

# Influence of Module Package on C2M interfaces

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# Contributors & Supporters

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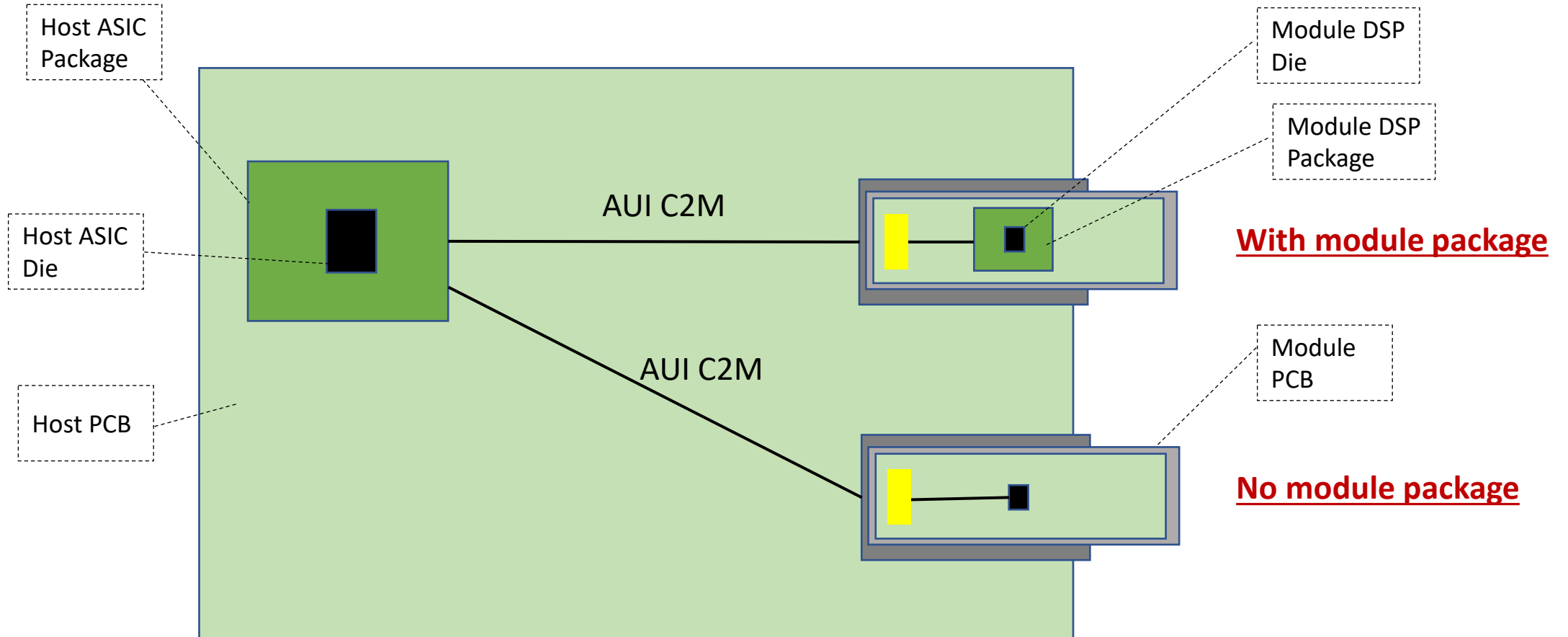
# Goals

- Address module package assumption
- Provide results from COM 4.1 and the two package assumptions on a subset of channels
  - With module package
  - No module package

# Background

- In September 2023, TF provided feedback on the module-side package parameters used in the AUI C2M analysis
  - Analysis used
    - Class A host package with Class A module package
    - Class B host package with Class B module package
  - See: [LINK TO PRESO HERE](#)
- Offline discussions suggest that 200G/lane pluggable transceiver modules are trending towards “bare die attach” (e.g. no module package)

