

Cabling Transmission Parameters

Wayne Larsen CommScope

Supporters

- George Zimmerman, CME Consulting
- Paul Kish, Belden
- Jeff Poulsen, Leviton
- Anna An, Foxconn
- Thuyen Dihn, Pulse
- Peter Wu, Marvell
- Shadi AbuGhazaleh, Hubbell
- Andy Jimenez, Anixter

Outline

- NEXT
- PSNEXT
- ACRF
- PSACRF
- Delay
- Delay Skew
- Balance Parameters
 - TCL
 - ELTCTL

NEXT

Table 5 – Equations for pair-to-pair NEXT limits for a channel

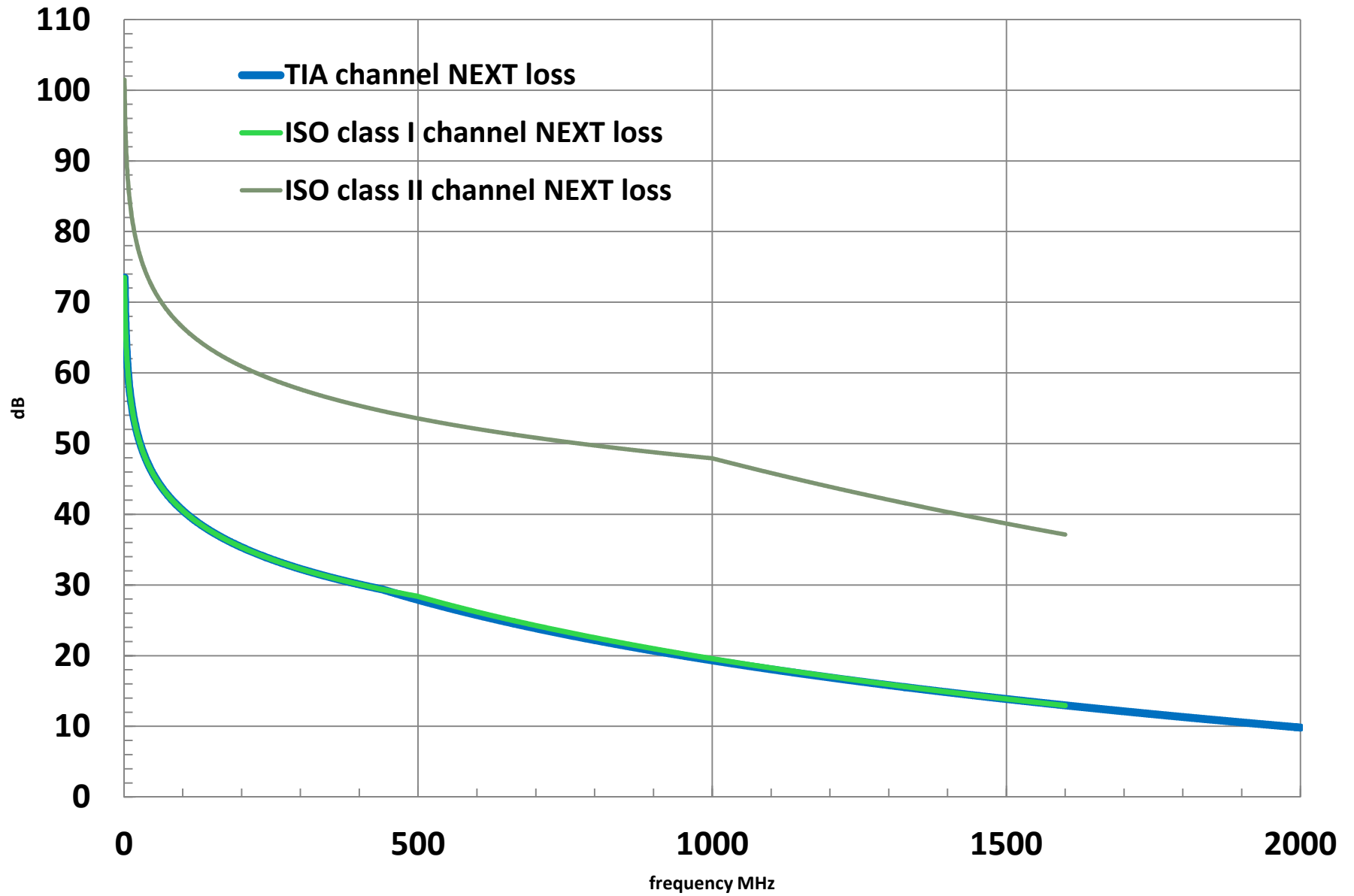
	Frequency MHz	Minimum NEXT dB
Class I	$1 \leq f \leq 500$	$-20 \lg \left(\frac{75,3 - 15 \lg(f)}{10} + \frac{94 - 20 \lg(f)}{2 \times 10} - 20 \right)$ <p>For measurements 65,0 ffs max</p>
	$500 < f \leq 1\ 600$ $1\ 600 < f \leq 2\ 000$ ffs	$-20 \lg \left(\frac{75,3 - 15 \lg(f)}{10} + \frac{40 - 38 \lg(f/500)}{2 \times 10} - 20 \right)$ <p>For measurements 65,0 ffs max</p>
Class II	$1 \leq f \leq 1\ 000$	$-20 \lg \left(\frac{105,4 - 15 \lg(f)}{10} + \frac{116,3 - 20 \lg(f)}{2 \times 10} - 20 \right)$ <p>For measurements 65,0 ffs max</p>
	$1\ 000 < f \leq 1\ 600$ $1\ 600 < f \leq 2\ 000$ ffs	$-20 \lg \left(\frac{105,4 - 15 \lg(f)}{10} + \frac{56,3 - 60 \lg(f/1000)}{2 \times 10} - 20 \right)$ <p>For measurements 65,0 ffs max</p>

