# 100G OSFP Cable Assemblies

## Insertion Loss Analysis and Channel Contribution

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# Agenda

Cable assembly model and test vehicle description

Review of measured cable assembly data

Review of 2m 26AWG cable assembly expected performance

100G connector performance, initial review

S-Parameter file contribution for two cable assemblies

Summary

# Measured Cable Assembly Analysis and Simulation Contribution

TE has presented cable assembly simulation data previously as our development results have progressed

- tracy_100GEL_01a_0318, recommends 30dB loss budget
- tracy_3ck_02a_1118, suggests there is going to be an issue with the 28dB 2m goal
- February 27, 2019 P802.3ck adhoc, provided simulation and measured results for a number of cables and configurations, projecting a 19.4 to 20.4 dB loss range of loss for 2m cable assemblies
- This presentation repeats some of the Feb 27, 2019 data and contributes two new cable assembly channel S-Parameter simulations for a 1.5m 28AWG cable assembly and a 2m 28AWG cable assembly for working group analysis

# Model and Test Setup

The following data is from 50G OSFP MCBs with 2.55 dB of insertion loss at 26.56 GHz rather than the 2.3 dB currently being used as a placeholder in IEEE 802.3ck

There is currently an IEEE generated 17.6 dB insertion loss target placeholder for the cable assembly channel TP1 to TP4.

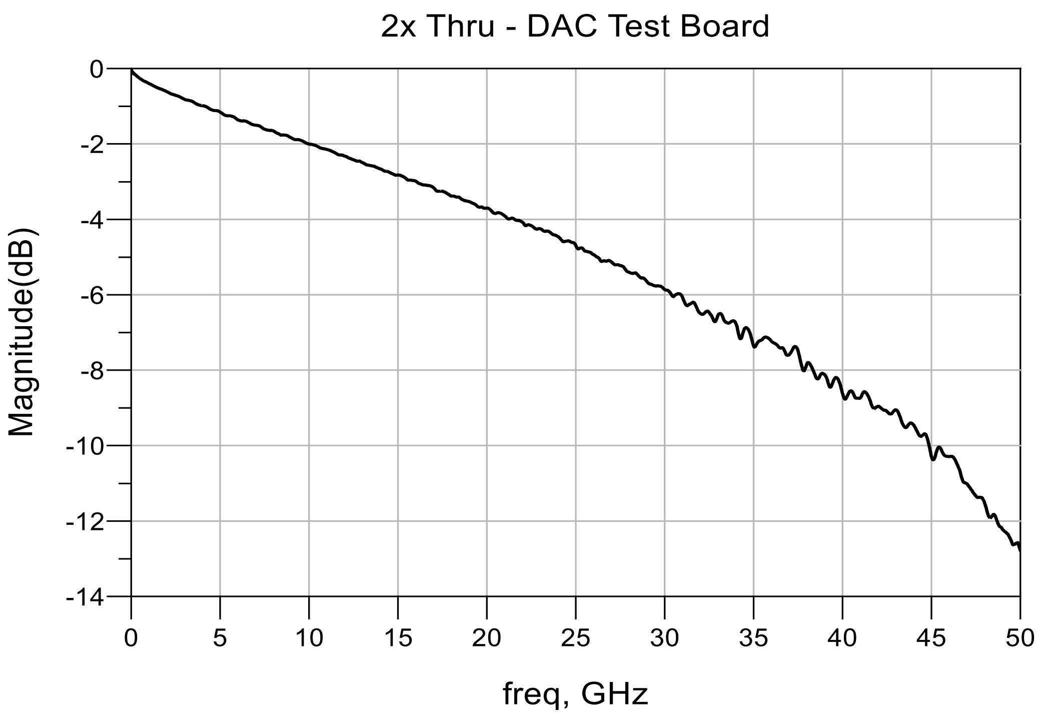
Due to the fact TE is using a **2.55 dB MCB**, the following data is referenced to an 18.1 dB IEEE target

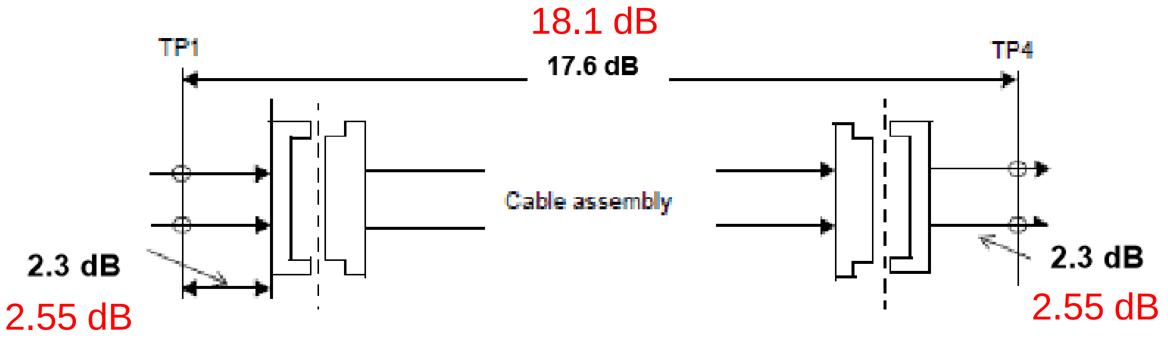
17.6 dB + (2.55 – 2.3)* 2 = 18.1 dB

TE is using a **modified 50G OSFP receptacle** (modified module mating zone, MSA compliant)

