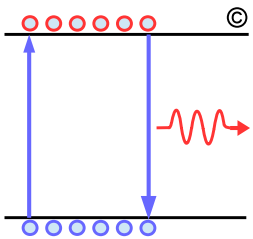


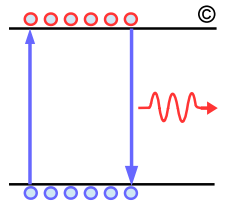
COM Analysis on Backplane and Cu DAC Channels

Ali Ghiasi
Ghiasi Quantum LLC

IEEE 802.3cd Task Force Meeting
Whistler

May 25, 2016

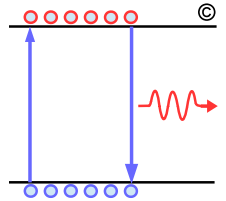
Overview



- **Follow on the Macau presentation**

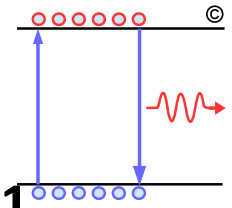
- **Investigating COM analysis on following set of channels**
  - TE Whisper Std 1 m backplane
  - Molex older zQSFP 3 m DAC cable
  - Molex newer zQSFP 3 m DAC cable
- **Following COM parameters are varied**
  - Bmax to investigate COM penalty to constrain the 1st DFE tap to mitigate burst error
  - DER to investigate COM penalty at lower DER to see feasibility of KR4 FEC for operation over the backplane and 3 Cu DAC
    - All 4 backplane FEXT/NEXT aggressors are kept to address dense backplane
    - QSFP module 3 FEXTs and 4 FEXTs are kept as typical application may use QSFP break out into 50GbE or 100 GbE.

Changes Made to Baseline CDAUI-8 C2C COM parameter for 50G KP4



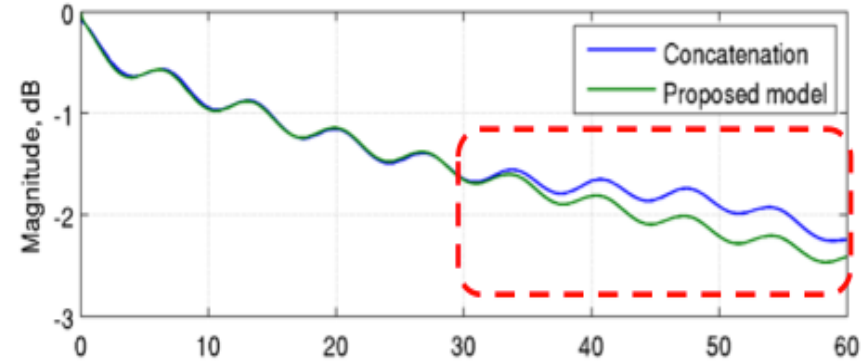
Parameters	CDAUI-8 C2C COM Parameters	50G KP4 COM Parameters
Baudrate	26.5625 GBd	26.5625 GBd
Device Capacitance Cd [TX, RX]	[0.28, 0.28] pf	[0.2, 0.2] pf
BGA pad Cp [TX, RX]	[0.11, 0.11] pf	[0.11, 0.11] pf
CTLE Gain	15 dB	18 dB
G_DC_HP	4 dB	6 dB
TX SNR	31.1 dB	32 dB
DER	1E-5	1E-4, 1e-5, 1e-6
# of taps N_b	10	16, 20, 24
B_max(1)	0.5	0.5, 0.625, 0.75
B_max(2..N_b)	0.2	0.5*Bmax
C(0)	0.6	0.6
C(1)	0.35	NA (did not help & to speed up)
C(-1)	-0.15	-0.24 (max value used for channels)
C(-2)	NA	+0.06 (max value used for channels)
Package Zc impedance	85 Ω	90 Ω
COM threshold	3 dB	2 dB