# Front Panel Pluggable (FPP) Diagram



Not to scale

# Reference EQ & Params Highlights – By Class

No change from September

- Class I/II/III

| Parameter              | 802.3ck C2M | 802.3ck CR | 802.3ck KR | 802.3ck C2M-like | 802.3ck CR-like | 802.3ck CR-like<br>+ <b>MLSE</b> |
|------------------------|-------------|------------|------------|------------------|-----------------|----------------------------------|
| DER_0                  | 1E-5        | 1E-4       | 1E-4       | 2E-5             | 2E-5            | 2E-5                             |
| SNR_TX                 | 32.5        | 32.5       | 33         | 33               | 33              | 33                               |
| R_LM                   | 0.95        | 0.95       | 0.95       | 0.95             | 0.95            | 0.95                             |
| TxFIR Length           | 4 (2 pre)   | 5 (3 pre)  | 5 (3 pre)  | 6 (4 pre)        | 6 (4 pre)       | 6 (4 pre)                        |
| eta_0                  | 4.10E-08    | 9E-09      | 8.2E-09    | 1.25E-08         | 1.25E-08        | 1.25E-08                         |
| N_b                    | 4           | 12         | 12         | 1                | 1               | 1                                |
| ffe_pre_tap_len        | -           | -          | -          | 4                | 4               | 4                                |
| ffe_post_tap_len       | -           | -          | -          | 24               | 24              | 24                               |
| N_bg                   | 0           | 3          | 3          | 0                | 4               | 6                                |
| N_bf                   | -           | 3          | 3          | 3                | 5               | 3                                |
| N_f                    | -           | 40         | 40         | 60               | 60              | 60                               |
| MLSE                   | 0           | 0          | 0          | 0                | 0               | 1                                |
| <b>Ref TX/RX Class</b> |             |            |            | <b>I</b>         | <b>II</b>       | <b>III</b>                       |

Note: these classes are starting points,  
not specific recommendations.

(Mild)

(Spicy!)

# 802.3dj C2M Channel Contributions

| Contribution   | Channel List  | Host Type |
|--|---|-----------|
| rabinovich_3df_01_2209 (3x)<br>rabinovich_3dj_02_230116 (1x)         | Rabinovich_C2M_200G_Ortho_[19, 67, 93]mil_092122_Thru.s4p<br>Rabinovich_C2M_200G_Ortho_135mil_011723_Thru.s4p | CONV PCB  |
| rabinovich_3df_02_2209 (3x)<br>rabinovich_3dj_03_230116 (1x)         | Rabinovich_C2M_200G_Paral_[19, 67, 93]mil_092122_Thru.s4p<br>Rabinovich_C2M_200G_Paral_135mil_011723_Thru.s4p | CONV PCB  |
| shanbhag_3dj_03_2305 (6x)  | C2M_TP0TP1a_XpYdB_PCBHost_3p7dB_THRU  | CONV PCB  |
|  | C2M_TP0TP1a_XpYdB_CabledHost_7p85dB_THRU  | NCC       |
| akinwale_3dj_02_2307 (28x)   | C2M_PCB_85ohms_XpYin_20230620_v3_thru1  | CONV PCB  |
| akinwale_3dj_03_2307 (27x)   | C2M_PCB_93ohms_XpYin_20230620_v3_thru1  | CONV PCB  |
| akinwale_3dj_04_2307 (28x)   | C2M_PCB_100ohms_XpYin_20230620_v3_thru1   | CONV PCB  |
| lim_3dj_01_2307 (1x)<br>lim_3dj_02_2307 (1x)<br>lim_3dj_06_2309 (1x) | li_dj_C2M_DesignA_Rev1_THRU   | CONV PCB  |
|  | li_dj_C2M_DesignB_Rev1_THRU   | CONV PCB  |
|  | li_dj_C2M_DesignC_Rev1_THRU   | CONV PCB  |
| Weaver_3dj_elec_02_230831 (16X)                                      | C2M_A_OSFP224_Xin_host_PCB_YC_thru_TPO_....s4p  | CONV PCB  |
| Kareti_3dj_02_2309 (12x)   | PCB_Host_ball_ball_Xdb_set3   | CONV PCB  |
|  | Cable_Host_ball_ball_Xdb_set3   | NCC       |
| Gore_3dj_elec_02_231026 (18x)  | C2M_Tp1a_N_twskew_A_PCB-X_mm_FO-Y_mm  |           |