Table 9 - Channel NEXT loss

	Frequency (MHz)	NEXT loss (dB) ¹
Category 8	$1 \leq f \leq 440$	$-20 \lg \left(\frac{(45,3 - 15 \lg(f/100))}{10} + \frac{(54 - 20 \lg(f/100))}{2 \cdot 10} - 20 \right)$
	$440 < f \leq 2000$	$-20 \lg \left(\frac{(45,3 - 15 \lg(f/100))}{10} + \frac{(39,12 - 36,14 \lg(f/500))}{2 \cdot 10} - 20 \right)$

1 Calculations that result in category 8 channel NEXT loss values greater than 65 dB shall revert to a requirement of 65 dB minimum.

NEXT



NEXT

- TIA limit up to 0.5 dB lower than ISO in the middle range
- Choose TIA.

PSNEXT

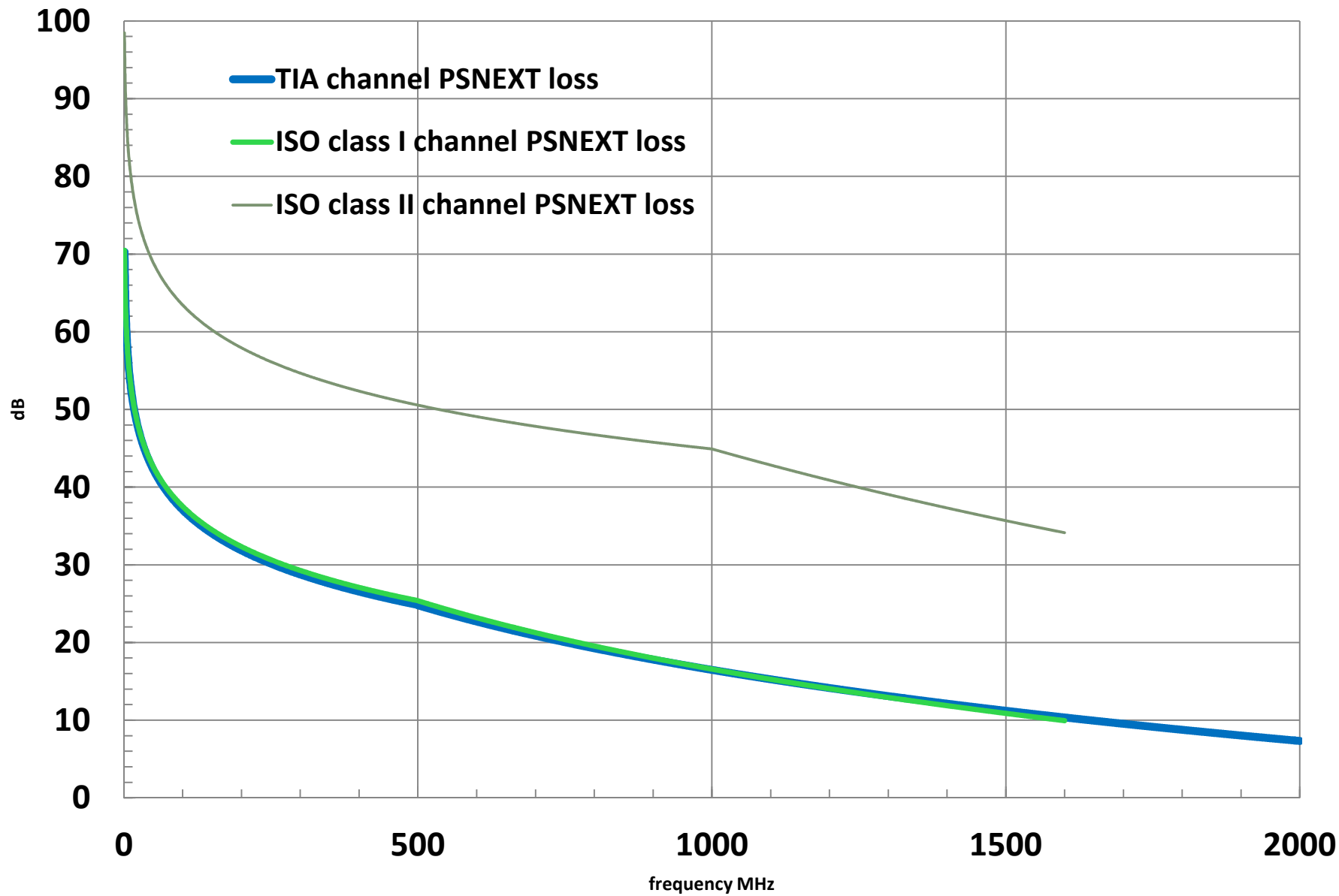
Table 7 – Equations for PS NEXT limits for a channel

