

32GFC over backplane proposal

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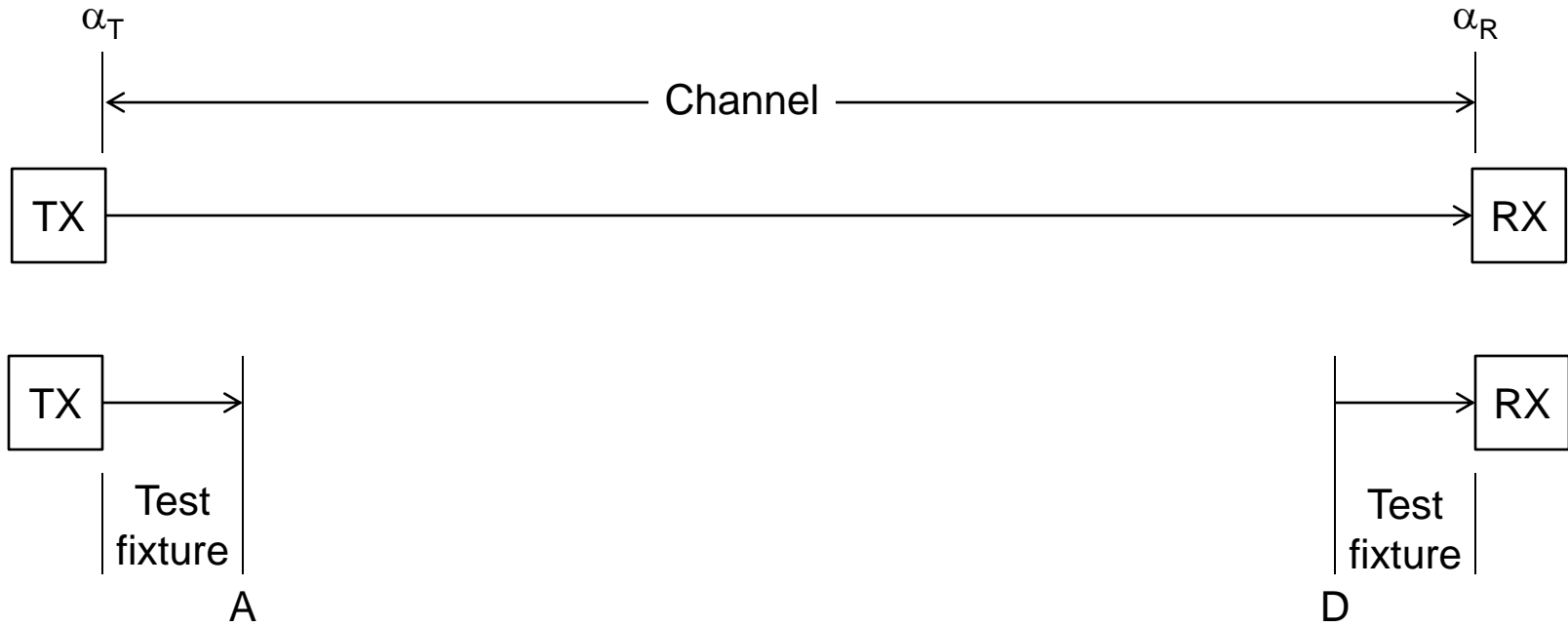


Accelerate.

Guiding principles

- Specify at alpha points rather than epsilon points because ...
- ...there is no standard demarcation of intra-enclosure links
- Define test fixtures to obtain accessible test points A and D
- Leverage recent work by IEEE P802.3bj™ Task Force

32GFC over backplane reference model



Test fixture requirements

- Test fixture insertion loss

$$1.3 \leq IL(f) \leq 1.7 \text{ dB} \quad f = 14 \text{ GHz}$$

- Test fixture insertion loss deviation (see IEEE P802.3bj/D1.4, 93A.2)

