Cable and cabling capabilities to suppress differential and common mode noise

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Agenda

- Former documents
- Cable capabilities to suppress common mode noise
- Cable capabilities to suppress differential mode noise
- Cabling capabilities to suppress common mode noise
- Cabling capabilities to suppress differential mode noise
- What we might need
- Discussion

Former documents

- xu_3dg_01_05252022.pdf introduced a setup of a single data pair next to a PWM motor drive cable.
- fischer_3dg_01_20220622 analysed in discussion with an EMC lab which standards might be useful
- horrmeyer_3dg_01_20220713.pdf explained standard activities related to servo drives (connector)
- beruto_3dg_01_20220711_noise_env.pdf made some noise environment definitions

Former documents

- beruto_3dg_01_20220711_noise_env.pdf is considering a mode conversion loss of 43 dB, however, this was taken from 10Base-T1L and might be not sufficient for 100Base-T1L especially in this harsh environment (PWM for servo drives)

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

10Base-T1L defines only up to E2, a level of 44 dB@20 MHz

Cable capabilities to suppress common mode noise

The cable specification for 10Base-T1L is IEC 61156-13, for higher data rates IEC 61156-11 is considered for EMC capabilities.

For -13 only low frequency coupling attenuation (LFCA) is defined as the maximum frequency is 20 MHz, for -11 LFCA and coupling attenuation(CA) is defined.

Cable capabilities to suppress common mode noise

IEC 61156-13 LFCA (0.1-20 MHz; For MICE E3 at least Type Ib is required):

Type I: 85-10*log(f/30), 100 dB max.

Type Ib: 70-10*log(f/30), 85 dB max.

Type II: 55-10*log(f/30), 70 dB max.

Type III: 40-10*log(f/30), 55 dB max. (understood as UTP)

Cable capabilities to suppress common mode noise

IEC 61156-11 LFCA (0.1-30 MHz) and CA (30-1000 MHz);
For MICE E3 at least Type Ib is required:

LFCA has the same requirements as -13 but no Type III.
CA:

30-100MHz: Plateau X dB; 100-1000 MHz: X-20*log(f/100) dB; Type I: X= 85; Type Ib: X= 70; Type II: X= 55

Cable capabilities to suppress differential mode noise

IEC 61156-13 (0.1-20 MHz)

PS ANEXT: 40-17*log(f/20); Screened cables meeting the CA requirements of Type I or Type Ib, Alien Crosstalk requirements are proven by design.

PS AACR-F: 40-18*log(f/20); Screened cables meeting the CA requirements of Type I or Type Ib, Alien Crosstalk requirements are proven by design.

Cable capabilities to suppress differential mode noise

IEC 61156-11 (0.1-600 MHz)

PS ANEXT: Plateau X dB up to 100 MHz; 70-10*log(f/100); Screened cables meeting the CA requirements (minimum Type Ib) ANEXT is proven by design.

PS AACR-F: 98-20*log(f); Screened cables meeting the CA requirements (minimum Type Ib), PS AACR-F is proven by design.

Cabling capabilities to suppress common mode noise

ISO/IEC 11801-1 AMD1 (JTC1-SC25/3094/CD):

Coupling attenuation

T1-A (0.1-20 MHz): E1=54 dB; E2=64dB; E3=74dB

T1-B (0.1-600 MHz): Up to 20 MHz same as T1-A, above:
E1= 80-20*log(f); E2= 90-20*log(f); E3= 100-20*log(f)

Cabling capabilities to suppress differential mode noise

ISO/IEC 11801-1 AMD1 (JTC1-SC25/3094/CD)
PS ANEXT:
T1-A (0.1-20 MHz): 37.5-17*log(f/20)
T1-B (0.1-600 MHz): Up to 100MHz 60-10*log(f/100)
PS AACR-F (to 100m):
T1-A (0.1-20 MHz): 72-20*log(f)
T1-B (0.1-600 MHz): 77-20*log(f)
If coupling attenuation is above 60 dB for T1-A and 64 dB up to 20 MHz and 90-20*log(f) above for T1-B (E2 or better), PS ANEXT and PS AACR-F are met by design.

What we might need

1. Data pairs next to a PWM servo drives can be seen as a MICE E3 environment. Measurements have to show that this assumption is valid.
2. Proposals are given based on the assumption above
3. For E3 environments screened cables and cabling, PS ANEXT and PS AACR-F are met by design.

What we might need

CM suppression for cables propose at least Type Ib for E3 compliance, which is 70-10*log(f/30), 85dB max. for LFCA and at least 70 dB@100 MHz for CA.