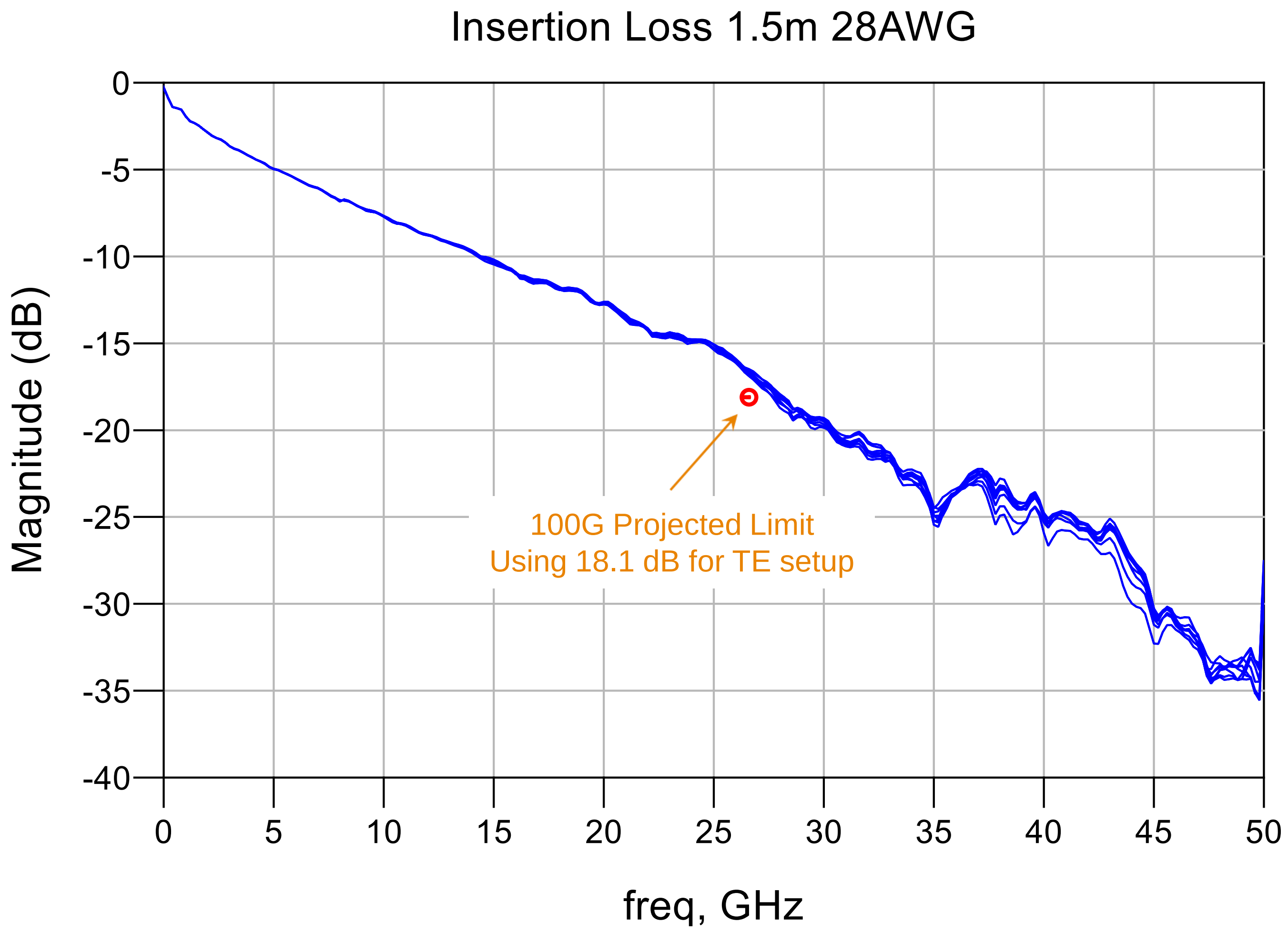
TE is using a 100G OSFP cable assembly

TE's suggested new target loss will be shared later in the slide deck



# Model: 1.5 meter 28 AWG Insertion Loss




16 traces represented

1 cable assembly * 16 pairs

Nominal Geometry

17.6 dB IEEE setup = 18.1 dB TE setup

Average = 16.7 dB at 26.56 GHz

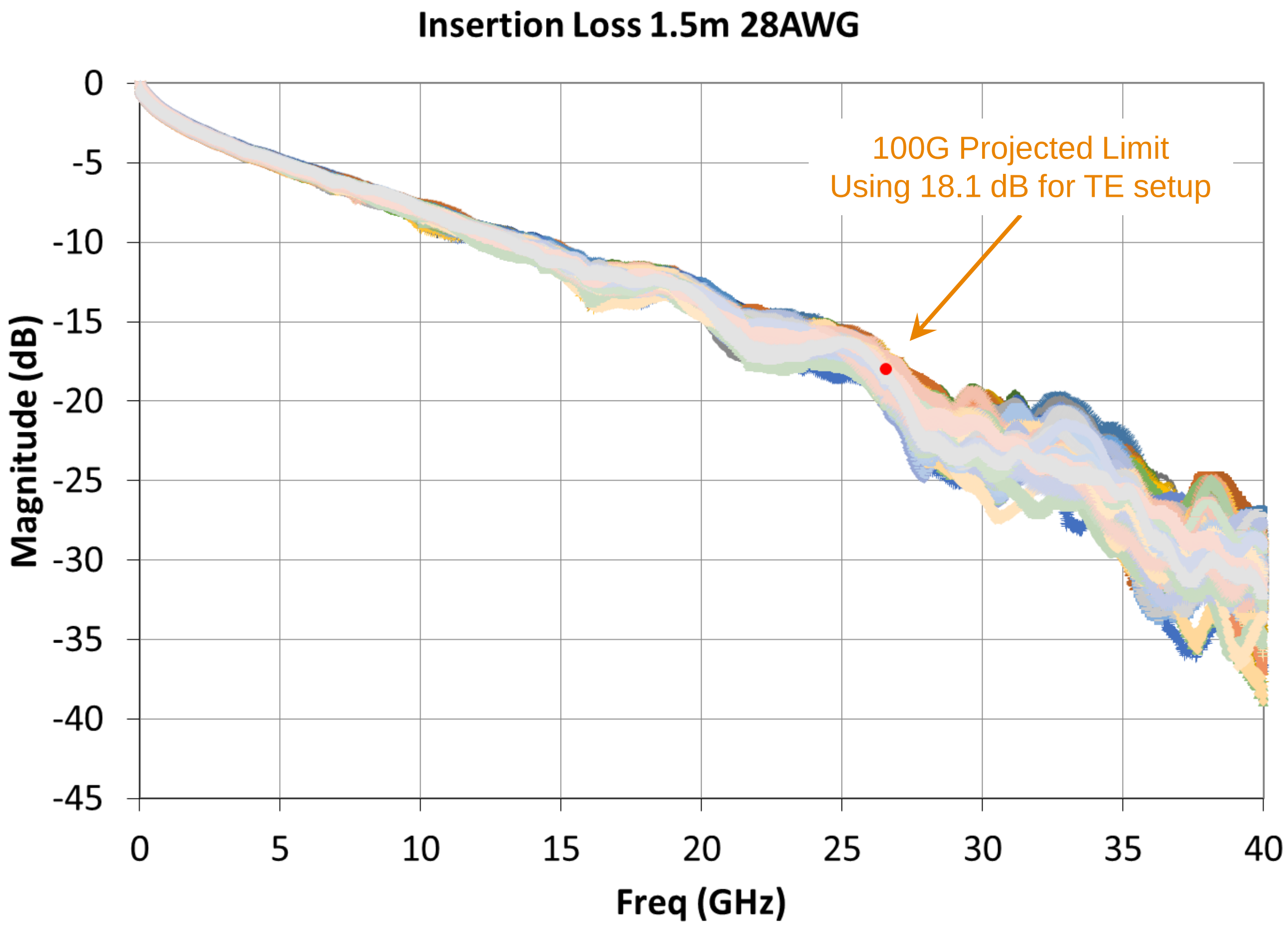
Minimum = 16.5 dB at 26.56 GHz

Maximum = 16.9 dB at 26.56 GHz

Passing with margin

Should we be confident? No!