	Frequency MHz	Minimum PS NEXT dB
Class I	$1 \leq f \leq 500$	$-20 \lg \left(\frac{72,3 - 15 \lg(f)}{10^{-20}} + 2 \times 10^{\frac{91 - 20 \lg(f)}{-20}} \right)$ <p>For measurements 62,0 ffs max</p>
	$500 < f \leq 1\ 600$ $1\ 600 < f \leq 2\ 000$ ffs	$-20 \lg \left(\frac{72,3 - 15 \lg(f)}{10^{-20}} + 2 \times 10^{\frac{37 - 38 \lg(f/500)}{-20}} \right)$ <p>For measurements 62,0 ffs max</p>
Class II	$1 \leq f \leq 1\ 000$	$-20 \lg \left(\frac{102,4 - 15 \lg(f)}{10^{-20}} + 2 \times 10^{\frac{113,3 - 20 \lg(f)}{-20}} \right)$ <p>For measurements 62,0 ffs max</p>
	$1\ 000 < f \leq 1\ 600$ $1\ 600 < f \leq 2\ 000$ ffs	$-20 \lg \left(\frac{102,4 - 15 \lg(f)}{10^{-20}} + 2 \times 10^{\frac{53,3 - 60 \lg(f/1000)}{-20}} \right)$ <p>For measurements 62,0 ffs max</p>

Table 11 - Channel PSNEXT loss

	Frequency (MHz)	PSNEXT loss (dB) ¹
Category 8	$1 \leq f \leq 500$	$-20 \lg \left(\frac{(42,3 - 15 \lg(f/100))}{10^{-20}} + 2 \cdot 10^{\frac{(50,0 - 20 \lg(f/100))}{-20}} \right)$
	$500 < f \leq 2000$	$-20 \lg \left(\frac{(42,3 - 15 \lg(f/100))}{10^{-20}} + 2 \cdot 10^{\frac{(35,95 - 34,85 \lg(f/500))}{-20}} \right)$
¹ Calculations that result in category 8 channel PSNEXT loss values greater than 62 dB shall revert to a requirement of 62 dB minimum.		

PSNEXT



PSNEXT

- TIA up to 0.6 dB lower in the middle
- ISO up to 0.4 dB lower near 1600 MHz
- TIA extends to 2000 MHz
- Choose TIA

ACRF

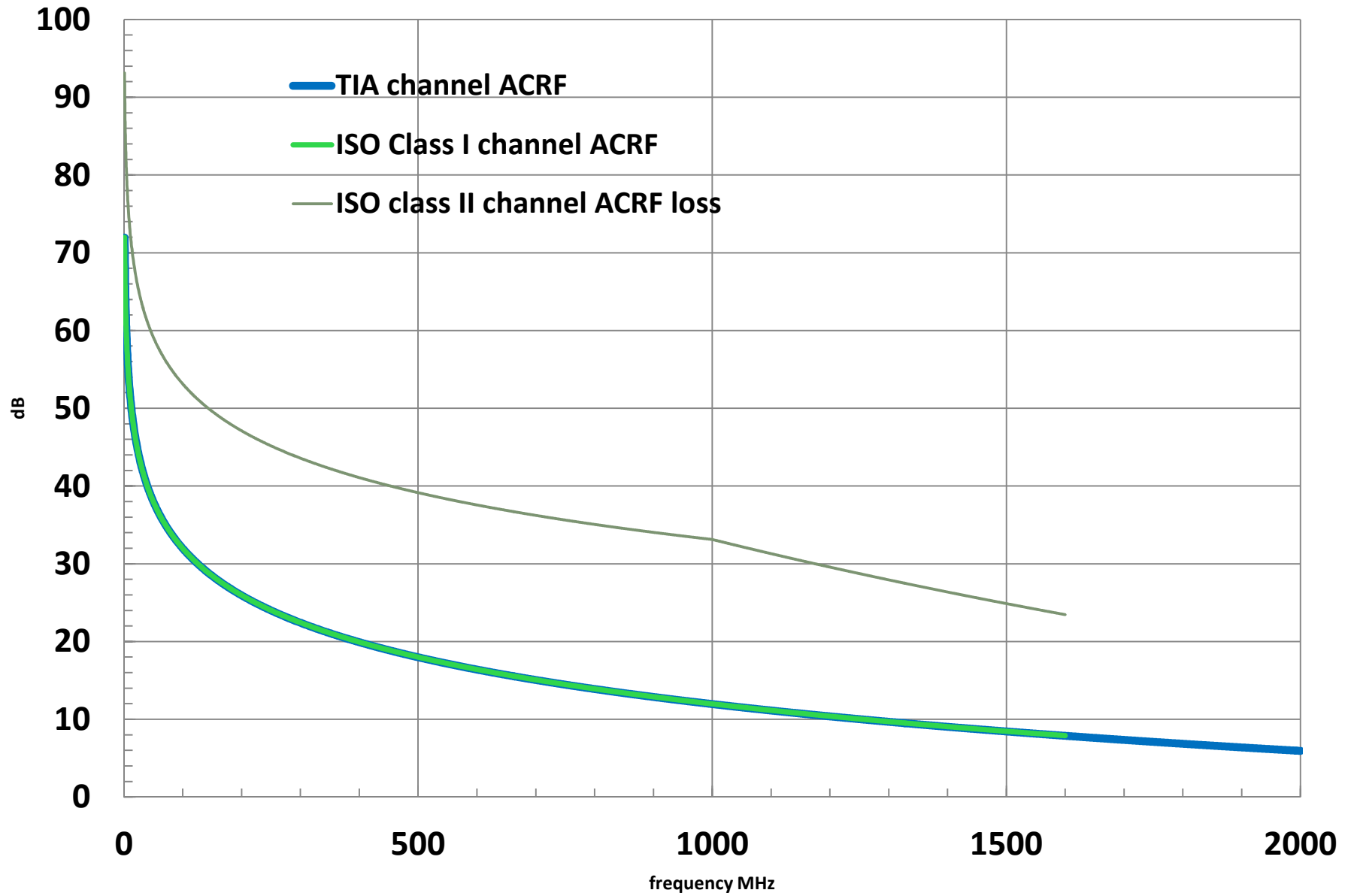
Table 9 – Equation for ACR-F limits for a channel