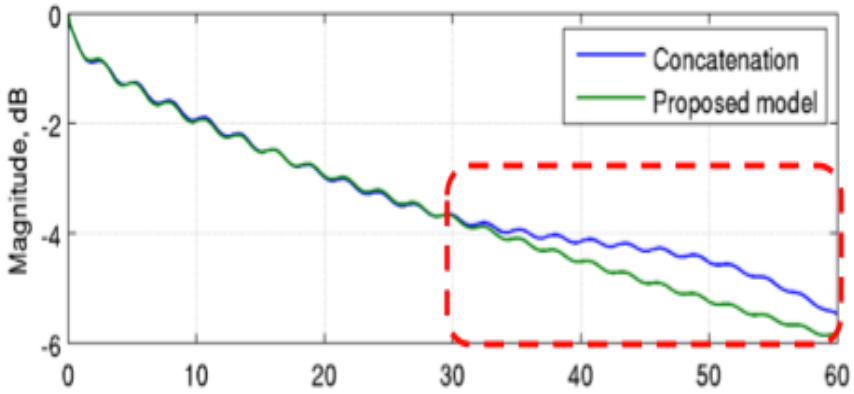
IEEE Package Model



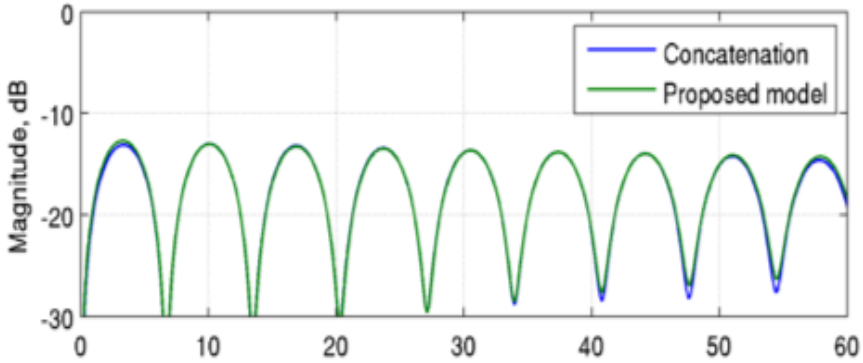
- **IEEE package has strong ripple in the return loss and SDD21**
  - Representative GZ-41 packages have more than 0.6 dB of COM margin compare to IEEE package.