# Test: 1.5 meter 28 AWG Insertion Loss




128 traces represented

8 cable assemblies * 16 pairs

17.6 dB IEEE setup = 18.1 dB TE setup

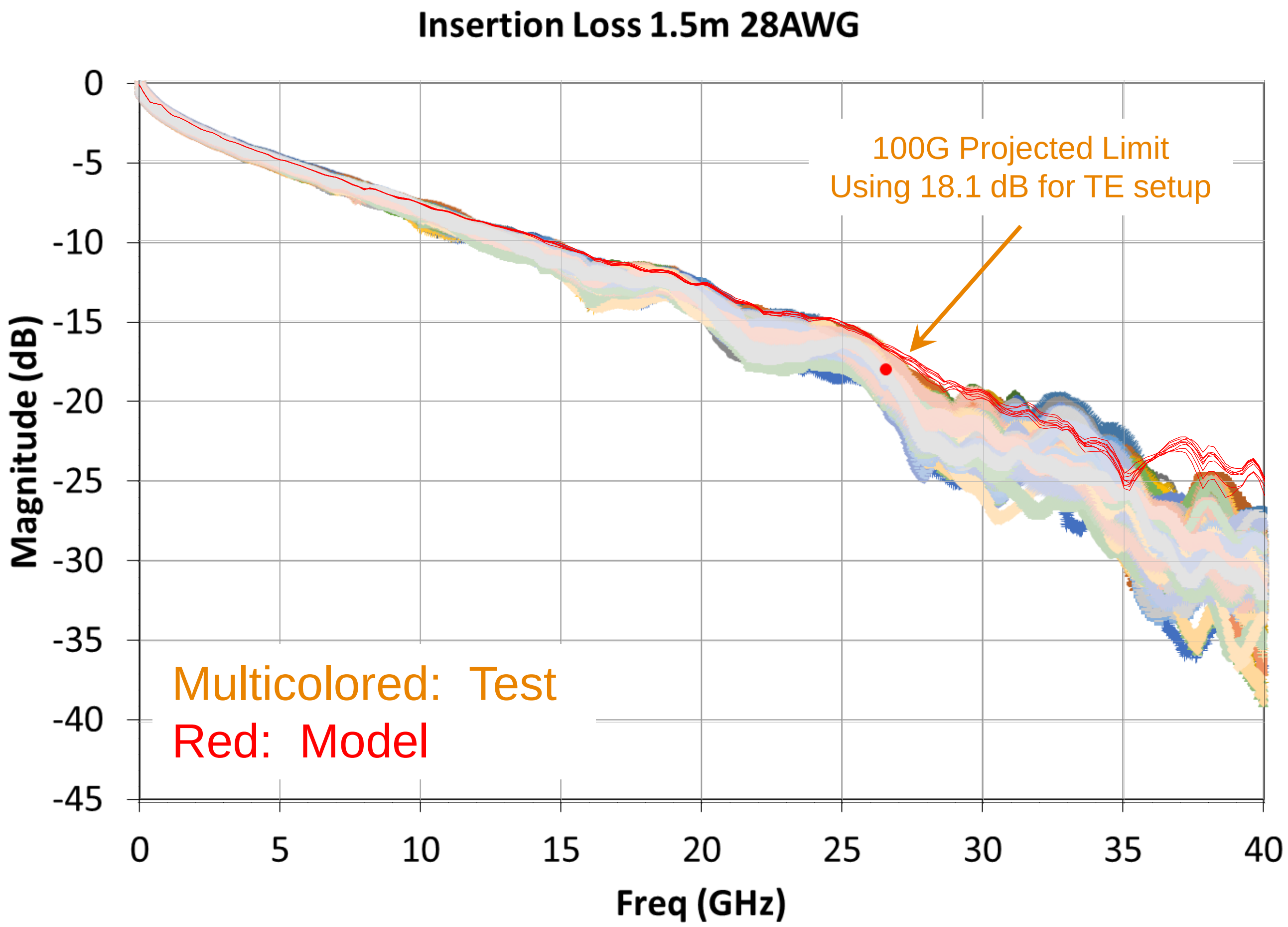
Average = 18.4 dB at 26.56 GHz

Minimum = 17.0 dB at 26.56 GHz

Maximum = 20.5 dB at 26.56 GHz

Manufacturing variation causes a spread in the insertion loss data

# Model vs Test:  1.5 meter 28 AWG Insertion Loss



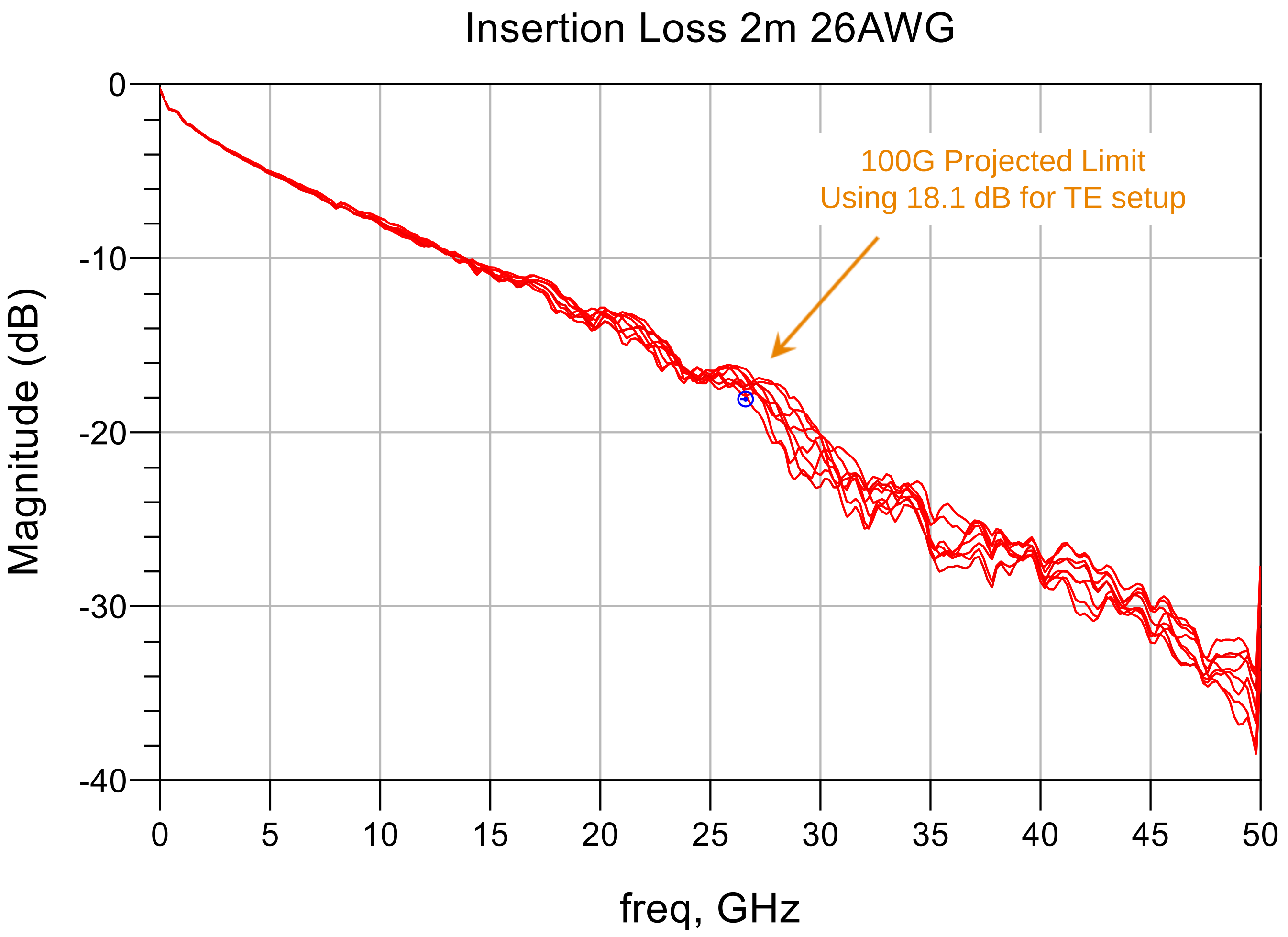

Model matches best case in test which is expected for a nominal model

Test data will include all manufacturing tolerances and variations.  This data includes multiple raw cable lots and multiple paddlecard lots

Spread of test data at 26.56 GHz is much larger than at previous nyquist frequency of 13.28 GHz

Must consider variation in the ability for a cable assembly to meet the IEEE requirement

