anyone believe elementary loss specifications is sufficient for 100G specifications!

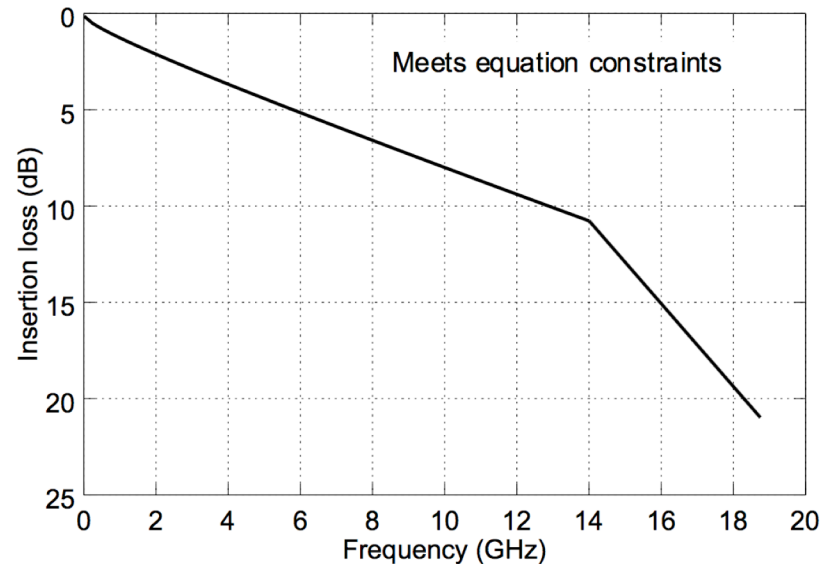


Figure 83E-3—CAUI-4 chip-to-module channel insertion loss

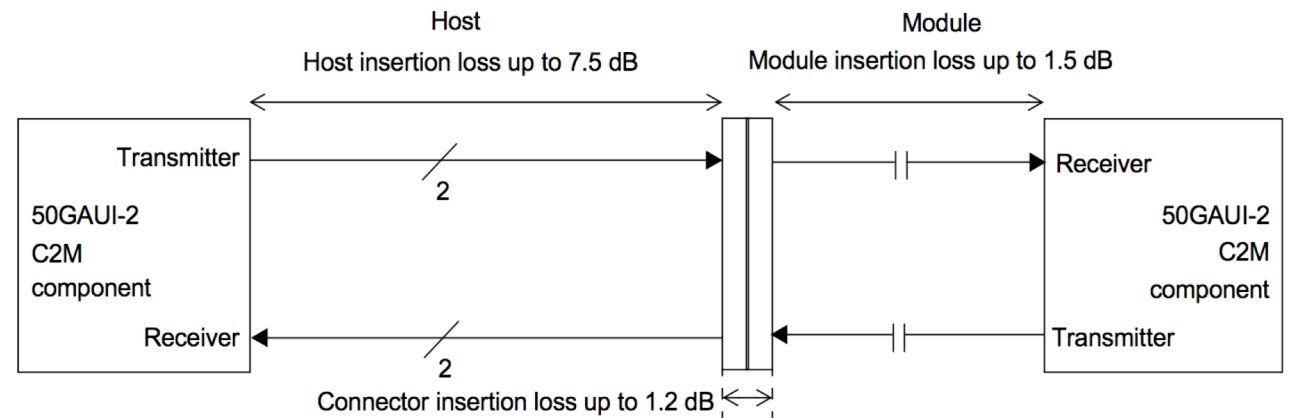
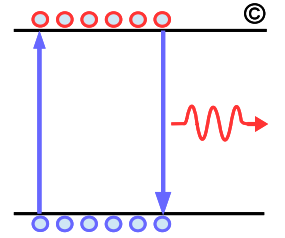


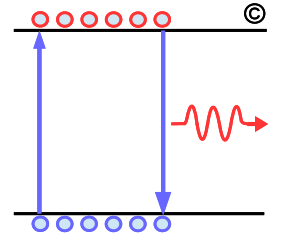
Figure 135E-2—50GAUI-2 C2M insertion loss budget at 13.28 GHz

Improving C2M Methodology



- ❑ **The normative specifications are at TP1a and TP4**
 - Any host package/channel combination delivering TP1a EH/EW/VEC is a compliant host
 - Any module delivering TP4/farend EH/EW/VEC is a compliant module
- ❑ **As we move from 50G to 100G with ever expanding connector option more robust specifications in addition to max insertion loss**
 - It has been suggested to add limit on ICN, ILD, ERL, and IL but adding these hard limit potentially may outlaw some channel which are compliant at TP1a/TP4
 - COM is now being used as the tool to study C2M equalizers and channel compliance
 - COM can be utilized as a tool to trade-off ICN, ILD, ERL, IL instead of defining hard limits
 - An informative COM annex will provide significant benefit to the industry given the complexity of 100G
- ❑ **In addition we should also explore use of COM for mated boards.**

Summary



- ❑ **The 5 tap low power FFE equalizer may not be sufficient unless ILD, ICN, and channel reflections are better controlled**
 - The source of problems are long barrel vias and connector crosstalk which is improving
- ❑ **The new CK proposed package with higher ILD and lower loss penalizes C2M applications where the C2M equalizers are not capable to cancel the package double reflections**
 - Need to consider limitations of C2M interface as we develop a common package for CK
 - Otherwise C2M will get the short end and forced to higher power class equalizer such as 12 tap FFE or 5 tap FFE+1 DFE
 - These more capable equalizer with higher power will make it difficult to build 800G modules
- ❑ **Combination of new proposed CK package with higher ILD, channels with long barrel via/stubs, and QSFP-dd new contacts may drive C2M equalizer complexity to 12 tap FFE or 5 tap FFE+1DFE**
 - 5 Tap FFE might be sufficient if we can improve CK package ILD, tune short package traces, or use blind vias
 - Alternatively we can explore two C2M receivers for connectors with improved SI and a more capable receiver for connector with more challenging SI – not the best option
- ❑ **Instead of defining hard limit on ILD, ICN, IL, or ERL COM can be used as the tool for channel goodness but first we need to agree on complexity of equalizer 1st**
 - Purpose to add a C2M COM informative annex instead of adding hard limits on ILD, ICN, IL, or ERL.