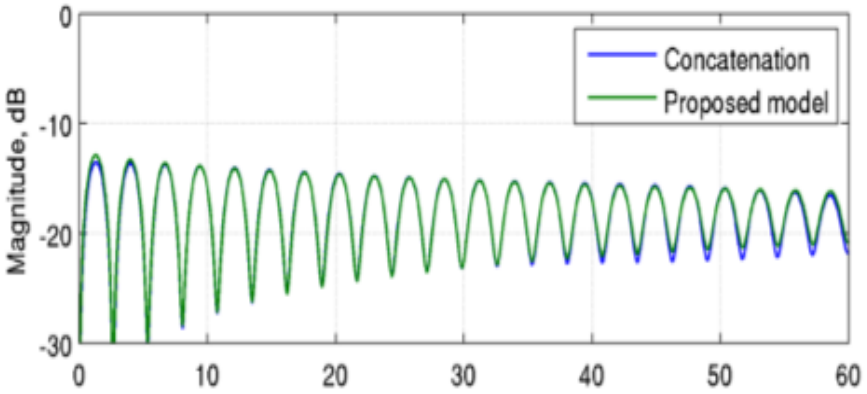
s21



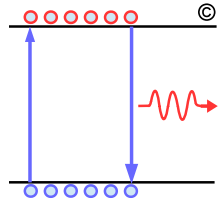


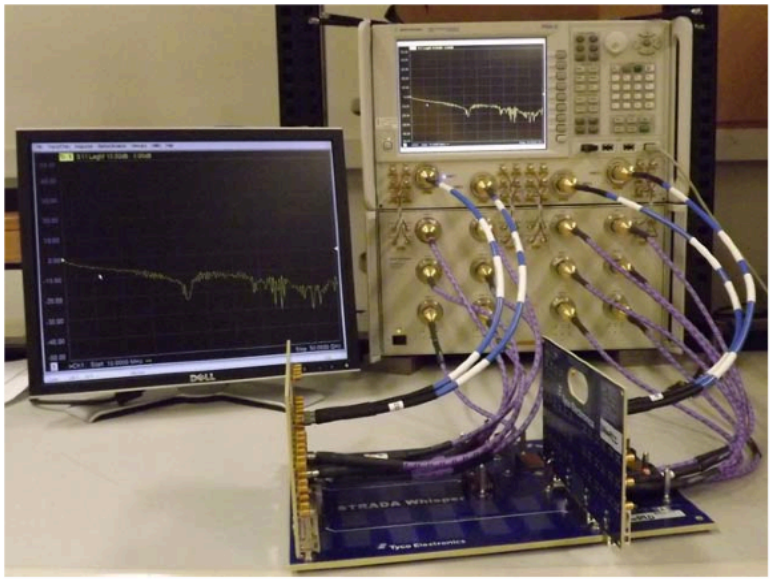
s11





TE Whisper 40” Backplane





H11-H12	H14-H15	H17-H18
G11-G12	G14-G15	G17-G18
F11-F12	F14-F15	F17-F18

- All data is measured and includes 2.4mm test points
- Measurements are pair G14-G15 centric .s4p files
- 4 Near-End and 4 Far-End measurements
- Data is from 0-30GHz in 10MHz steps

DAUGHTER CARD

- Board Material = Megtron6 VLP
- Trace length = 5”
- Trace geometry = Stripline
- Trace width = 6 mils
- Differential trace spacing = 9 mils
- PCB thickness = 110mils, 14 layers
- Counterbored vias, up to 6mil stub
- Test Points = 2.4mm (included in data)

BACKPLANE

- Board Material = Megtron6 HVLP
- Trace length = 30”
- Trace geometry = Stripline
- Trace width = 6 mils
- Differential trace spacing = 9 mils
- PCB thickness = 200 mils, 20 layers
- Counterbored vias, up to 6mil stub

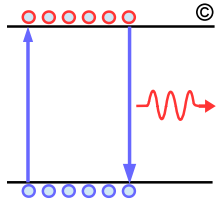
Use

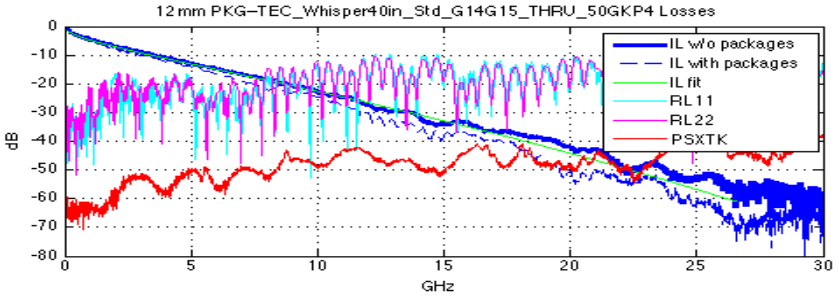
CONNECTORS

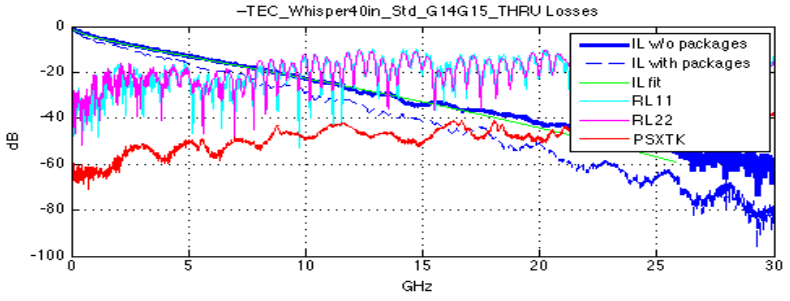
- Dataset 1 includes
  - Mated standard STRADA Whisper connector at each end
- Dataset 2 includes
  - Mated Embedded Capacitor STRADA Whisper connector at one end and,
  - Mated standard STRADA Whisper connector at other end