	Frequency MHz	Minimum ACR-F dB
Class I	$1 \leq f \leq 1\,600$ $1\,600 < f \leq 2\,000$ ffs	$-20 \lg \left(\sqrt{0,8 \cdot 10} \frac{76,8 - 20 \lg(f)}{-20} + 2 \cdot 10 \frac{83,1 - 20 \lg(f)}{-20} \right)$ For measurements 65,0 ffs max
	$1 \leq f \leq 1\,000$	$-20 \lg \left(\sqrt{0,8 \cdot 10} \frac{98,4 - 20 \lg(f)}{-20} + 2 \cdot 10 \frac{103,9 - 20 \lg(f)}{-20} \right)$ For measurements 65,0 ffs max
Class II	$1\,000 < f \leq 1\,600$ $1\,600 < f \leq 2\,000$ ffs	$-20 \lg \left(\sqrt{0,8 \cdot 10} \frac{98,4 - 20 \lg(f)}{-20} + 2 \cdot 10 \frac{43,9 - 60 \lg(f/1000)}{-20} \right)$ For measurements 65,0 ffs max
The term 0,8 is to calculate the cable part of the channel formula for 30 m while the cable definition refers to 50 m.		
ACR-F limits at frequencies that correspond to measured values of FEXT greater than 70 dB (ffs) shall be for information only.		

Table 13 - Channel ACRF

	Frequency (MHz)	ACRF (dB) ¹
Category 8	$1 \leq f \leq 2000$	$-20 \lg \left(10 \frac{(39,0 - 20 \cdot \log(f/100))}{-20} + 2 \cdot 10 \frac{(43,1 - 20 \cdot \log(f/100))}{-20} \right)$
1 Calculations that result in category 8 channel ACRF loss values greater than 65 dB shall revert to a requirement of 65 dB minimum.		