# Model:  2 meter 26 AWG Insertion Loss




16 traces represented

1 cable assembly * 16 pairs

Nominal Geometry

17.6 dB IEEE setup = 18.1 dB TE setup

Average = 17.3 dB at 26.56 GHz

Minimum = 16.4 dB at 26.56 GHz

Maximum = 17.9 dB at 26.56 GHz

Tight to limit

Larger spread due to termination constraints and larger conductor size

# Test Expectations: 2 meter 26 AWG Insertion Loss

1.5m 28AWG model comparison to 2m 26 AWG model

- Worst case pair 16.9 dB versus 17.9 dB
- Delta of 1 dB

1.5m 28AWG model comparison to 1.5m 28AWG test

- Worst case pair 16.9 dB versus 20.5 dB
- Delta of 3.6 dB

2m 26AWG test expectation

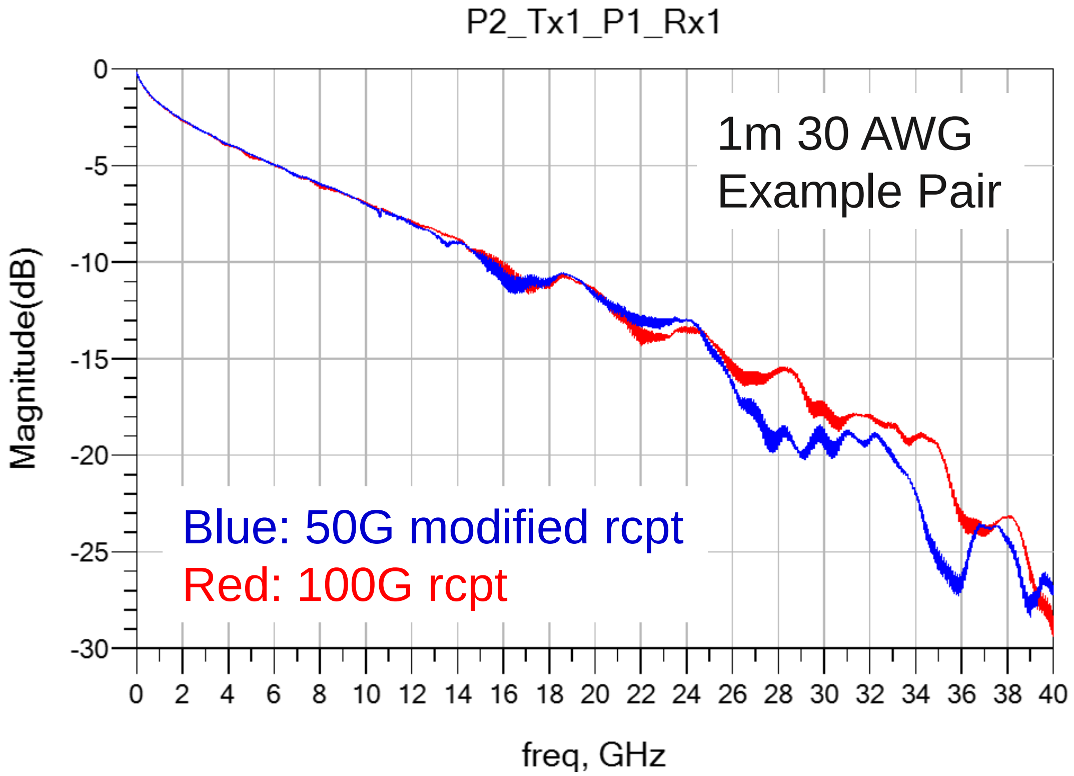
- 20.5 dB (1.5m28 test) + 1 dB (delta 1.5m28 and 2m26 models) = 21.5 dB (18.1 dB target)
- 17.9 dB (2m26 model) + 3.6 dB (delta worst case test and model 1.5m28) = 21.5 dB (18.1 dB target)
- Adjusting for MCB differences = 21.5 dB – (2.55 – 2.3)* 2 dB = **21 dB (17.6 dB target)**

# Improvements using 100G Receptacle

TE has recently built our first 100G receptacle prototypes.  No conditioning, no refinements

Comparison testing between the 50G modified receptacle and 100G receptacle has been limited to date

Improvements are expected, but not enough statistical data to make a firm recommendation




**1m 30 AWG Cable Assembly**

| | 100G receptacle | 50G modified receptacle | Delta | 21 dB Improves to… |
|---|---|---|---|---|
| Worst Pair | -16.3 | -17.9 | 1.6 | 19.4 |
| Average | -15.3 | -16.0 | 0.7 | 20.3 |
| Best Pair | -14.4 | -15.0 | 0.6 | 20.4 |

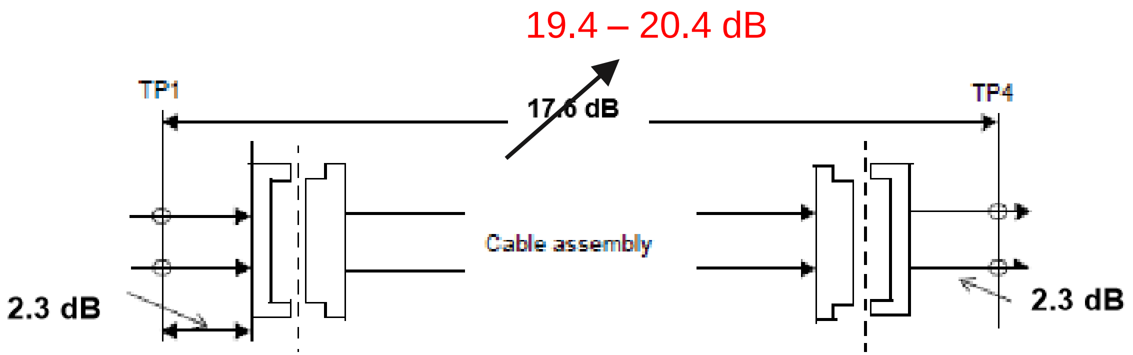
**2m 28 AWG Cable Assembly**

| | 100G receptacle | 50G modified receptacle | Delta | 21 dB Improves to… |
|---|---|---|---|---|
| Worst Pair | -22.5 | -24.3 | 1.8 | 19.2 |
| Average | -21.1 | -22.7 | 1.6 | 19.4 |
| Best Pair | -19.9 | -20.8 | 0.8 | 20.2 |

* Improvement subtracted delta from 21 dB

# Conclusions Based on Measured and Simulated Cable Assemblies

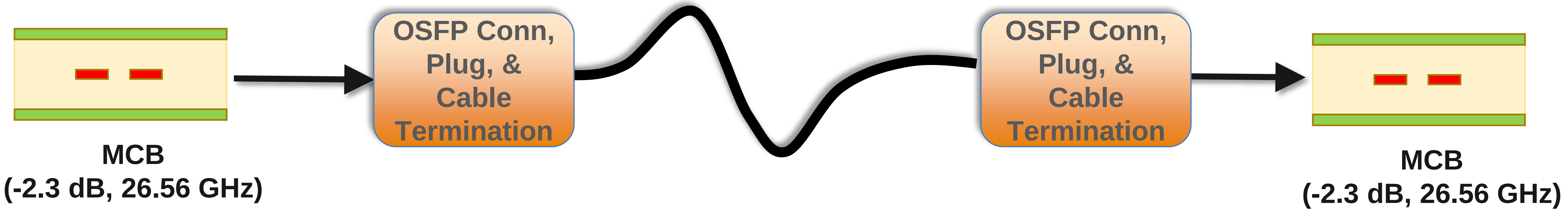
- The current 17.6 dB placeholder does not allocate enough insertion loss to the cable assembly channel TP1 to TP4
- TE would recommend increasing this insertion loss budget to approx. 19.4 – 20.4 dB
    - I will continue to bring more data to refine this number
- There is manufacturing variation that needs to be accounted for when setting the TP1-TP4 budget
- Note that the analysis conducted by TE does not include other known variables such as temperature