# A Relative Comparison

Host package loss (30 mm): ~7.34dB  
 Module package loss (8 mm): ~2.36dB

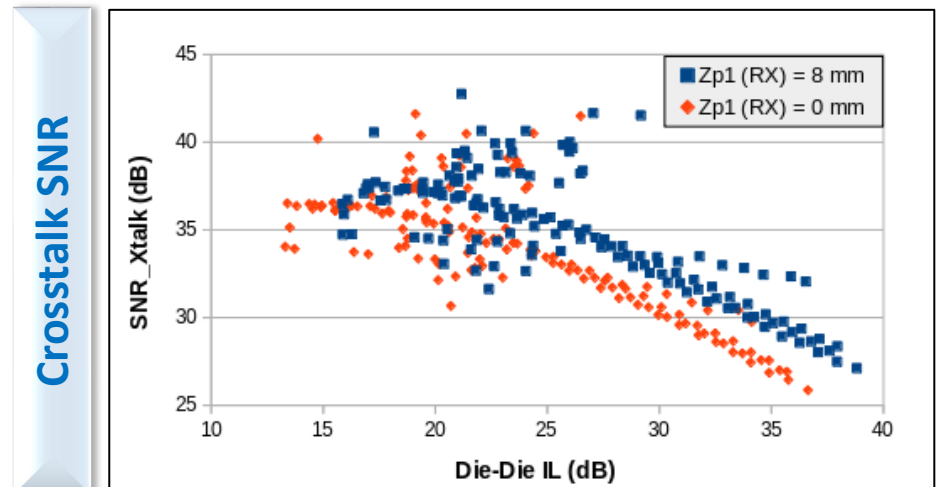
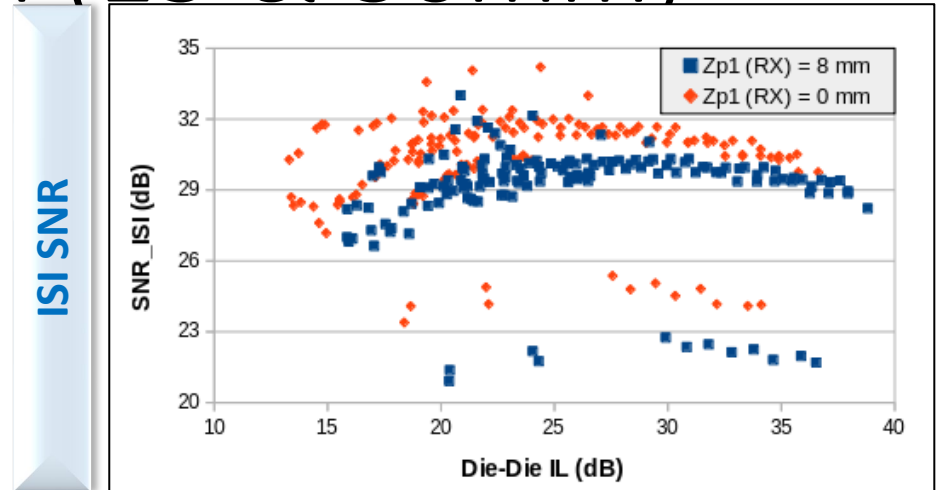
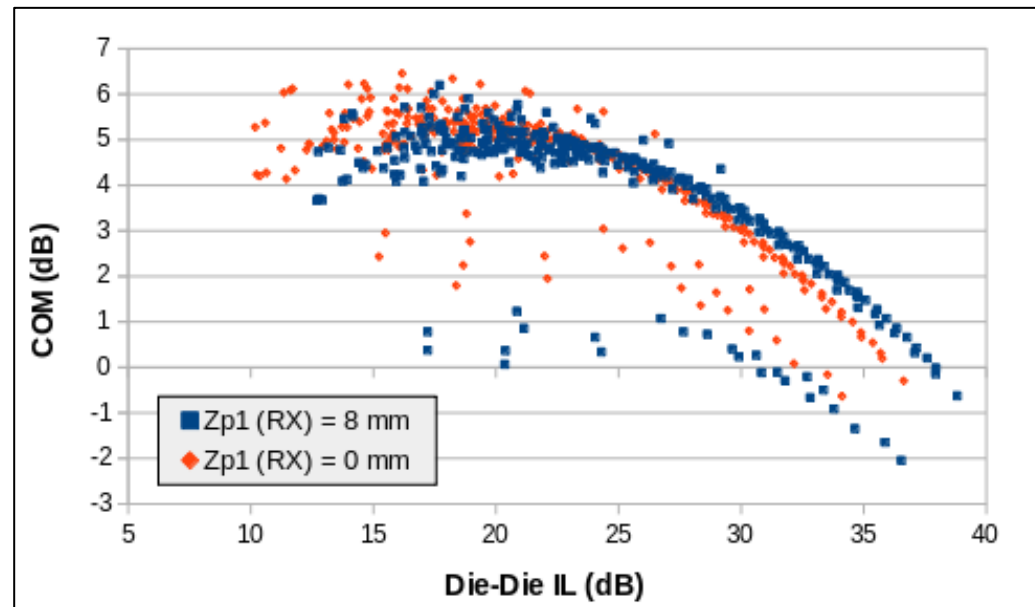
## With Module PKG