ACRF / ELFEXT



ACRF

- These are not any different in the calculated results

PSACRF

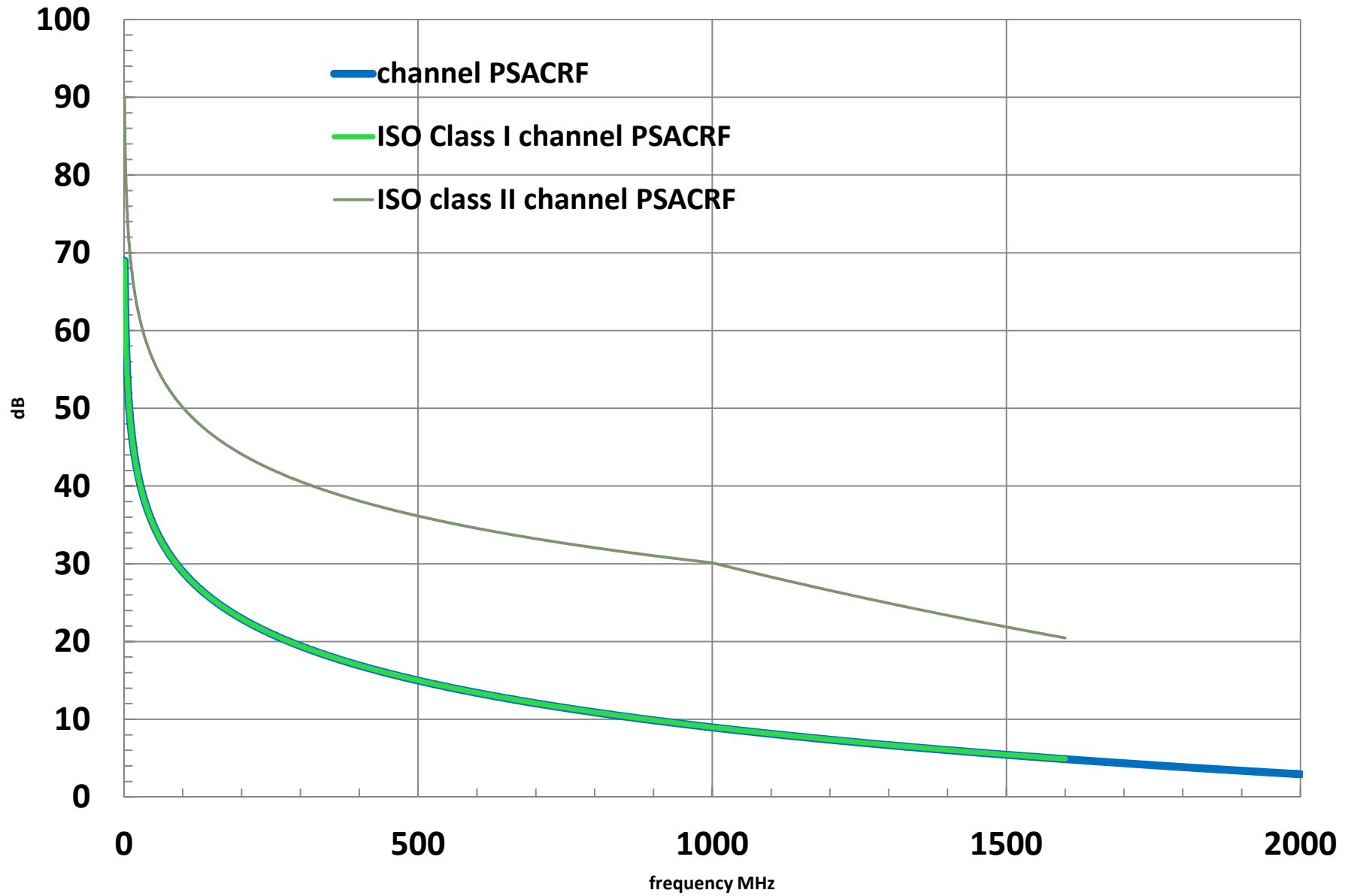
Table 11 – Equations for PS ACR-F limits for a channel

	Frequency MHz	Minimum PS ACR-F dB
Class I	1 ≤ f ≤ 1 600 1 600 < f ≤ 2 000 ffs	$-20 \lg \left(\sqrt{0,8 \cdot 10} \frac{73,8 - 20 \lg(f)}{-20} + 2 \times 10 \frac{80,1 - 20 \lg(f)}{-20} \right)$ <p>For measurements 62 ffs max</p>
	1 ≤ f ≤ 1 000	$-20 \lg \left(\sqrt{0,8 \cdot 10} \frac{95,4 - 20 \lg(f)}{-20} + 2 \times 10 \frac{100,9 - 20 \lg(f)}{-20} \right)$ <p>For measurements 62 ffs max</p>
Class II	1 000 < f ≤ 1 600 1 600 < f ≤ 2 000 ffs	$-20 \lg \left(\sqrt{0,8 \cdot 10} \frac{95,4 - 20 \lg(f)}{-20} + 2 \times 10 \frac{40,9 - 20 \lg(f/1000)}{-20} \right)$ <p>For measurements 62 ffs max</p>
<p>The term 0,8 is to calculate the cable part of the channel formula for 30 m while the cable definition refers to 50 m.</p>		
<p>PSACRF limit at frequencies that correspond to calculated values of PS FEXT greater than 67 dB (ffs) shall be for information only.</p>		

Table 15 - Channel PSACRF

	Frequency (MHz)	PSACRF (dB) ¹
Category 8	1 ≤ f ≤ 2000	$-20 \lg \left(10 \frac{(36,0 - 20 \lg(f/100))}{-20} + 2 \cdot 10 \frac{(40,1 - 20 \lg(f/100))}{-20} \right)$
<p>¹ Calculations that result in category 8 channel/ACRF loss values greater than 62 dB shall revert to a requirement of 62 dB minimum.</p>		