# Cable Assembly Simulations For Working Group Analysis

# Description of Simulated Cable Assemblies

1.5m 28 AWG Twinax Cable, Contribution: tracy_3ck_02_0319
2.0m 28 AWG Twinax Cable, Contribution: tracy_3ck_03_0319
(100 Ohm)




## OSFP Pin Map

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pin # | 60 | 59 | 58 | 57 | 56 | 55 | 54 | 53 | 52 | 51 | 50 | 49 | 48 | 47 | 46 | 45 | 44 | 43 | 42 | 41 | 40 | 39 | 38 | 37 | 36 | 35 | 34 | 33 | 32 | 31 |
| | G | Tx1+ | Tx1- | G | Tx3+ | Tx3- | G | Tx5+ | Tx5- | G | Tx7+ | Tx7- | G | SB | SB | SB | SB | G | Rx8- | Rx8+ | G | Rx6- | Rx6+ | G | Rx4- | Rx4+ | G | Rx2- | Rx2+ | G |
| | G | Tx2+ | Tx2- | G | Tx4+ | Tx4- | G | Tx6+ | Tx6- | G | Tx8+ | Tx8- | G | SB | SB | SB | SB | G | Rx7- | Rxy+ | G | Rx5- | Rx5+ | G | Rx3- | Rx3+ | G | Rx1- | Rx1+ | G |
| Pin # | 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 |

| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pin # | 60 | 59 | 58 | 57 | 56 | 55 | 54 | 53 | 52 | 51 | 50 | 49 | 48 | 47 | 46 | 45 | 44 | 43 | 42 | 41 | 40 | 39 | 38 | 37 | 36 | 35 | 34 | 33 | 32 | 31 |
| | G | Tx1+ | Tx1- | G | Tx3+ | Tx3- | G | Tx5+ | Tx5- | G | Tx7+ | Tx7- | G | SB | SB | SB | SB | G | Rx8- | Rx8+ | G | Rx6- | Rx6+ | G | Rx4- | Rx4+ | G | Rx2- | Rx2+ | G |
| | G | Tx2+ | Tx2- | G | Tx4+ | Tx4- | G | Tx6+ | Tx6- | G | Tx8+ | Tx8- | G | SB | SB | SB | SB | G | Rx7- | Rxy+ | G | Rx5- | Rx5+ | G | Rx3- | Rx3+ | G | Rx1- | Rx1+ | G |
| Pin # | 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 |

Victim
FEXT Aggressor
NEXT Aggressor

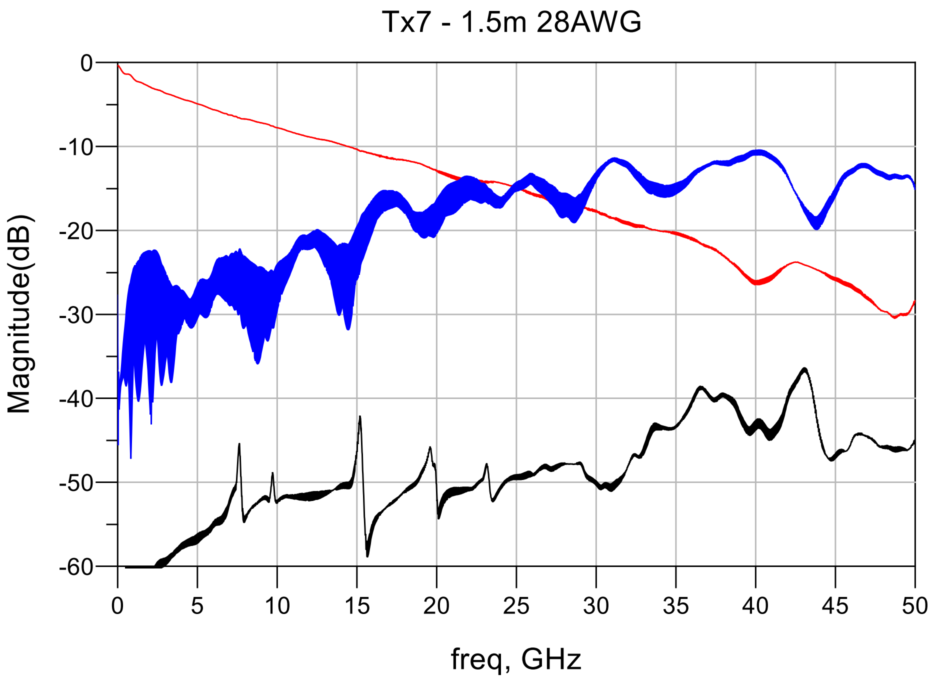
# COM CR Configuration File “config_com_ieee8023_93a100GEL-CR_030119.xls”