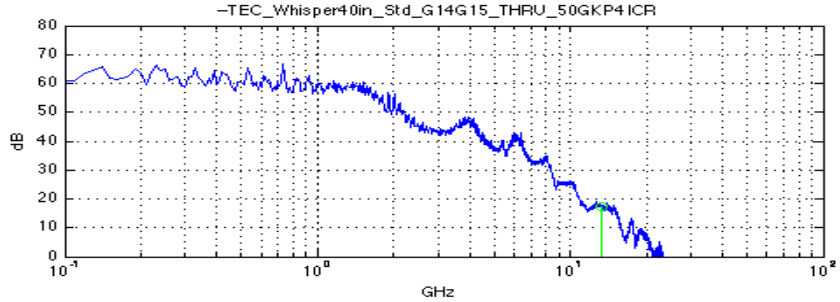
TE Whisper 1 m Std Backplane

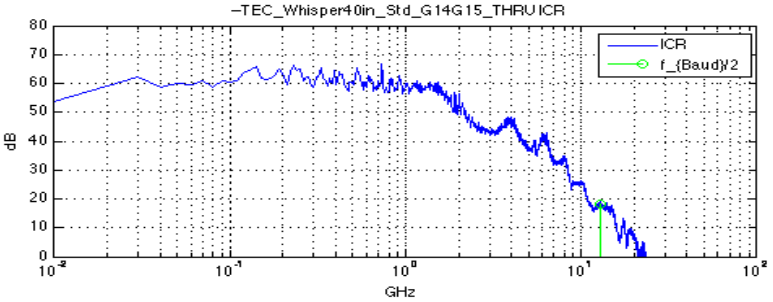
http://www.ieee802.org/3/bj/public/jul13/tracy_3bj_01_0713.pdf

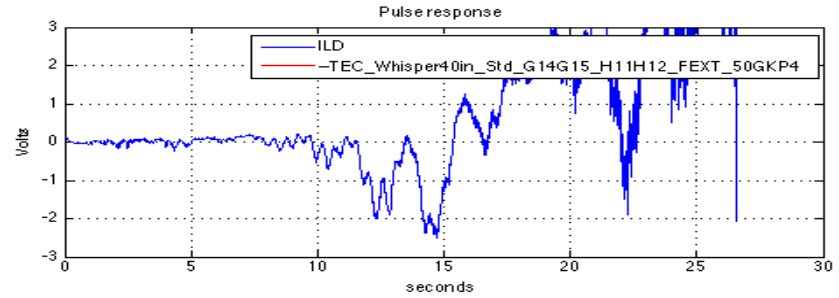


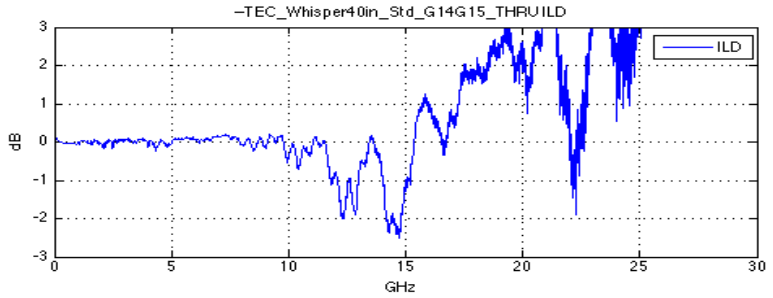




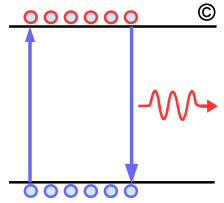








Summary Results for TE Whisper 1 m Backplane

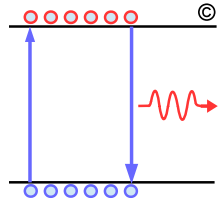


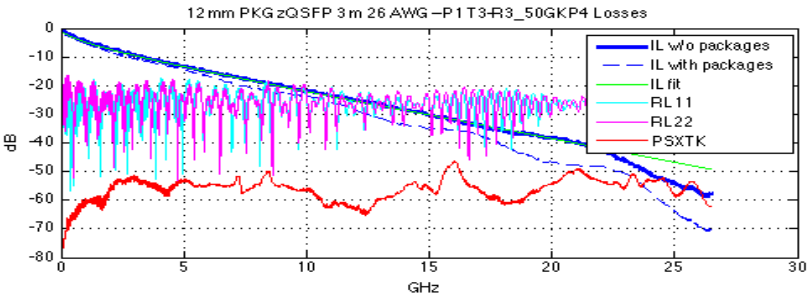
- **To safely say a channel passes 2 dB of COM margin is required!**
  - Pre $C(-2)_{max}$=0.04, $C(-1)_{min}$=-0.22