## No Module PKG

| Channel                                      | IL (dB) | Fit IL (dB) | ILD (dB) | ERL (dB) | ICN (mV) | ICR (dB) | Bump-Bump IL<br>Zp(RX) = 8 | COM, Zp (TX) = 30mm |       |       | Bump-Bump IL<br>Zp(RX) = 0 | COM, Zp (TX) = 30mm |      |      |
|--|---------|-------------|----------|----------|----------|----------|----------------------------|---------------------|-------|-------|----------------------------|---------------------|------|------|
|  |         |             |          |          |          |          |                            | I                   | II    | III   |                            | I                   | II   | III  |
| weaver/egress/C2M_X_OSFP224_3in_host_PCB_80C | 7.32    | 7.91        | 0.18     | 14.19    | 5.12     | 27.99    | 16.28                      | 4.60                | 5.51  | 6.23  | 13.72                      | 5.28                | 5.81 | 6.33 |
| akinwale_3dj_02_2307/C2M_PCB_93ohms_1p0in    | 7.64    | 7.96        | 0.25     | 15.06    | 4.17     | 27.30    | 16.80                      | 4.77                | 5.38  | 6.21  | 14.38                      | 4.81                | 5.46 | 6.01 |
| shanhag/C2M_TP0TP1a_11p7dB_CabledHost_7p85dB | 8.35    | 8.83        | 0.30     | 17.19    | 2.48     | 36.64    | 17.26                      | 5.49                | 5.75  | 6.35  | 14.76                      | 6.12                | 6.42 | 6.85 |
| weaver/egress/C2M_X_OSFP224_5in_host_PCB_80C | 10.08   | 10.73       | 0.17     | 14.45    | 4.05     | 28.01    | 19.70                      | 4.72                | 5.67  | 6.73  | 17.01                      | 5.31                | 5.84 | 6.67 |
| gore/C2M_TP1a_3_twskew_high_PCB-55_mm_FO-150 | 11.39   | 11.90       | 0.22     | 15.51    | 2.75     | 27.26    | 20.93                      | 5.16                | 5.44  | 6.75  | 18.70                      | 4.82                | 5.06 | 5.94 |
| li_dj_C2M_Design_C_Rev1_THRU                 | 11.54   | 12.30       | 0.62     | 14.45    | 2.59     | 26.12    | 21.00                      | 4.72                | 5.08  | 6.24  | 19.01                      | 5.19                | 5.63 | 6.49 |
| li_dj_C2M_Design_B_Rev1_THRU                 | 11.57   | 11.59       | 0.38     | 15.65    | 2.46     | 27.78    | 20.32                      | 4.79                | 5.04  | 5.83  | 18.56                      | 4.99                | 5.25 | 6.02 |
| li_dj_C2M_Design_A_Rev1_THRU                 | 11.61   | 11.69       | 0.18     | 14.90    | 4.06     | 24.23    | 20.54                      | 4.50                | 4.73  | 5.83  | 18.77                      | 5.14                | 5.40 | 6.25 |
| Kareti/Cabled_Host_ball_ball_11db.s4p        | 11.65   | 12.83       | 0.64     | 7.94     | 3.83     | 24.86    | 20.36                      | 0.06                | 2.00  | 2.78  | 18.38                      | 1.79                | 3.07 | 3.83 |
| shanhag/C2M_TP0TP1a_8p4dB_PCBHost_3p7dB      | 11.68   | 12.10       | 0.15     | 14.36    | 1.65     | 25.34    | 21.17                      | 4.89                | 5.10  | 6.19  | 19.12                      | 5.51                | 5.76 | 6.47 |
| shanhag/C2M_TP0TP1a_12p1dB_PCBHost_7p3dB     | 12.13   | 12.53       | 0.30     | 17.59    | 1.72     | 37.72    | 22.06                      | 5.60                | 5.87  | 6.87  | 19.37                      | 6.22                | 6.53 | 7.25 |
| Rabinovich_C2M_200G_Ortho_19mil              | 12.38   | 13.57       | 0.70     | 15.90    | 1.79     | 28.68    | 20.86                      | 5.66                | 5.89  | 7.10  | 19.21                      | 5.69                | 5.94 | 6.75 |
| gore/C2M_TP1a_6_twskew_high_PCB-60_mm_FO-200 | 12.40   | 13.03       | 0.21     | 15.80    | 2.55     | 25.90    | 21.63                      | 4.52                | 4.77  | 6.10  | 19.21                      | 4.77                | 5.01 | 6.07 |
| weaver/egress/C2M_X_OSFP224_7in_host_PCB_80C | 12.91   | 13.53       | 0.17     | 14.63    | 3.27     | 27.53    | 22.78                      | 4.49                | 5.43  | 6.91  | 20.15                      | 5.04                | 5.52 | 6.67 |
| Rabinovich_C2M_200G_Ortho_135mil             | 13.35   | 14.99       | 0.96     | 13.26    | 3.39     | 22.24    | 22.40                      | 4.47                | 4.73  | 5.80  | 20.70                      | 4.25                | 4.28 | 5.39 |