PSACRF / PSELFEXT



PSACRF

- These also are not any different in the calculated results

Delay

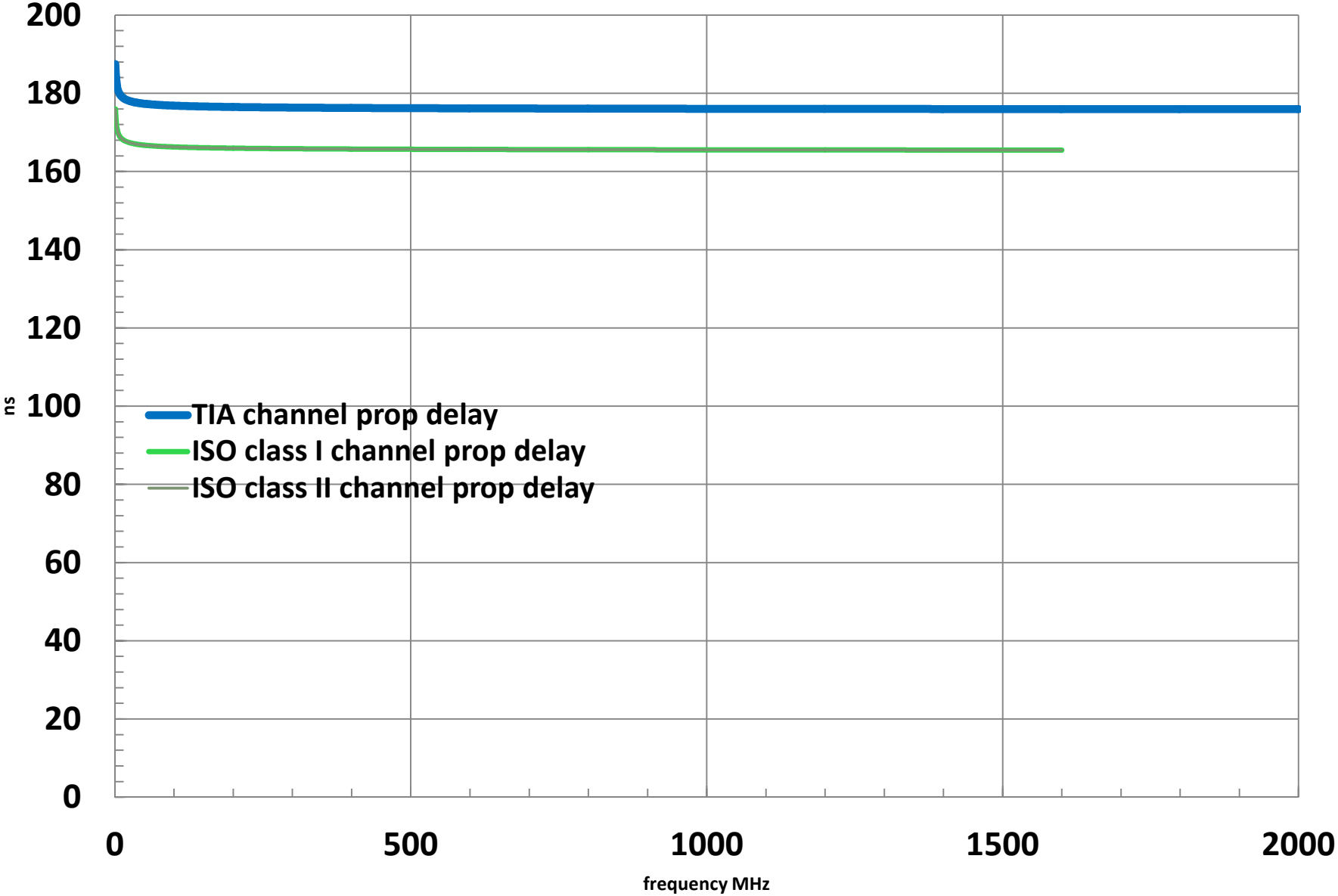
Table 17 – Equations for propagation delay limits for a 30 m channel

	Frequency MHz	Maximum propagation delay µs
Class I Class II	$1 \leq f \leq 1\,600$ $1\,600 < f \leq 2\,000$ ffs	$0,3 \times \left[0,534 + 0,038 / \sqrt{f} \right] + 2 \times 0,0025$

Table 23 - Channel propagation delay

	Frequency (MHz)	Propagation delay (ns)
Category 8	$1 \leq f \leq 2000$	$32 / 30 \left(160 + \frac{11}{\sqrt{f}} \right) + (2 \times 2.5)$

delay



Delay

- ISO results in 165 ns maximum
- TIA results in 176 ns maximum
- Choose TIA to include all cabling options

Delay skew

Table 19 - Delay skew limits for a 30 m channel

Class	Maximum delay skew ^{a,b} for 1 MHz < f < 1 600 MHz µs
Class I	0,018
Class II	0,010

^a Calculation is based on $0,045 \cdot 0,3 + 2 \times 0,001$ 25 Class I
Calculation is based on $0,025 \cdot 0,3 + 2 \times 0,001$ 25 Class II

^b Skew between any two channel pairs due to environmental conditions shall not vary by more than 3 ns within the channel delay skew requirement (this is met by design)

6.2.20 Channel propagation delay skew

Channel propagation delay skew for category 8 channels shall be less than 17 ns for all frequencies from 1 MHz to 2000 MHz. The delay skew of any given category 8 channel shall not vary by more than +/- 3 ns