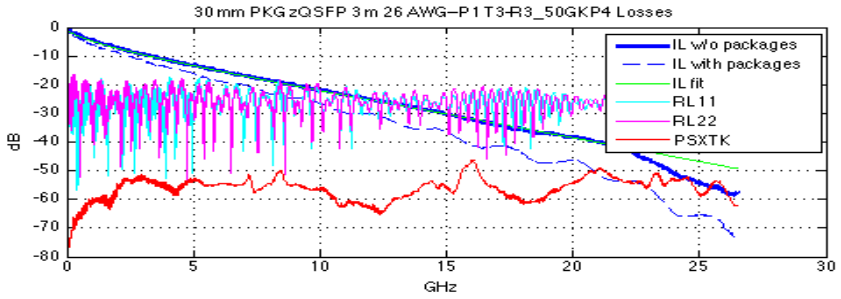
Test Cases	Channel IL (dB)	DFE	ISI/Noise/ XTALK	ILD	ICN (mV)	PSXT (mV)	COM (dB)
Backplane IEEE 12 mm Package, b=0.75, 1e-4	29.8	16	23/39/38%	0.37	1.63	3.19	2.66
Backplane IEEE 30 mm Package, b=0.75, 1e-4	29.8	16	22/41/37%	0.37	1.63	2.66	2.17
Backplane IEEE 12 mm Package b=0.625, 1e-4	29.8	16	22/38/40%	0.39	1.63	3.11	2.45
Backplane IEEE 30 mm Package b=0.625, 1e-4	29.8	16	18/41/42%	0.39	1.63	2.61	1.79
Backplane IEEE 12 mm Package b=0.5, 1e-4	29.8	16	23/36/41%	0.39	1.63	3.08	2.04
Backplane IEEE 30 mm Package b=0.5, 1e-4	29.8	16	18/40/42%	0.39	1.63	2.57	1.45
Backplane IEEE 12 mm Package b=0.75, 1e-5	29.8	16	22/40/38%	0.37	1.63	3.57	1.50
Backplane IEEE 30 mm Package b=0.75, 1e-5	29.8	16	22/42/36%	0.37	1.63	3.00	1.01
Backplane IEEE 12 mm Package b=0.5, 1e-5	29.8	16	23/37/40%	0.37	1.63	3.46	0.88
Backplane IEEE 30 mm Package b=0.5, 1e-5	29.8	16	18/41/41%	0.37	1.63	2.89	0.29
Backplane IEEE 12 mm Package, b=0.75, 1e-6	29.8	16	22/41/37%	0.40	1.63	3.90	0.60
Backplane IEEE 30 mm Package, b=0.75, 1e-6	29.8	16	22/43/35%	0.43	1.63	3.24	0.11

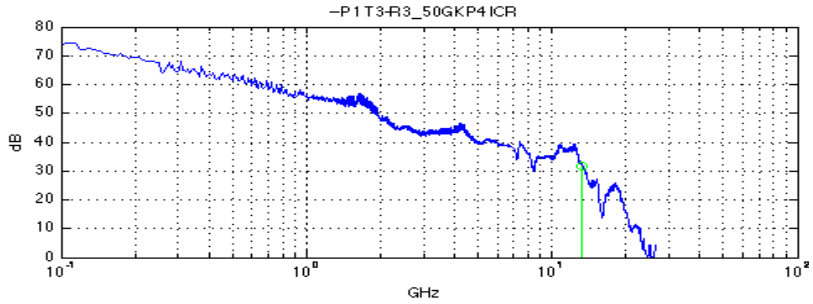
Molex Newer zQSFP 3 m 26 AWG TX3-RX3

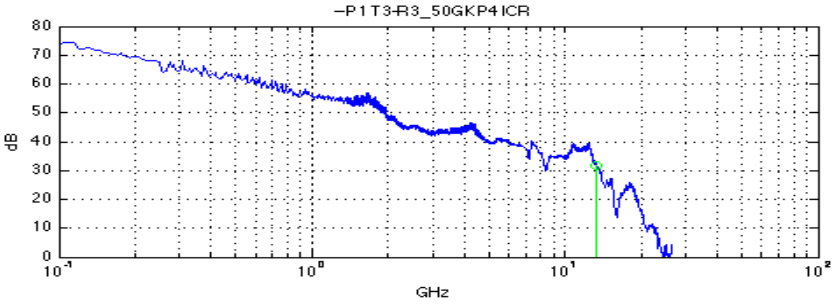
http://www.ieee802.org/3/50G/public/Jan16/roth_50GE_NGOATH_01a_0116.pdf