| gore/C2M_TP1a_9_twskew_high_PCB-65_mm_FO-250 | 13.42   | 14.15       | 0.21     | 16.03    | 2.34     | 26.79    | 23.15                      | 4.52                | 4.76  | 6.27  | 20.66                      | 4.98                | 5.24 | 6.41 |
| Rabinovich_C2M_200G_Ortho_93mil              | 14.17   | 14.81       | 0.95     | 13.08    | 2.83     | 24.90    | 23.34                      | 4.64                | 4.94  | 6.29  | 21.61                      | 4.57                | 4.84 | 5.65 |
| akinwale_3dj_02_2307/C2M_PCB_93ohms_5p0in    | 14.43   | 14.47       | 0.23     | 16.53    | 2.83     | 25.31    | 23.89                      | 4.80                | 5.06  | 6.68  | 21.64                      | 5.26                | 5.54 | 6.92 |
| gore/C2M_TP1a_12_twskew_high_PCB-70_mm_FO-30 | 14.60   | 15.27       | 0.20     | 16.26    | 2.13     | 27.27    | 23.80                      | 4.55                | 4.81  | 6.41  | 21.46                      | 4.94                | 5.21 | 6.56 |
| shanhag/C2M_TP0TP1a_14p6dB_PCBHost_9p8dB     | 14.61   | 14.99       | 0.31     | 17.73    | 1.39     | 37.43    | 24.04                      | 5.36                | 5.66  | 7.07  | 21.39                      | 6.02                | 6.31 | 7.31 |
| Rabinovich_C2M_200G_Ortho_67mil              | 14.70   | 14.87       | 0.69     | 15.65    | 2.71     | 27.00    | 23.06                      | 4.98                | 5.24  | 6.65  | 21.45                      | 4.99                | 5.15 | 6.25 |
| Kareti/Cabled_Host_ball_ball_14p5db.s4p      | 15.28   | 16.40       | 0.64     | 8.41     | 3.05     | 24.21    | 24.30                      | 0.34                | 2.20  | 3.57  | 22.11                      | 1.95                | 3.27 | 4.45 |
| weaver/egress/C2M_X_OSFP224_9in_host_PCB_80C | 15.71   | 16.31       | 0.18     | 14.75    | 2.72     | 26.74    | 25.61                      | 4.05                | 4.92  | 6.70  | 23.01                      | 4.52                | 4.97 | 6.50 |
| gore/C2M_TP1a_15_twskew_high_PCB-75_mm_FO-40 | 16.75   | 17.14       | 0.19     | 16.52    | 1.75     | 27.18    | 26.47                      | 4.31                | 4.58  | 6.35  | 24.03                      | 4.81                | 5.09 | 6.67 |
| shanhag/C2M_TP0TP1a_17p1dB_PCBHost_12p2dB    | 17.12   | 17.43       | 0.31     | 17.86    | 1.14     | 37.48    | 27.06                      | 4.91                | 5.17  | 6.96  | 24.39                      | 5.61                | 5.90 | 7.22 |
| gore/C2M_TP1a_18_twskew_high_PCB-80_mm_FO-45 | 17.36   | 18.17       | 0.19     | 16.68    | 1.55     | 27.30    | 26.59                      | 4.19                | 4.44  | 6.38  | 24.17                      | 4.69                | 4.96 | 6.60 |
| shanhag/C2M_TP0TP1a_19p6dB_PCBHost_14p6dB    | 19.60   | 19.87       | 0.32     | 17.94    | 0.95     | 37.60    | 29.18                      | 4.35                | 4.58  | 6.62  | 26.49                      | 5.13                | 5.39 | 7.19 |
| akinwale_3dj_02_2307/C2M_PCB_93ohms_9p0in    | 20.96   | 20.86       | 0.26     | 16.59    | 2.37     | 22.92    | 30.13                      | 3.44                | 3.64  | 5.69  | 27.91                      | 3.85                | 4.06 | 6.11 |
| Kareti/Cabled_Host_ball_ball_20p5db.s4p      | 21.18   | 22.37       | 0.64     | 8.80     | 1.89     | 23.58    | 30.83                      | -0.12               | 1.51  | 3.56  | 28.35                      | 1.36                | 2.85 | 4.82 |
| Kareti/Cabled_Host_ball_ball_22p6db.s4p      | 23.22   | 24.37       | 0.65     | 8.81     | 1.63     | 23.54    | 32.82                      | -0.67               | 0.95  | 2.98  | 30.33                      | 0.80                | 2.28 | 4.34 |
| akinwale_3dj_02_2307/C2M_PCB_93ohms_11p0in   | 24.21   | 24.01       | 0.28     | 16.62    | 2.24     | 21.47    | 33.39                      | 2.22                | 2.36  | 4.42  | 31.17                      | 2.58                | 2.75 | 4.81 |
| Kareti/Cabled_Host_ball_ball_24p5db.s4p      | 25.19   | 26.31       | 0.66     | 8.81     | 1.48     | 23.04    | 34.65                      | -1.35               | 0.21  | 2.22  | 32.16                      | 0.08                | 1.51 | 3.56 |
| Kareti/Cabled_Host_ball_ball_26p4db.s4p      | 27.12   | 28.43       | 0.66     | 8.92     | 1.33     | 22.70    | 36.53                      | -2.05               | -0.53 | -0.53 | 34.12                      | -0.64               | 0.78 | 2.81 |