Delay skew

- ISO is 16 ns maximum
- TIA is 17 ns maximum
- Choose 17 ns to include all cabling

Balance parameters - TCL

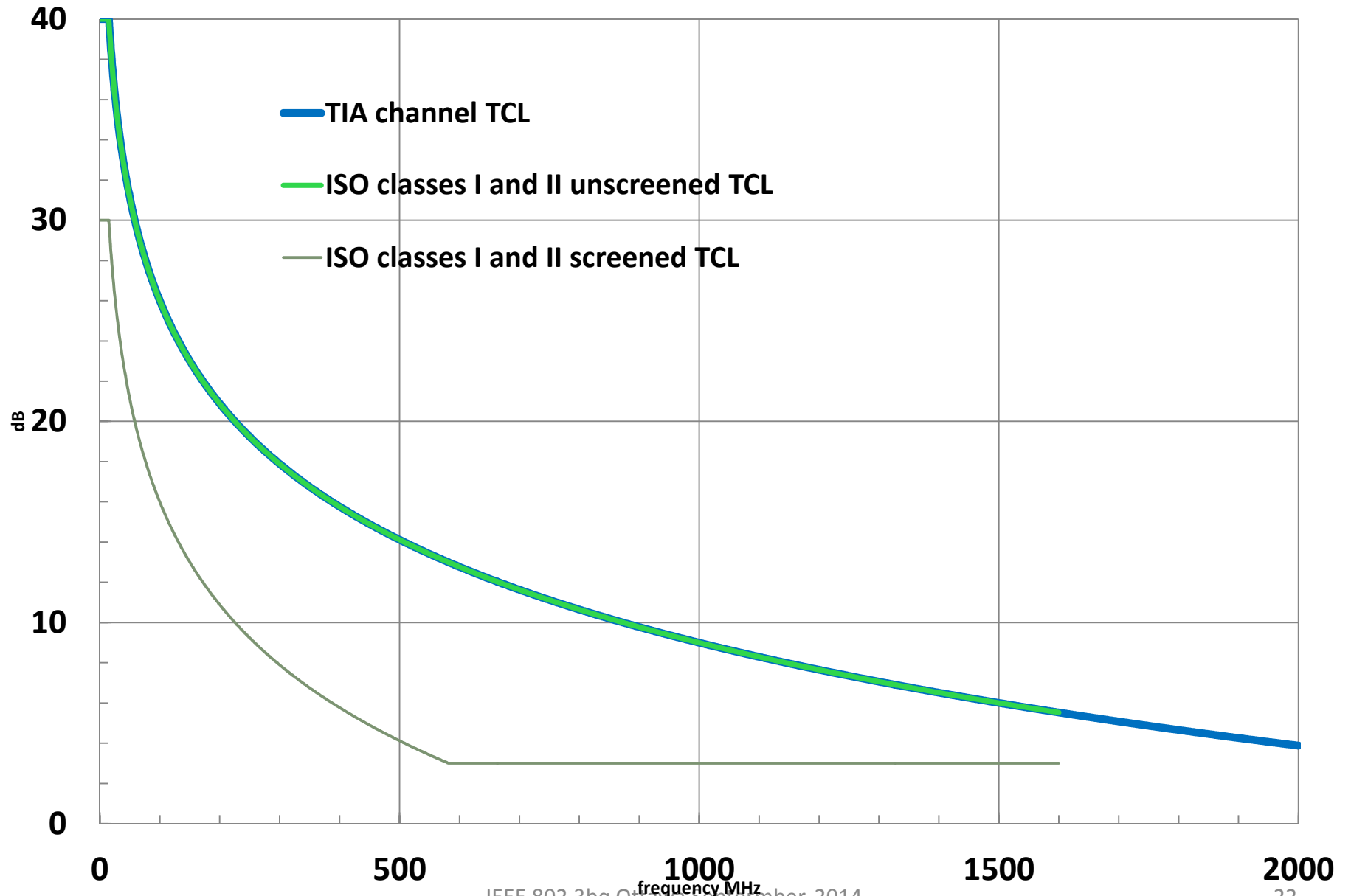
Table 20 – TCL for a channel

Frequency MHz	Minimum TCL for Class I and Class II dB	
	Channels using cables with unscreened pairs	Channels using cables with screened pairs
$1 \leq f \leq 1\,600$ $1\,600 < f \leq 2\,000$ ffs	$60 - 17 \lg(f)$ ffs 40,0 max	$50 - 17 \lg(f)$ ffs 30,0 max, 3,0 min

Table 17 - Channel TCL

	Frequency (MHz)	TCL (dB) ¹
Category 8	$1 \leq f \leq 2000$	$26 - 17 \log(f/100)$ (TBD)
1 Calculations that result in category 8 channel TCL values greater than 40 dB shall revert to a requirement of 40 dB minimum.		