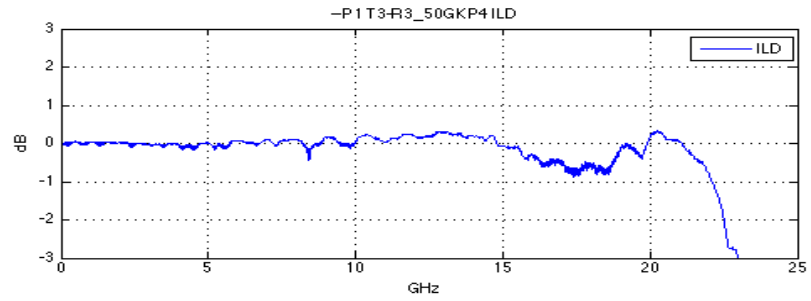


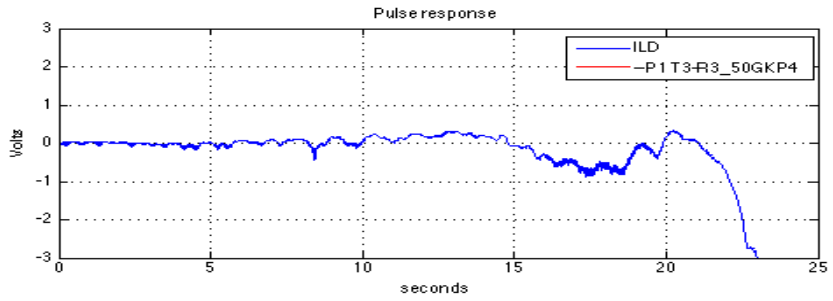






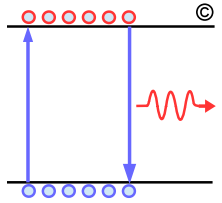


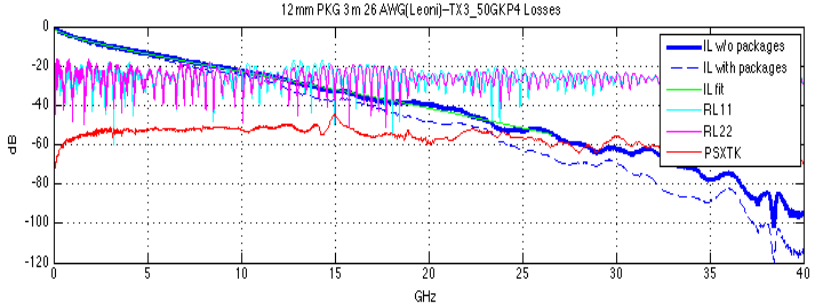


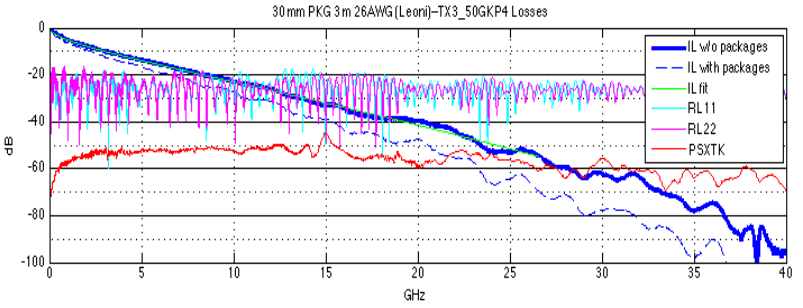


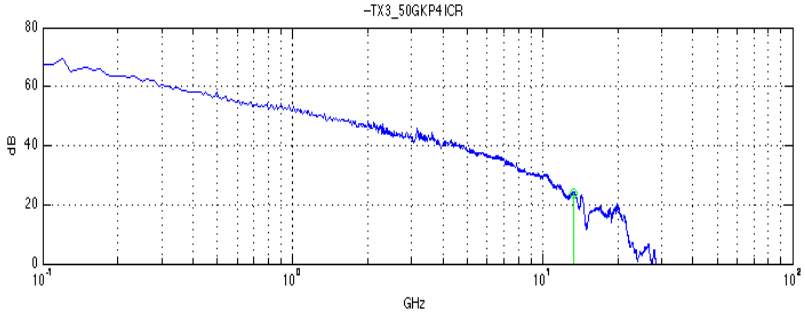
Molex Older zQSFP 3 m 26 AWG TX3-RX3 with Leoni Cable