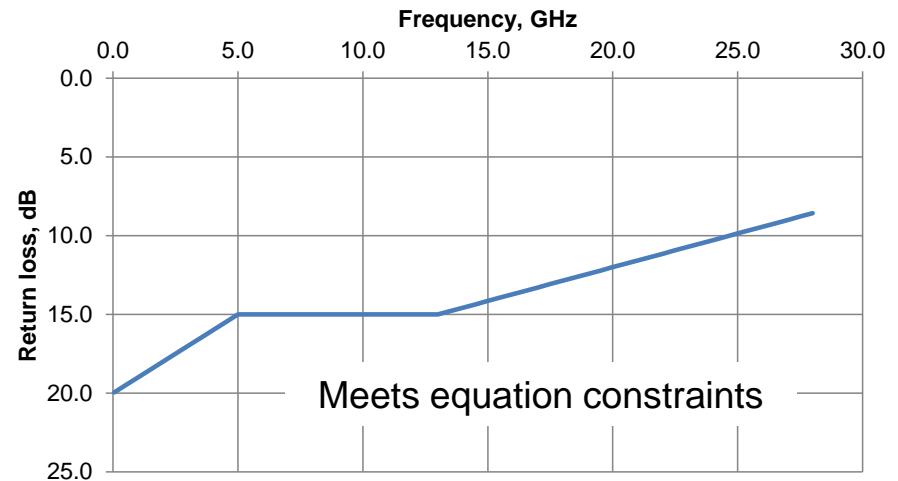
$$|ILD(f)| \leq 0.1 \text{ dB} \quad 0.05 \leq f \leq 28$$

- Test fixture differential return loss

$$RL_d(f) \geq \left\{ \begin{array}{ll} 20 - f & 0.05 \leq f \leq 5 \\ 15 & 5 < f \leq 13 \\ 20.57 - 0.4286f & 13 < f \leq 28 \end{array} \right\}$$

- Test fixture common-mode return loss

- $RL_{cm}(f) \geq 10 \text{ dB} \quad 0.05 \leq f \leq 28$



Transmitter electrical specifications at A

| Parameter | Value | Units | Notes |
|---|------------------|----------|-------|
| Signaling rate | 28.05 | GBd | 1 |
| Differential peak-to-peak output voltage, max. Transmitter enabled Transmitter disabled | 1200 30 | mV mV | 2 |
| DC common-mode output voltage, max. | 1.9 | V | |
| DC common-mode output voltage, min. | 0 | V | |
| AC common-mode output voltage, RMS max. | 12 | mV | |
| Transition time, 20-80% min. | 8 | ps | 3 |
| Output waveform | | | 4 |
| Steady-state voltage v_f , max. | 0.6 | V | |
| Steady-state voltage v_f , min. | 0.4 | V | |
| Linear fit pulse peak, min. | $0.8 \times v_f$ | V | |
| Normalized RMS linear fit error, max. | 0.037 | — | |
| Normalized coefficient step size, min. | 0.0083 | — | |
| Normalized coefficient step size, max. | 0.05 | — | |
| Pre-cursor full-scale range, min. | 1.54 | — | |
| Post-cursor full-scale range, min. | 4 | — | |

Transmitter electrical specifications at A, continued

| Parameter | Value | Units | Notes |
|---|-------|-------|-------|
| Output jitter | | | 5 |
| Even-odd jitter, max. | 0.035 | UI | |
| Effective deterministic excluding DDJ, max. | 0.15 | UI | |
| Effective random jitter, max. | 0.15 | UI | |
| Total jitter excluding DDJ, max. | 0.28 | UI | |

Linear fit pulse and equalizer parameters

| Parameter | Symbol | Value | Units |
|-------------------------|--------|-------|-------|
| Linear fit pulse length | N_p | 8 | UI |
| Linear fit pulse delay | D_p | 2 | UI |
| Equalizer length | N_w | 8 | UI |
| Equalizer delay | D_w | 2 | UI |