In cabling E3 is defined as 74dB up to 20 MHz and 100-20*log(f) above. The cable specification is always above the cabling specification, as it should be.

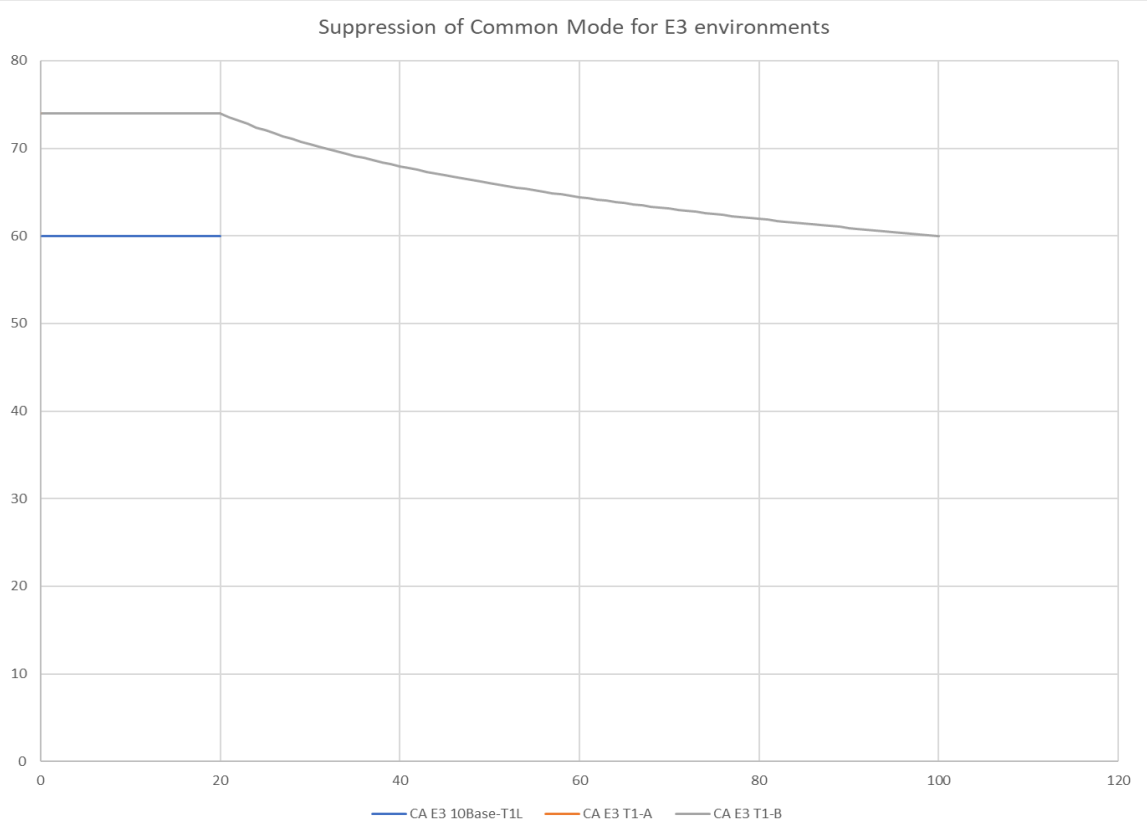
What we might need

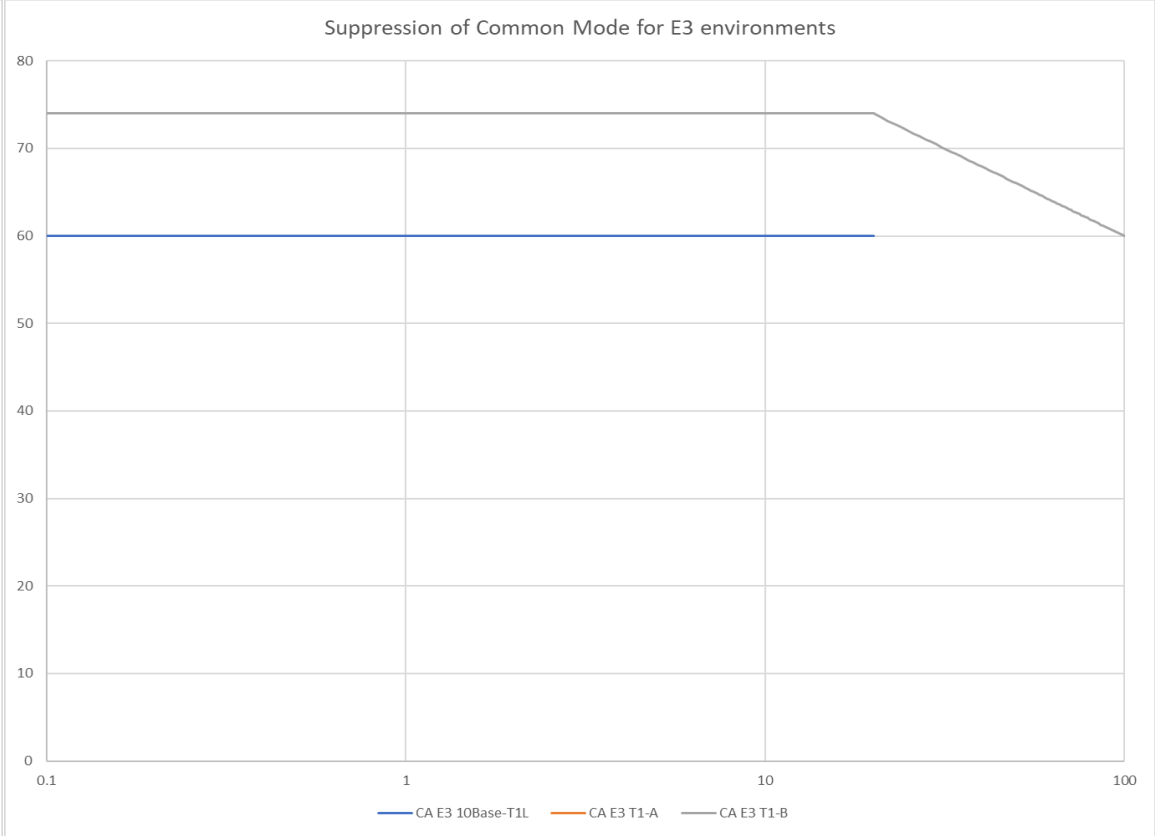
DM suppression for cables propose at least PS ANEXT: 40-17*log(f/20) and PS AACR-F: 40-18*log(f/20) for T1-A (up to 20 MHz). If cables meet the E3 requirements (minimum Type Ib), PS ANEXT and PS AACR-F are met be design.

For T1-B PS ANEXT has a Plateau up to 100 MHz; 70-10*log(f/100), PS AACR-F is 98-20*log(f).

For both parameters screened cables meeting the requirements of E3 (minimum Type Ib) are proven by design.