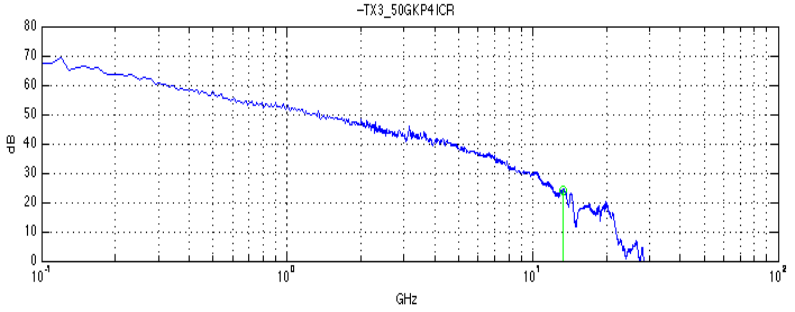
http://www.ieee802.org/3/100GCU/public/ChannelData/Molex_11_0516/bugg_02_0511.zip

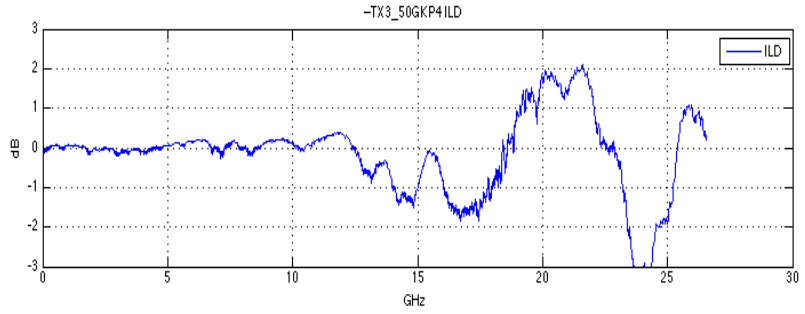


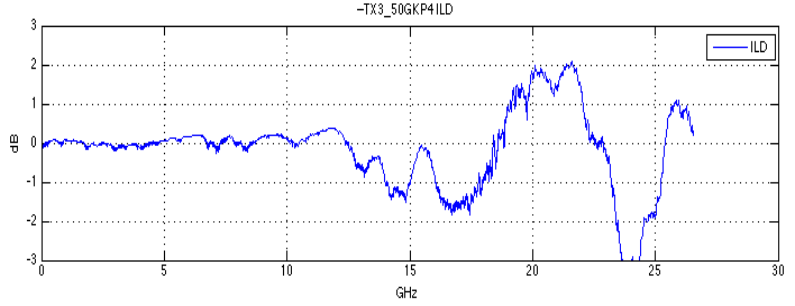




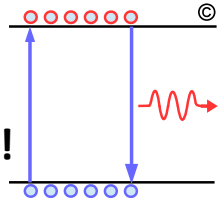








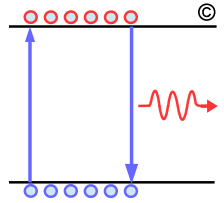
Molex 3 m 26 AWG Older Cables



- **It might be feasible to even support 3 m 28 AWG cables with 3 dB COM margin!**
  - Older 3 m 26 AWG cable have loss of ~29.5 dB newer cable ~27.5 dB
  - Stack connectors add ~1 dB of loss and have higher crosstalk
  - 30 dB channel loss provides margin to support stack connectors with newer cables
  - Pre $C(-2)_{max}$=0.04, $C(-1)_{max}$=-0.2