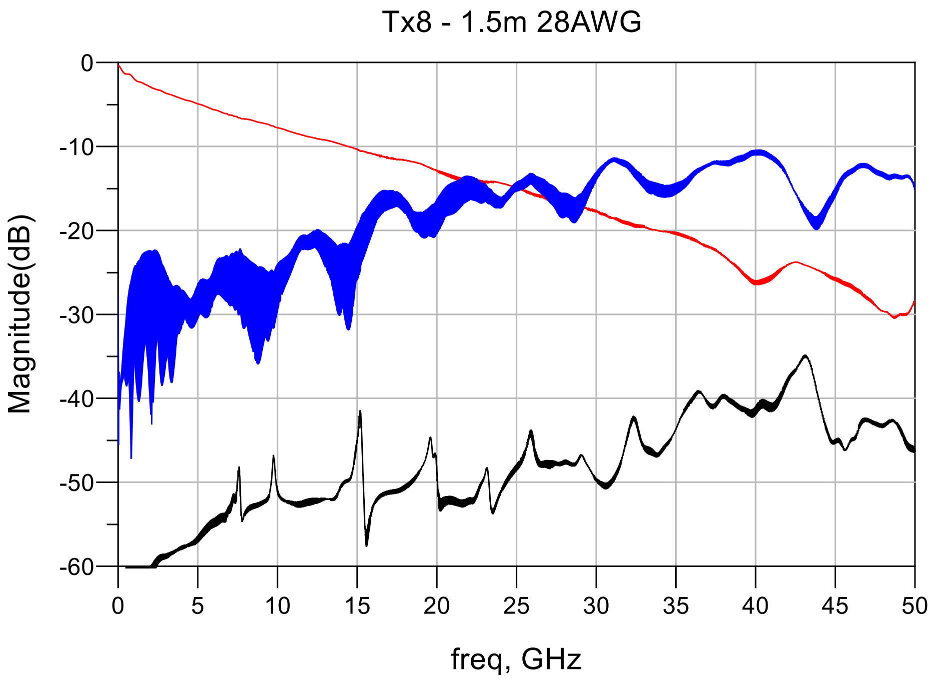
| | A | B | C | D |
|---|---|---|---|---|
| 1 | Table 93A-1 parameters | | | |
| 2 | Parameter | Setting | Units | Information |
| 3 | f_b | 53.125 | GBd | |
| 4 | f_min | 0.05 | GHz | |
| 5 | Delta_f | 0.01 | GHz | |
| 6 | C_d | [1.1e-4 1.1e-4] | nF | [TX RX] |
| 7 | z_p select | [ 1 2] | | [test cases to run] |
| 8 | z_p (TX) | [12 32; 1.8 1.8] | mm | [test cases] |
| 9 | z_p (NEXT) | [12 32; 1.8 1.8] | mm | [test cases] |
| 10 | z_p (FEXT) | [12 32; 1.8 1.8] | mm | [test cases] |
| 11 | z_p (RX) | [12 32; 1.8 1.8] | mm | [test cases] |
| 12 | C_p | [0.87e-4 0.87e-4] | nF | [TX RX] |
| 13 | R_0 | 50 | Ohm | |
| 14 | R_d | [ 50 50] | Ohm | [TX RX] |
| 15 | A_v | 0.413 | V | vp/vf=.694 |
| 16 | A_fe | 0.413 | V | vp/vf=.694 |
| 17 | A_ne | 0.608 | V | |
| 18 | L | 4 | | |
| 19 | M | 32 | | |
| 20 | filter and Eq | | | |
| 21 | f_r | 0.75 | *fb | |
| 22 | c(0) | 0.54 | | min |
| 23 | c(-1) | [-0.34:0.02:0] | | [min:step:max] |
| 24 | c(-2) | [0:0.02:0.12] | | [min:step:max] |
| 25 | c(-3) | [-0.06:0.02:0] | | [min:step:max] |
| 26 | c(1) | [-0.1:0.05:0] | | [min:step:max] |
| 27 | N_b | 24 | UI | |
| 28 | b_max(1) | 0.85 | | |
| 29 | b_max(2..N_b) | 0.3 | | |
| 30 | g_DC | [-20:1:0] | dB | [min:step:max] |
| 31 | f_z | 21.25 | GHz | |
| 32 | f_p1 | 21.25 | GHz | |
| 33 | f_p2 | 53.125 | GHz | |
| 34 | g_DC_HP | [-6:1:0] | | [min:step:max] |
| 35 | f_HP_PZ | 0.6640625 | GHz | |
| 36 | | | | |

| | F | G | H | I |
|---|---|---|---|---|
| 1 | I/O control | | | |
| 2 | DIAGNOSTICS | 0 | logical | |
| 3 | DISPLAY_WINDOW | 0 | logical | |
| 4 | CSV_REPORT | 1 | logical | |
| 5 | RESULT_DIR | \results\100GEL_WG_{date}\ | | |
| 6 | SAVE_FIGURES | 0 | logical | |
| 7 | Port Order | [1 3 2 4] | | |
| 8 | RUNTAG | CR_eval_ | | |
| 9 | COM_CONTRIBUTION | 0 | logical | |
| 10 | Operational | | | |
| 11 | COM Pass threshold | 3 | dB | |
| 12 | ERL Pass threshold | 10.5 | dB | |
| 13 | DER_0 | 1.00E-04 | | |
| 14 | T_r | 6.16E-03 | ns | |
| 15 | FORCE_TR | 1 | logical | |
| 16 | Include PCB | 1 | logical | 4.7 db/side |
| 17 | TDR and ERL options | | | |
| 18 | TDR | 1 | logical | |
| 19 | ERL | 1 | logical | |
| 20 | ERL_ONLY | 0 | logical | |
| 21 | TR_TDR | 0.01 | ns | |
| 22 | N | 1000 | | |
| 23 | TDR_Butterworth | 1 | logical | |
| 24 | beta_x | 1.70E+09 | | |
| 25 | **rho_x** | **0.25** | | |
| 26 | fixture delay time | 0 | enter sec | |
| 27 | Receiver testing | | | |
| 28 | RX_CALIBRATION | 0 | logical | |
| 29 | Sigma BBN step | 5.00E-03 | V | |
| 30 | Noise, jitter | | | |
| 31 | sigma_RJ | 0.01 | UI | |
| 32 | A_DD | 0.02 | UI | |
| 33 | eta_0 | 8.20E-09 | V^2/GHz | |
| 34 | SNR_TX | 33 | dB | |
| 35 | R_LM | 0.95 | | |

| | J | K | L |
|---|---|---|---|
| 1 | Table 93A–3 parameters | | |
| 2 | Parameter | Setting | Units |
| 3 | package_tl_gamma0_a1_a2 | [0 0.0009909 0.0002772] | |
| 4 | package_tl_tau | 6.141E-03 | ns/mm |
| 5 | package_Z_c | [87.5 87.5 ; 92.5 92.5 ] | Ohm |
| 6 | | | |
| 7 | Table 92–12 parameters | | |
| 8 | Parameter | Setting | |
| 9 | board_tl_gamma0_a1_a2 | *[0 0.000599 0.0001022]* | |
| 10 | board_tl_tau | *6.200E-03* | ns/mm |
| 11 | board_Z_c | 90 | Ohm |
| 12 | z_bp (TX) | *92.7* | mm |
| 13 | z_bp (NEXT) | *92.7* | mm |
| 14 | z_bp (FEXT) | *92.7* | mm |
| 15 | z_bp (RX) | *92.7* | mm |