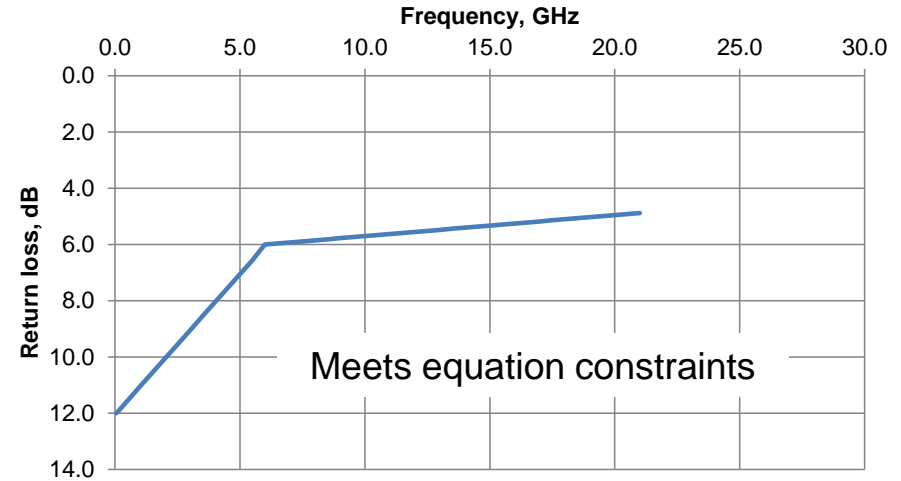
Notes

1. Signaling rate tolerance is ± 100 ppm
2. Definition required to support FC-EE
3. Output waveform parameters defined by FC-MSQS Clause 5
4. Transition time is defined by IEEE Std 802.3™-2012 86A.5.3.3
5. Jitter parameters are defined by IEEE P802.3bj/D1.4, 92.8.3.6

Transmitter and receiver return loss

- Transmitter differential return loss at A
- Receiver differential return loss at D

$$RL_d(f) \geq \begin{cases} 12.05 - f & 0.05 \leq f \leq 6 \\ 6.45 - 0.075f & 6 < f \leq 21 \end{cases}$$

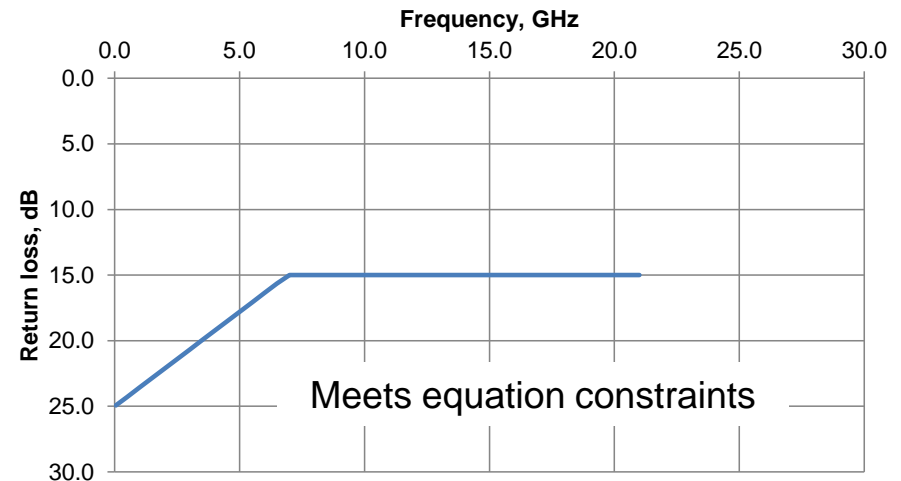


- Transmitter common-mode return loss at A

$$RL_{cm}(f) \geq 6 \text{ dB} \quad 0.05 \leq f \leq 21$$

- Receiver differential to common-mode return loss at D

$$RL_{cd}(f) \geq \begin{cases} 25 - 1.44f & 0.05 \leq f \leq 6.95 \\ 5 & 6 < f \leq 21 \end{cases}$$