TCL



TCL

- Balance parameters TCL and TCTL should be added to protect the PHY from harmful noise conversion from common mode
- No difference between TIA cat 8 and ISO unscreened
- ISO screened (class I or class II) is lower
- Choose the ISO screened equation to include all cabling

ELTCTL

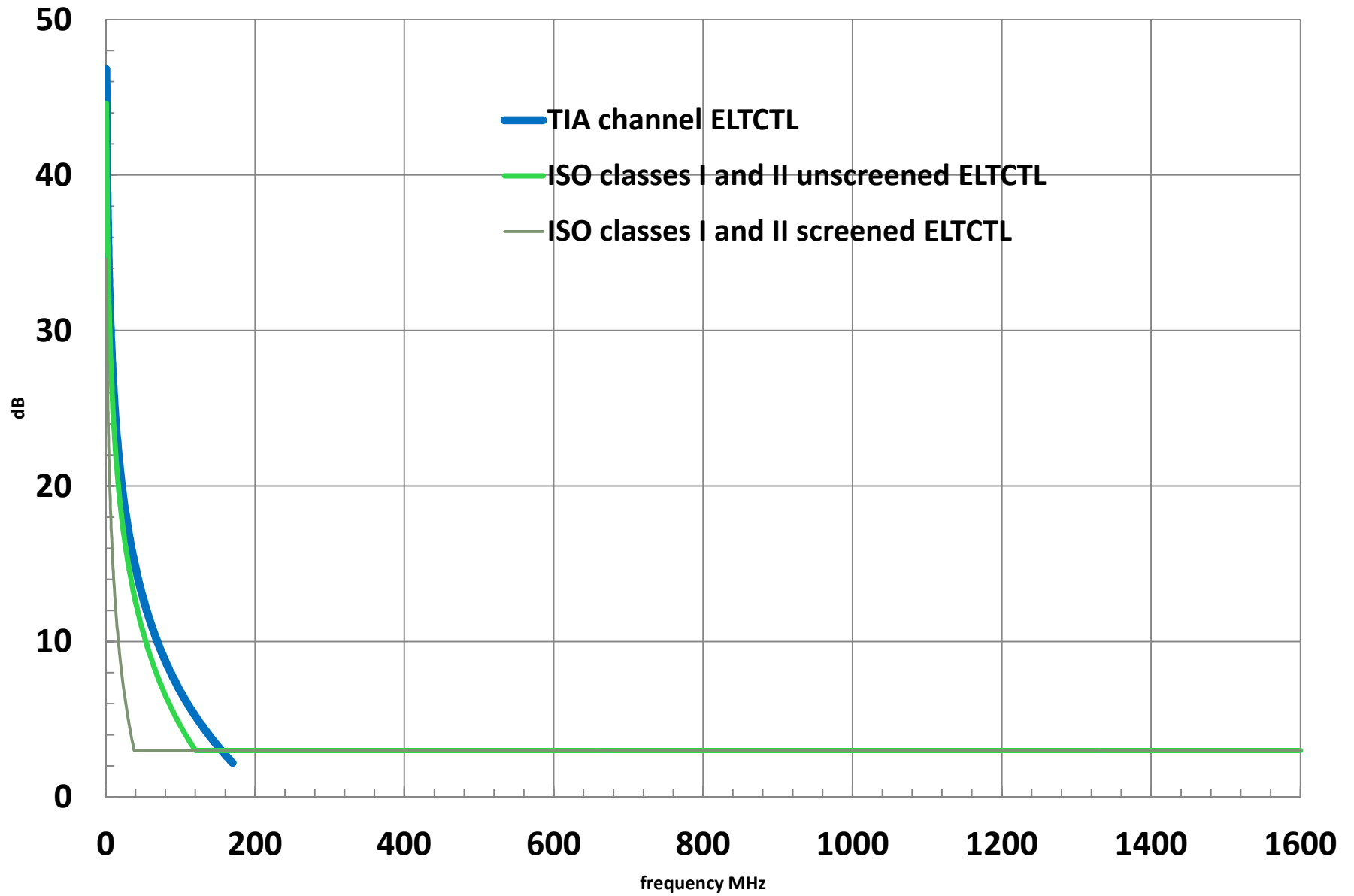
Table 22 – ELTCTL for a channel

Frequency MHz	Minimum ELTCTL for Class I and Class II dB	
	Channels using cables with unscreened pairs	Channels using cables with screened pairs
$1 \leq f \leq 1\,600$ $1\,600 < f \leq 2\,000$ ffs	$44,6 - 20\lg(f)$ ffs 3,0 min	$34,6 - 20\lg(f)$ ffs 3,0 min

Table 19 - Channel ELTCTL

	Frequency (MHz)	ELTCTL (dB)
Category 8	$1 \leq f \leq 170$	$46.8 - 20\lg(f)$ (TBD)
	$170 < f \leq 2000$	N/A (TBD)

ELTCTL



ELTCTL

- Balance parameters TCL and TCTL should be added to protect the PHY from harmful noise conversion from common mode
- Choose the ISO screened to include all cabling
- Not to worry about specification less than 3 dB