# Results for 1.5m, 28AWG Cable Assembly



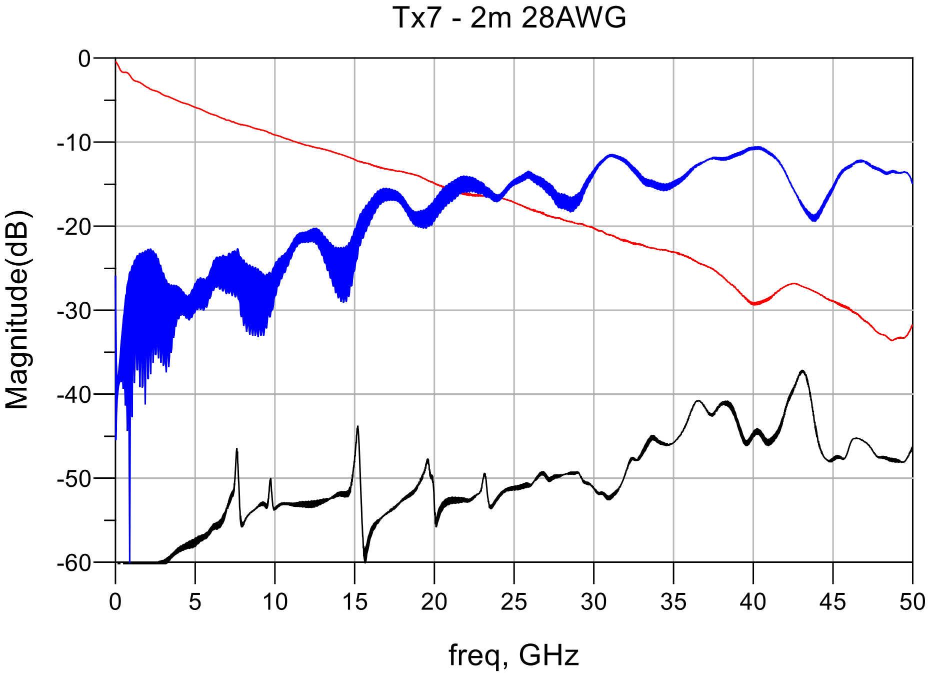



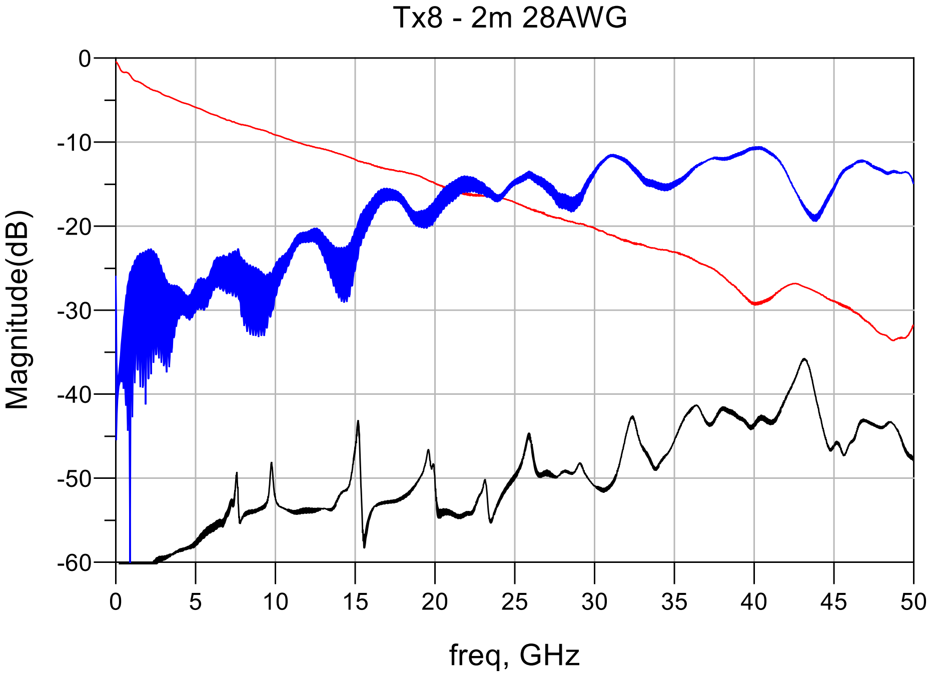

Keep in mind that manufacturing variation adds about 3.6dB IL at 26.5Ghz to modeled results

Results for Tx7 pair

- COM Case 1: 6.375
- COM Case 2: 5.401
- ERL11: 14.366
- ERL22: 14.067

# Results for 2m, 28AWG Cable Assembly




Keep in mind that manufacturing variation adds about 3.6dB IL at 26.5Ghz to modeled results

Results for Tx7 pair

- COM Case 1: 5.663
- COM Case 2: 4.554
- ERL11: 14.352
- ERL22: 14.075

# Summary

TE will continue to accumulate additional data and share with the working group

Two new cable assembly S-Parameter files are being contributed for analysis

- 1.5m, 28 AWG cable assembly, Contribution: tracy_3ck_02_0319
- 2.0m, 28 AWG cable assembly, Contribution: tracy_3ck_03_0319

TE would recommend increasing this insertion loss budget to approx. 19.4 – 20.4 dB