Channel requirements

- Based on Channel Operating Margin (COM) as defined in IEEE P802.3bj/D1.4 Annex 93A
- COM shall be greater than or equal to 3 dB

Channel operating margin parameters

| Parameter | Symbol | Value | Units |
|--|------------|-------------------|-------|
| Signaling rate | f_b | 28.05 | GBd |
| Maximum start frequency | f_{\min} | 0.05 | GHz |
| Maximum step frequency | Δf | 0.01 | GHz |
| Package transmission line length | z_{tl} | 12 | mm |
| Device shunt parasitic capacitance | C_d | 0.25 | pF |
| Package-board interface shunt capacitance | C_b | 0.18 | pF |
| Transmitter differential peak output voltage | | | |
| Victim | A_v | 0.4 | V |
| Far-end aggressor | A_f | 0.6 | V |
| Near-end aggressor | A_n | 0.6 | V |
| Receiver -3dB bandwidth | f_r | $0.75 \times f_b$ | GHz |
| Transmitter equalizer, pre-cursor coefficient | $c(-1)$ | | |
| Minimum value | | -0.18 | — |
| Maximum value | | 0 | — |
| Step size | | 0.02 | — |
| Transmitter equalizer, post-cursor coefficient | $c(1)$ | | |
| Minimum value | | -0.38 | — |
| Maximum value | | 0 | — |
| Step size | | 0.02 | — |

Channel operating margin parameters, continued

| Parameter | Symbol | Value | Units |
|--|---------------|-----------|-------|
| Continuous time filter, DC gain | g_{DC} | | |
| Minimum value | | -12 | dB |
| Maximum value | | 0 | dB |
| Step size | | 1 | dB |
| Number of signal levels | L | 2 | — |
| Number of samples per unit interval | M | 32 | — |
| Decision feedback equalizer (DFE) length | N_b | 16 | UI |
| Normalized DFE coefficient magnitude limit | b_{max} | 1 | — |
| Random jitter, RMS | σ_{RJ} | 0.01 | UI |
| Dual-Dirac jitter, peak | A_{DD} | 0.07 | UI |
| Receiver additive Gaussian noise, RMS | σ_r | 1 | mV |
| Target detector error ratio | DER_0 | 10^{-6} | — |

Receiver signal tolerance

- Currently based on IEEE Std 802.3-2012 Annex 69A
- Likely to be revised in the future for tighter integration with COM channel specification methodology

Receiver signal tolerance parameters

| Parameter | Test 1 | Test 2 | Units | Notes |
|---|-----------|-----------|-----------------------|-------|
| Max. BER at receiver output | 10^{-6} | 10^{-6} | — | 1 |
| Channel insertion loss at 12.89 GHz | 16 | 30 | dB | 2 |
| a_0 , max. | 1 | 1 | dB | |
| a_1 , max. | 3.3 | 3.3 | dB/GHz ^{1/2} | |
| a_2 , max. | — | — | dB/GHz | |
| a_4 , max. | 0.022 | 0.031 | dB/GHz ² | |
| Applied sinusoidal jitter, peak-to-peak | 0.115 | 0.115 | UI | 3 |
| Applied random jitter, peak-to-peak | 0.15 | 0.15 | UI | 4 |
| Applied even-odd jitter | 0.035 | 0.035 | UI | |
| Applied broadband noise, RMS | TBD | TBD | mV | |

1. BER is measured prior to error correction by Reed-Solomon decoder.
2. See IEEE P802.3bj/D1.4 93A.2. For each test channel, a_0 is limited to a minimum value of -1 and a_1 , a_2 , and a_4 are limited to a minimum value of 0 . There is no maximum value specified for a_2 .
3. The frequency of the sinusoid must be greater than 100 MHz.
4. Random jitter is specified at a BER of 10^{-12} .

Summary

- First cut specifications for 32GFC operation over electrical backplanes were presented