Test Cases	Cable IL (dB)	Channel IL (dB)	ISI/Noise/ XTALK	ILD	ICN (mV)	PSXT (mV)	COM (dB)
T3-R3 (P1), 12 mm PKG, b=0.75, 1e-4	16.4	29.4	23/65/12%	0.26	1.09	1.30	4.82
T3-R3 (P1), 30 mm PKG, b=0.75, 1e-4	16.4	29.4	20/70/10%	0.26	0.79	1.02	4.26
T4-R4 (P1), 12 mm PKG, b=0.75, 1e-4	16.6	29.5	27/64/9	0.23	1.09	1.27	4.97
T4-R4 (P1), 30 mm PKG, b=0.75, 1e-4	16.6	29.5	22/69/9	0.23	1.09	0.99	4.39
T3-R3 (P1), 12 mm PKG, b=0.625, 1e-4	16.4	29.4	24/65/12%	0.26	1.09	1.29	4.80
T3-R3 (P1), 30 mm PKG, b=0.625, 1e-4	16.4	29.4	19/70/11%	0.26	0.79	1.01	4.26
T3-R3 (P1), 12 mm PKG, b=0.5, 1e-4	16.4	29.4	23/65/12%	0.26	1.09	1.27	4.64
T3-R3 (P1), 30 mm PKG, b=0.5, 1e-4	16.4	29.4	17/71/12%	0.26	0.79	1.00	4.01
T3-R3 (P1), 12 mm PKG, b=0.5, 1e-5	16.4	29.4	22/65/12%	0.26	1.09	1.42	3.44
T3-R3 (P1), 30 mm PKG, b=0.5, 1e-5	16.4	29.4	17/72/11%	0.26	1.09	1.13	2.81
T4-R4 (P1), 12 mm PKG, b=0.5, 1e-5	16.6	29.5	17/71/12	0.23	1.09	1.09	3.66
T4-R4 (P1), 30 mm PKG, b=0.5, 1e-5	16.6	29.5	13/17/11	0.23	1.09	1.06	2.95

Molex 3 m 26 AWG Newer Cables



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  - Older 3 m 26 AWG cable have loss of ~29.5 dB newer cable ~27.5 dB
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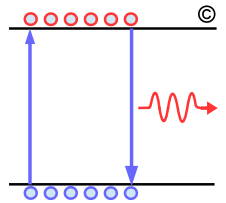
  - 30 dB channel loss provides margin to support stack connectors with newer cables
  - Pre $C(-2)_{max}$=0.04, $C(-1)_{max}$=-0.2

Test Cases	Cable IL (dB)	Channel IL (dB)	ISI/Noise/ XTALK	ILD	ICN (mV)	PSXT (mV)	COM (dB)
T3-R3 (P1), 12 mm PKG, b=0.75, 1e-4	14.3	27.3	24/69/6%	0.13	0.79	1.03	5.87
T3-R3 (P1), 30 mm PKG, b=0.75, 1e-4	14.3	27.3	24/71/5%	0.13	0.79	0.83	5.29
T4-R4 (P2), 12 mm PKG, b=0.75, 1e-4	14.4	27.3	19/75/6%	0.10	0.66	0.89	6.00
T4-R4 (P2), 30 mm PKG, b=0.75, 1e-4	14.4	27.3	24/72/4%	0.10	0.66	0.72	5.40
T3-R3 (P1), 12 mm PKG, b=0.5, 1e-5	14.3	27.3	17/75/8%	0.13	0.79	1.10	4.64
T3-R3 (P1), 30 mm PKG, b=0.5, 1e-5	14.3	27.3	15/79/6%	0.13	0.79	0.86	3.92
T4-R4 (P2), 12 mm PKG, b=0.5, 1e-5	14.4	27.3	18/76/6%	0.10	0.66	1.01	4.73
T4-R4 (P2), 30 mm PKG, b=0.5, 1e-5	14.4	27.3	16/79/5%	0.10	0.66	0.78	4.06

Summary



- **COM analysis show feasibility of operating at 50 Gb/s over representative 802.3bj backplane and 3 m Cu cables with ~30 dB loss**
  - The TE Whisper channel do not have TX and RX grouping with better TX/RX grouping NEXT could be improved
  - Older 3 m AWG 26 cables have loss of ~29.5 dB but newer cable have nominal loss of ~27.5 dB
  - Newer cable material may allow using less bulky cables based on smaller 28 AWG
- **Investigated Bmax with 0.5, 0.625, and 0.75 to reduce burst error**
  - Reducing Bmax from 0.75 to 0.625 for ~30 dB backplane reduces COM margin by ~0.4 dB pushing COM margin <2 dB and into red
  - Reducing Bmax from 0.75 to 0.625 on 3 m DAC has insignificant COM penalty
- **Also investigated DER 1E-5 and 1E-6 to show feasibility of RS (528,514) for NG 100GbE PMDs**
  - We currently have no NG 100 GbE optical PMD
  - The 3 m Cu DAC 100G-CR2 could supported with RS(528,514) in support of legacy implementation not having RS(544,514) FEC with just a PMA mux
- **COM configuration to close 30 dB TE Whisper required strong C(-1) and C(-2) with little or no C(1)**
  - Something the needs to get reconciled with broader audience otherwise COM margin maybe less than reported here!