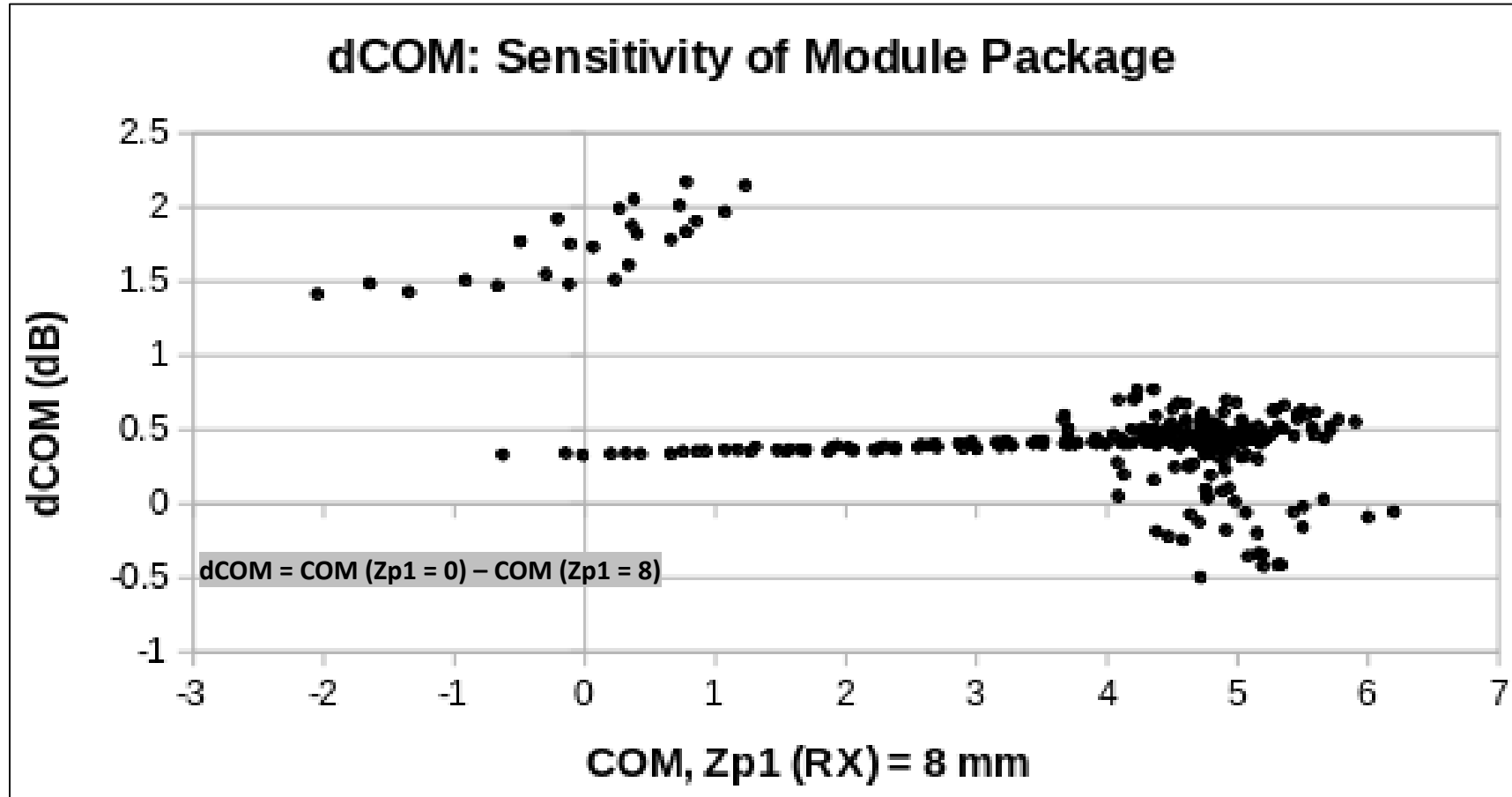
# Sensitivity of Module Package: Class I EQ, all channels, 2 host pkg length (15 & 30mm)