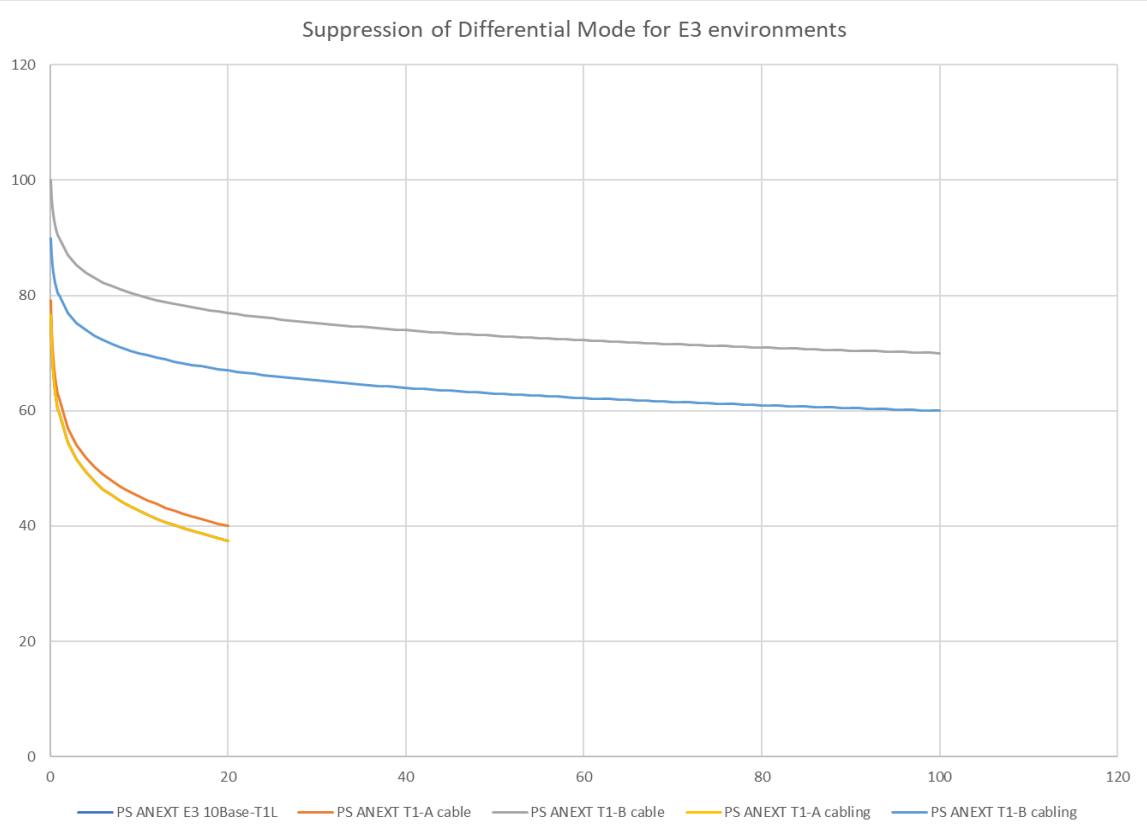
What we might need

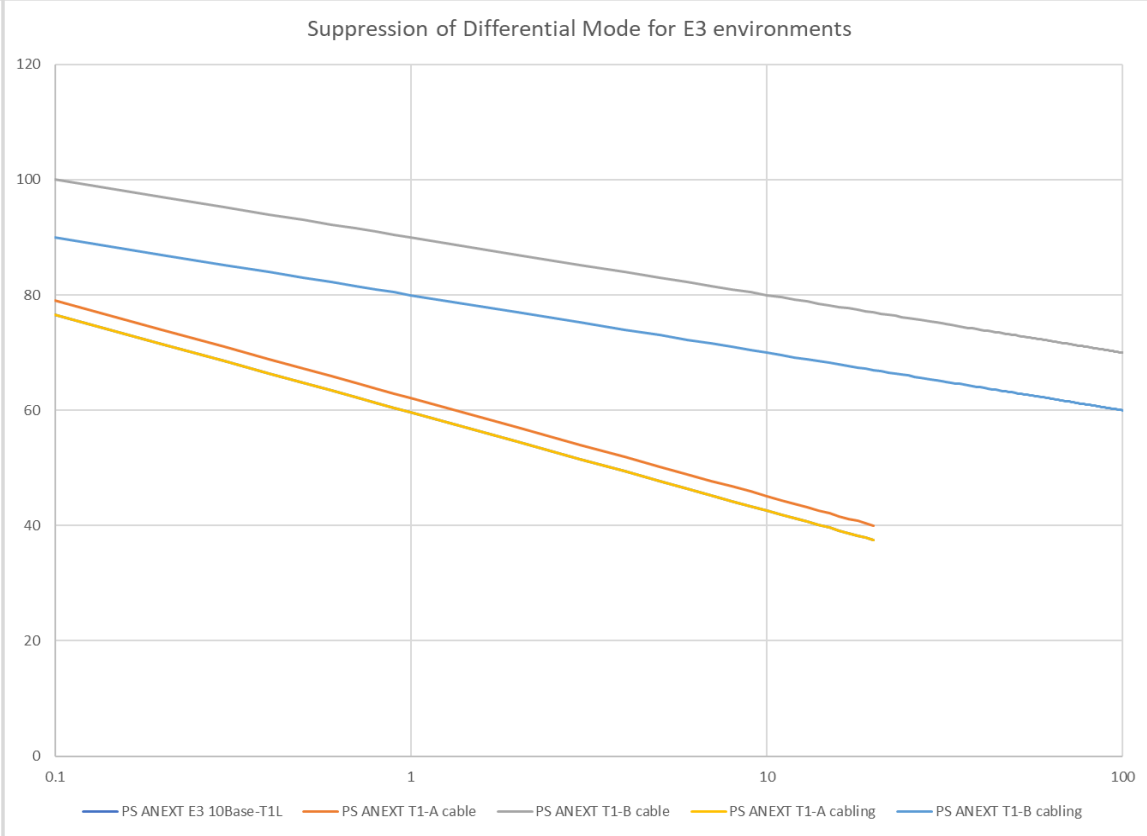




Common mode suppression for E3 environment

What we might need





Differential mode suppression (PS ANEXT) for E3 environment

Discussion

Backup information

IEEE 802.3 already references and specifies IEC coupling attenuation test procedures; e.g., IEC 62153-4-7 using the triaxial test fixture.

Coupling attenuation requirements prior to SPE, BASE-T PHYs relied on a form of coupling attenuation for unshielded cabling to assure common-mode noise rejection; the injection clamp method of 1000BASE-T was updated for 25G/40GBASE-T.

Backup information

SPE PHYs adopted IEC coupling attenuation test procedures:

- 1000BASE-T1 Type-B, references IEC 62153-4-14.
- 10BASE-T1L, includes low-frequency coupling attenuation requirements.
- MultiGBASE-T1, IEC 62153-4-7, using the triaxial test fixture.