Coupling attenuation and TCL requirement proposals for 100Base-T1L

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Agenda

- Requirements for 10Base-T1L
- Use case for 100Base-T1L
- EMC test description
- EMC discussion
- SNR Margin Analysis
- Proposal for TCL and coupling attenuation

Requirements for 10Base-T1L

- TCL requirements

Table 146–5—Differential-to-common-mode conversion

	Frequency (MHz)	E_1	E_2
TCL	$0.1 \le f \le 10$	≥ 50 dB	≥ 50 dB
TCL	$10 < f \le 20$	$\ge 50 - 20\log_{10}\left(\frac{f}{10}\right)$ dB	$\ge 50 - 20\log_{10}\left(\frac{f}{10}\right)$ dB

- Coupling attenuation

Table 146–6—Coupling attenuation

Frequency (MHz)	(dB)		
	E_1	E_2	E_3
0.1 to 20	≥ 50	≥ 50	≥ 60

TCL is defined for E1 and E2, Coupling attenuation for E1, E2 and E3.

Use case for 100Base-T1L

At the very beginning of the task force the use case of ‘motor feedback communication’ was introduced by Dayin Xu in xu_3dg_01_05252022.

It consists of a shielded AWG22 single twisted pair cable for up to 100m length.

The cable was described as a robust shielded cable with >85% braid coverage and foil shield to reduce the crosstalk from power wires to data wires and protect the signal integrity of the digital feedback communication.

EMC test description

In fischer_3dg_01_20220622 the EMC tests were described and discussed.

Afterwards beruto_3dg_01_20220711_noise_env took this information over to define the noise environment. Therein with 43dB TCL and a 10Vrms disturber a 400mV p-p differential signal can be expected.

In fischer_3dg_01_08172022 the cable and cabling capabilities to suppress differential and common mode noise was introduced as a list of choices.

EMC discussion

In xu_3dg_01_09132022 we got some EMC measurements of PWM noise and its induced differential noise, concluding that the differential signal can communicate reliably under PWM common mode noise when there is a robust shield design for the motor cable.

As an answer Schicketanz_3dg_01a_10122022 explained RL and coupling attenuation as key parameters, proposing the same values at the respective maximum frequency for dg as for cg.

EMC discussion

In a further update of 100BASE-T1L for motor feedback communication in xu_3dg_01a_1116_2022 the need of FEC was discussed and it was found that a 100m shielded AWG22 cable does not need this option but a link for 500m requires it.

SNR Margin Analysis

Tingting_3dg_01_18_01_2023 explains that for motor feedback communication, alien crosstalk noise is very small (as shown in xu_3dg_01a_1116_2022), therefore, it can be ignored.

For 100m motor feedback communication with negligible alien crosstalk, SNR margin is over 30dB and decreases with PAM level.

Proposal for TCL and coupling attenuation

As shown above, link segments in industrial areas may profit from good shielded cables to reduce common mode coupling of disturbing sources nearby, like power cables of motors but also for alien crosstalk of adjacent link segments.

Such environments are very common in the industrial area and shielded cables will help to run 100Base-T1L successfully.

Proposal for TCL and coupling attenuation

TCL

	Frequency (MHz)	E1	E2
TCL	0.1 ≤ f ≤ 31	50	50
TCL	31 < f ≤ 60	60-20*log(f/10)	60-20*log(f/10)

Coupling attenuation

	Frequency (MHz)	E1	E2	E3
Coupling attenuation	0.1 ≤ f ≤ 20	60	60	70
Coupling attenuation	20 < f ≤ 60	66-20*log(f/10)	66-20*log(f/10)	76-20*log(f/10)

Discussion