- Reflection reduction vs crosstalk attenuation
  - Removing the module package is beneficial for highly reflective channels at the sacrifice of  $\sim -2$ dB achievable loss
  - Module package can attenuate channel crosstalk
    - We do not model package crosstalk in COM





Sensitivity: Class I EQ, all available channels and 2 host package length (15 & 30 mm)



# Summary

- Provided results from COM 4.1 and the two package assumptions on a subset of channels
  - With module package
  - No module package
- Removing the module package does improve COM on most channels studied
- Looking towards 200G/lane AUI C2M baselines, do we keep the module package in or take it out?

Thanks!

# BACKUP

# COM Reference Sheets for “Add RX PKG”

| Table 93A-1 parameters |  |         |                     | I/O control                                |                        |         |  | Table 93A-3 parameters  |                                |       |  |
|------------------------|--|---------|---------------------|--|------------------------|---------|--|-------------------------|--------------------------------|-------|--|
| Parameter              | Setting                                      | Units   | Information         |  |                        |         |  | Parameter               | Setting                        | Units |  |
| f_b                    | 106.25                                       | GBd     |                     | DIAGNOSTICS                                | 0                      | logical |  | package_tl_gamma0_a1_a2 | [0 8.455e-4 3.40225e-4]        |       |  |
| f_min                  | 0.05   | GHz     |                     | DISPLAY_WINDOW                             | 0                      | logical |  | package_tl_tau          | 0.00644805                     | ns/mm |  |
| Delta_f                | 0.01   | GHz     |                     | CSV_REPORT                                 | 0                      | logical |  | package_Z_c             | [92 92; 70 70; 80 80; 100 100] | Ohm   |  |
| C_d                    | [0.4e-4 0.9e-4 1.1e-4; 0.4e-4 0.9e-4 1.1e-4] | nF      | [TX RX]             | RESULT_DIR                                 | .\results\CAKR_{date}\ |         |  |                         |                                |       |  |
| L_s                    | [0.13 0.15 0.14; 0.13 0.15 0.14]             | nH      | [TX RX]             | SAVE_FIGURES                               | 0                      | logical |  |                         |                                |       |  |
| C_b                    | [0.3e-4 0.3e-4]                              | nF      | [TX RX]             | Port Order                                 | [ 1 3 2 4 ]            |         |  |                         |                                |       |  |
| z_p select             | [1 2]  |         | [test cases to run] | RUNTAG                                     | CAKR_RCos_eval_        |         |  |                         |                                |       |  |
| z_p (TX)               | [15 30; 1 1; 1 1; 0.5 0.5]                   | mm      | [test cases]        | COM CONTRIBUTION                           | 0                      | logical |  |                         |                                |       |  |
| z_p (NEXT)             | [8 8; 0 0; 0 0; 0 0]                         | mm      | [test cases]        | Operational                                |                        |         |  |                         |                                |       |  |
| z_p (FEXT)             | [15 30; 1 1; 1 1; 0.5 0.5]                   | mm      | [test cases]        | ERL Pass threshold                         | 9.7                    | dB      |  |                         |                                |       |  |
| z_p (RX)               | [8 8; 0 0; 0 0; 0 0]                         | mm      | [test cases]        | COM Pass threshold                         | 3                      | dB      |  |                         |                                |       |  |
| PKG_Tx_FFE_preset      | 0  |         |                     | DER_0                                      | 2.00E-05               | ns      |  |                         |                                |       |  |
| C_p                    | [0.5e-4 0.5e-4]                              | nF      | [TX RX]             | T_r  | 4.00E-03               | ns      |  |                         |                                |       |  |
| R_0                    | 50   | Ohm     |                     | FORCE_TR                                   | 1                      | logical |  |                         |                                |       |  |
| R_d                    | [45 45]                                      | Ohm     | [TX RX]             | PMD_type                                   | C2C                    |         |  |                         |                                |       |  |
| A_v                    | 0.39235                                      | V       | vp/vf=              | EW   | 1                      |         |  |                         |                                |       |  |
| A_fe                   | 0.39235                                      | V       | vp/vf=              | TDR and ERL options                        |                        | logical |  |                         |                                |       |  |
| A_ne                   | 0.45   | V       |                     | TDR  | 1                      | logical |  |                         |                                |       |  |
| L                      | 4  |         |                     | ERL  | 1                      | logical |  |                         |                                |       |  |
| M                      | 32   |         |                     | ERL_ONLY                                   | 0                      | ns      |  |                         |                                |       |  |
| filter and Eq          |  |         |                     | TR_TDR                                     | 0.01                   |         |  |                         |                                |       |  |
| f_r                    | 0.6  | *fb     |                     | N  | 2000                   | logical |  |                         |                                |       |  |
| c(0)                   | 0.54   |         | min                 | TDR_Butterworth                            | 1                      |         |  |                         |                                |       |  |
| c(-1)                  | [-0.4:0.02:0]                                |         | [min:step:max]      | beta_x                                     | 0                      |         |  |                         |                                |       |  |
| c(-2)                  | [0.02:0.12]                                  |         | [min:step:max]      | rho_x                                      | 0.618                  |         |  |                         |                                |       |  |
| c(-3)                  | 0  |         | [min:step:max]      | TDR_W_TXPKG                                | 0                      | UI      |  |                         |                                |       |  |
| c(-4)                  | 0  |         | [min:step:max]      | N_bx                                       | 0                      |         |  |                         |                                |       |  |
| c(1)                   | 0  |         | [min:step:max]      | fixture delay time                         | [ 0 0 ]                |         |  |                         |                                |       |  |
| N_b                    | 1  | UI      |                     | Tukey_Window                               | 1                      |         |  |                         |                                |       |  |
| b_max(1)               | 0.75   |         | As/dffe1            | Noise_jitter                               |                        |         |  |                         |                                |       |  |
| b_max(2..N_b)          | [0.3 0.2*ones(1,22)]                         |         | As/dfe2..N_b        | sigma_RJ                                   | 0.01                   | UI      |  |                         |                                |       |  |
| b_min(1)               | 0  |         | As/dffe1            | A_DD                                       | 0.02                   | UI      |  |                         |                                |       |  |
| b_min(2..N_b)          | [-0.2 -0.2*ones(1,22)]                       |         | As/dfe2..N_b        | eta_0                                      | 1.25E-08               | V^2/GHz |  |                         |                                |       |  |
| g_DC                   | [-15:1:0]                                    | dB      | [min:step:max]      | SNR_TX                                     | 33                     | dB      |  |                         |                                |       |  |
| f_z                    | 42.5   | GHz     |                     | R_LM                                       | 0.95                   |         |  |                         |                                |       |  |
| f_p1                   | 42.5   | GHz     |                     |  |                        |         |  |                         |                                |       |  |
| f_p2                   | 106.25                                       | GHz     |                     | Enforce Causality                          | 0                      |         |  |                         |                                |       |  |
| g_DC_HP                | [-6:1:0]                                     |         | [min:step:max]      | S-parameter magnitude extrapolation policy | trend_to_DC            |         |  |                         |                                |       |  |
| f_HP_PZ                | 1.328125                                     | GHz     |                     |  |                        |         |  |                         |                                |       |  |
| Butterworth            | 1  | logical | include in fr       | Filter: RxFFE                              |                        |         |  |                         |                                |       |  |
| Raised_Cosine          | 0  | logical | include in fr       | ffe_pre_tap_len                            | 4                      | UI      |  |                         |                                |       |  |
| RC_Start               | 6.70E+10                                     | Hz      | start freq for RCos | ffe_post_tap_len                           | 24                     | UI      |  |                         |                                |       |  |
| RC_end                 | 7.97E+10                                     | Hz      | end freq for RCos   | ffe_tap_step_size                          | 0                      |         |  |                         |                                |       |  |
|                        |  |         |                     | ffe_main_cursor_min                        | 1                      |         |  |                         |                                |       |  |
| sample_adjustment      | [-16 8]                                      | phase   |                     | ffe_pre_tap1_max                           | 1                      |         |  |                         |                                |       |  |
| ts_anchor              | 1  |         |                     | ffe_post_tap1_max                          | 1                      |         |  |                         |                                |       |  |
|                        |  |         |                     | ffe_tapn_max                               | 1                      |         |  |                         |                                |       |  |
|                        |  |         |                     | ffe_backoff                                | 0                      |         |  |                         |                                |       |  |



